Department of Chemical Engineering

On 28-02-2020, CBIT signed MoU with M/s. CSIR-Indian Institute of Chemical Technology, Hyderabad to work in Partnership for R&D projects, Training programs/ Workshops, Research and Capacity Building programs including Certification programs.

S.N	**Name of Faculty**	**Title of the project**	**Funding agencies**	**Year**	**Funding amount (in Rs. Lacs)**	**Status**	**Role**
1	Harsha Nagar	Novel cost-effective water treatment tap filter for household applications	TSCOST	2019 - 2020	4.5	Submitted	PI
2	Harsha Nagar	Biochar based controlled release nitrogen fertilizers with Reduced Nitrogen leaching, volatilization and N_2O emissions	TSCOST	2019 - 2020	5	Submitted	CO-PI
3	Harsha Nagar	An Integrated Biorefinery approach for Valorization of waste Marigold flowers.	DST	2019 - 2020	27.63	Submitted	PI
4	Harsha Nagar	Post-Harvest Green Wastes Valorization as a Sustainable Source of Fuels, Nutraceuticals, Biomaterials and Chemicals	DST International call for Proposal	2019 - 2020	22.8	Submitted	PI
5	Harsha Nagar	Process scale up for conversion of plastic waste to generator fuel, paver block/brick and plastic granules with process wastewater treatment	DST WMT	2020 - 2021	32.01	Submitted	PI

Joint Publications = 03

S. No	Author's Name, Title of Paper, Journal Name, Volume, issue and Year.	DOI	Impact Factor	Scopus Indexed
	Harsha Nagar, Vineet Aniya, P. Mondal, High proton conductivity dual modified ionic crosslink membrane for fuel cell application at low humidity condition with molecular dynamics simulations. Renewable Energy. 160, 2020, 1036-1047.	https://doi.org/10.1016/j.renene.2020.06.026	6.274	Elsevier
	Harsha Nagar, Vineet Aniya, Microporous Material Induced Composite Membrane with Reduced Oxygen Leakage for MFC Application. Journal of Environmental Chemical Engineering, 8, 5, 2020, 104117	https://doi.org/10.1016/j.jece.2020.104117	4.3	Elsevier

	Abhilash Reddy, **Harsha Nagar**, Bankupalli Satyavathi, Vineet Aniya (2020) Phase equilibria and thermophysical properties of dibromomethane: Measurement and correlation studies. Journal of Molecular liquids, 306, 2020,11297.	https://doi.org/10.1016/j.molliq.2020.112917	5.065	Elsevier

International Conferences: 02

- Saranya Ch, Harsha Nagar, Vineet Aniya, Raja Rao, Biochar Valorization for Kitchen Wastewater Treatment through Microbial Fuel Cell, CHEMCON 2020, 129.

- Naresh Kathula, Dhiraj Ingle, Rakesh Velagala, Alka Kumari , Harsha Nagar , Vineet Aniya, Selective Hydrogenation of 2-Furoic Acid to Tetrahydro-2-Furoic Acid Over Heterogeneous Catalyst, CHEMCON 2020, 195.

Department of Chemical Engineering

On 07-01-2021, CBIT signed MoU with M/s. Green Waves Environmental Solutions (GWES), Vishakhapatnam with the aim to Joint working on Research Projects, Start-up Creation, and Internship Program for students.

Activities Report

1) Mr. Anil, M.D, delivered Invited talk for students and staff of Chemical Engg Dept., CBIT on 25-11-2020.
2) Mr. Anil, M.D, was honoured by CBIT as Outstanding Alumnus of Chemical Engg Dept on 25-12-2020
3) Mr. Anil and Mr. Aditya Madhav, were co-supervisors for UG collaborative research project on Design of aromatic industry with floral waste as raw material, to K. Nagaraju (160116802308) and P. Venkatesh Nayak (160116802310), TWO final year students of Chemical Engg Dept., CBIT, during AY 2020-21.
4) Mr. Anil and Mr. Aditya Madhav, were co-supervisors for UG collaborative research project on Replenishing the earth - Biocomposting of dry green waste, to P. Sri Tanmayee (160118802011) and M. Bhanu Prakash (160118802018), TWO final year students of Chemical Engg Dept., CBIT during AY 2021-22
5) Mr. Aditya Madhav was Judge for technical session during CHEMSPARK-2022 on 24-03-2022
6) Mr Anil was mentor and supervisor for two teams (IV sem students) to present at Ideathon 2023 by ACIC-CBIT on 25-04-2023.

HOD – Chemical Engg Dept., CBIT

Chaitanya Bharathi Institute of Technology (A), Gandipet, Hyderabad - 075

Chemical Engineering Department

ARIIA Event-3 November 2020

1) **Invited expert lecture - 3**

Objective of the lecture:

In this era of technological gadgets, to understand the impact of e-waste on the depletion of our natural resources and the role of today's youth and chemical engineers in exploring and adapting the various possibilities to convert e-waste into cost-effective usable products.

Topic:

"**E-Waste Management**"

Date (Day) and time: 25-11-2020 (Wednesday) from 11:00 AM to 12:10 PM (PED Slot)

Online-ZOOM Platform for faculty and B.Tech Sem-VII (4th year) students

Speaker details:

Mr. Anil Potluri
(Dept. Alumnus – 2010 batch)
Managing Director, Green Waves Environmental Solutions,
(First Authorized E - waste collection and handling unit),
Visakhapatnam, Andhra pradesh
Email: anil@greenwavesrecyclers.in
Mobile: +91 – 7093351666

Organised by:

Faculty coordinators:

1) Dr. Ravindra Pogaku, Professor & Head
2) Dr. Naga Prapurna P V, Associate Prof.,
3) Dr. B.Ganesh, Assistant Prof. & Class teacher

Student Coordinators:

1) Hanusha Durisetty
2) Phanindra Gupta
3) Rithusha Kamma

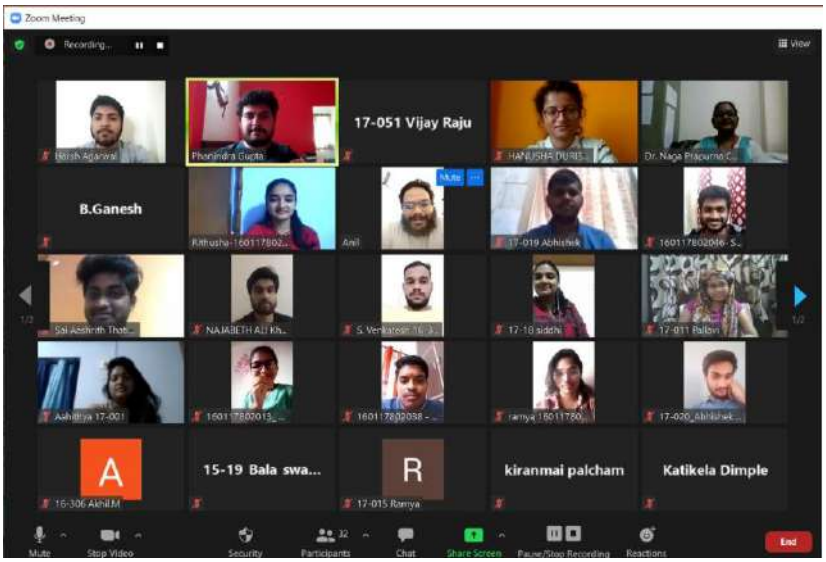
Attendance:

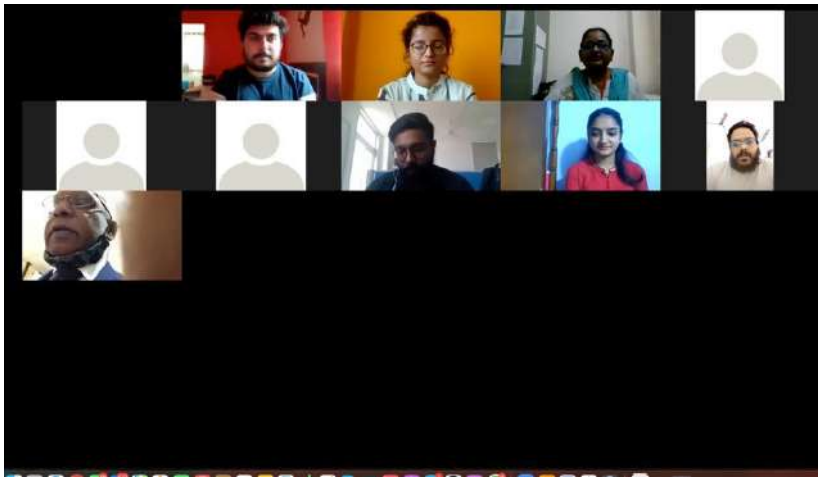
Faculty attended = 7
Students present = 43

Outcomes of the lecture:

Innovation and development in the field of science and technology and an open global market resulted in availability of a range of electronic products at affordable prices, changing the very lifestyle of societies. Their safe disposal is a challenge and includes dismantling, segregation and recycling into preparation of pencils, simple jewellery to bags.

Event photos:





Brief note:

The importance of e-waste management involves different methods for recycling or for disposing. Tracing the path of recycled electronic products is considerably more complicated.

For example:

- CIRCUIT BOARDS -Most circuit boards and some hard drives can be marketed for resale as operational parts. Unusable circuit boards are chopped into a powder and separated into fiberglass, metals
- PLASTIC HOUSINGS -plastic housings on computers and monitors will not fit on newer equipment.
- SMALL PLASTIC COMPONENTS The small plastic parts inside computers are typically made from uniform-colored, high density polyethylene (HDPE). This makes them easier to remove, grind, and process. It must be taken a great care not to mix other materials (e.g., metals) or different resins in with these plastics
- SCREWS, CLIPS, SMALL METAL PARTS Screws, clips, and small metal components are sorted and separated magnetically into ferrous and nonferrous groups. The metals are sold as scrap.

The company, Green Waves Environmental Solutions is a start-up that focused on collecting the e-waste, its safe storage, dismantling, extraction, segregation, recycle or reassemble into simple useful products.

C.B.I.T
E-MAIL & WEB SERVICES

Dr.P.V.Naga Prapurna Associate Prof. <nagaprapurna_chem@cbit.ac.in>

Reg: Sudhee-Chemspark2k22 Invitation Letter

2 messages

CBIT CHEMSPARK 2K22 <chemspark2k22@gmail.com> Tue, Mar 22, 2022 at 2:19 PM
To: aditya.madhav@gmail.com, balakrishna i <ibk@cbit.ac.in>, "Dr.B.Ganesh Assistant Professor" <bganesh_chem@cbit.ac.in>, "Dr.P.V.Naga Prapurna Associate Prof." <nagaprapurna_chem@cbit.ac.in>, Harsha Nagar <harshanagar_chem@cbit.ac.in>, "prasannarani_chem Asst. Professor" <prasannarani_chem@cbit.ac.in>, pydimalla madhuri <pmadhuri_chem@cbit.ac.in>, "Sri K.Prasad Babu Assistant Professor" <kprasadbabu_chem@cbit.ac.in>, Swapna V <vswapna_chem@cbit.ac.in>, balutumma@gmail.com

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

CHEMICAL ENGINEERING DEPARTMENT
SUDHEE-CHEMSPARK 2022
A National Level Technical Symposium: 23rd & 24th March 2022

Dear All,
Warm greetings!!!

Our department is organizing a two day National level Technical symposium, **CHEMSPARK 2022** on **23rd & 24th March.** This national level technical event serves as a platform for not only Chemical Engineering but all allied discipline students to present their work and interact with the peer community. The Chemical Engineering field envisages tremendous technology upgrades in different sectors. This event is an endeavor to educate on such technologies through Paper, Poster, Idea presentations and technical quiz.
In this regard, we invite you to spare your valuable time to evaluate the following technical sessions:

Date	Time	Technical session	Judges
23rd March	1:35 to 3:00 PM	Oral presentation session-I	Mr. N Aditya Madhav Dr. B. Ganesh
		Oral presentation session-II	Dr. Bala Narsaiah T Dr. P. Madhuri
24th March	10:00-11:30 AM	Oral presentation session-III	Ms. T. Sindhuja Dr. V. Swapna
		Poster presentation	Mr. Jagadishwar Ausala Dr. P. V. Naga Prapurna
	11:55-12:55 PM	Idea presentation	Dr. R. Prasanna Rani Dr. K. Prasad Babu
	1:35-3:00 PM	Technical Quiz	Sir. I. Balakrishna Dr. Harsha Nagar

Thanking You,
With Best Regards

Dr. P. V. Naga Prapurna **Sri. I. Balakrishna** **Dr. K. Prasad Babu**

HOD, Chairman

Convener Co-ordinator

Chemical Engineering Department
Outstanding Alumni Awardee on 25-12-2020

As part of Institute Alumni meet “Rejoicing Reunion”, the department communicates to all the alumni and invite them to alumni meet on 25th Dec every year to celebrate alumni success, strengthen the bond and evolve ways as to form mutual beneficial relationships. The institute selects and honors its Alumni for their contributions to the department and institute.

Mr. ANIL POTLURI (Batch: 2011)
Managing Director of Green Waves Environmental Solutions, Hyderabad

HoD – Chemical Engg

Department of Chemical Engineering

On 27-01-2021, CBIT signed MoU with M/s. Biosephia Engineering Services (BES), Hyderabad with the aim to Joint working on Research Projects, Start-up Creation, and Internship Program for students.

Activities Report

1) Mr. Himanshu, M.D, was honoured by CBIT as Outstanding Alumnus of Chemical Engg Dept on 25-12-2021
2) Ms. Sindhuja was Guest of honour and session chair during SUDHEE CHEMSPARK-2022 on 24-02-2022
3) Ms. Sindhuja delivered Invited talk on “Circular Economy & Sustainability and Internship
4) Opportunities at Biosephia” to for students and staff of Chemical Engg Dept., CBIT on 21-06-2022.
5) Ms. Sindhuja and Mr. Himanshu were internship supervisors for 14 students, during 2022-23
6) Ms. Sindhuja is Member, Department Advisory Board, Chemical Engg., CBIT, academic year 2022-23 onwards.
7) Mr. Himanshu, is Member, Department PAQIC, Chemical Engg., CBIT, academic year 2022-23 onwards
8) Ms. Sindhuja was mentor and supervisor for two teams (IV sem students) to present at Ideathon 2023 by ACIC-CBIT on 25-04-2023.

HOD – Chemical Engg Dept., CBIT

Certificate

PRATHISTA
The pride of being

OF INTERNSHIP

This is to certify that

(~~Mr~~/Ms) YERRAJU SHRUTHI

student of Chaitanya Bharathi Institute Of Technology (A)

has successfully completed as an intern at Prathista Industries Limited in the field of Routined Operational Activities in Production, QC and R&D

from 09.08.2022 to 21.08.2022

under the guidance of Dr. Abhishek Malhur
Dr. G.V. Ranganathan

During this period of her/his internship program with us, she/he had been exposed to different processes and was found diligent, hardworking and inquisitive.

We wish him/her every success in life and career.

Vaishnavi

M. Vaishnavi
Chief Incharge of Finance and Administration
Prathista Industries Ltd

Abhishek

Authorised Signature

Certificate

PRATHISTA
The pride of living

OF INTERNSHIP

This is to certify that

(~~Mr~~/Ms) PUTTALA . ALLIKA

student of Chaitanya Bharathi Institute of Technology (A)

has successfully completed as an intern at Prathista Industries Limited in the field of Routined Operational Activities in Production, Q.C. and R&D

from 09.08.2022 to 21.08.2022

under the guidance of Dr. Abhishek Malthur
Dr. B.V. Ranganathan

During this period of her/his internship program with us, she/he had been exposed to different processes and was found diligent, hardworking and inquisitive.

We wish him/her every success in life and career.

Vaishnavi

M. Vaishnavi
Chief Incharge of Finance and Administration
Prathista Industries Ltd

Abhishek

Authorised Signature

Certificate

PRATHISTA
The pride of being

OF INTERNSHIP

This is to certify that

(~~Mr~~/Ms) KALA SAI SRIYA

student of Chaitanya Bharathi Institute Of Technology(A)

has successfully completed as an intern at Prathista Industries Limited in the field of Routined Operational Activities in Production, QC and R&D

from 09.08.2022 to 21.08.2022

under the guidance of Dr. Abhishek Malkur
Dr. B.V. Rangarathan

During this period of her/his internship program with us, she/he had been exposed to different processes and was found diligent, hardworking and inquisitive.

We wish him/her every success in life and career.

Vaishnavi

M. Vaishnavi
Chief Incharge of Finance and Administration
Prathista Industries Ltd

Abhishek

Authorised Signature

Certificate

PRATHISTA
The pride of India

OF INTERNSHIP

This is to certify that

(Mr/Ms) CHIPPA MANOJ

student of Chaitanya Bharathi Institute Of Technology(A)

has successfully completed as an intern at Prathista Industries Limited in the field of Routined Operational Activities in Production, QC and R&D

from 09.08.2022 to 21.08.2022

under the guidance of Dr. Abhishek Malkur
Dr. B.V. Rangarajulu

During this period of her/his internship program with us, she/he had been exposed to different processes and was found diligent, hardworking and inquisitive.

We wish him/her every success in life and career.

Vaishnavi

M. Vaishnavi
Chief Incharge of Finance and Administration
Prathista Industries Ltd

Abhishek

Authorised Signature

Certificate

PRATHISTA
The pride of India

OF INTERNSHIP

This is to certify that

(Mr/~~Ms~~) BOILLA NITHIN

student of Chaitanya Bharathi Institute of Technology(A)

has successfully completed as an intern at Prathista Industries Limited in the field of Routined Operational Activities in Production, QC and R&D

from 09.08.2022 to 21.08.2022

under the guidance of Dr. Abhishek Mathur
Dr B.V. Ranganathan

During this period of her/his internship program with us, she/he had been exposed to different processes and was found diligent, hardworking and inquisitive.

We wish him/her every success in life and career.

Vaishnavi

M. Vaishnavi
Chief Incharge of Finance and Administration
Prathista Industries Ltd

Abhishek

Authorised Signature

Certificate

PRATHISTA
The pride of India

OF INTERNSHIP

This is to certify that

(Mr/~~Ms~~) NAMPELLY DILIP KUMAR
student of Chaitanya Bharathi Institute Of Technology (A)
has successfully completed as an intern at Prathista Industries Limited in the field of Routined Operational Activities in Production, QC and R&D
from 09.08.2022 to 21.08.2022
under the guidance of Dr. Abhishek Malkur
Dr. B.V. Ranganathan
During this period of her/his internship program with us, she/he had been exposed to different processes and was found diligent, hardworking and inquisitive.

We wish him/her every success in life and career.

Vaishnavi

M. Vaishnavi
Chief Incharge of Finance and Administration
Prathista Industries Ltd

Authorised Signature

Certificate

PRATHISTA

OF INTERNSHIP

This is to certify that

(Mr/Ms) GAVARI ABHINAY

student of Chaitanya Bharathi Institute Of Technology(A)

has successfully completed as an intern at Prathista Industries Limited in the field of Routined Operational Activities in Production, QC and R&D

from 09.08.2022 to 21.08.2022

under the guidance of Dr. Abhishek Malhux
Dr. B.V. Ranganathan

During this period of her/his internship program with us, she/he had been exposed to different processes and was found diligent, hardworking and inquisitive.

We wish him/her every success in life and career.

Vaishnavi

M. Vaishnavi
Chief Incharge of Finance and Administration
Prathista Industries Ltd

Abhishek

Authorised Signature

Department of Chemical Engg

Industrial Visit to Prathista Industries Limited on 27-09-2023

A total of 40 Chemical Engg students from the 3rd Year, along with faculty Dr. BVS Praveen and Dr Rupam Sinha, representing CBIT Engineering College., visited Prathista Industries Ltd Swamivari Lingottam (Village), Yadadri-Bhongir District on 27th September 2023. Prof. M. Mukunda Vani, HOD, Chemical Engg has coordinated the visit.

Prathista is a leading producer of Natural, Clean Label, non-GMO nutraceuticals (Food Ingredients) through the fermentation process & FSSAI licenses products - Govt. of India along with other global certifications like " USFDA, Kosher, & Halal.

The objective of the industrial visit is to provide the students with the added advantage of better understanding the key elements implicitly used in adding value to carbohydrates through advanced Bio-Technology processes, strategically focusing on key areas to align with the nation's needs. These thrust areas include Agro Bio-Technology, Food and Industrial Biotechnology, and Pharma Biotechnology.

Dr. Abhishek Mathur, GGM R&D/QC/QA, provided comprehensive explanations to the students about crucial unit operations and processes, including mixers, plate and frame filter presses, and industrial vacuum dryers. He also covered essential tests necessary for analyzing food samples. Moreover, he emphasized the importance of Industrial Waste Management, highlighting biotechnological approaches to transform waste into valuable resources.

The major outcome of this visit is that it helped the students to relate their theoretical knowledge with practical aspects of their study covering the curriculum related to design and operation.

Department of Chemical Engineering

01-03-2023

Office Order

To ensure that the Vision and Mission of the department are achieved by acting as a catalyst in improving the quality of the programs offered, Department advisory Board is constituted as a core committee for the department to help in decision making process of the matters pertaining to Academic, Infrastructural facilities, student support systems, short and long-term goals. The term of the membership of DAB shall be for a period of three years from 01-03-2023 to 28-02-2026.

Composition of Department Advisory Board (DAB)

S. N	Category	Name of member	Designation
1.	Principal	Dr P. Ravinder Reddy	Chairman
2.	Head of the Department	Dr M. Mukunda Vani	Convener
3.	Two senior faculty	Dr N. L. N. Reddy Dr M. Mallaiah	Members
4.	NBA Coordinators - UG	Dr K. Prasad Babu, Dr B. Ganesh	Members
5.	Alumni	Mr. Phani Raj Kiran, Managing Director, Tripura BioTech, Choutuppal, Nalgonda Ms. T. Sindhuja, Managing Director, Biosephia Engineering Services, Hyderabad	Members
6.	Academic expert from IIT	Dr M. Narasimha, Professor, Department of Chemical Engineering, IIT-Hyderabad, Sangareddy	Member
7.	Academic expert from NIT	Dr Shirish H Sonawane, Professor, Department of Chemical Engineering, NIT Warangal	Member
8.	Employer	Mr Shiva Kumar, Neuland Pharma Ltd., Hyderabad	Member
9.	Industry expert	Mr. A Jagadishwar Kumar, CEO & Managing Director, Punya Herbals Pvt. Ltd., Hyderabad	Member

Principal

Chemical Engineering Department Outstanding Alumni Awardee on 25-12-2022

As part of Institute Alumni meet “Rejoicing Reunion”, the department communicates to all the alumni and invite them to alumni meet on 25th Dec every year to celebrate alumni success, strengthen the bond and evolve ways as to form mutual beneficial relationships. The institute selects and honors its Alumni for their contributions to the department and institute.

Mr. Phani Raj Kiran
(Batch: 2016)
Managing director for Tripura Bio Tech Limited

HoD – Chemical Engg

05/02/2020

Memorandum of Understanding

(herein after referred to as "MOU")

Between

CONTRACTORS DEVELOPMENT INSTITUTE (CDI)

AND

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (CBIT)

(Autonomous Institution under UGC, Affiliated to Osmania University)

Accredited by NBA and NAAC-UGC, Chaitanya Bharathi (Post), Gandipet, Hyderabad – 500075

Contractors Development Institute (CDI), is a constituent unit of National Academy of Construction (NAC), and has been promoted by Builders Association of India (BAI) Telangana, Hyderabad, Centre. CDI is a training Institute, established in the year 1998, with a vision to professionalize the business of contracting in construction and Infrastructure Industry. CDI has been training contractors, builders, engineers, architects and entrepreneurs in the field of construction, real estate and infrastructure development. CDI is committed to enhancing the skills of Indian construction fraternity. **Herein after referred to as first party, represented by Shri N Sachitanand, Chairman, Contractor Development Institute**. Whereas the first party having its office in the campus of NAC, runs various training courses and programs of relevance to the construction industry. It is offering short-term and long-term programmes on different subjects of construction, technology and management. In addition, NAC is also conducting Post Graduate Diplomas, various seminars, workshops, conferences etc., for the benefit of construction industry. NAC programmes are recognized and well received by State, Central government and construction industry throughout India. The first party by virtue of its good association with NAC, has all the scope to organise workshops & training programmes, internships and finishing school, to suit students' requirements and can come out with even tailor-made programmes for a specific purpose.

Chaitanya Bharathi Institute of Technology (Autonomous), herein after called as second party represented by its Principal Dr. P. Ravinder Reddy, established in the year 1979, esteemed as the premier engineering institute in the states of Telangana and Andhra Pradesh, was promoted by Chaitanya Bharathi Educational Society (CBES) a group of visionaries from varied professions of engineering, medical, legal and management, with an objective to facilitate the best engineering and management education to the students and contribute towards meeting the need of skilled and technically conversant engineers and management professionals, for the country that embarked on an economic growth plan.

The Institute, committed to Education and Innovation, started with three-Degree Courses in Engineering for 200 Students and over the 40 Years, has emerged as a Dream Destination for; Students seeking to excel in Engineering and Management Education, Teaching Community to progress with a rewarding Career and Corporates to source well-rounded Engineers. Stringent Academic Standards, Industry compliant Teaching Methodology, Research Projects from Private and Public Sector Industries in Engineering and Management and Consultancy Practice, enabled the Institute to establish its Identity in the Technical Education and is Ranked No. 1 amongst the Private Engineering Colleges in both the Telugu Speaking States. In its Four Decades of existence, all the Stake Holders of the Institute, relentlessly endeavoured to position CBIT as an Institution that is a Leader and an Innovator in the Ecosystem of Engineering Higher Education. With the Students being the singular Objective, the Institute has established excellent Infrastructure such as State-of – the Art Laboratories, spacious Library with Printed and Digital Collection of Books and Journals, Sports, Hostel, and other Infrastructure for Extra and Co-Curricular Engagements with a total Built-up Area of about 57,714 Sq. Mts., in the serene Ambience of 50 Acres to inspire, encourage and pursue Academics. In its relentless strive for Academic excellence, CBIT has scaled great heights both Nationally and Internationally in Industry and Global Universities.

Whereas the participants, on the basis of this MOU, have stated their mutual desire to establish a framework of co-operation in the discipline of Education and to promote Research and Training programmes, Internships and Finishing school, to suit students' requirements and can come out with even tailor-made programmes for a specific purpose, as per the terms of reference enclosed.

Validity of the MOU:

This MOU shall be valid for a minimum period of three years from the date of commencement of the MOU and may be extended for a period of three years each time thereafter.

Termination of MOU

This MOU can be terminated with either party giving notice of three months intimating their intention to terminate.

Signatures

This Memorandum of Understanding is signed by both parties on this day 25th **Feb 2020** at CBIT, Gandipet, Hyderabad.

Vroomster

MEMORANDUM OF UNDERSTANDING
(MoU)

BETWEEN

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)
(Affiliated to Osmania University)
Gandipet, Hyderabad – 75.

&

VROOMSTER TECHNOLOGIES PVT LTD
Rajapushpa Summit 1st floor, ISB Road,
Hyderabad – 500032, Telangana.

FOR

SKILL DEVELOPMENT, OUTCOME BASED TRAININGS, PLACEMENT, R&D SERVICES AND RELATED SERVICES

Vroomster

MEMORANDUM OF UNDERSTANDING

This **Memorandum of Understanding** (hereinafter called as the 'MoU') is entered into on this 9th DAY of November Two Thousand and Twenty-Three (9/11/2023), by and between

Chaitanya Bharathi Institute of Technology (A), Gandipet, Hyderabad represented herein by Prof. C V. Narasimhulu, Principal (hereinafter referred as **'First Party'**, the institution which expression, unless excluded by or repugnant to the subject or context shall include its successors – in-office, administrators and assigns).

AND

Vroomster Technologies Pvt Ltd, Hyderabad, the Second Party, and represented herein by its Founder, Rajeev Ghattamaraju, (hereinafter referred to as "**Second Party**", company which expression, unless excluded by or repugnant to the subject or context shall include its successors – in-office, administrators and assigns).

(First Party and Second Party are hereinafter jointly referred to as 'Parties' and individually as 'Party') as

WHEREAS:

A) First Party is a Higher Educational Institution named:

(i) **Chaitanya Bharathi Institute of Technology (A)** herein after called **CBIT**

B) First Party & Second Party believe that collaboration and co-operation between themselves will promote more effective use of each of their resources and provide each of them with enhanced opportunities.

C) The Parties intent to cooperate and focus their efforts on cooperation within area of Skill Based Training, Education and Research.

D) Both Parties, being legal entities in themselves desire to sign this MOU for advancing their mutual interests.

E) **VROOMSTER TECHNOLOGIES PVT LTD, HYDERABAD**, the Second Party is engaged in Enterprise Software, Machine Learning Applications and R&D Services in the fields of *Logistics and Supply Chain Management* and *Healthcare Technology*.

F) **VROOMSTER TECHNOLOGIES PVT LTD, HYDERABAD**, the Second Party is promoted by **Rajeev Ghattamaraju**; resident of Financial District, Hyderabad

G) Give related information, its branches, and dimensional information about the industry concerned with whom the MoU is sworn.

NOW THEREFORE, IN CONSIDERATION OF THE MUTUAL PROMISES SET FORTH IN THIS MOU, THE PARTIES HERE TO AGREE AS FOLLOWS:

CLAUSE 1 - CO-OPERATION

Both Parties are in cohesion by common interests and objectives, and they shall establish channels of communication and co-operation that will promote and advance their respective operations within the **Institution** and its related wings. The Parties shall keep each other informed of potential opportunities and shall share all information that may be relevant to secure additional opportunities for one another.

CBIT, Gandipet, Hyderabad and **Vroomster Technologies** co-operation will facilitate effective utilization of the intellectual capabilities of the faculty of **CBIT** providing significant inputs to them in developing suitable teaching / training systems, keeping in mind the needs of the industry.

The general terms of co-operation shall be governed by this MOU. The Parties shall cooperate with each other and shall, as promptly as is reasonably practical, enter into all relevant agreements, deeds, and documents (the 'Definitive Documents') as may be required to give effect to the actions contemplated in terms of this MOU. The term of Definitive Documents shall be mutually decided between the Parties. Along with the Definitive Documents, this MOU shall represent the entire understanding as to the subject matter hereof and shall supersede any prior understanding between the Parties on the subject matter hereof.

CLAUSE 2 - SCOPE OF THE MoU

The budding graduates from the institutions could play a key role in technological up-gradation, innovation, and competitiveness of an industry. Both parties believe that close co-operation between the two would be of major benefit to the student community to enhance their skills and knowledge.

Student Enrollment: The interested students of **CBIT** will be enrolled in the projects based on eligibility criteria set by Vroomster Technologies. The eligibility will be decided based on students' performance in the tests and interviews conducted by Vroomster Technologies.

Designated working space for the students: CBIT will provide a designated working area for its students enrolled in Vroomster Technologies' software development projects. This designated space will also house any (if needed) computer hardware provided by Vroomster Technologies for its software projects. Electricity and work area (Internet access, desk, chair) will be provided by **CBIT.**

Vroomster

Time commitment from the students: The students enrolled in Vroomster Technologies' projects will have to commit to at least 35 hours of work in a week during regular school weeks. These minimum commit hours can be adjusted based on **CBIT's examination schedule.** If the student does not work on the project for the minimum committed hours, the compensation will be adjusted on pro-rata basis.

Industrial Training & Visits: Industry and Institution interaction will give an insight in to the latest developments / requirements of the industries; Vroomster Technologies to permit the Faculty and Students of CBIT to visit its group companies and involve in Industrial Training Programs for CBIT. The industrial training and exposure provided to students and faculty through this association will build confidence and prepare the students to have a smooth transition from academic to working career. Vroomster Technologies will provide its Labs / Work Area as and when needed for the hands-on training of the learners enrolled with the First Party.

Research and Development: Both Parties have agreed to carry out the joint research activities in the fields of **Software Design and Development with Machine Learning** and will explore to apply for joint projects funding from DST and other and other Institutions.

Skill Development Programs: Vroomster Technologies to train students of **CBIT** enrolled in its projects on the emerging technologies to bridge the skill gap and make them industry ready. This is contingent on students meeting the eligibility criteria set forth in the enrollment clause above.

Placement of Trained Students: Vroomster Technologies will facilitate placements for the students of the first party enrolled in its projects, based on the students' performance in the projects.

Both Parties to obtain all internal approvals, consents, permissions, and licenses of whatsoever nature required for offering the programmes on the terms specified herein.

Financial commitment there is no financial commitment on the part of the **CBIT**, the First Party to take up any programme mentioned in the MoU.

Vroomster Technologies will pay a fixed monthly compensation of ₹ 68,000 amounting to ₹ 8,16,000 in an annual contract to CBIT at the first week of the following month the students are enrolled. This compensation is contingent on the following conditions.

1. A minimum of **FOUR** students from **CBIT** are enrolled in the projects.
    a. if fewer than 4 students are enrolled in the month, the amount payable for the month will be adjusted proportionately.
    b. If more than 4 students are enrolled in the month, the amount payable for the month will be adjusted proportionately.
2. If the student contributes less than the stipulated number of hours, the payment will be modified to a pro rata basis as follows

(Hours contributed) / (140 hours) X ₹ 17,000

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enabling personalized medicine

TM

Memorandum of Understanding

This **Memorandum of Understanding** ("MOU" also called "Agreement") is made as of the panace.ai **(Healthcare Products | AI Centers of Excellence) between Chaitanya Bharathi Institute of Technology(A), Hyderabad** (hereinafter called "**CBIT(A)**" or "**Institute**") on 19th day of September 2022.

1. Introduction

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (CBIT(A)), established in the Year 1979, esteemed as the Premier Engineering Institute in the States of Telangana and Andhra Pradesh, was promoted with an Objective to facilitate the Best Engineering and Management Education to the Students and contribute towards meeting the need of Skilled and Technically conversant Engineers and Management Professionals, for the Country that embarked on an Economic Growth Plan. In its four decades of existence, all the Stake Holders of the Institute, relentlessly endeavored to position CBIT(A) as an Institution that is a Leader and an Innovator in the Ecosystem of Engineering Higher Education and Management. With the Students being the singular Objective, the Institute has established excellent Infrastructure such as State-of – the Art Laboratories, spacious Library with Printed and Digital Collection of Books and Journals, Sports, Hostel, and other Infrastructure for Research, Innovation, Incubation, Entrepreneurship, Extra and Co-Curricular Engagements with a total built-up Area of about 57,714 Sq. Mts., in the serene Ambience of 50 Acres to inspire, encourage and pursue Academics. In its relentless strive for Academic excellence, CBIT(A) has scaled great heights both Nationally and Internationally in Industry and Global Universities.

Panace.ai is a startup company registered in the year 2021 under Companies Act, 2013 (18 of 2013). panace.ai attempts to democratize medical interventions by making them affordable and ubiquitous by making the most accurate diagnosis driven by state-of-the-art artificial

intelligence, identifying and provide highly personalized medical treatment for patients. This is achieved by utilizing evidence-based medical decision-making from detection & diagnosis to prescriptions & treatment.

Through this MOU, panace.ai initiates activities of research and development with students, faculty and researchers in providing the projects, research studies and internships and interaction session with students on innovative ideas and scaling up the startup thoughts and ideas.

2.0 Recitals

panace.ai (Healthcare Products | AI Centers of Excellence) is interested in engaging with CBIT(A) in areas of mutual interest as framework outlined below but not necessarily restricted to those mentioned in 2.1 & 2.2.

CBIT(A) is having faculties with expertise in the area of Electrical, Mechanical, ECE, Bio-Tech, Chemical, CSE, IT and other emerging technologies areas, whose services can by availed by MSME Industries in Hyderabad to develop new products/process and software required by the customers and the society. Ministry of MSME, GOI, has approved MSME Incubation Centre at CBIT(A) to conduct various Programs. The services of Experts available with CBIT (A)can be availed by panace.ai, an MSME, to develop new products/process, software and incubate new ideas required by the customers and the society. The Proposed Interaction will also help students of CBIT (A) to have industry interaction and involvement in development projects taken up by panace.ai along with CBIT(A) or live projects being carried out by panace.ai for other organizations under their internship. The industrial visits by the students will provide them with an exposure to various equipment's, design, software and manufacturing/business process etc.

2.1 Innovative designs and development in the fields of ...Computer Science, Natural Language Processing, Artificial Intelligence, IOT, Cloud Computing.

2.2 Development of Innovative Solutions for Capital Good Sector

In consideration of the above recitals and the mutual benefits to be derived hereafter, the parties agree to enter into an Agreement as follows:

ARTICLE – I: Scope of the MoU

panace.ai – Proposed MOU Objectives:

To have the long-term relationship with CBIT in terms of establishing a start-up Ecosystem in CBIT involving faculty and students for innovation and entrepreneurship, this will relate to the field of mutual interest for both the parties.

Research/ Innovation Projects:

With understanding between panace.ai and CBIT, projects in the concerned field can be proposed in collaboration with one another. The details of such proposal will be as per the agreement by both the parties. The following areas are considered for further research/ Innovation activities.

- Development of the technology and advancement in precision Medicine and Healthcare.
- The projects that we (panace.ai and CBIT) research / Innovation and to create enriched datasets needed for innovations in Medicine and Healthcare.
- Create cutting edge MVPs addressing various areas of healthcare – Clinical Diagnosis, preventive medicine, precision medicine and nutrition.
- CBIT's Expertise can be availed for Consultancy projects. This will be carried under a separate consultancy agreement
- The panace.ai may allow for student internship and student projects as per the mutual terms and conditions.

Publications and Patents:

All publications in the program of cooperation will be co-authored by the concerned of ACIC CBIT and the employees of panace.ai. The Coordination Committee shall review the patentability aspect of the research/ Innovation work and direct whether a patent or a publication to be made.

Rights regarding publications, patents, royalty, ownership of software/design/product developed etc. under the scope of this MoU, will be decided by Mutual agreement. These decisions shall be pre-specified and detailed in individual's project/activity specific agreements that will follow under this MOU.

ARTICLE – II: Scope and Terms of Interactions

Both CBIT(A) and panace.ai shall encourage interactions between both the Institutes, Students& Staff and Engineers, of both the organizations through the following arrangements:

1. Both CBIT(A) and panace.ai will plan to work on Joint development projects of Mutual Interest and also explore for joint working on Govt. funded projects and other industrial projects based on mutual agreement. If necessary, both parties will also involve other premier Institutions in case the work is of Multidisciplinary work.
2. Panace.ai may seek assistance/guidance of CBIT(A)'s RE Hub for incubating New ideas under MSME/ACIC Incubation Centre and initiating any start-up company to develop new products or process along with CBIT(A).
3. Practical training of CBIT(A) students at panace.ai in the form of One-full Semester Internship at panace.ai
4. Joint guidance of student projects/thesis in various technical areas including Embedded Systems and related Technologies and other areas of national interest at CBIT(A) by panace.ai on mutual agreement.
5. panace.ai may depute its personnel as visiting faculty at CBIT(A) to supplement the teaching of any specialized topics.
6. panace.ai will allow the industrial visits of students for half/full day to provide them with an exposure to various equipment, instrument, etc.
7. panace.ai may be allowed to showcase its business activities at the Seminar/Workshop/Conference, etc. if possible,at CBIT(A) that will be conducted time-to-time, with necessary permission from CBIT(A).
8. panace.ai may avail library facilities at CBIT(A) for combined projects for students' project work with necessary permission from the Institute.
9. There will be no restriction on the contents of the thesis and on publication of results of the thesis, subject to the condition that no Intellectual Property Rights can be secured for any part of the work which will be decided with mutual consent.
10. If the outcome of a project related to product development, process technology and design etc. which involves matter of secrecy and concern with security of the State and

the Country, the same will not be allowed for publication/printing in any form such as Electronically/verbal, etc.

11. If the outcome of an Internship or the Thesis work or the combined project results into an intellectual property, for which rights can be secured, it will be decided on case-to-case basis depending upon the contribution from both the Institutions. Similarly, sharing of expenditure in securing such rights and income accrued through royalty etc. will be decided on case- to-case basis after mutual consultation and agreement.

ARTICLE-III: Sharing of Facilities

a) panace.ai shall extend its facilities for CBIT(A) students towards the smooth conduct of Internships and Projects depending on their convenience and availability of time & staff.

b) CBIT(A) and panace.ai may explore to share their respective important R&D facilities in order to promote academic and research interaction in the areas of cooperation depending upon availability of such facility without affecting their regular working.

c) CBIT(A) and panace.ai will permit the sharing software and other components developed during any combined project work in the areas of cooperation, if permissible within the rules governing the two institutions. However, responsibility regarding confidentiality terms of the software and other materials during the exchange will rest on respective Head of department of the branch/section and panace.ai.

d) panace.ai. provide access to the library facilities to the members of faculty and students as per the prevailing rules and norms.

ARTICLE-IV: Effective Date and duration of the MoU.

a) This MoU will be effective from the date of its approval by competent authorities at both ends.

b) The duration of the MoU will be for a period of 2 years from the effective date which may be extended after mutual understanding. However, if any Important combined projects are under execution, both parties agree to complete the work even the MoU is not effective after two years.

c) During its tenancy, the MoU may be extended or terminated by a prior notice of not less than one month by either party. However, termination of the MoU will not in any manner

affect the interests of the students & faculty who have been admitted to pursue a Training/Project under the MoU.

d) Any clause or article of the MoU may be modified or amended by mutual agreement of panace.ai and CBIT(A).

ARTICLE - V: IPR

Rights regarding publications, patents, royalty, ownership of software/design/product developed etc. under the scope of this MoU, will be decided by CBIT and panace.ai based on Mutual agreement.

ARTICLE – VI: Confidentiality

During the tenure of the MoU both CBIT(A) and panace.ai will maintain strict confidentiality and prevent disclosure of all the information and data exchanged under the scope of this MoU for any purpose other than in accordance with this MoU.

Both CBIT(A) and panace.ai shall bind their respective personnel who come into possession or knowledge of any confidential information not to disclose the same to third parties without written approval of the disclosing party or use such confidential information for any use other than intended under this agreement or PROJECTS. Further both CBIT(A) and panace.ai should put in place adequate and reasonable measures to keep and store confidential information secure so as to prevent any unauthorized use.

CONFIDENTIAL INFORMATION shall mean any proprietary information, data or facts belonging to PARTIES collectively or severally, disclosed by the disclosing party under this agreement or any subsequent agreement, whether in writing, verbal or electronically, irrespective of the medium in which such information is stored, which is marked confidential or with any other words having similar meaning by the disclosing party, or specifically agreed to be kept confidential by the parties, or declared or identified so by the disclosing party before such disclosure or during the discussions. However confidential information should not include any data or information which:

(a) is or becomes publicly available through no fault of the receiving party,

(b) is already in the rightful possession of the receiving party prior to its receipt of such data or information;

(c) is independently developed by the receiving party without reference to the confidential information of the disclosing party

(d) is rightfully obtained by the receiving party from a third party or is in the public domain

(e) is disclosed with the written consent of the party whose information it is, or

(f) is disclosed pursuant to court order or other legal compulsion, after providing prior notice to the disclosing party.

ARTICLE – VII: AMENDMENTS

Any amendment and/or addenda to the AGREEMENT should be in writing and signed by the PARTIES hereto and shall only after such execution be deemed to form part of the AGREEMENT and have the effect of modifying the AGREEMENT to the extent required by such amendment or addenda.

ARTICLE – VIII: Compensation, Force Measure, Approval and Dispute Settlement

a) Compensation

Neither Party shall be liable to the other for any incidental, indirect, special or consequential damages, including but not limited, to loss of profits, loss of use, loss of revenues or damages to business or reputation arising out of or in connection with this Agreement or any aspect thereof. Neither Party shall be liable to the other by reason of the termination or expiry of this Agreement for compensation or damages on account of the loss of prospective business or on account of expenditures in expectation thereof.

b) Force Majeure

Any delay or failure in performance by the party to this Agreement, shall not constitute default hereunder to give rise to any claims for damages against said party, if any, to the extent caused by matters beyond the control of said party including but not limited to acts of Nature, Strikes, Lock outs or other concerted acts of workmen, fires, floods, explosions, blockages, embargoes, riots, war (declared or undeclared), rebellion, sabotage, extraordinary severe weather, pandemic situation, civil commotion and criminal acts of third persons. If the project under execution is delayed by such force

majeure, then upon the happening of such delay, the parties within 30 days of the happening of such event, shall give notice in writing, requesting for extension of time indicating the period for which extension is desired. Efforts will be made by both parties to give fair and reasonable extension of time for the projects at their discretion but no monetary allowances shall be made unless it is mutually agreed.

c) Approval of the MoU

This Agreement may be signed by authorized officials, whether by original signature or by scanned signature due to the current situation (provided the pdf document is accompanied with official email), signature/approval over official email, with the same effect as if the signature to any counterpart was an original signature upon the same instrument.

d) Dispute and Settlement

i) In case of any dispute (s), steps shall be taken by the parties to the MOU to settle the same through amicable negotiations. In case, dispute is not settled in negotiations, it shall be referred to Conciliator appointed by the designated official as per the bye law of CBIT(A), Hyderabad to arrive at a settlement.

In case dispute is not settled in conciliation proceedings, the same shall be referred to Arbitration for resolution of the dispute under Arbitration and conciliation Act 1996. The arbitration proceeding shall be conducted as per provisions of the Arbitration and Conciliation Act, 1996. The dispute shall be referred for arbitration to sole arbitrator to be appointed by the designated official (s) as per the bye law of CBIT(A) – Hyderabad. The award of the sole arbitrator shall be final and binding on both the parties. The venue of the Arbitration shall be at Hyderabad in India. The Award to be given by the Arbitration shall be a speaking award.

ii) Applicable Laws and Jurisdiction of Courts

Indian laws both substantive and procedural, for the time being in force, including modifications thereto, shall govern the MOU including the arbitral proceedings. The competent Courts at Hyderabad in the State of Telangana - India shall have sole jurisdiction. All questions, disputes, differences arising under, out of or in connection with this MOU shall be to the exclusive jurisdiction of Hyderabad courts in the State of Telangana.

For

Panace.ai
48, Lilac Tower,
Serene County, Telecom Nagar
Gachibowli, Hyderabad – 500032

Name: Surya Putchala
Director

For

Chaitanya Bharathi Institute of Technology
Gandipet,
Hyderabad -500075

Name Prof. P. Ravinder Reddy
Principal, CBIT

Witness:1

Witness: 1 (Dr. U.K. Choudhury)

Director Incubation & Innovation
R&E Hub, CBIT(A)
Gandipet, Hyderabad-500075

Witness: 2

Witness: 2 (Dr Y. Ramadevi)

Professor and Head Department
Department of Computer Science & Engineering
Chaitanya Bharathi Institute of Technology (A)
Gandipet, Hyderabad-500 075.(T.S.)

Automation Anywhere Academic Alliance Agreement

This Academic Alliance Agreement ("Agreement"), effective as of March 28, 2023 (the "Effective Date"), is entered into by and between Automation Anywhere, Inc., a California corporation with offices at 633 River Oaks Parkway, San Jose, CA 95134 U.S.A. (hereafter referred to as "AAI"), and Chaitanya Bharathi Institute of Technology (Autonomous) State of Telangana, India located at Near Ocean Park, Shankerpally Road, Gandipet (hereafter referred to as "University"). University and AAI are hereafter collectively referred to as the "parties".

WHEREAS, AAI is offering the "Automation Anywhere Academic Alliance Program" (the ***"Program"***), in which enrolled students of certain universities (***"Students"***) may attend a university course (the ***"Course"***), taught by a faculty member directly trained and certified by AAI as an AAI trainer (***"Faculty Trainer"***) in a classroom enabled with AAI software as an AAI Center of Excellence.

WHEREAS, University is not seeking to prepare students for certification by AAI on Robotic Process Automation. Should University elect to include certification as part of its Course offering(s) in the future, the parties shall amend this Agreement in writing to incorporate terms governing certification;

WHEREAS, University desires to participate in the Program.

THEREFORE, for good and valuable consideration as set forth below, the parties agree as follows:

1. Definitions.

"Center of Excellence" or ***"CoE"*** means the setup of the Software on University equipment by AAI and provision of Documentation to enable the Faculty Trainer to instruct the Students in the Course.

"Documentation" means (a) the manuals, handbooks, and other written materials related to the Use of the Software, whether in hard copy or soft copy form, that are provided by AAI along with the Software, and (b) the training materials that the Faculty Trainer will use in instructing Students as part of the Course, as such Documentation may be updated by AAI from time to time.

"Software" means AAI's proprietary software in machine-readable, object code form only, the Documentation, and all modifications made thereto by AAI, and any updates or upgrades that AAI provides to University, in order for University to provide the Course under this Agreement.

"Use" means the installation, accessing, displaying, and operation of the AAI Software to automate business processes and tasks.

2. Roles and Responsibilities. The parties agree to each undertake and fully perform during the Term the following obligations for the success of the Program, and, except as explicitly stated in Section 2.2, such obligations will be undertaken at the respective party's sole cost and expense:

2.1 *AAI Responsibilities.*

-Provide courses for University's faculty (at either University's premises or remotely);
-Provide e-learning access to those Students enrolled in the Course;
-Provide the Software under the license terms set forth in Section 3 of this Agreement;
-Work with the University to install the Software and provide Documentation;

2.2 *University Responsibilities.*

- Avoid deceptive, misleading or unethical practices detrimental to AAI, its Software and services offerings, or to the public, including, without limitation, by refraining from making any representations or warranties to any third party with respect to the features or capabilities of any AAI products or services that are inconsistent with the materials distributed by AAI in connection with the Program.
-Subject to University's request for AAI on-site assistance and subject to University's prior written consent, reimburse AAI for reasonable costs of travel, accommodations, and incidental expenses, incurred by AAI representatives who assist on-site at University with setting up the CoE, on-site training of Faculty, and the like.
-Reporting: provide designated AAI contact with number of Students enrolled in each Course (Student names not required) and research uses.
Participate in Academic Alliance Faculty Training Program as per the available schedule in Public batch trainings.

3. Intellectual Property.

3.1 *Limited Software License.* Subject to the terms and conditions of this Agreement, AAI grants University a limited, non-exclusive, non-transferable, non-production license to Use the Software during the Term only for University's Use for the express purpose of providing the Course to Students in connection with Program. For clarity, University may not Use the Software for its own internal use.

3.2 *Restrictions.* The Software is licensed, not sold. Title to the Software and all associated intellectual property rights are retained by AAI and/or its suppliers. All rights in the Software not expressly granted hereunder are reserved. University shall not modify, enhance, translate, supplement, create derivative works from, reverse engineer, reverse compile or otherwise reduce the Software to human readable form. University shall not remove any copyright or other proprietary notices contained in the Software. University shall not cause or permit: (a) competitive analysis, benchmarking, or the Use, evaluation or viewing of the Software or Documentation for the purpose of designing, modifying, or otherwise creating any software program, or any portion thereof, that performs functions similar to the functions performed by the Software; or (b) any of the following: (i) copying (except as set forth herein), (ii) sublicensing, or (iii) providing access or other dissemination of the Software, in whole or in part, to any third party.

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3.3 *Warranty Disclaimer*. AAI DISCLAIMS ALL WARRANTIES AS TO ANY MATTER WHATSOEVER, EITHER EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT, AND THE SOFTWARE IS PROVIDED "AS IS". TO THE EXTENT THE LAWS OF UNIVERSITY'S JURISDICTION DO NOT PERMIT SUCH DISCLAIMER WITH RESPECT TO THE SOFTWARE AS LICENSED HEREUNDER, AAI PROVIDES ONLY THE MINIMUM LAWFUL WARRANTY BEYOND THAT WARRANTY EXPRESSLY MADE ABOVE AND DISCLAIMS ALL WARRANTIES TO THE EXTENT PERMITTED BY APPLICABLE LAW.

3.4 *Publicity; Trademarks*.

3.4.1. At AAI's discretion, the parties may issue a joint press release in form and substance reasonably acceptable to each party as promptly as practicable following the Effective Date. Further, AAI may include University's name on list of schools participating in the Program in AAI promotional materials including but not limited to AAI's website.

3.4.2. This Agreement does not grant either party the right to use the other party's trademarks except as set out under this Section 3.4.2. Subject to the parties' respective trademark policies and style guidelines as either posted on the parties' respective websites or available upon the other party's request (which policies and guidelines may be amended from time to time in each respective trademark owner's sole discretion), and the terms and conditions of this Agreement, each party hereby grants to the other a non-exclusive, non-transferable, non-sublicensable, and world-widelicense to use its respective trademarks, wherein AAI grants the foregoing mentioned rights to its marks as identified in Annex B (the ***"AAI Marks"***) and wherein University grants the foregoing mentioned rights to its marks as identified in Annex C (the ***"University Marks"***), during the Term solely in connection with the promotion and advertising of the Courses and Program as more fully set forth in Sections 2.1 and 2.2 under this Agreement.

3.4.3. Each party shall have the right to inspect and approve prior to the other party's use any and all proposed usage of its Marks. Each party will not alter the the other party's Marks in any way, nor will it incorporate, combine, or use the other party's Marks in any manner as part of, or in close proximity to, another company's name, product or service name, logo, slogan, or trademarks without obtaining the prior written approval of the other party.

3.4.4. Each party acknowledges and admits the validity and other party's ownership of all right, title and interest in and to the other party's Marks and all goodwill associated with the other party's Marks, and each party agrees that all use by it of the other party's Marks will inure to the other party's benefit.

4. Confidentiality

4.1 *Confidential Information.* ***"Confidential Information"*** means with respect to AAI information, the Documentation, Software, any results of any testing or analysis of the Software or Documentation by any party and any Feedback regarding the Course, and with respect to any party's information, all information that: (a) is marked as confidential or proprietary; (b) is disclosed verbally and identified as confidential or proprietary at the time of disclosure; or (c) by its nature is normally and reasonably considered confidential.

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4.2 *Non-Disclosure and Restrictions on Use.* As a result of the relationship entered into by the parties under this Agreement, the parties acknowledge that they may from time to time require or gain access to Confidential Information of the other party. The receiving party: (a) shall hold all Confidential Information in confidence; (b) shall use the Confidential Information only for the purposes expressly permitted herein; (c) shall reproduce the Confidential Information only to the extent necessary for such purpose; (d) shall restrict disclosure of the Confidential Information to its employees, consultants, agents and representatives with a valid need to know in connection with this Agreement and who are bound to protect the confidentiality of such Confidential Information (and shall advise such employees, agents and representatives of the obligations assumed herein); and (e) shall not disclose or cause to be disclosed the Confidential Information to any third party without prior written approval of the disclosing party, except as allowed under (d) above.

4.3 *Confidentiality Exceptions.* The foregoing confidentiality restrictions shall not apply to Confidential Information that: (a) is or becomes a part of the public domain through no wrongful act or omission of the receiving party; (b) was in the receiving party's lawful possession prior to the disclosure and had not been obtained by the receiving party either directly or indirectly from the disclosing party; (c) is lawfully disclosed to the receiving party by a third party without restriction on disclosure; (d) is independently developed by the receiving party without reference to or reliance on the Confidential Information; or (e) that the disclosing party agrees in writing is free of such restrictions.

5. Indemnity.

5.1 *Indemnification Obligation*. Each party (the "***Indemnifying Party"***) will defend the other party, and its employees, directors, agents, and representatives (collectively, the ***"Indemnified Party"***), from any actual or threatened third-party claim to the extent that it arises from: (a) the Indemnifying Party's breach of its confidentiality obligations in Section 4; (b) any alleged infringement by the Indemnifying Party of any third party intellectual property rights; (c) the negligent acts, omissions, negligence or willful misconduct of the Indemnifying Party in the performance of its obligations pursuant to this Agreement; (d) the failure of the Indemnifying Party to comply with, and any liabilities arising under, any applicable law (each, a ***"Claim"***).

5.2 *Indemnification Procedures*. The parties' respective indemnification obligations above are conditioned on: (a) the Indemnified Party giving the Indemnifying Party prompt written notice of any Claim; (b) the Indemnifying Party having full and complete control over the defense and settlement of the Claim; (c) the Indemnified Party providing assistance in connection with the defense and settlement of the Claim as the Indemnifying Party may reasonably request, and (d) the Indemnified Party complying with any settlement or court order made in connection with the Claim. The Indemnifying Party will indemnify the Indemnified Party against: (i) all damages, costs, and attorneys' fees finally awarded against any of them by a court of competent jurisdiction in any Claim under this Section 5; (ii) all out-of-pocket costs (including reasonable attorneys' fees) reasonably incurred by any of them in connection with the defense of the Claim (other than attorneys' fees and costs incurred without the Indemnifying Party's consent after it has accepted the defense of such Claim); and (iii) if any Claim arising under this Section is settled by the Indemnifying Party or with its approval, then the Indemnifying Party will pay any amounts to any third party agreed to by the Indemnifying Party in settlement of any such Claims.

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5.3 *Indemnification Limitations for Third Party Infringement Claims*. An Indemnifying Party will have no obligation under this Section 5 or otherwise solely to the extent the claim is based on: (i) any combination of the Indemnifying Party's technology, products, or services with technology, products or services not provided by the Indemnifying Party; (ii) use of Indemnifying Party's technology, products or services for a purpose or in a manner for which the technology, products or services were not designed; (iii) any modification to Indemnifying Party's technology, products or services made without Indemnifying Party's express written approval, (v) any modifications made to the technology, products or services by Indemnifying Party pursuant to the Indemnified Party's specific instructions, or (vii) any intellectual property right owned or licensed by the Indemnified Party.

5.4 THIS SECTION 5 STATES AN INDEMNIFIED PARTY'S SOLE AND EXCLUSIVE REMEDY AND THE INDEMNIFYING PARTY'S ENTIRE LIABILITY FOR ALL THIRD-PARTY CLAIMS.

6. Limitation of Liability

6.1 NETHER PARTY SHALL BE LIABLE FOR: (A) ANY PUNITIVE, SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES (INCLUDING ANY COST OF PROCUREMENT OF SUBSTITUTE SOFTWARE, LOSS OF USE, DATA, BUSINESS, OR PROFITS), REGARDLESS OF THE THEORY OF LIABILITY OR WHETHER THE LIABLE PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES; OR (B) AGGREGATE DAMAGES IN EXCESS OF FIFTY THOUSAND DOLLARS (USD $50,000).

6.2 *Limitation of Liability Exclusions.* The limitations of liability set forth in Section 6.1 above do not apply to, and each party accepts liability to the other for: (a) damages related to claims that are the subject of indemnification under this Agreement, (b) claims based on either party's intentional breach of its obligations set forth in Section 4 (Confidentiality), and (c) either party's unauthorized use, distribution, or disclosure of the other party's intellectual property.

7. Term and Termination.

7.1 *Agreement Term.* This Agreement is effective as of the Effective Date for three (3) year period thereafter (***"Term"***). For clarity, the license granted to University in Section 3 will terminate immediately upon termination or expiration of the Term. Prior to the expiration of the Term, the parties may amend this Agreement to extend its term.

7.2 *Termination.* Notwithstanding the foregoing, this Agreement may be terminated (a) by AAI for any reason upon sixty (60) days' notice to University, and (b) either party immediately upon written notice if the other party materially breaches any of its obligations under this Agreement and fails to cure such breach within thirty (30) days following receipt of written notice.

7.3 *Effect of Termination.* Upon the effective date of termination of this Agreement: (a) University's license to the Software ceases, and University shall immediately remove all copies of the Software from all systems owned or controlled by University. Each party will securely destroy all copies of Confidential Information of the other party in its possession except as required to comply with any applicable legal or accounting record keeping requirement.

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8. General.

8.1 *Export.* University agrees not to export, or allow the export or re-export of any Software, or of information regarding any Software in violation of any export laws, restrictions and regulations of the Department of Commerce or other United States or foreign agency or authority.

8.2 *Business Practices.* University will: (a) conduct its business (including, without limitation, performance of its obligations under this Agreement) in a manner that reflects favorably on the goodwill and reputation of AAI; and (b) avoid deceptive, misleading or unethical practices detrimental to AAI, it Software and services offerings, or the public, including, without limitation, by refraining from making any representations or warranties to any third party with respect to the features or capabilities of any AAI courses or training certifications, AAI products or services, that are inconsistent with the literature and documentation distributed by AAI.

8.3 *Anti-Corruption*. The parties each represent and warrant that neither it, nor any of its subsidiaries, nor any of their respective directors, officers, employees or agents have taken any action, directly or indirectly, that would constitute a violation, or implicate AAI in a violation, of any law of any jurisdiction in which it performs business, or of the United States of America, including without limitation, the Foreign Corrupt Practices Act of 1977, as amended (***"FCPA"***), and where applicable, any anti-bribery/corruption legislation (***"Anti-Bribery Act"***) enacted by countries in which it is incorporated as an entity, including, but not limited to, the country or countries in which it is to perform under this Agreement (collectively, ***"Anti-corruption Laws"***). University, and, to its knowledge, its affiliates have conducted their businesses in compliance with such Anti-corruption Laws and have instituted and maintain policies and procedures designed to ensure, and which are reasonably expected to continue to ensure, continued compliance therewith.

8.4 Open-Source Software. The AAI Software contains open source software (***"OSS"***) that is subject to separate licenses. University agrees to comply with the applicable license terms for any such OSS. Neither the OSS nor its applicable license terms shall restrict University's use and enjoyment of the Software, or limit University's rights, benefits or remedies under this CAA. Any such OSS, and the notices, license terms and disclaimers applicable to such OSS shall be identified to University by email, website identification or a notice visible within the Software.

8.5 *Governing Law and Jurisdiction.* This Agreement and all matters relating to this Agreement shall be governed by, and construed in accordance with the following laws:

8.5.1. If the University is located outside of the United States, then any dispute arising out or in connection with this Agreement, including any question regarding its existence, validity, or termination, shall be referred to and finally resolved by arbitration under the LCIA Rules (the ***"Rules"***), which Rules are deemed to be incorporated by reference into this clause. The number of arbitrators shall be three. The seat, or legal place, of arbitration, shall be London. The language to be used in the arbitral proceedings shall be English.

8.5.2. If University is located within the United States, then the governing law of this Agreement shall be the substantive law of California. Jurisdiction shall be of the State of California (without giving effect to the choice of law principles thereof). Any action based on

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or arising out of this Agreement or the Services shall be brought and maintained exclusively in any state or federal court, in each case located in Santa Clara County.

The parties hereby expressly and irrevocably submit to the jurisdiction of the above-referenced courts for the purposes of any such action and expressly and irrevocably waives, to the fullest extent permitted by law, any objection which it may have or hereafter may have to the laying of venue of any such action brought in any such court and any claim that any such action has been brought in an inconvenient forum.

8.6 *Injunctive Relief.* The parties acknowledge that any breach of the confidentiality provisions or the unauthorized use of a party's intellectual property may result in serious and irreparable injury to the aggrieved party for which damages may not adequately compensate the aggrieved party. The parties agree, therefore, that, in addition to any other remedy that the aggrieved party may have, it shall be entitled to seek equitable injunctive relief without being required to post a bond or other surety or to prove either actual damages or that damages would be an inadequate remedy.

8.7 *Force Majeure.* A party is not liable under any Agreement for non-performance (other than failure to pay) caused by events or conditions beyond that party's reasonable control, if the party makes reasonable efforts to perform.

8.8 *Parties' Relationship.* The parties agree that this Agreement is non-exclusive, and no party will be prevented from entering into similar arrangements with other third parties. The parties are independent contractors of each other in the performance of the obligations of this Agreement. Notwithstanding the identification of "Partner" in this Agreement, neither party will be considered the legal partner of the other party in any respect, and nothing in this Agreement or in the performance hereof will create or imply any joint venture, franchisee-franchisor relationship, or principal-agent relationship between the parties. No party will have any right, power or authority to create any obligation, express or implied, on behalf of the other party.

8.9 *Binding Nature; Assignment.* This Agreement shall be binding on the respective parties thereto and their respective permitted successors and assigns; provided, however, that University shall not assign, delegate, or otherwise transfer this Agreement or any of its rights or obligations to a third party without the prior written consent of AAI; any other attempted assignment shall be void.

8.10 *Notices.* Ordinary day-to-day operational communications may be conducted by email or telephone communications. Any other notice required by this Agreement shall be made in writing and given by (a) personal delivery, (b) prepaid, first class, certified mail, return receipt requested, (c) email (with a duplicate notice sent promptly by one of the other methods in this Section), or (d) courier service of recognized standing (with confirmation of receipt); in any case to the receiving party, "Attention: Legal" at its address set forth in the heading to this Agreement, or to a different address of which the addressee party has notified the other in accordance with this Section. Any notice given in conformance with this Section shall be effective upon actual delivery or refusal of delivery.

8.11 *Headings.* Section headings are included for convenience or reference only and are not intended to define or limit the scope of any provision of this Agreement and should not be used to construe or interpret this Agreement.

8.12 Survival; *Interpretation; Severability.* All provisions which are intended by their nature to survive, shall survive such performance, or the expiration or termination of this Agreement, including without limitation those relating to limitation of liability, and infringement indemnity. Each provision of this Agreement shall apply to the fullest extent of the law, whether in contract, statute, tort (such as *negligence*) or otherwise, notwithstanding the failure of the essential purpose of any remedy. If any provision of this Agreement shall for any reason be held illegal or unenforceable, such provision shall be deemed severable from the remaining provisions of this Agreement and shall in no way affect or impair the validity or enforceability of the remaining provisions of this Agreement, unless such omission would frustrate the intent of the parties, in which case this Agreement may be reformed to give effect to the other provisions hereof.

8.13 *Entire Agreement; Modification and Wavier*. This Agreement constitutes the entire understanding between the parties with respect to the subject matter hereof, and no other terms or conditions set forth in any other document provided by University shall be part of any this Agreement unless specifically accepted by AAI in writing. No modification of this Agreement will be binding unless in writing and signed by an authorized representative of each party. Any express waiver or failure to exercise promptly any right under this Agreement will not create a continuing waiver or any expectation of non-enforcement. There are no third-party beneficiaries to this Agreement.

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be signed by duly authorized officers or representatives as of the Effective Date.

AUTOMATION ANYWHERE, INC.

By: Bob Baker (Apr 6, 2023 09:17 EDT)

Name: Bob Baker

Title: Vice President, Corporate Operations

Date: 06-Apr-2023

UNIVERSITY: Chaitanya Bharathi Institute of Technology

By: Prof. P. Ravinder Reddy (Apr 6, 2023 10:41 GMT+5.5)

Name: Dr.P.Ravinder Reddy

Title: Principal

Date: 06-Apr-2023

Email : principal@cbit.ac.in

ANNEX B

AAI Marks

University may use the below identified mark(s) of AAI:

1. Composite "A-Logo + Automation Anywhere + Go be great" mark, as specifically shown below. US Registration Nos. 4,781,160; 3,913,711; 5,566,006; 5,661,561; 5,553,222.

2. Composite "A-Logo + Automation Anywhere + Bot Lab" mark, as specifically shown below. US Registration Nos. 4,781,160; 3,913,711; 5,566,006; 5,661,561.

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ANNEX C

University Marks

AAI may use the below-identified mark(s) of the University.

1. College Header

2. College Logo "Swayam Tejo Bhav" mark, as specifically shown below

తెలంగాణ तेलंगाना TELANGANA

AV 721250

Sl. No. 6441, Date: 31/01/2023, Rs.100/-
Sold to. M V Nageshwar Rao,
S/o. Late. M.Venkateshwar Rao, R/o. Hyd.
For Whom: CDAC.

P. SANDHYA RANI
Liscensed Stamp Vendor, Lic No. 16-07-004/2006,
Regn. No. 16-07-09/2021, H.No.3-5-944, Shop No. 4,
Ground Floor, Panchavati Mall, Narayanaguda,
Hyderabad-29, Phone No.7680000870

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (hereinafter referred as MoU) is made and executed on the _____2023

BY AND BETWEEN

a) **Centre for Development of Advanced Computing (C-DAC)**, a scientific society under the Ministry of Electronics and Information Technology, Government of India registered under the Societies Registration Act 1860 and the Bombay Public Trust Act 1950 having its registered and Head office at Pune University Campus, Pune 411 007, and having one of its constituent units at Plot No. 6 & 7, Hardware Park, Sy No. 1/1, Keshavagiri Post Hyderabad – 501510, Telangana (India) (hereinafter called **"RC"** or **"C-DAC")** which expression shall wherever the context so submits mean and include its successors and assignees of the **FIRST PART**;

AND

b) **Chaitanya Bharathi Institute of Technology** registered under section 35 of 2001 act on 01-07-2009 having its registered address at CBIT, CBIT campus, Kokapet village, Rajendranagar (M) hereinafter referred "**SPOKE**" which

expression shall wherever the context so submits mean and include its successors and assignees of the **SECOND PART**.

RC and **SPOKE** are hereinafter individually referred to as "Party" and collectively referred to as "Parties" as the context may require.

WHEREAS Future Skills PRIME – Programme for Re-skilling/ Up-skilling of IT Manpower for Employability' (hereinafter referred to as the Programme) has been approved as a Central Sector Scheme under the "Champion Services Sector Scheme (CSSS)" of Department of Commerce (DoC), to be implemented jointly by SSC NASSCOM (Key Implementing Agency) and Programme Management Unit. In order to institutionalize blended-learning mechanisms, a hub and spoke model would be adopted through Lead Resource Centres and Co-Lead Resource Centres for wider reach and deeper penetration in the country. Further, Lead and Co-Lead centers will enter into MoU with the spokes and thereby ensure adequate demographic coverage of the relevant technology across length and breadth of India.

AND WHEREAS, the objectives of the Future Skills PRIME Programme are as follows:

The main objective of the Programme is "to create a re-skilling/ up-skilling ecosystem in emerging and futuristic technologies to facilitate continuous skill as well as knowledge enhancement of the IT professionals in line with their aspirations and aptitude in a self-paced digital skill environment."

The Programme would offer a robust platform to encourage any-time, any-where, self-paced learning. The existing pan-India presence & skilling capabilities of training providers (SSC NASSCOM, NIELIT, C-DAC etc.) would be leveraged through blended-learning framework in hub-and-spoke model. The Programme would also seek to tap the untapped potential that emerging technologies bring along by causing a transition from traditional classroom learning methodologies, to an online and blended skilling framework. The Programme framework would take into account Job-roles/ NOS (National Occupational Standards) in emerging technologies, which would specify the standard of performance, knowledge and understanding, along with mechanisms for assessment and certification.

The Programme would provide re-skilling/ up-skilling opportunities in 10 Emerging Technologies – Virtual Reality, Internet of Things, Big Data Analytics, Artificial Intelligence, Robotic Process Automation, Additive Manufacturing/ 3D Printing, Cloud Computing, Social & Mobile, Cyber

Security and Blockchain. The framework would also have the flexibility to add new Job Roles/NOS in any new emerging technology.

Under this programme, C-DAC Hyderabad is identified as a Lead Resource Centre **(LRC)** for Cyber Security domain and Co-Lead Resource centre **(CRC)** for Blockchain Technology and Additive Manufacturing / 3D printing. Courses offered are specifically targeting the student and Professional community to give shape to their professional careers. Now, therefore, it is agreed between the Parties **(RC & SPOKE)** into writing in the form of this MoU containing the following terms and conditions set forth in the Articles 1 to 31 along with Annexure I for a clear understanding

1. DEFINITIONS

Unless otherwise stated, for the purpose of this MoU, the capitalized terms given hereunder shall have the following meanings:

i. **3D:** Additive Manufacturing/ 3D Printing
ii. **AI:** Artificial Intelligence
iii. **Annexure:** Any annexure to this MoU as enumerated and cross-referred in these articles
iv. **Articles:** Any Clause of this MoU or partial clause with separate marginal number as referred to anywhere in the workings of this MoU or its Annexures
v. **AVR**: Augmented Reality/ Virtual Reality
vi. **BC:** Blockchain
vii. **BDA:** Big Data Analytics
viii. **CC:** Cloud Computing
ix. **C-DAC:** Centre for Development of Advanced Computing
x. **CRC:** Co-Lead Resource centre
xi. **CS:** Cyber Security
xii. **CSSS/ Scheme:** Champion Services Sector Scheme
xiii. **DoC:** Department of Commerce
xiv. **DPR:** Detailed Project Report of FutureSkills PRIME (February, 2019)
xv. **EC:** Expert Committee
xvi. **GC:** Group Coordinator, MeitY
xvii. **GFR:** General Financial Rules, 2017 (as amended from time to time)
xviii. **GIA:** Grants-In-Aid
xix. **HRD:** Human Resource Development Division of MeitY
xx. **IoT**: Internet of Things

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xxi. **IPR:** Shall mean all rights, benefits, title or interest in or to any Intellectual Property (whether registered or not and include all applications for the same).

xxii. **IR:** Internal Revenue

xxiii. **IT:** Information Technology

xxiv. **ITeS:** Information Technology enabled Services

xxv. **LRC:** Lead Resource Centre

xxvi. **MeitY:** Ministry of Electronics and Information Technology, Government of India having its office at Electronics Niketan, 6, CGO Complex, Lodhi Road, New Delhi – 110003

xxvii. **MoU:** Memorandum of Understanding

xxviii. **MIS**: Management Information System

xxix. **NASSCOM:** National Association of Software and Service Companies through IT-ITeS Sector Skill Council, NASSCOM (SSC NASSCOM)

xxx. **NIELIT:** National Institute of Electronics & Information Technology

xxxi. **NSDA**: National Skill Development Agency

xxxii. **NSQF:** National Skills Qualifications Framework

xxxiii. **NOS:** National Occupational Standards

xxxiv. **Party/Parties:** means Lead Resource Centre or/and Co-Lead Resource Centres or/and Programme Management Unit (PMU)

xxxv. **Participating Agencies:** means C-DAC and NIELIT Centres selected as Resource Centres (Leads/Co-Leads) under FutureSkills PRIME or/and NASSCOM and IT-ITeS SSC NASSCOM or/and Training Partners affiliated to C-DAC, NIELIT and IT-ITeS SSC NASSCOM selected under the Programme or/and stakeholders on-boarded by the Parties under FutureSkills PRIME

xxxvi. **PMU:** Programme Management Unit

xxxvii. **PRSG:** Project Review and Steering Group

xxxviii. **RC:** Resource Centre

xxxix. **RPA**: Robotic Process Automation

xl. **SM:** Social & Mobile

xli. **SSC/ SSC NASSCOM:** IT-ITeS Sector Skill Council NASSCOM

xlii. **TP:** Training Partners

xliii. **TSC:** Technology Sub-Committee

2. SCOPE OF MEMORANDUM OF UNDERSTANDING

The Articles 1 to 31 and Annexure I to this MoU form an integral part of MoU between the Parties. The terms herein referred in the MoU and Annexures shall be binding on the Parties. The MoU together with the Annexures indicate the responsibilities and obligations of the Parties to this

MoU including terms and conditions, financial arrangement, intellectual property rights (IPR), monitoring mechanism etc. of the Programme.

3. BROAD IMPLEMENTATION FRAMEWORK

The FutureSkills PRIME would be implemented by NASSCOM, C-DAC, NIELIT and other stakeholders under the aegis of MeitY. The Programme would essentially follow an "aggregator of aggregators" approach with the entire platform being hosted online. The Programme envisages to maximise reach and participation of the aspirants irrespective of their present profile/ skill. It seeks to create value through a repository of free and curated content/ pathways on new and emerging technologies.

4. ROLES AND RESPONSIBILITIES

4.1. Roles of RC as

4.1.1 LRC

i. LRC would designate a person as RC Head to promote interface across the Parties, review of various activities, implementation planning, provide the requisite logistics and co-ordination support in close liaison with other stakeholders.

ii. Act as an overarching mechanism, to monitor, audit, support and ensure that all components of the Programme are being administered as per the norms and guidelines of the FutureSkills PRIME Programme. These components include:
   - Syllabus / Curriculum development
   - Blended Learning Course conduction
   - Standard Operating Procedures
   - Course Fees
   - Publicity & Promotion (Blended Learning)

iii. To facilitate in uploading required information in Management Information System (MIS) developed by PMU to enable enrolments and certifications through Spokes.

iv. To devise marketing and awareness programs, which are key components for the success of scheme.

v. To develop e-Content for blended-learning programs.

vi. To establish Lab/e-Lab facilities.

vii. To create suitable processes/ mechanisms in respect of the following to achieve the envisaged project objectives/deliverables in the respective thematic areas:
   - Access to Labs/ e-Labs
   - Promotional and awareness related activities
   - Feedback mechanism
   - Collection of success stories, etc.

- To develop/ design courses and course content for Bridge Courses

viii. To share the respective registered user data with the SPOKE on a monthly / timely / on request basis.

ix. To liaise with academic institutions, NIELIT/C-DAC Centres, Training Partners of SSC NASSCOM, and Institutes under line ministries, State Government and associated departments for overall implementation of the program for achieving the target.

x. To setup a Technology Sub-Committee (TSC) as an internal mechanism in the identified thematic area to evolve standard operating procedures connected with development and delivery of blended-learning programs, including identification of equipment for setting up of labs/ e-Labs.

xi. To create reports/ journals/ blogs (with support of Spokes), and conduct seminars, workshops, discussion forums, etc., which would inter-alia include the following aspects

- New skill-sets/ job roles as a result of emerging/ disruptive technologies
- Significance of re-skilling/ up-skilling/ continuous skilling in the online/ blended mode as a potent tool to stay relevant
- Challenges associated with flip over from conventional modes of training to online/ blended mode of training
- New and emerging technologies that are shaping the future of IT; etc

4.1.2 Co-Lead RC

i. **CRC** would designate a person as RC Head to promote interface across the Parties, review of various activities, implementation planning, provide the requisite logistics and co-ordination support in close liaison with other stakeholders.

ii. Act as an overarching mechanism, to monitor, audit, support and ensure that all components of the Programme are being administered as per the norms and guidelines of the FutureSkills PRIME Programme.

iii. To facilitate in uploading required information in Management Information System (MIS) developed by PMU to enable enrolments and certifications through Spokes.

iv. To devise marketing and awareness programs, which are key components for the success of scheme.

v. To create suitable processes/ mechanisms in respect of the following to achieve the envisaged project objectives/deliverables in the respective thematic areas:

- promotional and awareness related activities
- feedback mechanism
- collection of success stories, etc.

vi. To share the respective registered user data with the SPOKE on a monthly / timely / on request basis.

vii. To liaise with academic institutions, NIELIT/C-DAC Centres, Training Partners of SSC NASSCOM, and Institutes under line ministries, State Government and associated departments for overall implementation of the program for achieving the target.

viii. To create reports/ journals/ blogs (with support of Spokes), and conduct seminars, workshops, discussion forums, etc., which would inter-alia include the following aspects

- New skill-sets/ job roles as a result of emerging/ disruptive technologies
- Significance of re-skilling/ up-skilling/ continuous skilling in the online/ blended mode as a potent tool to stay relevant
- Challenges associated with flip over from conventional modes of training to online/ blended mode of training
- New and emerging technologies that are shaping the future of IT; etc

4.2 SPOKE

i. To establish a team and identify a single point of contact to facilitate communication, interactions, implementation, planning, and review of various activities across teams and corresponding parties involved.

ii. To create an enabling mechanism for supporting **RC** in institutionalization of Blended Learning Mechanisms in the identified thematic area.

iii. To pro-actively support **RC** for establishing/developing the followings to achieve the envisaged project objectives/deliverables in the identified thematic area:

- Blended Learning Course Conduction in respective Technology
- To arrange regular doubt clearing sessions for the enrolled students
- Promotional and awareness activities
- Collection of success stories

iv. To ensure the regular updating of MIS within the **RC** operated tools.

v. To provide status and plan of action w.r.t milestones for achieving the deliverables, access of e-Lab, promotional activities, candidates/beneficiary details, Financials/Course Fees, etc.

vi. To submit the Monthly Report (Technical & Financial) and other necessary documents to **RC** in a timely manner.

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5. SPOKE OUTCOMES/ DELIVERABLES

The Blended Learning courses in the emerging technologies envisage that the following categories of courses would be conducted by SPOKE.

Sl No	Technology	Course Name	Target
1	Cyber Security	Pragmatic Approach to Cyber Security	200*
2	Blockchain	Introduction to Blockchain	100*
3	3D Printing	3D Printing and CAD Modeling	100*

- If any updations by lead centre in terms of course fee/revenue sharing, spoke share will vary accordingly
- Any new courses launched by the **RC** are eligible to be conducted by SPOKE upon mutual consent from both the parties

*Minimum target to be achieved till Dec 2023.

6. MONITORING & EVALUATION OF PROGRAMME

6.1 Bi-Monthly Review: The FutureSkills PRIME envisages to bring about a paradigm shift in the way re-skilling/ up-skilling is imparted in the country. The Programme has multiple components offering varied skilling options across the board. The bimonthly review would entail a detailed technical and financial review by **RC**.

6.2 Impact Assessment Study: An impact assessment would also be carried out at the end of the tenure to gauge the actual reach and outcomes of the Programme.

7. TARGET AUDIENCE

- Students of 3rd year and 4th year students of B.Tech, M.Tech and MCA*
- Fresh Recruits – Internship/apprenticeship
- IT employees in IT firms and non-IT firms
- Non-IT employees who use new and emerging technologies
- Re-skill/Up-skill employees whose IT skill is obsolete
- Central Govt. & State Govt. employees
- PSUs and Autonomous (Govt. Employees)

* They will be applicable for the incentive program only if they have internship / apprenticeship certificate.

8. DETAILS OF INCENTIVES / FINANCIAL ASSISTANCE TO BRIDGE COURSE PARTICIPANTS

Incentive Model: The Incentive model would take into account that in order to motivate aspirants, a virtual Skills Wallet (provided by NASSCOM & PMU Admin) would be assigned to each candidate on registration. When a candidate registers for a bridge course, his/her Skills Wallet would be provided with an incentive amount of Rs. 3,000, which would get encashable once s/he successfully gets assessed and certified. The maximum ceiling of incentive per course would be limited to a maximum of 50% of the course fee paid by the candidate. In case of a student, he/she should have internship / apprenticeship certificate / offer letter in hand when applying for incentive.

A total of 5000 participants are eligible for the incentives under each emerging technology. All the participants trained by LRC, CRC and all the SPOKE are eligible for incentives. Participants are eligible to get incentives only if they clear the assessment conducted by SSC NASSCOM as per the GoI guidelines

9. FINANCIAL DETAILS

The details of Course to be conducted, Course Fee and its distribution across parties are as follows:

Reimbursement

- Payments would be received by **RC** from SECTOR SKILLS COUNCIL NASSCOM (SSC NASSCOM) / Lead Resource Centre post 150 (One hundred fifty) days from the date on which the relevant Bridge Course is sold to the Subscriber and shall be subject to deductions on account of applicable taxes, gateway fee etc.
- **RC**, upon receipt of the Bridge Course Fee, request SPOKE, in writing, to raise an GST invoice for the value as indicated in Annexure-II. **RC** shall, upon receipt of an invoice form SPOKE, pay the same within 30 (thirty) days.
- If payment to SPOKE, is not made by **RC**, in accordance with the terms hereof, the Parties shall, in good faith, take necessary measures to determine the causes of delay and resolutions thereof.
- For any change in course fee, **RC**, shall intimate in writing to the SPOKE and an amendment for the same will be made between the Parties considering all applicable clauses of this MoU.

Revenue Sharing

- For the mentioned Bridge Courses, revenue would be shared between **RC** and the **SPOKE** in the ratio of 40:60 respectively

Activity	Cost for Pragmatic Approach to Cyber Security	Cost for Introduction to Blockchain**	Cost for 3D Printing and CAD Modeling
Base price of the course (a)	₹1017/-	₹1000 /-	₹3390/-
GST(18%) (b)	₹183/-	₹180 /-	₹610.20/-
Total (c) = (a) +(b)	₹1200/-	₹1180 /-	₹4000.20/-
FSP platform payment gateway charges @2.6% (d)	₹37/-	₹36 /-	₹122.72/-
A Terms and Conditions retained by NASSCOM till the receipt of tax refunds (e)	₹22/-	₹22 /-	₹74/-
Cost to LRC inclusive of GST (f) = (c) –(d) –(e)	₹1141/-	₹1122 /-	₹3803.28/-
Actual cost to LRC (g)	₹967/- (after removing GST)	₹951 /-	₹3193/- (after removing GST)
RC Share	₹387/-	₹380/- (40% of (g))	₹1277.23/- 40% of (g))
SPOKE share	₹580/- (60% of (g)	₹571/-	₹766.34/-

** For the enrolments post 31st Mar 2023, the revenue sharing details will be communicated separately.

NB: Cost mentioned in column (e) - the TDS retained by NASSCOM till the refund is received shall be transferred and retained by the Lead Centre.

- Any changes in the course fee / discount will be communicated to the SPOKE.

10. Copyright and Intellectual Property

Means all proprietary inventions, processes, product designs, know-how or any other intellectual property of a Party or any other third party which is associated with such Party in development of any products and any other materials/application in any media and information, whether registered by such Party or not and here after acquired or developed by such Party. It also includes any service mark, commercial name, trademark, or trade name, whether registered by a Party or not or hereafter acquired or developed, that is associated with each institution.

All pre-existing IP shall be owned by the Party which owns it. The present course materials which are either in print, audio/video or electronic form belonging to and/or developed exclusively by the respective parties shall continue to remain the exclusive property of the respective parties.

Any Intellectual Property in respect of any training materials which may be developed in future by respective organizations for the use of students who

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are enrolled for these programmes shall be exclusively owned by the respective parties who created / developed it.

Intellectual property in the form of patents, copyrights etc. arising out of work carried out jointly under these collaborative programmes will be decided in writing in advance before commencement of work.

Overall, all parties shall strive to protect the interest of other in the context of IPRs and agrees to do nothing which is void of such laws and regulation of the land with respect to IPRs.

11. Use of Name

Either party may use other's name for the purpose of identifying above mentioned programmes and shall not use, or be entitled to use, parties' name, trademarks, logos, trade name or any other intellectual property in any other way without the prior written consent or as may be authorized under a separate written consent. Upon termination by efflux of time, or prior determination thereof as provided for herein, of this MoU either party shall immediately stop using name, trademarks, trade name and logos, etc.

12. Validity

This MoU will come into effect on the date of signature of both the parties and will remain in force for _1_ years until either of the two parties serves a written notice to the other at their addresses as indicated vide MoU by a registered post of its intention to terminate the MoU in which case it will terminate one month after the receipt of such a notification. The agreement can be renewed on expiry on mutually agreed terms and conditions.

Notwithstanding anything in this MoU, neither Party shall be liable to the other for any failure to achieve any of the objectives and undertakings herein.

However, commitments made by either party in respect of personnel hired or equipment ordered, under this MoU would be honoured by respective parties.

13. Termination

This MoU may be terminated by either of the parties by giving one month prior written notice to the other side sent through RPAD/Speed Post AD. In such an event, both parties shall complete their respective responsibilities

outlined under this MoU until the completion of running session / or academic programmes to which students may have been enrolled prior and up to the date of the notice of termination.

14. Amendment/Renewal or Extension

No amendment or modification / renewal or extension of this MoU shall be valid unless it is made in writing jointly by SPOKE and RC. The modification / change / renewal or extension shall be effective from the date on which they are made / executed unless otherwise agreed to in writing.

15. Matters not provided in the MoU

If any doubt arises as to the interpretation of the provisions of this MoU or as to matters not provided therein; the parties to this MoU may consult each other for each such instance and resolve those doubts in good faith and spirit.

16. Dispute Resolution and Jurisdiction

In case any dispute/claim arises between the Parties with respect to the MoU, including its validity, interpretation, implementation or alleged material breach of any of its provisions or regarding a question, including the questions as to whether the termination of this MoU by one Party hereto has been legitimate, both Parties hereto shall endeavor to settle such dispute amicably. If the Parties fail to bring about an amicable settlement within a period of 30 (thirty) days, the dispute shall be referred to the sole arbitrator appointed by both parties. If both parties do not agree on the name of a sole arbitrator, they will appoint one arbitrator each and these two arbitrators will appoint a third arbitrator and the arbitration proceedings will be conducted by the panel of these three Arbitrators. Arbitration proceedings shall be conducted in accordance with the provisions of the Arbitration and Conciliation Act, 1996 and Rules made there under, or any legislative amendment or modification made thereto. The seat and venue of the arbitration shall be Hyderabad. The award given by the arbitrator shall be final and binding on the Parties. The language of arbitration shall be English. The common cost of the arbitration proceedings shall initially be borne equally by the Parties and finally by the Party against whom the award is passed. Any other costs or expenses incurred by a Party in relation to the arbitration proceedings shall ultimately be borne by the Party as the arbitrator may decide.

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17. Force Majeure

The parties to this MoU shall not be liable to each other for failure or delay in the performance of any of their obligations under this MoU for the time and to the extent such failure or delay is caused by riots, civil commotion, wars, hostilities between nations, government loss, court orders in rem, orders regulations, embargos, action by the government(s) or any agency thereof act of God, storms, fires, accidents, strikes, sabotages, pandemic, epidemic, explosions; or other similar or different categories beyond the reasonable control of the respective parties to this MoU.

In the event that either party is wholly or in part prevented from or hindered in carrying out or observing any of the terms or conditions of this MoU for any cause set forth herein above, such party shall give written notice to the other party by the most expeditious means as soon as possible after the occurrence of the cause relied on, giving full particulars of the reason for such prevention or hindrances, and the parties shall in good faith consult each other and take necessary measures for the resolution of the affairs so prevented or hindered.

18. Severability

If any provision of this MoU becomes or is declared illegal, invalid, or unenforceable, the provisions will be divisible from this MoU and deemed to be deleted from this MoU and the rest of the MoU shall be valid and binding However, if the deletion substantially alters the basis of this MoU, the parties will negotiate in good faith to amend the provisions of this MoU to give effect to the original intent of the parties.

19. Confidentiality

i. It is envisaged that the Parties or any members of their respective Groups or any of their respective Agents may from time to time disclose Confidential Information relating to its current or proposed business to each other. In consideration of such Confidential Information being made available to both parties, the first party and the second party agree that any disclosure or dealings between the Parties will be subject to the terms and conditions of this MoU. Both Parties will treat and keep all Confidential Information confidential and will not, without the Disclosing Party's prior written consent, directly or indirectly communicate or disclose (whether in writing or orally or in any other manner) Confidential Information to any other person other than in accordance with the terms of this MoU (for the

avoidance of doubt, this will also prohibit discussing the same with any Disclosing Party Group employees other than those involved in connection with the Project).

ii. Intellectual Property and Trademarks - Both the parties will continue with their respective trademarks including that of any improvements or work done at its own cost for this MoU.

iii. The obligations undertaken hereto shall not apply to any information obtained which is or becomes published or is otherwise generally available to the public other than in consequence of any willful or negligent act and such obligations shall survive the termination of this MoU.

iv. Parties may enter into a separate NDA if desired.

20. Headings

The heading used in the MoU is inserted for convenience / reference only and shall not affect the interpenetration of the respective clauses and paragraphs of this MoU.

21. Non-Waiver

The failure or neglect by either of the Parties to enforce any of the terms of this MoU shall not be construed as a waiver of its rights preventing subsequent enforcement of such provision or recovery of damages for breach thereof.

22. Assignment and Transfer

Any and all rights, duties and obligations of the parties under this MoU shall not be transferred or assigned by either party to any third party without prior written consent of the other party.

23. Representations and Warranties

The parties hereby represent and warrant to each other:

a) That it is duly established and existing under the laws of jurisdiction stated against its name hereinabove and has the power and authority to sign this MoU and implement the Project agreed to herein.

b) That it has the requisite legal power and authority to enter into this MoU, perform and comply with its duties and obligations hereunder.

c) That this MoU constitutes legal, valid and binding obligations enforceable against it in accordance with the terms hereof:

d) That the execution, delivery and performance of this MoU have been duly authorized by all requisite actions and will not constitute a violation of (i) any statute, judgment order, decree or regulation of any court, Governmental Instrument or arbitral tribunal applicable or relating to itself, its assets or its functions or (ii) any other documents or to the best of its knowledge any indenture, contract or agreement to which it is a party or by which it may be bound.

e) That there are no actions, suits or proceedings pending or, to the best knowledge threatened against it before any Court, Governmental Instrument or arbitral tribunal that restrain it from performing its duties and obligations under this MoU; and that no representation or warranty made herein contains any untrue statement.

f) Parties shall respect and abide by laws of India in carrying out respective responsibilities/fulfilling obligations under this MoU. Parties shall not commit any act/omission which will be illegal/unlawful/unethical/immoral.

24. No partnership

Nothing in this MoU shall be deemed to neither constitute or create an association, trust, partnership or joint venture between the Parties nor constitute either party the agent of the other party for any purpose.

25. Relationship between parties

It is clearly understood by the parties that this Memorandum does not create any employer-employee agency relationship between the parties.

26. Address for Communication

Any notice or communication with reference to this MoU, unless otherwise specified herein shall be deemed to be validly sent, if dispatched by registered post acknowledgement due to the other party at the following respective address.

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CHAITANYA BHARATHI CBIT HYDERABAD INSTITUTE OF TECHNOLOGY (U)

Contact Person for _SPOKE_:

Technology	Cyber Security	Block Chain	3D Printing & CAD Modelling
Name	Sri. S. Rakesh	Dr. Sangeeta Gupta	P Anjani Devi
Email ID	srakesh_it@cbit.ac.in	sangeetagupta_cse@cbit.ac.in	panjanidevi_mech@cbit.ac.in

Contact Person for C-DAC:

Technology	Cyber Security	Block Chain	3D Printing & CAD Modelling
Name	Jyostna G	Radhika K	Sharan B
Email ID	gjyostna@cdac.in	radhika@cdac.in	sharan@cdac.in

Either party may by a similar written notice to the other party change his / her aforesaid addresses.

27. Indemnity

Either party shall save and indemnify, protect and keep saved and indemnified the other party against all claims, actions, losses, costs, damages, expenses, legal suits and other proceedings resulting from and arising out of actions, inaction or negligence of either party or their employees, agents or for violation of any provision of this MoU or any provision thereof by any party or its employees or for infringement of any patent, trademark copyright of any third party.

28. Limitation of Liability

Except the circumstances of mens rea and gross negligence, in no event will the parties be liable to each other for any incidental, consequential, special, and exemplary or indirect damages, or for lost profits, lost revenues, or loss of business arising out of the subject matter of this MOU, regardless of the cause of action, even if the party has been advised of the likelihood of damages.

29. ANNOUNCEMENT

From the date of signature, both the parties can announce the existence of this MoU. Both the parties can submit the MoU for any regulatory or Government related purposes.

Centre for Development of Advanced Computing Hyderabad

CBIT

C-DAC and Chaitanya Bharathi Institute of Technology can announce about the MoU on their websites.

30. OTHER TERMS AND GENERAL CONDITIONS:

- All the documents prepared and used by the parties wherein Brand Name, LOGOs or photos, individual names, physical/virtual property of the other party is used for any purpose relating to the proposed MoU should be formally approved by the designated competent authority of the other party
- While the MoU is under force, both the parties should refrain from poaching any resources presently working with the respective entities. They should not be employed directly or in-directly by any party without the consent in writing of the other party
- The verification of the documents in support of the candidate's eligibility criteria such as Educational qualifications lies with _SSC NASSCOM__ and all the rights whether to accept or reject the admission of any candidate into the proposed course
- Notwithstanding anything contained in the rules, the administrative rules, regulations, discipline and conduct rules procedures being applicable to the regular students of the university are applicable to the participants in mutatis-mutandis
- Wholly or partly both parties are not responsible to each other for refund of the capital cost losses on account of damage to the property or infrastructure, any insurance coverage, payment of Insurance premium, processing of claims towards equipment/services.

31. Entire agreement:

This MoU constitutes the entire Understanding between the Parties. Any and all written or oral agreements, representations or understandings of any kind that may have been made prior to the date hereof shall be deemed to have been superseded by the terms of this MoU.

In witness whereof, both the parties jointly agree to all the provisions as set out above and have set their hands, signed an affixed their respective seal through their authorized representatives, this ___ day of _____ 2023.

This MoU has been signed in two originals and each party has one signed original in its possession.

Signed, Sealed and Delivered by by

For and on behalf of C-DAC, Hyderabad

Lakshmi

Name: P R Lakshmi Eswari
Designation: Director

P R LAKSHMI ESWARI / पी आर लक्ष्मी इश्वरी
Director / निदेशक
प्रगत संगणन विकास केंद्र (सी-डैक)
Centre for Development of Advanced Computing (C-DAC)
प्लाट नंबर 6 एवं 7 हार्डवेयर पार्क
Plot No: 6 & 7, Hardware Park
सर्वेक्षणनं. श्रीशैलम राजमार्ग
Sy. No: 1/1, Srisailam Highway,
पहाड़ी शरीफ वाया (केशवगिरि पोस्ट)
हैदराबाद - 501510 / Hyderabad-501510

Signed, Sealed and Delivered

For and on behalf of _____

Name: Prof. P. Ravinder Reddy
Designation: Principal

Principal
Chaitanya Bharathi Institute of Technology
(Autonomous)
Gandipet, Hyderabad-500 075.

In presence of

1. (M.V. NAGESWARARAO)
Manager, C-DAC

2. (JYOSTNA G)
Joint Director C-DAC

In presence of

1. Head, CSE, CBIT

2. Professor, CSE, CBIT.

Annexure-I

Bridge Module Definition

National Skill Development Agency (NSDA) definition of Bridge Course is as follows: "Bridge Course is a course designed to equip students to take up a new subject or course by covering the gaps between the students' existing knowledge and skills and the subject or course prerequisites and assumed knowledge". Each Bridge module is essentially a preparatory level course (as per NSDA definition) for the accredited Occupational Standard (OC) of the respective technology verticals under FutureSkills PRIME.

Bridge Course 1: Pragmatic Approach to Cyber Security - Towards Detecting and Mitigating Cyber Security Threats

Technology: Cyber Security

1. Course Objective

The objective of this module is to equip IT professionals with strong fundamentals in the Cyber Security domain. This course builds core competencies in the area of Network, End System and Application Security that acts as a bridge for advanced deep skilling courses which are aligned to National Occupational Standards (NOS) defined under the National Skill Qualification Framework (NSQF). This course offers a virtual lab through which participants gains hands-on training on various security tools with an aim to detect and mitigate Cyber Security threats

2. Learning Outcomes

- Analyze the live network traffic for detecting the attacks that abuse the TCP/IP Network Protocol vulnerabilities
- Use of security tools for analyzing the network traffic and end system vulnerabilities
- Leverage the Cryptography concepts for protecting the data
- Understand application vulnerabilities and their mitigation techniques
- Understand OWASP Top 10 Vulnerabilities
- Understand the latest trends in Malware and Cyber Attacks
- Design Defensive Network architectures
- Hardening the Operating System
- Understand Secure Development Life Cycle (SDLC)

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3. Course Prerequisites

Familiarity with Linux Operating System

4. Conduction Mode

Online/Blended

5. Syllabus

As per the guidelines, the bridge course is mapped to the Qualification Pack/National Occupation Standard (NOS). This course would consist of one or more Bridge Modules

1. Linux Environment
    a. Basic commands & File Structure
    b. Linux Installation
    c. Shell Scripting
    d. TCP/IP Cyber Security perspective
    e. Understanding TCP/IP towards Cyber Security
    f. Cyber Security: Background and Current Trends
2. Security Threats & Vulnerabilities
    a. Common Network Attacks
    b. Security Threats & Vulnerabilities
    c. Cyber Security Current Trends
3. Cryptography and Network Security
    a. Cryptography & its applications
    b. Network Security & protocols for secure communication
4. Overview of End system security
    a. OS Security and Hardening
    b. Authentication, Authorization and Accountability
    c. Event Log Analysis
    d. Endpoint Security Solutions
5. Overview of Network defence
    a. Network Components (Firewall, IDS, Router)
    b. Defensible Network Architecture
6. Application Security
    a. Common Applications vulnerabilities (Buffer, heap overflows)
    b. Web Application Security
    c. OWASP Top 10

7. Threat Modelling
8. Overview of Malware Analysis

6. Course Duration

The total duration of the course is 90 hours (40% Theory sessions and 60% Demonstration & Labs). This course would be spread across either three to five weeks.

7. Lab Details

Topic	*Objective*	*Tools*
Linux Environment	•To get familiar with Linux commands and file structures •Write shell scripts for routine tasks	• VMware • Bash
TCP/IP Cyber Security perspective	•Demonstrate the understanding of TCP/IP Protocols •Analyze the network traffic for protocol vulnerability	• Wireshark • Tcpdump
Security Threats & Vulnerabilities	• Understand the common network attacks, detection and mitigation techniques • Exposure to tools and techniques for identifying the vulnerabilities	• Cain and Abel • Ettercap • Nmap • Nessus • Metasploit
Cryptography and Network Security	• Understand the concepts of cryptography and leveraging these techniques in the Network Security • Understand various network protocols • Creation of Certification Authority and Integration with Apache Web Server • Configuring E-mail & Remote Access Applications	• Openssl • Apache Server
Overview of End System Security	• Hardening of latest Windows OS and one Linux distribution • Understand SELinux concepts • Understand and analyze events for detecting the cyber attack • Understand different endpoint security solutions	• Windows & Linux VM

Overview of Network Defence	• Configuration of Firewall, IDS & Router	• IPTables • Demos of Firewall, IDS, IPS
Application Security	• A case study demonstrating Web Application vulnerabilities and hardening the application • Understand the web traffic using various security tools • Understand Top 10 vulnerabilities	• Nikto, OWASP ZAP, Dirbuster, Ssltest, testssl, httpprint & Burpsuite
Threat Modelling	• Understand threat attack surface • A case study demonstrating threat modelling for an application	• Microsoft Threat Modeling Tool • OWASP Threat Dragon tool
Malware Analysis	• Understand different types of malware • Exposure to Static and Dynamic Analysis	• CFF Explorer, Strings, procmon, regshot

1. Course Objective

Blockchain Certification Training course provides the participants with insights into Blockchain technology and its platforms. It provides an overview of the structure and mechanism of Blockchain. The participants will be able to understand how transactions are stored in a block and mined on a Blockchain. The course acts as a bridge for advanced deep skilling courses which are aligned to National Occupational Standards (NOS) defined under the National Skill Qualification Framework (NSQF). This course offers a virtual lab through which participants gain hands-on training on popular tools/platforms used in developing core Blockchain. (https://futureskillsprime.in/course/introductionto-blockchain-technology)

2. Learning Outcomes

- Provides insights into Blockchain technology and its platforms. Provides an overview of the structure and mechanism of Blockchain.
- Knowledge about popular tools/platforms used in developing core Blockchain.
- Course includes sessions on Ethereum Blockchain platform. Participants would be able to know how to deploy smart contracts on Ethereum.
- Use-cases will ascertain how Blockchain technology is shaping the future of the world.

3. Course Prerequisites

Basic programming skills and proficiency in any programming language such as Java, C++, or Python

4. Conduction Mode

Online/Blended

5. Syllabus

- Introduction to Blockchain-Distributed Ledger Technologies.
- How to Develop basic codes using blockchain tools/platforms.
- Interpret the applications of blockchain across different industry verticals.
- Prior Learning Module (includes front end development approch through CSS, HTML, JavaScript, PHP and a database, Python/Go language/Java/ Node Js- Design process including Work flow and Problem solving

approach)

6. Course Duration

The total duration of the course is 90 hours (40% Theory sessions and 60% Demonstration & Labs). This course would be spread across 90 days.

Course Objective

Objective of this course is to demonstrate the viability of utilizing Additive Manufacturing technology to develop product prototypes and Develop skills to allow for prototype models for a range of products to be produced. This course acts as a bridge for advanced deep skilling courses which are aligned to National Occupational Standards (NOS) defined under the National Skill Qualification Framework (NSQF).

3. Target Audience

- IT professionals, Non-IT professionals working in IT/ITeS industries
- State Govt. & Central Govt. Employees
- Employees from PSUs and Autonomous institutions
- Faculties of educational institutes
- Students of 3rd year and 4th year of Btech, Mtech or equivalent degrees.
- Fresh Recruits
- Interns/Apprentices.

Note: They will be applicable for the incentive program only if they have internship/apprenticeship certificate.

4. Course Prerequisites

Familiarity with Mechanical CAD and Manufacturing Technologies

5. Conduction Mode

Online/Blended

6. Syllabus

Module1 - Introduction to Additive Manufacturing

- Evolution of 3D printing
- Various 3D printing technologies
- Fused deposition modelling (FDM) in detail

Module 2 - CAD Modeling

- Creating support less designs
- Optimizing for orientation
- Achieving accuracy and fit

Module 3 - Prototyping using 3D Printer

- Design guidelines for printing
- Designing assemblies
- converting CAD model to STL format
- Print settings

7. Course Duration

The total duration of the course is 90 hours (40% Theory sessions and 60% Demonstration & Labs). This course would be spread across 90 days.

MEMORANDUM OF UNDERSTANDING

Between

ACD Communications Pvt. Ltd.

&

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

Memorandum of Understanding

This **Memorandum of Understanding** ("MOU" also called "Agreement") is made as of the 19th of August, 2022 between **Chaitanya Bharathi Institute of Technology, Hyderabad** (hereinafter called "**CBIT(A)**" or "**Institute**") and M/s **ACD Communications** (having its office at Plot No.43, IDA, Phase-I, Cherlapally, Hyderabad – 500 051) hereinafter called "**ACD Communications**" or "**Industry**".

Preamble:

This Memorandum of understanding is made between CBIT (A) and ACD Communications **on** 19th August, 2022.

Between

Chaitanya Bharathi Institute of Technology (A), Gandipet, Hyderabad, established in the year 1979, esteemed as one of the premier engineering college in the states of Telangana and Andhra Pradesh. (Herein referred to as CBIT which expression shall unless repugnant to the context of the meaning) as FIRST PART

And

ACD Communications, Plot No.43, IDA, Phase-I, Cherlapally, Hyderabad – 500 051. (Herein referred to as **ACD Communications** which expression shall unless repugnant to the context of the meaning) as SECOND PART

1. Introduction

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (CBIT (A)), established in the Year 1979, esteemed as the Premier Engineering Institute in the States of Telangana and Andhra Pradesh, was promoted with an Objective to facilitate the Best Engineering and Management Education to the Students and contribute towards meeting the need of Skilled and Technically conversant Engineers and Management Professionals, for the Country that embarked on an Economic Growth Plan. In its four decades of existence, all the Stake Holders of the Institute relentlessly endeavored to position CBIT (A) as an Institution that is a Leader and an Innovator in the Ecosystem of Engineering Higher Education and Management. With the Students being the singular Objective, the Institute has established excellent Infrastructure such as State-of – the Art Laboratories, spacious Library with Printed and Digital Collection of Books and Journals, Sports, Hostel, and other Infrastructure for Research,

Innovation, Incubation, Entrepreneurship, Extra and Co-Curricular Engagements with a total built-up Area of about 57,714 Sq. Mts., in the serene Ambience of 50 Acres to inspire, encourage and pursue Academics. In its relentless strive for Academic excellence, CBIT (A) has scaled great heights both Nationally and Internationally in Industry and Global Universities.

ACD Communications was established in the year 1999 and has become a leader in the design, development, manufacture and marketing of state of the art HF, V/UHF and Microwave Antennas, Components and Sub-Systems for applications like GSM, CDMA, Satellite, and Wireless Local Loop as well as Defense applications like Electronic Intelligence, Electronic Welfare for Airborne, Ship-borne, Vehicle and Submarine platforms base on either through built to print or built to spec mode. ACD Communications Pvt. Ltd. is dedicated to providing high class customer service and high quality products. ACD maintains high quality standards and has been certified for ISO 9001:2015. ACD is a registered vendor for all the major DRDO Laboratories like DLRL, DRDL, RCI, ADE, DARE, DEAL, LRDE, DL, PGAD, BROHMOS and Public sector units like BEL, ECIL, BEML, BDL, BSNL etc.

ACD Communications employs modern equipment available for production and development testing. It utilizes Vector Network Analyzers upto 40 GHz for development and production testing. They are equipped with plotters and computer printouts for recording of test parameters. And also it is equipped with Anechoic Chambers and Open Test Ranges for Antenna evaluation.

2. **Recitals**

'ACD Communications' is interested in engaging with CBIT(A) in areas of mutual interest as framework outlined below but not necessarily restricted to those mentioned in 2.1 to 2.6.

CBIT(A) is having faculties with expertise in the area of Electronics & Communication, Electrical, Mechanical, Bio-Tech, Chemical, CSE, IT and other emerging technologies areas, whose services can by availed by MSME Industries in Hyderabad to develop new products/process and software required by the customers and the society. Ministry of MSME, GOI, has approved MSME Incubation Centre at CBIT (A) to conduct various Programs. The services of Experts available with CBIT (A) can be availed by 'ACD Communications', to

develop new products/process and software required by the customers and the society. The Proposed Interaction will also help students of CBIT (A) to have industry interaction and involvement in development projects taken up by 'ACD Communications' along with CBIT (A) or live projects being carried out by 'ACD Communications' for other organizations under their internship. The industrial visits by the students will provide them with an exposure to various equipment, design and manufacturing process etc.

'ACD Communications' is interested in engaging with CBIT (A) in areas of mutual interest with focus areas as follows.

2.1 Innovative designs and development in the fields of Electronics & Communications, Antennas and CDMA / GSM Communications.

2.2 In the Design & Development, Manufacture and Deployment of infrastructure in the areas of Antennas

2.3 In the Design & Development, Manufacture and Deployment of infrastructure in the areas of Broad Band Horns ¬ Filters (HF to Microwave) ¬ Power Divider/ Combiners ¬ CDMA/ GSM Patch Panel Antenna, Wi-Fi Antennas etc.

2.4 In the Design & Development, Manufacture of Antennas for Wi-Fi, Wi-Max, GPS and Satellite communication.

2.5 Other areas of mutual Interest and jointly apply for Projects to funding agencies such as DST, AICTE and etc.,

2.6 'ACD Communications' will explore to incubate new Ideas using facilities of CBIT (A) incubation center with due approval.

With this MoU, Chaitanya Bharathi Institute of Technology, Gandipet, Hyderabad would like to create a new model of Industry-Institute collaboration that will serve the dual purpose of providing practical knowledge/ exposure to the students and a source of continuous research / technical interaction for the Industry.

Terms and Conditions

The Following are the modalities that are agreed under the provision of this MoU.

Setting up of Point-of- Contact:

The Industry and the Institute shall nominate a faculty and an employee respectively, as their Point-of-Contact for each other. Any exchange of official communication related to implementation of modalities mentioned below shall be through the Point-of –Contacts only. Both the parties shall let others informed if there are any changes in Point of Contact.

Industrial Training: The Industry shall provide certified training of duration not less than 2 weeks to the interested students of the Institute who have completed II SEM course work, , during summer vacation in basic/advanced area of the industry's expertise . The industry shall nominate an employee as a coordinator for this activity. The industry is expected to conduct at least one test to evaluate the performance of students at the conclusion of the training. Provisions should be made to record daily Attendance/ Performance of the students that can be shared with the institute on request. The industry shall provide the successful students with a 'certificate –of-completion' after training.

BE Projects: The Industry shall provide provision for the interested student teams of Final year, BE to carry out their projects at the industry, for duration of complete one Semester. The student-teams, working on a project shall be jointly guided by the institute and industry. Institute shall allot a faculty member to guide them in institute and the industry shall allot appropriate employee to guide each team at their facility. Students should be allowed to present their work in the evaluation seminars, which will be conducted during/end of the semester.

ME Projects: The Industry shall provide provision for the interested students of Final year, ME to carry out their projects at the industry, for duration of not less than 9 months. The students working on a project shall be jointly guided by the institute and industry. Institute shall allot a faculty member to guide them in institute and the industry shall allot an employee to guide each team at their facility. The Industry shall share their hardware/software infrastructure with these students so that they can complete their project in specified time. Industry can provide these students with an aim/project that serves both parties interest i.e. students can work on/ part of live project and they should be allowed to present the same as their project at institute/conferences/events. During this period students should be given relaxations for attending their mid-exams, semester-end exams and other performance evaluation related activity at the institute as and when required. The point-of-contact at the institute can convey this information to the industry's point-of-contact as and when required.

Internship or Placement: The Industry shall provide Internship to the B.E. / M.E. students it deems fit for a duration of not less than one semester. The Industry may also have provisions to later absorb, these interns as regular employees as per their due recruitment process only if the industry deems them fit for their organization. This clause if completely provision and it is at the sole discretion and the interest of the Industry.

Curriculum Design: The Industry shall provide inputs that can help the institute to enhance it's syllabus, such that it meets the requirements of the industry and current job market. The Industry's engineers may be invited as guest members in BoS/Curriculum Design meetings by the Institute.

Guest Lectures: The Industry shall provide on request by the institute, experienced engineers to present technical guest lectures, in the domain of expertise of the Industry. The Industry can also share their innovative projects/innovative experiments, etc ., that it deems fit through these guest lectures.

Course Delivery: The Industry shall provide on request from Institute the services of experienced engineers as a guest/ visiting faculty for delivery of advanced courses/curriculum courses, that are domain of expertise of the Industry.

Industrial Visit: The Industry shall allow 1 Day Industrial visit by students at their facility, in order to motivate students. The visit shall be organized by allotting a faculty coordinator from the institute and similarly a coordinators by the Industry.

Research Services: The Industry may request the Institute for the services of a faculty, deemed as expert in a given domain by granting them research projects of Industry's interest and providing them with necessary funding for carrying out the research at the institute. The faculty shall visit the Industry as and when need arise to share/collaborate with the research.

Consultancy Services: The Industry may request the Institute for consultancy on the design/ test /review of their products /services/Design. The Institute based on the availability of domain expert faculty and required infrastructure may provide an estimate of cost and time to complete the consultancy job. The Industry may accept the proposal by providing the Institute with necessary Cost.

PhD guidance for Industry professionals: If any employee of Industry wishes to and secures admission in PhD then the Institute's domain expert faculty shall provide them with research guidance in the faculty's domain of expertise.

In consideration of the above recitals and the mutual benefits to be derived hereafter, the parties agree to enter into an Agreement as follows:

ARTICLE – I: Scope of the MoU

This MoU details the modalities and general conditions regarding collaboration between CBIT(A) and 'ACD Communications' for enhancing, within the country, the availability of highly qualified manpower in the areas of Innovative Designs of Electronics & Communications, Antennas and CDMA / GSM Communications, etc. The area of interaction will also include training and internship of CBIT(A) students to work on live projects at 'ACD Communications'. The areas of cooperation can be further extended through mutual consent.

ARTICLE – II: Scope and Terms of Interactions

Both CBIT(A) and 'ACD Communications' shall encourage interactions between the Institutes, Students & Staff and Engineers, of both the organizations through the following arrangements:

1. Both CBIT(A) and 'ACD Communications' will plan to work on Joint development projects of Mutual Interest and also explore for joint working on Govt. funded projects based on mutual agreement.
2. Practical training of CBIT(A) students at 'ACD Communications' in the form of One-full Semester Internship at 'ACD Communications';
3. Joint guidance of student projects/thesis in various technical areas including Microwaves, Antennas and related Technologies and other areas of National interest at CBIT(A) by 'ACD Communications' on mutual agreement.
4. 'ACD Communications' may depute its personnel as visiting faculty at CBIT(A) to supplement the teaching of any of the regular Course or specialized topics.
5. 'ACD Communications' may seek assistance/guidance of CBIT(A)'s Research & Entrepreneurship (R&E) Hub for initiating any start-up company to develop new products or process along with CBIT(A).
6. 'ACD Communications' will allow the industrial visits of students for half/full day to provide them with an exposure to various equipment, instrument, etc.
7. 'ACD Communications' may be allowed to showcase its business activities at the Seminar/Workshop/Conference, etc. if possible, at CBIT(A) that will be conducted time-to-time, with necessary permission from CBIT(A).
8. 'ACD Communications' may avail library facilities at CBIT(A) for combined projects for students' project work with necessary permission from the Institute.
9. There will be no restriction on the contents of the thesis and on publication of results of the thesis, subject to the condition that no Intellectual Property Rights can be secured for any part of the work which will be decided with mutual consent.
10. If the outcome of a project related to product development, process technology and design etc. which involves matter of secrecy and concern with security of the State and the Country, the same will not be allowed for publication/printing in any form such as Electronically/verbal, etc.
11. If the outcome of an Internship or the Thesis work or the combined project results into an intellectual property, for which rights can be secured, it will be decided on case-to-case basis depending upon the contribution from both the Institution. Similarly, sharing

of expenditure in securing such rights and income accrued through royalty etc. will be decided on case- to-case basis after mutual consultation and agreement.

ARTICLE-III: Sharing of Facilities

a) 'ACD Communications' shall extend its facilities for CBIT (A) students towards the smooth conduct of Internships, Industrial Visit and Projects depending on their convenience and availability of time & staff.

b) CBIT(A) and 'ACD Communications' may explore to share their respective important R&D facilities in order to promote academic and research interaction in the areas of cooperation depending upon availability of such facility without affecting their regular working.

c) CBIT (A) and 'ACD Communications' will permit the sharing of software and other components developed during any combined project work in the areas of cooperation, if permissible within the rules governing the two institutions. However, responsibility regarding confidentiality terms of the software and other materials during the exchange will rest on respective Head of department of the branch/section and 'ACD Communications'.

d) 'ACD Communications' provide access to the library facilities to the members of faculty and students as per the prevailing rules and norms.

ARTICLE-IV : Effective Date and duration of the MoU.

a) This MoU will be effective from the date of its approval by competent authorities at both ends.

b) The duration of the MoU will be for a period of 3 years from the effective date which may be extended after mutual understanding. However, if any Important combined projects are under execution, both parties agree to complete the work even though the MoU is not effective after three years.

c) During its tenancy, the MoU may be extended or terminated by a prior notice of not less than one month by either party. However, termination of the MoU will not in any manner affect the interests of the students & faculty who have been admitted to pursue a Training/Project under the MoU.

d) Any clause or article of the MoU may be modified or amended by mutual agreement of 'ACD Communications' and CBIT (A).

ARTICLE - V: IPR

Rights regarding publications, patents, royalty, ownership of software/ design/product developed etc. under the scope of this MoU, will be decided by CBIT and 'ACD Communications' based on Mutual agreement.

ARTICLE – VI: Confidentiality

During the tenure of the MoU both CBIT(A) and 'ACD Communications' will maintain strict confidentiality and prevent disclosure of all the information and data exchanged under the scope of this MoU for any purpose other than in accordance with this MoU.

Both CBIT(A) and 'ACD Communications' shall bind their respective personnel who come into possession or knowledge of any confidential information not to disclose the same to third parties without written approval of the disclosing party or use such confidential information for any use other than intended under this agreement or PROJECTS. Further both CBIT (A) and 'ACD Communications' should put in place adequate and reasonable measures to keep and store confidential information secure so as to prevent any unauthorized use.

CONFIDENTIAL INFORMATION shall mean any proprietary information, data or facts belonging to PARTIES collectively or severally, disclosed by the disclosing party under this agreement or any subsequent agreement, whether in writing, verbal or electronically, irrespective of the medium in which such information is stored, which is marked confidential or with any other words having similar meaning by the disclosing party, or specifically agreed to be kept confidential by the parties, or declared or identified so by the disclosing party before such disclosure or during the discussions. However confidential information should not include any data or information which:

(a) is or becomes publicly available through no fault of the receiving party,

(b) is already in the rightful possession of the receiving party prior to its receipt of such data or information;

(c) is independently developed by the receiving party without reference to the confidential information of the disclosing party

(d) is rightfully obtained by the receiving party from a third party or is in the public domain

(e) is disclosed with the written consent of the party whose information it is, or

(f) is disclosed pursuant to court order or other legal compulsion, after providing prior notice to the disclosing party.

ARTICLE – VII: AMENDMENTS

Any amendment and/or addenda to the AGREEMENT should be in writing and signed by the PARTIES hereto and shall only after such execution be deemed to form part of the AGREEMENT and have the effect of modifying the AGREEMENT to the extent required by such amendment or addenda.

ARTICLE – VIII: Compensation, Force Measure, Approval and Dispute Settlement

a) Compensation

Neither Party shall be liable to the other for any incidental, indirect, special or consequential damages, including but not limited, to loss of profits, loss of use, loss of revenues or damages to business or reputation arising out of or in connection with this Agreement or any aspect thereof. Neither Party shall be liable to the other by reason of the termination or expiry of this Agreement for compensation or damages on account of the loss of prospective business or on account of expenditures in expectation thereof.

b) Force Majeure

Any delay or failure in performance by the party to this Agreement, shall not constitute default hereunder to give rise to any claims for damages against said party, if any, to the extent caused by matters beyond the control of said party including but not limited to acts of Nature, Strikes, Lock outs or other concerted acts of workmen, fires, floods, explosions, blockages, embargoes, riots, war (declared or undeclared), rebellion, sabotage, extraordinary severe weather, pandemic situation, civil commotion and

criminal acts of third persons. If the project under execution is delayed by such force majeure, then upon the happening of such delay, the parties within 30 days of the happening of such event, shall give notice in writing, requesting for extension of time indicating the period for which extension is desired. Efforts will be made by both parties to give fair and reasonable extension of time for the projects at their discretion but no monetary allowances shall be made unless it is mutually agreed.

c) Approval of the MoU

This Agreement may be signed by authorized officials, whether by original signature or by scanned signature due to the current situation (provided the pdf document is accompanied with official email), signature/approval over official email, with the same effect as if the signature to any counterpart was an original signature upon the same instrument.

d) Dispute and Settlement

i) In case of any dispute (s), steps shall be taken by the parties to the MOU to settle the same through amicable negotiations. In case, dispute is not settled in negotiations, it shall be referred to Conciliator appointed by the designated official as per the bye law of CBIT(A), Hyderabad to arrive at a settlement.

In case dispute is not settled in conciliation proceedings, the same shall be referred to Arbitration for resolution of the dispute under Arbitration and conciliation Act 1996. The arbitration proceeding shall be conducted as per provisions of the Arbitration and Conciliation Act, 1996. The dispute shall be referred for arbitration to sole arbitrator to be appointed by the designated official (s) as per the bye law of CBIT(A) – Hyderabad. The award of the sole arbitrator shall be final and binding on both the parties. The venue of the Arbitration shall be at Hyderabad in India. The Award to be given by the Arbitration shall be a speaking award.

ii) Applicable Laws and Jurisdiction of Courts

Indian laws both substantive and procedural, for the time being in force, including modifications thereto, shall govern the MOU including the arbitral proceedings. The competent Courts at Hyderabad in the State of Telangana - India shall have sole jurisdiction. All questions, disputes, differences arising under, out of or in connection with this MOU shall be to the exclusive jurisdiction of Hyderabad courts in the State of Telangana.

For

ACD Communications
Hyderabad

By B. ADI LAKSHMI 19/08/2022

Name: ~~Miss B. Adhi Lakshmi~~

Managing Director

ACD Communications Pvt. Ltd. Hyderabad

Witness:

K. Bhramaramba 19/8/22

(Smt. K. Bhramaramba)

Technical Advisor

For

Chaitanya Bharathi Institute of Technology Hyderabad

By 19/8/2022

Name Dr. P. Ravinder Reddy

Principal

Principal
Chaitanya Bharathi Institute of Technology
(Autonomous)
Gandipet, Hyderabad-500 075.

Chaitanya Bharathi Institute of Technology (A) Gandipet, Hyderabad-75

Witness:

A.D. Sarma 19/8/22

(Dr. A.D. Sarma)

Director - Research & Development
R&E Hub, CBIT(A)
Gandipet, Hyderabad-500075

Director R&D

19/08/2022

(Dr. D. Krishna Reddy)

Head Department of ECE

HEAD
DEPARTMENT OF ECE
Chaitanya Bharathi Institute of Technology
Hyderabad-500 075

Memorandum of Understanding

This **Memorandum of Understanding** ("MOU" also called "Agreement") is made as of the 10th of February, 2021 between **Chaitanya Bharathi Institute of Technology, Hyderabad** (hereinafter called "**CBIT(A)**" or "**Institute**") and **College Bag Private Limited**, plot no 123&124, **Defence colony, Bairamalguda, Telangana**, India.

1. Introduction

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (CBIT(A)), established in the Year 1979, esteemed as the Premier Engineering Institute in the States of Telangana and Andhra Pradesh, was promoted with an Objective to facilitate the Best Engineering and Management Education to the Students and contribute towards meeting the need of Skilled and Technically conversant Engineers and Management Professionals, for the Country that embarked on an Economic Growth Plan. In its four decades of existence, all the Stake Holders of the Institute, relentlessly endeavoured to position CBIT(A) as an Institution that is a Leader and an Innovator in the Ecosystem of Engineering Higher Education and Management. With the Students being the singular Objective, the Institute has established excellent Infrastructure such as State-of – the Art Laboratories, spacious Library with Printed and Digital Collection of Books and Journals, Sports, Hostel, and other Infrastructure for Research, Innovation, Incubation, Entrepreneurship, Extra and Co-Curricular Engagements with a total built-up Area of about 57,714 Sq. Mts., in the serene Ambience of 50 Acres to inspire, encourage and pursue Academics. In its relentless strive for Academic excellence, CBIT(A) has scaled great heights both Nationally and Internationally in Industry and Global Universities.

College Bag private Limited was established in Nov, 2020 with registration with MSME(Corp. Identity No of Company : U45201TG2020PTC145773 dated 11-11-2020) . College Bag is a product based technical company which develops the products to make student lives easier and increase their productivity. College Bag Private Limited has a plan to wide spread its services throughout the country. By providing technical and innovation solutions, production development, and marketing.

2.0 Recitals

'College Bag private Limited' is interested in engaging with CBIT(A) in areas of mutual interest as framework outlined below but not necessarily restricted to those mentioned in 2.1 to 2.5.

CBIT(A) is having faculties with expertise in the area of Electrical, Mechanical, ECE, Bio-Tech, Chemical, CSE, IT and other emerging technologies areas, whose services can by availed by MSME Industries in Hyderabad to develop new products/process and software required by the customers and the society. Ministry of MSME, GOI, has approved MSME Incubation Centre at CBIT(A) to conduct various Programs. The services of Experts available with CBIT (A) can be availed by College Bag Private Limited, an MSME, to develop new products/process, software and incubate new ideas required by the customers and the society. The Proposed Interaction will also help students of CBIT (A) to have industry interaction and involvement in development projects taken up by College Bag Private Limited along with CBIT(A) or live projects being carried out by College Bag Private Limited for other organizations under their internship. The industrial visits by the students will provide them with an exposure to various equipment, design, software and manufacturing/business process etc.

College Bag Private limited is interested in engaging with CBIT(A) in areas of mutual interest with focus areas as follows.

In consideration of the above recitals and the mutual benefits to be derived hereafter, the parties agree to enter into an Agreement with scope of the work by College Bag Pvt. Ltd. as follows:

2.1 Innovation designs and development in field of technology which helps college students.

2.2 Development of software which acts as bridge between administration and students.

2.3 Development of application for Virtual Labs ,providing internship for students in Industries and career counselling.

2.4 Development of application for farmer's education for modern farming.

2.5 To help Village school Children by providing them on line courses/classes and Skill Development.

ARTICLE – I: Scope of the MoU

This MoU details the modalities and general conditions regarding collaboration between CBIT(A) and College Bag Private Limited for enhancing, the availability of highly qualified manpower in the areas of innovation, product development, and testing etc. The area of interaction will also include training and internship of CBIT(A) students to work on live projects at College Bag Private Limited. The areas of cooperation can be further extended through mutual consent.

ARTICLE – II: Scope and Terms of Interactions

Both CBIT(A) and College Bag Private Limited shall encourage interactions between both the Institutes, Students & Staff and Engineers, of both the organizations through the following arrangements:

1. Both CBIT(A) and College Bag Private Limited will plan to work on Joint development projects of Mutual Interest and also explore for joint working on Govt. funded projects based on mutual agreement.
2. Practical training of CBIT(A) students at College Bag Private Limited in the form of One-full Semester Internship at College Bag Private Limited;
3. Joint guidance of student projects in various technical areas including Embedded Systems and related Technologies and other areas of national interest at CBIT(A) by College Bag Private Limited on mutual agreement.
4. College Bag Private Limited may depute its personnel as resource person to CBIT(A) for supplementing the teaching of specialized topics.
5. College Bag Private Limited may seek assistance/guidance of CBIT(A)'s RE Hub for incubating New ideas and initiating any start-up company to develop new products or process along with CBIT(A).
6. College Bag Private Limited will allow the industrial visits of students for half/full day to provide them with an exposure to various equipment, instrument, etc.
7. College Bag Private Limited may be allowed to showcase its business activities at the Seminar/Workshop/Conference, etc. if possible, at CBIT(A) that will be conducted time-to-time, with necessary permission from CBIT(A).
8. College Bag Private Limited may avail library facilities at CBIT(A) for combined projects for students' project work with necessary permission from the Institute.
9. There will be no restriction on the contents of the thesis/project work and on publication of results of the thesis, subject to the condition that no Intellectual Property Rights can be secured for any part of the work which will be decided with mutual consent.
10. If the outcome of a project related to product development, process technology and design etc. which involves matter of secrecy and concern with security of the State and the Country, the same will not be allowed for publication/printing in any form such as Electronically/verbal, etc.
11. If the outcome of an Internship or the Project/Thesis work or the combined project results into an intellectual property, for which rights can be secured, it will be decided on case-to-case basis depending upon the contribution from both the Institution. Similarly, sharing of expenditure in securing such rights and income accrued through royalty etc. will be decided on case- to-case basis after mutual consultation and agreement.

ARTICLE-III: Sharing of Facilities

a) College Bag Private Limited shall extend its facilities for CBIT(A) students towards the smooth conduct of Internships and Projects depending on their convenience and availability of time & staff.

b) CBIT(A) and College Bag Private Limited may explore to share their respective important R&D facilities in order to promote academic and research interaction in the areas of cooperation depending upon availability of such facility without affecting their regular working.

c) CBIT(A) and College Bag Private Limited will permit the sharing software and other components developed during any combined project work in the areas of cooperation, if permissible within the rules governing the two institutions. However, responsibility regarding confidentiality terms of the software and other materials during the exchange will rest on respective Head of department of the branch/section and head of College Bag Private Limited.

d) College Bag Private Limited provide access to the library facilities to the members of faculty and students as per the prevailing rules and norms.

ARTICLE-IV : Effective Date and duration of the MoU.

a) This MoU will be effective from the date of its approval by competent authorities at both ends.

b) The duration of the MoU will be for a period of 2 years from the effective date which may be extended after mutual understanding. However, if any Important combined projects are under execution, both parties agree to complete the work even the MoU is not effective after two years.

c) During its tenancy, the MoU may be extended or terminated by a prior notice of not less than one month by either party. However, termination of the MoU will not in any manner affect the interests of the students & faculty who have been admitted to pursue a Training/Project under the MoU.

d) Any clause or article of the MoU may be modified or amended by mutual agreement of College Bag Private Limited and CBIT(A).

ARTICLE - V: IPR

Rights regarding publications, patents, royalty, ownership of software/ design/product developed etc. under the scope of this MoU, will be decided by CBIT and College Bag Private Limited based on Mutual agreement.

ARTICLE – VI: Confidentiality

During the tenure of the MoU both CBIT(A) and College Bag Private Limited will maintain strict confidentiality and prevent disclosure of all the information and data exchanged under the scope of this MoU for any purpose other than in accordance with this MoU.

Both CBIT(A) and College Bag Private Limited shall bind their respective personnel who come into possession or knowledge of any confidential information not to disclose the same to third parties without written approval of the disclosing party or use such confidential information for any use other than intended under this agreement or PROJECTS. Further both CBIT(A) and College Bag Private Limited should put in place adequate and reasonable measures to keep and store confidential information secure so as to prevent any unauthorized use.

CONFIDENTIAL INFORMATION shall mean any proprietary information, data or facts belonging to PARTIES collectively or severally, disclosed by the disclosing party under this agreement or any subsequent agreement, whether in writing, verbal or electronically, irrespective of the medium in which such information is stored, which is marked confidential or with any other words having similar meaning by the disclosing party, or specifically agreed to be kept confidential by the parties, or declared or identified so by the disclosing party before such disclosure or during the discussions. However confidential information should not include any data or information which:

- is or becomes publicly available through no fault of the receiving party,
- is already in the rightful possession of the receiving party prior to its receipt of such data or information;
- is independently developed by the receiving party without reference to the confidential information of the disclosing party
- is rightfully obtained by the receiving party from a third party or is in the public domain
- is disclosed with the written consent of the party whose information it is, or
- is disclosed pursuant to court order or other legal compulsion, after providing prior notice to the disclosing party.

ARTICLE – VII: AMENDMENTS

Any amendment and/or addenda to the AGREEMENT should be in writing and signed by the PARTIES hereto and shall only after such execution be deemed to form part of the AGREEMENT and have the effect of modifying the AGREEMENT to the extent required by such amendment or addenda.

ARTICLE – VIII: Compensation, Force Measure, Approval and Dispute Settlement

a) Compensation

Neither Party shall be liable to the other for any incidental, indirect, special or consequential damages, including but not limited, to loss of profits, loss of use, loss of revenues or damages to business or reputation arising out of or in connection with this Agreement or any aspect thereof. Neither Party shall be liable to the other by reason of the termination or expiry of this Agreement for compensation or damages on account of the loss of prospective business or on account of expenditures in expectation thereof.

b) Force Majeure

Any delay or failure in performance by the party to this Agreement, shall not constitute default hereunder to give rise to any claims for damages against said party, if any, to the extent caused by matters beyond the control of said party including but not limited to acts of Nature, Strikes, Lock outs or other concerted acts of workmen, fires, floods, explosions, blockages, embargoes, riots, war (declared or undeclared), rebellion, sabotage, extraordinary severe weather, pandemic situation, civil commotion and criminal acts of third persons. If the project under execution is delayed by such force majeure, then upon the happening of such delay, the parties within 30 days of the happening of such event, shall give notice in writing, requesting for extension of time indicating the period for which extension is desired. Efforts will be made by both parties to give fair and reasonable extension of time for the projects at their discretion but no monetary allowances shall be made unless it is mutually agreed.

c) Approval of the MoU

This Agreement may be signed by authorized officials, whether by original signature or by scanned signature due to the current situation (provided the pdf document is accompanied with official email), signature/approval over official email, with the same effect as if the signature to any counterpart was an original signature upon the same instrument.

d) Dispute and Settlement

i) In case of any dispute (s), steps shall be taken by the parties to the MOU to settle the same through amicable negotiations. In case, dispute is not settled in negotiations, it

shall be referred to Conciliator appointed by the designated official as per the bye law of CBIT(A), Hyderabad to arrive at a settlement.

In case dispute is not settled in conciliation proceedings, the same shall be referred to Arbitration for resolution of the dispute under Arbitration and conciliation Act 1996. The arbitration proceeding shall be conducted as per provisions of the Arbitration and Conciliation Act, 1996. The dispute shall be referred for arbitration to sole arbitrator to be appointed by the designated official (s) as per the bye law of CBIT(A) – Hyderabad. The award of the sole arbitrator shall be final and binding on both the parties. The venue of the Arbitration shall be at Hyderabad in India. The Award to be given by the Arbitration shall be a speaking award.

ii) Applicable Laws and Jurisdiction of Courts

Indian laws both substantive and procedural, for the time being in force, including modifications thereto, shall govern the MOU including the arbitral proceedings. The competent Courts at Hyderabad in the State of Telangana - India shall have sole jurisdiction. All questions, disputes, differences arising under, out of or in connection with this MOU shall be to the exclusive jurisdiction of Hyderabad courts in the State of Telangana.

For
College Bag Private Limited
Hyderabad

Signature:

Name: K Jeevan Reddy

Director of College Bag Private Limited

For COLLEGE BAG PRIVATE LIMITED

Director

Witness:

10/02/2021

(Dr Krishna Reddy)
HoD, ECE

HEAD
DEPARTMENT OF ECE
Chaitanya Bharathi Institute of Technology
Hyderabad-500 075

For
Chaitanya Bharathi Institute of Technology
Hyderabad

Signature:

Name: Dr. G. P. Saradhi Varma

Principal, CBIT

Principal
Chaitanya Bharathi Institute of Technology
(Autonomous)
Gandipet, Hyderabad-500 075

Witness:

10/2/21

(Dr. Umakanta Choudhury)
Prof. & Director(I&I)

Director - Incubation & Innovation
R&E Hub, CBIT(A)
Gandipet, Hyderabad-500075

सत्यमेव जयते

GOVERNMENT OF INDIA
MINISTRY OF CORPORATE AFFAIRS

Central Registration Centre

Certificate of Incorporation

[Pursuant to sub-section (2) of section 7 and sub-section (1) of section 8 of the Companies Act, 2013 (18 of 2013) a rule 18 of the Companies (Incorporation) Rules, 2014]

I hereby certify that COLLEGE BAG PRIVATE LIMITED is incorporated on this Tenth day of November Two thousand twenty under the Companies Act, 2013 (18 of 2013) and that the company is limited by shares.

The Corporate Identity Number of the company is U45201TG2020PTC145773.

The Permanent Account Number (PAN) of the company is **AAJCC1074C** *

The Tax Deduction and Collection Account Number (TAN) of the company is **HYDC11229B** *

Given under my hand at Manesar this Eleventh day of November Two thousand twenty .

DS MINISTRY OF CORPORATE AFFAIRS 6

Digital Signature Certific
Mr. Pankaj Srivasta
ASST. REGISTRAR OF COMPANI
For and on behalf of the Jurisdictional Registrar of Compan
Registrar of Compan
Central Registration Cen

Disclaimer: This certificate only evidences incorporation of the company on the basis of documents and declaratic of the applicant(s). This certificate is neither a license nor permission to conduct business or solicit deposits or fur from public. Permission of sector regulator is necessary wherever required. Registration status and other details of company can be verified on www.mca.gov.in

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Mailing Address as per record available in Registrar of Companies office:

COLLEGE BAG PRIVATE LIMITED
PLOT NO 123 & 124, DEFFENCE
COLONY,BAIRAMALGUDA,KARMANGAT, HYDERABAD,
Hyderabad, Telangana, India, 500079

* as issued by the Income Tax Department

C.B.I.T
E-MAIL & WEB SERVICES

Sri T.Sridhar Assistant Professor <tsridhar_ece@cbit.ac.in>

Fwd: College Bag control panel

1 message

Dr.A.Vani Associate Professor (Adhoc) <avani_ece@cbit.ac.in> Wed, May 5, 2021 at 11:03 AM
To: "A. Krishna Kumar" <krishnakumar_ece@cbit.ac.in>, "A. Satyavati" <satyavati_ece@cbit.ac.in>, Abdul Mubeen <abdulmobeen_ece@cbit.ac.in>, "B. Neeraja" <bneeraja_ece@cbit.ac.in>, Chintaiah N <chintaiah_ece@cbit.ac.in>, "D. Nagadevi" <dnagadevi_ece@cbit.ac.in>, "D. Sony" <sonyd_ece@cbit.ac.in>, Dattatreya Sarma Achanta <director_randd@cbit.ac.in>, "Dr. A. Supraja Reddy" <suprajareddy_ece@cbit.ac.in>, "Dr. A. Vani" <avani_ece@cbit.ac.in>, "Dr. A.D. Sarma" <adsarma_ece@cbit.ac.in>, "Dr. D. Krishna Reddy" <dkrishnareddy_ece@cbit.ac.in>, "Dr. K. Suman" <ksuman_ece@cbit.ac.in>, "Dr. Kondoju. Sai Krishna" <ksaikrishna_ece@cbit.ac.in>, "Dr. M Raj Kumar Naik" <rajkumarnaik_ece@cbit.ac.in>, "Dr. M.L.N.Charyulu" <mlncharyulu_ece@cbit.ac.in>, "Dr. N. Alivelu Manga" <alivelumanga_ece@cbit.ac.in>, "Dr. N.V. Koteswara Rao" <nvkoteswararao_ece@cbit.ac.in>, "Dr. P. Narahari Sastry" <naraharisastry_ece@cbit.ac.in>, "Dr. Vinodh Kumar Minchula" <vinodhkumarm_ece@cbit.ac.in>, "E. Chandrasekhar" <echandrasekhar_ece@cbit.ac.in>, "G. Mallikharjuna Rao" <mallikarjunarao_ece@cbit.ac.in>, "G. V. Pradeep Kumar" <pradeepkumar_ece@cbit.ac.in>, Ghata Chouhan <ghatachauhan_ece@cbit.ac.in>, "J. Balakrishna" <jbalakrishna_ece@cbit.ac.in>, "J. Mounika" <jmounika_ece@cbit.ac.in>, "K. S. R. S. Jyothsna" <jyothsna_ece@cbit.ac.in>, "K. Sudershan Reddy" <sudarshanreddy_ece@cbit.ac.in>, "M. Ramana Reddy" <mramanareddy_ece@cbit.ac.in>, "M. V. Nagabhushanam" <nagabhushanam_ece@cbit.ac.in>, "M. Venkata Sireesha" <sireesha_ece@cbit.ac.in>, Mohd Ziauddin Jahangir <jahangir_ece@cbit.ac.in>, "N. Dhana Lakshmi" <dhanalakshmi_ece@cbit.ac.in>, "N. Jagan Mohan Reddy" <jaganmohanreddy_ece@cbit.ac.in>, "Navitha Ch." <navitha_ece@cbit.ac.in>, Nisha Rani Misra <nisharanimisra_ece@cbit.ac.in>, "P. Chandra Sekhar" <pchandrasekhar_ece@cbit.ac.in>, "P. Ranjith" <pranjith_ece@cbit.ac.in>, "P. Sathish" <psathish_ece@cbit.ac.in>, Sikander <sikander_ece@cbit.ac.in>, Suraj Prakash Sahoo <surajprakashsahoo_ece@cbit.ac.in>, "T. Aravinda Babu" <aravindababu_ece@cbit.ac.in>, "T. Sridher" <tsridhar_ece@cbit.ac.in>

---------- Forwarded message ---------
From: **jeevan kasireddy** <jeevankasireddy2468@gmail.com>
Date: Mon, May 3, 2021 at 4:45 PM
Subject: College Bag control panel
To: A. Professor <avani_ece@cbit.ac.in>

College Bag

Welcome!

We are happy to launch **College Bag App** for the Students

to stay connected with your College.

Login Details

Login ID : YOUR_COLLEGE_EMAIL

Password : collegebag

Available on the App Store

GET IT ON Google Play

Visit our Website

Now you can easily stay connected on your mobile device
with your **CBIT College** campus instructors
right from within the app!

Also, stay up to date on all the latest news and events!

support@thecollegebag.com

Karmangat, Hyderabad, Telangana 500079.

C.B.I.T
E-MAIL & WEB SERVICES

Sri T.Sridhar Assistant Professor <tsridhar_ece@cbit.ac.in>

Fwd: Admin login Credentials

1 message

Dr.A.Vani Associate Professor (Adhoc) <avani_ece@cbit.ac.in> Wed, May 5, 2021 at 11:03 AM
To: "A. Krishna Kumar" <krishnakumar_ece@cbit.ac.in>, "A. Satyavati" <satyavati_ece@cbit.ac.in>, Abdul Mubeen <abdulmobeen_ece@cbit.ac.in>, "B. Neeraja" <bneeraja_ece@cbit.ac.in>, Chintaiah N <chintaiah_ece@cbit.ac.in>, "D. Nagadevi" <dnagadevi_ece@cbit.ac.in>, "D. Sony" <sonyd_ece@cbit.ac.in>, Dattatreya Sarma Achanta <director_randd@cbit.ac.in>, "Dr. A. Supraja Reddy" <suprajareddy_ece@cbit.ac.in>, "Dr. A. Vani" <avani_ece@cbit.ac.in>, "Dr. A.D. Sarma" <adsarma_ece@cbit.ac.in>, "Dr. D. Krishna Reddy" <dkrishnareddy_ece@cbit.ac.in>, "Dr. K. Suman" <ksuman_ece@cbit.ac.in>, "Dr. Kondoju. Sai Krishna" <ksaikrishna_ece@cbit.ac.in>, "Dr. M Raj Kumar Naik" <rajkumarnaik_ece@cbit.ac.in>, "Dr. M.L.N.Charyulu" <mlncharyulu_ece@cbit.ac.in>, "Dr. N. Alivelu Manga" <alivelumanga_ece@cbit.ac.in>, "Dr. N.V. Koteswara Rao" <nvkoteswararao_ece@cbit.ac.in>, "Dr. P. Narahari Sastry" <naraharisastry_ece@cbit.ac.in>, "Dr. Vinodh Kumar Minchula" <vinodhkumarm_ece@cbit.ac.in>, "E. Chandrasekhar" <echandrasekhar_ece@cbit.ac.in>, "G. Mallikharjuna Rao" <mallikarjunarao_ece@cbit.ac.in>, "G. V. Pradeep Kumar" <pradeepkumar_ece@cbit.ac.in>, Ghata Chouhan <ghatachauhan_ece@cbit.ac.in>, "J. Balakrishna" <jbalakrishna_ece@cbit.ac.in>, "J. Mounika" <jmounika_ece@cbit.ac.in>, "K. S. R. S. Jyothsna" <jyothsna_ece@cbit.ac.in>, "K. Sudershan Reddy" <sudarshanreddy_ece@cbit.ac.in>, "M. Ramana Reddy" <mramanareddy_ece@cbit.ac.in>, "M. V. Nagabhushanam" <nagabhushanam_ece@cbit.ac.in>, "M. Venkata Sireesha" <sireesha_ece@cbit.ac.in>, Mohd Ziauddin Jahangir <jahangir_ece@cbit.ac.in>, "N. Dhana Lakshmi" <dhanalakshmi_ece@cbit.ac.in>, "N. Jagan Mohan Reddy" <jaganmohanreddy_ece@cbit.ac.in>, "Navitha Ch." <navitha_ece@cbit.ac.in>, Nisha Rani Misra <nisharanimisra_ece@cbit.ac.in>, "P. Chandra Sekhar" <pchandrasekhar_ece@cbit.ac.in>, "P. Ranjith" <pranjith_ece@cbit.ac.in>, "P. Sathish" <psathish_ece@cbit.ac.in>, Sikander <sikander_ece@cbit.ac.in>, Suraj Prakash Sahoo <surajprakashsahoo_ece@cbit.ac.in>, "T. Aravinda Babu" <aravindababu_ece@cbit.ac.in>, "T. Sridher" <tsridhar_ece@cbit.ac.in>

---------- Forwarded message ---------
From: **jeevan kasireddy** <jeevankasireddy2468@gmail.com>
Date: Mon, May 3, 2021 at 5:04 PM
Subject: Admin login Credentials
To: <hod_ece@cbit.ac.in>, A. Professor <avani_ece@cbit.ac.in>

Hello Sir/Madam,
Good day, hope you are doing great. Ther credentials for staff are mentioned below, please use them to communicate with students.

https://portal.thecollegebag.com/cbit

Credentials
FACULTY_EMAIL_ID
password
collegebag

Thank you,
Team college bag.

C.B.I.T
E-MAIL & WEB SERVICES

Sri T.Sridhar Assistant Professor <tsridhar_ece@cbit.ac.in>

Fwd: College Bag testing request

1 message

Dr.A.Vani Associate Professor (Adhoc) <avani_ece@cbit.ac.in> Wed, May 5, 2021 at 11:05 AM
To: "A. Krishna Kumar" <krishnakumar_ece@cbit.ac.in>, "A. Satyavati" <satyavati_ece@cbit.ac.in>, Abdul Mubeen <abdulmobeen_ece@cbit.ac.in>, "B. Neeraja" <bneeraja_ece@cbit.ac.in>, Chintaiah N <chintaiah_ece@cbit.ac.in>, "D. Nagadevi" <dnagadevi_ece@cbit.ac.in>, "D. Sony" <sonyd_ece@cbit.ac.in>, Dattatreya Sarma Achanta <director_randd@cbit.ac.in>, "Dr. A. Supraja Reddy" <suprajareddy_ece@cbit.ac.in>, "Dr. A. Vani" <avani_ece@cbit.ac.in>, "Dr. A.D. Sarma" <adsarma_ece@cbit.ac.in>, "Dr. D. Krishna Reddy" <dkrishnareddy_ece@cbit.ac.in>, "Dr. K. Suman" <ksuman_ece@cbit.ac.in>, "Dr. Kondoju. Sai Krishna" <ksaikrishna_ece@cbit.ac.in>, "Dr. M Raj Kumar Naik" <rajkumarnaik_ece@cbit.ac.in>, "Dr. M.L.N.Charyulu" <mlncharyulu_ece@cbit.ac.in>, "Dr. N. Alivelu Manga" <alivelumanga_ece@cbit.ac.in>, "Dr. N.V. Koteswara Rao" <nvkoteswararao_ece@cbit.ac.in>, "Dr. P. Narahari Sastry" <naraharisastry_ece@cbit.ac.in>, "Dr. Vinodh Kumar Minchula" <vinodhkumarm_ece@cbit.ac.in>, "E. Chandrasekhar" <echandrasekhar_ece@cbit.ac.in>, "G. Mallikharjuna Rao" <mallikarjunarao_ece@cbit.ac.in>, "G. V. Pradeep Kumar" <pradeepkumar_ece@cbit.ac.in>, Ghata Chouhan <ghatachauhan_ece@cbit.ac.in>, "J. Balakrishna" <jbalakrishna_ece@cbit.ac.in>, "J. Mounika" <jmounika_ece@cbit.ac.in>, "K. S. R. S. Jyothsna" <jyothsna_ece@cbit.ac.in>, "K. Sudershan Reddy" <sudarshanreddy_ece@cbit.ac.in>, "M. Ramana Reddy" <mramanareddy_ece@cbit.ac.in>, "M. V. Nagabhushanam" <nagabhushanam_ece@cbit.ac.in>, "M. Venkata Sireesha" <sireesha_ece@cbit.ac.in>, Mohd Ziauddin Jahangir <jahangir_ece@cbit.ac.in>, "N. Dhana Lakshmi" <dhanalakshmi_ece@cbit.ac.in>, "N. Jagan Mohan Reddy" <jaganmohanreddy_ece@cbit.ac.in>, "Navitha Ch." <navitha_ece@cbit.ac.in>, Nisha Rani Misra <nisharanimisra_ece@cbit.ac.in>, "P. Chandra Sekhar" <pchandrasekhar_ece@cbit.ac.in>, "P. Ranjith" <pranjith_ece@cbit.ac.in>, "P. Sathish" <psathish_ece@cbit.ac.in>, Sikander <sikander_ece@cbit.ac.in>, Suraj Prakash Sahoo <surajprakashsahoo_ece@cbit.ac.in>, "T. Aravinda Babu" <aravindababu_ece@cbit.ac.in>, "T. Sridher" <tsridhar_ece@cbit.ac.in>

---------- Forwarded message ---------
From: **ECE HEAD** <hod_ece@cbit.ac.in>
Date: Wed, May 5, 2021 at 8:52 AM
Subject: Fwd: College Bag testing request
To: Dr. A. Vani <avani_ece@cbit.ac.in>

Dr. D. Krishna Reddy
Professor and Head, Dept. of ECE
Chaitanya Bharathi Institute of Technology
Autonomous Institution Under UGC
Accredited by NBA & NAAC
Chaitanya Bharathi (Post), Gandipet
HYDERABAD-500075, INDIA

---------- Forwarded message ---------
From: **Director Incubation & Innovation** <director_ii@cbit.ac.in>
Date: Wed, May 5, 2021 at 8:48 AM
Subject: Re: College Bag testing request
To: ECE HEAD <hod_ece@cbit.ac.in>
Cc: Director HRE <director_hre@cbit.ac.in>, Principal CBIT <principal@cbit.ac.in>

Dear Prof. Krishna Reddy

Please allow Dr Vani to share with some of the Faculties who can test this demo application developed by the startup being incubated by us. . This is one of the start-ups, we have been guiding for the last few months. The application will be useful for Educational purposes and will benefit the students also for the Teachers. Similar applications will also be extended to farmer's education by the M/s College bag in the future. The faculties should communicate with the students as well as M/S College Bag either through HoD or Dr Vani. We hope in the next few months, this start-up will go for commercial applications and such achievement is going to be useful for CBIT.
Best Wishes.

Dr U.K. Choudhury
Prf. & Director(I&I)

On Wed, May 5, 2021 at 8:35 AM ECE HEAD <hod_ece@cbit.ac.in> wrote:

> Dear Jeevan
> After getting clearance from director I&I, Dr Vani madam will initiate the process
> Thank you
> ***Dr. D. Krishna Reddy***
> **Professor and Head, Dept. of ECE**
> Chaitanya Bharathi Institute of Technology
> Autonomous Institution Under UGC
> Accredited by NBA & NAAC
> Chaitanya Bharathi (Post), Gandipet
> HYDERABAD-500075, INDIA
>
> On Wed, May 5, 2021 at 5:23 AM jeevan kasireddy <jeevankasireddy2468@gmail.com> wrote:
>
> > hello sir,
> > Good day, hope you are doing great. I'm writing this mail to request the faculty to use the college bag admin control panel to communicate with students. We are working so hard since march 2020 to develop this application, and now we are in the final stage to succeed and we also able to convince 4 colleges to use our application from the next intake. we really need your help in testing the features. It only happens when faculty starts using our application. I'm very thankful to you for giving ECE 3rd year students to test the application.
> > Please use these 3 modules:
> > 1.Attendance
> > 2.knowledge base
> > 3.Messages for notifications.
> >
> > Please use this link
> > Credentials
> > FACULTY_EMAIL_ID
> > password
> > collegebag
> >
> > Thank you,
> > Jeevan.

From: **Director Incubation & Innovation** <director_ii@cbit.ac.in>
Date: Mon, Jul 26, 2021 at 1:51 PM
Subject: IIC Calendar Activity on July 27th at 6 pm
To: Principal CBIT <principal@cbit.ac.in>
Cc: ECE HEAD <hod_ece@cbit.ac.in>, CSE HEAD <hod_cse@cbit.ac.in>, IT HEAD <hod_it@cbit.ac.in>

Dear Sir

IIC, CBIT would like to arrange a session by one of the young Entrepreneur and ECE, CBIT Alumni Mr. K. Jeevan Reddy who is Incubating his Idea as a start-up on the development of Software and Application on Educational Technology at our campus. We have signed an MoU with M/S College Bag, MSME Company established by Mr. Jeevan for the idea Incubation. a

We request your kind permission to go ahead with the Program. Being our Alumni, No honorarium will be paid.

With Warm Regards.
Dr U.K. Choudhury
Prof. & Director(II&I)

The topic of the session and the link are as follows.

Interactive Session/Mentoring Session with "Successful Start-up founders" (Entrepreneurs in Campus) by Young Entrepreneur and CBIT Alumni , Mr K. Jeevan Reddy

Tuesday, July 27, 2021

6:00 PM (1 hr 30 mins)

Join from the meeting link

https://cbithyd.webex.com/cbithyd/j.php?MTID=me6b0b6441125ac0af7b093aabb5cc530

Join by meeting number

Meeting number (access code): 158 403 1474

Meeting password: WYrbYMBf552 (99729623 from phones)

Note: PS To Principal, to please arrange for circulation after approval by Principal Sir.

Sl. No & of Q3: **Interactive Session/Mentoring Session with "Successful Start-up founders" (Entrepreneurs in Campus) by Young Entrepreneur and CBIT Alumni , Mr K. Jeevan Reddy**

Tuesday, July 27, 2021

6:00 PM (1 hr 30 mins)

Link: https://drive.google.com/file/d/19sku7UgcT_QmZ7yiBrTzOyBwO0AKzXDP/view?usp=sharing

IIC, CBIT have arranged a talk on **Interactive Session/Mentoring Session with "Successful Start-up founders" (Entrepreneurs in Campus)** by one of the young Entrepreneur and ECE, CBIT Alumni **Mr. K. Jeevan Reddy** who is Incubating his Idea as a start-up on the development of Software and Application on Educational Technology named as **College Bag** (Stay connected with the Institute like never Before).

- Indian education system
- How english education came to india and how does english education have to do with the life of indian education.
- The domination of indian engineers on IT industry.
- What USA imports from India?

Presentation on College Bag start-up

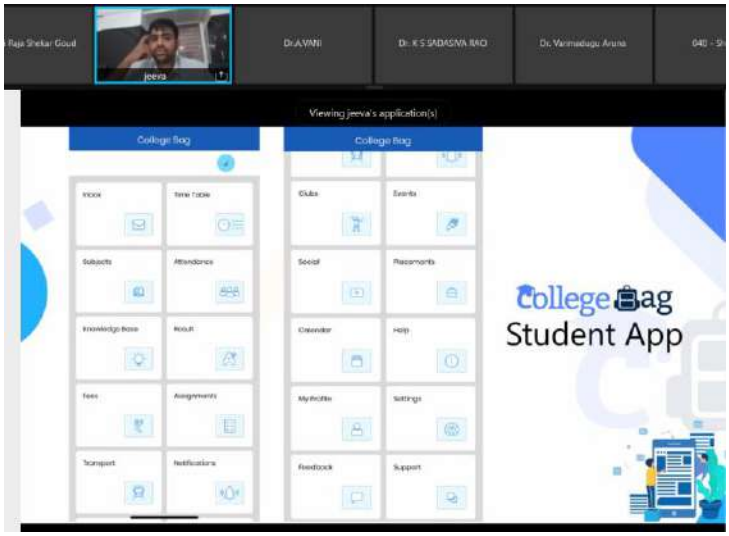
He presented features and function of his start-up and how **College Bag** is useful for **Ease of doing. College Bag** is used for students to know about attendance, marks, faculty to interactive with students to provide lecture notes assignments and administration to collect fee online. He also discussed the upcoming features of **College Bag** which includes career counselling, online exams. College social media, Placements and Assignments submission with Plagiarism Software.

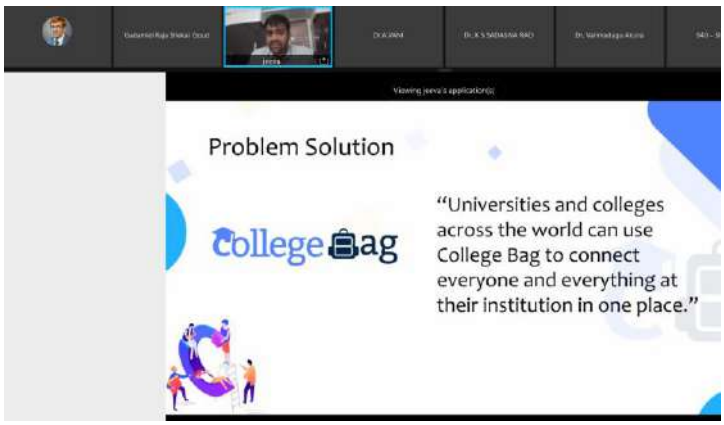
Mr.K.Jeevan Reddy ,Motivated the students to become a **Young Entrepreneurs in Campus.**A story surrounding more then a million students in india built around a booming IIT industry,a machine like education system, a race to a seat amongst the top engineering colleges and student sucides in our system. The Indian education system in all its complexity has turned out to be one of the most fascinating educational stories in the world. Jeeevan Reddy presented about his product, College Bag and he also shared his entroprenureal jurney and his strugles he is facing in marketing his product.

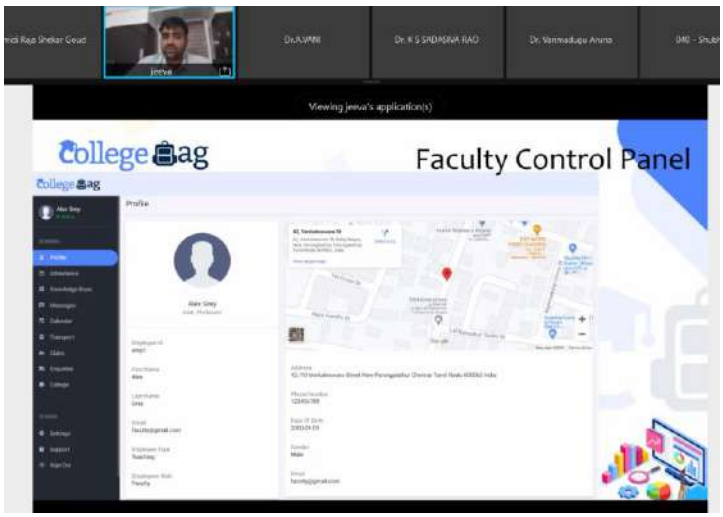

INSTITUTION'S INNOVATION COUNCIL
CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)
42 years
(For Innovators, Startups, Students and Faculty)
IIC - CBIT
Organizes
Interactive Session/Mentoring Session with "Successful Start-up founders" (Entrepreneurs in Campus)
Meeting Link:
https://cbithyd.webex.com/cbithyd/j.php?MTID=me6b0b6441125ac0af7b093aabb5cc530
Cisco access Code: 158 403 1474
Password: WYrbYMBf552
Tuesday, July 27, 2021
@ 6.00 pm to 7.30 pm
Resource Person
Mr K. Jeevan Reddy
Entrepreneur & CBIT Alumni
Coordinators :
Dr. P. Narahari Sastry 9948397802
Dr. A. Vani 9440079310
Dr. V. Aruna 9849831044

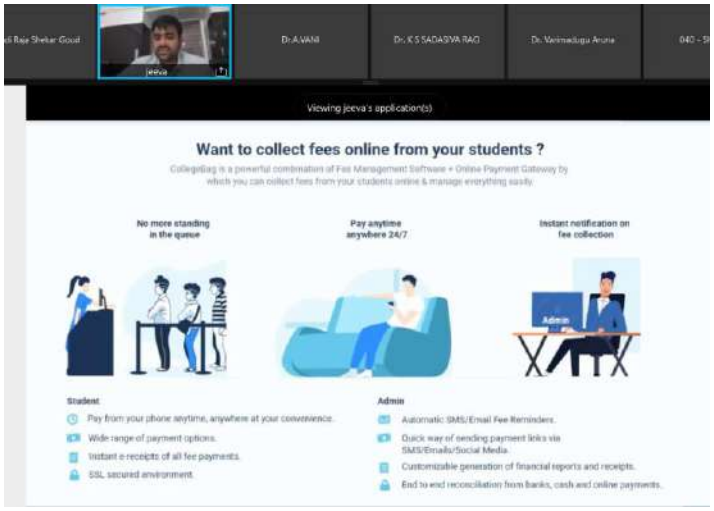

Meeting Breakout Sessions Help
Viewing jeeva's application(s)
College Bag
Stay Connected With The Institution Like Never Before

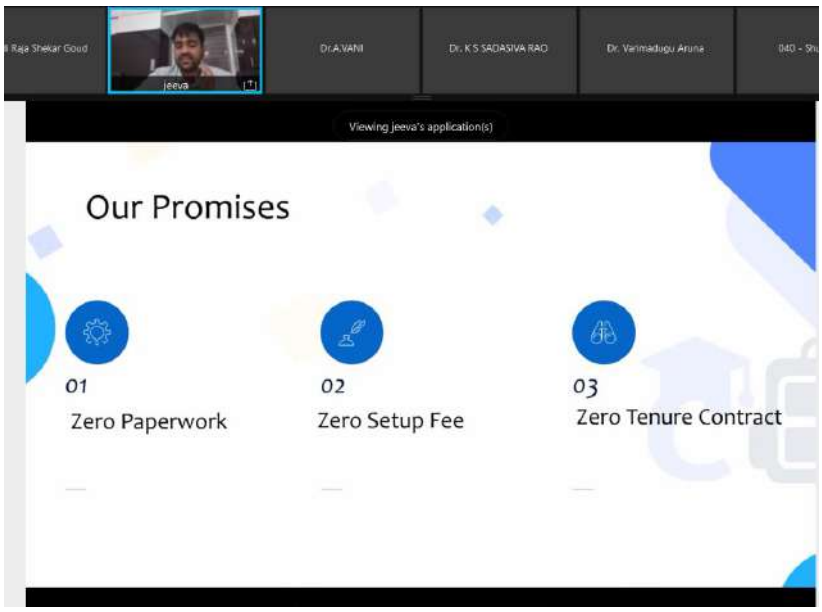

Mohana Lakshmi_CMRTC
More options
Unmute
Stop video
Record
Breakout sessions
Participants

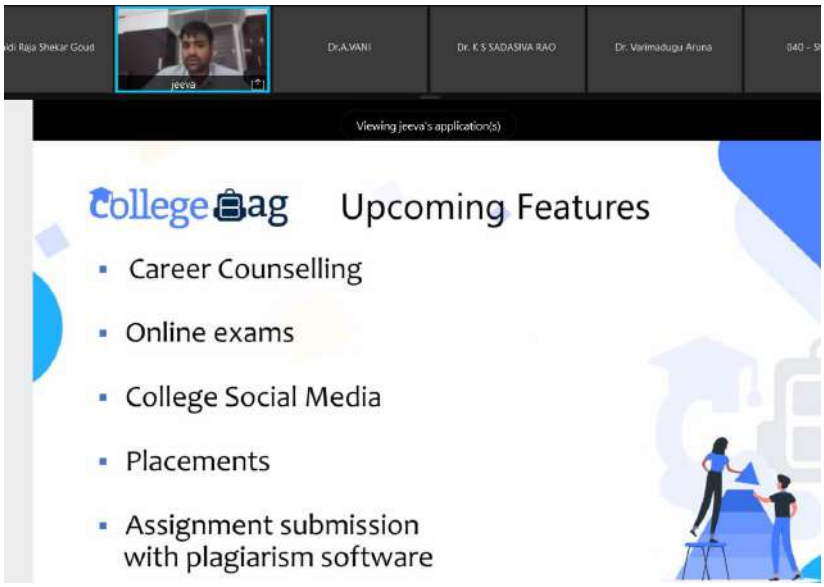

Viewing jeeva's application(s)
College Bag
College Bag
College Bag
Student App


Viewing jeeva's application(s)
Problem Solution
College Bag
"Universities and colleges across the world can use College Bag to connect everyone and everything at their institution in one place."


Viewing jeeva's application(s)
College Bag
Faculty Control Panel
College Bag
Profile


Dr.A.VANI
Dr. K S SADASIVA RAO
Dr. Varimadugu Aruna
jeeva
Viewing jeeva's application(s)
Want to collect fees online from your students ?
No more standing in the queue
Pay anytime anywhere 24/7
Instant notification on fee collection
Admin
Student
Pay from your phone anytime, anywhere at your convenience.
Wide range of payment options.
Instant e-receipts of all fee payments.
SSL secured environment.
Admin
Automatic SMS/Email Fee Reminders.
Quick way of sending payment links via SMS/Emails/Social Media.
Customizable generation of financial reports and receipts.
End to end reconciliation from banks, cash and online payments.


Dr.A.VANI
Dr. K S SADASIVA RAO
Dr. Varimadugu Aruna
jeeva
Viewing jeeva's application(s)
Our Promises
01
Zero Paperwork
02
Zero Setup Fee
03
Zero Tenure Contract


Dr.A.VANI
Dr. K S SADASIVA RAO
Dr. Varimadugu Aruna
jeeva
Viewing jeeva's application(s)
College Bag
Upcoming Features
Career Counselling
Online exams
College Social Media
Placements
Assignment submission with plagiarism software

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A), HYDERABAD-75

Dt. 10-2-22

CIRCULAR

CBIT's Institute Innovation Council (**IIC**) is organizing the following Webinars as a part of IIC Calendar activities as per the following schedule. The online platform will be Cisco webex as per enclosed links. The Session is designed keeping in view of development of Innovation and Entrepreneurial mindset for the students.

S. No	Activity (Theme Inspiration Motivation and Ideation)	Resource Person	Coordinator
1	My Story - Motivational Session by Successful Innovators **11-2-22 , 10:20 am to 11:45 am**	Alumni ECE and CSE Depts. K. Jeevan and Sharmila Gayatri	Dr. A. Vani , Asst. Prof. ECE Mobile: 9440079310 Dr. G. Vanitha, Asst. Prof, CSE Mobile No: 9959959585
2	My Story - Motivational Session by Successful Entrepreneur/Startup founder. **12-2-22 , 10:20 am to 11:30 am**	Alumni . Mech. Engg Dept. MSME Owner/Founder Mr. Venkatesh Yeramalla	Mr. BVS Rao Asst. Prof. MED Mobile:9290545750 Mrs. V. Sandhya, Asst. Prof. MED, Mobile:9290545750
3	Expert talk on "Process of Innovation Development & Technology Readiness Level (TRL)" & "Commercialisation of Lab Technologies & Tech-Transfer **12-2-22 , 2:30 pm to 4:00 pm**	Mr. Ashu Agarwal, Skill IT	Dr. GNR Prasad ASST. Prof. MCA Mobile:9885191683 Dr. V. Aruna Asst. Prof. BioTech Mobile:9849831044

WebEx Link **Sl No1:** CBIT's IIC Session on My Story - Motivational Session by Successful Innovators
Hosted by Dr. Vanitha G Friday, **Feb 11, 2022 10:20 am**
https://cbithyd.webex.com/cbithyd/j.php?MTID=m18f7cf91879fe01423e40a93ee27eb33
Meeting number: 2644 121 9857
Password: IIC@Talks (44218255 from phones and video systems)
Agenda:" My Story - Motivational Session by Successful Innovators , Interactive Session/Mentoring Session with "Successful Start-up founders

Webex link **Sl No 2:** CBIT's IIC Session on Motivational Session by Successful Entrepreneur/Startup founder. **12-2-22 , 10:20 am to 11:30 am** Hosted by director_ii@cbit.ac.in
https://cbithyd.webex.com/cbithyd/j.php?MTID=m9c662849a56813ccb217e619ee53daf0
Saturday, **Feb 12, 2022 10:20 am**
Meeting number: 2641 457 8924
Password: cbitiic (2248442 from phones and video systems)

Webex link Sl No 3: CBIT's IIC Session on Expert talk on "Process of Innovation Development & Technology Readiness Level (TRL)" 12-2-22 , 2:30 pm Hosted by director_ii@cbit.ac.in
https://cbithyd.webex.com/cbithyd/j.php?MTID=m50b6a49733c937eacc70db01589d3211
Saturday, **Feb 12, 2022 2:30 pm** | 1 hour 30 minutes |
Meeting number: 2643 789 6068
Password: cbitiic (2248442 from phones and video systems)

Interested students and faculties are advised to attend the sessions as per above mentioned links. The Sessions will be coordinated by the faculties mentioned in the above table.

Principal, CBIT

To: All Heads of the Departments/ Sections for information and for circulation among all the class teachers of their Department for necessary action.

All Directors, HR & PRO for information & n/a.

Office of the PGM / Principal,
Regional Telecom Training Centre,
Gachibowli, Hyd-32. Ph:040-23000232
www.rttchyd.bsnl.co.in,
vvvsnarayana@bsnl.co.in
rttchyd@bsnl.co.in

BSNL
Connecting India

भारत संचार निगम लिमिटेड
(भारत सरकार का उपक्रम)
BHARAT SANCHAR NIGAM LIMITED
(A Govt. of India Enterprise)

Lr.No: RTTC-HYD/BD/MoUs/2019-21/19 Dated at Hyderabad the 26-03-2021

To
The Principal,
CBIT,
Gandipet,
Hyderabad-75.

Dear Sir,

Sub: Extension of MoU between CBIT and RTTC BSNL Hyderabad – Reg.

* * * * *

With reference to your letter dated 2nd March 2021 to this office on the above cited subject, this is to inform you that the competent authority has **pleased to extend the existing MoU with CBIT for a period of 2 years from 12th March 2021** with the following new provisos:

1. A minimum number of 100 CBIT students per annum have to be sent to RTTC Hyderabad for undergoing Industrial training programmes such as Internship / In plant / Main projects / Mini Projects / Certificate Program in latest technologies / FDPs, etc,.

2. The details of RTTC Hyderabad along with the URL link of www.rttchyd.bsnl.co.in are to be hosted in the CBIT website for the updated information to the students and the faculty members

Looking forward to strengthening the CBIT and BSNL RTTC Hyderabad relations for mutual benefit.

Kind Regards,

V.V.V. Sty

(VVV Satyanarayana)
Asst. General Manager,
Regional Telecom Training Centre,
BSNL, Gachibowli, Hyderabad-32
9441262300

MEMORANDUM OF UNDERSTANDING

BETWEEN

REGIONAL TELECOM TRAINING CENTRE, HYDERABAD
under
BHARAT SANCHAR NIGAM LTD

BSNL
Connecting India faster

RTTC HYD

AND

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A), HYDERABAD

TM
CHAITANYA BHARATHI
INSTITUTE OF TECHNOLOGY
1979

FOR OFFERING TRAINING IN

TELECOM TECHNOLOGIES

MEMORANDUM OF UNDERSTADING

Preamble

Through this MOU, RTTC Hyderabad, a training centre of BHARAT SANCHAR NIGAM LIMITED and M/S CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY. intend to impart training courses in the area of Telecommunications & Information Technology.

This MEMORANDUM OF UNDERSTANDINGS ("MOU") is made on 12th of March 2020.

Between

RTTC Hyderabad, a training centre of BHARAT SANCHAR NIGAM LIMITED, headed by Sri P.V.V.V.Prasada Rao, Principal General Manager & Principal of RTTC, Hyderabad (Herein referred to as RTTC which expression shall unless repugnant to the context of meaning thereof includes its successors and permitted assignees) of the FIRST PART.

AND

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY, established in the Year 1979, esteemed as the Premier Engineering Institute in the States of Telangana and Andhra Pradesh (Herein referred to as CBIT which expression shall unless repugnant to the context of meaning thereof includes its successors and permitted assignees) of the SECOND PART.

The parties are individually referred as 'Party' and collectively referred to as 'Parties'.

WHERE AS

BSNL is a State-owned company engaged in providing all Telecom Solutions through its network all across the country except at Delhi & Mumbai. BSNL is having its dedicated training infrastructure consisting of ALTTC Ghaziabad BRBRAITT Jabalpur, NATFM Hyderabad and various other RTTCs/CTTCs/DTTCs.

RTTC, Hyderabad is a fully standards-compliant Training Center, established by BSNL to impart training in Latest Telecom Technologies and Information Technology to its employees all over India. It is also providing value-added Certification Courses and Major/Mini projects to B.Tech/B.E/MCA students in ECE and CSE/IT, coming from various Engineering Colleges within and outside Telangana/Andhra Pradesh.

PURPOSE

1. This MOU is the statement of intent between both the above-mentioned parties with an idea to conduct the telecom technical training programmes as per the Annexure by RTTC, HYDERABAD for students of M/s CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY, HYDERABAD.
2. All contractual terms (including but not limited to those relating to ownership of intellectual property rights, licensing and the right to use materials) shall be agreed by the parties prior to undertaking specific projects as referred to herein.

Terms and Conditions: -

1. The charges for the trainings offered by RTTC Hyderabad for the students of M/s CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY will be as per the approved rates of CGM, BSNL, Telangana Circle, Hyderabad.
2. M/s CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY has to submit the necessary details of the trainees and the payment of the charges in advance.
3. This MOU is valid for a period of one (1) year from the date of signing the agreement and can be extended with mutual consent for one more year at the same discount rates and conditions. The MOU may be amended at any time on the mutual agreeable terms and conditions of both the parties. However, the parties agree that this MOU can be terminated by either of the parties on an advance written notice of three months to the other party. The expiry or termination of this MOU shall not impact on any specific agreement in force which should continue up to its normal expiry.
4. FORCE MAJEURE

   The Parties shall not be liable for any failure to perform any of its obligations under this MOU. If the performance is prevented, hindered or delayed, by a Force Majeure event like strike, bundh, natural calamity etc and in such case its obligations shall be suspended for so long as the Force Majeure Event continues (provided that this shall not prevent the accrual of interest on a principal amount which would have been payable but for this provision). Each party shall promptly inform the other of the existence of Force Majeure Event and shall consult together to find a mutually acceptable solution.

8. COMPLIANCE OF LAWS

   RTTC and CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY shall perform their duties in strict compliance with all applicable laws in India along with rules and regulations of duly constituted Govt. authorities in India and shall obtain all licenses, restrictions or other approval, if any, required by laws in India in connection with the services to be rendered hereunder.

9. NOTICE-

   a. Unless otherwise provided herein, all notices or other communications under or in connection with this MOU shall be given in writing and may be sent by personal delivery. The address referred to herein above are:

   If to BSNL

   Kind Attn: Divisional Engineer (Admn)
   Regional Telecom Training Center
   Gachibowli, Hyderabad-500032

   Attn. Sri VVV.SATYANARAYANA

   Mail:- bsnlrttchyd@gmail.com Fax:- 040-23000229.

   If to M/s CBIT.

   Kind Attn: Principal, CBIT
   Gandipet, Hyderabad - 500075

   Attn:- Dr. P. Ravinder Reddy

   Mail:- principal@cbit.ac.in Ph No.: 8466997201

b. This MOU constitutes the entire agreement between the Parties with respect to the subject matter hereof and supersedes all prior written agreements, understandings and negotiations, both written and oral between the parties with respect to the subject matter of this MOU. No representation inducement, promise, understanding, condition, warranty or indemnity not set forth herein has been made or relied upon by any Party hereto.

10. ARBITRATION

In the event of any dispute, controversy, or difference arising out of or relating to this agreement, or the breach, termination or invalidity thereof, between the parties, such party or parties shall make a request to the other party or parties to amicably settle such difference or dispute and parties shall thereupon make every effort to settle the same amicably within a period of sixty days from the date of making such request, failing which such dispute, difference, controversy finally settled by arbitration in accordance with the Arbitration and Reconciliation Act, 1996, at present in force, by three arbitrators. Each party shall appoint one arbitrator. The two arbitrators thus appointed shall choose the third arbitrator who will act as the presiding arbitrator of the Arbitration Tribunal. The arbitration shall be conducted in English language. The place of Arbitration shall be Hyderabad. The agreement shall be governed by and construed in accordance with the Laws of India.

11. CONFIDENTIALITY

11.1 The parties agree to keep in the strictest confidence and not disclose to any third party or use for any purpose (other than in connection with this MOU) any information relating to the other's business which is marked 'confidential' or is clearly by its nature confidential without the disclosing party's written consent. Each of the parties may disclose the other's confidential information to our employees, agents, contractors and professional advisors on a need to know basis and to others having a legal right or duty to know that information.

11.2 The obligations in Clause 11.1 shall not apply to information which is or comes into the public domain disclosure or required to be disclosed, by official authority in accordance with the applicable laws has been disclosed pursuant to the requirements of law or court order without restrictions or other protection against public disclosure; provided, however, that the other party

For M/s CBIT

(Dr. P. Ravinder Reddy).
Principal, CBIT,
Gandipet, Hyderabad.

Date: 12.03.2020

Principal
Chaitanya Bharathi Institute of Technology
(Autonomous)
Gandipet, Hyderabad-500 075.

Witness Signature, Name,
Address and Occupation.

1) 12/03/2020
(Dr. D. Krishna Reddy)
Prof & Head, ECE dept

2) CBIT, Gandipet, Hyd.
12/3/2020
C. Mallikharjuna Rao
Asst Prof, Dept of ECE
Gandipet, Hyd-75

For BSNL

(VVV.SATYANARAYANA)
Divisional Engineer (Admn)
O/o Principal, RTTC, Hyderabad.

Date: 12.03.2020

DIVISIONAL ENGINEER (ADMN)
O/o. SENIOR PRINCIPAL
R.T.T.C., B.S.N.L., HYD-32

Witness Signature, Name,
Address and Occupation.

1) 12/03/2020
SDE(BD) RTTC, HO.

2) J.T.O(BD)-RTTC
R. Prashanth Hyd.

Bharat Sanchar Nigam Limited
(A Government of India Enterprise)
Office of the Principal, Regional Telecom. Training Centre,
Gachibowli, Hyderabad – 500 032
(An Institute certified to ISO 9001:2008)
Ph:040-23000232 (o), Fax 040-23000229, Email: rttchyd@bsnl.co.in,
Web: www.rttchyd.bsnl.co.in

ANNEXURE

Sub:- Trainings to the Engineering students/Graduates for improving their employability skills in Telecommunication sector - Reg.

---XXX---

1. B.Tech and Diploma in ECE / ETE / CSE/ IT education is broad based and students do not have specific skills required for the different sectors of the industry, as they are not exposed to the technologies and equipment in use.
2. With the burgeoning growth that is being experienced in the Telecom sector, there is requirement of manpower to plan, install, operate and maintain the Telecom networks. The Telecom networks could be fixed access landline - voice and broadband,, Data networks, Optical fibre local access and back-haul networks and 4G/5G Wireless Technologies . Further the Telecom professional has to keep abreast of Next generation Technologies and specific skills are required for each of these areas and activities encompassing Technology, Commercial, marketing, sales and customer service aspects.
3. Keeping this in mind, BSNL has designed and is offering customized training programs to the engineering students, fresh engineering graduates / experience persons to acquire the knowledge and skills for specific activities so that the they possess employable skills from day one.
4. Inplant / Vocational / Industrial training courses are conducted at all district head quarters and some are conducted at our centralized state training center, i.e Regional Telecom Training Centre, Gachibowli, Hyderabad.
5. Industrial Visits are conducted at Regional Telecom Training Centre, Gachibowli, Hyderabad.
6. We are having excellent lab facilities where students can undergo hands-on practice.
7. We offer faculty development training programs on latest telecom technologies
8. RTTC Hyderabad is offering the following training courses.
    a. For Engineering students:-
        i. In-plant /Industrial training for 18 Hr/ 36 Hr/ 54 Hrs programs to the II & III year B.Tech students to familiarize the fields of Communications and to give overview of all fields so as to enable them to choose a project area in third year of engineering and gain expertise in a selected field of their choice.
        ii. Mini Projects to III Year B.Tech students in Telecommunications field at RTTC, Hyderabad .
        iii. Major Projects to IV Year B.Tech students in Telecommunications field at RTTC, Hyderabad.
        iv. Intern ship (2/3/4 weeks) courses for the III & IV year engineering students in the following fields.
            1. **Optical Fibre Communications:-** Including SDH / DWDM / FTTH / GPON/ OTN Technologies, etc.

2. **Broadband, Networking and Latest Datacom Techniques :-** WiFI,Wimax Advanced concepts in Networking using IPv6, VOIP, MPLS ,MPLS VPN Technologies, CCNA/CCNP level trainings, etc.

3. **CSE / IT:** Cyber security,Block chain Technologies,IOT, Python, Core & Advanced Java, MySQL, Android,Spring framework, etc.

4. **Mobile Communications:-** 4G / 5G wireless standards, RF planning and Optimisation, RF Drive testing, Core Network technologies, etc.

5. **Electronic Switching** and NGN Technologies, with latest signaling techniques like CCS7, VoIP, SIP, SIGTRAN, IMS, etc.

b. Classes on advanced subjects like Block chain Technologies, Cyber Security, IPv6, SIP, MPLS VPN , FTTH, GPON etc., for the students who have selected these topics as elective in UG/ PG courses.

c. For fresh engineering graduates and persons with some experience we are conducting the following certified courses at RTTC, Hyderabad,which will be quite helpful especially for the students willing to pursue higher education in abroad .

   i. BSNL Certified GSM RF Engineer course for 5 weeks (4 weeks in-house training of theory and practicals and 1 week on-site training) for the engineering graduates.

   ii. BSNL Certified Optical Fibre Communication Engineer course for 4 weeks for Engineering candidates.

   iii. BSNL Certified Network Engineer course for 4 weeks for Engineering candidates.

(For further details like Course fee, brochures, etc, please visit our website www.rttchyd.bsnl.co.in or mail to bsnlrttchyd@gmail.com)

A.V.V Satya 12/03/2024

Asst.General Manager(Admin)
Regional Telecom Training Centre,
B.S.N.L., Gachibowli,
Hyderabad-32.

डिविजनल अभियंता (प्रशा)
DIVISIONAL ENGINEER (ADMN.)
वरिष्ठ प्रधानाचार्य का कार्यालय
O/o SENIOR PRINCIPAL
क्षे.दू.प्र.के. भा.सं.नि.लि. हैदराबाद - 32
R.T.T.C., B.S.N.L., HYD - 32

Certificate Number

RHYTMNB1742-2022-79390101

RHYTMNB1742-2022-79390101

Bharat Sanchar Nigam Limited

(A Govt. of India Enterprise)

Regional Telecom Training Centre

Erragadda, Hyderabad - 500 018
Phone: 040-23000172 / 233
Web site: www.rttchyd.bsnl.co.in

CERTIFICATE

This is to certify

GURRAM BALAJI

has completed successfully the following course conducted by
Bharat Sanchar Nigam Limited

Name of the course	**: ONLINE INTERNSHIP TRAINING-ECE-2WEEKS**
Commencing Date	**: 16-08-22**
Completion Date	**: 27-08-22**

V.V.V. Satya

(SATYANARAYANA V V V)
Dep. General Manager (DGM)

Dated : 27-08-22

Course Code : RHYTMNB1742 Course Schedule Code : RHYTMNB1742-2022-7939

Certificate Number

RHYTMNB1742-2022-79390120

RHYTMNB1742-2022-79390120

Bharat Sanchar Nigam Limited

(A Govt. of India Enterprise)

Regional Telecom Training Centre

Erragadda, Hyderabad - 500 018
Phone: 040-23000172 / 233
Web site: www.rttchyd.bsnl.co.in

CERTIFICATE

This is to certify

MALOJI.PRAVALLIKA

has completed successfully the following course conducted by
Bharat Sanchar Nigam Limited

Name of the course	**: ONLINE INTERNSHIP TRAINING-ECE-2WEEKS**
Commencing Date	**: 16-08-22**
Completion Date	**: 27-08-22**

V.V.V. Satya

(SATYANARAYANA V V V)
Dep. General Manager (DGM)

Dated : 27-08-22

Course Code : RHYTMNB1742 Course Schedule Code : RHYTMNB1742-2022-7939

Certificate Number

RHYTMNB1742-2022-7939085

RHYTMNB1742-2022-7939085

Bharat Sanchar Nigam Limited

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Regional Telecom Training Centre

Erragadda, Hyderabad - 500 018
Phone: 040-23000172 / 233
Web site: www.rttchyd.bsnl.co.in

CERTIFICATE

This is to certify

AKHILA KADARI

has completed successfully the following course conducted by
Bharat Sanchar Nigam Limited

Name of the course	**: ONLINE INTERNSHIP TRAINING-ECE-2WEEKS**
Commencing Date	**: 16-08-22**
Completion Date	**: 27-08-22**

V.V.V. Satya

(SATYANARAYANA V V V)
Dep. General Manager (DGM)

Dated : 27-08-22

Course Code : RHYTMNB1742 Course Schedule Code : RHYTMNB1742-2022-7939

Certificate Number

RHYTMNB1742-2022-79390141

RHYTMNB1742-2022-79390141

Bharat Sanchar Nigam Limited

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Regional Telecom Training Centre

Erragadda, Hyderabad - 500 018
Phone: 040-23000172 / 233
Web site: www.rttchyd.bsnl.co.in

CERTIFICATE

This is to certify

PANDITH KULKARNI

has completed successfully the following course conducted by
Bharat Sanchar Nigam Limited

Name of the course	**: ONLINE INTERNSHIP TRAINING-ECE-2WEEKS**
Commencing Date	**: 16-08-22**
Completion Date	**: 27-08-22**

V.V.V. Satya

(SATYANARAYANA V V V)
Dep. General Manager (DGM)

Dated : 27-08-22

Course Code : RHYTMNB1742 Course Schedule Code : RHYTMNB1742-2022-7939

Certificate Number

RHYTMNB1742-2022-79390103

RHYTMNB1742-2022-79390103

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Regional Telecom Training Centre

Erragadda, Hyderabad - 500 018
Phone: 040-23000172 / 233
Web site: www.rttchyd.bsnl.co.in

CERTIFICATE

This is to certify

JAHNAVI EPPALA

has completed successfully the following course conducted by
Bharat Sanchar Nigam Limited

Name of the course	**: ONLINE INTERNSHIP TRAINING-ECE-2WEEKS**
Commencing Date	**: 16-08-22**
Completion Date	**: 27-08-22**

V.V.V. Satya

(SATYANARAYANA V V V)
Dep. General Manager (DGM)

Dated : 27-08-22

Course Code : RHYTMNB1742 Course Schedule Code : RHYTMNB1742-2022-7939

Certificate Number

RHYTMNB1742-2022-79390116

RHYTMNB1742-2022-79390116

Bharat Sanchar Nigam Limited

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Regional Telecom Training Centre

Erragadda, Hyderabad - 500 018
Phone: 040-23000172 / 233
Web site: www.rttchyd.bsnl.co.in

CERTIFICATE

This is to certify

MOIGARI CHARAN KUMAR

has completed successfully the following course conducted by
Bharat Sanchar Nigam Limited

Name of the course	**: ONLINE INTERNSHIP TRAINING-ECE-2WEEKS**
Commencing Date	**: 16-08-22**
Completion Date	**: 27-08-22**

V.V.V. Satya

(SATYANARAYANA V V V)
Dep. General Manager (DGM)

Dated : 27-08-22

Course Code : RHYTMNB1742 Course Schedule Code : RHYTMNB1742-2022-7939

Certificate Number

RHYTMNB1742-2022-79390117

RHYTMNB1742-2022-79390117

Bharat Sanchar Nigam Limited

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Regional Telecom Training Centre

Erragadda, Hyderabad - 500 018
Phone: 040-23000172 / 233
Web site: www.rttchyd.bsnl.co.in

CERTIFICATE

This is to certify

MUCCHU SAI CHARAN

has completed successfully the following course conducted by
Bharat Sanchar Nigam Limited

Name of the course	**: ONLINE INTERNSHIP TRAINING-ECE-2WEEKS**
Commencing Date	**: 16-08-22**
Completion Date	**: 27-08-22**

V.V.V. Satya

(SATYANARAYANA V V V)
Dep. General Manager (DGM)

Dated : 27-08-22

Course Code : RHYTMNB1742 Course Schedule Code : RHYTMNB1742-2022-7939

Certificate Number

RHYTMNB1742-2022-7939094

RHYTMNB1742-2022-7939094

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Regional Telecom Training Centre

Erragadda, Hyderabad - 500 018
Phone: 040-23000172 / 233
Web site: www.rttchyd.bsnl.co.in

CERTIFICATE

This is to certify

DEVI SREE KAILASH

has completed successfully the following course conducted by
Bharat Sanchar Nigam Limited

Name of the course	**: ONLINE INTERNSHIP TRAINING-ECE-2WEEKS**
Commencing Date	**: 16-08-22**
Completion Date	**: 27-08-22**

V.V.V. Satya

(SATYANARAYANA V V V)
Dep. General Manager (DGM)

Dated : 27-08-22

Course Code : RHYTMNB1742 Course Schedule Code : RHYTMNB1742-2022-7939

Certificate Number

RHYTMNB1742-2022-7939090

RHYTMNB1742-2022-7939090

Bharat Sanchar Nigam Limited

(A Govt. of India Enterprise)

Regional Telecom Training Centre

Erragadda, Hyderabad - 500 018
Phone: 040-23000172 / 233
Web site: www.rttchyd.bsnl.co.in

CERTIFICATE

This is to certify

BOPPARAPU SAI CHANDRA PRASAD

has completed successfully the following course conducted by
Bharat Sanchar Nigam Limited

Name of the course	**: ONLINE INTERNSHIP TRAINING-ECE-2WEEKS**
Commencing Date	**: 16-08-22**
Completion Date	**: 27-08-22**

V.V.V. Satya

(SATYANARAYANA V V V)
Dep. General Manager (DGM)

Dated : 27-08-22

Course Code : RHYTMNB1742 Course Schedule Code : RHYTMNB1742-2022-7939

Certificate Number

RHYTMNB1742-2022-7939078

RHYTMNB1742-2022-7939078

Bharat Sanchar Nigam Limited

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Regional Telecom Training Centre

Erragadda, Hyderabad - 500 018
Phone: 040-23000172 / 233
Web site: www.rttchyd.bsnl.co.in

CERTIFICATE

This is to certify

AISHWARYA KONDAPARTHI

has completed successfully the following course conducted by
Bharat Sanchar Nigam Limited

Name of the course	**: ONLINE INTERNSHIP TRAINING-ECE-2WEEKS**
Commencing Date	**: 16-08-22**
Completion Date	**: 27-08-22**

V.V.V. Satya

(SATYANARAYANA V V V)
Dep. General Manager (DGM)

Dated : 27-08-22

Course Code : RHYTMNB1742 Course Schedule Code : RHYTMNB1742-2022-7939

Certificate Number

RHYTMNB1742-2022-7939089

RHYTMNB1742-2022-7939089

Bharat Sanchar Nigam Limited

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Regional Telecom Training Centre

Erragadda, Hyderabad - 500 018
Phone: 040-23000172 / 233
Web site: www.rttchyd.bsnl.co.in

CERTIFICATE

This is to certify

BOLLU SRIKANTH

has completed successfully the following course conducted by
Bharat Sanchar Nigam Limited

Name of the course	**: ONLINE INTERNSHIP TRAINING-ECE-2WEEKS**
Commencing Date	**: 16-08-22**
Completion Date	**: 27-08-22**

V.V.V. Satya

(SATYANARAYANA V V V)
Dep. General Manager (DGM)

Dated : 27-08-22

Course Code : RHYTMNB1742 Course Schedule Code : RHYTMNB1742-2022-7939

Certificate Number

RHYTMNB1742-2022-7939083

RHYTMNB1742-2022-7939083

Bharat Sanchar Nigam Limited

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Regional Telecom Training Centre

Erragadda, Hyderabad - 500 018
Phone: 040-23000172 / 233
Web site: www.rttchyd.bsnl.co.in

CERTIFICATE

This is to certify

ARDHANOOR CHARAN SAI

has completed successfully the following course conducted by
Bharat Sanchar Nigam Limited

Name of the course	**: ONLINE INTERNSHIP TRAINING-ECE-2WEEKS**
Commencing Date	**: 16-08-22**
Completion Date	**: 27-08-22**

V.V.V. Satya

(SATYANARAYANA V V V)
Dep. General Manager (DGM)

Dated : 27-08-22

Course Code : RHYTMNB1742 Course Schedule Code : RHYTMNB1742-2022-7939

Certificate Number

RHYTMNB1742-2022-7939095

RHYTMNB1742-2022-7939095

Bharat Sanchar Nigam Limited

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Regional Telecom Training Centre

Erragadda, Hyderabad - 500 018
Phone: 040-23000172 / 233
Web site: www.rttchyd.bsnl.co.in

CERTIFICATE

This is to certify

EMMADI NITHINKUMAR

has completed successfully the following course conducted by
Bharat Sanchar Nigam Limited

Name of the course	**: ONLINE INTERNSHIP TRAINING-ECE-2WEEKS**
Commencing Date	**: 16-08-22**
Completion Date	**: 27-08-22**

V.V.V. Satya

(SATYANARAYANA V V V)
Dep. General Manager (DGM)

Dated : 27-08-22

Certificate Number

RHYTMNB1742-2022-7939098

RHYTMNB1742-2022-7939098

Bharat Sanchar Nigam Limited

(A Govt. of India Enterprise)

Regional Telecom Training Centre

Erragadda, Hyderabad - 500 018
Phone: 040-23000172 / 233
Web site: www.rttchyd.bsnl.co.in

CERTIFICATE

This is to certify

JILAKARI CHAITANYA

has completed successfully the following course conducted by
Bharat Sanchar Nigam Limited

Name of the course	**: ONLINE INTERNSHIP TRAINING-ECE-2WEEKS**
Commencing Date	**: 16-08-22**
Completion Date	**: 27-08-22**

V.V.V. Satya

(SATYANARAYANA V V V)
Dep. General Manager (DGM)

Dated : 27-08-22

Course Code : RHYTMNB1742 Course Schedule Code : RHYTMNB1742-2022-7939

Certificate Number

RHYTMNB1742-2022-79390119

RHYTMNB1742-2022-79390119

Bharat Sanchar Nigam Limited

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Regional Telecom Training Centre

Erragadda, Hyderabad - 500 018
Phone: 040-23000172 / 233
Web site: www.rttchyd.bsnl.co.in

CERTIFICATE

This is to certify

POOJITHA REDDY

has completed successfully the following course conducted by
Bharat Sanchar Nigam Limited

Name of the course	**: ONLINE INTERNSHIP TRAINING-ECE-2WEEKS**
Commencing Date	**: 16-08-22**
Completion Date	**: 27-08-22**

V.V.V. Satya

(SATYANARAYANA V V V)
Dep. General Manager (DGM)

Dated : 27-08-22

Course Code : RHYTMNB1742 Course Schedule Code : RHYTMNB1742-2022-7939

Certificate Number

RHYTMNB1742-2022-79390139

RHYTMNB1742-2022-79390139

Bharat Sanchar Nigam Limited

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Regional Telecom Training Centre

Erragadda, Hyderabad - 500 018
Phone: 040-23000172 / 233
Web site: www.rttchyd.bsnl.co.in

CERTIFICATE

This is to certify

NISHANTH JADA

has completed successfully the following course conducted by
Bharat Sanchar Nigam Limited

Name of the course	**: ONLINE INTERNSHIP TRAINING-ECE-2WEEKS**
Commencing Date	**: 16-08-22**
Completion Date	**: 27-08-22**

V.V.V. Satya

(SATYANARAYANA V V V)
Dep. General Manager (DGM)

Dated : 27-08-22

Course Code : RHYTMNB1742 Course Schedule Code : RHYTMNB1742-2022-7939

Certificate Number

RHYTMNB1742-2022-79390124

RHYTMNB1742-2022-79390124

Bharat Sanchar Nigam Limited

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Regional Telecom Training Centre

Erragadda, Hyderabad - 500 018
Phone: 040-23000172 / 233
Web site: www.rttchyd.bsnl.co.in

CERTIFICATE

This is to certify

RALLABHANDI S M A SRIDATTA

has completed successfully the following course conducted by
Bharat Sanchar Nigam Limited

Name of the course	**: ONLINE INTERNSHIP TRAINING-ECE-2WEEKS**
Commencing Date	**: 16-08-22**
Completion Date	**: 27-08-22**

V.V.V. Satya

(SATYANARAYANA V V V)
Dep. General Manager (DGM)

Dated : 27-08-22

Course Code : RHYTMNB1742 Course Schedule Code : RHYTMNB1742-2022-7939

Certificate Number

RHYTMNB1742-2022-7939083

RHYTMNB1742-2022-7939083

Bharat Sanchar Nigam Limited

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Regional Telecom Training Centre

Erragadda, Hyderabad - 500 018
Phone: 040-23000172 / 233
Web site: www.rttchyd.bsnl.co.in

CERTIFICATE

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ARDHANOOR CHARAN SAI

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Bharat Sanchar Nigam Limited

Name of the course	**: ONLINE INTERNSHIP TRAINING-ECE-2WEEKS**
Commencing Date	**: 16-08-22**
Completion Date	**: 27-08-22**

V.V.V. Satya

(SATYANARAYANA V V V)
Dep. General Manager (DGM)

Dated : 27-08-22

Course Code : RHYTMNB1742 Course Schedule Code : RHYTMNB1742-2022-7939

Knowledge Research Academy

Coimbatore, Tamil Nadu
(An MSME Registered Organization)
UDYAM-TN-03-0021905

International Award Ceremony on Star Achievers in Higher Educational Institutions [SAHEI 2024]

BEST FACULTY AWARD

This Certificate of Excellence is awarded to

Dr. N. Satyanarayana

Associate Professor,
Department of Artificial Intelligence and Data Science,
Chaitanya Bharathi Institute of Technology,
Hyderabad, Telangana, India-500075

in recognition of his outstanding contribution in Academics and Research

28th January 2024

Director

FILE NO. CRG/2021/001660

SCIENCE & ENGINEERING RESEARCH BOARD(SERB)

(A statutory body of the Department of Science & Technology, Government of India)

Science and Engineering Research Board
3rd & 4th Floor, Block II
Technology Bhavan, New Mehrauli Road
New Delhi - 110016

Dated: 11 February, 2022

ORDER

Subject: Financial Sanction of the research project titled **A New Model for Short Term Forecasting of Scintillations using Machine Learning Approach and Generation of Regional Scintillation Maps** under the guidance of Dr. Dattatreya Sarma Achanta, Electronics and Communication Engineering , Chaitanya Bharathi Institute of Technology , Gandipet, Hyderabad, Telangana-500075 and by Dr. Lakshmisreenivasareddy Dirisinapu, ASSOCIATE PROFESSOR, INFORMATION TECHNOLOGY, Chaitanya Bharathi Institute Of Technology and by Prof. Desireddy Krishna Reddy, Professor, Electronics And Communication Engineering , Chaitanya Bharathi Institute Of Technology - Release of 1st grant.

Sanction of **Science and Engineering Research Board (SERB)** is hereby accorded to the above mentioned project at a total cost of **Rs. 3704360/- (Rs.** Thirty Seven Lakh Four Thousand Three Hundred and Sixty **Only)** with break-up of **Rs. *1645000*/- under Capital (Non-recurring) head** and **Rs.*2059360*/- under General (Recurring) head** for a duration of 36 months. The items of expenditure for which the total allocation of **Rs. 3704360/-** has been approved are given below:

The following budget may be considered for **Chaitanya Bharathi Institute Of Technology, Gandipet**

S. No	Head	Total (in Rs.)
A	**Non-recurring**	
1	Equipment -> PoLaRx5S Ionospheric Monitoring GNSS	1645000
A'	*Total (Non-Recurring)*	***1645000***
B	**Recurring Items**	
1	Recurring - I : (Manpower) Recurring - II : (Consumables, Travel, Contingencies) Recurring - III : Scientific Social Responsibility	1443360 220000 60000
2	Recurring - IV : (Overhead Charges)	336000
B'	*Total (Recurring)*	***2059360***
C	**Total cost of the project (A' + B')**	**3704360**

2. Sanction of the grant is subject to the conditions as detailed in Terms & Conditions available at website (www.serb.gov.in).

3. Overhead expenses are meant for the host Institute towards the cost for providing infrastructural facilities and general administrative support etc. including benefits to the staff employed in the project.

4. While providing operational flexibility among various subheads under head Recurring-II, it should be ensured that not more than Rs. 1.5 lakh each should be spent for travel and contingency.

5. Budget sanctioned under Scientific Social Responsibility (SSR) is meant only for activites enlisted under SSR norms and under no circumstances it can be reappropriated.

6. As per rule 211 of GFR, the accounts of project shall be open to inspection by sanctioning authority/audit whenever the institute is called upon to do so.

7. The sanctioned equipment would be procured as per GFR and its disposal of the same would be done with prior approval of SERB.

8.The institute will furnish to the SERB, separate Utilization certificate(UCs) financial year wise to the SERB for Recurring (Grants-in-aid General) & Non-Recurring (Grants for creation of capital assets) and an audited statement of accounts pertaining to the grant immediately after the end of each financial year.

9. The institute will maintain separate audited accounts for the project. A part or whole of the grant must be kept in an interest earning bank account which is to be reported to SERB. The interest thus earned will be treated as credit to the institute to be adjusted towards further installment of the grant.

10. The manpower sanctioned in the project, if any is co-terminus with the duration of the project and SERB will have no liability to meet the fellowship and salary of supporting staff if any. beyond the duration of the project

11. The institute may refund any unspent balance to SERB by means of a Demand Draft favoring "FUND FOR SCIENCE AND ENGINEERING RESEARCH" payable at New Delhi.

12. The project File no. CRG/2021/001660 should be mentioned in all communications arising from the above project. The organization/institute/university should ensure that the technical support/financial assistance provided to them by SERB should invariably be highlighted/ acknowledged in their media releases as well as in bold letters in the opening paragraphs of their Annual Report.

13. In addition, the investigator/host institute must also acknowledge the support provided to them in all publications, patents and any other output emanating out of the project/program funded by SERB.

14. Sanction order for release of funds under a) Non-recurring and b) Recurring will be issued separately depending on the availability of funds. The project become operational from the day the first release of grant received by the implementing Institute.

(Dr. Prahlad Ram)
Scientist D
prahlad@serb.gov.in

To,
Under Secretary
SERB, New Delhi
Copy forwarded for information and necessary action to: -

1.	The Principal Director of Audit, A.G.C.R.Building, IIIrd Floor I.P. Estate, Delhi-110002
2.	Sanction Folder, SERB , New Delhi.
3.	File Copy
4.	**Dr. Dattatreya Sarma Achanta** **Electronics and Communication Engineering** **Chaitanya Bharathi Institute of Technology , Gandipet, Hyderabad, Telangana-500075** **Email: ad_sarma@yahoo.com** **Mobile: 919440934242** **Dr. Lakshmisreenivasareddy Dirisinapu** **INFORMATION TECHNOLOGY** **Chaitanya Bharathi Institute Of Technology** **Prof. Desireddy Krishna Reddy** **Electronics And Communication Engineering** **Chaitanya Bharathi Institute Of Technology** (Start date of the project may be intimated by name to the undersigned. For guidance, terms & Conditions etc. Please visit www.serb.gov.in.)
5.	**Principal,** **Chaitanya Bharathi Institute Of Technology, Gandipet** (Receipt of Grant may be intimated by name to the undersigned)

(Dr. Prahlad Ram) 11/2/22
Scientist D
prahlad@serb.gov.in

BP-2021-22-11111

FILE NO. CRG/2021/001660-G

SCIENCE & ENGINEERING RESEARCH BOARD(SERB)

(A statutory body of the Department of Science & Technology, Government of India)

Science and Engineering Research Board
3rd & 4th Floor, Block II
Technology Bhavan, New Mehrauli Road
New Delhi - 110016

Dated: 11 February, 2022

ORDER

Subject: Research project entitled **A New Model for Short Term Forecasting of Scintillations using Machine Learning Approach and Generation of Regional Scintillation Maps** under the guidance of Dr. Dattatreya Sarma Achanta, Electronics and Communication Engineering , Chaitanya Bharathi Institute of Technology , Gandipet, Hyderabad, Telangana-500075 and by Dr. Lakshmisreenivasareddy Dirisinapu, ASSOCIATE PROFESSOR, INFORMATION TECHNOLOGY, Chaitanya Bharathi Institute Of Technology and by Prof. Desireddy Krishna Reddy, Professor, Electronics And Communication Engineering , Chaitanya Bharathi Institute Of Technology.

1. In continuation of SERB's sanction order No. CRG/2021/001660 dated 11 February, 2022, sanction of the competent authority is hereby accorded to the payment of a sum of **Rs.*705000*/-** under 'Grants-in-aid General' to Chaitanya Bharathi Institute Of Technology , Gandipet, Hyderabad, Telangana-500075 being the grant for the financial year 2021-2022 for implementation of the above said project.

2. Sanction of the grant is subject to the conditions as detailed in Terms & Conditions available at the website (www.serb.gov.in) and as mentioned in the sanction order of even number dated 11 February, 2022.

3. As this is the first grant being released under 'Grants-in-aid General' for the project, no previous U/C is required.

4. The expenditure involved is debitable to Fund for Science & Engineering Research (FSER) This release is being made under Core Research Grant **(PAC Earth & Atmospheric Sciences)** (General) .

5. The Sanction has been issued with the approval of the competent authority on **09 February, 2022** and vide Diary No. **SERB/F/8301/2021-2022** dated **10 February, 2022**..

6. The release amount of **Rs. 705000/-** (Rupees Seven Lakh Five Thousand only) will be drawn by the Under Secretary of the SERB and will be disbursed by means of RTGS transaction as per their Bank details given below:

PFMS Unique Code	CBIT
Account Name	CBIT RECURRING EXPENDITURE
Account Number	180401001258
Bank Name & Branch	ICICI Bank CBIT, Gandipet, Kokapet (V), Gandipet (M), Rangareddy (D)
IFSC/RTGS Code	ICIC0004385
Email id of A/C Holder	principal@cbit.ac.in
Email id of PI	ad_sarma@yahoo.com

(Dr. Prahlad Ram)
Scientist D
prahlad@serb.gov.in

To,
Under Secretary
SERB, New Delhi
Copy forwarded for information and necessary action to: -

1.	The Principal Director of Audit, A.G.C.R.Building, IIIrd Floor I.P. Estate, Delhi-110002
2.	Sanction Folder, SERB , New Delhi.
3.	File Copy

4.	**Dr. Dattatreya Sarma Achanta** **Electronics and Communication Engineering** **Chaitanya Bharathi Institute of Technology , Gandipet, Hyderabad, Telangana-500075** **Email: ad_sarma@yahoo.com** **Mobile: 919440934242** **Dr. Lakshmisreenivasareddy Dirisinapu** **INFORMATION TECHNOLOGY** **Chaitanya Bharathi Institute Of Technology** **Prof. Desireddy Krishna Reddy** **Electronics And Communication Engineering** **Chaitanya Bharathi Institute Of Technology** (Start date of the project may be intimated by name to the undersigned. For guidance, terms & Conditions etc. Please visit www.serb.gov.in.)
5.	**Principal,** **Chaitanya Bharathi Institute Of Technology, Gandipet** (Receipt of Grant may be intimated by name to the undersigned)

11/2/2022

(Dr. Prahlad Ram)
Scientist D
prahlad@serb.gov.in

BP-2021-22-11116

FILE NO. CRG/2021/001660-C

SCIENCE & ENGINEERING RESEARCH BOARD(SERB)

(A statutory body of the Department of Science & Technology, Government of India)

Science and Engineering Research Board
3rd & 4th Floor, Block II
Technology Bhavan, New Mehrauli Road
New Delhi - 110016

Dated: 11 February, 2022

ORDER

Subject: Research project entitled **A New Model for Short Term Forecasting of Scintillations using Machine Learning Approach and Generation of Regional Scintillation Maps** under the guidance of Dr. Dattatreya Sarma Achanta, Electronics and Communication Engineering , Chaitanya Bharathi Institute of Technology , Gandipet, Hyderabad, Telangana-500075 and by Dr. Lakshmisreenivasareddy Dirisinapu, ASSOCIATE PROFESSOR, INFORMATION TECHNOLOGY, Chaitanya Bharathi Institute Of Technology and by Prof. Desireddy Krishna Reddy, Professor, Electronics And Communication Engineering , Chaitanya Bharathi Institute Of Technology.

1. In continuation of SERB's sanction order No. CRG/2021/001660 dated 11 February, 2022, sanction of the competent authority is hereby accorded to the payment of a sum of **Rs.*1645000/-*** under 'Grants-in-aid Capital' to Chaitanya Bharathi Institute Of Technology , Gandipet, Hyderabad, Telangana-500075 being the grant for the financial year 2021-2022 for implementation of the above said project.

2. Sanction of the grant is subject to the conditions as detailed in Terms & Conditions available at the website (www.serb.gov.in) and as mentioned in the sanction order of even number dated 11 February, 2022.

3. As this is the first grant being released under 'Grants-in-aid Capital' for the project, no previous U/C is required.

4. The expenditure involved is debitable to Fund for Science & Engineering Research (FSER) This release is being made under Core Research Grant **(PAC Earth & Atmospheric Sciences)** (Capital).

5. The Sanction has been issued with the approval of the competent authority on **09 February, 2022** and vide Diary No. **SERB/F/8300/2021-2022** dated **10 February, 2022**.

6. The release amount of **Rs. 1645000/-** (Rupees Sixteen Lakh Forty Five Thousand only) will be drawn by the Under Secretary of the SERB and will be disbursed by means of RTGS transaction as per their Bank details given below:

PFMS Unique Code	CBIT
Account Name	CBIT RECURRING EXPENDITURE
Account Number	180401001258
Bank Name & Branch	ICICI Bank CBIT, Gandipet, Kokapet (V), Gandipet (M), Rangareddy (D)
IFSC/RTGS Code	ICIC0004385
Email id of A/C Holder	principal@cbit.ac.in
Email id of PI	ad_sarma@yahoo.com

(Dr. Prahlad Ram)
Scientist D
prahlad@serb.gov.in

To,
Under Secretary
SERB, New Delhi
Copy forwarded for information and necessary action to: -

1.	The Principal Director of Audit, A.G.C.R.Building, IIIrd Floor I.P. Estate, Delhi-110002
2.	Sanction Folder, SERB , New Delhi.
3.	File Copy

4.	**Dr. Dattatreya Sarma Achanta** **Electronics and Communication Engineering** **Chaitanya Bharathi Institute of Technology , Gandipet, Hyderabad, Telangana-500075** **Email: ad_sarma@yahoo.com** **Mobile: 919440934242** **Dr. Lakshmisreenivasareddy Dirisinapu** **INFORMATION TECHNOLOGY** **Chaitanya Bharathi Institute Of Technology** **Prof. Desireddy Krishna Reddy** **Electronics And Communication Engineering** **Chaitanya Bharathi Institute Of Technology** (Start date of the project may be intimated by name to the undersigned. For guidance, terms & Conditions etc. Please visit www.serb.gov.in.)
5.	**Principal,** **Chaitanya Bharathi Institute Of Technology, Gandipet** (Receipt of Grant may be intimated by name to the undersigned)

(Dr. Prahlad Ram)
Scientist D
prahlad@serb.gov.in

PHD 7551

Osmania University

Ref. No. PHD44565 Receipt no.:CN112300094

Provisional Certificate

This is to certify that RATHANKUMAR CHENOORI

son/daughter of RAMESH

having pursued a course of study prescribed by this University and having passed the requisite examinations in NOVEMBER 2023 by dissertation/thesis, has been admitted to the Degree of Ph.D. in CSE in the Faculty of ENGINEERING

CONTROLLER OF EXAMINATIONS
Osmania University
HYDERABAD-500 007.

Hyderabad

Dated 25/11/2023

Section - Incharge

for Registrar

CONFIDENTIAL SECTION
EXAMINATION BRANCH
NO. 797/Ph.D/Exams/2023

OSMANIA UNIVERSITY
HYDERABAD-500 007,T.S.
Dated: 20 Nov, 2023

PRESS NOTE

The following candidates who had presented the Thesis on the subject mentioned against each for the degree of Ph.D are declared qualified for the award of Degree of Doctor of Philosophy (Ph.D.) of Osmania University, Hyderabad.

Ph.D.

S.N	Reference No.	Name of the Candidate/ Father Name	Subject	Thesis Title	Supervisor/ Regn. Date
1	PHD44562	**Mr. Ajay Kumar Mamindla** S/o. Ramachandraiah	Computer Science & Engineering	Optimization of Breast Cancer Detection and Classification in Digital Mammograms	Prof. Y Rama Devi Dept. of CSE, CBIT(A), Hyd. **(03/04/2017)**
2	PHD44563	**Ms. Laxmi Prasanna P** D/o. Shekaram	Statistics	Forecasting Macroeconomic Aggregates - A Statistical and Neural Network Approach	Prof. S A Jyothi Rani Dept. of Statistics, O.U., Hyd. **(07/04/2017)**
3	PHD44564	**Ms. Venkataravamma Kandula** D/o. Venkateshwarlu	Sociology	Women in Higher Education: Status, Challenges and Prospects - A Study of Nalgonda District in Telangana	Dr. K Padmavathi Asst. Professor, Dept. of Sociology, Satavahana Univ., Karimnagar. **(18/02/2013)**
4	PHD44565	**Mr. Rathankumar Chenoori** S/o. Ramesh	Computer Science & Engineering	Improvement of Recommender System Performance by Spamming Detection in Online Opinions using Machine Learning	Prof. K Radhika Dept. of IT, CBIT(A), Hyd. **(03/04/2017)**
5	PHD44566	**Mr. Bhukya Nageswar Rao** S/o. Harja	Information Technology	Brain MRI Analysis and Segmentation using Deep Learning	Dr. D L Sreenivasa Reddy Assoc. Professor, Dept. of IT, CBIT(A), Hyd. **(04/09/2018)**
6	PHD44567	**Ms. Shaikh Heena Anwar** D/o. Shaikh Anwar	Hindi	Dhumil Ke Kavya Ka Shaili Vaiganik Adhyayan	Prof. Sheela Mishra Dept. of Hindi, O.U., Hyd. **(14/03/2017)**
7	PHD44568	**Mr. M Pradeep** S/o. M Yakaiah	Chemistry	Synthesis and Biological Activity of Novel Heterocyclic Pendent/Annulated Isoflavone Derivatives	Prof. Y Jayaprakash Rao Dept. of Chemistry, O.U., Hyd. **(15/03/2011)**
8	PHD44569	**Mr. Kaitha Hanok** S/o. John Kaitha	Philosophy	The Influence of St. Augustine on Theological Developments of Christianity	Prof. Mallesh Sankasala Dept. of Philosophy, O.U., Hyd. **(25/02/2013)**

Cp. Vardhani 20/11/23

Addl.Controller of Examinations
(Confidential)

Copy forwarded to:

1. The Candidate _____
2. P.A. to Controller of Examination, O.U.
3. The Dean, Faculty of Arts / Engineering / Informatics/ Science / Social sciences , O.U.
4. The Chairperson, BOS in Chemistry/ Computer Science & Engineering/ Hindi/ Information Technology/ Philosophy/ Sociology/ Statistics, O.U.
5. The Head Dept of Chemistry/ Computer Science & Engineering/ Hindi/ Information Technology/ Philosophy/ Sociology/ Statistics/Journalism, O.U.
6. The Secretary to the Vice-Chancellor/P.A. to Registrar, O.U.
7. The Deputy Registrar/ Accounts/ Admin/ Academic/ UGC Cell, O.U.
8. The Librarian, General Library, O.U.
9. The Public Relations Officer, O.U.
10. The Cheif Warden, Hostel and Messes, O.U.
11. The ACOE(EDP), Examination Branch, O.U.
12. The Director, Infrastructure, Admin. Buildings, O.U.
13. The Secretary, Assoc. of Indian Universities, 16, Kotla Road, New Delhi-110002
14. The Director, Research Division, Assoc. of Indian Universities, 16, Kotla Road, New Delhi-110002
15. The Secretary, UGC, 35, Feroz Shah Road, New Delhi-110002
16. The Editor, University News, AIU Campus, Kotla Road, New Delhi-110002
17. The Senior Statistical Officer, U G C, (Info & Stats Bureau), 35, Feroze Shah Road, New Delhi - 110 221.
18. The Local Press (through DIPR), Govt. of T.S., Hyderabad.
19. The Examiner _____

With a request to send the remuneration bill dully filled in immediately and also to return the copy of the Thesis/Dissertation if it is not done so far.

DEAN
Prof.P.Premchand

Off No : 27095845
27097577

Faculty of Informatics
Osmania University, Hyderabad-500007.

DFI/2018/Ph.D.(I)/15 Date: 18-08-2018

ORDERS

Sub: Admission to Ph.D. Programme for the Academic years 2014-2015, 2015-16 and 2016-17 in the Faculty of Informatics. OU- Regarding.
Ref: Your Lr.No.1053/A/F/Acad.III/2018 dated: 10.08.2018

Dear : Mr.Nageshwar Rao Bhukya

Sanction is accorded for the admission of the candidates and name of the Supervisor Dr.D.Lakshmi Sreenivasa Reddy,Associate Professor, Department of MCA,Chaitanya Bharathi Institute of Technology, Gandipet,Hyderabad to the Ph.D. Programme, under the Faculty of Informatics in the Department of CSE, for the Academic years 2014-2015, 2015-16 and 2016-17. On Full-Time basis.

The candidates are required to submit the joining report within 15 days from the date of issue of this letter. The proforma of the joining Report duly stamped by the Dean's Office can be obtained after submitting the under mentioned documents in the Office of the Dean, faculty of Informatics, Osmania University:

1. Undertaking that Hostel Facility will not be asked
2. Latest N.O.C from employer
3. Copies of Degree Certificate – P.G.
4. Supervisor Acceptance letter (if not submitted **earlier**)

Candidates are required to submit Half Yearly Report (Jan-June/ July- Dec.) to this office through the Supervisor and Head of the Department concerned regularly, failing which registration will be cancelled.

Dean
Faculty of Informatics, OU

Dean,
Faculty of Informatics
Osmania University

Encl: as above
Person Concerned.
CC to:

1) The Supervisors (s)
2) The Dy.Registrar (Academic) OU.
3) The Principal CoE, OU
4) Head, Dept. of CSE, UCE (A), OU
5) Chairman, BOS in Informatics, OU
6) The Controller of Examinations, OU
7) The officer in-charge, Examination cell, UCE, (A) OU.

DEAN
Prof.P.Premchand

Off No : 27097577
: 27682343

(34)

Faculty of Informatics
Osmania University, Hyderabad-500007

DFI/2017/Ph.D.(I)/10 14th March, 2017

ORDERS

Sub: Admission to Ph.D. Programme for the Academic year 2013-2014 in the Faculty of Informatics. OU- Regarding.

Ref: University order No.307/F/Acad.III/2017 dated: 21.02.2017

Dear:Mr.Battapothula V Ratnam

Sanction is accorded for the admission of the candidate and name of the Supervisor Dr.D.Lakshmi Sreenivasa Reddy, Associate Professor, Dept. of MCA, CBIT,Gandipet,Hyderabad to the Ph.D. Programme, under the Faculty of Informatics in the Department of CSE, for the Academic year 2013-2014. On Part-time basis.

The candidates are required to submit the joining report within 15 days from the date of issue of this letter. The proforma of the joining Report duly stamped by the Dean's Office can be obtained after submitting the under mentioned documents in the Office of the Dean, faculty of Informatics, Osmania University:

1. Undertaking that Hostel Facility will not be asked
2. Latest N.O.C from employer
3. Copies of Degree Certificate – P.G.
4. Supervisor Acceptance letter (if not submitted **earlier**)

Candidates are required to submit Half Yearly Report (Jan-June/ July- Dec.) to this office through the Supervisor and Head of the Department concerned regularly, failing which registration will be cancelled.

P. Premchand
Dean
Faculty of Informatics, OU

Dean,
Faculty of Informatics
Osmania University

Encl: as above
CC to:

1) The Supervisors (s)
2) The Dy.Registrar (Academic) OU.
3) The Principal CoE, OU
4) Head, Dept. of CSE, UCE (A), OU
5) Chairman, BOS in Informatics, OU
6) The Controller of Examinations, OU.
7) The officer in-charge, Examination cell, UCE, (A) OU.

EXAMINATION BRANCH HYDERABAD-500 007, T.S.

NO. 797/Ph.D/Exams/2023 Dated: 20 Nov, 2023

PRESS NOTE

The following candidates who had presented the Thesis on the subject mentioned against each for the degree of Ph.D are declared qualified for the award of Degree of Doctor of Philosophy (Ph.D.) of Osmania University, Hyderabad.

Ph.D.

S.N	Reference No.	Name of the Candidate/ Father Name	Subject	Thesis Title	Supervisor/ Regn. Date
1	PHD44562	**Mr. Ajay Kumar Mamindla** S/o. Ramachandraiah	Computer Science & Engineering	Optimization of Breast Cancer Detection and Classification in Digital Mammograms	Prof. Y Rama Devi Dept. of CSE, CBIT(A), Hyd. **(03/04/2017)**
2	PHD44563	**Ms. Laxmi Prasanna P** D/o. Shekaram	Statistics	Forecasting Macroeconomic Aggregates - A Statistical and Neural Network Approach	Prof. S A Jyothi Rani Dept. of Statistics, O.U., Hyd. **(07/04/2017)**
3	PHD44564	**Ms. Venkataravamma Kandula** D/o. Venkateshwarlu	Sociology	Women in Higher Education: Status, Challenges and Prospects - A Study of Nalgonda District in Telangana	Dr. K Padmavathi Asst. Professor, Dept. of Sociology, Satavahana Univ., Karimnagar. **(18/02/2013)**
4	PHD44565	**Mr. Rathankumar Chenoori** S/o. Ramesh	Computer Science & Engineering	Improvement of Recommender System Performance by Spamming Detection in Online Opinions using Machine Learning	Prof. K Radhika Dept. of IT, CBIT(A), Hyd. **(03/04/2017)**
5	PHD44566	**Mr. Bhukya Nageswar Rao** S/o. Harja	Information Technology	Brain MRI Analysis and Segmentation using Deep Learning	Dr. D L Sreenivasa Reddy Assoc. Professor, Dept. of IT, CBIT(A), Hyd. **(04/09/2018)**
6	PHD44567	**Ms. Shaikh Heena Anwar** D/o. Shaikh Anwar	Hindi	Dhumil Ke Kavya Ka Shaili Vaiganik Adhyayan	Prof. Sheela Mishra Dept. of Hindi, O.U., Hyd. **(14/03/2017)**
7	PHD44568	**Mr. M Pradeep** S/o. M Yakaiah	Chemistry	Synthesis and Biological Activity of Novel Heterocyclic Pendent/Annulated Isoflavone Derivatives	Prof. Y Jayaprakash Rao Dept. of Chemistry, O.U., Hyd. **(15/03/2011)**
8	PHD44569	**Mr. Kaitha Hanok** S/o. John Kaitha	Philosophy	The Influence of St. Augustine on Theological Developments of Christianity	Prof. Mallesh Sankasala Dept. of Philosophy, O.U., Hyd. **(25/02/2013)**

Cp. Vardhani 20/11/23

Addl.Controller of Examinations

(Confidential)

Copy forwarded to:

1. The Candidate _____
2. P.A. to Controller of Examination, O.U.
3. The Dean, Faculty of Arts / Engineering / Informatics/ Science / Social sciences , O.U.
4. The Chairperson, BOS in Chemistry/ Computer Science & Engineering/ Hindi/ Information Technology/ Philosophy/ Sociology/ Statistics, O.U.
5. The Head Dept of Chemistry/ Computer Science & Engineering/ Hindi/ Information Technology/ Philosophy/ Sociology/ Statistics/Journalism, O.U.
6. The Secretary to the Vice-Chancellor/P.A. to Registrar, O.U.
7. The Deputy Registrar/ Accounts/ Admin/ Academic/ UGC Cell, O.U.
8. The Librarian, General Library, O.U.
9. The Public Relations Officer, O.U.
10. The Cheif Warden, Hostel and Messes, O.U.
11. The ACOE(EDP), Examination Branch, O.U.
12. The Director, Infrastructure, Admin. Buildings, O.U.
13. The Secretary, Assoc. of Indian Universities, 16, Kotla Road, New Delhi-110002
14. The Director, Research Division, Assoc. of Indian Universities, 16, Kotla Road, New Delhi-110002
15. The Secretary, UGC, 35, Feroz Shah Road, New Delhi-110002
16. The Editor, University News, AIU Campus, Kotla Road, New Delhi-110002
17. The Senior Statistical Officer, U G C, (Info & Stats Bureau), 35, Feroze Shah Road, New Delhi - 110 221.
18. The Local Press (through DIPR), Govt. of T.S., Hyderabad.
19. The Examiner _____

With a request to send the remuneration bill dully filled in immediately and also to return the copy of the Thesis/Dissertation if it is not done so far.

CONFIDENTIAL SECTION
EXAMINATION BRANCH
NO. 801/Ph.D/Exams/2023

OSMANIA UNIVERSITY
HYDERABAD-500 007,T.S.
Dated: 07 Dec, 2023

PRESS NOTE

The following candidates who had presented the Thesis on the subject mentioned against each for the degree of Ph.D are declared qualified for the award of Degree of Doctor of Philosophy (Ph.D.) of Osmania University, Hyderabad.

Ph.D.

S.N	Reference No.	Name of the Candidate/ Father Name	Subject	Thesis Title	Supervisor/ Regn. Date
1	PHD44594	**Mr. Ponna Srinivasa Kumar** S/o. Peda Kotilingam	Physics	Investigation of Ultrasonic Velocities on Micro Biological Samples at Different Growth Phases and Temperature	Prof. D Linga Reddy(Retd.) Dept. of Physics, O.U., Hyd. **(04/02/2009)**
2	PHD44595	**Ms. N Arundhathi** D/o. Ramarao	Telugu	Nizambad Zilla Yekshaganalu - Samagra Adhyayanam	Prof. N Shankaram(Retd.) GDC(W), Sangareddy. **(09/03/2011)**
3	PHD44596	**Mr. P Kaushik** S/o. Ramchandram	Genetics	Single Nucleotide Polymorphic Associations of Matrix Metalloproteinases (MMP7, MMP2, MMP14 and TIMP2) and STAT3 Genes in Breast Cancer	Prof. H Surekha Rani Dept. of Genetics, O.U., Hyd. **(25/11/2016)**
4	PHD44597	**Ms. Soujanya Ganta** D/o. Satyakumar G	Biotechnology	Molecular and Immunoregulatory Aspects of T-Helper Cytokines in Asthma	Dr. G Sumanlatha Asst. Professor, Dept. of Genetics, O.U., Hyd. **(03/12/2016)**
5	PHD44598	**Ms. K V L D Spandana** D/o. K Viswanadha Sastry	Pharmaceutical Sciences	Development and Validation of Stability Indicating RP-HPLC Method with PDA Detection for the Estimation of Selected Drugs	Dr. N J P Subhashini Asst. Professor, Dept. of Chemistry, O.U., Hyd. **(10/04/2017)**
6	PHD44599	**Mr. [illegible]** S/o. Mallai[illegible]	[illegible]ilosophy	The Origin and Evaluation of Yoga in Indian Philosophy	Prof. T Krishna Rao Dept. of Philosophy, O.U., Hyd. **(17/03/2017)**
7	PHD44600	**Ms. M Rajani** D/o. M Balanarasimha	Information Technology	Prediction of Student Performance [illegible]sing Data [illegible]ining T[illegible]chniques	Dr. D L Sreenivasa Reddy Assoc. Professor, Dept. of IT, CBIT(A), Hyd. **(03/04/2017)**

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Crop Recommendation System Using Improved Apriori Algorithm

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Abstract— A crop suggestion system is a technologically advanced tool that helps farmers choose which crops to plant in a certain location or with precise environmental circumstances. These systems use a variety of data sources and analytical methods to give farmers customized crop recommendations. This work presents the Crop Recommendation System Using an Improved Apriori Algorithm, which is an Apriori-based crop recommendation system. The goal of the system is to assist farmers in making well-informed choices about which crops to grow and what fertilizers to use depending on the properties of the soil and environment. With consideration for crop variety, climate, and soil nutrient content, the suggested method is an enhanced version of the Apriori algorithm. Tests of the updated algorithm on a dataset of soil samples from different parts of India revealed that it could correctly suggest the optimal crop. The model's output, association rules, is a suggestion system that farmers can use to boost crop productivity while lowering input costs. The method suggested operates in three phases: In the first stage, preprocessing the data is carried out to gather the input parameters that are crucial for determining the recommendation system. In Stage 2, the recommendation system's association rules are extracted by using an iterative approach to determine the threshold support count and confidence. Stage 3: The recommendation system's knowledge base is formed by pruning the top 8 apriori rules depending on priority. From the experiments, it is evident that the improved apriori algorithm-based extracted recommendation system is an interesting development in precision agriculture that could raise farming practices' sustainability and efficiency.

Keywords- Rice, Maize, Mango, Crop Recommendation, Apriori Algorithm.

I. INTRODUCTION

India has a diversified agricultural economy, with many different crops growing in different parts of the nation due to differing agro-climatic conditions. India's farmers select their crops taking into account the country's climate, soil composition, consumer demand, and personal tastes [1]. The following are some of the several crops that Indian farmers love to grow: **Rice:** Grown extensively throughout India, especially in places like West Bengal, Punjab, and Uttar Pradesh, rice is a staple food. It is usually grown in areas with heavy rainfall or access to irrigation since it needs a lot of water. **Wheat:** Grown in Punjab, Haryana, and Uttar Pradesh, among other northern Indian states, wheat is another staple crop. It is sown in the Rabi season and is a winter crop. **Corn, or maize:** Cultivated across India, but especially in Andhra Pradesh, Karnataka, and Madhya Pradesh. It is utilized as cattle feed as well as for human consumption. **Millets** are drought-resistant crops that are cultivated in arid and semi-arid regions of India, such as Rajasthan, Maharashtra, and portions of Karnataka and Andhra Pradesh [1]. Millets include finger millet (ragi), pearl millet (bajra), and sorghum (jowar). **Pulses:** Several states, including Madhya Pradesh, Uttar Pradesh, and Maharashtra, grow pulses like chickpeas (gram), lentils (masoor), and pigeon peas (tur). In Indian cuisine, pulses are a vital source of protein. **Cotton:** Grown in areas like Gujarat, Maharashtra, and Andhra Pradesh, cotton is a significant cash crop. India ranks among the world's top producers of cotton [2]. **Sugarcane:** Grown in states like Uttar Pradesh, Maharashtra, and Karnataka, sugarcane is widely farmed for its sugary yield. **Oilseeds:** Edible oil production is the purpose of cultivating oilseeds such as sunflower, groundnuts, and soybeans. Many states, notably Gujarat, Maharashtra, and Madhya Pradesh, grow these crops. **Spices:** Known as the "Land of Spices," farmers in states like Kerala, Karnataka, and Andhra Pradesh grow a vast array of spices, including black pepper, cardamom, turmeric, and chili peppers.

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India is one of the world's leading producers of fruits and vegetables, with areas like Punjab and Haryana focusing on the production of citrus and apple-based foods [2]. **Coffee and tea:** Karnataka, Kerala, and Tamil Nadu are the main growing regions for coffee, while Assam, West Bengal, and Kerala are known for their tea plantations. **Cash Crops:** Various states cultivate cash crops for commercial use, such as sugarcane, rubber, and tobacco. analyses large amounts of data and generates recommendations using data analytics and machine learning algorithms [3]. fertilizers to use on their crops. To provide personalized recommendations to farmers, the system considers various The system can be linked to sensors and other data sources to provide real-time advice based on current weather and soil conditions. In recent days' modern agriculture is using sensors to know crop and soil details.

A crop recommendation system is a computer-based tool that assists farmers in making informed decisions about factors such as soil type, weather conditions, crop type, and nutrient requirements.

Increased crop yields, lower input costs, improved soil health, and reduced environmental impact are all advantages of using a crop and fertilizer recommendation system. Farmers can optimize their fertilizer use and reduce waste and pollution by receiving personalized recommendations. AgroCares, CropIn, and the International Plant Nutrition Institute are among the companies and organizations developing and implementing crop and fertilizer recommendation systems. These systems are being used to help farmers increase productivity and sustainability in various parts of the world, including the United States, Europe, and Asia. Overall, a crop recommendation system is a promising tool for farmers looking to optimize their use of fertilizers and improve their crop yields while reducing their environmental impact [4]. As technology advances, we can expect more sophisticated and accurate recommendation systems to be developed to meet the needs of farmers worldwide.

Several kinds of sensors that are intended to track and gather data about various facets of farming and the environment can detect agricultural data. Modern precision agriculture relies heavily on these sensors to assist farmers in making data-driven decisions that maximize crop yields, minimize resource use, and boost overall productivity.

Fig. 1. Crop and Fertilizer recommendation based on soil and climate changes

II. MOTIVATION

Many studies have shown that crop and fertilizer recommendation systems can significantly increase crop yields while also lowering farmers' input costs. A study conducted in India, for example, discovered that using a recommendation system increased yields by 14% while decreasing fertilizer use by 22%. The quality and quantity of data used, the algorithms and models used to generate recommendations, and the user interface and ease of use for farmers all have an impact on the accuracy and effectiveness of crop and fertilizer recommendation systems [5].

While crop and fertilizer recommendation systems have many advantages, they also have some drawbacks and limitations. These systems, for example, can be costly to implement and maintain, and they may necessitate significant technical expertise to function properly. Overall, the literature suggests that crop and fertilizer recommendation systems can be a valuable tool for farmers looking to optimize fertilizer use and improve crop yields. More research is needed, however, to fully understand the factors that influence the accuracy and effectiveness of these systems, as well as to develop more sophisticated and user-friendly recommendation systems that farmers can easily adopt [6]. Crop classification and yield prediction are common applications for decision trees. These models are based on a hierarchical structure of decision nodes that divide data into smaller subsets based on specific criteria, resulting in a prediction. Neural networks are a type of machine learning model inspired by the human brain's structure. These models can predict crop yield, analyze nutrients, and categorize crops. Support vector machines

(SVMs) are a type of machine learning algorithm that can be used to predict crop yield and classification. SVMs work by determining the best decision boundary between different classes of data and mapping the data into a higher-dimensional space using a kernel function [7].

Random forest is an ensemble learning technique for improving prediction accuracy by combining multiple decision trees. These models are frequently used to forecast crop yields and assess nutrient levels. Deep learning is a subfield of machine learning that uses multiple-layer neural networks to learn complex data representations. Deep learning models have been used to predict crop yield, detect disease, and characterize plant phenotypes [8]. Bayesian networks are probabilistic graphical models that represent the relationships and conditional dependencies between variables. These models have been used to predict crop yields and manage nutrients. Overall, machine learning techniques have yielded promising results for crop and fertilizer recommendation, with many studies demonstrating increased accuracy and efficiency over traditional methods. However, the technique used is determined by the specific problem and data available, and more research is required to determine the most effective approaches for various applications [9]. Though the decision trees are good enough in crop recommendation the outcome of these models are complex to decode and need some prerequisite knowledge to understand. The proposed work in the paper conveys the outcome of apriori association rules in the form of classification rules, like if –then –else rules which are easily understood by the farmers. This set of rules recommends that farmers select the best crop based on soil and weather features [10].

III. LITERATURE REVIEW

Crop recommendation systems are based on the collection of data from various sources, such as soil samples, meteorological conditions, past crop yields, and local agricultural practices. Sensors, satellite imagery, and other methods are utilized to facilitate data collection. (Savary et al., 2012; Zhang et al., 2017) [10] [11]. Then, using sophisticated algorithms and machine learning models, data analysis is conducted while accounting for variables including crop-specific requirements, temperature, precipitation, pH levels, and type of soil (Anaya-Romero et al., 2017; Alippi et al., 2019) [12][13. Then, using the data that has been analyzed, these systems determine which crops are suitable for which farms or places. They take into account factors such as pest resistance, nutrient requirements, and crop growth cycles (Braun et al., 2010; Tekinerdogan et al., 2019) [14]. Personalized crop recommendations are produced after the study, and farmers are frequently provided with a list of appropriate crops that are graded according to their potential yield and profitability in the specified location (Das et al., 2017; Pan et al., 2019) [15]. According to Liu et al. (2019) and Nalwanga et al. (2020), these guidelines provide a basis for well-informed decision-making concerning crop selection, planting schedules, and agronomic practices, ultimately assisting in resource optimization and risk reduction. Aside from giving real-time guidance on pest management, fertilization, and irrigation based on continuously updated data and meteorological information, some systems also provide continuous monitoring and feedback throughout the growing season (Wu et al., 2018; Yang et al., 2019) [16]. To improve accessibility, these systems can be accessed via many platforms such as web-based interfaces, Smartphone applications, or SMS services. This guarantees that farmers with different levels of technological literacy can still use the systems (Savary et al., 2012; Zhang et al., 2017) [17].

Crop recommendation systems encounter several obstacles and constraints. First, as their efficacy is largely dependent on the quantity and quality of data, they are prone to errors when there is a lack of data or when the data is not representative of the real world [18]. Second, some systems suggest intricate machine learning models or algorithms, which could be difficult for farmers or organizations with little technical know-how or funding to install and maintain [19]. Furthermore, the high resource needs of some technologies, like as satellite images or sensor networks may prevent small-scale or resource-constrained farmers from adopting them. Furthermore, when studies fail to sufficiently explore the applicability of their methods in broader agricultural settings, scalability difficulties may surface. Moreover, the reliance on internet connectivity for data updates and recommendations may result in the inefficiency of these systems in locations with sporadic or restricted internet access [20]. A critical component, model correctness, depends on the caliber and volume of training data, and some studies might not fully validate their models. Precision agriculture raises several ethical and environmental issues that should be carefully considered, such as the overuse of chemical inputs and the replacement of traditional farming methods [20]. Farmers may also accept technology differently than other users due to cultural norms, lack of faith in technology, and availability of support and training. The dynamic and unpredictable character of agriculture, which is impacted by pests, market fluctuations, and climate change, needs appropriate system adaptation, which some publications may not sufficiently address.

IV. METHODOLOGY

In this paper, we have proposed an advanced Apriori algorithm that extracts the classification rules to recommend the best crop to farmers based on soil and properties. An important factor in identifying significant links between items in transactional databases is the Apriori algorithm, which is the foundation of association rule mining. Known for its use in

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market basket analysis in particular, this algorithm is excellent at detecting products that are commonly bought together, providing insightful information about consumer behavior.

Fundamentally, Apriori makes use of the "apriori property," which states that all of an item set's subsets must likewise be frequent if an item is frequent. This characteristic facilitates the rapid creation of candidate item sets while eliminating those that don't meet the minimal support requirement. Using pseudo code, this procedure is concisely described as follows: candidate and frequent item sets are carefully created, counted, pruned, and aggregated until no new frequent item sets appear. An essential tool for identifying patterns and correlations in a variety of fields, such as market analysis and recommendation systems, the algorithm's power comes from its capacity to sort through enormous amounts of transactional data. It does this by using the apriori characteristic to expedite the search process.

The data set (crop recommendation data set) was obtained from Kaggle which includes seven input parameters and one class label attribute. The experimental design is based on 2200 records from 22 different crops. Table 2 lists the input parameters considered for the experiments. Table 1 tabulates the various crops and the number of records with a specific crop's class label. Using a heuristic approach, all numerical values of input parameters are converted into categorical values during the data preprocessing step. A range of soil and environmental factors are presented in the table, each having continuous and categorical values. These variables include temperature, humidity, pH value (pH), rainfall, nitrogen content (N), phosphorous content (P), and potassium content (K). While the category values divide these parameters into "Low," "Medium," and "High" categories based on predetermined criteria, the continuous values show the actual measurements or ratios of these parameters. These classifications make it easier to understand and use these vital measures in practice when evaluating soil quality and environmental conditions for things like land management, environmental monitoring, and agriculture.

The data set is divided into 22 subsets. Each subset contains 100 records, one for each crop chosen for the experiment. A heuristic approach is a problem-solving or decision-making strategy that uses practical rules of thumb or shortcuts to find solutions or make decisions more quickly and efficiently, often in situations where a perfect or exhaustive solution is not feasible or would require too much time and resources. Heuristics are mental strategies or cognitive tools that help individuals simplify complex problems and navigate through uncertainty. They are particularly useful in situations where people need to make quick decisions or when faced with incomplete information.

TABLE 1. DATA SET DETAILS

S. No.	Class Label Name	Number of Records
1	Rice	100
2	Apple	100
3	Banana	100
4	Chickpea	100
5	Coconut	100
6	Coffee	100
7	Cotton	100
8	grapes	100
9	jute	100
10	Kidney beans	100
11	Lentil	100
12	Maize	100
13	Mango	100
14	Moth beans	100
15	Moonbeam	100
16	Muskmelon	100
17	Orange	100
18	Papaya	100
19	Pigeon peas	100
20	Pomegranate	100
21	Watermelon	100

TABLE 2. INPUT PARAMETERS

S. No.	Input Parameter Name	Details	Continuous values (Categorical value)		
1	N	The ratio of Nitrogen content in the soil	<=50(Low)	>50 &&<=100 (Medium)	>100(High)
2	P	The ratio of Phosphorous content in the soil	<=50(Low)	>50 &&<=100 (Medium)	>100 (High)
3	K	The ratio of Potassium content in the soil	<=70(Low)	>71&&<=140 (Medium)	>140(High)
4	Temperature	Temperature in degrees Celsius	<=20(Low)	>21&&<=32(Medium)	>32 (High)
5	Humidity	Relative humidity in %	<=35(Low)	>35&&<=70 (Medium)	>70 (High)
6	Ph	ph value of the soil	<=5(Low)	>5&&<=7 (Medium)	>7 (High)
7	Rain Fall	Rainfall in mm	<=90(Low)	>90&&<=180 (Medium)	>180 (High)

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Pseudo code:

The Apriori algorithm is based on the "apriori property," which states that if an item is frequent (i.e., it occurs with a minimum support threshold), all of its subsets must also be frequent. This property is leveraged to efficiently generate candidate item sets and prune those that do not meet the minimum support threshold.

Initialization:

Initialize a list of candidate itemsets, C, with frequent items of size 1.

Initialize a list of frequent itemsets, L, with frequent items of size 1.

Generate Frequent Itemsets:

while L is not empty:

// Generate candidate itemsets of size k+1 from frequent itemsets of size k.

Ck+1 = Apriori-Gen(L)

// Count the support of each candidate itemset by scanning the transaction database.

for each transaction in the database:

for each candidate item in Ck+1:

if the candidate item is a subset of the transaction:

Increment the support count of the candidate itemset.

// Prune candidate itemsets that do not meet the minimum support threshold.

Lk+1 = {candidate in Ck+1 | support(candidate) >= min_support}

// Add frequent itemsets of size k+1 to the list of frequent itemsets.

L = L ∪ Lk+1

Repeat the process until no new frequent itemsets can be generated.

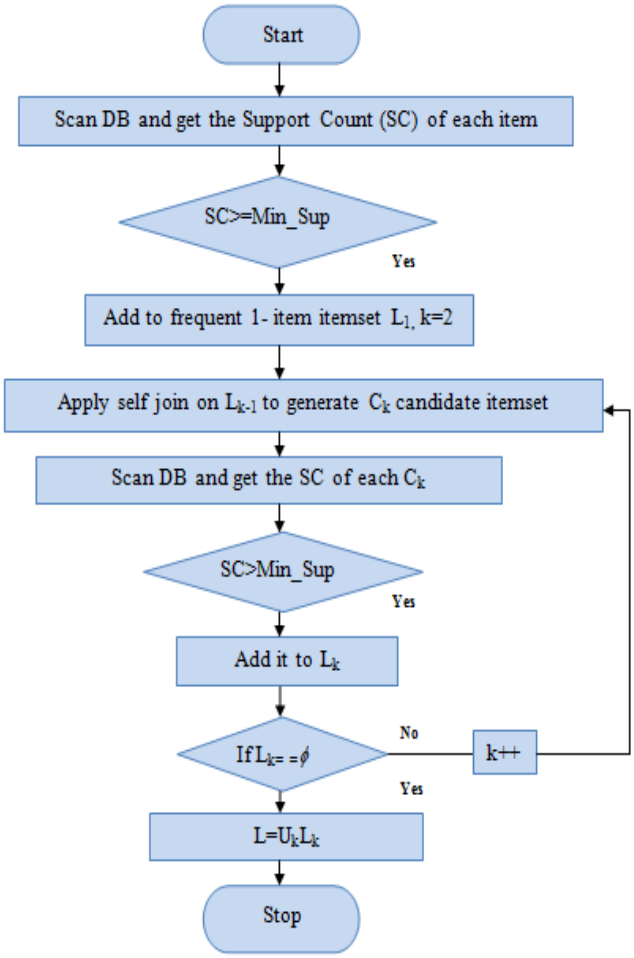

Figure 2: Flow diagram of Apriori Algorithm

V. IMPLEMENTATION & RESULTS

The Apriori algorithm is a well-known association rule mining technique for identifying frequent itemsets in a transactional database. It seeks out interesting relationships between different items in a dataset, such as products that are frequently purchased together in a store or items that are frequently viewed together on an online retail website. The Algorithm is driven by two metrics: support and confidence. Support quantifies an itemset's frequency and is defined as the proportion of transactions that contain the itemsets. Confidence is defined as the proportion of transactions containing both items over the number of transactions containing the first item and measures the likelihood of one item being purchased given the purchase of another item. The Experimental setup is done initially at support 0.6 and confidence 0.9, and an iterative heuristic approach is used to extract the association rules. The best top 8 rules are extracted at support count 0.4 and confidence 0.9. They are considered as best rules as their consequent part of the rule covers almost all input parameters considered for the experiments and also covers most of the input records. The rules recommending the best crop for the farmers are given below.

a) R1:N=Medium&&K=Low &&temperature=Medium &&humidity=High&&ph=Medium &&rainfall= High ➔rice

b) R2: N=Low && P=High &&ph=Medium && rainfall=Medium ➔ apple

c) R3:P=Medium && K=Low && temperature=Medium && humidity=High &&ph=Medium && rainfall=Medium ➔banana

d) R4: N=Medium && P=Low && K=Low && temperature=Medium &&ph=Medium ➔maize

e) R5: N=Low && P=Low && K=Low && temperature=High&& humidity=Medium && rainfall=Medium ➔mango

f) R6: K=Low && humidity=High &&ph=Medium && rainfall=Medium && P=Low ➔orange

g) R7: P=Medium && temperature=High && humidity=High &&ph=Medium ➔papay

h) R8:temperature=Medium&&humidity=High &&ph=Medium && rainfall=Low && K=Low ➔watermelon

VI. CONCLUSION

Based on the Apriori algorithm's experimental setup and association rule mining, the algorithm has generated eight recommended rules for suggesting the best crop for farmers based on certain input parameters. Each rule consists of a set of conditions (antecedent) that indicate the input parameter values and a consequent part that suggests the best crop to grow. The rules are ranked based on their support and confidence values. Example Rule 1 (R1): If Nitrogen (N) is Medium, Potassium (K) is Low, Temperature is Medium, Humidity is High, pH is Medium, and Rainfall is High, then the recommended crop is Rice. Rule 2 (R2): If Nitrogen (N) is Low, Phosphorus (P) is High, pH is Medium, and Rainfall is Medium, then the recommended crop is Apple.

These rules are extracted from the transactional database and have been chosen as the best rules based on their ability to cover a significant portion of the input parameters considered in the experiments and cover a substantial number of input records. Farmers can use these rules as guidelines to make informed decisions about the most suitable crops to grow based on specific environmental conditions and soil nutrient levels.

REFERENCES

[1] Birthal, P. S., et al. "Indian Agriculture: Status, Importance, and Role in Indian Economy." Agricultural Economics Research Review, Vol. 27, 2014.

[2] Ramesh Chand. "Agriculture in India: Issues for Policy Analysis." Indian Journal of Agricultural Economics, Vol. 58, No. 3, 2003.

[3] Z. Doshi, S. Nadkarni, R. Agrawal, and N. Shah, “AgroConsultant: Intelligent Crop Recommendation System Using Machine Learning Algorithms,” IEEE Xplore, Aug. 01, 2018.

[4] Nimmala, S., Vikranth, B., Muqthadar Ali, S., Usha Rani, R., & Rambabu, B. (2022). An intelli MVC: An intelligent majority voting and heuristic-based hybrid classifier to predict high blood pressure. Journal of Intelligent & Fuzzy Systems, 43(3), 3003–3020.

[5] G. Chauhan and A. Chaudhary, “Crop Recommendation System using Machine Learning Algorithms,” IEEE Xplore, Dec. 01, 2021.

[6] S. Bhanumathi, M. Vineeth, and N. Rohit, “Crop Yield Prediction and Efficient use of Fertilizers,” IEEE Xplore, Apr. 01, 2019.

[7] K. Bakthavatchalam et al., “IoT Framework for Measurement and Precision Agriculture: Predicting the Crop Using Machine Learning Algorithms,” Technologies, vol. 10, no. 1, p. 13, Jan. 2022.

[8] P. Akulwar, “A Recommended System for Crop Disease Detection and Yield Prediction Using Machine Learning Approach,” Recommender System with Machine Learning and Artificial Intelligence, pp. 141–163

[9] Chlingaryan, S. Sukkarieh, and B. Whelan, “Machine learning approaches for crop yield prediction and nitrogen status estimation in precision agriculture: A review,” Computers and Electronics in Agriculture, vol. 151, pp. 61–69, Aug. 2018.

[10] Savary, S., Ficke, A., Aubertot, J. N., &Hollier, C. (2012). Crop losses due to diseases and their implications for global food production losses and food security. Food Security, 4(4), 519-537.

[11] Zhang, X., Li, W., & Zhang, M. (2017). Crop yield prediction under soil constraints. Computers and Electronics in Agriculture, 135, 25-33.

[12] Anaya-Romero, M., Fajardo, J. O., Sanchez-Ortiz, A., Fuentes-Angel, J., & Vargas-Vazquez, D. (2017). Crop yield prediction based on machine learning. Procedia Computer Science, 120, 161-168.

[13] Alippi, C., Boracchi, G., Roveri, M., &Benassi, G. (2019). Robust online cropping season classification of time series of multi-spectral images. Computers and Electronics in Agriculture, 157, 322-330.

[14] Braun, M., Fritz, C., & Schulz, H. (2010). A model-based system for agricultural decision support. Environmental Modelling & Software, 25(10), 1225-1232.

[15] Tekinerdogan, B., Tosun, A., &Kuscu, I. (2019). An ontology-based expert system for precision agriculture. Computers and Electronics in Agriculture, 156, 304-315.

[16] Das, A., Ghosh, S., & Ghosh, A. (2017). A novel fuzzy logic and neural network-integrated framework for crop yield prediction. Computers and Electronics in Agriculture, 136, 44-53.

[17] Pan, L., Wang, W., Chen, J., Shi, W., & Wei, L. (2019). Deep crop classification using 3D convolutional neural networks. Computers and Electronics in Agriculture, 162, 1069-1076.

[18] Liu, B., Sun, F., & Ma, W. (2019). A hybrid model for maize yield prediction using machine learning methods. Computers and Electronics in Agriculture, 157, 282-292.

[19] Nalwanga, R., Walker, S., & May, K. (2020). Fertilizer recommendation for maize using machine learning. Computers and Electronics in Agriculture, 177, 105712.

[20] Satyanarayana, N., Ramadevi, Y., Manasa, K., & Rambabu, B. (2020). An intelli AFM: An Intelligent Association-based fuzzy rule miner to predict high blood pressure using bio-psychological factors. Intelligent Decision Technologies, 14(2), 227–237.

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Comparison of Periodic Pattern Mining Algorithms on Temporal Datasets

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Abstract: The identification of periodic patterns is of great significance in revealing hidden temporal patterns and regularities across various domains, including finance, healthcare, and social networks. As the availability of large-scale temporal datasets continues to grow, the selection of an appropriate periodic pattern mining algorithm becomes crucial for efficient and accurate analysis. The objective of this research paper is to conduct a comparative evaluation of various periodic pattern mining algorithms applied to temporal datasets. The algorithms under consideration include Apriori-based methods such as Modified-Apriori and LPP-Apriori, as well as Tree-based approaches such as LPP Breadth, and LPP-FP Growth. We have assessed the performance of these algorithms across different datasets, focusing on metrics such as Execution Time, LPP Count, and memory usage.

Keywords: LPP-Apriori, LPP-FP-Growth, Modified-Apriori, Periodic Patterns, Timestamps.

1. Introduction

1.1 Introduction to Periodic Pattern Mining

Periodic pattern mining is a data mining technique that focuses on discovering recurring patterns in temporal datasets. Temporal datasets contain data points associated with timestamps or time intervals, representing events or observations that occur over time. By analyzing these datasets, we can discover hidden regularities and temporal dependencies, providing valuable insights into the underlying dynamics and patterns of various phenomena.

The analysis of temporal data has gained significant importance due to the increasing availability of large-scale datasets in diverse domains such as Retail, finance, healthcare, social networks, transportation, and more. These datasets capture time-varying information, which often exhibits periodic or cyclic behaviour. Examples of periodic patterns include daily stock market fluctuations, Market Basket Analysis, weekly social media trends, seasonal disease outbreaks, and monthly electricity consumption patterns.

The discovery of periodic patterns is crucial for understanding the inherent periodicity in temporal data and extracting meaningful knowledge from it. Periodic pattern mining algorithms are designed to search for recurring patterns that repeat at regular intervals or exhibit cyclical behaviour.

1.2 Motivation for comparing periodic pattern mining algorithms on temporal datasets

Comparing periodic pattern mining algorithms on temporal datasets is essential to identify the best algorithm for extracting recurring patterns from time-dependent data. This comparison is motivated by the need for algorithm selection, performance evaluation, scalability, accuracy, generalization, and advancement of the field. Such comparisons enable researchers and practitioners to make informed decisions, enhance algorithm design, and facilitate effective analysis of temporal data in various domains.

1.3 Research Objectives and Methodology

The research objectives are:

- Compare and evaluate periodic pattern mining algorithms on temporal datasets.
- Assess performance, capabilities, and limitations of selected algorithms.
- Determine algorithm suitability for various temporal data and applications.
- Identify strengths and weaknesses in pattern detection accuracy, scalability, and efficiency.
- Contribute to advancing periodic pattern mining research and algorithm design improvements.

Methodology:
To accomplish the research objectives, the following methodology is employed:

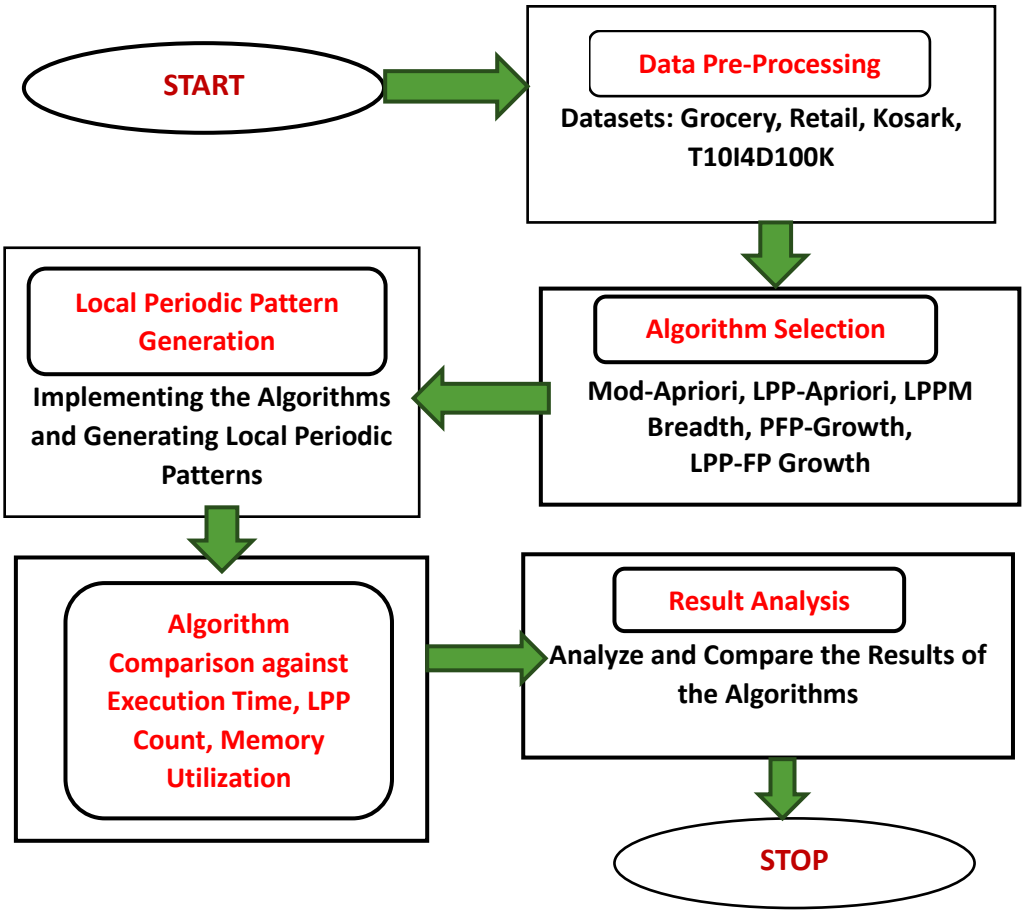

Fig 1.0 Proposed Methodology

By following this methodology, in this research paper we contribute the review of related work in the section2. In section 3 we present the description of our previously proposed algorithms. Section 4 follows the Results and discussion on comparative analysis of the algorithms. Section 5 concludes the research paper with the scope of future research directions.

2. Related Work

In the field of periodic pattern mining on temporal datasets, several studies have been conducted to compare and evaluate different algorithms. These works have contributed to the understanding of algorithmic performance, scalability, and applicability in various domains. The following is a review of some relevant related works:

Temporal data mining, as explored by Antunes and Oliviera (2001)[1], represents a significant expansion of traditional data mining techniques. By incorporating the temporal aspect, this approach allows for the extraction of more intriguing patterns that are influenced by time. Within temporal data mining, there are two main directions, as highlighted by Roddick and Spillopoulou (1999) [2]. The first direction focuses on uncovering causal relationships among events that are oriented in time. These events are arranged in sequences, where the cause of an event always precedes the event itself. The second direction involves identifying similar patterns within the same time sequence or across different time sequences.

An important expansion of the mining problem involves incorporating a temporal aspect. When a transaction occurs, its timestamp is automatically recorded. In datasets of this nature, certain patterns may exist that are specific to particular time periods rather than spanning the entire dataset's duration. Such patterns can provide valuable insights into customer behaviour. In their work (Ale and Rossi, 2000)[3], Ale and Rossi propose a method for extracting association rules that hold within the lifespan of a given item set, rather than the

lifespan of the entire dataset. However, this method does not take into account the time intervals between successive transactions involving an item set. It is not designed to identify patterns with a periodic nature.

In [15], a novel method was presented by the author to detect periodicities based on calendar intervals (annual, monthly, and daily) and interval-based temporal patterns.

In research [4], Fourier-Viger expanded the traditional problem of mining periodic patterns to discover common periodic patterns across multiple sequences. Two new measures, the standard deviation of periods and the sequence periodic ratio, were introduced. Two algorithms, MPFPS BFS and MPFPS DFS, were proposed to efficiently mine these patterns using breadth-first search and depth-first search, respectively.

While traditional techniques for frequent itemset mining are valuable, they are limited in extracting periodically appearing patterns in databases. However, in domains like market basket analysis, understanding the periodic behavior of items provides important insights for marketing strategies and inventory management. Tanbeer et al. [5] introduced the concept of Periodic Frequent Patterns (PFPs) to address this issue in transactional databases. They utilized a compact tree-based data structure called PF-tree and a pattern growth mining technique to extract complete sets of periodic frequent patterns based on user-defined periodicity and support thresholds.

In another study [6], Philippe Fournier-Viger proposed a solution to the limitations of periodic pattern mining algorithms that discard patterns with single periods exceeding a user-defined threshold. They introduced three measures: minimum periodicity, maximum periodicity, and average periodicity. These measures offered more flexibility, and an efficient algorithm named PFPM (Periodic Frequent Pattern Miner) was proposed to discover all frequent periodic patterns based on these measures. However, this approach couldn't identify patterns that were periodic only during specific time intervals or sold during specific non-predefined periods, which is common in real-life scenarios.

Adhikari [13] incorporated transaction frequency (TF) and database frequency (DF) concepts to mine locally frequent item sets and two types of periodic patterns (cyclic and acyclic) in a two-phase algorithm.

While the occurrence frequency of patterns is considered important in many applications, the temporal regularity of patterns can provide additional valuable insights. Rashid et al. [14] proposed an alternative definition of PFPs that considers the variance of interval time between pattern occurrences. They used a pattern-growth approach with user-defined minimum support and maximum variance thresholds to find regularly frequent patterns. However, this method may generate uninteresting patterns and is influenced by outlier periods.

Esther Galbrun [17] proposed an approach for mining periodic patterns from event logs using a Minimum Description Length (MDL) criterion.

Titarenko [16] presented a method for fast implementation of pattern mining algorithms with time stamp uncertainties and temporal constraints, providing an integrated approach for efficient code generation.

A study [7] introduced HOVA-FPPM, an approach based on the Apriori method with hashed occurrence vectors, to find flexible periodic patterns. However, this method requires multiple dataset scans to discover the periodic patterns.

In [8], the problem of efficiently identifying patterns with interesting behavior, such as regularly repeating occurrences within a time interval, was addressed. The author extended an existing approach derived from frequent pattern mining to operate without user-specified periodicity. The proposed algorithms could identify time intervals, periodicity, and frequency of occurrence of all periodically occurring patterns within a user-defined tolerance. However, this method discovered more fragmented patterns and was more susceptible to noise. The issue of interestingness was not addressed.

Literature [18-20] discussed the extraction of gradual patterns from temporal sequences using periodic patterns and from ordered datasets under temporal constraints.

While many algorithms exist for identifying periodic frequent patterns, most assume that the periodic behavior remains consistent over time. Philippe Fournier [9] proposed a method to discover a novel type of periodic pattern in a sequence of events or transactions, called Local Periodic Patterns (LPPs) which are patterns (sets of events) that have a periodic behaviour in some non-predefined time-intervals. Two novel measures Max-So-Perd. (Maximum Spillover Period) which allow detecting time-intervals of variable lengths where a pattern is continuously periodic, while the Min-Dur. (Minimum Duration) ensures that those time intervals have a minimum duration. These measures are used to assess the periodicity and frequency of patterns in time intervals. To discover all LPPs, the paper proposed an efficient algorithm, named LPP-Growth. It respectively adopts a pattern-growth approach by extending the FP-Growth algorithm.

Based on the literature review provided, it can be inferred that considering varying time intervals can result in the extraction of different frequent patterns, which can yield valuable insights. In this research, our focus is on identifying valid time intervals in which frequent patterns exist and determining their periodicity.

Our study involves comparing the efficiency of novel techniques for mining local periodic patterns and their associated time intervals from temporal transactional datasets.

To initiate our research, we built upon the considerations presented in a base paper [10]. Inspired by this work, we introduced a new notation called TC (Time Cube) to represent time hierarchies in the mining process. Subsequently, we implemented this novel algorithm called Modified-Apriori, which incorporates the Apriori property while introducing two new threshold values: support and density. This algorithm successfully discovers frequent itemsets along with their corresponding time intervals, merging those with neighbouring time intervals. We evaluated the algorithm's performance through experiments conducted on synthetic datasets, and during this evaluation, we identified a major limitation: the algorithm requires the user to specify the periods (time intervals) as a user-defined parameter.

To overcome this limitation, we extended our research and proposed a novel algorithm called LPP-Apriori in our previous research paper [11]. LPP-Apriori is capable of extracting various types of periodic patterns present in temporal datasets without the need for users to predefine the periods. In this method, we treated timestamps as a hierarchical data structure and extracted periodic patterns along with a list of time intervals in which they appear frequently or periodically. To determine the count of periodic patterns in different time intervals, we utilized a set operation known as Set-Superimposition, proposed by Baruah (1999), for string periods associated with itemsets. However, it was observed that this algorithm also had limitations. The assessment of periodicity relied on a strict measure called Maximum Periodicity, which assumed that a pattern must have a periodicity below a threshold value to be considered periodic. This strict measure posed a problem as real-life data often exhibits variability between periods within a pattern. Consequently, if a pattern had a single period length exceeding the Maximum threshold, it would be discarded. Thus, this method was overly strict and unable to detect patterns that are periodic only within specific time intervals rather than the entire dataset.

To address these limitations, a novel technique is required to identify local periodic patterns that consider timestamps and exhibit flexibility by finding periodic patterns within time intervals. Three challenges need to be tackled:

1) Avoiding the use of a strict definition of periodicity to discover local periodic patterns, necessitating the design of novel measures that consider the changing periodic behaviour of patterns.
2) Identifying non-periodic time intervals where patterns exhibit periodicity, requiring the identification of starting and ending points for these time intervals.
3) Efficiently finding desired patterns while minimizing the consideration of a large number of candidate patterns. Effective search space pruning techniques are essential to exclude unpromising patterns and non-periodic time intervals, as considering a large number of candidates can lead to lengthy execution times and excessive memory consumption.

To overcome these challenges, we expanded our previous method, the LPP-Apriori Algorithm, and introduced a novel technique called LPP-FP Growth Algorithm in our earlier research paper [12]. This new technique, motivated by [34], aims to identify local periodic patterns that exhibit periodic behaviour within non-predefined time intervals. The LPP-FP Growth Algorithm introduces two novel measures for assessing periodicity and frequency in time intervals:

Maximum Spillover Period (Max-So-Perd), which detects time intervals of varying lengths where a pattern exhibits periodic behaviour that may vary.

Minimum Duration (Min-Dur), a threshold ensuring that these time intervals have a minimum duration.

In the following section, we provide a brief description of our earlier proposed Algorithms.

3. Periodic Pattern Mining Algorithms

3.1 Modified Apriori:

MazaherGhorbani and Masoud Abessi, in [17] proposed a novel technique for mining frequent itemsets from temporal data. The authors proposed an efficient algorithm that focuses on discovering frequent patterns along with their associated time intervals within transactional databases.

The approach begins by introducing time cubes (TC) as a new notation to incorporate time hierarchies into the mining process. Subsequently, the authors developed an algorithm based on two thresholds: support and density, the latter being a novel addition. Frequent itemsets are identified, and those with neighbouring time intervals belonging to the same frequent itemsets are merged. This technique assumes that patterns can exist in some or all time intervals. To achieve this, a time cube analysis of frequent patterns is conducted. The entire dataset is partitioned into various time cubes, such as (hour, day, month), (day, month, year), etc., and the

Apriori algorithm is applied to these time cube data. The concept of temporal support value is utilized. The minimum support threshold is employed to assess the frequent itemsets. However, due to uneven distribution of records within time intervals, some occasions may have very few records, resulting in potentially invalid discovered patterns lacking sufficient evidence to demonstrate their validity throughout the entire time interval. This issue leads to an overestimation problem. To address these challenges, an additional threshold called Density is proposed. Density not only ensures the validity of the patterns but also eliminates time intervals with few transactions, thereby mitigating the overestimation of timespans.

Nevertheless, the algorithm described in the paper has certain limitations. The processing time is significant as the itemsets need to be mined for each time cube. Additionally, one limitation of the algorithm is that the time intervals are user-defined, potentially restricting its flexibility and adaptability.

3.2 LPP Apriori:

LPP Apriori, an improved version of the Modified Apriori algorithm, was developed to mine periodic patterns in temporal datasets. In a previous research paper [11], we introduced LPP Apriori to overcome the limitations of the Modified Apriori algorithm. Our approach leverages timestamp data to identify frequent itemsets and their corresponding time intervals.

In this method, we treat time as a hierarchical structure and dynamically extract local periodic patterns by considering time intervals without requiring explicit user input. During the scanning process, the algorithm automatically identifies time intervals where patterns exhibit frequency. By utilizing the Spillover Period and Maximum Spillover Period of itemsets, the algorithm constructs time intervals for periodic patterns. These intervals are pruned based on user-defined thresholds for Minimum Duration and Minimum Support. The algorithm generates candidate periodic patterns iteratively and prunes infrequent ones according to the specified thresholds.

While LPP Apriori offers a straightforward and intuitive approach, scalability can be a concern when dealing with large datasets since multiple scans are required to generate and validate candidate patterns. Furthermore, a major limitation of LPP Apriori lies in its strict evaluation of periodicity using the Maximum Periodicity measure. This criterion assumes that a pattern must have a periodicity below the given threshold to be considered periodic. However, real-life data often exhibits variability between periods. Unfortunately, if a pattern has a single period exceeding the Maximum threshold, it is discarded. Consequently, this strict measure fails to capture patterns that are periodic only within specific time intervals rather than spanning the entire dataset.

To address these limitations, we have extended our research with a novel technique called LPP-FP Growth, which is discussed in the subsequent section.

3.3 LPP FP Growth

Tree-based algorithms such as LPPM Breadth, LPPM Depth, and LPP-FP Growth offer effective solutions for discovering periodic patterns in temporal datasets. These algorithms leverage tree structures to efficiently capture and extract recurring patterns. In this section, we present a detailed description of our proposed LPP-FP Growth algorithm [12].

The LPP-FP Growth algorithm utilizes three important parameters: Max-Perd, Max-So-Perd, and Min-Dur. The Max-Perd parameter allows users to specify the maximum expected time between consecutive occurrences of periodic patterns. With the Max-So-Perd parameter, patterns can temporarily exceed the Max-Perd threshold if the cumulative spillover (surplus) remains below the Max-So-Perd value. This parameter enhances flexibility compared to traditional periodic frequent pattern mining algorithms that rely solely on the maximum periodicity constraint. Lastly, the Min-Dur parameter defines the minimum length of time intervals and is utilized to discard short intervals. It is crucial to set these parameters appropriately, as they depend on the dataset characteristics and user preferences.

The LPP-FP Growth algorithm operates in two steps:

(i) It first compresses the input database into a tree structure called the time-interval periodic frequent tree (LPP-tree).

(ii) It then recursively mines the LPP-tree to discover all Local Periodic Patterns (LPPs).

Inspired by the tree-based pattern-growth approach of the FP-Growth algorithm, the LPP-FP Growth algorithm has been specifically adapted for the task of mining LPPs.

3.3.1 LPP-Tree Structure

The algorithm consists of two main components: a prefix-tree and an LPP-list. The LPP-list contains entries with two fields: an Item Name and a Periodic Time-Interval List (PTL). The prefix-tree, known as the LPP-tree, draws inspiration from the structure of the FP-tree used in FP-Growth for transaction storage. Similar to the FP-tree, the LPP-tree organizes transactions as paths within a tree, where each node represents an item.

However, there is a significant distinction between the FP-tree and the LPP-tree. In the LPP-tree, nodes explicitly store occurrence information about items in transactions to efficiently calculate the PTL of patterns. Specifically, a timestamp list known as the TS-list is stored in the last node of every transaction within the LPP-tree. As a result, the LPP-tree maintains two types of nodes: Ordinary Nodes and Tail Nodes.

3.3.2 Mining LPP-Tree

Once the LPP-tree has been constructed, the proposed algorithm no longer requires scanning the original database to discover Local Periodic Patterns (LPPs). This is because all the crucial information for LPP mining is stored within the LPP-tree. To identify LPPs, our algorithm utilizes a depth-first search approach, similar to the FP-Growth algorithm, to explore the itemset search space. The exploration begins with LPPs that consist of a single item, which are stored in the LPP-list.

The algorithm performs a depth-first search exploration, taking as input the initial LPP-tree (T), user-defined thresholds such as Maximum Period, Maximum Spillover Period, and Minimum Duration, and an itemset (α) for LPP identification. By pruning itemsets that lack periodic time-intervals, the algorithm can uncover all LPPs while minimizing unnecessary search efforts.

4. Implementation &Experimental Setup

In this section, we discuss the implementation of our proposed Algorithms LPP-Apriori, LPP-FP Growth and existing algorithm in research literature Modified Apriori and LPPM-Breadth. Here we evaluate the performance of the algorithm in terms of execution time, local pattern count, and memory utilization. The performance of our proposed algorithm is compared with earlier local periodic pattern algorithms based on Apriori based Approach and Tree based Approach. These proposed algorithms are implemented in Python 3.10.2 on Intel® Core™ i5-10210U CPU @1.60 GHz on Windows 11 operating system. We have collected the data from FIMI-Frequent Itemset Mining Dataset Repository (http://fimi.uantwerpen.be/data/)& from UCI Machine Learning Repository (https://archive.ics.uci.edu/ml/datasets/Online+Retail+II).

We conducted the experiments on different datasets including Grocery, Kosark, Retail, and T10I4D100K.

4.1 Description of Data sets

1. Grocery

This is the groceries data with the list of items bought by customers. From the left side is the number of items in a basket then Item 1, 2, 3, etc. stands for list of the item. The dataset contains 10027 transactions by customers shopping for groceries. The data contains 169 unique items. The data is suitable to do data mining for market basket analysis which has multiple variables. We have taken subset of this data fromhttps://www.kaggle.com/datasets/irfanasrullah/groceriesweb page.

2. Kosark

This dataset was provided by Ferenc Bodon and contains (anonymized) click-stream data of a Hungarian On-Line New Portal. This is a very large dataset containing 990 000 sequences of click-stream data. The dataset was converted in SPMF format using the original data from: http://fimi.ua.ac.be/data/. We have downloaded a subset of this data from https://www.philippe-fournier-viger.com/spmf/index.php?link=datasets.php web page.

3. Retail

This dataset was donated by Tom Brijs and contains the (anonymized) retail market Basket data from an anonymous Belgian Retail Store. The data is collected over three non-consecutive periods. The total amount of receipts being collected equals 88,162. The average number of distinct items (i.e. different products) purchased per shopping visit equals 13 and most customers buy between 7 and 11 items per shopping visit.

4. T10I4D100K

This dataset was generated using the generator from the IBM Almaden Quest research group. It is available on the http://fimi.uantwerpen.be/data/ web page.

The characteristics of the above dataset(s) after formatting into a temporal dataset are shown in the following table.

Table 1 Characteristics of Dataset(s)

SNO	DATASET	NO. OF TRANSACTIONS	NO. OF ITEMS	MIN. TRANS. SIZE	MAX. TRANS. SIZE
1	Grocery	10027	86	1	11
2	Kosark	44953	18287	1	699
3	Retail	88162	16470	1	76
4	T10I4D100K	100000	870	1	29

4.2Incorporating Temporal Features in datasets

As the dataset is non-temporal so it cannot be directly used. We have incorporated the temporal features in the dataset so that it can be a temporal dataset and can be used by our proposed Algorithm. We developed a program for this. The program takes starting date and time (Timestamp), the number of Transactions or records in the dataset, and synthetic data as inputs. It then generates the series of Timestamps equal to the number of transactions and merges the generated Timestamps with the dataset as the first column entry in the dataset. Dataset features such as the number of items, number of transactions, average transaction length, and time span of the dataset can be set by the user. The Algorithms for pre-processing the data is given below:

To pre-process data by converting non-temporal data into temporal or timestamp data and handling missing values, has been done with the following steps:

1. Identify non-temporal data: Analyze the dataset and identify columns that contain non-temporal data but can be converted into temporal or timestamp data. For example, columns containing dates or time information represented in a non-temporal format.

2. Convert non-temporal data to temporal format: For each identified column, apply appropriate data conversion techniques to convert the non-temporal data into a temporal or timestamp format. This has been done by parsing and reformatting the values using Python's datetime module or specific date/time libraries.

3. Handle missing values: Missing values are common in datasets and can impact the quality of data analysis. Considered the following technique to handle missing values:

Imputation: Since the missing values are significant or removing them would result in data loss, we have considered imputing or filling in the missing values with Zero or NaN Values.

4. Fix the Number of Columns:

To fix the number of columns in a text file using Python, you can follow these steps:

Step1. Read the text file.

Step2. Split each line of the file by the delimiter (such as a comma or tab) to obtain the individual columns.

Step3. Check the number of columns in each line.

Step4. If the number of columns is less than the desired number, append empty values to make up the difference.

Step5. If the number of columns is greater than the desired number, truncate the list of columns to the desired length.

Step6. Join the columns back together using the delimiter.

Step7. Write the modified lines to a new file or overwrite the original file.

5. Update or save the pre-processed data

Finally, we have updated the original dataset with the pre-processed values or save the pre-processed data to a new file for further analysis.

We have implemented the proposed Algorithm Mod-Apriori in Python 3.10.2 on the windows 10 Operating System. The executive summary and the experimental results of the Proposed Algorithm implemented on different formatted temporal data sets are discussed in the following section.

4.3 Implementation Results

We have implemented the proposed Algorithm Mod-Apriori in python 3.10.2 on the Windows 11 Operating System. The executive summary and the experimental results of the Proposed Algorithm implemented on different formatted temporal data sets are discussed in this section. The frequent patterns of Grocery Dataset along with timestamp intervals received after implementing the LPP-Apriori Algorithm is shown below as an example. The Generated Frequent Patterns with Time intervals are:

Frequent One Itemset
Item Starting Date Ending Date Item Count Item Support
[{'bread'}, '09-10-2000 14:00:00', '14-10-2000 04:00:00', 11, 0.2]
[{'citrus'}, '19-02-2000 00:00:00', '25-02-2000 14:00:00', 16, 0.2]
[{'fruit'}, '01-01-2000 00:00:00', '15-04-2002 12:00:00', 2131, 0.21]
[{'milk'}, '01-01-2000 04:00:00', '15-04-2002 02:00:00', 2750, 0.27]
[{'other'}, '04-11-2001 00:00:00', '15-04-2002 12:00:00', 385, 0.2]
[{'pip'}, '22-10-2000 20:00:00', '25-10-2000 20:00:00', 8, 0.22]
[{'rolls/buns'}, '01-01-2000 12:00:00', '18-06-2000 22:00:00', 411, 0.2]
[{'rolls/buns'}, '22-06-2000 00:00:00', '01-09-2000 18:00:00', 185, 0.21]
[{'rolls/buns'}, '16-08-2001 14:00:00', '16-01-2002 14:00:00', 371, 0.2]
[{'vegetables'}, '01-01-2000 08:00:00', '15-04-2002 12:00:00', 2898, 0.29]
[{'water'}, '13-06-2001 04:00:00', '21-06-2001 22:00:00', 23, 0.22]
[{'white'}, '10-10-2000 00:00:00', '13-10-2000 22:00:00', 11, 0.23]
[{'whole'}, '01-01-2000 04:00:00', '19-09-2000 14:00:00', 796, 0.25]
[{'whole'}, '23-09-2000 08:00:00', '15-04-2002 02:00:00', 1717, 0.25]
Frequent-TWO itemset
Item Starting Date Ending Date Item Count Item Support
[{'fruit', 'citrus'}, '19-02-2000 00:00:00', '25-02-2000 14:00:00', 16, 0.2]
[{'fruit', 'pip'}, '22-10-2000 20:00:00', '25-10-2000 20:00:00', 8, 0.22]
[{'milk', 'other'}, '01-10-2001 20:00:00', '07-10-2001 10:00:00', 15, 0.22]
[{'milk', 'whole'}, '01-01-2000 04:00:00', '19-09-2000 14:00:00', 796, 0.25]
[{'milk', 'whole'}, '23-09-2000 08:00:00', '15-04-2002 02:00:00', 1717, 0.25]
[{'vegetables', 'other'}, '04-11-2001 00:00:00', '15-04-2002 12:00:00', 385, 0.2]
[{'whole', 'other'}, '01-10-2001 20:00:00', '07-10-2001 10:00:00', 14, 0.21]
[{'vegetables', 'whole'}, '03-09-2000 00:00:00', '19-09-2000 14:00:00', 41, 0.2]
[{'vegetables', 'whole'}, '21-07-2001 08:00:00', '08-08-2001 06:00:00', 44, 0.2]
[{'vegetables', 'whole'}, '08-09-2001 06:00:00', '12-09-2001 18:00:00', 11, 0.2]
Frequent-THREE itemset
Item Starting Date Ending Date Item Count Item Support
[{'milk', 'whole', 'other'}, '01-10-2001 20:00:00', '07-10-2001 10:00:00', 14, 0.21]
[{'vegetables', 'whole', 'other'}, '01-10-2001 20:00:00', '07-10-2001 10:00:00', 14, 0.21]

We have received the same type of results after implementing the LPP-Apriori, Mod-Apriori, LPP-FP Growth algorithms on different datasets as shown above. We have not included them due to space problem.

5. Results and Discussion

In this section, we delve into the analysis of performance for the proposed algorithms, namely LPP-Apriori and LPP-FP Growth, as well as other Python-implemented algorithms including Mod-Apriori, PFP Growth, and LPP Breadth. Our analysis focuses on two key parameters: Execution time and the generation of Local Periodic Patterns. The objective of our research revolves around generating Frequent Itemsets within specific time intervals. We aim to explore how these item sets manifest across different temporal intervals, highlighting their detection limitations in non-temporal datasets.

In the second experiment, we conduct a comparative assessment of the algorithm's execution performance against our previously developed Periodic Pattern Algorithm. The algorithms are executed on each dataset while varying parameter values. The purpose is to compare algorithm performance in diverse scenarios and observe the impact of parameter settings on their effectiveness. Generally, as the values of Max-So-Per and Max-Perd increase, and Min-Dur decreases, the search space is expected to expand, potentially uncovering more patterns and resulting in longer runtimes. However, it should be noted that the performance of the same

algorithm can vary significantly across different datasets due to varying dataset characteristics, even with identical parameter values.

5.1 Execution Time

In this section, we present a comparative analysis of the runtime performance for the proposed algorithms LPP-Apriori and LPP-FP Growth, as well as the implemented algorithms Modified-Apriori, PFP-Growth, and LPP-Breadth. The table below displays the execution time taken by each algorithm, measured in seconds.

Table 2 Comparative Table of Execution Time

Dataset	Execution Time (Sec.)				
	Mod-Apriori	LPP-Apriori	PFP-Growth	LPP Breadth	LPP-FP Growth
Grocery	46.25	51.57	50	54	47
Kosark	407.5	894.98	680	354	421
Retail	912.5	1755	1400	936	751
T10I4D	452.7	339	185	127	109

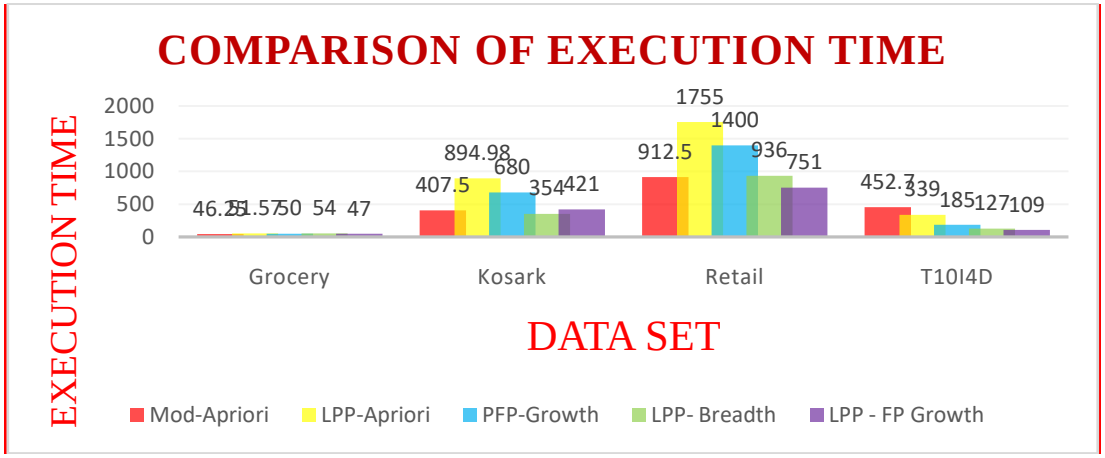

Fig2 Comparison of Execution Time

Based on the comparative graph above, it is evident that the LPP-FP Growth Algorithm exhibits shorter execution times compared to LPP-Apriori, Mod-Apriori, PFP-Growth, and LPP-Breadth Algorithms. The LPP-FP Growth algorithm demonstrates superior speed compared to the other algorithms. The graph reveals that it takes 751 seconds for execution on the Retail dataset, which is smaller in size compared to the T10I4D dataset where it takes 109 seconds. This disparity can be attributed to the Retail dataset generating a higher number of periodic patterns and being denser in nature. Therefore, we can conclude that the LPP-FP Growth algorithm excels in runtime efficiency compared to the other algorithms. The objective of improving the algorithm's runtime efficiency has been successfully achieved through the implementation of LPP-FP Growth.

5.2 Memory Usage

In the third experiment, we compared the peak memory consumed by our proposed algorithm LPP-FP Growth, LPP Apriori and earlier algorithms Mod-Apriori, PFP-Growth, LPP Breadth. The statistics of these algorithms is shown in the following table.

Table 3Comparative Table of Memory Usage

Dataset	Memory Usage				
	Mod-Apriori	LPP-Apriori	PFP-Growth	LPP Breadth	LPP-FP Growth
Grocery	59	115	165	162	147
Kosark	297	629	345	321	282
Retail	602	1342	363	480	560
T10I4D	642	1432	456	392	125

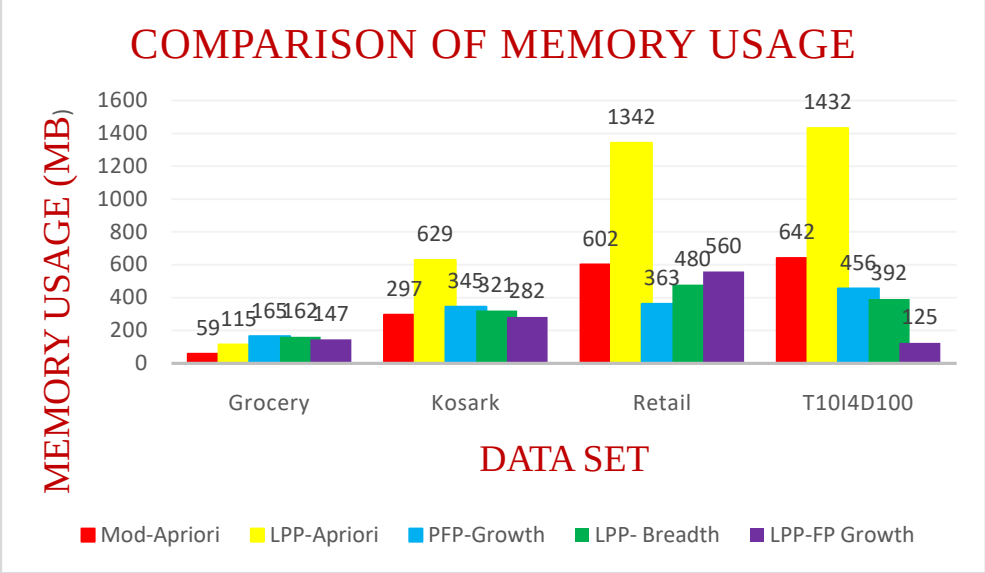

Fig3 Comparative Graph of Memory Usage

From the above Figure it is observed that our proposed Algorithm LPP-FP Growth consumes less memory than the other Algorithms. So we can conclude that the LPP-FP Growth is memory efficient than other Algorithms. The reason behind this is it uses a compact tree structure for representing the database, and timestamps are only saved in tail nodes.

5.3 LPP Count

In this we discuss the comparative results of our proposed algorithms LPP-Apriori, LPP-FP-Growth and implemented algorithms Mod-Apriori,PFP-Growth and LPP Breadth for the Local Periodic Patterns generated by the algorithms. The following table shows the LPP-count of algorithms on various datasets.

Table 4Comparative table of LPP Count

Dataset	LPP Count				
	Mod-Apriori	LPP-Apriori	PFP-Growth	LPP Breadth	LPP-FP Growth
Grocery	16	26	58	65	73
Kosark	12	38	24	38	41
Retail	23	13	84	89	94
T10I4D	12	22	46	52	55

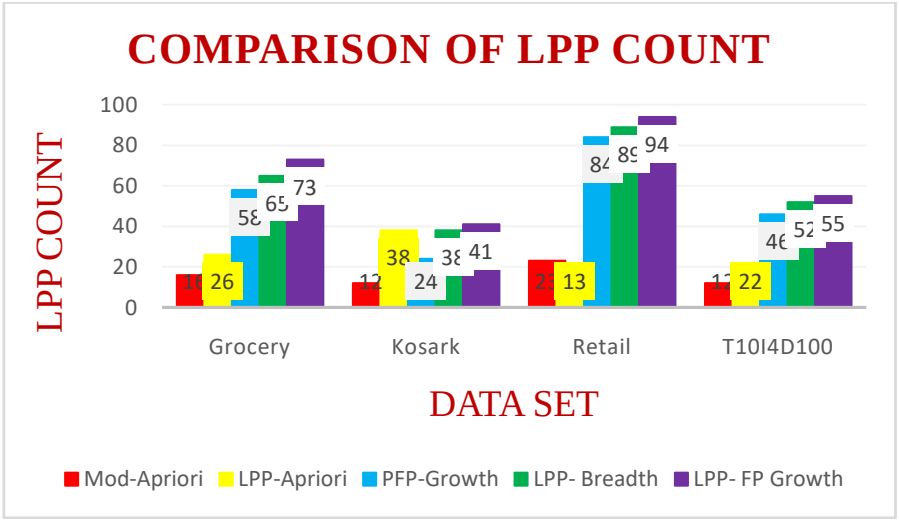

Fig4 Comparative Graph of LPP Count

Based on the comparative chart provided, it can be observed that the LPP-FP Growth Algorithm outperforms Mod-Apriori, LPP-Apriori, LPP-Breadth, and PFP Algorithms in terms of generating a greater number of Local Periodic Patterns. This indicates that the LPP-FP Growth Algorithm effectively prunes uninteresting patterns and focuses on detecting the recurring and relevant local patterns.

Through the aforementioned comparisons, it is evident that the LPP-FP Growth Algorithm excels in various aspects, including Execution time, Memory usage, and the generation of meaningful Local Periodic Patterns. The comparative results demonstrate that the LPP-FP Growth algorithm utilizes less memory, produces a higher number of LPPs, and exhibits faster runtime performance compared to the other algorithms, namely LPP-Apriori, Mod-Apriori, LPP-Breadth, and PFP-Growth algorithms.

5.4 Pattern Count Analysis of LPP FP Growth

In this section we analysed the LPP Count of LPP FP Growth Algorithm on the Grocery Dataset by varying the parameters Maximum Period, Maximum Spill Over Period, and Minimum Duration. The results obtained are shown in the following table.

Table 5 LPP Count Analysis

Max-Perd	Max.Spillover Perd.	Min.Dur	LPP count	Execution Timein Sec.	Memory Usage In MB
3	3	7	12	67.88	150.21
3	3	10	6	63.9	148.28
5	5	7	57	28.45	160.43
5	5	10	41	28.57	156.07

From the above table, it is observed that by increasing the Maximum Period and Maximum Spillover Period and decreasing the Minimum duration the LPP Count is increased, i.e. we can generate more number of Local Periodic Patterns by varying these parameters. The impact of these measures on the number of LPPs discovered is comparable to their effect on the runtime of the algorithms. This is due to the fact that modifying these parameters affects the size of the search space, which tends to increase or decrease in proportion to the number of patterns.

5.5 Pattern Analysis

In order to evaluate the effectiveness of the proposed LPP Apriori Algorithm, an analysis of patterns discovered in the Grocery dataset, consisting of customer transactions, was conducted. The objective of this experiment was to determine whether the algorithm identifies interesting patterns that offer insights into customer shopping behavior. By adjusting the parameters, it was discovered that setting Max.Perd to 2 days, MaxSoPerd to 2 days, and Min.Dur to 10 days resulted in the identification of several noteworthy patterns. A selection of these patterns is presented in the following table.

Table 6 Pattern Analysis

[{'vegetables', 'whole-Milk'}, '03-09-2000 00:00:00', '19-09-2000 14:00:00', 41, 0.2]
[{'vegetables', 'whole-Milk'}, '21-07-2001 08:00:00', '08-08-2001 06:00:00', 44, 0.2]
[{'vegetables', 'whole-Milk'}, '08-09-2001 06:00:00', '12-09-2001 18:00:00', 11, 0.2]

As depicted above, the first pattern highlights the periodic sale of Vegetable and Milk products occurring during specific time intervals: from '03-09-2000 00:00:00' to '19-09-2000 14:00:00', from '21-07-2001 08:00:00' to '08-08-2001 06:00:00', and from '08-09-2001 06:00:00' to '12-09-2001 18:00:00'. This pattern reflects the purchasing behavior of customers during these time periods. It is noteworthy that this pattern exhibits periodicity only for a short duration within the entire year and repeats within the same time intervals across multiple years (2000 and 2001). Consequently, traditional periodic frequent pattern mining algorithms, which primarily focus on identifying patterns that are periodic throughout the entire year, would disregard this pattern. Moreover, it is important to note that this pattern encompasses multiple distinct periodic time intervals within the same year.

Overall, it has been noted that the algorithms exhibit satisfactory performance and possess the ability to identify intriguing patterns within real-world data that traditional models, which primarily emphasize periodicity throughout the entire database, fail to uncover. The suggested algorithms have the capability to unveil patterns within time intervals that are not predetermined, with each algorithm demonstrating superior performance under

specific circumstances. There are various potential avenues for future research, including exploring alternative forms of localized periodic patterns, accommodating streaming data, and devising techniques for automated parameter selection.

6. Conclusion

This study presents an innovative comparative analysis of Local Periodic Pattern Mining Algorithms, specifically Modified Apriori, LPP-Apriori, PFP-Growth, LPP-Breadth, and LPP-FP Growth. The assessment of these algorithms is conducted using three real-world datasets and one synthetic dataset. The evaluation focuses on three key aspects: Execution time, Memory Utilization, and the generation of Local Period Patterns. The results reveal that the LPP-FP Growth algorithm outperforms other periodic pattern mining algorithms in terms of Execution time, Memory Consumption, and the generation of local periodic patterns. The experimental evaluation across various datasets demonstrates the efficiency of the LPP-FP Growth algorithm, highlighting its ability to discover valuable patterns that traditional periodic pattern mining algorithms fail to identify.

In future research, there would be intriguing to adapt the suggested algorithms for implementation within big data frameworks, incorporating technologies like GPUs, multi-threading, and other high-performance computing approaches. Such adaptations would enable the processing of larger databases in shorter time frames. Another intriguing avenue for exploration involves extending the proposed model to handle non-static databases, such as incremental databases and data streams. Furthermore, there is the possibility of extending the model to accommodate other types of patterns, such as sequential patterns and rules, or designing automated methods for parameter selection.

References:

[1]. C. Antunes, Arlindo L. Oliveira ,Temporal Data Mining: an overview, Proceedings Antunes 2001 Temporal DM, Published 2001, Computer Science

[2]. John F Roddick, Myra Spiliopoulou, Temporal data mining: Survey and Issues, School of Computer and Information Science, University of South Australia ISBN: ACRC-99-007, January 1999

[3]. J. M. Ale and G. H. Rossi, “An approach to discovering temporal association rules,” Proc. ACM Symp. Appl. Comp.-vol. 1, 2000, pp. 294–300.

[4]. Philippe Fournier-Viger, Zhitian Li, Efficient algorithms to identify periodic patterns in multiple sequences, ©2019 Elsevier Inc.

[5]. Syed KhairuzzamanTanbeer, Chowdhury Farhan Ahmed, Byeong-Soo Jeong, and Young-Koo Lee, T. Discovering Periodic-Frequent Patterns in Transactional Databases, PAKDD 2009, LNAI 5476, pp. 242–253, 2009.c Springer-Verlag Berlin Heidelberg 2009.

[6]. [6] Philippe Fournier-Viger, PFPM: Discovering Periodic Frequent Patterns with Novel Periodicity Measures,Perspectives in Science, April 16, 2016.

[7]. M. Javed ,Nawaz , K. Khan, HOVA-FPPM: Flexible Periodic Pattern Mining in Time Series Databases Using Hashed Occurrence Vectors and Apriori Approach Scientific Programming (IF 1.672) Pub Date: 2021-01-04 , DOI:10.1155/2021/8841188.

[8]. A. Krzywicki, A. Mahidadia and M. Bain, "Discovering Periodicity in Locally Repeating Patterns," 2022 IEEE 9th International Conference on Data Science and Advanced Analytics (DSAA), Shenzhen, China, 2022, pp. 1-10, doi: 10.1109/DSAA54385.2022.10032435.

[9]. Philippe Fournier-Viger, Peng Yang, Rage Uday Kiran, Maria Luna, Mining Local Periodic Patterns in a Discrete Sequence, Journal of LATEX Templates September 20, 2020.

[10]. MazaherGhorbani and Masoud Abessi, "A New Methodology for Mining Frequent Itemsets on Temporal Data", in IEEE Transactions on Engineering Management, Vol. 64, Issue. 4, pp. 566 - 573, Nov 2017.

[11]. Md. Ghouse Mohiuddin, Dr. D.L.Srinivasa Reddy, A Novel Technique for Temporal Frequent Itemset Mining, IJIRT 156966 INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN TECHNOLOGY, © October 2022 | IJIRT | Volume 9 Issue 5 | ISSN: 2349-6002.

[12]. Md. Ghouse Mohiuddin, Dr.D.L.Srinivasa Reddy, Discovery of Local Periodic Patterns in Temporal Data: A Novel Approach, The International journal of analytical and experimental modal analysisVolume XV, Issue I, January/2023ISSN NO: 0886-9367Page

[13]. Jhimli Adhikari, Mining Periodic Patterns from Non-binary Transactions, Journal of Intelligent Computing Volume 9 Number 4 December 2018.

[14]. Md. Mamunur Rashid, Md. Rezaul Karim, Byeong-Soo Jeong, Efficient Mining Regularly Frequent Patterns in Transactional Databases, Database Systems for Advanced Applications, 2012, Volume 7238, ISBN : 978-3-642-29037-4

[15]. P. Fournier-Viger, Z. Li, J. C. Lin, R. U. Kiran, H. Fujita, Efficient algorithms to identify periodic patterns in multiple sequences, Inf. Sci. 489 (2019) 205–226.
[16]. Sofya S. Titarenko, Valeriy N. Titarenko, Georgios Aivaliotis and Jan Palczewski, Fast implementation of pattern mining algorithms with time stamp uncertainties and temporal constraints, Titarenko et al. J Big Data (2019) 6:37, Springer. https://doi.org/10.1186/s40537-019-0200-9
[17]. Esther Galbrun, Cellier ,Tatti1,Termier, and Bruno Cremilleux, Mining Periodic Patterns with a MDL Criterion, ECML PKDD, 2018, pp. 535–551.
[18]. Jerry Lonlac, Yannick Miras, Aude Beauger, An Approach for Extracting Frequent (Closed) Gradual Patterns Under Temporal Constraint July 2018, DOI:10.1109/FUZZ-IEEE.2018.8491665, Conference: 2018 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)
[19]. Mining, Jerry Lonlaca, Arnaud Donieca, Stephane Lecoeuche, Extracting Seasonal Gradual Patterns from Temporal Sequence Data Using Periodic Patterns, Elsevier October 21, 2020.
[20]. J. Lonlac, E. MephuNguifo, A novel algorithm for searching frequent gradual patterns from an ordered data set, Intelligent Data Analysis, Volume 24, Issue 5, 2020 pp 1029–1042.
[21]. Kiran R.U., Veena P., Zettsu K., Efficient Discovery of Partial Periodic Patterns in Large Temporal Databases,Electronics 2022, 11, 1523.
[22]. Johnny, F. A., Bennett, E. O. Sako, D. J. S., A Model For Exploration Of Periodic Patterns In A Database, International Journal of Advanced Research in Computer and Communication Engineering, Vol. 11, Issue 1, January 2022.
[23]. YalingXun , L. Wang , H.Yang Jiang Hui, Mining relevant partial periodic pattern of multi-source time series data, Information Sciences, (Elsevier) Volume 615, November 2022, Pages 638-656
[24]. FIMI-Frequent Itemset Mining Dataset Repository (http://fimi.uantwerpen.be/data/)
[25]. UCI Machine Learning Repository (https://archive.ics.uci.edu/ml/datasets/Online+Retail+II).
[26]. https://www.kaggle.com/datasets/irfanasrullah/groceries

Contemporary Mathematics
http://ojs.wiserpub.com/index.php/CM/

Research Article

Analysis of Deep Learning Methods for Healthcare Sector - Medical Imaging Disease Detection

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Abstract: In this paper, artificial intelligence (AI) and the ideas of machine learning (ML) and deep learning (DL) are introduced gradually. Applying ML techniques like deep neural network (DNN) models has grown in popularity in recent years due to the complexity of healthcare data, which has been increasing. To extract hidden patterns and some other crucial information from the enormous amount of health data, which traditional analytics are unable to locate in a fair amount of time, ML approaches offer cost-effective and productive models for data analysis. We are encouraged to pursue this work because of the quick advancements made in DL approaches. The idea of DL is developing from its theoretical foundations to its applications. Modern ML models that are widely utilized in academia and industry, mostly in image classification and natural language processing, include DNN. Medical imaging technologies, medical healthcare data processing, medical disease diagnostics, and general healthcare all stand to greatly benefit from these developments. We have two goals: first, to conduct a survey on DL techniques for medical pictures, and second, to develop DL-based approaches for image classification. This paper is mainly targeted towards understanding the feasibility and different processes that could be adopted for medical image classification; for this, we perform a systematic literature review. A review of various existing techniques in terms of medical image classification indicates some shortcomings that have an impact on the performance of the whole model. This study aims to explore the existing DL approaches, challenges, brief comparisons, and applicability of different medical image processing are also studied and presented. The adoption of fewer datasets, poor use of temporal information, and reduced classification accuracy all contribute to the lower performance model, which is addressed. The study provides a clear explanation of contemporary developments, cutting-edge learning tools, and platforms for DL techniques.

Keywords: deep learning, deep features, medical image classification, DL techniques, healthcare sector analysis

MSC: 68T05

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1. Introduction

In this age of algorithms, numerous industries, including manufacturing, transportation, and government, have seen significant transformations due to the frameworks of machine learning (ML) and various deep learning (DL) techniques. DL has had a significant impact on many scientific fields in recent years [1]. With respect to the advancements in AI (artificial intelligence) technology, the world is currently growing quickly. The use of AI techniques in healthcare is increasingly common for precise illness diagnosis, patient risk assessment, and clinical research. These approaches vary from ML to DL. AI is concerned with how intelligent robots act to mimic human behavior and use algorithms that can be successfully developed using machine technology. The current models for disease classification in healthcare systems either involve ML or DL.

Since it helps with diagnosis and medication analysis, precise medical picture classification has become increasingly important in the last few years. One of the most crucial concerns in the field of image detection is the classification of images for medical purposes. The main goal is to categorize medical images into different categories to aid clinicians in identifying the precise ailment and use them for further research. Medical picture classification often involves two phases. Getting useful features out of the image is the first step. The next stage is to build models to categorize the clinical data using the features.

Given the complexity of the data, it has become more appealing to apply ML and different techniques of data mining, such as deep neural networks (DNNs), to analyze such data. To develop trustworthy assessment methods utilizing ML models and data-driven techniques, establishing the correlations between all the various patient data formats is a fundamental challenge.

This systematic literature review is intended to supplement existing research by providing the following contributions to the DL approach in medical image data processing. In this review work, we divided DL techniques utilized between 2015 and 2019 into two groups: single DL and hybrid DL. Single-supervised learning refers to techniques that only use DL architecture to create their models. On the other hand, hybrid DL refers to processes that combine DL with other classical ML models. This is how we compare the benefits and drawbacks of DL techniques to models that use both traditional ML algorithms and DL design.

In the last ten years, numerous ML and various AI concepts have been employed to efficiently evaluate the vast amounts of data in the healthcare industry. For instance, a statistical regression-based methodology was proposed to create an automated early detection system for heart disease [2]. Medical imaging has also used ML to automatically identify object attributes [3]. DNN-based techniques are garnering a lot of attention among the many ML models, especially when it comes to the analysis of large datasets. DL approaches, which go through a number of stages in the learning process, are used to filter data through a cascade of layers. DNN models outperform many conventional ML models because, as they process enormous volumes of data, they become more accurate. Processing of natural language and image processing have both shown outstanding performance using DNN-based techniques [4-7].

In light of the success of DL techniques in other disciplines and their swift ongoing improvement in the proposed methodology, these models are quickly emerging as the most innovative and fascinating tools to analyze health records. DL models using biomedical and healthcare data have been used in a wide range of projects. As an illustration, Google DeepMind [8] and IBM Watson [9] have created a computer-based support system that helps analyze healthcare information [10]. The left ventricle (LV) may be segmented using short-axis cardiac magnetic resonance imaging (MRI) with the help of a deformable model, and this model's parameters have been effectively encoded using DL [11]. A separate DL model based on RBM (restricted Boltzmann machines) in medical imaging was utilized to extract biomarkers from MRI data [12].

Here, the overall effectiveness of each method is described in more detail, and mainly the learning curve of the present DL healthcare is again highlighted. Recently, the survey of deep electronic health record (EHR) [13] identified unique deep-gaining knowledge of strategies that can be hired on digital fitness records (EHR). They mentioned the medical packages utilized by unique DL fashions and diagnosed numerous barriers to modern-day DLs consisting of version interpretability, statistical heterogeneity, and the absence of familiar benchmarks. At last, deep EHR concludes the brand-new fashions and diagnosed results for destiny.

In diverse, deep EHR critiques of unique deep gaining knowledge of strategies on digital fitness records, our assessment paper specializes in hybrid deep gaining knowledge of strategies tailor-made to early disorder detection. While our survey indicates a few impediments for single and mixed DLs in the health area, as well as deep EHR, it

highlights multiple barriers for DLs using EHR. Our analysis employs the same contemporary categorization measures to highlight the area under the curve (AUC), precision, and responsivity of single-hybrid DL, somehow like deep EHR, and basically points to criteria of DLs including AUC and other accuracy parameters like P (precision), R (recall), and F1 score. This assessment document examines the length of current DL-schooling, health care systems (HCSs) in contrast to deep EHR. While a few research studies have comparable research and assessment metrics, outcomes aren't without delay similar because of the proprietary nature of the data sets.

Personalized treatment is increasingly dependent on the analysis of medical data. For instance, customized cancer treatment aims to give proper care to sick patients by considering a variety of patient-specific factors, including genetic variations, the patient's environment, imaging genetics, current medications, and lifestyle. A vast and complicated amount of health data has been collected in the last ten years by current technologies like genomics, imaging, and lifetime monitoring, enabling researchers to give patients improved therapies. Despite the abundance of data, we still lack a thorough understanding of diseases and effective patient treatments.

For specialized bioinformatics comprehension, Lan et al. [14] provided an overview study on statistics mining and in-depth learning techniques. DL approaches are summarized, along with the advantages and disadvantages of cleaning, segmentation, grouping, and improved neural community structures. Our overview study, in contrast to this effort, deals with more original DL research that is combined with several conventional device learning methodologies. The survey of this paper additionally specializes in unique deep-gaining knowledge of strategies used to become aware of disorder detection. Even the overall performance assessment is not protected, as mentioned in [14]. Overall, the author has specialized in brand-new research that has deep-gaining knowledge of techniques for disorder detection and the evaluation of massive statistics within the subject of healthcare [15, 16]. In this assessment, four deep-gaining knowledge strategies are decided on by means of pointing to the fitness care (HCS) system within the length of the years 2015 to 2019.

Convolutional neural networks (CNNs), deep-belief networks (DBNs), auto-encoders (AEs), and recurrent neural networks (RNNs) are the four architectures under question. The disorder detection software commonly uses these structures [17, 18]. The year-wise growth and research distribution for DL articles in HCS is depicted in Figure 1. The following list can be used to summarize significant contributions are:

- A taxonomy of the most widely utilized DL techniques in the medical field.
- The tremendous insights into the precision and applicability of DL trends in healthcare solutions.
- Discussing the center technology that could reshape deep-gaining knowledge of techniques in healthcare technology.
- Presenting open problems and demanding situations in modern-day deep-gaining knowledge of fashions in healthcare.

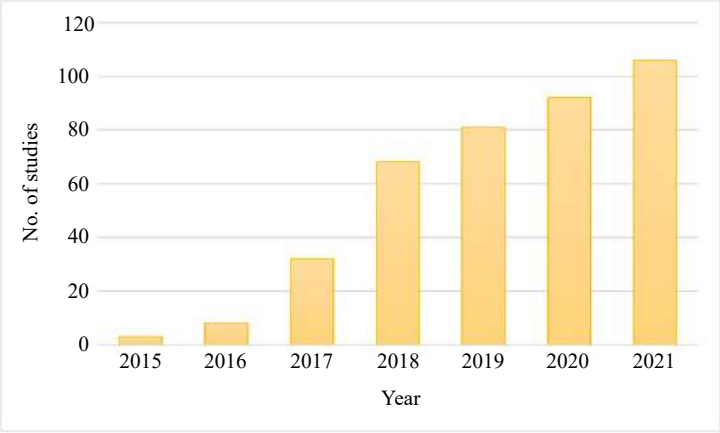

Figure 1. DL approaches for healthcare per year [14]

Table 1 indicates the analysis of different existing methods.

Table 1. Analysis of existing classification methods

Author name	Technique used	Dataset used	Merits	Demerits	Performance (%)
Alshazly et al. [19]	Deep CNN	SARS-CoV-2 and COVID19-CT	High scalability and robustness.	Non-accurate localization of abnormal image regions.	Accuracy- 92.9
Zheng et al. [20]	3D DNN	Real-time data	Storage complexity is reduced.	Inaccurate design, network training and non-utilization of temporal information.	AUC-95.9 PR-97.6
He et al. [21]	2D and 3D CNN	CC-CCII	Effective pre-processing can be carried out.	Limited classification accuracy and increased time complexity.	Accuracy-87.62
Shah et al. [22]	CTnet-10 and VGG-19 model	COVID-CT	Improved detection accuracy can be attained.	Experimentation can be done only on binary classes.	Accuracy-82.1 (CTnet-10) Accuracy- 94.5 (VGG-19)
Purohit et al. [23]	CNN	Public database from GitHub	Discontinuity information can be obtained efficiently.	FPR and testing time is high.	Accuracy-95.38

The medical image classification of these existing methods indicates various constraints that have an impact on the performance of the whole model. Due to growing complexity, poor design, and the training network, some limitations exist, such as improper localization of abnormal picture regions. The adoption of fewer datasets, poor use of temporal information, and reduced classification accuracy all contribute to the lower performance of the model, which is addressed. Moreover, a lengthy processing time is needed for performance estimation, and the likelihood of incorrect forecasts is higher. These difficulties make it impossible to classify computed tomography (CT) scans precisely.

The structure of the current review is described as follows: A variety of research techniques are described in the second section. The definition, framework, algorithm, and architecture of DL techniques are discussed in the third section. The top DL illness detection techniques are presented in the fourth section. Open questions, difficulties, and this paper's findings are offered in the fifth and sixth sections.

2. DL Framework

2.1 *Architecture and algorithms of DL*

An artificial neural network (ANN), a pair or more convolution layers, is the simplest description of a DL architecture that seeks to increase prediction accuracy [24]. In comparison to typical ANNs, DL uses a lot more hidden layers. In a typical DNN, an output is produced by processing a weighted input value with bias correction and a non-linear input vector, such as the SoftMax function. As an output, a DNN's weights are optimized during training in order to reduce the loss function [25]. Figure 2 displays the ontology of popular DL models used to examine HCS data together with a few chosen applications, particularly in illness identification.

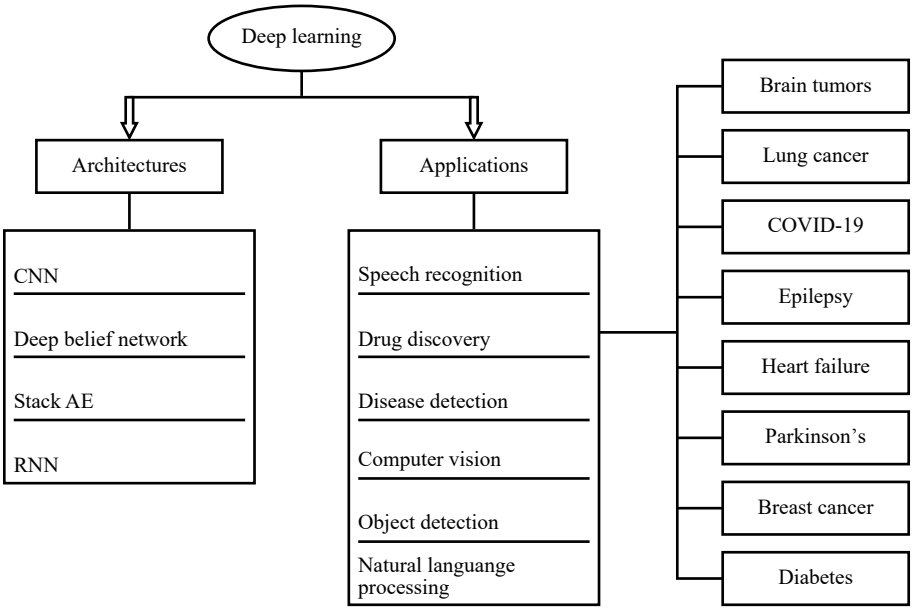

Figure 2. For the analysis of the data in health systems, prominent DL architectures are categorized [20, 21, 24]

2.1.1 *RNN*

Recognition of patterns in sequential or stream data, including voice, writing, and text, is done using RNNs [26].

Every one of the earlier inputs is saved in hidden units of a state vector, and the outputs are computed using these state vectors. RNNs compute the new output by considering both the current and prior inputs. The fundamental issue with RNNs, despite their promising performance, is the diminishing gradient during data training [27]. The structure of RNNs contains a cyclic connection. These hidden unit cyclic connections carry out the recurrent computations for processing the data input sequentially [28].

One method to address this issue is to use Gated Recurrent Units (GRUs) and Long Short-Term Memory networks, which have a long-term capacity for storing sequences [29, 30]. Figure 3 depicts the architectural layout of an RNN. Besides encouraging success using GRU to deal with the issue of vanishing gradients, the success of this strategy is very high because connections between the first two layers are undirected; they are reliant on the input data, whereas connections between all subsequent directed layers [31-33].

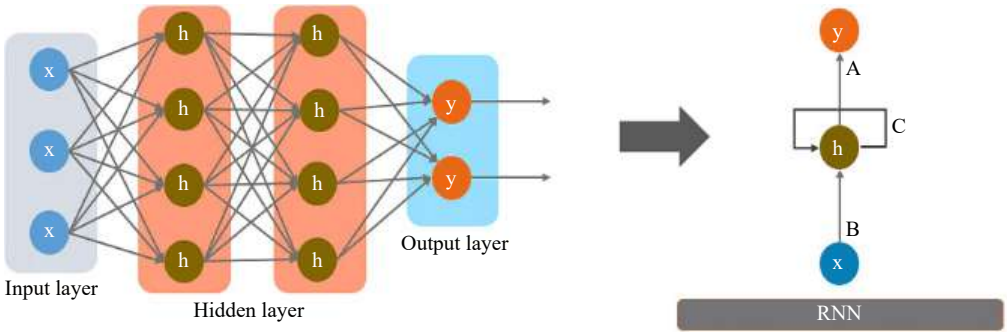

Figure 3. Architecture of RNNs [22]

2.1.2 *CNN*

CNN is an architecture for supervised DL. Applications involving image analysis are its principal use cases [34, 35].

CNN employs three different types of layers: convolutional (the main building block), pooling (to reduce the dimensions of feature maps), and fully connected (which is nothing but output from the other two layers). The input data as the image is processed modifies the convolutional layer with kernels or filters to create different feature maps [36]. Each feature map's size is decreased in the pooling layer to minimize the number of weights. This method is often referred to as subsampling or down-sampling [37]. There are numerous types of pooling techniques, including average, maximum, and global pooling. For the final classification following the layers, the completely linked layer is utilized for one-dimensional vectorization of two-dimensional feature maps [38-40].

Deepr [41] offers an end-to-end solution for extracting essential details from medical records and predicting anomalies. A CNN is used to anticipate unexpected readmissions following discharge by applying it to a series of discrete elements. A DL approach was later used by Gnanasankaran et al. [42] to investigate the temporal aspects of patient EHRs. The convolution operator was applied to the patient EHR matrices' time dimension in the proposed DL's second layer. To incorporate the integration of the EHR's temporal smoothness into learning, early, late, and slow fusion are used as temporal fusion strategies in the model [43].

A CNN design with two convolutional layers is shown in Figure 4. A pooling or subsampling layer came after each fully connected layer. A fully linked layer and a final output layer both receive the output of the final pooling layer.

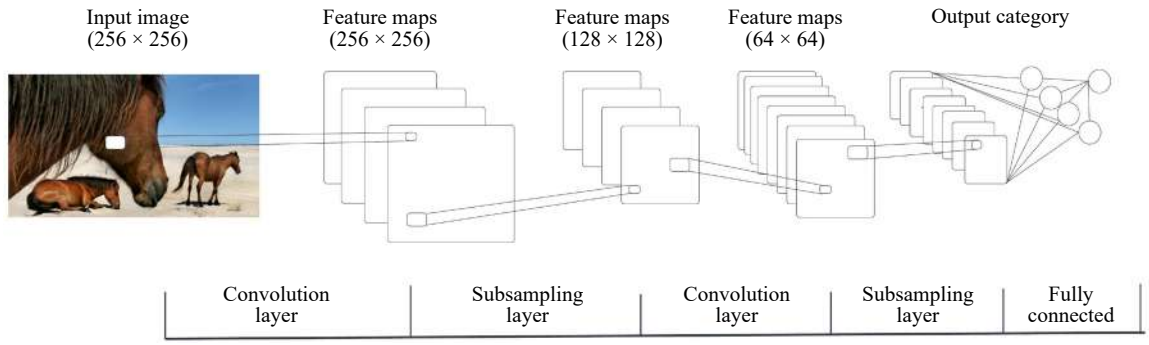

Figure 4. CNN architecture [40]

2.1.3 *The deep belief networks (DBNs)*

The DBNs are capable of learning high-dimensional data manifolds. Directed and undirected connections are seen in DBNs, a multi-layer hybrid network [44]. While all other connections between levels are directed, The upper two layers do not directly connect to one another. DBNs could be thought of as a pile of greedily trained Boltzman machines with restrictions (RBMs) [45]. The RBM layers communicate with one another as well as with earlier and later layers [46-48]. A feed-forward network and multiple RBM layers serve as feature representations in this model [49]. RBM merely contains two layers: a hidden and a visible layer [50]. The structure of the DBN methodology, which was adapted from [51], is shown in Figure 5. In this diagram, "v" represents deep belief mode's stochastic visible variable. The architecture of the DBN technique, which was adapted from [51], is shown in Figure 5, where v is the deep belief model's stochastic visible variable.

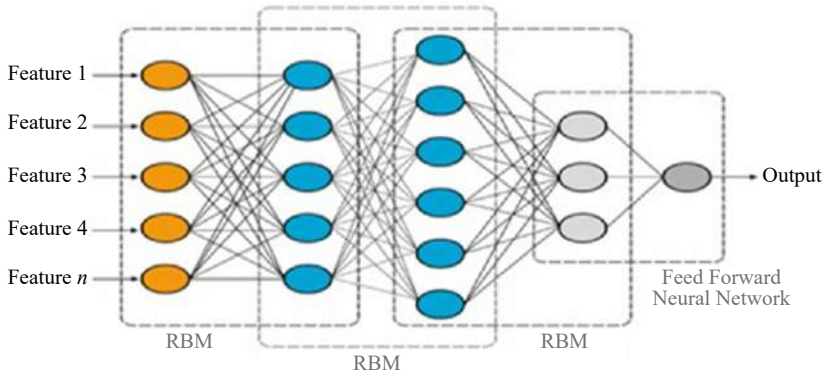

Figure 5. Architecture of DBN [51]

2.1.4 *AE*

An ANN called the AE seeks to efficiently code the data. As a result, it can be applied to network startup or feature reduction. It does this by translating the information through a network of linked neurons to itself. Unsupervised learning is categorized as AE, which encompasses sparse autoencoder (SAE), variational autoencoders (VAE), and denoising auto encoder (DAE) [52]. A neural network called AE with denoising, which was developed from AE, mostly considers collecting features from various noisy and unclear datasets. The DAE has three layers: encoding, decoding, and input layers. DAE may be used to produce advanced features. Stacked Denoising Auto-Encoder (SDAE) is a different DL technique that has always just been applied for reducing dimension, which is nonlinear in nature. The architecture of the DAE approach is shown in Figure 6, according to [53].

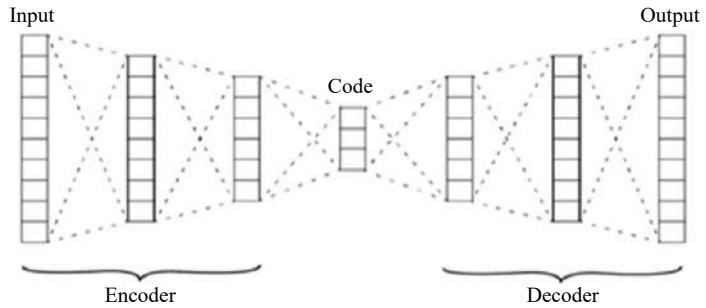

Figure 6. Architecture of AE [53]

Table 2. Review of the study on how DL designs utilized in the health system sector are influenced by neural networks

Architecture	Summary
RNN	RNNs are helpful for processing data streams [53]. The value of every output depends on the preceding iterations, and they are made up of a single network that completes the identical task for each sequence element. Due to vanishing and expanding gradient issues, RNNs could only go back a few steps in the original formulation. By modeling the obscured state, which contains cells that decide what information to keep in memory based on the input value, the current memory, and the prior state. In applications involving natural language processing, these modifications achieved excellent results [54] and are effective at capturing long-term interdependence.
CNN	CNNs were designed using the visual brain anatomy of cats [55, 56]. CNNs use feature merging after local contacts and associated weights across the units to get translation-invariant descriptors. The basic CNN design consists of one pooling and convolutional layer, optionally continued by a completely connected layer for monitored prediction. To model the input space more accurately, Over ten convolutional and pooling layers are frequently used in CNN architectures. The best applications of CNNs have been created by computer vision [57]. CNNs often require a large data collection of labeled documents in order to be properly trained.
AE	An AE is a model of unsupervised learning in which the input and target values are identical [58]. A decoder that maps the input into a low-dimensional representation and reconstructs the input value from this low-dimensional representation that makes up an AE is nothing but a decoder. The goal of AE training is to reduce reconstruction errors. It is possible to find important patterns in the data by requiring the implicit representation's dimension to vary again from the input. AEs are frequently regularized by including noise in the original data and are mostly utilized for learning low-dimensional representation.
Deep Boltzmann machines (DBMs)	Using data from the input space, a DBM is a stochastic model that is generative and adopts a posterior probability [52, 53]. confined to the requirement that its neurons form a bipartite graph; Boltzmann machines are known as DBMs. There are only symmetric interactions between pairs of nodes in each of the two categories; there aren't any interactions among nodes within a group. In comparison, Boltzmann machines have a general class, which permits hidden unit connections; this constraint enables more effective training techniques.

3. DL: Medical imaging and detection of disease

This section comprises a variety of DL algorithms used in the medical field to distinguish between healthy and unwell people. Finally, here, some of the effectiveness of DL is highlighted for differentiating between infectious and healthy individuals.

3.1 *Medical imagery*

In image processing, namely in the analysis of central nervous system MRI scanning to forecast Alzheimer's disease and its variants, DL was first applied to clinical data [54]. CNNs have been used for the automated segmentation of cartilage and the prognostication of osteoarthritis in low-field knee MRI data in other medical fields. Despite using 2D photos, this method outperformed a cutting-edge technique that used manually chosen characteristics with a 3D multiscale. Additionally, supervised learning was used for the evaluation of patients with benign versus malignant breast masses from CT and to segment chronic regions in multi-channel 3D MRI [55].

In a more recent study, Yin and Zhang [56] employed CNNs, which help to recognize the various retinal fundus, diabetic retinopathy, achieving more specificity and sensitivity across around nine to 10,000 different test photos in comparison for certifying the ophthalmologist's annotations. On a huge data set for a variety of skin cancers, CNN also produced categorization results that were on par with those of 21 board-certified dermatologists.

3.2 *Disease categories*

Here, we examine various approaches based on different categories of disease. This section focused on the significant DL techniques, along with performance variations and applications in various categories of disease.

First, those that have received extensive DL model research. Second, those who used DL models to address problems or produce encouraging outcomes.

The DL approaches utilized to combat these diseases are covered in full below.

3.2.1 *Breast cancer*

After that, [59] presented DL architecture with two layers to classify benign and malignant breast cancers using

shear wave elastography, which contains a Boltzmann machine that is confined and also one that is point-wise gated. The method's accuracy, specificity, AUC, and sensitivity were compared to statistical parameters that characterize image intensity and texture. A computer-aided disease diagnosis machine using DL techniques to identify, divide, and categorize masses in mammograms was introduced by the authors in [57, 58]. They thought about three steps — detection, segmentation, and classification — to do this:

For mass detection, a series of DL-process including convolutional, deep belief, and conditional random field (CRF) was suggested. To boost the performance of handcrafted features, it was suggested to use a DL classifier for mass recognition and a deep structure output for mass separation. CNN received training to divide the mass into two categories. The handcrafted features were used to estimate a regressor in the first phase, and the CNN model was tweaked in the second phase. Figure 7 illustrates the method's architectural layout.

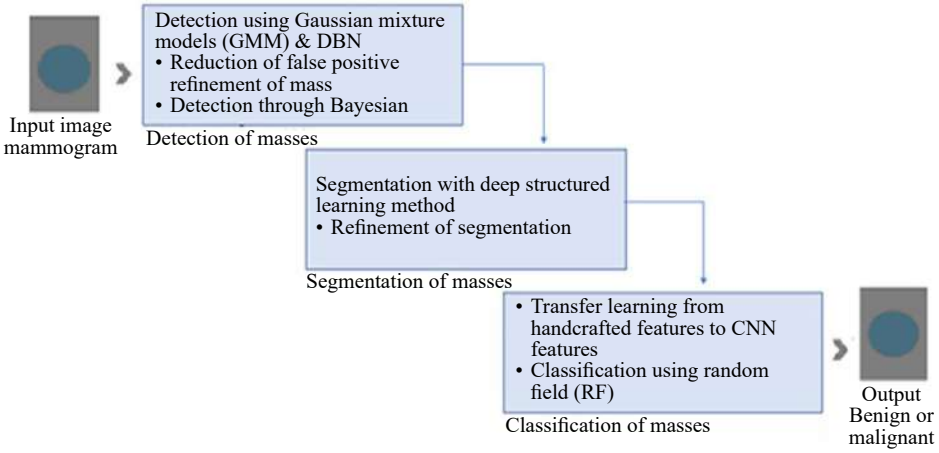

Figure 7. Architectural layout of DL [58]

3.2.2 *Electroencephalography (EEG) imagery signals*

This section's main goal is to demonstrate the importance of DL techniques in terms of performance variation by considering classification. Deep belief networks were utilized by the authors of [56, 57], brain activity EEG waveforms according to categories. The DBN results show that even on raw data, this model's prediction task requires less time than those of support vector machine (SVM) and K-nearest neighbors (KNN) classifiers. Later, [58] proposed a brand-new method for categorizing electrocardiogram (ECG) signals, which are typically DL-based.

The resulting hidden representation layer in this model was then covered with a regression layer to produce a DNN after the feature learning phase. Less expert participation and a quicker online retraining phase boosted this novel method's accuracy compared to prior approaches.

The classification of breast cancer with both migratory and non-mitotic nuclei images was presented in [60] using a unique technique of data balancing utilizing the CNN model. Considering the substantial overlaps between cell divisions and non-mitoses, a CNN model is used in this model to deal with a classification example. K-means with a blue ratio histogram were developed in the second stage to under-sample the skewness in the majority of classes with little information loss. The study's findings showed that the model decreased training time while also increasing CNN's mitotic detection rate. The CNN model's construction in two phases is shown in Figure 8.

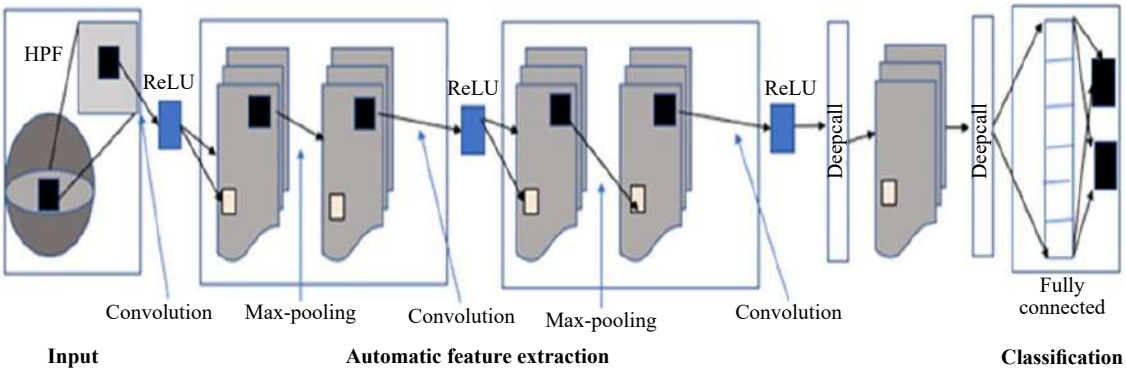

Figure 8. CNN model's construction with two-layer phases [55, 60]

3.2.3 *Multiple sclerosis*

To categorize mental workload, a denoising-stacked AE was created [56, 61]. Both within-session and across-session conditions were considered when calculating the classification's accuracy. Then, using various feature selection and noise corruption models, this is the new classification, which was contrasted with conventional categorizers for mental effort. Later, delayed multiple sclerosis (MS) patterns called lesion patterns were extracted from represented pictures using a CNN approach [59, 61]. It was suggested in [62] to apply a DBN and random forest on myelin images as well as T1W images where MS pathology can be found in brain tissue that appeared normal with an MRI. To develop a latent feature representation, DBN with four layers (Figure 9) was applied to 3D images of normal-appearing gray matter (NAGM) and normal-appearing white matter (NAWM) in this model. Then, the picture patches were chosen using a voxel-wise t-test.

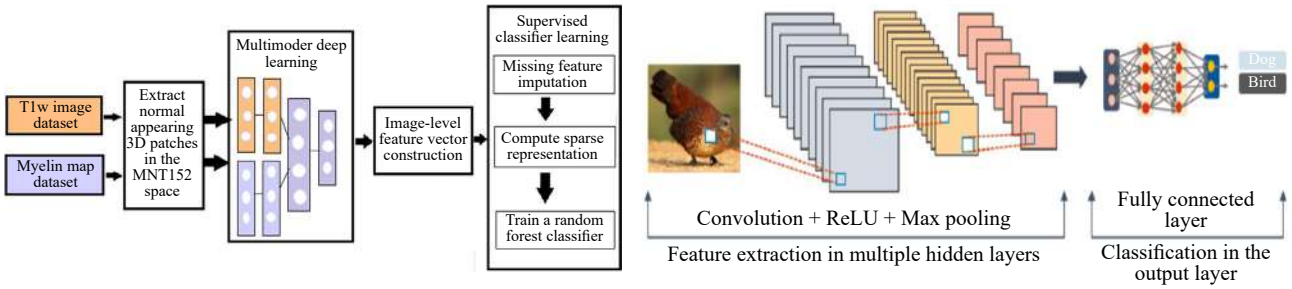

Figure 9. Modeling DBN with four layers [56, 57, 61]

3.2.4 *Brain cancer*

In [63], a multi-scale CNN-based approach to tissue segmentation for brain MRI was proposed. Different levels of irregularity were used to test the methodology. The findings demonstrate precisely divided brain lesions. Transparency in models is a significant problem in the clinical sector that has an impact on the prediction of patient therapies and real-world medical decision-making [64]. A new DL model for segmenting brain tumors was proposed in [65] in a distinct study by fusing fully CNN and conventional random fields (Figure 10).

To train the model, three different phases were used. Image slots were first used to train the fully connected neural networks (FCNN). Second, CRF-RNN was trained by image pixels. Finally, the entire network was tuned using the picture slices [65, 66]. The four steps of the method include pre-processing, fragmenting picture slices with DL models that incorporate FCNNs and CRF-RNNs, extraction of features, and identification.

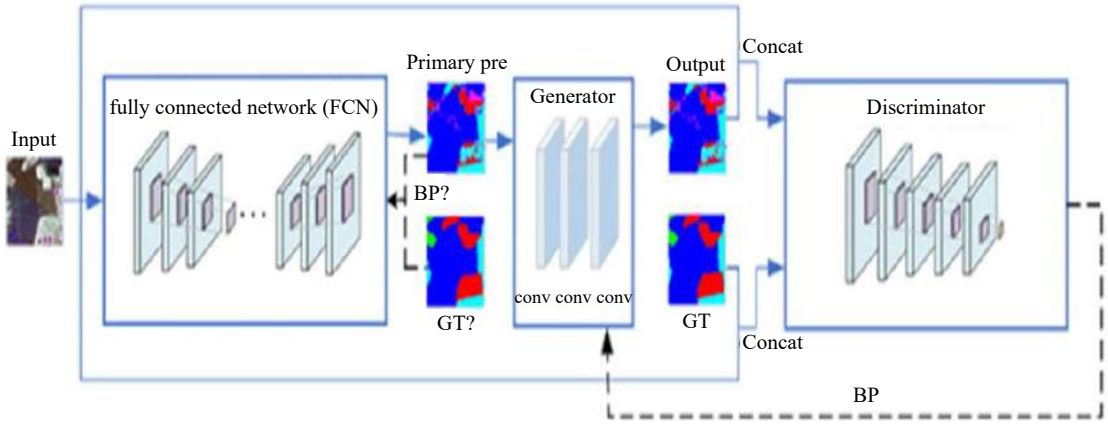

Figure 10. A fully integrated CRF and CNN [63, 64]

3.2.5 *Hybrid disease detection*

To identify three different cancer types [67] — LACAR (lung small/large adenocarcinoma), SACAR (stomach-related adenocarcinoma), and BICAR (breast-related invasive carcinoma) — hybrid DL approaches are used. They used studies of various gene expressions to pick the key genes in this model. Five CNN classifiers were trained using these chosen genes, and the combined output was then obtained. They showed that, in comparison to a single classifier or the algorithm for qualified majority, their approach can improve the reliability of cancer diagnosis across all tested datasets of RNA-Seq. The authors of [67] suggested a technique for automatically classifying gastric cancer using a CNN. Three deep structural algorithms with multichannel release of information (ROI) — stacked denoising AE, DBN, and CNN — were used in a different study [68] to diagnose lung cancer.

3.2.6 *Epilepsy diagnosis*

To diagnose epilepsy using the encephalogram signals, the authors of [69] explained a new system for computer-aided diagnosis that makes use of CNN. Its precision, efficiency, and responsiveness are contrasted with those of other ML techniques. The CNN method uses thirteen layers to develop a complicated and robust model to identify seizures. To the best of our knowledge, this is DL's only substantial application to the diagnosis of epilepsy.

3.2.7 *Heart disease*

Although this condition is common, DL has not been utilized frequently for it. The most important application of DL is to help identify this condition, as is done in [70]. For instance, [70] used an RNN to detect heart failure. To identify cardiac disease by examining the relationships between gated recurrent units, they suggested an RNN model using events that were time-stamped and a case-and-control observation window [71, 72].

3.2.8 *Eye disease*

A framework of ML for enhancing clinical decision-making systems was proposed in [73], along with an unsupervised deep feature learning method. To identify red lesions in fundus images, a combination of DL and domain expertise was developed in [74]. The addition of handcrafted features culminated in the learning process for CNN architecture. According to reports, this combination performs better than other separate classifiers [74].

The Sutter-PAMF dataset is utilized. The outcome shows a detection accuracy of 77.68 percent. It also displays the RNN technique for brain tumor detection. The Cancer Genome Atlas (TCGA) project provided the gene expression data that was utilized.

3.2.9 *COVID-19*

A viral illness called COVID-19 has infected billions of people worldwide and spread to additional countries at an accelerated rate [75, 76]. The World Health Organization (WHO) initially referred to this dangerous infection as SARS-CoV-2, and later COVID-19 became more well-known [77]. Fever, coughing, and a loss of taste or smell are some of the main COVID-19 symptoms that people experience [78, 79]. Chest pain, shortness of breath, diarrhea, headaches, sore throats, and other symptoms are among the main ones. The Nidovirales family includes COVID-19, which is regarded as a positive-sense non-segmented RNA virus. The COVID-19 illness spreads in an unanticipated way around the world, and on January 30, 2020, the WHO declared this epidemic a PHEIC (Public Health Emergency of International Concern) [80, 81]. According to the data study, there were 4,592,893 COVID-19 fatalities and 222,180,532 infections. According to records, nearly 198,785,372 people have been treated for COVID-19 as of September 7th, 2021.

3.3 *Summary of dataset used in healthcare*

In this area, we highlighted some important datasets that were applied to various DL algorithms for the detection of disease and healthcare. The most common healthcare or cancer dataset utilized with DL techniques is mentioned in Table 3.

Table 3. Most common healthcare dataset utilized with DL techniques

Paper Number	Dataset	CNN	RNN	DNN	DAE	DBN	KNN
P2 [46]	Lung image dataset	√			√	√	
P3 [55]	MITOS12, TUPCAC16	√					
P4 [57]	MRI dataset for relapsing-remaining MS					√	
P5 [58]	INBreast	√					
P6 [60]	MITBIH, SVDB and INCART			√	√		
P7 [61]	DDSM	√					
P8 [65]	BRATS	√	√				
P9 [64]	Dataset related popular disease from WebMD						√
P1 [66]	LUAD, STAD, BRCA			√			
P10 [71]	Electronic health record dataset		√				
P11 [74]	MESSIDOR and e-ophtha, DiareTDB1	√					
P12 [82]	Bonn University Dataset	√					
P13 [83]	PPMI, SNUH	√					
P14 [88]	Gastric cancer dataset	√					
P15 [92]	Myelin and T1W					√	

According to Table 3, the CNN algorithm has been implemented in more databases than any other. Take the MITOS12 system, which is offered by the ICPR competition's organizers and consists of five slides from different individuals that have been H&E stained and labeled by a skilled pathologist. For MITOS12 and TUPAC16, the CNN has been used. The University of South Florida (USF) makes their DDSM database available. Four breast photos are provided for each case in the DDSM, together with patient data.

3.4 *Summary of dataset used in healthcare*

Based on the design of the DL approaches used for illness detection, we discuss the results of the studies reported in this part. Then, we examine each study's advantages and disadvantages. We first go over each study in detail before

contrasting it with the other techniques listed in Table 1. To assess the effectiveness of DL approaches, the entire number of DL articles listed in Table 1 were examined for two crucial factors: accuracy and area under the curve. Finally, we emphasized the methods that have the greatest influence on detection rates.

Acharya et al.'s [69] analysis of a dataset of EEG signals from Bonn University using a ten-fold merge procedure and the CNN technique. Results from this study were compared to those from other related studies that were identified in the literature. The findings from the investigation are suggested in [69]. These are the accuracy (a) and sensitivity comparison findings between different CNN models and various approaches established in the mentioned database (b).

To assess time-stamped events, a gated recurrent unit-based RNN was developed by Choiet al. [70]. The model's performance was compared to that using AUC values as the key metric, supporting vector machines, CNNs, K-nearest peers, etc. Figure 11 compares RNN's AUC for prediction between three and nine months to other approaches.

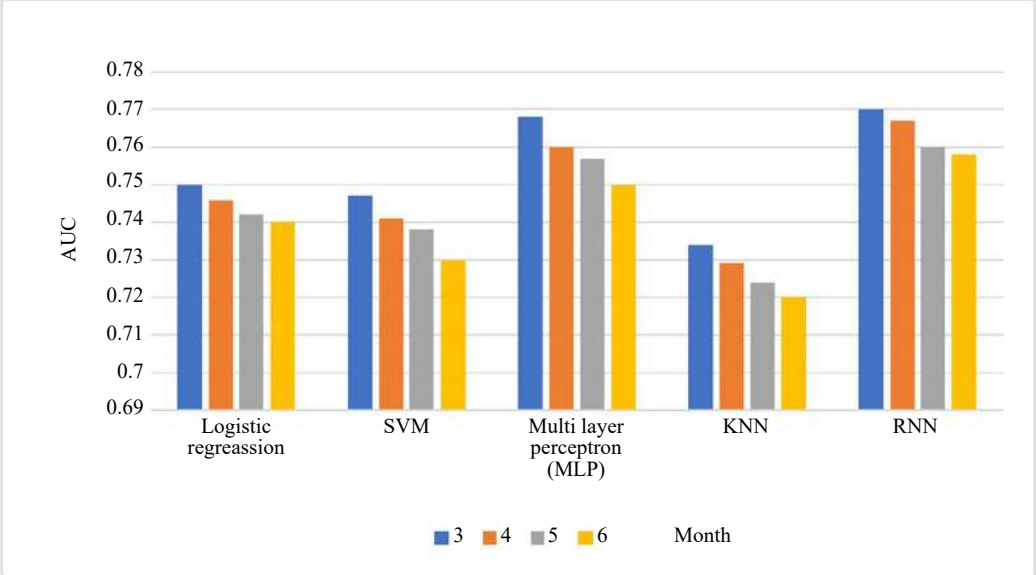

Figure 11. Comparing RNN's AUC for predictions between three and six months to different approaches [69, 70]

An automatic CNN technique for diagnosing Parkinson's disease was created by Choi et al. [71]. Accuracy, specificity, and sensitivity were compared between the visual interpretation and PD Net. The PPMI test set photographs were visually examined by two different readers who were unaware of the diagnosis and clinical details [72]. DAT binding was visually labeled as "normal" or "abnormal" on images. Readers' accuracy and that of PD Net were compared. The outcomes are displayed in Figure 12.

A Random Forest-based CNN was created by Dhungel et al. [58] for the INbreast dataset application in two settings: manual and minimal involvement. The outcomes in terms of accuracy for different CNNs and the area under the curve are displayed in Figure 13.

The CNN, which is based on the random forest technique used in manual configuration and supported by different CNN techniques in the setting with the least amount of user intervention, shows excellent accuracy of detection in Figure 13. This indicates that the RF's ability to classify data using an ensemble learning technique has a favorable impact on the CNN method. As a result, this capability raises the accuracy of the CNN technique [58].

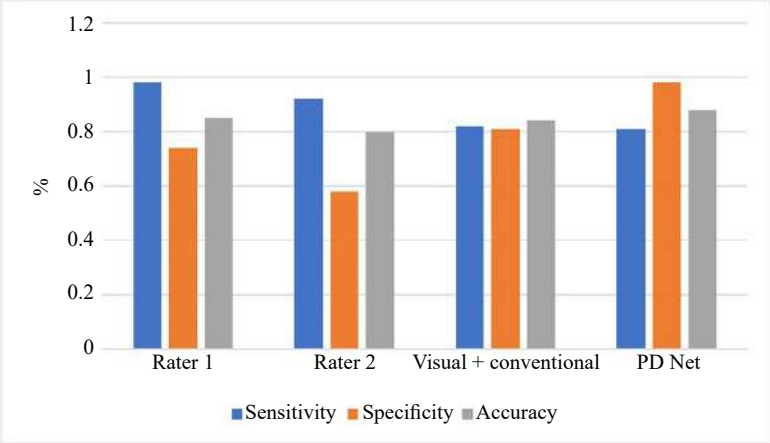

Figure 12. Results of sensitivity, specificity, and accuracy [71]

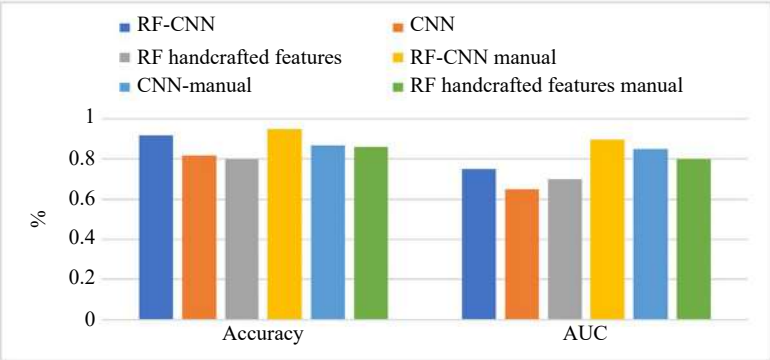

Figure 13. Outcomes of different CNN [58]

To estimate the rates of patients' survival using electronic medical information, Miotto et al. [73] introduced the deep patient unsupervised representation deep patient (URDP) technique. In terms of accuracy and area under the curve of the receiver operating characteristic (ROC) curve, the URDP approach was compared to other methods created in this area. The outcomes are shown in Figure 14.

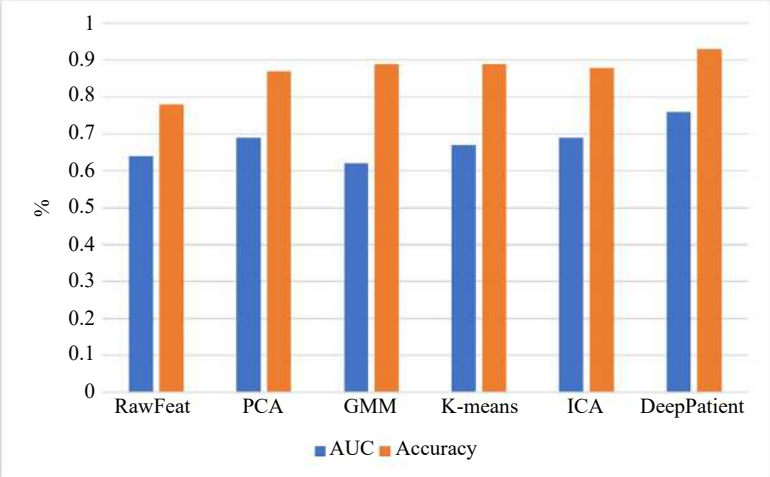

Figure 14. Comparison of URDP with other approaches [61]

An ensemble DL technique was created by the author of [74] Orlando et al. for the detection of a red lesion in fundus pictures. Figure 15 displays the results of CNN, hybrid CNN-hybrid CNN framework (HCF), and hand-crafted features in terms of sensitivity and AUC.

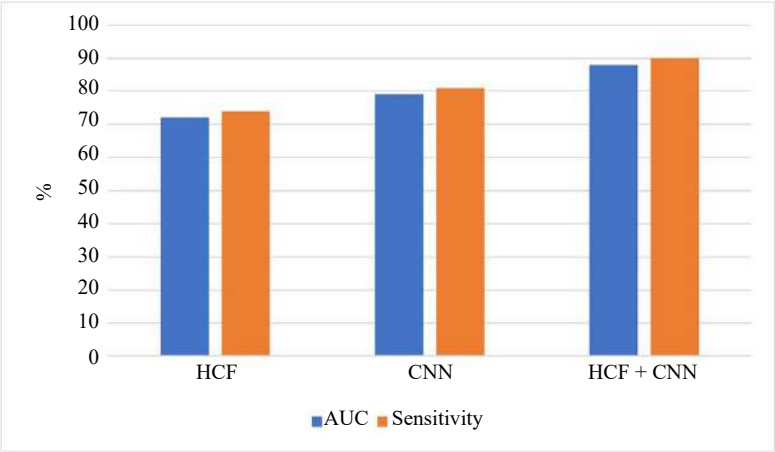

Figure 15. Results of CNN and hybrid CNN-HCF [74]

Based on the above findings, this review examines the value of mixed mode techniques since they combine several reliable models to create a classifier that is more accurate [75]. The hybrid method offers greater sensitivity and AUC in comparison to single methods, as demonstrated in Figure 20. The application of hybrid approaches in DL is highlighted in this work [76, 78].

An AE for denoising stacked and adaptive versions of SDAE algorithms for categorizing the levels of mental pressure was developed by Yin and Zhang [56]. Using EEG data that was obtained on different days, the procedures were practiced and evaluated. Figure 16 displays the study's findings in terms of sensitivity, specification, and accuracy.

According to the findings in Figure 16, when working on EEG features with cross-sessions, adaptive SDAE outperforms SDAE [79]. By examining the findings from this article, it becomes clear that A-SDAE is superior in situations involving the computing cost for iterative tuning, the best step length, and the data augmentation technique. A live web server is created using this method [80].

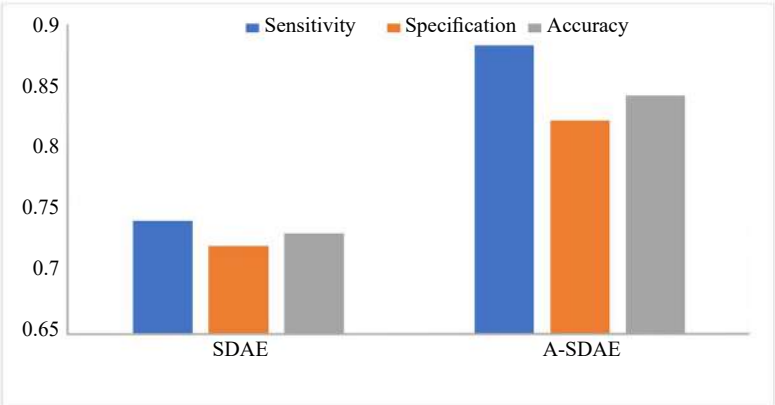

Figure 16. The review of findings of SDAE and A-SDAE [56]

To illustrate modeling in terms of AUC, reliability, and responsiveness, respectively, of output and performance,

present DL approaches. It may be inferred that DBN's use of the CNN methodology has contributed the most to this field. This might be because of the features and nature of these techniques. Additionally, these two techniques have the greatest propensity to be combined with other techniques [81].

4. Challenges and opportunities

Although deep architectures have delivered some hopeful results, a number of problems remain that must be fixed before classifiers in medical can be applied therapeutically. We particularly call attention to these grave issues:

Quality of data: Medical information are extremely varied, confusing, rough and insufficient, in contrast to other fields where the data is organized and clean. With such expansive and varied data sets, it is challenging to train a reliable DL model. Several issues, such as data sparsity, complexity, and missing values, must be taken into account [82].

Complexity in domain: Compared to other application sectors, the problems in the bioscience and healthcare industries are more complicated. It is still unknown precisely what causes the majority of the disorders and how they evolve because of their tremendous heterogeneity [83]. In a meaningful therapeutic setting, the patient count is commonly limited, hence we are not allowed to accept an infinite number of patients [84].

Data volume: DL refers to a class of computer models that require a lot of manual labor. One typical example is fully linked multi-layer neural networks, where it is necessary to precisely anticipate a number of network properties. The basis for reaching this goal is the presence of a massive amount of data. It is sometimes advised to utilize at least ten times as many cases in a network as parameters, despite the lack of specific guidelines for the minimum amount of training materials that must be used [85]. DL's effectiveness in industries where enormous volumes of information can be quickly obtained is another aspect.

Interpretability: Even though DL models have demonstrated effectiveness along a diverse range of domains, they are occasionally perceived as "black boxes" [86]. In other, more deterministic areas like image identification, where the end user can unbiasedly check the tags assigned to the photos, this might not be a problem, but in the healthcare industry, this is a concern, and It is crucial to comprehend the algorithms' qualitative as well as quantitative performance. This form of model interpretability — namely, identifying the phenotypes that are driving the predictions — is essential for persuading medical practitioners to follow the predictive system's advice [87].

Feature enrichment: Due to the restricted number of patients worldwide, we must collect various features as we can fully describe each patient and develop creative ways to analyze them all at once. The data input for creating features should consider, but not be restricted to, EHRs and other social media wearable technology, surroundings, observations, virtual communities, transcriptomes, such as the genome, omics data, and so on [88]. A significant and difficult research problem would be how to use such extremely varied data effectively in a DL model.

Integrating expert knowledge: For health care issues, the current expert information for medical issues is priceless. The integration of expert details in the DL process to direct it in the appropriate way is a crucial research area topic due to the restricted quantity of medical data, their diverse quality issues [89]. For instance, it is advisable to mine online clinical/medical encyclopedias to find trustworthy knowledge that may be incorporated into the deep architecture and improve the system's overall performance. The ability to employ both labeled and unlabeled samples make semi-supervised learning, an efficient method consider for learning from many unlabeled a small number of tagged samples, very promising [90].

Temporal modeling: Because time is a significant factor in many healthcare-related issues, particularly those involving EHRs and monitoring equipment, to better comprehend patient circumstances and provide timely support for medical decision-making, it is imperative to train a thing DL model [91]. As a result, temporal DL is crucial for resolving problems in the healthcare industry. To do this, we believe that RNNs and layouts with capacity will greatly enhance clinical feature sets.

5. Conclusion

DL has shown enormous potential as an emerging technology for solving difficult healthcare issues. In this study, we concentrated on healthcare issues that DL has been applied to with positive outcomes. DL-based methods have been

shown to be efficient tools for dealing with ailment detection in the preprocessing, edge detection, extraction of features, categorization, and grouping processes. In this paper, the detection of disease in healthcare systems served as the focal point for evaluating the technical features of ML and DL architectures [92]. The effectiveness of these techniques was discussed in terms of algorithm parameters and the precision of disease identification. Finally, the top DL technique architectures used in healthcare were examined and commented on.

We may conclude from this review that DL-based hybrid and ensemble approaches outperform single techniques in terms of accuracy. The existing classifier models [93] like ANN, adaptive neuro-fuzzy inference systems (ANFIS), CNN, and multi-objective differential evolution-based CNN (MODE_CNN) have obtained 88.8%, 90.39%, 92%, and 93.60% accuracy rates, respectively. DL techniques require a lot of memory and time, which is a drawback. Thus, creating and implementing ideal processes in healthcare systems is a significant problem [93, 94]. By integrating more procedures simultaneously and irrespective of the different types of datasets, these methods result in an enhancement of the process.

DL techniques require a lot of memory and time, which is a drawback [95]. Designing and implementing the best practices in healthcare systems is thus a significant task.

Researchers may concentrate on creating and integrating effective technologies in the future to meet the technical specifications for all types of decision-making algorithms, including those with DNN designs [96, 97]. As stated throughout this research, it is also required to enhance the current neural network models' topologies to create more efficient systems. Therefore, it is essential to develop well-defined, general architectures that can deal with many types of health data to tackle complicated challenges in healthcare systems [98-102].

Ethical approval

This study was approved by our institution and does not require ethical approval for reporting individual cases or case series.

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Conflicts of interest

The authors declare that they have no conflicts of interest to report regarding the present study.

References

[1] Kalantari A, Kamsin A, Shamshirband S, Gani A, Alinejad-Rokny H, Chronopoulos TA. Computational intelligence approaches for classification of medical data: State-of-the-art, future challenges and research directions. *Neurocomputing*. 2018; 276: 2-22. Available from: https://doi.org/10.1016/j.neucom.2017.01.126.

[2] Kumar PM, Gandhi UD. A novel three-tier Internet of Things architecture with machine learning algorithm for early detection of heart diseases. *Computers & Electrical Engineering*. 2018; 65: 222-235. Available from: https://doi.org/10.1016/j.compeleceng.2017.09.001.

[3] Mijwil MM, Aggarwal K, Doshi R, Hiran KK, Sundaravadivazhagan B. Deep learning techniques for COVID-19 detection based on chest X-ray and CT-scan images: A short review and future perspective. *Asian Journal of Applied Sciences.* 2019; 10(3). Available from: https://doi.org/10.24203/ajas.v10i3.6998.

[4] Abdel-Hamid O, Mohamed A-r, Jiang H, Deng L, Penn G, Yu D. Convolutional neural networks for speech recognition. *IEEE/ACM Transactions on Audio, Speech, and Language Processing*. 2014; 22(10): 1533-1545. Available from: https://doi.org/10.1109/TASLP.2014.2339736.

[5] Deng L, Li X. Machine learning paradigms for speech recognition: An overview. *IEEE Transactions on Audio, Speech, and Language Processing*. 2013; 21(5): 1060-1089. Available from: https://doi.org/10.1109/TASL.2013.2244083.

[6] Cho K, Courville A, Bengio Y. Describing multimedia content using attention-based encoder-decoder networks. *IEEE Transactions on Multimedia*. 2015; 17(11): 1875-1886. Available from: https://doi.org/10.1109/TMM.2015.2477044.

[7] Hannun A, Case C, Casper J, Catanzaro B, Diamos G, Elsen E, et al. Deep speech: Scaling up end-to-end speech recognition. *arXiv* [Preprint] 2014. Version 2. Available from: https://doi.org/10.48550/arXiv.1412.5567.

[8] Wikipedia contributors. Google DeepMind. Wikipedia, The Free Encyclopedia. Available from: https://en.wikipedia.org/w/index.php?title=Google_DeepMind&oldid=1184257608 [Accessed 10th November 2023].

[9] Watson IBM Health. Methodology: Watson health 15 top health systems study [Internet], 2020. 2020. Available from: https://www.ibm.com/downloads/cas/XERGJLK3.

[10] Cabrita M, op den Akker H, Tabak M, Hermens HJ, Vollenbroek-Hutten MM. Persuasive technology to support active and healthy ageing: An exploration of past, present, and future. *Journal of Biomedical Informatics*. 2018; 84: 17-30. Available from: https://doi.org/10.1016/j.jbi.2018.06.010.

[11] Avendi M, Kheradvar A, Jafarkhani H. A combined deep-learning and deformable-model approach to fully automatic segmentation of the left ventricle in cardiac MRI. *Medical Image Analysis*. 2016; 30: 95-106. Available from: https://doi.org/10.1016/j.media.2016.01.005.

[12] Li F, Tran L, Thung K-H, Ji S, Shen D, Li J. A robust deep model for improved classification of AD/MCI patients. *IEEE Journal of Biomedical and Health Informatics*. 2015; 19(5): 1610-1616. Available from: https://doi.org/10.1109/JBHI.2015.2429556.

[13] Shickel B, Tighe PJ, Bihorac A, Rashidi P. Deep EHR: A survey of recent advances in deep learning techniques for electronic health record (EHR) analysis. *IEEE Journal of Biomedical and Health Informatics*. 2017; 22(5): 1589-1604. Available from: https://doi.org/10.1109/JBHI.2017.2767063.

[14] Lan K, Wang D-t, Fong S, Liu L-s, Wong KK, Dey N. A survey of data mining and deep learning in bioinformatics. *Journal of Medical Systems*. 2018; 42: 139. Available from: https://doi.org/10.1007/s10916-018-1003-9.

[15] Krizhevsky A, Sutskever I, Hinton GE. ImageNet classification with deep convolutional neural networks. *Communications of the ACM*. 2017; 60(6): 84-90. Available from: https://doi.org/10.1145/3065386.

[16] Chen G, Tsoi A, Xu H, Zheng WJ. Predict effective drug combination by deep belief network and ontology fingerprints. *Journal of Biomedical Informatics*. 2018; 85: 149-154. Available from: https://doi.org/10.1016/j.jbi.2018.07.024.

[17] Macías-García L, Luna-Romera JM, García-Gutiérrez J, Martínez-Ballesteros M, Riquelme-Santos JC, González-Cámpora R. A study of the suitability of autoencoders for preprocessing data in breast cancer experimentation. *Journal of Biomedical Informatics*. 2017; 72: 33-44. Available from: https://doi.org/10.1016/j.jbi.2017.06.020.

[18] Laksana E, Aczon M, Ho L, Carlin C, Ledbetter D, Wetzel R. The impact of extraneous features on the performance of recurrent neural network models in clinical tasks. *Journal of Biomedical Informatics*. 2020; 102: 103351. Available from: https://doi.org/10.1016/j.jbi.2019.103351.

[19] Alshazly H, Linse C, Barth E, Martinetz T. Explainable COVID-19 detection using chest CT scans and deep learning. *Sensors*. 2021; 21(2): 455. Available from: https://doi.org/10.3390/s21020455.

[20] Zheng C, Deng X, Fu Q, Zhou Q, Feng J, Ma H, et al. Deep learning-based detection for COVID-19 from chest

CT using weak label. *medRxiv* [Preprint] 2020. Version 2. Available from: https://doi.org/10.1101/2020.03.12.20027185.

[21] He X, Wang S, Shi S, Chu X, Tang J, Liu X, et al. Benchmarking deep learning models and automated model design for COVID-19 detection with chest CT scans. *medRxiv* [Preprint] 2021. Version 3. Available from: https://doi.org/10.1101/2020.06.08.20125963.

[22] Shah V, Keniya R, Shridharani A, Punjabi M, Shah J, Mehendale N. Diagnosis of COVID-19 using CT scan images and deep learning techniques. *Emergency Radiology*. 2021; 28(3): 497-505. Available from: https://doi.org/10.1007/s10140-020-01886-y.

[23] Purohit K, Kesarwani A, Kisku DR, Dalui M. Covid-19 detection on chest x-ray and CT scan images using multi-image augmented deep learning model. In: *Proceedings of the Seventh International Conference on Mathematics and Computing*. Singapore: Springer; 2022. p.395-413. Available from: https://doi.org/10.1007/978-981-16-6890-6_30.

[24] Deng L, Yu D. Deep learning: Methods and applications. *Foundations and Trends® in Signal Process.* 2014; 7(3-4): 197-387. Available from: https://doi.org/10.1561/2000000039.

[25] Lim WYB, Luong NC, Hoang DT, Jiao Y, Liang Y-C, Yang Q, et al. Federated learning in mobile edge networks: A comprehensive survey. *IEEE Communications Surveys & Tutorials*. 2020; 22(3): 2031-2063. Available from: https://doi.org/10.1109/COMST.2020.2986024.

[26] Yu D, Deng L. *Automatic speech recognition: A deep learning approach*. London: Springer; 2014. Available from: https://doi.org/10.1007/978-1-4471-5779-3.

[27] Litjens G, Kooi T, Bejnordi BE, Setio AAA, Ciompi F, Ghafoorian M, et al. A survey on deep learning in medical image analysis. *Medical Image Analysis*. 2017; 42: 60-88. Available from: https://doi.org/10.1016/j.media.2017.07.005.

[28] Gawehn E, Hiss JA, Schneider G. Deep learning in drug discovery. *Molecular Information*. 2016; 35(1): 3-14. Available from: https://doi.org/10.1002/minf.201501008.

[29] Guo Y, Liu Y, Oerlemans A, Lao S, Wu S, Lew MS. Deep learning for visual understanding: A review. *Neurocomputing*. 2016; 187: 27-48. Available from: https://doi.org/10.1016/j.neucom.2015.09.116.

[30] Chen X, Xiang S, Liu C-L, Pan C-H. Vehicle detection in satellite images by hybrid deep convolutional neural networks. *IEEE Geoscience and Remote Sensing Letters*. 2014; 11(10): 1797-1801. Available from: https://doi.org/10.1109/LGRS.2014.2309695.

[31] Längkvist M, Karlsson L, Loutfi A. A review of unsupervised feature learning and deep learning for time-series modeling. *Pattern Recognition Letters*. 2014; 42: 11-24. Available from: https://doi.org/10.1016/j.patrec.2014.01.008.

[32] Gao S, Zhang Y, Jia K, Lu J, Zhang Y. Single sample face recognition via learning deep supervised autoencoders. *IEEE Transactions on Information Forensics and Security*. 2015; 10(10): 2108-2118. Available from: https://doi.org/10.1109/TIFS.2015.2446438.

[33] Kahou SE, Bouthillier X, Lamblin P, Gulcehre C, Michalski V, Konda K, et al. EmoNets: Multimodal deep learning approaches for emotion recognition in video. *Journal on Multimodal User Interfaces*. 2016; 10: 99-111. Available from: https://doi.org/10.1007/s12193-015-0195-2.

[34] Lawrence S, Giles CL, Tsoi AC, Back AD. Face recognition: A convolutional neural-network approach. *IEEE Transactions on Neural Networks*. 1997; 8(1): 98-113. Available from: https://doi.org/10.1109/72.554195.

[35] Chen S, Xu H, Liu D, Hu B, Wang H. A vision of IoT: Applications, challenges, and opportunities with China perspective. *IEEE Internet of Things Journal*. 2014; 1(4): 349-359. Available from: https://doi.org/10.1109/JIOT.2014.2337336.

[36] Zeiler MD, Fergus R. Visualizing and understanding convolutional networks. In: *European Conference on Computer Vision*. Cham, Switzerland: Springer; 2014. p.818-833. Available from: https://doi.org/10.1007/978-3-319-10590-1_53.

[37] Szegedy C, Liu W, Jia Y, Sermanet P, Reed S, Anguelov D, et al. Going deeper with convolutions. In: *Conference on Computer Vision and Pattern Recognition (CVPR)*. Boston, MA: IEEE Computer Society; 2015. p.1-9.

[38] Simonyan K, Zisserman A. Very deep convolutional networks for large-scale image recognition. *arXiv* [Preprint] 2014. Version 6. Available from: https://doi.org/10.48550/arXiv.1409.1556.

[39] He K, Zhang X, Ren S, Sun J. Deep residual learning for image recognition. In: *IEEE Conference on Computer Vision and Pattern Recognition (CVPR).* Las Vegas, NV: IEEE; 2016. p.770-778.
[40] Cong J, Xiao B. Minimizing computation in convolutional neural networks. In: Wermter S, Weber C, Magg S, Duch W, Honkela T, Koprinkova-Hristova P, et al. (eds.) *Artificial neural networks and machine learning – ICANN 2014*. Cham, Switzerland: Springer; 2014. p.281-290. Available from: https://doi.org/10.1007/978-3-319-11179-7.
[41] Nguyen P, Tran T, Wickramasinghe N, Venkatesh S. Deepr: A convolutional net for medical records. *IEEE Journal of Biomedical and Health Informatics*. 2017; 21(1): 22-30. Available from: https://10.1109/JBHI.2016.2633963.
[42] Gnanasankaran N, Subashini B, Sundaravadivazhagan B. *Amalgamation of deep learning in healthcare systems.* Denmark: River Publishers; 2023.
[43] Hochreiter S, Schmidhuber J. Long short-term memory. *Neural Computation*. 1997; 9(8): 1735-1780. Available from: https://doi.org/10.1162/neco.1997.9.8.1735.
[44] Chung J, Gulcehre C, Cho K, Bengio Y. Empirical evaluation of gated recurrent neural networks on sequence modelling. *arXiv* [Preprint] 2014. Available from: https://doi.org/10.48550/arXiv.1412.3555.
[45] Fries JA. Brundlefly at SemEval-2016 Task 12: Recurrent neural networks vs. joint inference for clinical temporal information extraction. *arXiv* [Preprint] 2016. Available from: https://doi.org/10.48550/arXiv.1606.01433.
[46] Sun W, Zheng B, Qian W. Automatic feature learning using multichannel ROI based on deep structured algorithms for computerized lung cancer diagnosis. *Computers in Biology and Medicine.* 2017; 89: 530-539. Available from: https://doi.org/10.1016/j.compbiomed.2017.04.006.
[47] Zhang Q, Xiao Y, Dai W, Suo J, Wang C, Shi J, et al. Deep learning based classification of breast tumors with shear-wave elastography. *Ultrasonics*. 2016; 72: 150-157. Available from: https://doi.org/10.1016/j.ultras.2016.08.004.
[48] Wulsin DF, Gupta JR, Mani R, Blanco JA, Litt B. Modeling electroencephalography waveforms with semi-supervised deep belief nets: fast classification and anomaly measurement. *Journal of Neural Engineering*. 2011; 8(3): 036015. Available from: https://doi.org/10.1088/1741-2560/8/3/036015.
[49] Patterson J, Gibson A. *Deep learning: A practitioner's approach*. California, US: O'Reilly Media; 2017.
[50] Vieira S, Pinaya WHL, Mechelli A. Using deep learning to investigate the neuroimaging correlates of psychiatric and neurological disorders: Methods and applications. *Neuroscience & Biobehavioral Reviews*. 2017; 74: 58-75. Available from: https://doi.org/10.1016/j.neubiorev.2017.01.002.
[51] Mannepalli K, Sastry PN, Suman M. A novel Adaptive Fractional Deep Belief Networks for speaker emotion recognition. *Alexandria Engineering Journal.* 2017; 56(4): 485-497. Available from: https://doi.org/10.1016/j.aej.2016.09.002.
[52] Al Rahhal MM, Bazi Y, AlHichri H, Alajlan N, Melgani F, Yager RR. Deep learning approach for active classification of electrocardiogram signals. *Information Sciences*. 2016; 345: 340-354. Available from: https://doi.org/10.1016/j.ins.2016.01.082.
[53] Saeed A, Trajanovski S, Van Keulen M, Van Erp J. Deep physiological arousal detection in a driving simulator using wearable sensors. In: *2017 IEEE International Conference on Data Mining Workshops (ICDMW)*. New Orleans, LA: IEEE; 2017. p.486-493. Available from: https://doi.org/10.1109/ICDMW.2017.69.
[54] Tabar YR, Halici U. A novel deep learning approach for classification of EEG motor imagery signals. *Journal of Neural Engineering*. 2016; 14: 016003. Available from: https://doi.org/10.1088/1741-2560/14/1/016003.
[55] Wahab N, Khan A, Lee YS. Two-phase deep convolutional neural network for reducing class skewness in histopathological images based breast cancer detection. *Computers in Biology and Medicine*. 2017; 85: 86-97. Available from: https://doi.org/10.1016/j.compbiomed.2017.04.012.
[56] Yin Z, Zhang J. Cross-session classification of mental workload levels using EEG and an adaptive deep learning model. *Biomedical Signal Processing and Control*. 2017; 33: 30-47. Available from: https://doi.org/10.1016/j.bspc.2016.11.013.
[57] Yoo Y, Tang LY, Brosch T, Li DK, Kolind S, Vavasour I, et al. Deep learning of joint myelin and T1w MRI features in normal-appearing brain tissue to distinguish between multiple sclerosis patients and healthy controls. *NeuroImage: Clinical*. 2018; 17: 169-178. Available from: https://doi.org/10.1016/j.nicl.2017.10.015.
[58] Dhungel N, Carneiro G, Bradley AP. A deep learning approach for the analysis of masses in mammograms with

minimal user intervention. *Medical Image Analysis*. 2017; 37: 101-128. Available from: https://doi.org/10.1016/j.media.2017.01.009.

[59] Yoo Y, Tang LY, Li DK, Metz L, Kolind S, Traboulsee AL, et al. Deep learning of brain lesion patterns and user-defined clinical and MRI features for predicting conversion to multiple sclerosis from clinically isolated syndrome. *Computer Methods in Biomechanics and Biomedical Engineering: Imaging & Visualization*. 2017; 7(3): 250-259. Available from: https://doi.org/10.1080/21681163.2017.1356750.

[60] Dubrovina A, Kisilev P, Ginsburg B, Hashoul S, Kimmel R. Computational mammography using deep neural networks. *Computer Methods in Biomechanics and Biomedical Engineering: Imaging & Visualization*. 2016; 6(3): 243-247. Available from: https://doi.org/10.1080/21681163.2015.1131197.

[61] Jiao Z, Gao X, Wang Y, Li J. A parasitic metric learning net for breast mass classification based on mammography. *Pattern Recognition*. 2018; 75: 292-301. Available from: https://doi.org/10.1016/j.patcog.2017.07.008.

[62] Samala RK, Chan HP, Hadjiiski L, Helvie MA, Wei J, Cha K. Mass detection in digital breast tomosynthesis: Deep convolutional neural network with transfer learning from mammography. *Medical Physics*. 2016; 43(12): 6654-6666. Available from: https://doi.org/10.1118/1.4967345.

[63] Moeskops P, de Bresser J, Kuijf HJ, Mendrik AM, Biessels GJ, Pluim JP, et al. Evaluation of a deep learning approach for the segmentation of brain tissues and white matter hyperintensities of presumed vascular origin in MRI. *NeuroImage: Clinical*. 2018; 17: 251-262. Available from: https://doi.org/10.1016/j.nicl.2017.10.007.

[64] Nie L, Wang M, Zhang L, Yan S, Zhang B, Chua T-S. Disease inference from health-related questions via sparse deep learning. *IEEE Transactions on Knowledge and Data Engineering*. 2015; 27(8): 2107-2119. Available from: https://doi.org/10.1109/TKDE.2015.2399298.

[65] Zhao X, Wu Y, Song G, Li Z, Zhang Y, Fan Y. A deep learning model integrating FCNNs and CRFs for brain tumor segmentation. *Medical Image Analysis*. 2018; 43: 98-111. Available from: https://doi.org/10.1016/j.media.2017.10.002.

[66] Xiao Y, Wu J, Lin Z, Zhao X. A deep learning-based multi-model ensemble method for cancer prediction. *Computer Methods and Programs in Biomedicine*. 2018; 153: 1-9. Available from: https://doi.org/10.1016/j.cmpb.2017.09.005.

[67] Sharma H, Zerbe N, Klempert I, Hellwich O, Hufnagl P. Deep convolutional neural networks for automatic classification of gastric carcinoma using whole slide images in digital histopathology. *Computerized Medical Imaging and Graphics.* 2017; 61: 2-13. Available from: https://doi.org/10.1016/j.compmedimag.2017.06.001.

[68] Sun W, Zheng B, Qian W. Automatic feature learning using multichannel ROI based on deep structured algorithms for computerized lung cancer diagnosis. *Computers in Biology and Medicine.* 2017; 89: 530-539. Available from: https://doi.org/10.1016/j.compbiomed.2017.04.006.

[69] Acharya UR, Oh SL, Hagiwara Y, Tan JH, Adeli H. Deep convolutional neural network for the automated detection and diagnosis of seizure using EEG signals. *Computers in Biology and Medicine*. 2017; 100: 270-278. Available from: https://doi.org/10.1016/j.compbiomed.2017.09.017.

[70] Choi E, Schuetz A, Stewart WF, Sun J. Using recurrent neural network models for early detection of heart failure onset. *Journal of the American Medical Informatics Association*. 2017; 24(2): 361-370. Available from: https://doi.org/10.1093/jamia/ocw112.

[71] Choi H, Ha S, Im HJ, Paek SH, Lee DS. Refining diagnosis of Parkinson's disease with deep learning-based interpretation of dopamine transporter imaging. *NeuroImage: Clinical*. 2017; 16: 586-594. Available from: https://doi.org/10.1016/j.nicl.2017.09.010.

[72] Gunduz H. Deep learning-based Parkinson's disease classification using vocal feature sets. *IEEE Access*. 2019; 7: 115540-115551. Available from: https://doi.org/10.1109/ACCESS.2019.2936564.

[73] Miotto R, Li L, Kidd BA, Dudley JT. Deep patient: An unsupervised representation to predict the future of patients from the electronic health records. *Scientific Reports*. 2016; 6: 26094. Available from: https://doi.org/10.1038/srep26094.

[74] Orlando JI, Prokofyeva E, del Fresno M, Blaschko MB. An ensemble deep learning based approach for red lesion detection in fundus images. *Computer Methods and Programs in Biomedicine*. 2018; 153: 115-127. Available from: https://doi.org/10.1016/j.cmpb.2017.10.017.

[75] Ciotti M, Ciccozzi M, Terrinoni A, Jiang W-C, Wang C-B, Bernardini S. The COVID-19 pandemic. *Critical*

Reviews in Clinical Laboratory Sciences. 2020; 57(6): 365-388. Available from: https://doi.org/10.1080/10408363.2020.1783198.

[76] Chakraborty I, Maity P. COVID-19 outbreak: Migration, effects on society, global environment and prevention. *Science of The Total Environment*. 2020; 728: 138882. Available from: https://doi.org/10.1016/j.scitotenv.2020.138882.

[77] Nazir T, Kayani RR, Nazir SUR, Zaidi SMM, Manzoor S, Taha N. Epidemiology, genomic evolution and molecular features of severe acute respiratory syndrome-related coronavirus. *Advanced Journal of Biomedical Sciences*. 2019; 4: 3-7.

[78] Ahmad T, Rodriguez-Morales AJ. Emergence of COVID-19 (formerly 2019-novel Coronavirus): A new threat from China. *Revista Panamericana de Enfermedades Infecciosas*. 2019; 2(2): 37-38.

[79] Chen X, Laurent S, Onur OA, Kleineberg NN, Fink GR, Schweitzer F, Warnke C. A systematic review of neurological symptoms and complications of COVID-19. *Journal of Neurology*. 2021; 268(2): 392-402. Available from: https://doi.org/10.1007/s00415-020-10067-3.

[80] Cheng A, Hu L, Wang Y, Huang L, Zhao L, Zhang C, et al. Diagnostic performance of initial blood urea nitrogen combined with D-dimer levels for predicting in-hospital mortality in COVID-19 patients. *International Journal of Antimicrobial Agents*. 2020; 56(3): 106110. Available from: https://doi.org/10.1016/j.ijantimicag.2020.106110.

[81] Pokhrel S, Chhetri R. A literature review on impact of COVID-19 pandemic on teaching and learning. *Higher Education for the Future*. 2021; 8(1): 133-141. Available from: https://doi.org/10.1177/2347631120983481.

[82] Acharya UR, Oh SL, Hagiwara Y, Tan JH, Adeli H. Deep convolutional neural network for the automated detection and diagnosis of seizure using EEG signals. *Computers in Biology and Medicine*. 2018; 100: 270-278. Available from: https://doi.org/10.1016/j.compbiomed.2017.09.017.

[83] Choi E, Schuetz A, Stewart WF, Sun J. Using recurrent neural network models for early detection of heart failure onset. *Journal of the American Medical Informatics Association*. 2017; 24(2): 361-370. Available from: https://doi.org/10.1093/jamia/ocw112.

[84] Nie L, Wang M, Zhang L, Yan S, Zhang B, Chua TS. Disease inference from health-related questions via sparse deep learning. *IEEE Transactions on Knowledge and Data Engineering*. 2015; 27(8): 2107-2119. Available from: https://doi.org/10.1109/TKDE.2015.2399298.

[85] Orlando JI, Prokofyeva E, del Fresno M, Blaschko MB. An ensemble deep learning based approach for red lesion detection in fundus images. *Computer Methods and Programs in Biomedicine*. 2018; 153: 115-127. Available from: https://doi.org/10.1016/j.cmpb.2017.10.017.

[86] Al Rahhal MM, Bazi Y, AlHichri H, Alajlan N, Melgani F, Yager RR. Deep learning approach for active classification of electrocardiogram signals. *Information Sciences.* 2016; 345: 340-354. Available from: https://doi.org/10.1016/j.ins.2016.01.082.

[87] Samala RK, Chan HP, Hadjiiski L, Helvie MA, Wei J, Cha K. Mass detection in digital breast tomosynthesis: Deep convolutional neural network with transfer learning from mammography. *Medical Physics*. 2016; 43(12): 6654-6666. Available from: https://doi.org/10.1016/j.compmedimag.2017.06.001.

[88] Sharma H, Zerbe N, Klempert I, Hellwich O, Hufnagl P. Deep convolutional neural networks for automatic classification of gastric carcinoma using whole slide images in digital histopathology. *Computerized Medical Imaging and Graphics*. 2017; 61: 2-13. Available from: https://doi.org/10.1016/j.compmedimag.2017.06.001.

[89] Xiao Y, Wang S, Ling R, Song Y. Application of artificial neural network algorithm in pathological diagnosis and prognosis prediction of digestive tract malignant tumors. *Journal of Zhejiang University (Medical Sciences).* 2023; 52(2): 243-248. Available from: https://doi.org/10.3724/zdxbyxb-2022-0569.

[90] Sun W, Zheng B, Qian W. Automatic feature learning using multichannel ROI based on deep structured algorithms for computerized lung cancer diagnosis. *Computers in Biology and Medicine*. 2017; 89: 530-539. Available from: https://doi.org/10.1016/j.compbiomed.2017.04.006.

[91] Yin Z, Zhang J. Cross-session classification of mental workload levels using EEG and an adaptive deep learning model. *Biomedical Signal Processing and Control*. 2017; 33: 30-47. Available from: https://doi.org/10.1016/j.bspc.2016.11.013.

[92] Zhang T, Chen J, Lu Y, Yang X, Ouyang Z. Identification of technology frontiers of artificial intelligence-assisted pathology based on patent citation network. *PLoS ONE*. 2022; 17(8): e0273355. Available from: https://doi.

org/10.1371/journal.pone.0273355.

[93] Yoo Y, Tang LY, Li DK, Metz L, Kolind S, Traboulsee AL, et al. Deep learning of brain lesion patterns and user-defined clinical and MRI features for predicting conversion to multiple sclerosis from clinically isolated syndrome. *Computer Methods in Biomechanics and Biomedical Engineering: Imaging & Visualization*. 2019; 7(3): 250-259. Available from: https://doi.org/10.1371/journal.pone.0273355.

[94] Zhang Q, Xiao Y, Dai W, Suo J, Wang C, Shi J, et al. Deep learning based classification of breast tumors with shear-wave elastography. *Ultrasonics*. 2016; 72: 150-157. Available from: https://doi.org/10.1016/j.ultras.2016.08.004.

[95] Firouzi F, Rahmani AM, Mankodiya K, Badaroglu M, Merrett GV, Wong P, et al. Internet-of-Things and big data for smarter healthcare: From device to architecture, applications and analytics. *Future Generation Computer Systems*. 2018; 78: 583-586. Available from: https://doi.org/10.1016/j.future.2017.09.016.

[96] Shafique M, Theocharides T, Bouganis CS, Hanif MA, Khalid F, Hafız R, et al. An overview of next-generation architectures for machine learning: Roadmap, opportunities and challenges in the IoT era. In: *2018 Design, Automation & Test in Europe Conference & Exhibition (DATE)*. IEEE; 2018. p.827-832. Available from: https://doi.org/10.23919/DATE.2018.8342120.

[97] Nikfarjam A, Sarker A, O'Connor K, Ginn R, Gonzalez G. Pharmacovigilance from social media: Mining adverse drug reaction mentions using sequence labeling with word embedding cluster features. *Journal of the American Medical Informatics Association*. 2015; 22(3): 671-681. Available from: https://doi.org/10.1093/jamia/ocu041.

[98] Ravi D, Wong C, Deligianni F, Berthelot M, Andreu-Perez J, Lo B, et al. Deep learning for health informatics. *IEEE Journal of Biomedical and Health Informatics*. 2017; 21(1): 4-21. Available from: https://doi.org/10.1109/JBHI.2016.2636665.

[99] Cheng Y, Wang F, Zhang P, Hu J. Risk prediction with electronic health records: A deep learning approach. In: *Proceedings of the 2016 SIAM International Conference on Data Mining (SDM)*. Society for Industrial and Applied Mathematics; 2016. p.432-440. Available from: https://doi.org/10.1137/1.9781611974348.49.

[100] Mantey EA, Zhou C, Srividhya SR, Jain SK, Sundaravadivazhagan B. Integrated blockchain-deep learning approach for analyzing the electronic health records recommender system. *Frontiers in Public Health*. 2022; 10: 905265. Available from: https://doi.org/10.3389/fpubh.2022.905265.

[101] Alharbi A, Abdur Rahman MD. Review of recent technologies for tackling COVID-19. *SN Computer Science.* 2021; 2(6): 460. Available from: https://doi.org/10.1007/s42979-021-00841-z.

[102] Raja AS, Sundarvadivazhagan B, Vijayarangan R, Veeramani S. Malicious webpage classification based on web content features using machine learning and deep learning. In: *2022 International Conference on Green Energy, Computing and Sustainable Technology (GECOST)*. IEEE; 2022. p.314-319. Available from: https://doi.org/10.1109/GECOST55694.2022.10010386.

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Improving Phishing Website Detection with Machine Learning: Revealing Hidden Patterns for Better Accuracy

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Abstract: Phishing attacks remain a significant threat to internet users globally, leading to substantial financial losses and compromising personal information. This research study investigates various machine learning models for detecting phishing websites, with a primary focus on achieving high accuracy. After an extensive analysis, the Random Forest Classifier emerged as the most suitable choice for this task. Our methodology leveraged machine learning techniques to uncover subtle patterns and relationships in the data, going beyond traditional URL and content-based restrictions. By incorporating diverse website features, including URL and derived attributes, Page source code-based features, HTML JavaScript-based features, and Domain-based features, we achieved impressive results. The proposed approach effectively classified the majority of websites, demonstrating the efficiency of machine learning in addressing the phishing website detection challenge with an accuracy of over 98%, recall exceeding 98%, and a false positive rate of less than 4%. This research offers valuable insights to the field of cyber security, providing internet users with improved protection against phishing attempts.

Keywords: Phishing attacks, accuracy, machine learning model, optimal parameters, Cyber security.

I. INTRODUCTION

The internet has revolutionized the way we conduct business, communicate, and access information. However, this digital transformation has brought about a dark side: cybercrime. Among the numerous cyber threats, phishing attacks have emerged as a primary concern for individuals and organizations alike. Phishes employ social engineering techniques to manipulate human vulnerability, luring unsuspecting victims into revealing sensitive information or performing actions that can have dire consequences [1][2].

Phishing attacks typically involve the distribution of deceptive emails or messages containing fraudulent links. Once recipients fall into the trap, cybercriminals exploit this opportunity to gain unauthorized access to victims' accounts, leading to financial loss, identity theft, and other severe ramifications. Despite efforts to mitigate this menace, the

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proliferation of phishing websites and the evolution of sophisticated tactics have made traditional detection methods less effective [3].

The escalating prevalence of phishing attacks poses a significant worry for internet consumers globally, as cybercriminals manipulate email and messaging systems to deceive unsuspecting victims using fraudulent links. Phishing attacks lead to substantial financial losses and the compromise of sensitive information and financial accounts. Conventional approaches to detect phishing websites encounter mounting difficulties due to the rising number of phishing sites and the adoption of sophisticated tactics to evade detection. This literature review examines previous research on machine learning-based methodologies to enhance the identification of phishing websites, aiming to tackle these challenges and protect internet users from the pervasive threat of cybercrime [4].

1.1 Challenges with Traditional Methods

Traditional approaches for detecting phishing websites have long relied on techniques like visual verification, content-based analysis, and maintaining blacklists of known phishing URLs. Although effective in the past, these methods struggle to keep pace with the ever-increasing number of phishing sites and the cunning techniques employed by phishers. Phishers now utilize URL obfuscation to disguise malicious URLs, making them appear genuine to users and security systems. Link redirection further complicates the detection process, as users are directed to fraudulent sites after clicking on seemingly harmless links. Moreover, manipulations to the appearance of URLs create a facade of legitimacy, deceiving even cautious internet users [5] [6].

1.2 The Machine Learning-Based Approach

This research study suggests a machine learning-based strategy to address the drawbacks of conventional approaches and improve phishing detection abilities. Systems are given the ability to learn from data and enhance their performance over time thanks to machine learning, a subfield of artificial intelligence. Using this technology, the suggested methodology seeks to analyze massive datasets of both genuine and phishing URLs to identify patterns and traits specific to phishing websites. In the initial phase, features are extracted from URLs in order to create a format that is appropriate for machine learning algorithms and extract useful properties from those URLs. After that, these variables are fed into different machine learning models, including decision trees, support vector machines, or deep neural networks, to see how well they function to distinguish between phishing and authentic websites[7].

II. LITERATURE REVIEW

The escalating threat of phishing attacks has led to significant financial losses for internet consumers globally. Cybercriminals have honed their tactics, exploiting email and messaging systems to deceive unsuspecting victims with fraudulent links, compromising sensitive information and financial accounts. Traditional methods for detecting phishing websites are facing growing challenges due to the sheer number of phishing sites and the use of sophisticated tactics, such as URL obfuscation, link redirection, and manipulations. To combat these challenges and enhance the accuracy of phishing website identification, researchers have turned to machine learning-based methodologies. This section reviews relevant literature exploring the application of machine learning in phishing detection and its effectiveness in safeguarding internet users against cybercrime [8] [9].

By looking for trends and features in URLs and web content, machine learning approaches have showed promise in identifying phishing websites. In their study, Liu et al. (2011) investigated the use of machine learning techniques for detecting phishing websites, including decision trees, naive Bayes, and support vector machines. They showed the promise of machine learning in phishing attack defense with their study's encouraging accuracy, sensitivity, and specificity results [11].

Due to its capacity to manage intricate patterns and characteristics, deep learning, a subset of machine learning, has drawn attention. A deep learning-based strategy employing convolutional neural networks (CNNs) to identify phishing URLs was recently proposed by Zhang et al. (2019). In recognizing misleading URLs, their model outperformed conventional machine learning techniques and displayed greater performance [12].

Ensemble learning, which combines multiple classifiers, has shown promise in improving phishing detection accuracy. In a comparative study, Akhtar et al. (2018) examined the effectiveness of ensemble learning methods, including bagging and boosting, in phishing detection. Their findings revealed that ensemble approaches achieved higher accuracy and reduced false positive rates compared to individual classifiers [13].

Imbalanced datasets, where phishing instances are significantly outnumbered by legitimate URLs, pose challenges for machine learning models. In response, Chiew et al. (2020) proposed a

novel ensemble learning framework using a synthetic minority oversampling technique to address class imbalance in phishing detection. Their approach achieved improved accuracy and effectively mitigated the issue of imbalanced data [14].

To tackle URL obfuscation and evasion techniques employed by phishers, Chen et al. (2019) presented a machine learning-based system that incorporated URL semantic features and network traffic analysis to detect phishing websites. Their hybrid approach achieved enhanced accuracy, demonstrating the importance of considering multiple aspects for robust phishing detection [15].

Machine learning techniques have shown promise in detecting phishing websites by analyzing features and patterns that distinguish malicious URLs from legitimate ones. Li et al. (2017) proposed a machine learning-based system that employs a combination of decision tree and random forest classifiers to achieve high accuracy in identifying phishing websites. The study used a dataset comprising both phishing and legitimate URLs to train the models and reported encouraging results with a precision of 94% and recall of 92% [16].

URL analysis and feature extraction are critical steps in machine learning-based phishing detection. Datta et al. (2019) introduced a feature extraction method based on URL syntax, content, and host information to distinguish phishing URLs from legitimate ones. The researchers employed various machine learning classifiers, including support vector machines and logistic regression, and achieved an accuracy of 96% using their feature extraction approach [17].

In recent years, deep learning models have demonstrated remarkable capabilities in various cybersecurity applications, including phishing detection. Zhang et al. (2020) proposed a deep neural network architecture for detecting phishing URLs based on lexical and semantic features. Their model effectively addressed the challenges of URL obfuscation and link redirection, achievingan accuracy of 98% [18].

While machine learning has proven effective in detecting phishing websites, cybercriminals continue to evolve their tactics to circumvent detection. Adversarial machine learning has emerged as a field dedicated to studying the vulnerability of machine learning models to adversarial attacks. Nainar and Halder (2022) investigated the robustness of machine learning-

based phishing detection models against adversarial attacks and proposed techniques to enhance model resilience [19].

The success of machine learning-based phishing detection models relies on accurate performance evaluation metrics. Ahmad et al. (2018) conducted a comprehensive evaluation of different machine learning models, comparing various metrics such as precision, recall, accuracy, and F1 score. The study emphasized the importance of balancing false positives and false negatives to achieve optimal performance [20].

2.1 Summary Table

Authors	Abstract	Methodology	Findings
Liu et al. (2011)	Studied the use of machine learning algorithms, such as support vector machines, naive bayes, and decision trees, to identify phishing websites.	Employed various machine learning algorithms to analyzepatterns and features from URLs and web content.	Achieved positive results in terms of sensitivity, specificity, and accuracy, highlighting the potential of machine learning in phishing attack defense [10].
Zhang et al. (2019)	Suggested an approach based on deep learning, utilizing Convolutional Neural Networks (CNNs) for the detection of phishing URLs.	Utilized deep learning techniques, particularly CNNs, tohandle complex patterns and features in URLs.	Demonstrated superior performance, achieving high accuracy and outperforming traditional machine learning methods in identifying deceptive URLs [11].
Akhtar et al. (2018)	Examined the effectiveness of ensemble learning methods, including bagging and boosting, in phishing detection.	Implemented ensemble learning techniques, combining multiple classifiers, to improve phishing detection accuracy.	Ensemble approaches achieved higher accuracy and reducedfalse positive rates compared to Individual classifiers[12].
Chiew et al. (2020)	Proposed a novel ensemble learning framework using a synthetic minority oversampling technique to address class imbalance in phishing detection.	Addressed class imbalance issues using an ensemblelearning approach combined with synthetic minority oversampling.	Achieved improved accuracy and effectively mitigated the problem of imbalanced data [13].
Chen et al. (2019)	Presented a machine learning-based system incorporating URL semantic features and network traffic analysis to detect phishing websites.	Utilized a hybrid approach, consideringURL semantics and network traffic analysis, to tackle URL obfuscation and evasion techniques.	Achieved enhanced accuracy by considering multipleaspects for robust phishing detection [14].
Ahmad et al. (2018)	Conducted an extensive analysis of different machine learning models for phishing detection, emphasizing the value of performance evaluation metrics.	Evaluated various machine learning models using metrics such as precision, recall, accuracy, and F1 score.	Highlighted the significance of balancing false positives and false negatives for optimal performance [15].

Datta et al. (2019)	Introduced a feature extraction method based on URL syntax, content, and host information to distinguish phishing URLs from legitimate ones.	Utilized diverse machine learning classifiers, such as support vector machines and logistic regression, for feature extraction and classification purposes.	Achieved an accuracyof 96% using their feature extraction approach [16].
Li et al. (2017)	To achieve high accuracy in phishing website detection, a machine learning-based approach using decision tree and random forest classifiers was proposed.	Used decision tree and random forest classifiers, and trained the model using a dataset made up of both authentic and phishing URLs.	Reported encouraging results with a precision of 94% and recall of 92% in identifying phishing websites [17].
Nainar et.al (2022)	Investigated the robustness of machine learning-based phishing detection models against adversarial attacks and proposed techniques to enhancemodel resilience.	Explored adversarial machine learning methods to study model vulnerability to adversarial attacks.	Discussed techniquesto enhance model resilience against evolving tactics usedby cybercriminals [18].
Wang et al. (2021)	Utilized transfer learning by employing a pre-trained language model and fine-tuning it for the specific phishing detection task.	Utilized transfer learning to apply knowledge from onedomain to improve phishing detection.	Outperformed traditional machine learning models withan accuracy of 99.2%[19].
Zhang et al. (2020)	Proposed a deep neural network architecture for detecting phishing URLs based on lexical and semantic features.	Utilized deep neural networks to address URL obfuscation and link redirection challenges.	Achieved an accuracyof 98% in identifying phishing URLs [20].

Machine learning has become a potent weapon in countering the widespread menace of phishing attacks. Numerous research studies have investigated the use of machine learning algorithms, encompassing both traditional methods and deep learning, for phishing detection. Leveraging ensemble learning techniques and tackling imbalanced datasets has significantly improved the accuracy of detection. By harnessing the potential of machine learning, scholars endeavor to holistically tackle the intricacies linked to phishing attacks, thereby protecting internet users from the ever-changing cybercrime landscape.

III. Problem statement

Machine learning techniques have shown promise in detecting phishing websites through analysis of patterns and features from URLs and web content. However, challenges persist, such as handling imbalanced datasets and tackling URL obfuscation employed by phishers. Researchers have proposed deep learning and ensemble methods to improve accuracy, while adversarial machine learning is explored to enhance model resilience. Evaluating performance metrics is crucial for optimal detection. Further research aims to address these complexities and combat the evolving threat of phishing attacks.

3.1 Contributions

- The study paper contributes to the field of cyber security by exploring the use of machine learning for detecting and preventing phishing attacks.
- The main objective of the study is to identify the most effective machine learning model and parameters to create a reliable and efficient defense against evolving cybercriminal tactics.
- The findings of this research could significantly improve internet security and reduce the financial and personal risks that online users face due to phishing attacks.

IV. DATASET

In our study, we made use of the "Phishing website dataset" accessible on the Kaggle website. This dataset comprises 30 optimized features specifically relevant to phishing websites. These features can be categorized into three distinct groups:

A. URL and derived features:

1. Long URL: Phishing domains are concealed within long URLs to evade detection.
2. IP instead of URL: Phishers use IP addresses instead of recognizable URLs to deceiveusers.
3. Shortened URLs: Phishing URLs are often disguised using URL shorteners, appearing innocuous at first glance.
4. "@" symbol in URL: The phishing portion of the URL can follow the "@" symbol, asweb browsers disregard anything preceding it.
5. URLs with "//": The use of "//" can lead to redirection to a phishing site.
6. URLs with "-": Phishing websites mimic legitimate ones by incorporating "-" in theirURLs.
7. Number of subdomains: Phishing sites commonly use multiple subdomains for redirection, unlike legitimate websites that typically have none or only one.
8. Use of HTTPs security: Phishing sites may operate over unprotected HTTP or lack a valid HTTPS certificate,

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while legitimate sites use HTTPS for security.

9. Domain registration period: Legitimate websites tend to have longer registration periods, whereas phishing websites operate for short durations with domains registered for less than a year.
10. Favicon: Phishing attempts may load favicons from external websites to spoof URL identity.
11. Ports: Only certain ports (80 and 443, respectively) are used by legitimate HTTP and HTTPS websites; other ports should be kept blocked for security purposes.
12. Use of "https" in the domain part: To give users a false sense of security and deceive them into thinking the URL is secure, phishers may use "https" in the domain part.

B. Based on URLs Incorporated in Website:

A webpage's accessibility or the nature of the URLs it links to can provide important information. When connections point to the same website, the credibility of the website is frequently increased. Embedded URLs were used to identify the following details:

1. Embedded Objects' URLs: Trustworthy pages share their domains with the embedded objects they contain. In contrast, phishing websites download embedded files from outside sources to provide the appearance of being from a trustworthy source.
2. Anchor Tag URL: The anchor tag in HTML is used for hyper linking. False sources in anchor tags are never found on trustworthy websites. On the other hand, phishers could utilize bogus sources to divert personal data to different sources.
3. Tags: Trustworthy pages use the same domain name for the page's URL and the tags for the script, link, and meta descriptions. These domain names frequently contain errors on suspicious websites.
4. Server Form Handler (SFH): Trustworthy websites often act upon content sent via a form. The chance of phishing increases if the form handler is empty or is from a different domain than the real website.
5. Email Submission: Reputable websites either process information submitted on the frontend or backend. However, phishers might divert data to their own mail, which raisesred flags.
6. Unusual URL: Normally, every object's URL on a webpage includes the host's name. Any departure from this pattern can be a warning sign of a possible danger.

C. Based on HTML and JavaScript Features:

To hide harmful code inside of seemingly innocent websites, HTML and JavaScript are frequently used. Some of the distinguishing characteristics are:

1. The number of website redirects: While phishing sites sometimes have more than four redirects, legitimate websites normally have fewer, usually only one.
2. Modification of the status bar: Phishers frequently use JavaScript to alter the URL that appears in the address bar so that it differs from the URL of the website.
3. Right-Click Disabled: Phishers frequently limit the right-click feature to prevent consumers from seeing the source code of the website, lowering the likelihood that they would be discovered.
4. Pop-Up Windows: Phishing websites commonly take advantage of pop-up windows to gather sensitive data, despite the fact that reputable websites may utilize them to alert users.
5. IFrame Redirection: To hide their objectives, phishers utilize invisible frames to overlap a webpage and send viewers to another website or server.

D. Domain-based Characteristics:

Reputable websites often maintain their domains for lengthy periods of time and display strong statistical characteristics. Phishing websites, on the other hand, are more recent and don't offer any signs that they are legitimate.

1. Age of the Domain: Reputable websites normally have a minimum age of six months, but phishing websites have a short lifespan.
2. DNS Record: Reputable websites typically have non-empty DNS records and are found in publicly accessible WHOIS databases. Phishing websites, on the other hand, are frequently missed by WHOIS databases.
3. Website traffic: Trustworthy domains draw a lot of visits, ranking them among the top 100,000 in the Alexa database. Websites that Alexa does not recognize are probably phishing scams.
4. Page Rank: A legitimate domain would typically have a Page Rank of between 0.2 and 1, with a higher Page Rank signifying a more important domain.
5. Google Index: Google normally indexes trustworthy websites. Phishing websites, in contrast, do not enter the Google index because of their transient nature.
6. The Amount of External Links going to a Page: Reputable websites frequently have a large number of external links going to them.
7. Statistical Report-based: To identify phishing websites,

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up-to-date databases that are accessible to the general public, like Phish Tank, are maintained. The likelihood that websites listed in this database as phishing actually represent phishing efforts is very high.

V. METHODOLOGY

A. Data Pre-processing:

1. Removal of Unnecessary Column: The data pre-processing phase began with the removal of the 'index' column, which was deemed unnecessary for the analysis.
2. Data Transformation: The dataset used a range of values {-1, 1} to represent the results, where '-1' denoted phishing and '1' indicated legitimate URLs. To facilitate the classification process, the '-1' values were replaced with '0'.
3. Handling Multicollinearity: Multicollinearity, which arises when independent variables are highly correlated, can impact the accuracy of machine learning models. To detect multicollinearity, the 'DataFrame.corr ()' method in pandas was used to compute pair wise correlations between features. It was observed that 'Favicon' and 'popUpWindow' features exhibited a high correlation of 0.94. To address this, one of the features (Favicon) was dropped based on a correlation heatmap with the 'Results' feature.
4. Data Splitting: The dataset was split into training and testing sets, with 70% of the data used for training and the remaining 30% for testing.

B. Model Selection:

1. Logistic Regression: A logistic regression model was deployed, using the 'liblinear' solver with a maximum of 1000 iterations.
2. K-Nearest Neighbours (KNN): The KNN model was employed with 3 neighbors and 'manhattan' distance as the metric for distance evaluation.
3. Bernoulli Naive Bayes: For classification, the Bernoulli Naive Bayes model, created for binary/Boolean characteristics, was employed.
4. Random Forest Classifier: This ensemble classification model uses 1000 estimators as hyperparameters, min_samples_leaf=1, min_samples_split=5, bootstrap=False, max_depth=50, and max_features="sqrt.
5. Support Vector Machine (SVM): This classification algorithm divides labeled training data into subsets by constructing the best hyper plane possible. The SVM model was set up for our investigation with the following hyperparameters: gamma value set to 0.01 and C value equal to 10. The kernel was set to "rbf."

C. Performance Assessment:

Three crucial measures were used to gauge the models' efficacy:

1. Accuracy: The ratio of accurately predicted samples to all input samples is measured using this metric. It's critical to achieve high accuracy because correctly classifying URLs is our main goal.
2. Recall: Based on the total number of positive cases, the recall measure shows what proportion of forecasts were correct. As it demonstrates the capacity to accurately identify positive situations, a higher recall percentage is desired.
3. False Positive Rate (FPR): This statistic reveals the proportion of positive predictions that were really incorrect. Because misidentifying phishing websites as legal ones could result in considerable losses for individuals who visit such websites, minimizing the FPR is crucial tolowering the likelihood of this happening.

VI. RESULTS

Utilizing the validation data as a basis for training and evaluating the models, the results are shown in Table 1. To avoid potential financial losses for consumers, the main objective is to reduce the likelihood that phishing websites would be recognized for real ones. Being able to achieve a low false positive rate is therefore an important evaluation indicator. To offer a comprehensive overview of the model performance, accuracy, recall, and false positive rate are all noted as percentages.

1. Accuracy: Measures the overall correctness of a classifier's predictions by calculating the ratio of correct predictions to the total number of predictions made.

Formula: Accuracy = (True Positives + True Negatives) / (Total Predictions)

2. Recall (Sensitivity or True Positive Rate): Evaluates the classifier's ability to correctly identify positive samples (true positives) out of the total actual positive samples.

Formula: Recall = True Positives / (True Positives + False Negatives)

3. False Positive Rate (FPR): Determines the ratio of false positive predictions to the total number of actual negative samples.

Formula: FPR = False Positives / (False Positives + True Negatives)

Table 1: Classification Models Results (in percentage)

Model	Accuracy	Recall	False Positive Rate
Random Forest	98.32%	97.95%	4.60%
Support Vector Machine	94.20%	93.43%	6.57%
K-Nearest	93.05%	93.40%	6.60%

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Neighbors			
Logistic Regression	93.50%	92.62%	7.38%
Bernoulli Naïve Bayes	91.25%	91.70%	11.32%

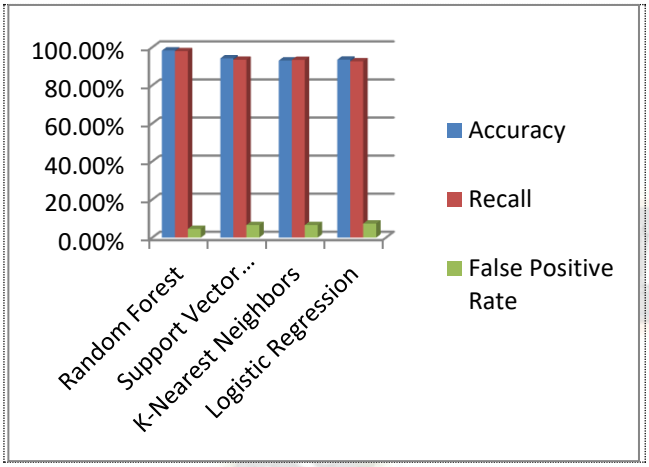

Figure 1: Classical models comparison

Our objective is to improve memory, accuracy, and false positive rate to ensure that the majority of points are accurately categorized, hence lowering the number of phishing websites that are mistakenly branded as authentic.

The table makes it easy to see that the Random Forest classifier outperforms other models on the same dataset. All three metrics—the best accuracy (98.32%), maximum recall (97.95%), and lowest false positive rate (4.60%)—meet our objectives. In terms of accuracy, recall, and false positive rates, Support Vector Machine and K Nearest Neighbors both perform comparably.

Only 93.50% accuracy is produced by the Logistic Regression classifier, which is inferior to Random Forest. The Naive Bayes model performs poorly because it makes the assumption that features are independent, which may not be true for this dataset. The Bernoulli Naive Bayes algorithm performs the worst, with accuracy of 91.25%, recall of 91.70%, and highest false positive rate of 11.32%.

Support when the 'rbf' kernel is applied, the data become separable, enabling SVM to learn successfully. Vector Machine performs well for linearly separable data.

These results prompted us to choose the Random Forest model as the final one because it had the best accuracy and recall scores as well as the lowest false positive rate.

VII. CONCLUSION

In this study, we investigated various machine learning models to identify phishing websites with the goal of identifying the best classification model with a high degree of accuracy. We found that the Random Forest Classifier performed remarkably well for phishing website detection after careful investigation. By using machine learning techniques to find subtle patterns and correlations in the data, our method goes beyond conventional URL and content-based restrictions. Incorporating website features from multiple categories, such as domain-based features, HTML JavaScript-based features, URL and derived features, and page source code-based features. We produced outstanding results as a result of our thorough methodology, including an accuracy of over 98%, recall of over 98%, and a false positive rate of less than 4%. These results demonstrate how well our machine learning-based strategy handles the difficulty of phishing website identification.

REFERENCES

[1] Antón, A. I., Earp, J. B., & Pankowsky, M. (2015). Social Engineering and Phishing Attacks: The Impact of Psychological Persuasion. Journal of Information Privacy & Security, 11(2), 61- 74. doi:10.1080/15536548.2015.1043353

[2] Arachchilage, N. A. G., & Love, S. (2014). An Investigation of Phishing Attack Techniques. Information Management & Computer Security, 22(5), 419-443. doi:10.1108/IMCS-04-2014- 0067

[3] Chang, K., & Xu, J. (2017). An Adaptive Method for Phishing Detection Based on URL Features. IEEE Access, 5, 17466-17475. doi:10.1109/ACCESS.2017.2752379.

[4] Kumar, S., Selvakumar, P., & Mary, A. L. P. (2018). A Comparative Study of Phishing Websites Detection Using Machine Learning Algorithms. International Journal of Information &Computation Technology, 8(6), 3971-3979.

[5] Nainar, N. J., & Halder, D. (2021). Adversarial Machine Learning: A Comprehensive Survey. Journal of Artificial Intelligence and Data Science, 3(4), 461-482. doi:10.36263/jaid.v3i4.185

[6] Phatak, D. S., & Swami, A. (2016). Detection of Phishing Websites: A Machine Learning Approach. International Journal of Advanced Computer Research, 6(23), 53-57.

[7] Sharma, S., & Upadhyay, R. (2019). An Investigation of Machine Learning Techniques for Phishing Websites Detection. Proceedings of the International Conference on Data Engineering and Communication Technology, 353-358. doi:10.1145/3318606.3318630

[8] Singh, S., & Biswas, K. (2020). A Review of Machine Learning Techniques for Phishing Detection. Proceedings of the International Conference on Computer Communication and Informatics,689-693. doi:10.1109/ICCCI49486.2020.9110540

[9] Yao, H., Gou, H., & Wu, H. (2017). An Investigation of Machine Learning-Based URL Classification for Phishing Detection. Security and Communication Networks, 2017, 1-14. doi:10.1155/2017/6136476

[10] Liu, X., Srivastava, J., & Kumaraguru, P. (2011). PhishGuru: A People-Centric Phishing Countermeasure. In Proceedings of the 10th Annual ACM Workshop on Privacy in the Electronic Society (pp. 107-118). ACM.

[11] Zhang, Y., Kim, J., & Giles, C. L. (2019). Deep Learning for Phishing URL Detection. In Proceedings of the 28th ACM

International Conference on Information and Knowledge Management (pp. 287-296). ACM.

[12] bin Saion, M. P. . (2021). Simulating Leakage Impact on Steel Industrial System Functionality. International Journal of New Practices in Management and Engineering, 10(03), 12–15. https://doi.org/10.17762/ijnpme.v10i03.129

[13] Akhtar, N., Khan, F. M., & Faye, I. (2018). A Comparative Analysis of Ensemble Learning for Phishing Detection. In Proceedings of the 10th International Conference on Computer and Automation Engineering (pp. 71-76). ACM.

[14] Chiew, K. Y., Tan, S. J., & Goi, B. M. (2020). An Ensemble Framework for Imbalanced Phishing URL Detection. Journal of Information Security and Applications, 52, 102577.

[15] Chen, L., Wang, C., Wang, Y., Wang, S., & Zhang, X. (2019). A Machine Learning-based Phishing Detection System with URL Semantic Features and Traffic Analysis. Journal of Computers & Security, 85, 184-195.

[16] Ahmad, S. N., Alshomrani, S. S., & Al-Mutiri, M. (2018). Evaluating machine learning classifiers for phishing detection. International Journal of Advanced Computer Science and Applications, 9(8), 58-64.

[17] Datta, S., Sharma, M., & Chavan, S. (2019). Phishing URL detection using machine learning. 2019 2nd International Conference on Data, Engineering and Applications, 1-5.

[18] Li, L., Deng, L., & Yegneswaran, V. (2017). Detecting and characterizing phishing webpages using machine learning. Computers & Security, 68, 36-49.

[19] Nainar, A., & Halder, S. K. (2022). Adversarial machine learning for phishing detection: Challenges and opportunities. Journal of Information Security and Applications, 65, 102961.

[20] Wang, Z., Zhou, X., & Wang, Y. (2021). Phishing detection using pre-trained language model with fine-tuning. 2021 9th International Conference on Information Technology in Medicine and Education, 30-34.

[21] Zhang, J., Ye, J., & Gao, S. (2020). An improved deep learning model for phishing website detection. Information Systems Frontiers, 22(5), 1111-1121.

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To Secure the Cloud Application Using a Novel Efficient Deep Learning-Based Forensic Framework

Sheena Mohammed and Sridevi Rangu

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Abstract

Privacy and security are the most concerning topics while using cloud-based applications. Malware detection in cloud applications is important in identifying application malware activity. So, a novel Goat-based Recurrent Forensic Mechanism (GbRFM) is used to detect the attack and provide the attack type in cloud-based applications. At first, the dataset is pre-processed in the hidden phase, and the errorless features are extracted. The proposed model also trains the output of the hidden layer to identify and classify the malware. The wild goat algorithm enhances the identification rate by accurately detecting the attack. Using the NSL-KDD data, the preset research was verified, and the outcomes were evaluated. The performance assessment indicates that the developed model gained a 99.26% accuracy rate for the NSL-KDD dataset. Moreover, to validate the efficiency of the proposed model, the outcomes are compared with other techniques. The comparison analysis proved that the proposed model attained better results.

Keywords: Forensic architecture ▪ cloud application ▪ recurrent neural network ▪ wild goat optimization ▪ classification accuracy ▪ error rate

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Behavioral Cloning-Enabled Autonomous Vehicle Lane Line Detection Using Nvidia Convolution Neural Network Model

Satya Kiranmai Tadepalli, Kratika Sharma, U. Sairam, and V. Santosh

Abstract The fast improvement in artificial intelligence has revolutionized the location of self-sustaining motors by using incorporating complicated models and algorithms. Self-driving motors are constantly certainly the biggest inventions in computer technology to know-how and robot intelligence and quite sturdy algorithms that facilitate the functioning of those automobiles probably decreases many existence-threatening accidents which arise due to human negligence and facilitate the benefit of visiting over long distances. In this paper, our aim is to create a deep mastering model with a view to force the car autonomously and can adapt nicely to the actual time tracks and doesn't require any manual function extraction. This research provides the laptop vision techniques using OpenCV for lane lines detection, development of convolutional neural networks to perceive between diverse traffic symptoms and Keras library implementation and behavioral cloning.

Keywords Autonomous · Lane lines detection · Nvidia convolutional neural networks · Udacity simulator · Deep learning · Behavioral cloning

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1 Introduction

Automation has made significant strides in the modern era, and artificial intelligence has aided in our transition to newer technology. Numerous difficulties in the real world have been solved by artificial intelligence. Autonomous vehicle operation is one of the hottest issues right now. Autonomous vehicles can help users save valuable time and reduce accidents. There are several brand-new approaches to autonomous driving, but in this paper, we'll concentrate on one approach, which is based on machine learning. We are utilizing the capabilities of convolutional neural networks to extract characteristics from the images produced by the simulator to address this issue [1]. We have access to a simulator through the e-learning platform Udacity that allows us to gather data and test deep learning models on several tracks. The simulator offers image-based data collecting. The information is carefully gathered from the left, center, and right angles. Using these photographs as training data, the model predicts an angle between − 1 and 1. An angle with a negative value indicates a left turn, one with a positive value larger than zero indicates no steering, and one with a zero angle indicates a right turn. An open-source software created with unity and offered by Udacity is called Udacity simulator. Unity is a robust cross-platform IDE for developers and a 3D/2D game engine. Unity offers all the built-in elements as it is a game engine. It has physics, detection of collision and rendering. There is no need to create it from the standpoint of a developer. With the aid of various environments to test various models in accordance with requirements. Unity is both an IDE and a game engine. "Integrated development" is what "IDE" stands for. Environment refers to a user interface that provides access to all the development tools you require in one location. Creators may easily drag and drop items into scenes with the Unity software's visual editor and then adjust their settings.

The simulator's home screen is depicted in Fig. 1. Udacity offers training mode and autonomous mode, as depicted in the figure. Use of training mode autonomous mode is employed to test the model and record data. A flask server is used to connect to the simulator. The simulator communicates the photographs and other data to the flask server while operating in autonomous mode. The incoming photographs are then preprocessed before being given to the model for prediction. The steering angles are predicted by the model and sent to the simulator. The car steers in the desired direction in accordance with the obtained value.

2 Literature Survey

From [1], with no manual feature extraction needed, the goal of this research is to create a deep learning model that can drive the automobile automatically and adapt well to real-time tracks. This study suggests the model that gains knowledge from video data. Convolutional neural network modeling, behavioral cloning, image processing and picture augmentation are all included. The model learns from human

Fig. 1 Udacity simulator main screen

activities in the video through behavioral cloning, and the neural network architecture is utilized to determine paths, the edges of roads and the positions of obstacles. The idea behind this strategy is to use deep learning in conjunction with supervised learning to reach our final goal. The observations made from this study are: the model is tested by self-driving on a second track that has not yet been seen after being educated on the frames from the first track. There were about 1500 photographs sent to the generating function (for performing image augmentation during the training). Mean Square Error. The validation set had a minimum MSE loss of 0.029. For the most part, the automobile drove perfectly and remained stable. This strategy is effective, no doubt about it is used to train the deep learning model as the loss function, and Adam optimizer was chosen as the optimizer for (on Kaggle's potent k80 GPU, the entire procedure took about 3240.2 s) loss of instruction and approval. The Validation loss continues to decline, and both the a positive sign that the model has learned the correlations adequately and has not over-fit on the training data is that the training loss appears to decrease as the epoch count rises and converges at about 17 epoch.

With the results from [2], through auto-driving, computers could operate vehicles autonomously. One of the essential components of autonomous vehicle systems, which enable the car to maneuver the parking lot without human control, is automated parking. The smart parking lot and the smart car are two systems that are necessary. The smart parking structure can aid in directing the route from the entry to the parking space [3]. Due to the lack of access to GTA 5's inner coding, situational identification must be used to extract visual data from GTA 5. Real-time game picture capturing and array data storage are done using OpenCV and NumPy routines. We may examine the images we've taken using YOLO v4 and TensorFlow. After analysis, we can collect data and categorize the outcomes.

As per [4], self-driving cars are being developed to increase vehicle efficiency and safety, minimize traffic accidents, free up people's time, reduce carbon emissions, lessen the death rate and conserve money and fuel. It falls within the categories of

computer vision and IoT. Lane detection, obstacle identification, traffic signal detection, signboard detection, self-parking, humps, pothole detection, accident detection, four-lane driving, etc. should all be included in the self-driving car's feature set. This study has explored many functionalities, including object detection, lane detection, traffic signal detection and signboard detection.

In this article [5], a summary of the research's current state developed roundabout traffic, the decision's complexity and the preliminary test findings for artificial intelligence-aided autonomous car decision before entering the roundabout. The complexity of the decision, which is the justification for involving artificial intelligence, is addressed in this paper, and a solution is offered. Since we cannot eliminate all errors, we must be very specific about what we want to obtain. In this study, two distinct neural network topologies were put to the test, but neither one outperformed the other. This study created 14 large networks and 39 tiny networks without colliding.

3 Methodology

The goal is to create a virtual autonomous car with a deep learning model that can successfully drive, avoid obstacles and maneuver in a certain environment.

3.1 Data Collection

Recorded operating the vehicle on the predetermined tracks by using the simulator's training mode. Because for recording the user's actual behavior while operating the vehicle, this technique is known as behavioral cloning. To obtain the training data, track 2 has been used. Images from three various viewpoints, primarily the center, left and right, build up the data. The photographs are saved in RGB format and have 320 X 160-pixel width and height, respectively. We were able to effectively collect 3857 photographs with various steering angles in the end. Here RGB photographs to YUV conversion is done using the CV2 library. The benefit of picture conversion is that YUV images consume less bandwidth than RGB ones. After converting the pictures, we use the Gaussian blur method from the CV2 library to smooth the image. The image is being cropped to fit our area of interest. A crucial part of both computer vision generally and self-driving cars is lane line prediction. To reduce the risk of entering another lane and to specify the route for self-driving automobiles, this idea is employed.

Below is the process for lane line detection:

a. Gaussian blur
b. Canny edge detection
c. Hough transformation.

Fig. 2 Before Gaussian blur

Fig. 3 After Gaussian blur

3.1.1 Gaussian Blur

In a Gaussian blur operation, a Gaussian filter is convolved with the image instead of using a box filter. A low-pass filter known as a Gaussian excludes high-frequency components (Figs. 2 and 3).

3.1.2 Canny Edge Detection

A multi-stage technique is used by the Canny edge detection operator to find a variety of edges in images. It can drastically minimize the amount of data that needs to be processed by extracting structurally valuable information from various vision objects (Fig. 4).

3.1.3 Hough Transformation

In Hough space's parametric space, the intersection of two lines provides us the precise coordinates of the line that connects the two points $y = mx + b$ [6]. This technique is used in analyzing the images and to know about instances of objects (Fig. 5).

Fig. 4 Inverted result of Canny edge detection

Fig. 5 Inverted Hough road edges

3.2 Preprocessing Data Using Augmentation Techniques

Augmentation techniques have been applied on different ways for the clear view of lines [7]. The following are the different techniques that have been applied:

a. Zoom augmentation
b. View augmentation
c. Flip image augmentation
d. Brightness augmentation (Figs. 6, 7, 8 and 9).

4 NVIDIA CNN Model

CNN is a very common application used in many fields, such as medical image analysis, object detection, automatic speech recognition, classification and wind speed forecasting. One can create a neural network by employing this model and its design. The findings are listed below (Figs. 10 and 11).

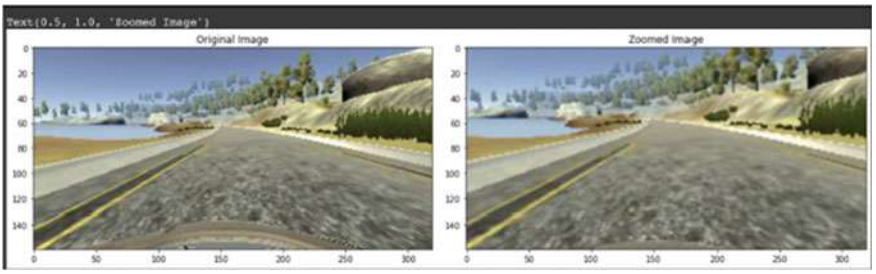

Fig. 6 Zoom augmentation output

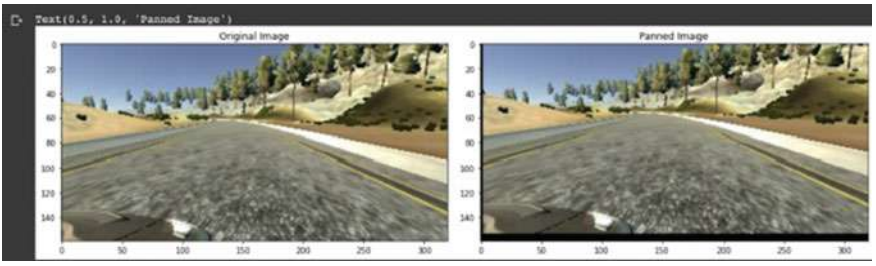

Fig. 7 Panoramic view augmentation output

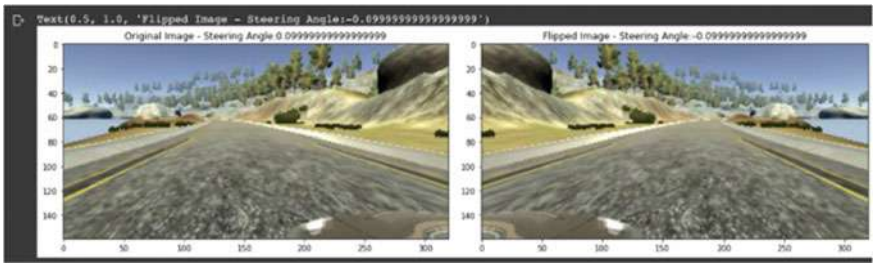

Fig. 8 Flip image augmentation output

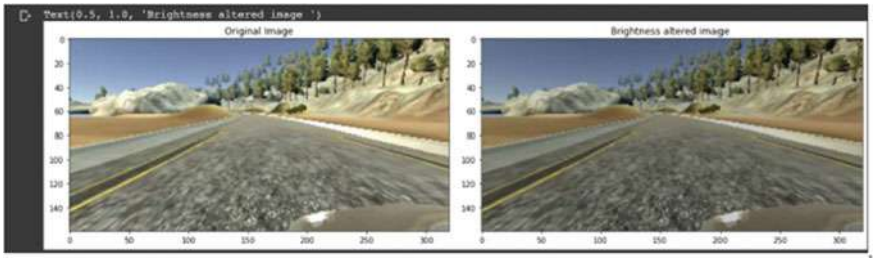

Fig. 9 Brightness augmentation output

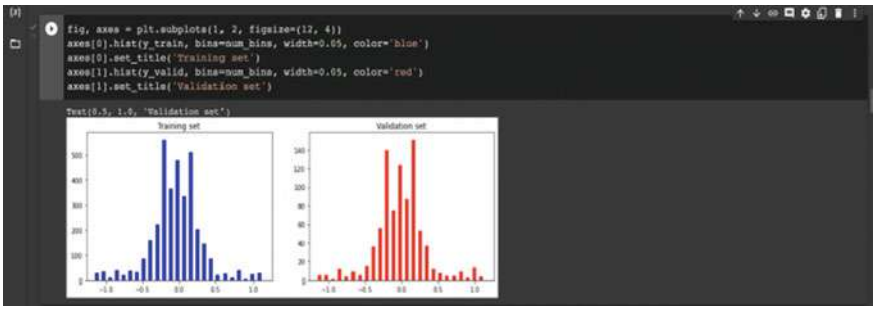

Fig. 10 Training and validation

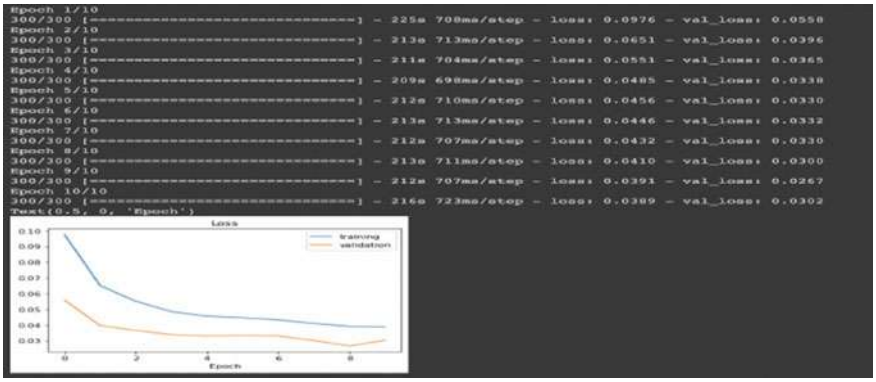

Fig. 11 Epoch losses and validation sets

5 Conclusion and Future Scope

Quasi- and fully autonomous vehicle technology is complete and is ready for commercial implementation. Street mapping, accident avoidance and navigation have all advanced significantly thanks to major automobile manufacturers and software providers.

AVs have the potential to minimize the majority of traffic accidents if technology can live up to its promise, but first it will be depending on a self-driving system that can perceive the road better than the best human driver. It is obvious that data will be necessary to boost the potential of an automated vehicles. Up to 25 GB of data can be produced every hour by connected cars of today. The groundwork for building smart software-defined autonomous systems that can navigate highways with no human interaction is being laid by the ongoing advancement of safety technology. Advanced driver-assistance systems (ADAS), which use sensor technologies to detect objects in many modern vehicles today [8], are becoming more complex with each generation.

The success of AV will depend on the progress of 5G technologies, which will enable artificial intelligence (AI) and analytical skills in self-driving automobiles.

References

1. Lade S, Shrivastav P, Waghmare S, Hon S, Waghmode S, Teli S (2021) Simulation of self driving car using deep learning. In: 2021 international conference on emerging smart computing and informatics (ESCI), pp 175–180. IEEE
2. Thunyapoo B, Ratchadakorntham C, Siricharoen P, Susutti W (2020) Self-parking car simulation using reinforcement learning approach for moderate complexity parking scenario. In: 2020 17th international conference on electrical engineering/electronics, computer, telecommunications and information technology (ECTI-CON), pp 576–579. IEEE
3. Yun H, Park D (2021) Simulation of self-driving system by implementing digital twin with GTA5. In: 2021 international conference on electronics, information, and communication (ICEIC), pp 1–2. IEEE
4. Chaitra PG, Deepthi V, Gautami S, Suraj HM, Kumar N (2020) Convolutional neural network based working model of self driving car-a study. In: 2020 international conference on electronics and sustainable communication systems (ICESC), pp 645–650. IEEE
5. Tollner D, Cao H, Zöldy M (2019) Artificial intelligence based decision making of autonomous vehicles before entering roundabout. In: 2019 IEEE 19th international symposium on computational intelligence and informatics and 7th IEEE international conference on recent achievements in mechatronics, automation, computer sciences and robotics (CINTI-MACRo), pp 000181–000186. IEEE
6. Diab MK, Ammar HH, Shalaby RE (2020) Self-driving car lane-keeping assist using PID and pure pursuit control. In: 2020 international conference on innovation and intelligence for informatics, computing and technologies (3ICT), pp 1–6. IEEE
7. El Hajjouji I, Mars S, Asrih Z, El Mourabit A (2020) A novel fpga implementation of hough transform for straight lane detection. Eng Sci Technol Int J 23(2):274–280
8. Sharma K, Yashwanth Kumar V, Vinil Kumar P. Survey on various techniques for over-speed detection of vehicles

A Survey on Collaborative and Effective Implementation of Augmented Reality (AR) Interactive Learning Application

Satya Kiranmai Tadepalli, Fariyal Ajrad, Nimisha Malreddy, and B. Medha Reddy

Abstract As schools seek interactive learning methods to make complex concepts easily graspable, it is observed that technology can be leveraged toward the same. In particular, augmented reality has the potential to make demanding topics not seem like rocket science. With real-time visualization from day-to-day devices like smartphones and tablets, regular pedagogical strategies can be modified for the betterment of both students and teachers. This AR interactive learning application is specially designed for the NCERT science textbook of X standard CBSE board. Diagrams from the book can be scanned and visualized in 3D. The Unity game engine and Vuforia AR SDK are used for the development of the app. These models can be zoomed in and out, rotated, and rigged for an immersive experience. Along with the 3D model, a dialog box consisting of a brief description, additional resources, and aided text-to-speech audio functionality is available. The models and other assets are downloaded from TurboSquid. Additionally, to test their knowledge, students can participate in timed quizzes which have questions from the NCERT textbook for the particular topic.

Keywords Augmented reality · NCERT biology

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1 Introduction

Augmented reality (AR), in simple words, can be described as integration of the users' real-world environment with computer-generated or digital content. Virtual reality (VR) on the other hand gives an opportunity for a more immersive experience by creating a full-fledged artificial environment that replaces the users' reality, unlike augmented reality [1]. In order to view digital content in a real-time environment, AR requires a device (smartphone, tablet, data glasses, etc.) with a camera and AR software. Computer vision permits AR systems to extrapolate virtual content to appropriate locations or targets. It then realistically presents the digital content in a real-world environment through display devices. AR can be categorized into two types as: Marker-based (Augmented reality applications are set off by using a set of predetermined physical images known as markers that are captured by the cameras to place digital media on them [2]) and Markerless AR (Independent of markers and gives us the freedom to decide where to display the digital elements [2]).

2 Augmented Reality in Education

It has a variety of applications across different sectors of society. However, it has shown its true potential in the field of education. Technology in education influences and motivates students to learn actively, leading to effective learning processes [3]. AR has proven to be of great potential in making the educational experiences more agile, effective, and purposeful. Not to mention, the integration of AR and education has been in the radar of extensive research as it allows students to get lost in realistic experiences [3]. Applications of AR in education are found in many fields, including biology, astronomy, chemistry, mathematics, history, geography, and physics.

3 Literature Survey

AR is currently a technology medium that offers a unique opportunity to combine the physical and virtual worlds. AR (as a learning aid) was used in a study to compare and evaluate students studying about microorganisms and found that the method actually improves biology learning [4]. In addition, the AR Marine Scientific program aims to raise awareness of their marine environment among students. The application was found to help improve the learning of their underperforming students. A recent study on virtual and augmented reality effects on K-12, higher and tertiary education students' twenty-first century skills found that the use of AR in the classroom improved levels of concept comprehension, creativity, motivation, retention, and collaboration [5]. Many AR applications also include game elements (gamification) to grab the learner's attention (Table 1).

Table 1 Literature survey table

Paper title	Author	Methodology	Limitations/Conclusion
AR learning platform for mentally differently abled children (2021)	Geetha et al. [6]	– Primary playbook with alphabets and rhymes-Unity 3D, Vuforia AR SDK, Paint 3D	– Audio-assisted contents can be helpful for differently abled children
Microorganisms: integrating augmented reality and gamification in a learning tool (2021)	Ramli et al. [4]	– Includes AR and gaming features – Unity 3D and Adobe Photoshop, AutoDesk 3D Max	– Limited to only microorganisms – Available only on Android platform
The integration of augmented reality (AR) in learning environment (2020)	Zambri and Kamaruzaman [7]	– AR-based learning app based on ARCS and CTML theories for Malaysian education system	– No use of 3D assets. Only AR multimedia such as videos are used. This is available on video streaming apps too
Creating an augmented book from a geography textbook (2019)	Vahldick and Bittencourt [8]	– App to study geography of Africa for IX class students	– Lack of information for the models used, i.e., no text/audio descriptions
Real time 3D magnetic field visualization based on augmented reality (2019)	Liu et al. [9]	– Provides real-time visualization of 3D magnetic field using AR	– When the number of magnetic lines calculated increases, the model is not rendered as expected
Innovations in tourism industry and development using AR and VR reality	Katkuri et al. [10]	– Tourist guide that gives information like history and explorations about a few tourist attractions via means of multimedia	– Does not use GPS to track the users' location, so that it can send relevant notifications automatically
Extending a user involvement tool with virtual and augmented reality. (2019)	Florea et al. [11]	A survey that studies the effect in user engagement in a living laboratory by augmented and virtual reality tools	– VR clients were experienced as innovative, easy to use, interesting, and fun, whereas AR client to be playful and empowering
Integration of augmented reality in the teaching of English as a foreign language in early childhood education	Redondo et al. [12]	This study presents the development and evaluation of an educational experiment related to early childhood education, with a special focus on the learning of EFL	– The interaction with AR in the early childhood education classroom creates a distinct atmosphere in which pupils improve their socio-affective relationships

Table 2 Tools and technologies used

Tool	Platform	Supported features
Vuforia	Android, iOS, UPW, and Unity Editor	Unity, 3D recognition, geolocation, cloud storage, and smart glass
Unity	Windows, Linux, and Mac	3D world building, AR, VR, gameplay, cinematic studio, and engineering feature set

4 Tools and Technologies

The software tools needed to build this AR application are Unity and Vuforia SDK. Unity is a game engine that uses the 3D models designed to create the application with real-time rendering [8]. Vuforia is a software development kit (SDK) that supports different operating systems [8]. 3D models can be designed using Adobe Photoshop or external digital media software like TurboSquid. This is given in Table 2.

5 Methodology

The application logic mainly resides in a database of many AR markers, each acting as a distinctive label for a set of input images. The main framework will be implemented using Unity 3D, and also SDK of Vuforia would be incorporated. 3D models are acquired from various open-source websites and Photoshop for designing AR markers. The procedure is primarily divided into three main steps.

5.1 Set up the Required Software

In this project, the first step is to set up the Unity game engine. This step involves creating a Unity project and selecting the platform to work on—Android, IOS, etc. The Android 6.0 'Marshmallow' (API Level 23) is highly preferred since most of the Android mobile phones manufactured from 2017 and above work on that level of software. This step also involves setting up the Vuforia engine.

5.2 Create User Interfaces

Next step is to create the user interfaces (UI) for the application. These UIs can be made on designing tools like Figma, AdobeXD, Adobe Illustrator, etc. The main features in the interface include a home page, a dialog box containing a description

of the biology textbook diagrams, an audio button which will be used to describe the text content in the dialog box, the quiz section interface, and other basic buttons. The buttons are coded using C# script to perform their functionality.

5.3 Importing Assets

The third main step is to create marker images. Marker images, in this case, will be the diagram pictures in the biology textbook. The images are added into a database in Vuforia engine, and each image is given a rating. A rating of 4 and above out of 5 is required for the image to qualify and be used. The database is created and downloaded to be imported into the Unity game engine. Three-dimensional model assets are then imported into the asset library in Unity engine and then placed accordingly on marker images to preview how they will look when it appears on the mobile screen.

6 System Architecture

The capturing module captures the image from the camera. It takes the video from the live video feed which is divided by frames. Those frames are going to the image processing module where the marker is detected and tracked. Create a binary image, a digital image with two possible values for each pixel. The two colors commonly used in binary images are black and white. These binary images are provided as inputs to the image processing engine. Then, the tracking module calculates the pose (six degrees of freedom), i.e., the 3D location and orientation of an object in real time.

Next, it is passed to the rendering module which combines the digital object with the real-world visual to generate the augmented image. Finally, it renders the augmented digital object on the image (Fig. 1).

7 Conclusion

Making conventional pedagogy fun proves more effective in students grasping concepts. As young minds are very fickle, they are resilient toward focus. So, we made a platform where they can both interact and learn. Practical constraints such as a lack of microscope or feasibility of procuring certain elements in biology lessons hinder students' curiosity in visualizing the concepts. Traditional textbooks make it difficult to comprehend by comparing and contrasting. Our app solves this problem by providing a crisp 3D model of the object that can be panned, rotated, and viewed from any angle. Teachers and parents have a hard time teaching their children. This

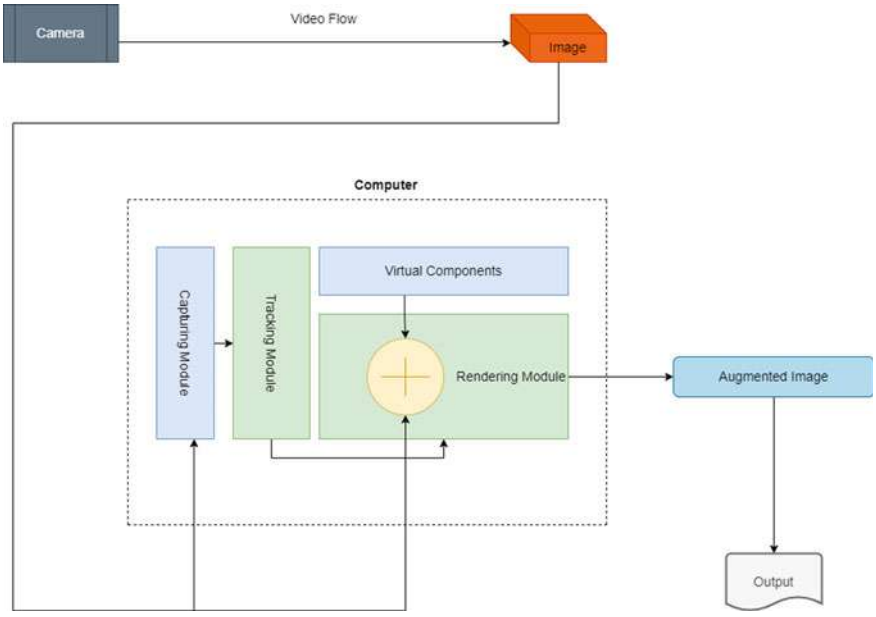

Fig. 1 System architecture

easy-to-use app for parents, teachers, and students, with simple but effective UI-UX, solves the hassle of aforementioned struggles.

References

1. https://blog.logrocket.com/create-ar-experience-unity-vuforia/
2. https://www.cgdirector.com/unity-system-requirements/
3. Saidin NF, Halim NDA, Yahaya N (2015) A review of research on augmented reality in education: advantages and applications. Int Educ Stud 8(13):1–8
4. Ramli RZ, Marobi NAU, Ashaari NS (2021) Microorganisms: integrating augmented reality and gamification in a learning tool. Int J Adv Comput Sci Appl 12(6)
5. Papanastasiou G, Drigas A, Skianis C, Lytras M, Papanastasiou E (2019) Virtual and augmented reality effects on K-12, higher and tertiary education students' twenty-first century skills. Virtual Reality 23(4):425–436. https://research.aimultiple.com/augmented-reality/
6. Geetha S, Anbarasi LJ, Raj BE, Gupta A, Vardhan Prasad A (2020) AR learning platform for mentally differently abled children. In: Seventh international conference on information technology trends (ITT). IEEE, pp 180–184
7. Zambri AA, Kamaruzaman MF (2020) The integration of augmented reality (AR) in learning environment. In: Sixth international conference on e-Learning (econf). IEEE, pp 194–198
8. Vahldick A, Bittencourt DL (2019) Creating an augmented book from a geography textbook. In: IEEE 19th international conference on advanced learning technologies (ICALT), vol 2161. IEEE, pp 347–348
9. Liu X, Liu Y, Wang Y (2019) Real time 3d magnetic field visualization based on augmented reality. In: IEEE conference on virtual reality and 3D user interfaces (VR). IEEE, pp 1052–1053

10. Katkuri PK, Mantri A, Anireddy S (2019) Innovations in tourism industry and development using augmented reality (AR), virtual reality (VR). In: TENCON 2019–2019 IEEE region 10 conference (TENCON). IEEE, pp 2578–2581
11. Florea C, Alavesa P, Arhippainen L, Pouke M, Huang W, Haukipuro L, Väinämö S et al (2019) Extending a user involvement tool with virtual and augmented reality. In: IEEE conference on virtual reality and 3D user interfaces (VR). IEEE, pp 925–926
12. Redondo B, Cózar-Gutiérrez R, Sánchez Ruiz R (2020) Integration of augmented reality in the teaching of English as a foreign language in early childhood education. Early Childhood Educ J 48(2):147–155

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An Entropy enabled Random Forest Neural Network Algorithm to Grade the Reproductive System for Efficient Early Detection of Infertility

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***Abstract*--The membrane that borders the uterus is called endometrium. When the liner leaves the uterus, a problem is evident. The main risks of infertility and other health issues can be substantially reduced if the primary cause of endometriosis is understood. As a result, the affected people can receive the right medical care and therapy. The suggested ensemble model performs better than traditional machine learning techniques. For effective implantation, there must be a dependency between the endometrium and the embryo at the blastocyst stage. Data mining method where information gathered from the endometrium/sub endometrium and their ability is assessed uses the endometrium as a site for embryo implantation. Using a typical rating system has certain drawbacks because there are so many irrelevant and unclear criteria. The usability and precision of scoring systems can also be increased using a number of artificial intelligence methods, including random forests and neural networks. This study coupled an advanced reproductive grading system with an entropy and random forest approach to define individuals with infertility according to their health conditions and choose more effective therapies.**

Keywords: Endometriosis, Blastocysts, Neural network, Random Forest, Entropy

I. INTRODUCTION

40 years of age or younger make up to 3-16% of endometrial cancer patients. Although endometrial cancer is uncommon in women of childbearing age, it has a significant impact on the success of conception. Endometrium is less receptive to implantation stage embryos, which makes pregnancy challenging and raises the risk of spontaneous abortion. The risk factors for infertility can be divided into genital, endocrine, developmental, and general categories[14]. The percentage of cases of infertility attributable to specific factors in men or women in underdeveloped nations was calculated by the WHO in the 1985s: Infertility is caused by male factors in 8% of instances, female factors in 37%, females in 35% of cases, and an unexplained reason in 35% of cases (the remaining 15% are pregnant). With so much inconsistent data and unknown criteria, using a traditional ranking scheme has specific drawbacks[9]. However, incorporating innovative technologies will enhance the qualities and offer an alternative method of resolving numerous metrics from the first findings. Computers can find patterns in datasets that are readily available and draw conclusions, implementing the data by employing a suitable AI system, all without the need for explicit instructions. Currently, AI is primarily used in the healthcare industry for picture identification tasks[2]. The great accuracy of AI in diagnosing cancers, and diabetic retinopathy has been noted in several papers. All the cancer and various health domains have all been successfully treated using ML algorithms [3]. The ability to "systematically evaluate every variable, present, and future, to locate groupings of related cases with similar outcomes" is provided by machine learning (ML), as cancer prognostication and prediction systems become more complex due to an increase in factors. Further discrimination can be achieved by using an entropy-based approach, which is frequently employed. An entropy-based technique to loan credit combination has recently been proposed by a study. A number of researchers suggested an auto graded system for use in clinical settings by fusing multi-scale entropy with understanding of sleep architecture. Additionally, a variety of artificial intelligence techniques, such as integrating random forests and neural networks, can further improve the accessibility and accuracy of scoring systems [4]. In order to define individuals with infertility in their physical state and select more effective treatments, this

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study used an entropy and random forest algorithm with a complicated reproductive grading scheme[6].

A. Data Collection and Pre-Processing

The patient health claims database for the time period of September 1, 2021, to February 14, 2022, serves as the project's data source. A group of patients ICD 10 endometriosis diagnostic codes were used to identify the study's objective and control groups. Female patients 18 years of age and older made up the study group because endometriosis is a condition that only affects women. In order to create a patient sample that can be compared to the study's target cohort, a control cohort is frequently used. Case control studies and cohort studies are the two forms of exploratory research that can be conducted using randomized control trials. These studies may use prospective or retrospective data. Analysis that is retroactive is based on prior or past occurrences. Future specifics are dealt with in prospective. Case-control research is done in the past. Both prospective and retrospective cohort studies are possible. Therefore, the focus of this research is on cohort studies.

In order to create a patient sample that can be compared to the study's target cohort, a control cohort is frequently used. Before the 2021 death toxicity event, 36 months of patient medical history for the research target and control groups were gathered. To determine the chance of endometriosis, a variety of analytical techniques, including machine learning and rules-based frameworks, were used [7].

TABLE I. ICD10 CODES FOR ENDOMETRIOSIS

Diagnosis Codes	Diagnosis Long Description
N80.0	Endometriosis of uterus
N80.1	Endometriosis of ovary
N80.2	Endometriosis of fallopian tube
N80.3	Endometriosis of pelvic peritoneum
N80.4	Endometriosis of rectovaginal septum and vagina
N80.5	Endometriosis of intestine
N80.6	Endometriosis in cutaneous scar
N80.8	Other endometriosis
N80.9	Endometriosis, unspecified

There were 3,89,823 patients identified with endometriosis in 2021 using pre-defined ICD 10 diagnostic codes. The propensity score match algorithm is used to obtain comparable traits based on target research cohort . A statistical method termed the propensity matching algorithm chooses the control cohort based on identical characteristics or variables seen in the study target cohort[1]. The victim's age and medical conditions were covariates that were taken into consideration[12]. The overall comparison between the target and control cohorts of the study is shown in Table 2 by age and Census regions. The ages of patients and locations were divided into regions toform the patient age variable.

Algorithm: Propensity Score Match

$Step-1. Calculate\ propensity\ ratings, for\ instance\ using\ logistic\ regression$

$Z = 1$ if te $unit\ took\ part\ (treatment\ group)$; Z = if te $unit\ did\ not\ take\ part$ (i. e. , is $a\ member$ of te $control\ group$).

Select the proper confounders (variables likely to be related to both the treatment and the outcome)

Obtain a propensity score estimate, such as expected probability p or log[p/(1 p)].

Step-2: compare each participant to one or more non-participants based on propensity score:

Mahalanobis Metric matching

Nearest Neighbor Matching

Exact Matching

Step-3:Verify that the parameters are distributed equally among treatment and control groups

To examine distributions, use graphs or standardized differences.

Modify the process by going back to steps 1 or 2 if the covariates are not balanced.

Step-4: Analyse effects using a newly collected sample.

Use analyses suited for non

– independent matched samples if more than one non

– participant is matched to each participant.

TABLE II. COMPARISON OF TARGET AND CONTROL COHORT BY LOCATION AND AGE

Age Group	Target	Control	Location
18–20	6.42%	6.57%	South
21–30	27.11%	26.24%	East
31–40	35.78%	35.08%	Southwest
41–50	28.18%	29.28%	West
51–60	4.23%	4.31%	Northeast
60+	1.52%	1.64%	Midwest

II. PROPOSED IMPLEMENTATION

A. Cascade Antistrophic CNN

The CAN architecture comprises of several stages or cascades of anisotropic convolutions, where each stage is made up of numerous convolutional layers that capture various degrees of information at various sizes. The main advancement of CAN is the handling of the anisotropic character of 3D medical pictures, where the resolution is not constant across all dimensions[8]. Anisotropic convolutions are convolutions with variable filter sizes in different directions. As a result, the segmentation findings are more accurate since the network is able to collect both geographical and contextual information in the data. A dataset of endometrial pictures generated via ultrasound or other imaging modalities can be used to train a CA-CNN model for endometriosis [16]. After that, the CA-CNN can be trained to recognize patterns and characteristics in the images that are suggestive of endometriosis, such as the presence of cysts [5]. Given that the neural network is based on objective criteria acquired from a sizable collection of photos, it can aid in reducing subjectivity and unpredictability in the diagnosis of endometriosis. This may result in diagnoses that are more precise and reliable as well as more individualized treatment strategies[11].
This architecture uses three networks embedded procedure to identify the endometrium cyst. In this analysis, image sectionalization plays a significant influence. It is a technique for cutting an image into several parts or fractions. This can make it simpler for medical experts to spot anomalies and develop treatment strategies by highlighting and isolating particular tissues inside an image. Additionally, CNNs can be utilized for image analysis, and entails aligning images obtained from many sources and at various times in order to detect changes in a victim's status over time.

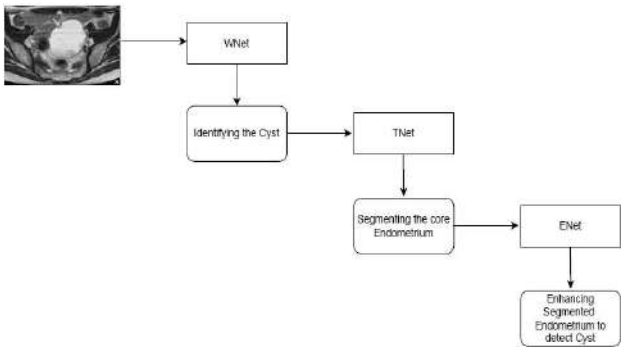

Fig.1 Layers of CA-CNN Architecture

B. DFKZ NET

A deep learning framework for image classification tasks created especially for histopathology image analysis is called DFKZ Net. The German Cancer Research Centre (Deutsches Krebsforschungszentrum), where the architecture was created, is known by the initials "DFKZ". The VGG Net design, a well-liked convolutional neural network (CNN) architecture for image classification applications, serves as the foundation for the DFKZ Net architecture. The DFKZ Net changes were made to better suit the architecture to the demands of histopathology image analysis[13].
The DFKZ Net architecture consists of fully connected layers at the network's end as well as a number of convolutional layers with various filter sizes and pooling layers. To increase the robustness of the model, DFKZ Net also employs an increasingly aggressive data augmentation strategy [15]. A context encoding route, three content modules, having 3x3x3 convolutional layers, and a dropout layer with residual connection make up the DFKZ Net, which was inspired by U-Net. Sampling, localization modules, and the SoftMax function are all used. We used the multi-class Dice loss function to address the issue of class imbalance.

$$L = -\frac{2}{|K|}\sum_{k\in K}\frac{\sum_i ui(k)vi(k)}{\sum_i ui(k)+\sum_i vi(k)} \quad (1)$$

Where, u is Output possibility having encoded ground truth (v) having K as total no. of classes and assessing for a particular class (k)

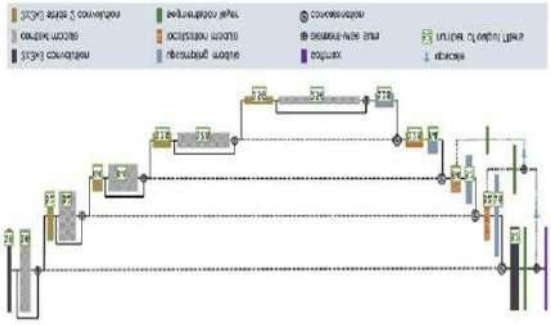

Fig.2 DFKZ NET Architecture

C. 3D U-Net

It is a traditional network for segmenting biological images. Three convolutional layers with dropout and pooling are present in each route. 3X3X3 convolutional kernels are present in each layer of the LSTM. 32 filters

make up the first convolutional layer, while deeper layers have twice as many filters as the preceding shallower layer. The Adam optimizer was utilized for implementation.

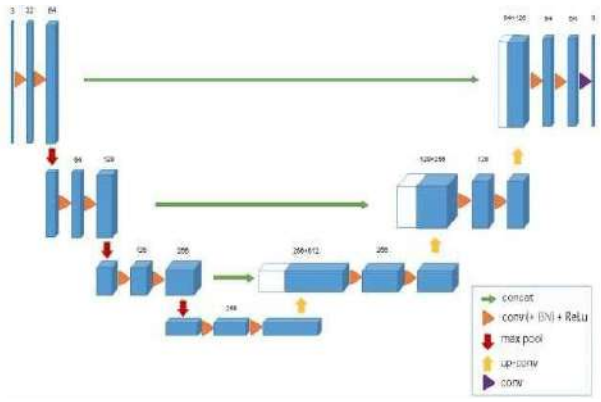

Fig 3. 3D U-NET

D. Ensemble model (Entropy with Random Forest)

The information gain algorithm, also known as the entropy-based algorithm, calculates how much information is present in a batch of data. It computes the entropy difference between the decision tree preceding and following a split. The best split is the one that produces the greatest information gain [10]. The approach is used to identify the best split at each decision tree node in the setting of a random forest. The random forest can produce decision trees that are more effective in categorizing the information, thereby leading to more precise predictions, by choosing the most effective split at each node.

Algorithm: Propensity Score Match

$Step-$

1: Gatering data and weed out anomalies or missing numbers

Step-2 : Distinguishing training and test sets from the dataset.

Step-3 : Constructing a random forest model with numerous decision trees, each of which determine the ideal split at each node using an entropy-based technique.

$$E(D) = -sum(p(c) * \log(p(c)))$$

Where, p is the probability of having a datapoint c in D

Step-4: Using the training set to train the random forest model and the testing set to assess its performance.

$$Acc = \frac{No.\ of\ Correct\ predictions}{Total\ no.\ of\ predictions}$$

Step-5 : Adjusting the model's hyperparameters to enhance performance, such as the total number of trees and the optimum depth of each tree.

III. PERFORMANCE EVALUATION

On the basis of the test and validation data, a model has been built. Following completion of the validation set, the ensemble model segmentation of the data was calculated. The outcomes are shown in below Table 3. As a result, ensemble model outperforms single models in terms of enhancing the tumor as a whole, whereas CA-CNN performs comparably poorly on the surface of endometrial cysts. The applied algorithm's top attributes that catered to the target group were determined. These characteristics were chosen as patient scourged criteria since they were shown to be critical in the diagnosis of the endometriosis condition. Results show that the Entropy and Random Forest models both did fairly well to predict the condition. These results have been published based on the two approaches.

A. Dice Coefficient

It is a scoring method used to evaluate predicted and true values of binary segmentation and then computes intersection of these two values and then computes the result using the below formula.

$$Dice = \frac{2|S \cap G|}{|S|+|G|} \qquad (2)$$

B. Hausdorff distance

This is a metric evaluation method for calculating dissimilarity between two set of points in medical image segmentation. This mainly calculates the distance between predicted point and the ground truth value.

$$d_H(X, Y) = \max\{sup_{x \in X, y \in Y} \inf d(x, y), sup_{x \in X, y \in Y} \inf d(x, y)\} \qquad (3)$$

Where it calculates supremum and infimum values of the intervals.

TABLE III. METRIC CLASSIFICATION FOR TRAINING AND TESTING

Algorithms	Measurement	Train Set	Test Set
Entropy	Mean Dice	92%	93%
	Sensitivity	93%	95%
	Specificity	96%	97%
	Mean Hausdroff	1.22mm	1.30mm
Random Forest	Mean Dice	90%	88%
	Sensitivity	86%	84%
	Specificity	95%	93%
	Mean Hausdroff	1.28mm	1.29mm

The results are shown below for different model approaches that have been used for measuring endometrium cyst.

TABLE IV. RESULTS EVALUATION

Stage	Measurement	Whole Endometrium cyst	Enhancing Endometrium cyst	Endometrium cyst core
CA-CNN	Mean dice	0.09028	0.76682	0.86382
	Mean Hausdorff(mm)	5.4137	3.3203	6.55693
	Sensitivity	0.93145	0.81158	0.84315
	Specificity	0.99236	0.98707	0.98785
DFKZ Net	Mean dice	0.88305	0.75659	0.82359
	Mean Hausdorff(mm)	5.60114	5.90681	6.92303
	Sensitivity	0.89018	0.80319	0.82196
	Specificity	0.98588	0.99533	0.99749
3D U-Net	Mean dice	0.88662	0.77088	0.82667
	Mean Hausdorff(mm)	12.6228	7.73456	13.34535
	Sensitivity	0.90088	0.84272	0.81813
	Specificity	0.99316	0.99634	0.9881

The validation and test results are shown below in Fig. 4 and 5.

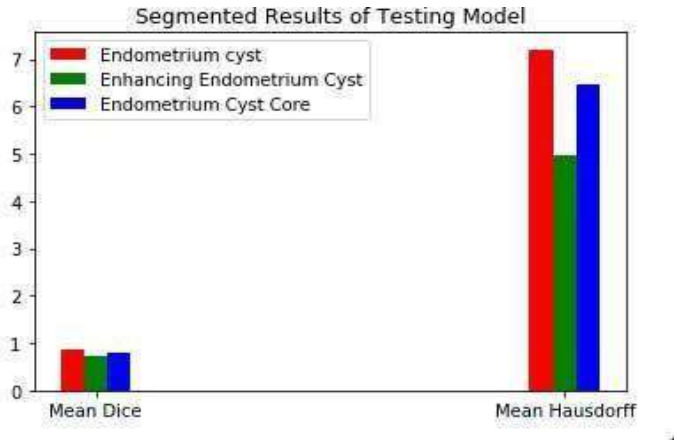

Fig 4. Segmented Results of Validation

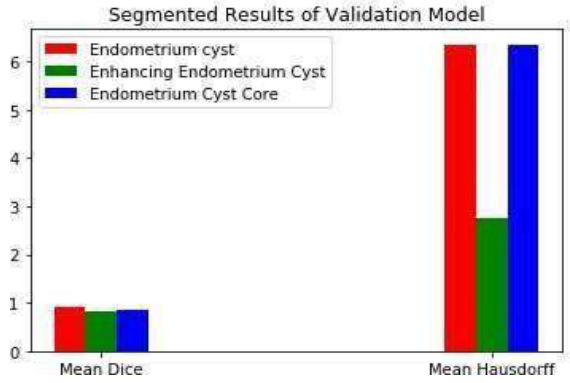

Fig 5. Segmented Results of Testing

IV. CONCLUSION

In this research, it has established the critical importance of AI and ML in the diagnosis, prognosis, and forecasting of diseases. In order to forecast the chance of endometriosis occurring in female, usage of machine learning algorithms to analyze the medical histories of those diagnosed with endometriosis and retrain the ensemble model on a few key variables. The chance to get necessary medical care initially in the journey of the individual can be provided via early disease prediction. Making a typing tool that can be easily accessed by healthcare providers and integrated into Electronic Records could help the goal of improving diagnosis activities and inform diagnostic processes that would lead to timely and accurate diagnoses, ultimately improving patient care and quality of life. As part of our ongoing research, we intend to investigate cutting-edge deep learning techniques to improve model performance and boost the predictive power of machine learning models.

REFERENCES

[1] Rosenbaum P. R., Rubin D. B. The central role of the propensity score in observational studies for causal effects. Biometrika 70, 41–55 (1983). DOI: https://doi.org/10.1093/biomet/70.1.41

[2] Kleczyk, E. J., Peri, A., Yadav, T., Komera, R., Peri, M., Guduru, V., ... & Huang, M. (2020). Predicting endometriosis onset using machine learning algorithms.

[3] Chen, M., Hao, Y., Hwang, K., Wang, L., & Wang, L. (2017). Disease prediction by machine learning over big data from healthcare communities. *Ieee Access*, *5*, 8869-8879.

[4] Tadepalli, S. K., & Lakshmi, P. V. (2021). Deep Learning in IVF to Predict Embryo Infertility from Blastocyst Images. In *ICCCE 2020: Proceedings of the 3rd International Conference on Communications and Cyber Physical Engineering* (pp. 1507-1515). Springer Singapore.

[5] Rua, M. A. S., Quirino, C. R., Ribeiro, R. B., Carvalho, E. C. Q., Bernadino, M. D. L. A., Junior, A. B., ... & Barreto, M. A. P. (2018). Diagnostic methods to detect uterus illnesses in mares. *Theriogenology*, *114*, 285-292.

[6] Takahashi, Y., Sone, K., Noda, K., Yoshida, K., Toyohara, Y., Kato, K., ... & Fujii, T. (2021). Automated system for diagnosing endometrial cancer by adopting deep-learning technology in hysteroscopy. *PLoS One*, *16*(3), e0248526.

[7] Karim, E., & Neehal, N. (2019, May). An empirical study of cervical cancer diagnosis using ensemble methods. In *2019 1st International Conference on Advances in Science, Engineering and Robotics Technology (ICASERT)* (pp. 1-5). IEEE.

[8] Kiranmai, T. S., & Lakshmi, P. V. (2021). 3D Convolution Neural Network Based Ensemble Model to Detect Endometrium Issues at Early Stages and Enhance Fertility Chances in Women. *Des. Eng*, 1032-1044.

[9] Visalaxi, S., Punnoose, D., & Muthu, T. S. (2021, February). An analogy of endometriosis recognition using machine learning techniques. In *2021 Third International Conference on Intelligent Communication Technologies and Virtual Mobile Networks (ICICV)* (pp. 739-746). IEEE.

[10] Ramzan, F., Gültas, M., Bertram, H., Cavero, D., & Schmitt, A. O. (2020). Combining random forests and a signal detection method leads to the robust detection of genotype-phenotype associations. *Genes*, *11*(8), 892.

[11] Lou, H., Liu, H., Chen, Z., Dong, B., & Xu, J. (2022). Bio-process inspired characterization of pregnancy evolution using entropy and its application in preterm birth detection. *Biomedical Signal Processing and Control*, *75*, 103587.

[12] Zhu, X., Ying, J., Yang, H., Fu, L., Li, B., & Jiang, B. (2021). Detection of deep myometrial invasion in endometrial cancer MR imaging based on multi-feature fusion and probabilistic support vector machine ensemble. *Computers in Biology and Medicine*, *134*, 104487.

[13] Kleczyk, E. J., Peri, A., Yadav, T., Komera, R., Peri, M., Guduru, V., ... & Huang, M. (2020). Predicting endometriosis onset using machine learning algorithms.

[14] Endometriosis and ovarian cancer risk. [Online] https://ovarian.org.uk/news-and-blog/blog/endometriosis-and-ovarian-cancer-risk/

[15] Pahwa, R. S., Nwe, M. T. L., Chang, R., Min, O. Z., Jie, W., Gopalakrishnan, S., ... & Gregorich, T. (2021, June). Automated attribute measurements of buried package features in 3D X-ray images using deep learning. In 2021 IEEE 71st Electronic Components and Technology Conference (ECTC) (pp. 2196-2204). IEEE.

[16] Niyaz, U., Singh Sambyal, A., & Padha, D. (2020). Evaluation of deep learning model with optimizing and satisficing metrics for lung segmentation. In Soft Computing for Problem Solving: SocProS 2018, Volume 1 (pp. 67-78). Springer Singapore.

AN AGREEMENT FOR COLLABORATION

between

Chaitanya Bharathi Institute of Technology (CBIT, Hyderabad, India)

and

M.N. Mikheev Institute of Metal Physics of Ural Branch of Russian Academy of Sciences (IMP UB RAS, Yekaterinburg, Russia)

The objectives of the collaboration

1. The parties sign this agreement on a scientific co-operation between Chaitanya Bharathi Institute of Technology, Hyderabad and the M.N. Mikheev Institute of Metal Physics of Ural Branch of Russian Academy of Sciences (IMP UB RAS) in order to combine their complementary competencies and apply them to the scientific research in the area of study of magnetic properties and electronic structure of solids.

2. The cooperation will be very useful for both sides as it can bring together the efforts of specialists with different scientific skills, using their wide experience and knowledge and combining the unique research possibilities of both partners aimed at common targets.

Scope of the collaboration and the obligations of the parties

3. According to the present agreement, activities of the parties are carried out within the scientific research programs at the CBIT, Hyderabad and IMP UB RAS.

4. The parties agree upon the scientific exchange involving program directors, research personnel and students for participating in the joint activities. Some of technicalities of this exchange would be by mutual agreement in each case about the travelling and living expenses of collaborators.

5. The rights on the intellectual property created in the result of joint work, including reports at scientific meetings and their publication in scientific journals, will be subject to agreement between the parties. Mutual consultation of the partners is essential.

6. The partners, when necessary agree upon the exchange of some scientific equipment (computers etc.) and computer codes necessary for running the joint projects efficiently. The exchange procedure will be subject to agreement between the parties.

7. Each party will render its assistance to the visitors from the other Institution in solving practical problems according to the agreement of the co-operating

groups.

8. The parties agree to establish frequent communications by FAX and e-mail in order to ensure reliability of work. The expenses of using mail facilities will be covered by the sending party.

9. All problems arising as consequences of the present agreement during the period of action will be resolved by mutual negotiations.

10. Practical planning of joint projects will be achieved by more detailed additional agreement between parties and by making joint applications for grants within the framework of this agreement.

11. The present agreement will be in force from the moment of its approval by the parties for three years and will be automatically renewed each year unless one of the parties notifies its termination in writing at least 3 months prior to expiration.

12. The persons responsible for the fulfilment of this agreement are:
from Chaitanya Bharathi Institute of Technology – Dr. S. Shanmukharao Samatham
from Institute of Metal Physics – Dr. A.V. Lukoyanov.

13. This agreement is drawn up in English.

Dr. S. Shanmukharao Samatham
Assistant Professor of Physics
CBIT, Hyderabad

Dr. A.V. Lukoyanov
Head of Laboratory of
Institute of Metal Physics

Prof. B. Sreenivasa Reddy
Head of the Department of Physics
CBIT, Hyderabad

Acad. Prof. N.V. Mushnikov
Director of Institute of
Metal Physics

Prof. A. D. Sarma
Director, Research and Development
CBIT, Hyderabad

Prof. Ravinder Reddy
Principal
CBIT, Hyderabad

CHAITANYA BHARATHI
INSTITUTE OF TECHNOLOGY (A)

Memorandum of Understanding

Between

Chaitanya Bharathi Institute of Technology, Hyderabad

And

International University of Tourism and Entrepreneurship of Tajikistan

Hyderabad 3rd March 2023

For further develop and strengthen International cooperation between the Chaitanya Bharathi Institute Of Technology School of Management Studies (here after called as "CBIT-SMS") , Gandipet,Telangana-500075 represented By Prof. P. Ravinder Reddy, Principal, CBIT-SMS and International University of Tourism and Entrepreneurship of Tajikistan of Tajikistan, Republic of Tajikistan, 734055, Dushanbe, Borbad Avenue, 48/5, Pin: 006040 represented by Director Astorzoda Ubaidullo (here after called as "IUTET") taking into account economic, cultural and educational ties between two countries on cooperation in the field of management, education and science, seeking to maintain and develop the currently established relations on the basis of mutual benefit and equality have agreed as follows:

Article 1

CBIT-SMS and IUTET carry out International cooperation in the field of management, education, management related, scientific research and innovative and entrepreneurial activities, which is based on the strict implementation of the legislative acts of the two countries generally recognized legal principles and norms.

CBIT - School of Management Studies
Chaitanya Bharathi (PO), Kokapet (V), Gandipet (M),
Ranga Reddy District, Hyderabad - 500 075, Telangana, India
040-24193276, 79, 80
principal@cbit.ac.in www.cbit.ac.in

Article 2
CBIT-SMS and IUTET provide mutual assistance in training, retraining, advanced training and improvement of management related, scientific and educational activities, including within the framework of International academic exchange. The number of students, teachers/faculties, researchers and joint collaborative research programs, areas of training, specialties and terms of study are additionally established in each specific case.

Article 3
CBIT-SMS and IUTET if necessary, may jointly develop or adjust curricula and value-added joint programs, management related, scientific and methodological documents, textbooks and teaching aids. For these purposes, groups of authors can be created.

Article 4
CBIT-SMS and IUTET exchange information in the field of management related, scientific and technical research, hackathons, joint management related, scientific programs, educational problems, as well as the organization and participation in International consultancy, International projects, grants and programs, conferences, seminars, workshops, refresher programs, induction programs, faculty development programs, management development programs, symposiums and exhibitions.

Article 5
CBIT-SMS and IUTET within their competence, contribute to the development of the material base, including the exchange of the results of management related, scientific, design and publishing work, visual aids and technical teaching aids, textbooks and educational and methodological literature, as well as the exchange of teachers/faculties for classes.

Article 6
CBIT-SMS and IUTET mutually review management related and scientific papers, oppose dissertations, contribute to the publication of management related and scientific papers of the other side on the pages of their publications.

Article 7
CBIT-SMS and IUTET are developing cooperation in the field of additional education, including in the field of management related, tourist and excursion activities, technical fields, pedagogical sphere, for students and teachers/faculties, organizing joint collaborative work and recreation, holding creative competitions, subject Olympiads and sports and athletics.

Article 8
In order to study the expansion of the scope of cooperation in the future, the CBIT-SMS and IUTET establish a bilateral working group and adjust the text of the MoU at any time by mutual agreement.

Article 9
The implementation of the MoU will be carried out subject to the availability of funds and the consent of the Principal CBIT and Rector of the IUTET. The conditions necessary for the financing of each of the programs and activities are subject to mutual discussion and agreement by both Sides in writing prior to the implementation of a particular program or activity.

Article 10
This MoU is concluded for a period of 5 (five) years and comes into force from the date of its signing. The validity of the MoU is automatically extended for subsequent five-year periods, unless either party notifies the other party in writing of its intention to terminate it.

Article 11
The Agreement is drawn up in English in two copies, having the same legal force and is kept in one copy by each Side.

City (region): Hyderabad
Address: Chaitanya Bharathi Institute Of Technology , Gandipet,Telangana-500075,

Phones: +918466997204, +919391033002

Website: https://www.cbit.ac.in/

E-Mail: principal@cbit.ac.in

Email of Principal:

Email of Single Point of contact: poornachandrika_sms@cbit.ac.in

3rd March 2023

Address: International University of Tourism and Entrepreneurship of Tajikistan (IUTET)

Phones:(+992 37)234-88-02, 234-88-03

Website: www.iutet.tj

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Email of Single Point of contact: Islom_2412@mail.ru
(Vice Rector- Asrorzoda Ubaidullo Sattor)

PRINCIPAL, CBIT

VICE RECTOR, International University of Tourism and Entrepreneurship of Tajikistan

BERKADIA

Memorandum of Understanding

Between

Berkadia Services India Private Limited

And

Chaitanya Bharathi Institute of Technology

This memorandum of understanding is made on February 21, 2023 between Berkadia Services India Private Limited, 9th Floor, Block 2, DLF Cybercity Gachibowli Village, Plot No:129 to 132 Serilingampalli Mandal, Hyderabad TS 500019 and Chaitanya Bharathi Institute of Technology, Osman Sagar Road, Kokapet, Gandipet, Telangana – 500 075. Review of this memorandum shall be made on or before September 30, 2023, at which time this agreement may be extended, modified, or terminated.

In order to promote cooperation and advancement of Academic and Business Exchanges between Berkadia Services India Private Limited and Chaitanya Bharathi Institute of Technology-School of Management Studies; the two institutions agree upon the following:

1.1 Berkadia Services India Private Limited & CBIT-School of Management Studies, Joint Certification Program (JCP) to be offered as a value-added course to the students along with the regular MBA course.

1.2 Berkadia Services India Private Limited would have the first right to interview and select students within the Academic Year for employment with Berkadia Services India Private Limited, from those who undergo this JCP.

2. Berkadia Services India Private Limited agrees to :

2.1 Develop the JCP-BCRE (Berkedia Commercial Real Estate) curriculum and communicate the same to CBIT-School of Management Studies

2.2 Conduct / arrange for guest lectures for the portion of the curriculum provided in the annexure

3. CBIT-School of Management Studies to:

3.1 Conduct lectures for the portion of the curriculum of JCP-BCRE provided in the annexure

3.2 Ensure infrastructure facilities / needs

4. The purpose of this Memorandum of understanding is only to express the intentions of the parties and is not intended to be legally binding on either party.

5. Provide training material, jointly developed between Berkadia Services India Private Limited and CBIT-School of Management Studies, for the JCP-BCRE being offered.

BERKADIA

6. The offers will be made to the select students by Berkadia Services India Private Limited post successful completion of the course & exam.

7. Post acceptance of offer by Berkadia Services India Private Limited, the students shall not participate in the on campus placement process of any other organization thereafter.

8. The terms of cooperation for each specific activity contemplated under this Memorandum of Understanding shall be mutually discussed and agreed upon in writing by both parties prior to the initiation of that activity.

9. Each institution shall designate a liaison officer to develop and co ordinate the specific activities agreed up on.

10. This Memorandum of Understanding imposes no financial obligation on either party.

11. Each party recognizes that the other party has, may have or will have arrangements of a similar or different nature with other institutions during the currency of this Memorandum of Understanding.

12. Each party shall keep confidential any information that it receives from the other party. Publication of any material that is jointly developed by the two parties will be considered as confidential and will not be shared in any public forum or with any third party, without prior consent / approval of the other in writing , obtained from the authorized signatory.

13. This memorandum shall remain in effect until terminated by either party.

14. The terms of cooperation may be extended beyond the terms mentioned in this Memorandum of understanding, basis discussion and up on mutual agreement between the two parties.

For Berkadia Services India Private Limited

Name – Debashish Ghosh

Debashish Ghosh

Designation – SVP - HR

Date – 21-Feb-2023

For Chaitanya Bharathi Institute of Technology

Name – Dr. P. Ravinder Reddy

Designation – Principal

Date – 21-Feb-2023

NAVATA ROAD TRANSPORT
REGULAR PARCEL SERVICE

PLOT NO : 1, BLOCK NO. 1, AUTONAGAR, HYDERABAD - 500 070. PHONES : 040 - 24020943, 65942222
FAX : 0866 - 24021066 e-mail : hyderabad@navata.com

MEMORANDUM OF UNDERSTANDING
(MoU)

BETWEEN

Chaitanya Bharathi Institute of Technology (A)
School of Management Studies
(Affiliated to Osmania University)
Gandipet, Hyderabad – 500075

&

Navata Road Transport
D.No.18-667, BOSE Buildings
Kanuru, Vijayawada – 520007
Andhra Pradesh

FOR

SKILL DEVELOPMENT, OUTCOME BASED TRAINING, CURRICULUM DEVELOPMENT, INTERNSHIPS, PLACEMENTS, R&D, INDUSTRIAL VISIT, GUEST LECTURES, EXTENSION ACTIVITIES AND OTHER COLLABORATIVE ACTIVITIES

NAVATA ROAD TRANSPORT
REGULAR PARCEL SERVICE

PLOT NO : 1, BLOCK NO. 1, AUTONAGAR, HYDERABAD - 500 070. PHONES : 040 - 24020943, 65942222
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MEMORANDUM OF UNDERSTANDING

This **Memorandum of Understanding** (hereinafter called as the 'MOU') is entered into on this the **4th JANUARY 2023 (04-01-2023) – TWO Thousand and twenty three**, by and between

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A), GANDIPET, HYDERABAD - SCHOOL OF MANAGEMENT STUDIES represented herein by Dr. P. Ravinder Reddy, Principal (hereinafter referred as **'First Party'**, the institution which expression, unless excluded by or repugnant to the subject or context shall include its successors – in-office, administrators and assigns).

AND

NAVATA ROAD TRANSPORT, ANDHRA PRADESH, THE SECOND PARTY, and represented herein by its Zonal / Divisional Head, **Name of Competent Authority / Representative**, (hereinafter referred to as "**Second Party**", company which expression, unless excluded by or repugnant to the subject or context shall include its successors – in-office, administrators and assigns).

(First Party and Second Party are hereinafter jointly referred to as 'Parties' and individually as 'Party') as

WHEREAS:

A) First Party is a Higher Educational Institution named:

   (i) **CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A) – SCHOOL OF MANAGEMENT STUDIES**

B) First Party & Second Party believe that collaboration and co-operation between themselves will promote more effective use of each of their resources, and provide each of them with enhanced opportunities.

C) The Parties intent to cooperate and focus their efforts on cooperation within area of Skill Based Training, Education and Research.

D) Both Parties, being legal entities in themselves desire to sign this MOU for advancing their mutual interests.

E) **NAVATA ROAD TRANSPORT, ANDHRA PRADESH**, the Second Party is

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FAX : 0866 - 24021066 e-mail : hyderabad@navata.com

engaged in Business, Manufacturing, Skill Development, Education and R&D Services in the fields of ***Logistics and Supply Chain Management*** and relatedfields.

F) **NAVATA ROAD TRANSPORT, ANDHRA PRADESH**, the Second Party is promoted by **promoter name** Group; Address and background of the Company.

G) Give related information, its branches, and dimensional information about the industry concerned with whom the MoU is sworn.

NOW THEREFORE, IN CONSIDERATION OF THE MUTUAL PROMISES SET FORTH IN THIS MOU, THE PARTIES HERE TO AGREE AS FOLLOW

CLAUSE 1 CO-OPERATION

Both Parties are united by common interests and objectives, and they shall establish channels of communication and co-operation that will promote and advance their respective operations within the **Institution** and its related wings. The Parties shall keep each other informed of potential opportunities and shall share all information that may be relevant to secure additional opportunities for one another.

Chaitanya Bharathi Institute of Technology - School of Management Studies and **Navata Road Transport** co-operation will facilitate effective utilization of the intellectual capabilities of the faculty of **Chaitanya Bharathi Institute of Technology-School of Management Studies** providing significant inputs to them in developing suitable teaching / training systems, keeping in mind the needs of the industry, **Navata Road Transport**.

The general terms of co-operation shall be governed by this MOU. The Parties shall cooperate with each other and shall, as promptly as is reasonably practical, enter into all relevant agreements, deeds and documents (the 'Definitive Documents') as may be required to give effect to the actions contemplated in terms of this MOU. The term of Definitive Documents shall be mutually decided between the Parties. Along with the Definitive Documents, this MOU shall represent the entire understanding as to the subject matter hereof and shall supersede any prior understanding between the Parties on the subject matter hereof.

NAVATA ROAD TRANSPORT
REGULAR PARCEL SERVICE
PLOT NO. 1, BLOCK NO. 1, AUTONAGAR, HYDERABAD - 500 070. PHONES : 040 - 24020943, 65942222
FAX : 0866 - 24021066 e-mail : hyderabad@navata.com

CLAUSE 2 SCOPE OF THE MoU

The budding graduates from the institutions could play a key role in technological up-gradation, innovation and competitiveness of an industry. Both parties believe that close co-operation between the two would be of major benefit to the student community to enhance their skills and knowledge.

Curriculum Design: Navata Road Transport will give valuable inputs to the First Party in teaching / training methodology and suitably customize the curriculum so that the students fit into the industrial scenario meaningfully.

Industrial Training & Visits: Industry and Institution interaction will give an insight in to the latest developments / requirements of the industries; Navata Road Transport to permit the Faculty and Students of Chaitanya Bharathi Institute of Technology- School of Management Studies to visit its group companies and also involve in Industrial Training Programs for Chaitanya Bharathi Institute of Technology- School of Management Studies. The industrial training and exposure provided to students and faculty through this association will build confidence and prepare the students to have a smooth transition from academic to working career. Navata Road Transport will provide its Labs / Workshops / Industrial Sites for the hands-on training of the learners enrolled with the First Party.

Research and Development: Both Parties have agreed to carry out the joint research activities in the fields of **Logistics and Supply Chain Management.**

Skill Development Programs: Navata Road Transport to train the students of Chaitanya Bharathi Institute of Technology- School of Management Studies on the emerging technologies in order to bridge the skill gap and make them industry ready.

Guest Lectures: Navata Road Transport to extend the necessary support to deliver guest lectures to the students of the Chaitanya Bharathi Institute of Technology- School of Management Studies on the technology trends and in house requirements.

Faculty Development Programs: Navata Road Transport to train the Faculties of Chaitanya Bharathi Institute of Technology- School of Management Studies for imparting training as per the industrial requirement considering the National Occupational Standards in concerned sector, if available.

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FAX : 0866 - 24021066 e-mail : hyderabad@navata.com

Placement of Trained Students: Navata Road Transport will actively engage to help the delivery of the training and placement of students of the First Party into internships/jobs;

Both Parties to obtain all internal approvals, consents, permissions, and licenses of whatsoever nature required for offering the Programmes on the terms specified herein

There is no financial commitment on the part of the **Chaitanya Bharathi Institute of Technology- School of Management Studies**, the First Party to take up any programme mentioned in the MoU. If there is any financial consideration, it will be dealt separately.

CLAUSE 3 INTELLECTUAL PROPERTY

3.1 Nothing contained in this MOU shall, by express grant, implication, Estoppel or otherwise, create in either Party any right, title, interest, or license in or to the intellectual property (including but not limited to know-how, inventions, patents, copy rights and designs) of the other Party.

CLAUSE 4 VALIDITY

This Agreement will be valid until it is expressly terminated by either Party on mutually agreed terms, during which period **Navata Road Transport**, the Second Party, as the case may be, will take effective steps for implementation of this MOU. Any act on the part of **Training Partner** or **Navata Road Transport**, the Second Party after termination of this Agreement by way of communication, correspondence etc., shall not be construed as an extension of this MOU

Both Parties may terminate this MOU upon 30 calendar days' notice in writing. In the event of Termination, both parties have to discharge their obligations

NAVATA ROAD TRANSPORT
REGULAR PARCEL SERVICE

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CLAUSE 5 RELATIONSHIP BETWEEN THE PARTIES

5.1 It is expressly agreed that **Chaitanya Bharathi Institute of Technology- School of Management Studies** and **Navata Road Transport** are acting under this MOU as independent contractors, and the relationship established under this MOU shall not be construed as a partnership. Neither Party is authorized to use the other Party's name in any way, to make any representations or create any obligation or liability, expressed or implied, on behalf of the other Party, without the prior written consent of the other Party. Neither Party shall have, nor represent itself as having, any authority under the terms of this MOU to make agreements of any kind in the name of or binding upon the other Party, to pledge the other Party's credit, or to extend credit on behalf of the other Party.

Chaitanya Bharathi Institute of Technology
School of Management Studies
First Party

Navata Road Transport
Second Party

Any divergence or difference derived from the interpretation or application of the MoU shall be resolved by arbitration between the parties as per the Arbitration Act, 1996. The place of the arbitration shall be at District Head Quarters of the First Party. This undertaking is to be construed in accordance with Indian Law with exclusive jurisdiction in the Courts of **Name of City.**

AGREED:

For **Navata Road Transport**

Authorized Signatory

For **Chaitanya Bharathi Institute of Technology School of Management Studies**

Authorized Signatory

Navata Road Transport
D.No.18-667, BOSE Buildings
Kanuru, Vijayawada – 520007
Andhra Pradesh.

Date:
Place:

Witness 1:

Chaitanya Bharathi Institute Of Technology
(Affiliated To Osmania University)
Gandipet Hyderabad 500075
Telangana.

Date:
Place:

Witness 1: