Handbook of Research on

Advances in Data Analytics and Complex Communication Networks

P. Venkata Krishna

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Handbook of Research on Advances in Data Analytics and Complex Communication Networks

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both are important for both buyers and sellers. This chapter introduced the combination of ML and DL approaches to predict the house price with the updated regression algorithm. The algorithm named as 'Mopuri algorithm' reads the 14 attributes like crime rate, population density, rooms, etc. and produces the cost estimation result as a prediction. The proposed model accurately estimates the worth of the house as per the given features. The results of the model tested with the different datasets existing in the Kaggle data source using Python libraries with the Jupyter platform and continuation of the model using the Android OS to develop the smart home web-based application.

An effective video surveillance system is a challenging task in the COVID-19 pandemic. Building a model proper way of wearing a mask and maintaining the social distance minimum six feet or one or two meters by using CNN approach in the COVID-19 pandemic, the video surveillance system works with the help of TensorFlow, Keras, Pandas, which are libraries used in Python programming scripting language used in the concepts of deep learning technology. The proposed model improved the CNN approach in the area of deep learning and named as the Ram-Laxman algorithm. The proposed model proved to build the optimized approach, the convolutional layers grouped as 'Ram', and fully connected layers grouped as 'Laxman'. The proposed system results convey that the Ram-Laxman model is easy to implement in the CCTV footage.

This chapter introduces the novel approach in deep learning for diabetes prediction. The related work described the various ML algorithms in the field of diabetic prediction that has been used for early detection and post examination of the diabetic prediction. It proposed the Jaya-Tree algorithm, which is updated as per the existing random forest algorithm, and it is used to classify the two parameters named as the 'Jaya' and 'Apajaya'. The results described that Pima Indian diabetes dataset 2020 (PIS) predicts diabetes and obtained 97% accuracy.

In this world there are thousands of plant species available, and plants have medicinal values. Medicinal plants play a very active role in healthcare traditions. Ayurveda is one of the oldest systems of medicinal science that is used even today. So proper identification of the medicinal plants has major benefits for not

only manufacturing medicines but also for forest department peoples, life scientists, physicians, medication laboratories, government, and the public. The manual method is good for identifying plants easily, but is usually done by the skilled practitioners who have achieved expertise in this field. However, it is time consuming. There may be chances to misidentification, which leads to certain side effects and may lead to serious problems. This chapter focuses on creation of image dataset by using a mobile-based tool for image acquisition, which helps to capture the structured images, and reduces the effort of data cleaning. This chapter also suggests that by ANN, CNN, or PNN classifier, the classification can be done accurately.

Many methods focus solely on the relationship between the API and the user and fail to capture their contextual value. Because of this, they could not get better accuracy. The accuracy of the API recommendation can be improved by considering the effect of API contextual information on their latent attribute and the effect of the user time factor on the latent attribute of the user through the deep learning-based matrix factorization method (DL-PMF). In this chapter, a CNN (convolutional neural network) with an attention mechanism for the hidden features of web API elements and an LSTM (long-term and short-term memory) network is introduced to find the hidden features of service users. Finally, the authors combined PMF (probabilistic matrix factorization) to estimate the value of the recommended results. Experimental results obtained by the DL-PMF method show better than the experimental results obtained by the PMF and the ConvMF (convolutional matrix factorization) method in the recommended accuracy.

The effectiveness of the transmission and sharing of data and information among people has been revolutionized by the internet and digital technology. Social networks have shortened the communication space among the technology users. Their relatively easy access through computers, cell phones, and many other devices has made them easy to use, so they are probably the most widely used today. Social network and internet media (SIM) has revolutionized providing useful resources for scientific research, especially in engaging citizen scientists in research. There are also various possible drawbacks in spite of the benefits of the SIM. With the increasing use of social media worldwide, sites with rich species diversity face potentially the greatest anthropogenic threats (resulting from high numbers of visitors), which results in the extinction of valuable species from the native area. Despite shortcomings, SIM can provide conservation education and awareness and also reconnect to the natural world.

isolated data storing and recovery and offers object tracking with a unique identity code. The system then sends sound and light warning information, while the photographic camera structure is triggered to capture a picture at the same time. The recognition of the accuracy in the hardware component of the device can be additionally enhanced by the use of this technology to increase the safety of museum equipment.

Mining Telugu news data and categorizing based on public sentiments is quite important since a lot of fake news emerged with rise of social media. Identifying whether news text is positive, negative, or neutral and later classifying the data in which areas they fall like business, editorial, entertainment, nation, and sports is included throughout this research work. This research work proposes an efficient model by adopting machine learning classifiers to perform classification on Telugu news data. The results obtained by various machine-learning models are compared, and an efficient model is found, and it is observed that the proposed model outperformed with reference to accuracy, precision, recall, and F1-score.

Outlier detection has become one of the prominent and most needed technologies these days. Outliers can be anything in our daily life like credit card fraud, intrusion in a network, aberrant condition detection in condition monitoring data. There are numerous methodologies to detect outliers. In the past few years many tools have come up in the outlier detection in data streams. In this chapter, the authors discuss the tool MOA (massive online analysis) to detect anomalies and the best performing algorithm amongst the prescribed algorithms of MOA. The authors elaborately discuss that MCOD (micro-cluster-based algorithm) is one of the best in the prescribed algorithms of the MOA (massive online analysis) tool which outperforms all other algorithms. In this paper, the authors will deeply discuss the performance of MCOD algorithm. The authors will also discuss which factor of MCOD separates its performance from others and also what the different parameters that influence the performance of MCOD are.

Power demand forecasting is one of the fields which is gaining popularity for researchers. Although machine learning models are being used for prediction in various fields, they need to upgrade to increase accuracy and stability. With the rapid development of AI technology, deep learning (DL) is being recommended by many authors in their studies. The core objective of the chapter is to employ the smart meter's data for energy forecasting in the industrial sector. In this chapter, the author will be implementing

popular power demand forecasting models from machine learning and compare the results of the best-fitted machine learning (ML) model with a deep learning model, long short-term memory based on RNN (LSTM-RNN). RNN model has vanishing gradient issue, which slows down the training in the early layers of the network. LSTM-RNN is the advanced model which take care of vanishing gradient problem. The performance evaluation metric to compare the superiority of the model will be R2, mean square error (MSE), root means square error (RMSE), and mean absolute error (MAE).

Preface

Today, the usage of internet and smart devices is tremendously increased. This leads to the wide use of wireless systems where Internet of Things (IoT) is in practice enormously. The smart devices in IoT generate huge amount of data and the data being generate is growing exponentially. To process, analyse and infer required information with respect to complex communication networks from this raw data, various techniques of data analytics play a major role. Processed data is needed to introduce novel systems and applications. The lifestyle of the human, public places, educational institutions, industries, etc. are reformed by the use of smart information and communication technology. Therefore, more research requirement and possibilities exist in data analytics and complex communication fields. The existing techniques need to be updated due to the unpredicted challenges and the disturbances in the normal flow of life because of the current pandemic situation and this enhances the requirement for the study on IoT, data analytics, and complex communication networks.

Research on advances in data analytics and complex communication are presented in this handbook. The chapters which present various characteristics of data analytics and complex communication networks, new proposals that are based on IoT, Machine Learning, Deep Learning, Smart Technologies, Health care applications, etc. are pursued by the editors of this book. Furthermore, the issues and challenges of the development of various systems using data analytics and complex communication networks are presented and discussed in this handbook. The chapters identify different issues, suggest feasible solutions to those identified issues, and present comprehensive information on emerging technologies related to data analytics and complex communication networks such as cloud computing, big data, and IoT. This book is valuable for data scientists, data analysts, network analysts, researchers, academicians, and students interested in the latest developments and advancements in data analytics and complex communication networks.

The objective of this handbook is to make the literature in the field of data analytics and complex communication networks available as an important source of reference.

TOPICS OF INTEREST INCLUDE (BUT ARE NOT LIMITED TO):

- Big Data
- Complex Communication Networks
- Data Analytics
- Deep Learning
- Healthcare Applications

- Information Technology
- Internet of Things (IoT)
- Machine Learning
- Risk Prediction and Analysis
- Security and Privacy
- Smart Technologies
- Wireless Systems.

We received several manuscripts and each manuscript was reviewed by at least two independent reviewers. A total sixteen manuscripts were finally selected for this reference book.

Sercan Demirci et al presents about OMNeT++ Framework that deals with multihop networks in Chapter 1. Theoretical applications and practical network algorithms are not very cost-effective and most of the algorithms in the commercial market are implemented in the cutting-edge devices. Open-source network simulators have gained importance in recent years due to the necessity to implement network algorithms in more realistic scenarios with reasonable costs, especially for educational purposes and scientific researches. OMNeT++ network simulator is selected as a testbed in order to verify the correctness of the network algorithms. The study focuses on the algorithms based on centralized and distributed approaches for multi-hop networks in OMNeT++. The implementation, analysis and visualization of these algorithms have also been addressed.

In Chapter 2, Amtul Waheed et al describe about Machine Learning Models for the Predictions of Speed in Smart Transportation Systems. This chapter presents the performance of the speed of vehicles on roadways employing machine learning methods. The performance of machine learning algorithms is calculated by comparing the result of predictions made by different Machine learning algorithms with true speed using the histogram. A result recommends that speed is varying according to the histogram.

Gayathri et al. explains about the need of privacy preserving in Smart City environments in Chapter 3. Now a Days, IoT has influenced our daily lives through various applications. The high possibility of sensing and publishing sensitive data in the smart environment leads to significant issues known as privacy-preserving and real-time services. Privacy is a complex and a subjective notion as its understanding and perception differ among individual. Hence the observation is that current studies are in lack of addressing these challenges.

Dutta et al. performs survey on explainability in Artificial Intelligence in Chapter 4. The world has been evolving with new technologies and advances every day. With learning technologies, the research community can provide solution in every aspect of life. However, it is found to lag behind the ability to explain its prediction. The current situation is such that these modern technologies can predict and decide upon various cases more accurately and speedily than a human, but has failed to provide an answer when the question of "how" it arrived at such a prediction or "why" one must trust its prediction, is put forward. The central premise of this chapter is to provide an overview of researches explored in the domain and obtain an idea of the current scenario along with the advancements achieved to date in this field. This survey aims to provide a comprehensive background of the broad spectrum of "Explainability."

In Chapter 5, Mallikarjuna et al. presents method for House Price/Land Price Prediction using Deep Learning. House price predictions are a crucial reflection of the economy, sometimes house prices include the land prices and demand of the place and location reflects the house prices. The house price and land price are two different things both are important for both buyers and sellers. This chapter introduced the combination of machine and deep learning approaches to predict the house price with the

updated regression algorithm. The discussed model accurately and estimate the worth of the house as per the given features. The results of the model tested with the different datasets existing in the Kaggle data source using python libraries with the Jupyter platform and continuation of the model using the Android OS to develop the smart home web-based application.

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In Chapter 8, medicinal plants identification using machine learning techniques is detailed by Udaya et al. In this world there are thousands of plant species available, from which many of plants have medicinal values. Medicinal plants plays very active role in healthcare traditions. Ayurveda is one of the oldest systems of Medicinal Science that is used even today. This chapter focuses on Creation of image dataset by using Mobile based tool for image acquisition, which helps to capture the structured images as well as reduces the effort of data cleaning. This paper also suggests that by ANN, CNN or PNN classifier, the classification can be done accurately.

In Chapter 9, Ramathulasi et al. mentions about a model to Predict User's Interest for Web API's Recommendations. Many methods nowadays focus solely on the relationship between the API and the user and fail to capture their contextual value. Because of this, could not get better accuracy. The accuracy of the API recommendation can be improved by considering the effect of API contextual information on their latent attribute and the effect of the user time factor on the latent attribute of the user through the deep learning-based matrix factorization method (DL-PMF). In this paper, a CNN (Convolutional Neural Network) with an attention mechanism for the hidden features of web API elements and an LSTM (Long-Term and Short-term Memory) network is introduced to find out the hidden features of service users. Finally, we combined PMF (Probabilistic Matrix Factorization) to estimate the value of the recommended results. Experimental results obtained by the DL-PMF method show better than the experimental results obtained by the PMF and the ConvMF (Convolutional Matrix Factorization) method in the recommended accuracy.

In Chapter 10, Bharathi et al. discussed on impact of social media network data bio resources, Role of Information Technology in Environmental Communication and use of telemedicine during COVID-19.

The effectiveness of the transmission and sharing of data and information among people has been revolutionized by the internet and digital technology. Social networks have shortened the communication space among the technology users. Their relatively easy access through computers, cell phones and many other devices has made them so easy to use, so they are probably the most widely used today.

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In Chapter 11, environmental communication emerged in United States around 1980s and reached multiple milestones in the area of environmental protection and management. Information and communication technological advancement took quantum leap in supporting environment related problems through Internet. Involvement of ICT in protecting environment lead to the development of 'Green Websites', which are associated with policies to improve, conserve, recycle and check the carbon emissions and for the development of eco-friendly products. Environmental nature communication is the exchange of information observed during interaction of plants with ecosystems. It was discovered that organs of the plants communicate when in danger to protect themselves from predators. Application of communication devices likes drones, collars, Wifi, usage of software servers for data collection, monitoring, will be a way forward to conserve bioresources. Therefore, environment communication will analyse data for scientific studies in protecting our earth. The present chapter provides an overview of environmental communication.

In Chapter 12, telehealth is effective in preventing, treating and taking precautions to avoid spreading of coronavirus. Telehealth allows people with symptoms to stay at home by helping them to communicate with doctors through internet. This decreases the spreading of corona virus to large number of people and hospital staff. But when it comes to treatment of patient's telemedicine do have some limitations. Medicines given through telemedicine may not be consistent to patients who have chronic disorders and makes the patients condition serious which leads them to hospitalization. The most significant limitation of telemedicine is that some hospitals do not have equipment to deliver care in this manner. In the present situation of COVID-19, the existing telemedicine has to be modified for helping quick testing and to diagnose the infection to take care of the patients. Hence in the present article some of the benefits and limitations of telemedicine have been summarized.

In Chapter 13, Sasikumar et al. develops a method for anti-theft System using RFID and IoT.

Art colonnades and museums all over the world consume the first option for individuals to visit with the enhancement of the cultural life of people. To ensure their safety, the museum has established numerous cultural security measures. Traditional strategies do not obstruct their pace entirely. They only use a computer in the museum to check individuals at the entrance and exit. Therefore, a gallery anti-stealing device created on the Internet-of-Things (IoT) technology that ensures security through passive readers/writers of RFID. Radio- Frequency-Identification (RFID) remains a system that practices isolated data storing and recovery and offers object tracking with a unique identity code. The system then sends sound and light warning information, while the photographic camera structure is triggered to capture a picture at the same time. The recognition of the accuracy in the hardware component of the device can be additionally enhanced by the use of this technology to increase the safety of museum equipment.

Bala Krishna et al describes about data classification using machine learning approach in Chapter 14. Mining Telugu news data and categorizing based on public sentiments is quite important since lot of fake news emerge with rise of social media. Identifying whether news text is positive, negative or neutral and later classifying the data in which areas they fall like Business, editorial, entertainment, nation and

sports is included throughout this research work. This chapter illustrates an efficient model by adopting machine learning classifiers to perform classification on Telugu news data.

In Chapter 15, Sandhya Madhuri et al. presents analysis of MCOD Algorithm with Varying Parameters. Outlier detection has become one of the prominent and most needed technologies these days. Outliers can be anything in our daily life like credit card fraud, intrusion in a network, aberrant condition detection in condition monitoring data. There are numerous methodologies to detect outliers. In this chapter, the authors discuss the tool MOA (Massive Online Analysis) to detect anomalies and the best performing algorithm amongst the prescribed algorithms of MOA. The authors elaborately discuss that MCOD (Micro – Cluster based algorithm) is one of the best in the prescribed algorithms of the MOA (Massive Online Analysis) tool which outperforms all other algorithms.

Finally, Bhawna Dhupia et al. present an Assessment of Electric Consumption Forecast using Machine Learning and Deep Learning Models for Industrial Sectors in Chapter 16.

Power demand forecasting is one of the fields which is gaining popularity for researchers. Although Machine learning models are being used for prediction in various fields, it needs to upgrade to increase accuracy and stability. With the rapid development of AI technology, Deep Learning (DL) is being recommended by many authors in their researches. The core objective of the paper is to employ the smart meter's data for energy forecasting in industrial sector. In this paper, the author will be implementing popular power demand forecasting models from machine learning and compare the results of the best-fitted Machine Learning (ML) model with a deep learning model, Long Short-Term Memory based on RNN (LSTM-RNN). RNN model has vanishing gradient issue, which slows down the training in the early layers of the network. LSTM-RNN is the advanced model which take care of vanishing gradient problem. The performance evaluation metric to compare the superiority of the model will be R2, mean square error (MSE), root means square error (RMSE), and mean absolute error (MAE).

The above chapters would help the researchers to understand the advancements happening in the field of data analytics, and complex communication networks.

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Chapter 1
OMNeT++ Framework for Simulation of Centralized and Distributed Algorithms in Multi-Hop Networks

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ABSTRACT

Theoretical applications and practical network algorithms are not very cost-effective, and most of the algorithms in the commercial market are implemented in the cutting-edge devices. Open-source network simulators have gained importance in recent years due to the necessity to implement network algorithms in more realistic scenarios with reasonable costs, especially for educational purposes and scientific researches. Although there have been various simulation tools, NS2 and NS3, OMNeT++ is more suitable to demonstrate network algorithms because it is convenient for the model establishment, modularization, expandability, etc. OMNeT++ network simulator is selected as a testbed in order to verify the correctness of the network algorithms. The study focuses on the algorithms based on centralized and distributed approaches for multi-hop networks in OMNeT++. Two network algorithms, the shortest path algorithm and flooding-based asynchronous spanning tree algorithm, were examined in OMNeT++. The implementation, analysis, and visualization of these algorithms have also been addressed.

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INTRODUCTION

Simulators are the common name for the tools used for implementing, testing and monitoring real-life situations in a virtual environment. Recently, simulators have been used in various scientific fields in order to obtain experimental results using limited resources. In addition to the limited resources such as time, money and labor, it is possible to test and implement difficult or impossible cases by means of simulators. Thanks to these tools, experimental studies and proofs-of-concept (PoCs) are conducted in virtual environments rather than the physical world. Real-life applications can also be performed based on the results obtained. This is also valid in the IT sector, and especially in computer networks.

Computer networks are structures consisting of many different nodes and various network elements (router, switch, etc.). These structures being in communication with each other can be found at different scales. There may be networks consisting of a small number of nodes, as well as networks spreading to the cities, countries, continents and even the planets. Establishing a real-test environment in experiments and researches in this field brings a major burden in the industry in terms of time and cost. Moreover, it may not be possible to access the environment where the network is planned to be installed or there may be situations where intervention is not possible after a real installation. Furthermore, it may be much more convenient to test the performance of a proposed algorithm in computer networks of different sizes using simulators, instead of working on real networks.

There are various tools used for Network Simulation. While some of these tools are free of charge, some of them are only free of charge for educational and academic purposes for commercial activities. Some of them are fully paid as well. In addition, each of these simulation tools focuses on different features of the networks and provides a more convenient environment for certain areas and analyses. Therefore, when choosing a simulation environment, the most suitable one will be selected according to the purpose of the environment. OMNeT++ (Varga, 2019), used in this chapter, and also other popular network simulators will be briefly introduced.

THE COMPARISON OF NETWORK SIMULATORS

In recent years various comparisons between network simulators are done (Weingartner et al., 2009; Chaudhary et al., 2012; Xian et al., 2008). We are briefly defining some of the most popular network simulators and we are giving comparison between them shown in Table 1 (Kabir et al, 2014).

NS2 (Network Simulator v2): NS2 which is a discrete event simulator with a focus on network research is used for simulating TCP, routing and multicast protocols over wireless and wired networks (Issariyakul and Hossain, 2009).

NS3 (Network Simulator v3): NS-3 which is a free software for simulating Internet systems is publicly available for research, development and educational purposes. Various virtual nodes can be created by using NS3 (Riley and Henderson, 2010). Various auxiliary classes, devices, internet stacks or applications can be installed on the previously created nodes. Connections between nodes such as PointToPoint, Wireless, CSMA can be simulated by means of NS3. C++ or Python languages are used to code the simulation.

Opnet: Opnet Network Simulator which is an event-based high-level network simulation tooloffers a large number of project scenarios (Chang X., 1999).

JSim: JSim is a simulation system for generating and analyzing quantitative numeric models. Although its main focus is on biomedicine and physiology, its computational engine is also applicable in many other scientific fields (Sobeih et al., 2006).

QualNet: The QualNet® is a network simulation simulating the behavior of the communication network. It is used as a planning, testing, and a training tool ("QualNet - Network Simulation Software | SCALABLE Networks," n.d.).

OMNeT++: OMNeT++ is a simulation library and framework for building network simulators. It has gained a great popularity and is widely used as an object-oriented, modular discrete-event network simulator (Varga, 2019). A detailed comparative table of the above-mentioned network simulators can be seen in Table 1 (Kabir et al, 2014).

How to create and scale a network topology using the OMNeT++ simulation tool and how to apply central and distributed algorithms on different sizes of topologies will be discussed in the chapter. A more detailed explanation will be provided using annotated examples, screenshots and pieces of codes.

OMNET++ AND ITS POPULAR FRAMEWORKS

OMNeT++ is a simulation library and a framework for building network simulators. It has gained a great popularity and is widely used as an object-oriented, modular discrete-event network simulator. It provides the modeling of communication networks used in many areas. It provides flexible design for the programmer by using C/C++ programming languages (Varga, 2019). OMNeT++ simulation kernel and simulation IDE GUI can also be run on Docker platform.

OMNeT++ consists of the following basic components:

- **Simulation IDE:** IDE using the Eclipse platform provides the development environment required to create the simulation. It allows interactive editing on both the graphical interface and on the source code. The screenshot is presented in Figure 1.
- **Simulation runtime GUI:** It enables the developed simulation to run on the graphical interface (Figure 2). Due to the control possibilities offered by the interface, many controls such as determining the parameters of the simulation and adjusting the simulation speed can be performed.
- **Documentation and samples:** OMNeT++ provides integrated documentation along with its installation. OMNeT++ also reveals various sample projects that can be used to experience and benefit from different features of the tool. A screenshot of the integrated documentation screen can be seen in Figure 3. Similarly, the sample project screenshot is shown in Figure 4.
- **NED network topology description language:** It is a Domain Specific Language (DSL) allowing topologies to be designed and run on the created simulation. It is possible to convert them from NED to XML and from XML to NED format.
- **Command-line interface:** The interface running simulation from the command line.
- **Utilities:** OMNeT++ simulation environment contains several complementary tools.
- **Simulation kernel library:** Modules written in C++ are used to describe the structures and behaviors of the elements making up the simulation. It is the core allowing these modules to be simulated.

Figure 1. Simulation IDE

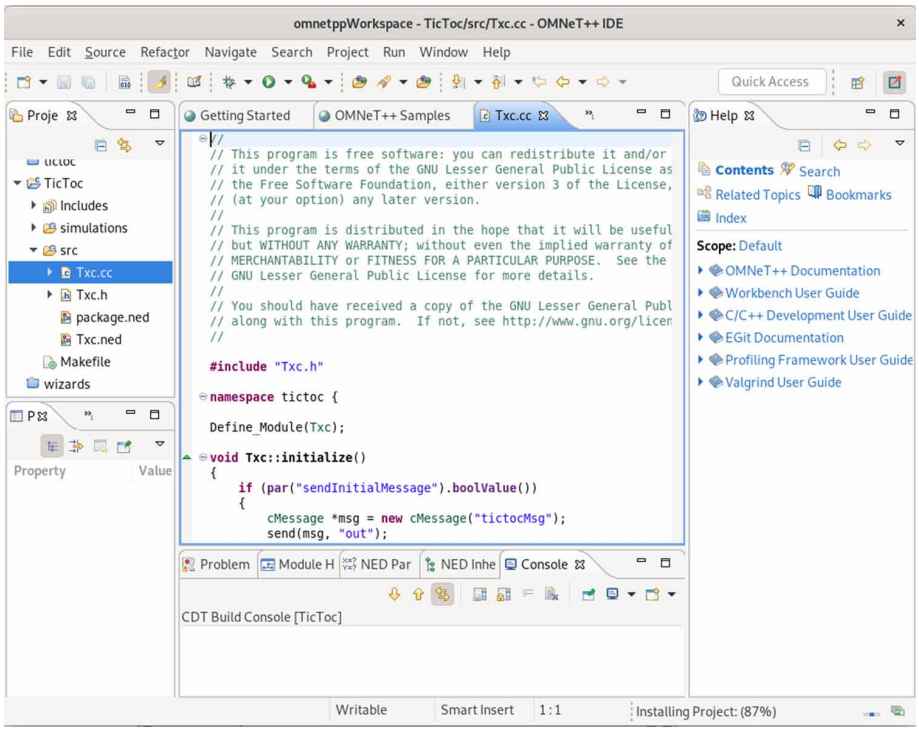


Figure 2. Simulation runtime GUI

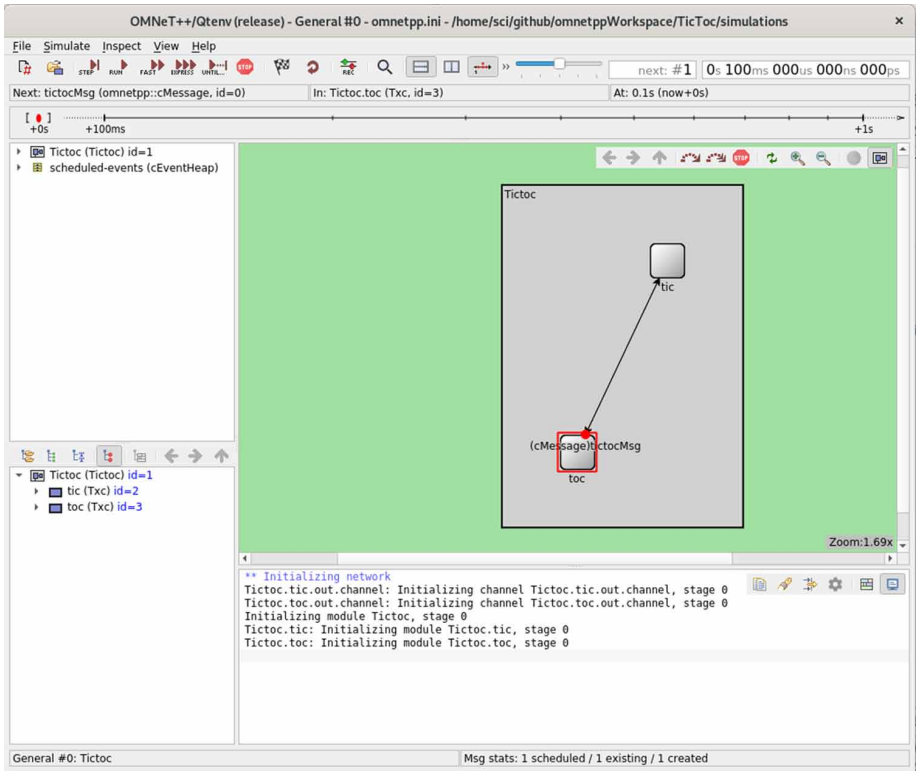


Figure 3. Documentation

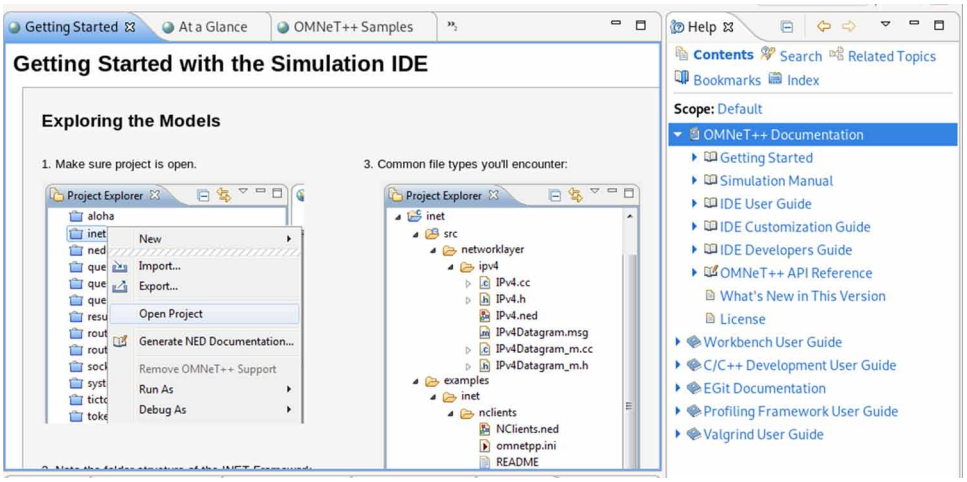
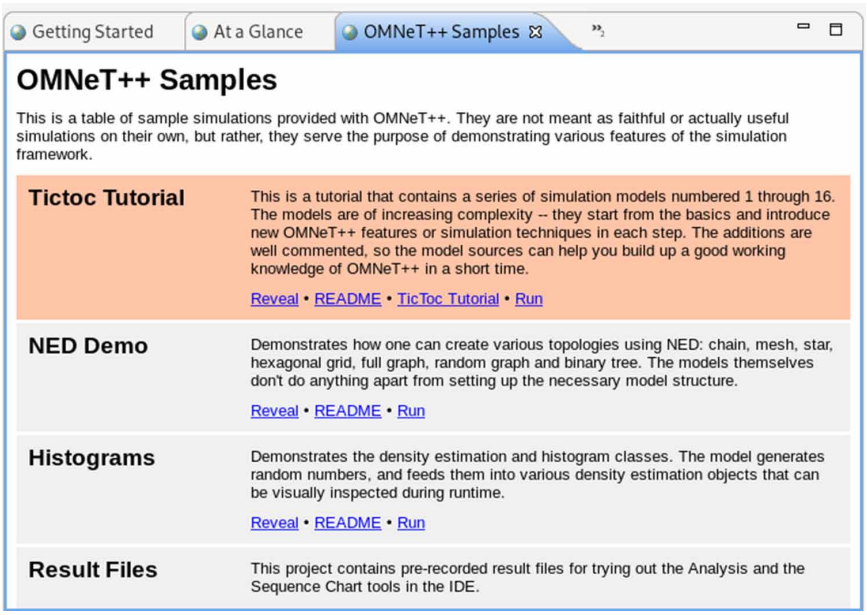


Figure 4. Sample projects



Various frameworks for working in different fields have been developed with the OMNeT++ extensible structure. Some of the popular frameworks used in different fields are mentioned below.

INET Framework

INET, which is one of the most popular OMNeT++ frameworks, provides numerous models facilitating the development of new protocols and tests on different scenarios (Mészáros et al., 2019).

The INET framework including OSI layers brings wired and wireless connection layer protocols such as Ethernet, PPP, IEEE 802.11, internet stacks such as TCP, UDP, Ipv4, Ipv6, OSPF and BGP, mobility and MANET protocols and many more together. The INET framework developed by the Community is completely free and offers visualization support.

SimuLTE Framework

SimuLTE is written in C++ and offers customization and pluggable interface support. It uses the INET framework and the dynamic infrastructure of OMNeT++. This framework is designed to facilitate the process on LTE networks and it can also be integrated with other modules of the INET framework. In the new versions, integration with Veins is also possible (Virdis et al., 2019).

Veins Framework

Veins is an OMNeT ++ framework with strong features used to develop vehicle networks. It provides realistic traffic modeling and great convenience in real-life modeling such as buildings that can be imported from OpenStreetMap. It also presents features like speed limits and the number of lanes (Sommer et al., 2019).

Creating an OMNeT++ Project and its Main Components

Launch the OMNeT++ IDE with the graphical interface using the application's shortcut on the desktop or using the omnetpp command on the console screen to get started working with OMNeT++ IDE,. Then follow File → New → OMNeT++ Project from the application menu to create an OMNeT ++ project. The screenshot of the relevant transaction is shown in Figure 5.

The project creation wizard seen in Figure 6 will be opened. Type the name you want to give to your project in the Project Name field.. You can change the path of the directory where the project will be created if you want to use this screen. If you want to configure the project in detail, you can continue the wizard by clicking Next, or you can finish the wizard by clicking on the Finish button to quickly create the project with the default configurations.

The project directory structure can be all in files as shown in Figure 7 or it can include src and simulations directories as shown in Figure 8. The project structure divided into sub-directories and containing all the files together includes the same files. These files are as follows:

- **Makefile:** Making directions for compiling simulation's source code.
- **.ned file:** Contains NED formatted network topology information.
- **.ini file:** The initialization file that OMNeT++ needs for initializing a simulation.
- **.cc file:** Module source codes written in C++ programming language.
- **.h file:** Header files for modules.

Table 1. Comparison of network simulation tools

Network Simulator	Type	Programming Languages	GUI Support	Main Features
NS2	Open Source	- C++ - OTcl	Limited	- Traffic distribution - Various protocol support - Scenario Generators - Agent generator - Topology generator - Routing generator - Event scheduler - NAM and X-Graph visualization
NS3	Open Source	- C++ - Optional Python bindings	Yes	- Less memory footprint - PCAP packet trace file generation - Incorporation with open-source networking software - Lightweight virtual machines - Well-documented
OPNET	Commercial	- C - C++	Yes	- Ability of external code component run - Powerful graphical support - NetDoctor - Compatible with complex networks and intensive traffic-flows - OPNET Modeller - Well-documented
JSIM	Open Source	- Java	Yes	- Loosely-coupled component-based programming model - Dynamic thread execution - Simple and well-defined component-based architecture - Extended programming flexibility - Well-documented
QualNet	Commercial	- C++	Yes	- Real-time speed support - Parallel computation - 500 to 20.000 nodes - Supports clusters and distributed computing - Well-documented
OMNeT++	Open Source for Study and Research Purposes Commercial for industrial purposes	C++ C# JAVA	Yes	- Eclipse-based IDE - General-purpose simulator - Component based extensible architecture - NED Language - Simulation kernel and models can be embedded easily in applications - GNED (Graphical Network Editor) - Graphical and command line interfaces - Well-documented

Network Description Languages(NED)

Behavioral characteristics should be defined with the C++ programming language in order to develop network simulations with OMNeT++. In addition, the NED language is used to create the simulation model where the simulation will be run. Module identification and connections between modules are performed by using the NED language. Thanks to its features, NED language is suitable for either big or small projects.

Due to its hierarchical structure, it provides a minimization of complexity. Similarly, it brings the benefits of inheritance by means of component-based structure. Thus, the features defined for a base module can be used in many submodules without any code repetition and allow the use of frameworks. The NED language uses a package structure, so the conflicts of method names are smoothly avoided. It can also be expressed in XML by using tree representation and cross conversion can be achieved with XML. Saving network definitions in individual NED files associated with their names is conventional but not mandatory. Modules and networks are defined in the NED file.

An example network definition is as follows;

Table 2.

1 *2* *3* *4*	*// A sample network* **network** MyNetwork { }	A new network named MyNetwork is defined in the code fragment on the left hand side. The defined network is completely empty.

There is a comment line which is the first line of the code. For making the NED files more understandable, comment lines are also used by OMNeT++ as documentation in some places. Networks can contain many submodules. These submodules should also be defined within the same NED file or in a separate NED file. An example Node module is defined in the NED file as follows;

Table 3.

1 *2* *3* *4*	*// A sample Node module* **simple** Node { }	In the piece of code on the left hand side, a module of SimpleModule type has been defined.

For the behavior of a module defined in the NED file, a decisive C++ source code file should also be created. This created module can now be used as a sub-module in a network.

Table 4.

1 *2* *3* *4* *5* *6* *7* *8* *9* *10* *11*	*// A sample Node module* **simple** Node { } *// A sample network* **network** MyNetwork { **submodules:** node1: Node; node2: Node; }	Two nodes defined as submodules in MyNetwork network are now elements of the network. If the Design tab is opened after making a definition, the view seen in Figure 5 will be obtained. Although there are two nodes in MyNetwork, we cannot connect these nodes as such.

For a module to establish any connection with an external unit, it should have gates allowing such cases. Expansion units of the modules expressed as ports in many other platforms are called as gates in the NED language in order to prevent name clutter as the port term is used in many other similar terms. There are three different gate types. These are input, output, and inout. The input gate provides messages to the module from outside, the output gate allows the module to send messages to the outside, the inout gate includes the input and output gateways together. In other words, both sending and receiving processes can be carried out through the same gateway. An input gate can be connected to an output and inout gate of another module. Moreover, an output gate can be connected to an input or inout gate of another module, and the inout gate can be connected to 3 gate types depending on the situation. A gate normally accepts only one connection. It is necessary to create more than one gate to connect a module to more than one module. However, multiple connections can be made to gateways defined as vectors. Square brackets "[ ]" are used to define a gate as a vector, similar to the array representation in programming languages. When defining a gate vector, the size of the vector can be limited by specifying it in square brackets, or it is possible to define the vector size dynamically by leaving it as a blank. The Node module defined above with one input and one output gate can be shown as follows.

Table 5.

1 *2* *3* *4* *5* *6* *7* *8* *9* *10*	*// A sample Node with one input and* *// one output gate* **simple** Node { **gates:** **input** in; **output** out; }	In this piece of code, the module named Node has one **input** and one **output** gate. Namely, this module can only send messages directly to an external module and can only receive messages from an external module.

input and **output** gates may connect with different modules. However, it is not mandatory to connect them to the same external module. To illustrate, we may define two instances from the Node module and make them sending messages together. We may also define three instances and connect them with the next one obtaining the ring topology. We should define their connections in the **connections** field in order to connect the submodules in the same network.

The above-mentioned two module connection situation can be implemented as below.

Table 6.

1 *2* *3* *4* *5* *6* *7* *8* *9* *10* *11* *12* *13*	*// Two node network* **network** MyNetwork { **submodules:** node1: Node; node2: Node; **connections:** node1.out **-->** node2.in; node2.out **-->** node1.in; *}*	In the code fragment on the left hand-side, two submodules of Node module type are defined in MyNetwork. The **output** gate of the submodule called node1 is connected to the **input** of node2 and the **output** of node2 is connected to the **input** of node1.

--> operator is used to express a unidirectional connection. <--> operator is used to make a bidirectional connection between two nodes. With the code mentioned above, node1 and node2 can send messages to each other. The image of this NED code is shown in Figure 6 in the Design tab of the OMNeT++ NED editor.

Figure 5. Two not connected nodes

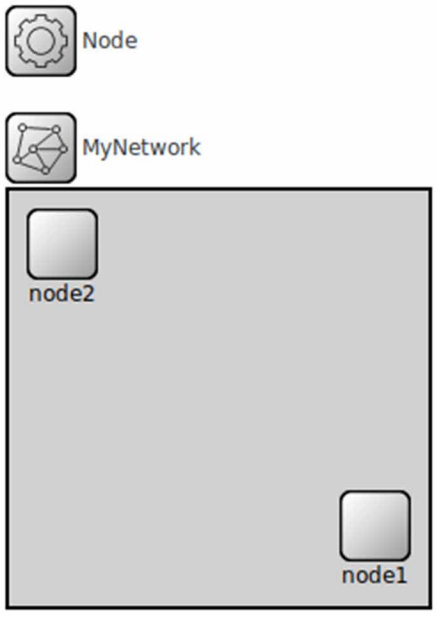
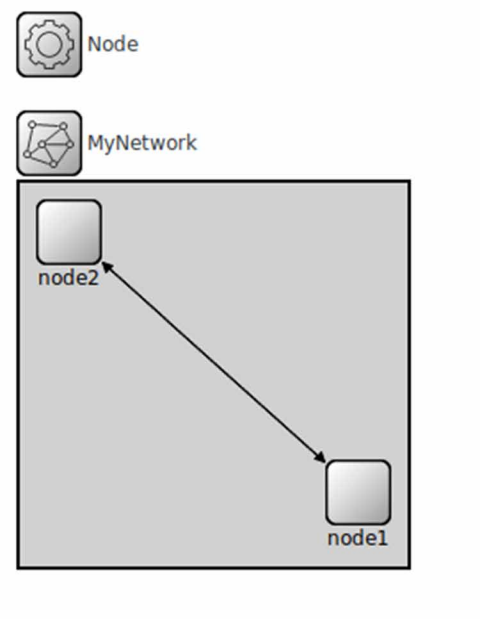


Figure 6.Two bidirectional connected nodes



If we would like to have a unidirectional ring topology by creating 3 submodules with the same Node module, it can be defined as follows.

Table 7.

1 *2* *3* *4* *5* *6* *7* *8* *9* *10* *11* *12*	*// Three node network* **network** MyNetwork { **submodules:** node1: Node; node2: Node; node3: Node; **connections:** node1.out **-->** node2.in; node2.out **-->** node3.in; node3.out **-->** node1.in; }	The view on a network Design tab defined below will be as shown in Figure 7. In this topology, node1 can only send messages to node2 and receive messages only from node3. Similarly, node2 can only send a message to node3 and only receive a message from node1, while node3 can only send a message to node1 and only receive a message from node2. Therefore, a unidirectional ring topology is formed.

Table 8.

1 *2* *3* *4* *5* *6*	*// A sample Node with gate vector* **simple** Node { **gates:** **inout** gate[]; }	Gate vectors are also frequently used. To illustrate, let's update the gates of our Node module as shown.

A topology network containing 4 of this Node module and being fully interconnected can be created as follows;

Table 9.

1 *2* *3* *4* *5* *6* *7* *8* *9* *10* *11* *12* *13* *14* *15* *16* *17* *18* *19* *20* *21* *22* *23*	*// Fully connected, four node network* **network** MyNetwork { **submodules:** node1: Node; node2: Node; node3: Node; node4: Node; **connections:** node1.gate++ **<-->** node2.gate++; node1.gate++ **<-->** node3.gate++; node1.gate++ **<-->** node4.gate++; node2.gate++ **<-->** node3.gate++; node2.gate++ **<-->** node4.gate++; node3.gate++ **<-->** node4.gate++; }	In the network definition on the left hand side, inout gate and gate vector are used together. By using the inout gate, it is not necessary to create two separate gates for input and output when defining the connection between the submodules. It enables to open the module as many times as desired by using the gate vector. When using the gate vector, "++" operation is performed to move on the vector in order to define the next gate.

In this example, the <--> operator is used to provide the connection between submodules bilaterally. By using the inout gate, gate vector structure and <--> operator together, all nodes are connected with 6 connection lines. The image of the above network in the Design tab is shown in Figure 8.

Channels can also be used when defining connections between nodes in NED files. A channel contains the parameters and behavior information about the connections. There are 3 integrated channels available in OMNeT++. These are IdealChannel, DelayChannel, and DatarateChannel. IdealChannel does not have any parameters and any delays between nodes or undesired situations that may arise from other real-life conditions. The use of IdealChannel causes same behaviors to be demonstrated as not using channels on two-node connections. The channel named DelayChannel has two parameters. The Delay parameter takes type double and a time unit and determines the propagation delay of the two messages. Another parameter named Disabled is set to false by default. If this variable is set to true it will cause all messages passing through the channel to be dropped. In addition to the delay and Disabled parameters in DelayChannel, the channel named DatarateChannel has a data rate parameter having a double value and supplied with its unit. DatarateChannel provides a basic level of error modeling thanks to its error parameters.

Figure 7. Three nodes with unidirectional ring topology

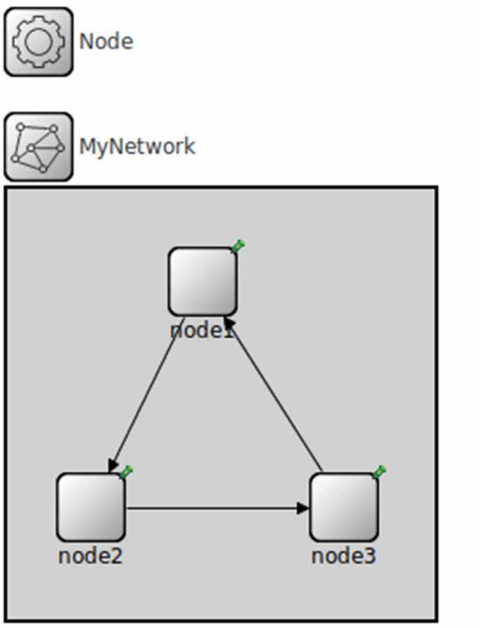
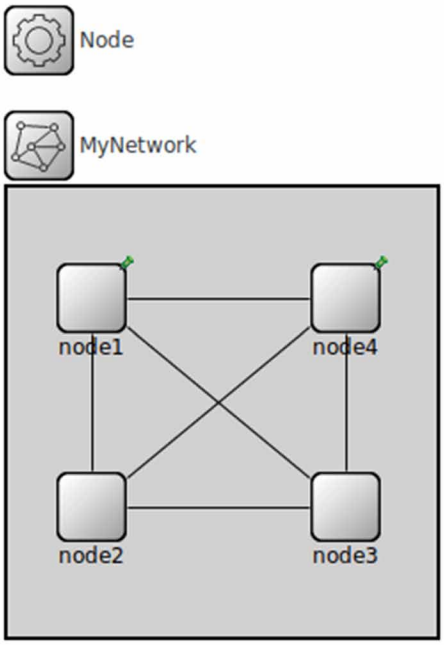


Figure 8. Bidirectionally connected nodes using inout gates



NED language has also powerful features offered by programming languages. Creating parameters, conditional structures and loops that can be used as variables are among the most used ones. For example, parameters in a created network can be defined as follows;

Table 10.

1 *2* *3* *4* *5* *6* *7* *8*	*// A sample Node with parameters* **network** MyNetwork { **parameters:** **int** node_count = 5; **submodules:** node[node_count]: Node; }	In the piece of code on the left hand side, a parameter named node_count of int type is defined and a value of 5 is assigned to it. Just below, the node vector is defined as a submodule and the size of the vector is set to the node_count parameter.

In this code, MyNetwork network has 5 submodules. The submodule vector defined above enabled the topology to acquire a dynamic structure. By changing the node_count parameter, it can be easily scaled from a small 5-element network to a large 5000-element network. Of course, a connection should be created according to the increasing number of nodes in a network with a variable number of elements. Therefore this process can be conveniently performed by using the loop instead of coding the connections between individual nodes.

Table 11.

1 *2* *3* *4* *5* *6* *7* *8* *9* *10* *11* *12* *13*	*// A sample Network with parameters* **network** MyNetwork { **parameters:** **int** node_count = 5; **submodules:** node[node_count]: Node; **connections allowunconnected:** **for** i = 0..node_count-2 { node[i].gate++ **<-->** node[i+1].gate++; } node[node_count-1].gate++ **<-->** node[0].gate++; }

If ***allowunconnected*** statement is included in the definition of ***connections*** then errors for idle (unconnected) gates can be avoided. In the ***for*** loop in the ***connections*** section, the elements of the node vector from 0 to 3 are connected bilaterally with the next indexed node respectively. In the statement after the loop, the 4. indexed node is connected to the 0. indexed node and thus, a ring topology is created. Dynamic structures identified are not fully visualized in the Design section of the NED editor. When you open the Design tab of the above code piece, you will get a view as shown in Figure 9. When you run the simulation; you will get a view as shown in Figure 10. When you change the value of the node_count parameter from 5 to 50 in order to benefit from the use of the parameter, When you run the simulation, you will obtain a much larger ring topology as shown in Figure 11.

Figure 9. Network before execution

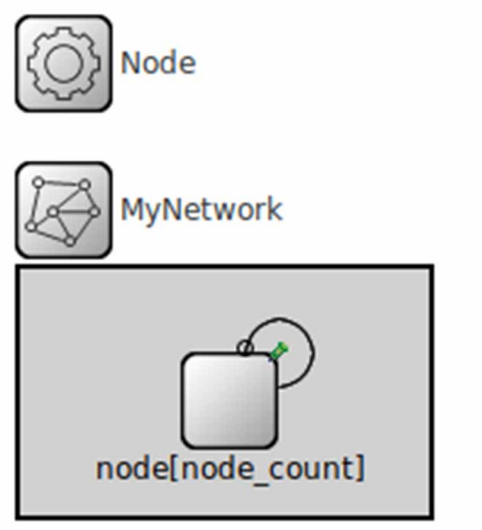


Figure 10. Network in execution

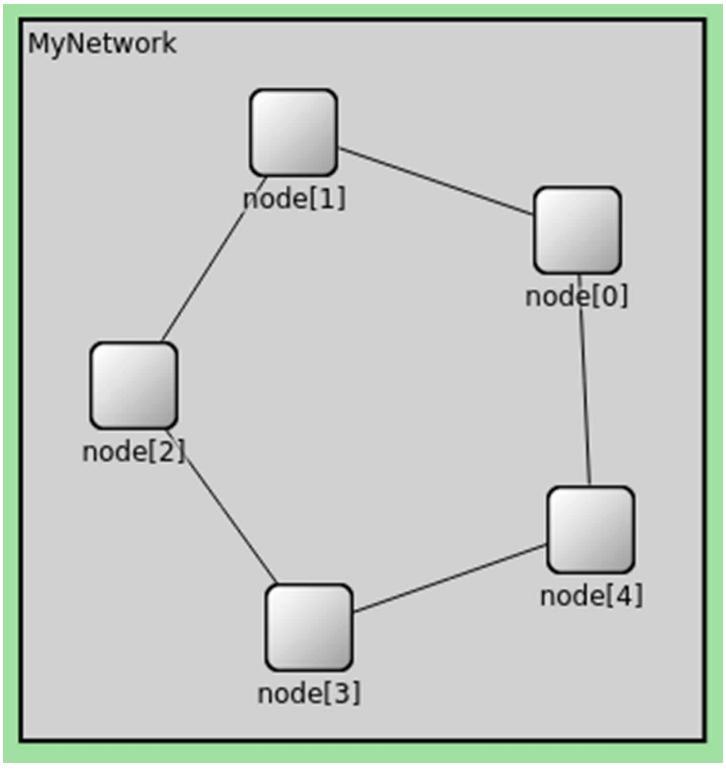
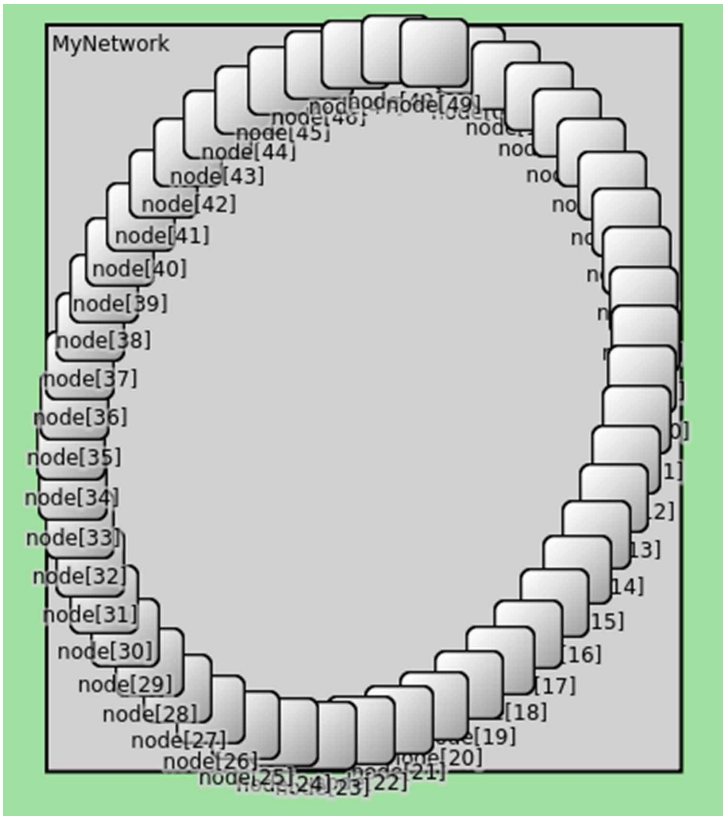


Figure 11. Network in execution with 50 nodes



There are more details about configuring the NED file. For more details,, you can examine the OMNeT ++ Simulation Manuals. Online link: https://doc.omnetpp.org/omnetpp/manual/

THE IMPLEMENTATION OF CENTRALIZED AND DECENTRALIZED ALGORITHMS IN OMNeT++

Routing algorithms can be classified in several ways (Stallings, 2007; Tanenbaum, 1996). One of these classification types depends on whether the nodes have general information about the topology. If a node is only knowledgeable about itself and its neighbor nodes and makes a routing process accordingly, it is called a "distributed routing method". If one or more nodes in the topology have information about the units further away from their neighbors or all of the topology then such topologies are called centralized topologies (Tommiska and Skyttä, 2001).

Since information about the topology is known by the nodes, no computational load falls on the nodes in a routing process in the centralized topologies. On the other hand, when the routing is to be made since the nodes have to communicate with their neighbors, more computing load falls on the nodes compared to using centralized algorithms in distributed routing methods. Routes created in centralized routing algorithms depend on the topology structure. Therefore, tolerance of connection problems cannot

provide a flexible structure as the node-based neighborhood information in the distributed algorithm. For this reason, the distributed routing algorithms are generally more tolerant to the problems than central algorithms in topology changes and link failures (Poonguzharselvi and Vetriselvi, 2013).

Figure 12. Creating a new project from the menu

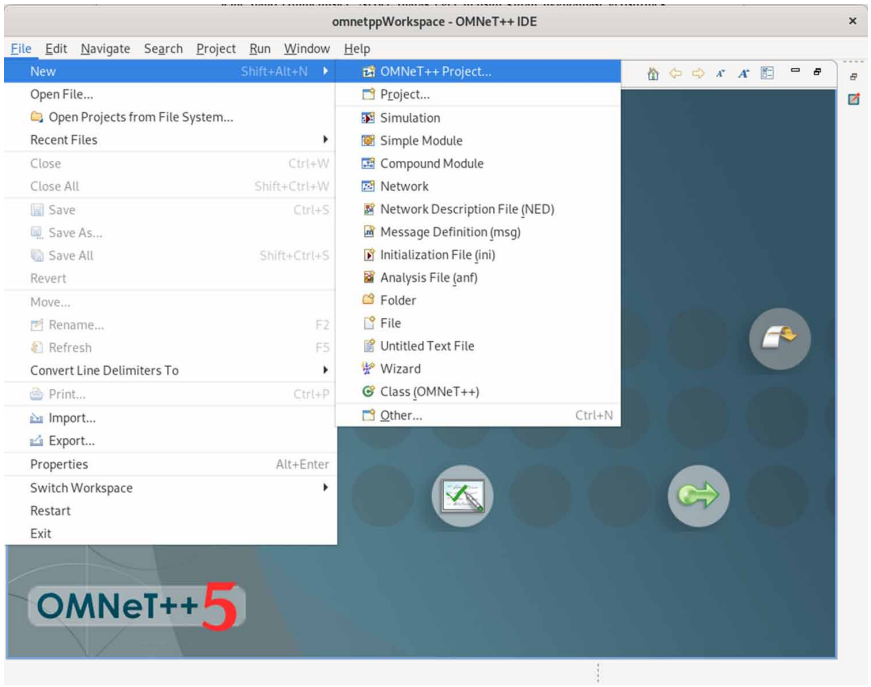


Figure 13. Creating a new project's popup window

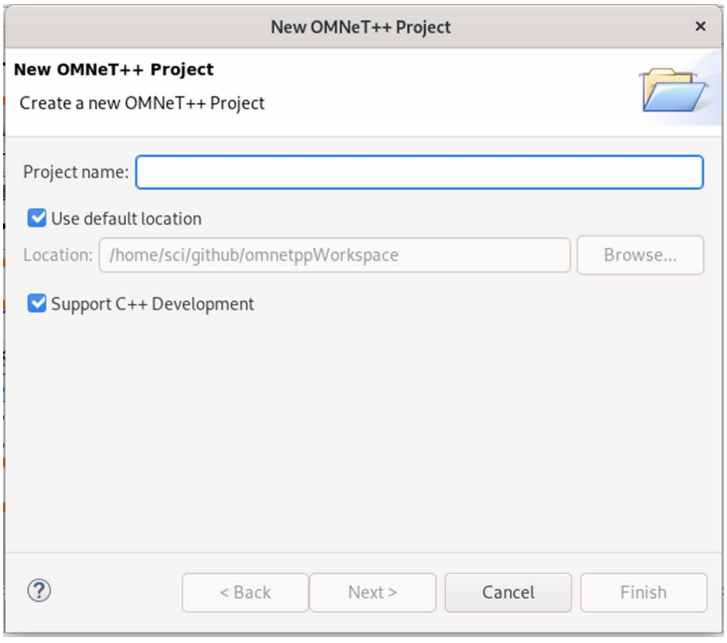


Figure 14. Project structure that contains all the files

Figure 15. Project structure divided into sub-directories

The Implementation of Centralized Algorithm in OMNeT++

Dijkstra's algorithm which was developed by Edsger Dijkstra in 1956 (Sedgewick and Wayne, 2011) is one of the most popular centralized algorithms for finding the shortest path (Luo et al., 2020) (Ortega-Arranz et al., 2014). Edge information representing the connection between nodes in a graph and the algorithm finding the shortest paths between a node determined by a greedy approach and all other nodes are also used by routing protocols in computer networks. The pseudo-code of the algorithm is as in Algorithm 1 (Jungnickel, 2005).

Running Dijkstra's Routing Algorithm on a Determined Topology Using OMNeT++

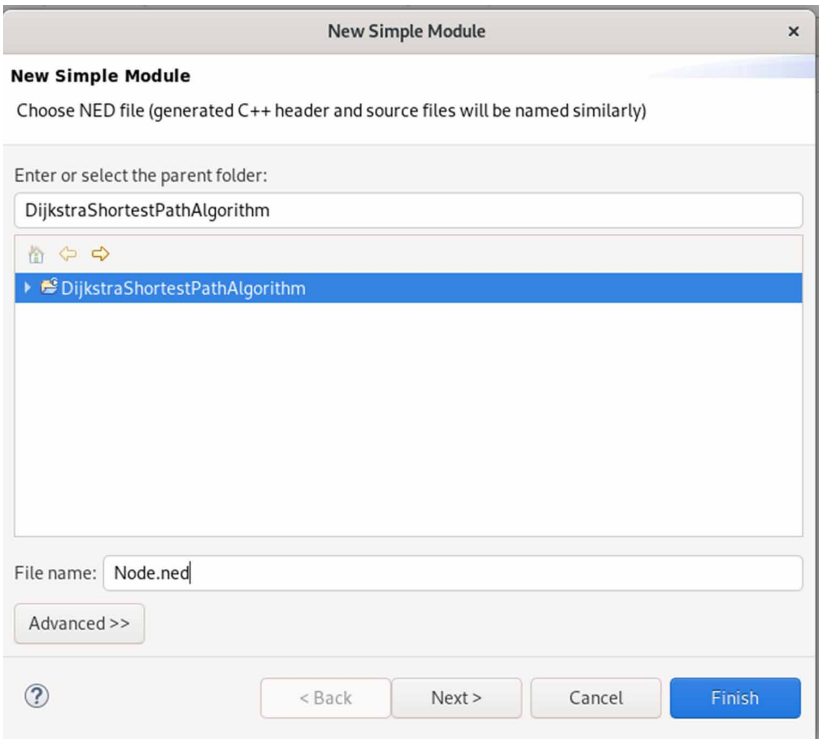
We should first create an OMNeT++ project to run the routing process on a topology that we have determined on OMNeT++ using Dijkstra's algorithm. This can be performed by following the steps shown in Figure 12 and Figure 13.

Table 12. Algorithm 1.

1	$d(s) \leftarrow 0$,
2	$T \leftarrow V$;
3	**for** v ∈ V \ { s } **do** d(v) ← ∞ **od**
4	**while** T ≠ ∅ **do**
5	find some $u \in T$ such that $d(u)$ is minimal;
6	$T \leftarrow T \setminus \{ u \}$;
7	**for** $v \in T \cap A_u$ **do** d(v) ← min($d(v)$, $d(u) + w(uv)$) **od**
	end while

First, let's create a new module. In order to bring the new features and behaviors to the simple modules offered by OMNeT++, a new module should be created. The new module can be created using the popup window shown in Figure 16 by following the steps of **New -> SimpleModule** from the menu opened by right-clicking on the project. When the module is created, a **NED** file, a **.cc** file and a **.h** file for the module will be created as shown in Figure 17.

Figure 16. Creating a new simple module



Although all of them could be created manually, it is preferred to use the previous method since it brings the essential components and functions ready for the module. Now, let's define the input and output gates of this module of array type as shown in Code.1.

Figure 17. View of the created Node module

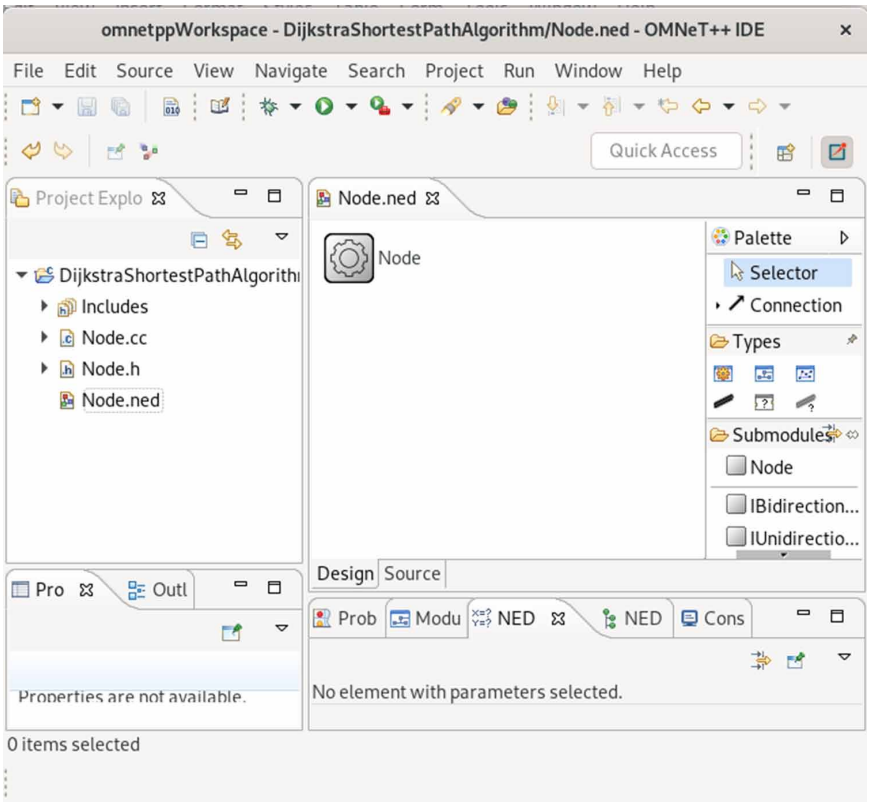


Table 13.

1 2 3 4 5 6 7	*// Node with input and output gate vector* **simple** Node { **gates:** **input** in[]; **output** out[]; }	Multiple connections can be added to the gates defined as arrays. It is easier to establish multiple connections between nodes thanks to the array gates especially when creating dynamic topologies.

Otherwise, it is necessary to re-define the gates manually for each entry and exit gate. Then, use the New -> NED (Network Description File) steps from the menu opened by right-clicking on the Project., NED file is created by using the opened window shown in Figure 18. In this file, the topology that we want to manipulate using Dijkstra's algorithm is created. For this purpose, the network editing environment with a graphical interface integrated with the OMNeT++ IDE environment can be used or it can be created by writing the source code directly in the NED language. To switch between these options, the following Design and Source tabs can be used as seen in Figure 19. It is also possible to use the aforementioned options together. The desired features are made through the graphic interface while more detailed settings are made through the source code.

Figure 18. Create new NED file window

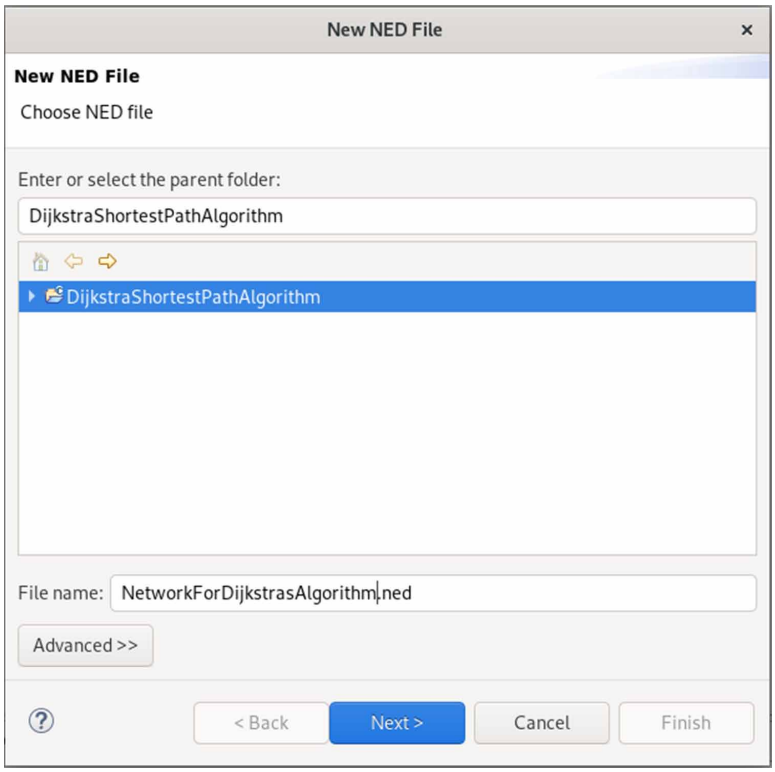
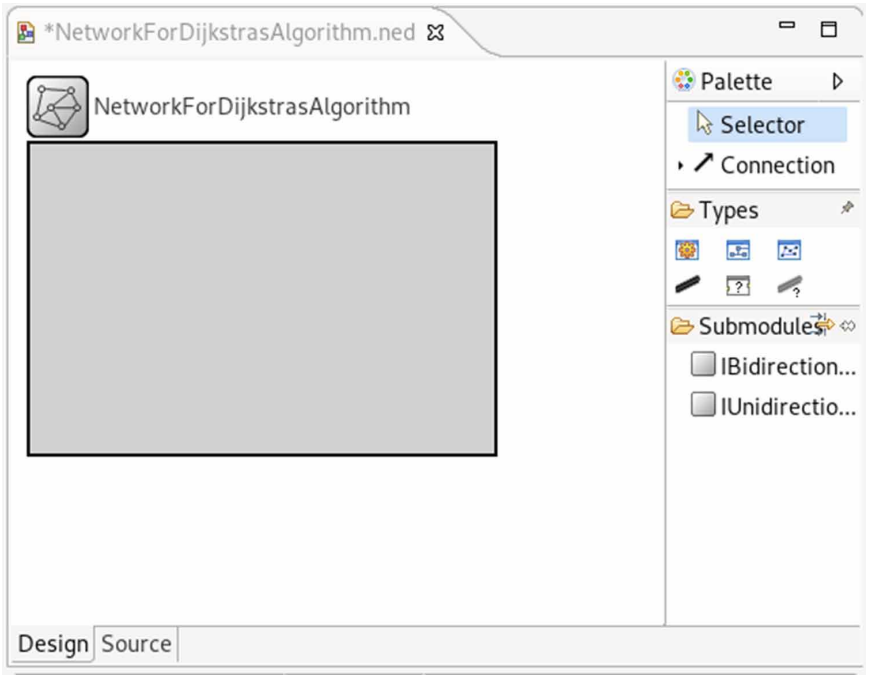


Figure 19. NED file preview



It is possible to create static and dynamic network topologies by using the NED file. The graphic interface may be sufficient to create static topologies. It is often necessary to edit the source code to create dynamic topologies. For example, if you want to test all connection information with a static number of nodes on a specific scenario, you can create a static topology and test it on the topology. Generally, the settings made on the graphic interface will be sufficient for this process. However, if the topology created is desired to be scaled or the aim is to create random connections between nodes and to assign random delays to these connections, it is possible to establish a dynamic topology structure by taking the advantages of the features offered by the NED language. It will be very tedious to do these operations manually. Using the source code of the NED language, variables, loops, conditional structures can also be created and many more programming characteristics can be used. More detailed information about the NED file can be obtained from the documents of OMNeT++ ("OMNeT++ Simulation Manual - The NED Language," n.d.).

Let's run Dijkstra's routing algorithm on this topology by creating a static network topology. In the next routing algorithm example, we will also create a dynamic network topology. We can take the map of Europe as an example to create a static topology. Using the dynamic features provided by the NED structure, let's define a visual topology consisting of modules called Node. The source code is in Code 2. The visual version of this topology is shown in Figure 20.

Table 14. Code 2. NetworkForDijkstrasAlgorithm.ned

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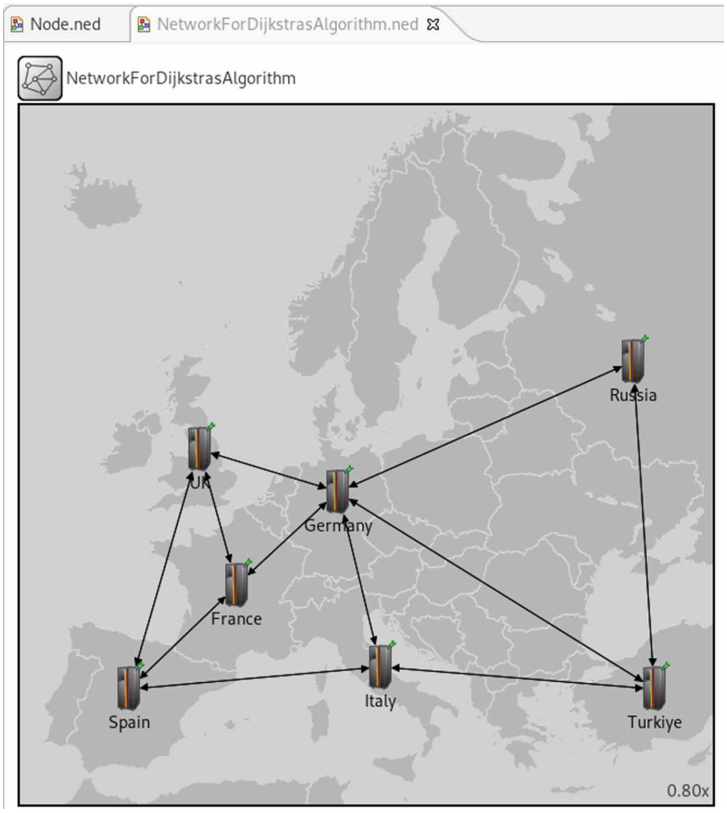
20
21
22
network NetworkForDijkstrasAlgorithm
{
@display("bgi=maps/europe;bgb=618,620");
 submodules:
Turkiye: Node { @display("p=564,522;i=device/mainframe"); } // Graph index: 0
UK: Node { @display("p=162,304;i=device/mainframe"); } // Graph index: 1
Russia: Node { @display("p=545,240;i=device/mainframe"); } // Graph index: 2
Italy: Node { @display("p=331,511;i=device/mainframe"); } // Graph index: 3
Spain: Node { @display("p=094,533;i=device/mainframe"); } // Graph index: 4
France: Node { @display("p=213,417;i=device/mainframe"); } // Graph index: 5
Germany: Node { @display("p=293,368;i=device/mainframe"); } // Graph index: 6
 connections:
Turkiye.out++ --> Russia.in++;
 // And other connections...
}
```

To illustrate, we have selected the map of Europe that came with OMNeT++ as the background for our network. You may set any other pictures on your computer as a background to your network. In addition, the symbols of the nodes representing the countries can be personally visualized with the icons coming with OMNeT++ or the pictures on the computer as seen in this example. In the graphic representation of the topology, the nodes will take index in order, starting from 0. We will use this index information for determining the destination node.

Figure 20. Visual topology view



We created our Node module and network to exemplify 7 countries on the European map. Now we can go to the programming section. Below you can see the source code written for the Node module in Code 3 and Code 4.

Table 15. Code 3. Node.h

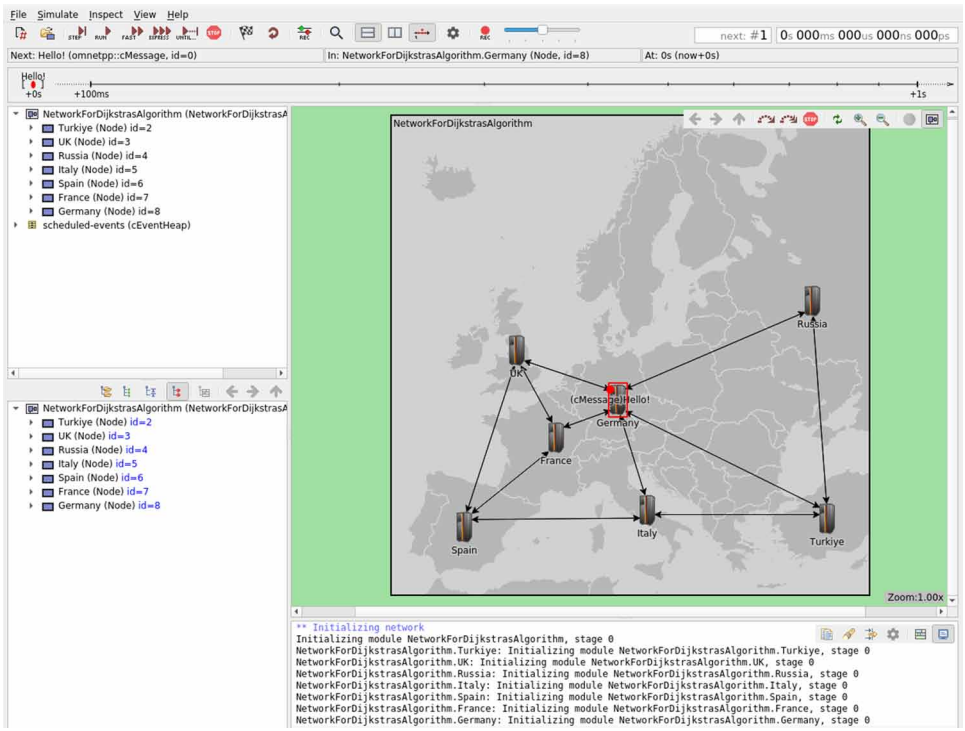
```
1  #ifndef __DIJKSTRASHORTESTPATHALGORITHM_NODE_H_
2  #define __DIJKSTRASHORTESTPATHALGORITHM_NODE_H_
3
4  #include <omnetpp.h>
5
6  using namespace omnetpp;
7
8  class Node: public cSimpleModule
9  {
10 protected:
11 virtual void initialize();
12 virtual void handleMessage(cMessage *msg);
13 virtual cTopology* generateTopology(const char *typeName, const char *topologyName);
14 };
15
16 #endif
17
```

Table 16. Code 4. Node.cc

```
1
2
3
4   #include "Node.h"
5
6   #define SRC_NODE "UK"
7   #define DEST_NODE 0 // 0 is Turkey's Graph index
8
9   Define_Module(Node);
10
11  void Node::initialize()
12  {
13  // If node index is equal to source node index
14  if(strcmp(SRC_NODE, getName()) == 0){
15  // Generate new topology
16  cTopology *topo = generateTopology("Node", "myTopology");
17
18  // Get source and destination nodes
19  cTopology::Node *sourceNode = topo->getNodeFor(this);
20  cTopology::Node *destNode = topo->getNode(DEST_NODE);
21
22  // Calculate shortest path from this node to destination node
23  topo->calculateUnweightedSingleShortestPathsTo(destNode);
24
25  // Generate and send message
26  cMessage *msg = new cMessage("Hello!");
27  send(msg, sourceNode->getPath(0)->getLocalGate());
28  }
29  }
30
31  cTopology* Node::generateTopology(const char *typeName, const char *topologyName){
32  std::vector<std::string> nedTypes;
33  nedTypes.push_back(typeName);
34  cTopology *topo = new cTopology(topologyName);
35  topo->extractByNedTypeName(nedTypes);
36  return topo;
37  }
38
39  void Node::handleMessage(cMessage *msg)
40  {
41  // Generate topology
42  cTopology *topo = generateTopology("Node", "myTopology");
43
44  // Get source and destination nodes
45  cTopology::Node *sourceNode = topo->getNodeFor(this);
46  cTopology::Node *destNode = topo->getNode(DEST_NODE);
47
48  // Calculate shortest path from this node to destination node
49  topo->calculateUnweightedSingleShortestPathsTo(destNode);
50
51  // Send message to the next node if this node is not the destination.
52  if(sourceNode->getNumPaths() != 0){
53  send(msg, sourceNode->getPath(0)->getLocalGate());
54  }
55  }
56
57
58
```

When we run the simulation prepared with the above codes from the menu, follow the path Run -> Run (Ctrl + F11) and a simulation as shown in Figure 21 will be opened. Using the NED file We can play the simulation at different speed options either automatically or step by step using the NED file. We can also rewind, stop, speed up, terminate and restart our simulation.

Figure 21. Executed simulation view



The Implementation of Decentralized Algorithm in OMNeT++

The flooding based algorithms are mainly depend on the principle that the message starting from a single source is forwarded to all its neighbors by all nodes receiving the message. It is one of the most popular decentralized algorithms. In this type of propagation, the process of propagation in the network continues until all nodes transmit their messages to their neighbors and receive the answers (Poonguzharselvi and Vetriselvi, 2013). Flooding based algorithms are distributed since they do not need a central knowledge of topology. Each node only knows about its ancestors, its neighbors, and if any, among these neighbors, the child nodes. In other words, a node's knowledge of topology covers only one-hop distance. The steps of creating Flooding Based Asynchronous Spanning Tree Construction algorithm are given in Algorithm 2 (Erciyes, 2013).

The algorithm is called *Flood_ST* where the message types used are *probe*, *ack* and *reject*. Any node willing to create a spanning tree sends the *probe* message to its neighbors. Then this message is transferred to other nodes and the algorithm is started. Since a node can receive more than one *probe* message, as shown in Algorithm 2, *ack* and *reject* messages are required to check whether a node receives a *probe*

message. The root starts the algorithm. When the node *i* receives a *probe* message, the sender marks *j* as the parent and sends an *ack* message to *j*. After parent *j* receives an *ack* message, it marks one of the children as its child. Then node *i* sends the *probe* message to all its neighbors except for parent *j*. If a node already has a parent when it receives a *probe* message from a neighbor node, it sends a *reject* message to its neighbor node. The termination condition of the algorithm is when the number of children and unrelated neighbors of a node *i* is equal to their neighbors other than the parent. This situation is pointed out in the 10th line of the algorithm. It should be noted that the main body of the algorithm between lines 10 and 21 is also executed by root. The finite state machine representation of the algorithm is shown in Figure 23 and the steps of the algorithm's progress in an example topology is shown in Figure 24.

Figure 22. FSM of Flood_ST algorithm

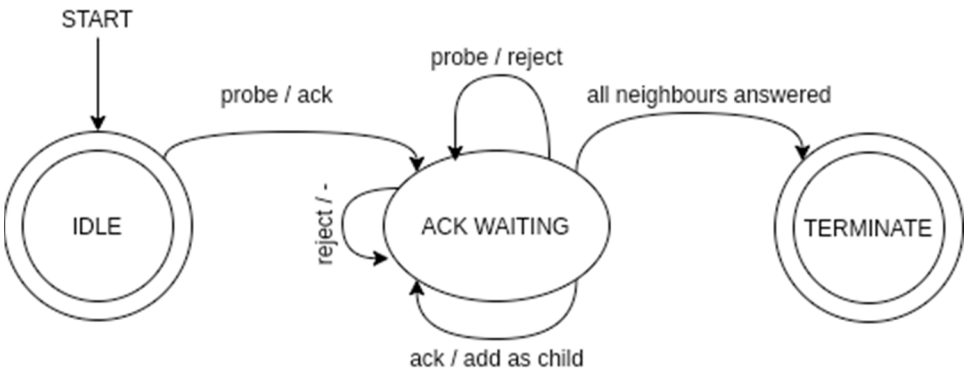


Figure 23. Step-by-step graph of creating flooding based asynchronous spanning tree construction algorithm

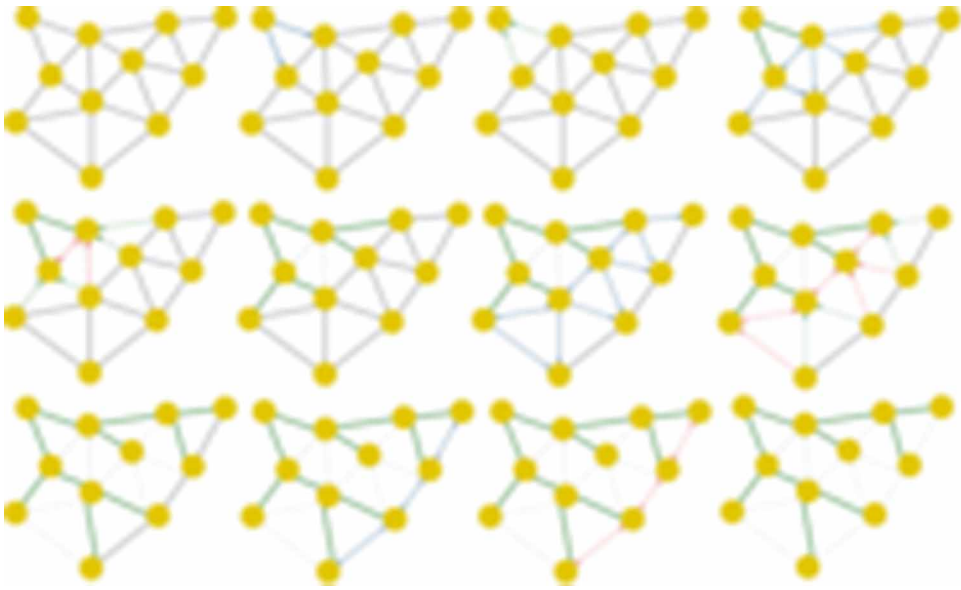
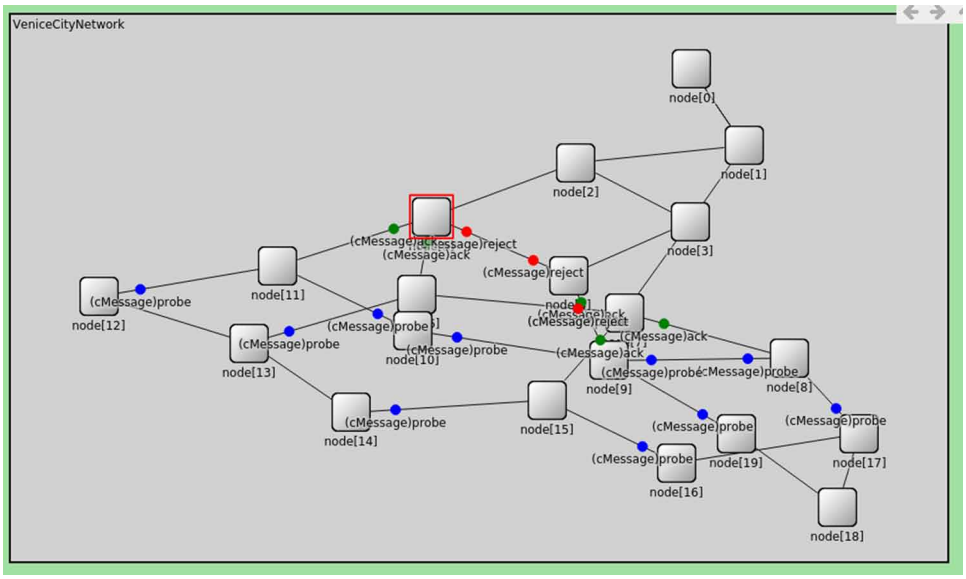


Figure 24. Simulation view showing PROBE, ACK and REJECT messages



Let's implement the algorithm shown above and the visual progress step by step.

Table 17. Algorithm 2.

```
1  int parent ← ⊥
2  set of int children ← ∅, others ← ∅
3  message types probe, ack, reject
4
5  if i = root then
6   send probe to Γ(i)
7   parent ← i
8  end if
9
10 while (children ∪ others) ≠ Γ(i) \ {parent}) do
11  receive msg(j)
12  case msg(j).type of
13  probe: if parent = ⊥ then
14 parent ← j
15  send ack to j
16  send probe to Γ(i) \ { j }
17  else
18  send reject to j
19  ack: children ← children ∪ { j }
20  reject: others ← others ∪ { j }
21 end while
```

Since the number of input and output ports may vary in topologies containing different numbers of nodes, an inout type gate vector is defined in the Node module.

Table 18. Code 5. Node.ned

```
1  // Node with inout gate vector
2  simple Node
3  {
4   gates:
5  inout gate[];
6  }
```

Table 19. Code 6. VeniceCityNetwork.ned

```
1
2
3   network VeniceCityNetwork
4   {
5    parameters:
6   int nodeCount = 20;
7   int half = int(nodeCount / 2);
8   @display("bgb=955,557");
9    types:
10  channel Channel extends ned.DelayChannel
11  {
12  delay = 100ms;
13  }
14  channel Channel1 extends ned.DelayChannel
15  {
16  delay = 200ms;
17  }
18   submodules:
19  node[nodeCount]: Node;
20   connections:
21  for i=0..nodeCount-2 {
22  node[i].gate++ <--> Channel <--> node[i+1].gate++;
23  }
24  for i=0..half-1 {
25  node[i].gate++ <--> Channel1 <--> node[i*2+1].gate++;
26  }
27  }
28
29
```

We have defined 2 channels in this network. These channels are inherited from DelayChannel. One of them has a delay of 100ms and the other has a delay of 200ms. Due to the delay difference, it will be easier for us to see where the algorithm has found the fastest routes.

Two loops are used for node connections. Each node is tied to the next node in the first loop, while, the nodes in the first half are tied together by i times 2 plus one (i*2 +1) indexed node in the other loop.

ROOT_NODE and 3 different message types are defined in this header file. Thanks to the color numbers provided with them, these message types appear in different colors when the simulation is run, and makes it easier to distinguish them. PROBE messages are displayed in blue, ACK messages in green and REJECT messages in red.

The **parent_gate** variable of int type keeps the information of the gate leading to the parent node. The gates used to reach the nodes designated as children are kept in the **children** array.

Table 20. Code 7. Node.h

```
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
#ifndef __FLOODST_NODE_H_
#define __FLOODST_NODE_H_

#include <string.h>
#include <omnetpp.h>

using namespace omnetpp;

#define ROOT_NODE 0 // Root Node's Index

#define PROBE new cMessage("probe", 2) // Color 2 = Blue
#define ACK new cMessage("ack", 1) // Color 1 = Green
#define REJECT new cMessage("reject", 0) // Color 0 = Red

class Node: public cSimpleModule
{
int parent_gate; // Parent node gate address
std::vector< cGate* > children; // Children gates

protected:
virtual void initialize();
virtual void handleMessage(cMessage *msg);
};

#endif
```

When we save and execute the codes described in the comment lines above, PROBE messages are shown in blue, ACK messages in green and REJECT messages in red, as shown in Figure 24. In addition, the logs made in the code can be displayed on the log screen at the bottom of the simulation window as shown in Figure 25.

CONCLUSION

Simulators are widely used to test, verify, and analyze the performances of distributed algorithms. We have briefly described simulators used for computer networks such as NS2, NS3, Opnet, JSim, Qualnet and OMNeT++. The emergence of networking simulation paradigm has highlighted the significance of a cost-effective implementation strategy for communication networks. Therefore, cost-effective approaches in communication networks have attracted considerable attention in recent years. Since the cost is a crucial factor in communication networks, cost-effective applications are of paramount importance in network simulators. This chapter summarized the procedure and methodology to simulate the network algorithms in multi-hop networks using OMNeT++. Additionally, how available models can be integrated to design a network was addressed. The simulation framework (INET) for multi-hop networks has been introduced as well.

Table 21. Code 8. Node.cc

```
#include “Node.h”

Define_Module(Node);

void Node::initialize()
{
parent_gate = -1; // Parent is not set
if (getIndex() == ROOT_NODE) { // If it’s root node
parent_gate = 0; // If it’s parent node
scheduleAt(0.0, PROBE); // Send message to itself(in order to follow message)
}
}

void Node::handleMessage(cMessage *msg)
{
EV << this->getIndex() << “: “<< parent_gate << “\n”;

if(strcmp(msg->getName(), “probe”) == 0){ // If received message is probe
cGate *arrival_gate = msg->getArrivalGate(); // save the arrival gate
if(arrival_gate != NULL){ // If message is acceptable (not from itself)
if(parent_gate == -1){ // And parent is not set
parent_gate = arrival_gate->getIndex(); // set arrival gate as parent gate
send(ACK, “gate$o”, arrival_gate->getIndex()); // send feedback with ‘ACK’ message

// Find children
for(int i = 0; i < this->gateCount() / 2; i++){ // Send probe message
if(msg->arrivedOn(“gate$i”, i)){continue;} // to all neighbors
send(PROBE, “gate$o”, i); // except for parent
}
}else{ // If parent is not already set
send(REJECT, “gate$o”, arrival_gate->getIndex()); // Send ‘reject’ message
}
}else{ // If parent node is empty (it is root)
for(int i = 0; i < this->gateCount() / 2; i++){ // Send message to every neighbor
if(msg->arrivedOn(“gate$i”, i)){continue;} // Except the one from which message is received
send(PROBE, “gate$o”, i); // Send probe message
}
}

}else if(strcmp(msg->getName(), “ack”) == 0){ // If received message is ‘ACK’
children.push_back(msg->getArrivalGate()); // include it in children vector
EV << this->getFullName() << “‘s children: “;
for(int i = 0; i < children.size(); i++){ // and print children vector
EV << children.at(i)->getPreviousGate()->getOwner()->getFullName() << “, “;
}
EV << “\n”;
}else if(strcmp(msg->getName(), “reject”) == 0){ // Do nothing if received message is ‘reject’ message
}else{
}
delete msg; // Delete message that has done its job
}
```

Figure 25. Log screen of executed simulation

```
** Event #62  t=1.2  VeniceCityNetwork.node[8] (Node, id=10)  on ack (omnetpp::cMessage, id=121)
INFO (Node)VeniceCityNetwork.node[8]: 8: 0
INFO (Node)VeniceCityNetwork.node[8]: node[8]'s children: node[17] ,
** Event #63  t=1.2  VeniceCityNetwork.node[16] (Node, id=18)  on probe (omnetpp::cMessage, id=123)
INFO (Node)VeniceCityNetwork.node[16]: 16: 0
** Event #64  t=1.2  VeniceCityNetwork.node[18] (Node, id=20)  on probe (omnetpp::cMessage, id=125)
INFO (Node)VeniceCityNetwork.node[18]: 18: 1
** Event #65  t=1.2  VeniceCityNetwork.node[15] (Node, id=17)  on ack (omnetpp::cMessage, id=127)
INFO (Node)VeniceCityNetwork.node[15]: 15: 2
INFO (Node)VeniceCityNetwork.node[15]: node[15]'s children: node[14] ,
** Event #66  t=1.2  VeniceCityNetwork.node[13] (Node, id=15)  on probe (omnetpp::cMessage, id=129)
INFO (Node)VeniceCityNetwork.node[13]: 13: 2
** Event #67  t=1.2  VeniceCityNetwork.node[15] (Node, id=17)  on ack (omnetpp::cMessage, id=131)
INFO (Node)VeniceCityNetwork.node[15]: 15: 2
INFO (Node)VeniceCityNetwork.node[15]: node[15]'s children: node[14] , node[16] ,
** Event #68  t=1.2  VeniceCityNetwork.node[17] (Node, id=19)  on probe (omnetpp::cMessage, id=133)
INFO (Node)VeniceCityNetwork.node[17]: 17: 2
** Event #69  t=1.4  VeniceCityNetwork.node[13] (Node, id=15)  on reject (omnetpp::cMessage, id=135)
INFO (Node)VeniceCityNetwork.node[13]: 13: 2
** Event #70  t=1.4  VeniceCityNetwork.node[13] (Node, id=15)  on reject (omnetpp::cMessage, id=137)
INFO (Node)VeniceCityNetwork.node[13]: 13: 2
** Event #71  t=1.4  VeniceCityNetwork.node[10] (Node, id=12)  on reject (omnetpp::cMessage, id=139)
INFO (Node)VeniceCityNetwork.node[10]: 10: 1
** Event #72  t=1.4  VeniceCityNetwork.node[12] (Node, id=14)  on reject (omnetpp::cMessage, id=141)
INFO (Node)VeniceCityNetwork.node[12]: 12: 0
** Event #73  t=1.4  VeniceCityNetwork.node[19] (Node, id=21)  on ack (omnetpp::cMessage, id=143)
INFO (Node)VeniceCityNetwork.node[19]: 19: 1
INFO (Node)VeniceCityNetwork.node[19]: node[19]'s children: node[18] ,
** Event #74  t=1.4  VeniceCityNetwork.node[17] (Node, id=19)  on probe (omnetpp::cMessage, id=145)
INFO (Node)VeniceCityNetwork.node[17]: 17: 2
** Event #75  t=1.4  VeniceCityNetwork.node[17] (Node, id=19)  on reject (omnetpp::cMessage, id=147)
INFO (Node)VeniceCityNetwork.node[17]: 17: 2
** Event #76  t=1.4  VeniceCityNetwork.node[17] (Node, id=19)  on reject (omnetpp::cMessage, id=149)
INFO (Node)VeniceCityNetwork.node[17]: 17: 2
** Event #77  t=1.4  VeniceCityNetwork.node[14] (Node, id=16)  on reject (omnetpp::cMessage, id=151)
INFO (Node)VeniceCityNetwork.node[14]: 14: 1
** Event #78  t=1.4  VeniceCityNetwork.node[16] (Node, id=18)  on reject (omnetpp::cMessage, id=153)
INFO (Node)VeniceCityNetwork.node[16]: 16: 0
** Event #79  t=1.6  VeniceCityNetwork.node[18] (Node, id=20)  on reject (omnetpp::cMessage, id=155)
INFO (Node)VeniceCityNetwork.node[18]: 18: 1
<!> No more events, simulation completed -- at t=1.6s, event #79
** Calling finish() methods of modules
```

The algorithms based on centralized and distributed approaches for multi-hop networks in OMNeT++ were discussed in this chapter. The main drawback of central algorithms is the need of gathering the entire graph topology in a single node requiring huge amount of data exchange in large networks. Two network algorithms, the shortest path algorithm (Dijkstra) and flooding based asynchronous spanning tree algorithm were adressed step by step in OMNeT++. The implementation, analysis and visualization of these algorithms have been described in this chapter. Furthermore, random network topologies have been created for realistic scenarios to demonstrate the correctness of these algorithms in the era of scalability. Random link delays have been assigned among hosts in OMNeT++ to model the network latency.

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Chapter 2
Comparing Machine Learning Models for the Predictions of Speed in Smart Transportation Systems

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ABSTRACT

In today's world of advanced technologies in IoT and ITS in smart cities scenarios, there are many different projections such as improved data propagation in smart roads and cooperative transportation networks, autonomous and continuously connected vehicles, and low latency applications in high capacity environments and heterogeneous connectivity and speed. This chapter presents the performance of the speed of vehicles on roadways employing machine learning methods. Input variable for each learning algorithm is the density that is measured as vehicle per mile and volume that is measured as vehicle per hour. And the result shows that the output variable is the speed that is measured as miles per hour represent the performance of each algorithm. The performance of machine learning algorithms is calculated by comparing the result of predictions made by different machine learning algorithms with true speed using the histogram. A result recommends that speed is varying according to the histogram.

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INTRODUCTION

With the advancement of the Intelligent Transport System (ITS) and the Internet of things (IoT), logistic and mobility are improved by reducing traffic-related problems. It provides users with prior information regarding traffic details such as traffic congestions, traffic controls, improving traffic safety, gathering traffic data, and parking management which helps in reducing travel time also enhances the safety and comfort of the users in smart cities. The Intelligent transportation system is progressing from a technology-oriented autonomous system to a data-driven integrated system. ITS applications are depended on the quality and size of the data (Zhang et al., 2011). With the availability of data, it is feasible to classify patterns such as the flow of traffic and behavior of a specific user in different traffic conditions to predict future trends and increase the effectiveness of the existing transportation system.

Information such as speed, rotation vector, and acceleration can be tracked and achieved from smartphones using a built-in global positioning system (GPS), sensors, and accelerometer (Susi et al., 2013) (Amtul W et al., 2020). By using these data user's transportation approaches can be recognized and can be used in different applications such as safety, transportation planning, information provision, and environment. By choosing the optimal route for delivering goods and packages to the destination by a secure monitored setup can reduce product delivery time. Many use cases are applicable in such logistics consisting of road traffic congestion solutions with sensors installed on roads and cloud-integrated systems that count, classify and detect vehicles commuting on roads through advanced ML (Machine Learning) techniques, data mining, and artificial neural networks. The setup intensive monitoring includes inclinometers and investigations for humidity and water on the road surface permit maintenance and alert driver or autonomous car for event-based driving inhomogeneous environment. Predictions are done in a real-time approach and compared with the sensed ones certifying zero error on the measurement.

In this paper, we provide an in-depth experimental valuation of the possibility of improving the overall speed that is measured as miles per hour represent the performance of each algorithm by hierarchical framework classifier and by observing structured set preview service realization by different ML models. By comparing several different features and substitute means to collect historical data with different predictive density, volume, and speed. Precisely, the organization of the paper is as follows. After presenting Introduction in section-1, background information of previous related studies is defined in section-2. Section-3 outlines Understanding data, its problem, data collection, data fusion, and data pre-processing. Section-4 represents the methodology of machine learning techniques. Section-5 outlines datasets used then Section-6 valuation of different machine learning methods for the prediction of speeds. Results are defined in Section-7. Finally, the conclusion of the paper is in section-8.

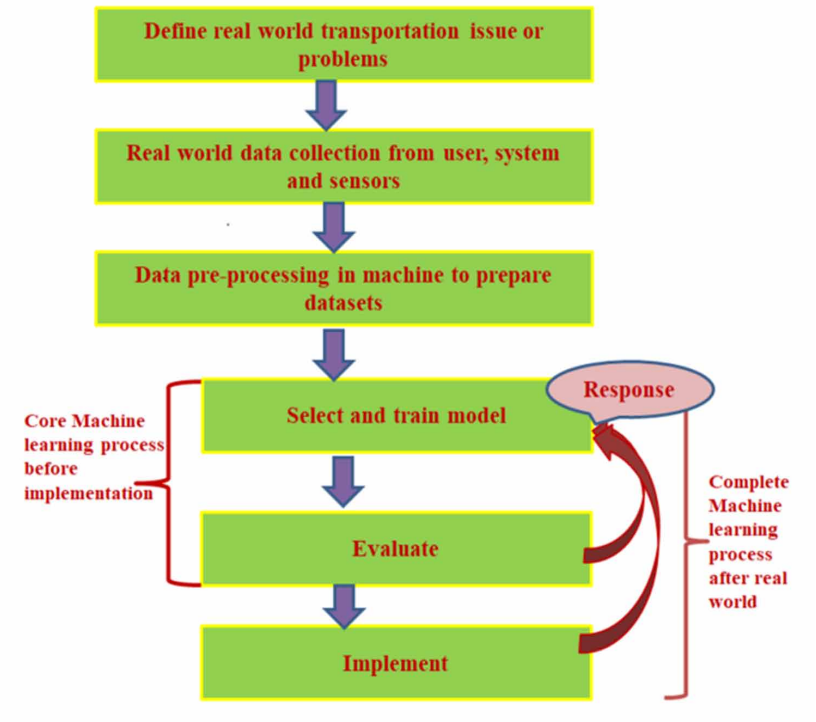
BACKGROUND

To differentiate between different transportation methods researchers have developed many techniques using mobile phones and visual tracking (Wang et al., 2017) (Kwapisz et al., 2011). A wide range of computational learning task types are addressed as active and comprising of several paradigms in machine learning (Bacciu et al., 2012). To build a detection model with high accuracy machine learning techniques are extensively used.

The main aim is to solve supervised learning tasks on ML models and algorithms. The supervised learning method trains an algorithm to calculate output variables based on a given data in which both input and output variables are present. Supervised learning methods such as linear regression, decision tree, Support Vector Machines (SVMs) (Zheng et al., 2010), (International Joint Conference on Neural Networks (IJCNN 2010) (Bolbol et al., 2012), Decision trees, Neural Network have been employed in various studies. Different classifying accuracies have been achieved by these studies. The factors that affect the detection of transportation speed accuracy are monitoring period, sensors, data resources, and the number of modes (Jahangiri & Rakha, 2015).

The important factor such as accuracy, efficiency, and robustness of the machine learning algorithm of supervised learning depends upon the quality, type, and size of the data. Machine learning application aims to define reality and model uncertainty, the learned model represent the reality presented by the data set. Figure 1 represents a step by step development process of the machine learning algorithm. Data processing and learning depend on the way issues are defined and data being gathered.

Figure 1. Represents machine learning algorithm's step by the step development process



Almost all proposed approaches are depending upon the use of GPS data. Which has many limitations such as GPS services are not available many areas or connection may lose in some particular area, as a result, inaccurate position information is recorded. As well as GPS systems rely on the smartphone's battery. This paper aims to provide a proposed framework using machine learning techniques and obtaining new features based on data extracted from sensors, accelerometer, smartphones, and rotation vector.

UNDERSTANDING DATA

Problem Definition

Various approaches to identify, define, and arrange transportation planning and engineering issues for the decision-oriented transportation system. In transportation data analytic applications, the problem definition provides much-needed information on the required output and possible input parameters. Additional study is required to rationalize the solution using the machine learning approach. To solve the problem using machine learning solution, it has to satisfy the following:

1. For a given set of input variables P and output variables Q, such that mapping between input and output variables exists as P=f (Q).
2. Function f in the above relationship is unknown, as there is no explicit algorithm.
3. Input and output variables are defined to train and test the learning algorithm.

Data Collection

Providing exact commuting time data for any roadways can anticipate the output of average speed. Anyhow this data cannot be considered as the input variables are not defined.so the major phase of data collection is to gather and define the list of possible input and output variables. Another phase of data collection is to identify data efficiency, quality, and amount of data quantity is required. Easy availability of resources and time plays a vital role. With this data, it is possible to develop, evaluate, and train learning algorithms in a real-world implementation.

Data Fusion

The data fusion method helps in improving prediction accuracy by integrating and combining multiple data sets into a single structured dataset. Data fusion methods are based on the data sources for input variables and their relation with output variables, which are broadly classified into the following types.

- Complementary: data sources are classified as complementary when the input variables in each data source act as partial information about the output. Speed information on any roadways from an individual vehicle and roadside unit location on the highway are complementary; collaborating both the information can improve the accuracy of speed prediction.
- Redundant: When two different resources are providing the same information having the same input variables. CCTV camera and radar unit located on the roadside provides average speed data for the same location of the roadway.
- Cooperative: To improve the accuracy of speed, a new dummy variable can be developed from the input variable of different data sources. To estimate speed accuracy on the roadways CCTV images can be combined with average speed information.

Data Pre-Processing

The goal of data preprocessing is to eliminate noise from raw data so that numerical errors in complex mathematical computations can be minimized. Data set with noise is considered as errors due to non-calibrated data collection devices, numerical errors, and measurement errors that can distress the learning process. To eliminate noise various filtering methods can be deployed. Normalization is a phase in data preprocessing where the data can be trained within a certain limit to reduce noise, eliminate redundancy, and remove numerical problems to improve the predictability of output.

It can be achieved by the mean and variance of the input and output variables, such that the normalized data have zero mean and unit variance as provided in the equation below:

$$\text{Normalize\_}x_i = (x_i - \mu_x) / \sigma_x \quad (1)$$

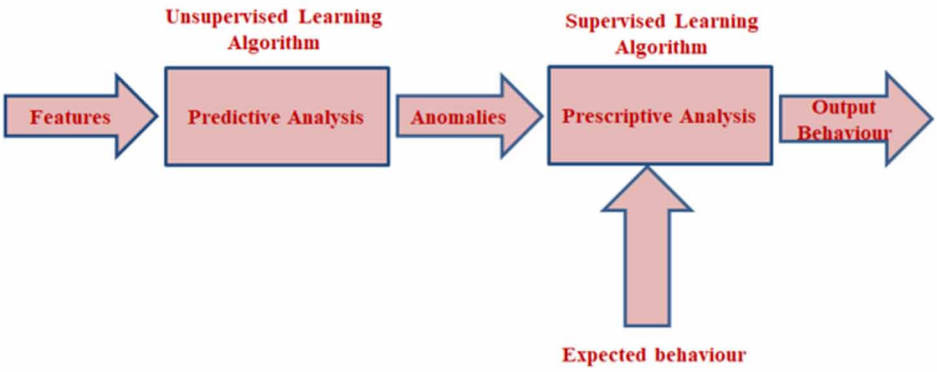
Where $x_i = i^{th}$ data component for input or output variable x,
μ_x = mean of variable x,
σ_x = standard deviation of variable x, respectively.

METHODOLOGY

Machine learning techniques help to make decisions independently by extracting patterns from data sets centered on specific occurrences to create and optimize advanced ITS (Waheed & Venkata Krishna, 2020). ITS advanced technology with ML algorithms can functionally connect to autonomous driving by exchanging information between human-driven vehicles and smart sensor networks. There are many applications of ITS collaborating with ML such as pedestrian and accident detection (Kim et al.2018) (Huang et al., 2020) and management of traffic intersection via a sensor network (Pourmehrab et al., 2020).

After predictive algorithms, the evolution of prescriptive maintenance is progressed. In predictive algorithms, classes were aimed to predict specific behavior and detect anomalies. Whereas prescriptive maintenance predicts as well as capable of taking definite actions where ever an anomaly or event needs. The algorithm is composed of two sub-modules of ML that are collaborating.

Figure 2. Structure of predictive and prescriptive analysis



The first module takes input features and detects the anomaly by unsupervised learning, then it performs a supervised learning algorithm, based on target behavior and anomaly classifier are trained to ensure that the expected result can be obtained. Figure 2 represents the structure of predictive and prescriptive analysis and maintenance.

DATASET

Machine learning algorithms that were used to predict the accuracy of speed include regression analysis, SVM, decision tree, and ANN. Using micro-simulation software VISSIM traffic data was generated and provided as datasets. The data is distributed as training and testing patterns. The input variable for each learning algorithm is the density that is measured as vehicle per mile and volume that is measured as vehicle per hour. And the result shows that the output variable is the speed that is measured as miles per hour represent the performance of each algorithm. The performance of machine learning algorithms is calculated by comparing the result of predictions made by different Machine learning algorithms with true speed.

MACHINE LEARNING MODELS

In this section, Machine Learning models are evaluated and compare to find the best way of predictions of speed in smart transportation systems.

Regression Analysis Methods

For the given input variables volume and weight, and target output variable average speed on highway regression specifies the object of dependence between the input variables and output target variables. And also measures the error variance which depends on one or more input variables by finding a fitting function.

The training data is defined as target variables or output variable which is speed s_i, where i=1, 2, 3, 4….n, and input variable which is volume v_i, each input variable is denoted as vector information.

Regression model is represented by $s_i=f(v_i) + \varepsilon_i$, ε_i is error

Linear regression model: One-variable linear regression model with the intended input and output variable is

$$(v_i) = w_0+w_1v_i+\varepsilon_i, \tag{2}$$

Where w_0 and w_1 are called regression coefficients.

Polynomial Regression Model*:* these are used for complex data; the function is simplified by a polynomial degree p as,

$$S_i=w_0+w_1v_i+w_2v_i^2+\ldots\ldots\ldots w_pv_i^p+\varepsilon_i. \tag{3}$$

Multivariate Regression Model: In the multivariate regression model multiple features are brought together with each feature having the function of either a single input or multiple inputs. In multivariate regression the output s is a scalar and the input is d-dimensional vector v=(v[0],v[1],v2],……v[d-1])T

The multivariable linear model then becomes:

$$S_i=w_0v_i[0]+w_1v_i[1]+\ldots\ldots+w_{d-1}v_i[d-1]+\varepsilon_i. \quad (4)$$

Using speed data of every vehicle with respective time, a regression model is established as shown in figure 3, figure 4, and figure 5. Using micro-simulation software VISSIM traffic data was generated and provided as datasets.

Figure 3. Linear regression models

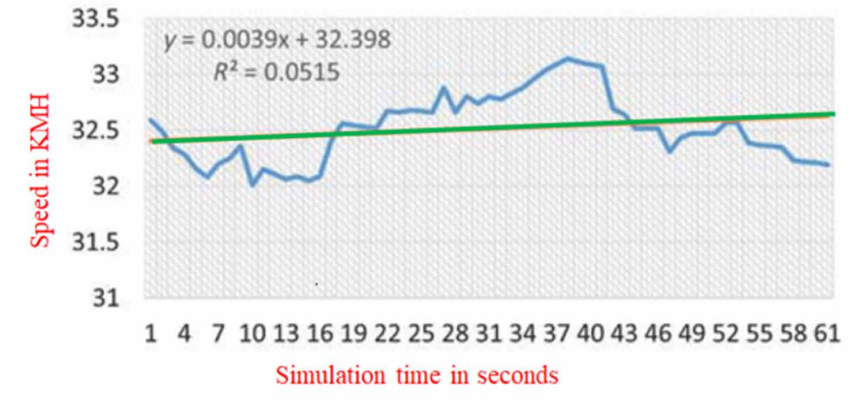


Figure 4. Polynomial regression models

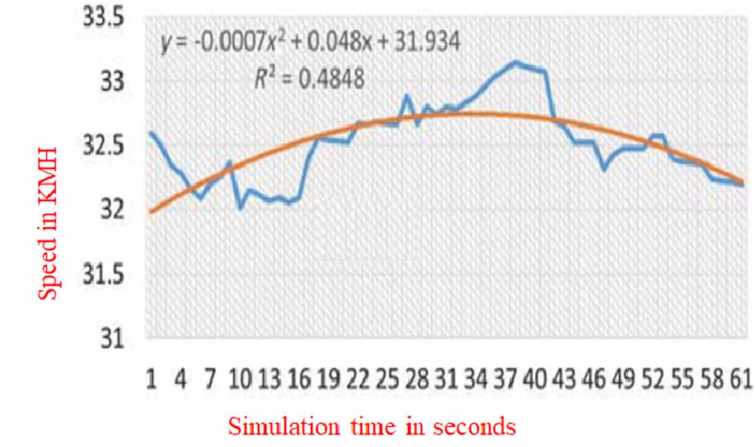
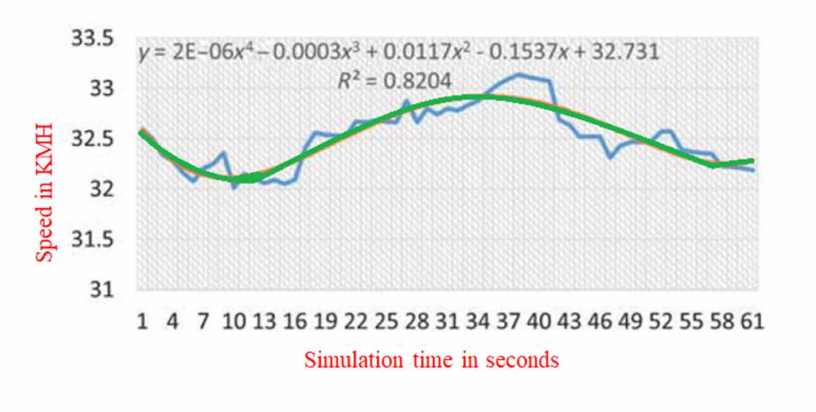


Figure 5. Multivariate regression models



The "x" axis represents the speed at every simulation in second. Each chart signifies a different regression model that defines the change in speed over time that can be used to estimate future speed. Model states "x" is the time in seconds and "y" is the target speed. R2 denotes the accuracy of the model and measure of goodness-of-fit of the model. As the model becomes a more complex degree of error decreases.

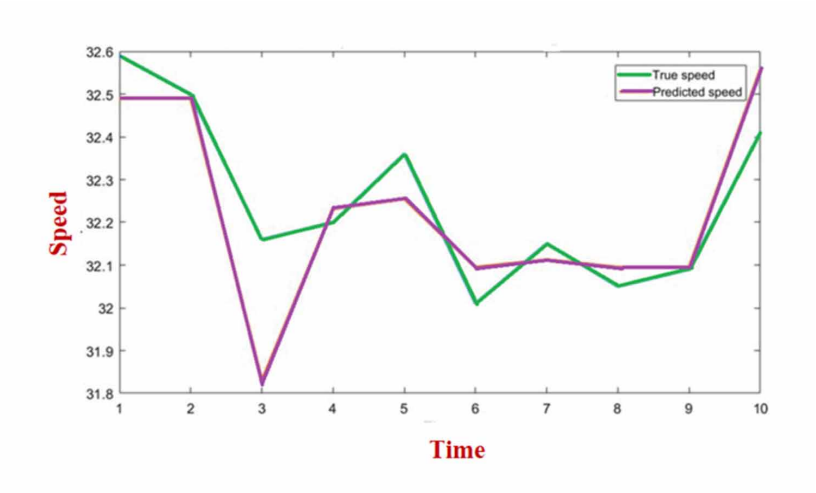
Decision Tree Method

Table 1 Represents a Comparison of true speed with predicted speed by using decision tree ML and also determines predicted accuracy and predicted error. Figure 6 shows a Comparison graph of true speed with predicted speed by a decision tree.

Table 1. Comparison of true speed with predicted speed by decision tree

Predicted speed by decision tree	
True speed	**Predicted speed**
32.59	32.49
32.5	32.49
32.16	31.83
32.2	32.232
32.36	32.255
32.01	32.112
32.15	32.095
32.05	32.095
32.09	32.095
32.41	32.558
Prediction Accuracy	0.7085
Prediction error	0.2915

Figure 6. Shows a comparison graph of true speed with predicted speed by a decision tree.



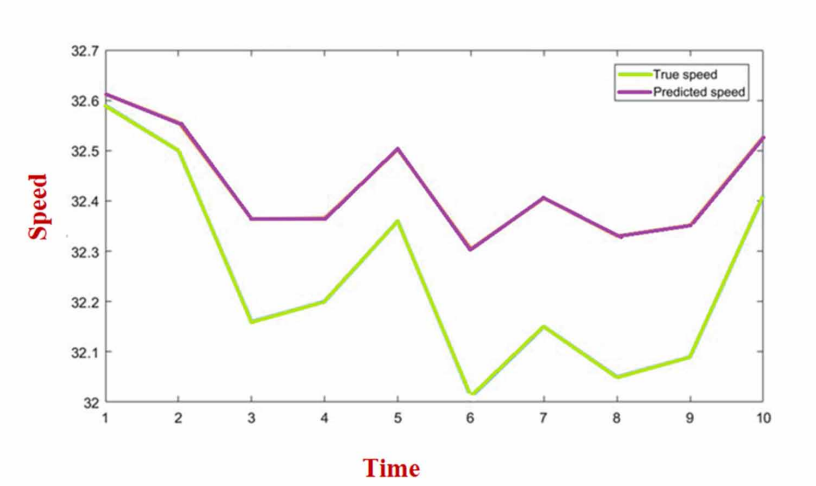
SVM

Table 2 Represents a Comparison of true speed with predicted speed by using SVM ML and also determines predicted accuracy and predicted error. Figure 7 shows a Comparison graph of true speed with predicted speed by SVM.

Table 2. Comparison of true speed with predicted speed by SVM

Predicted speed by SVM	
True speed	**Predicted speed**
32.59	32.612
32.5	32.556
32.16	32.364
32.2	32.366
32.36	32.502
32.01	32.305
32.15	32.405
32.05	32.33
32.09	32.352
32.41	32.528
Prediction Accuracy	0.9234
Prediction error	0.0766

Figure 7. Comparison of true speed with predicted speed by SVM



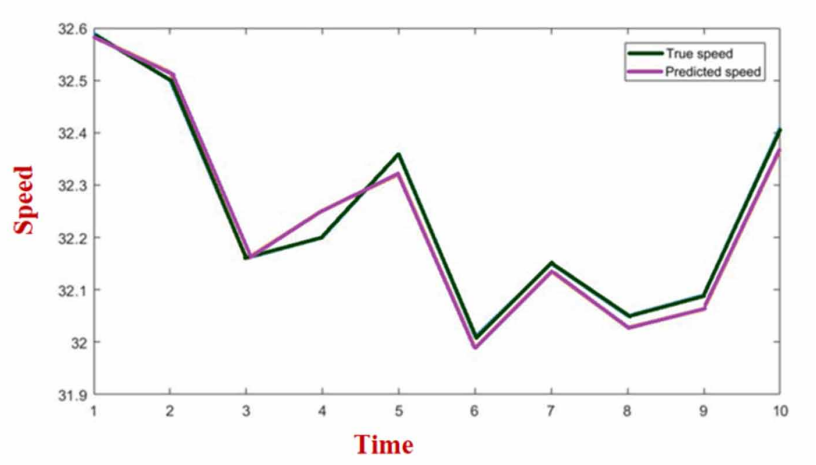
ANN

Table 3 Represents a Comparison of true speed with predicted speed by using MLP NN and also determines predicted accuracy and predicted error. Figure 8 shows a Comparison graph of true speed with predicted speed by MLP NN.

Table 3. Comparison of true speed with predicted speed by MLP NN

Predicted speed by MLP NN	
True speed	**Predicted speed**
32.59	32.584
32.5	32.516
32.16	32.159
32.2	32.252
32.36	32.32
32.01	31.99
32.15	32.135
32.05	32.028
32.09	32.062
32.41	32.368
Prediction Accuracy	0.9983
Prediction error	0.0017

Figure 8. Comparison of true speed with predicted speed by ANN



RESULT ANALYSIS

Table 4 provides an overview of overall accuracy and the best model score for prediction of speed in smart transportation systems is higher in the ANN model when compared to other machine learning models such as decision tree and SVM. Figure 9 represents a histogram of speed which describes speed can fluctuate between 31 and 34 mph. This model will not perform accurately when the target is outside this range; otherwise, within range, this model will be very accurate.

Figure 9. Histogram of speed

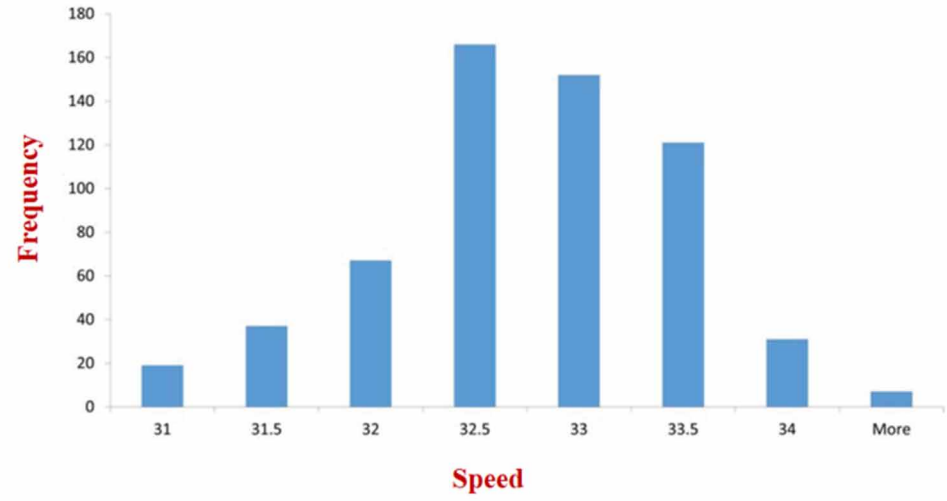


Table 4. Comparison of different machine learning models employing predicted accuracy and predicted error.

ML models	Predicted Accuracy	Predicted Error
Decision Tree	0.7085	0.2915
SVM	0.9234	0.0766
ANN	0.9983	0.0017

CONCLUSION

In this paper, we have discussed different machine learning approaches that can be used to predict the speed of vehicles on roadways in the smart transportation system. Using micro-simulation software VISSIM traffic data was generated and provided as datasets. The data is distributed as training and testing patterns. Machine learning methods that are compared to predict the best accuracy of speed include regression analysis, SVM, decision tree, and ANN. The performance of machine learning algorithms is calculated by comparing the result of predictions made by different Machine learning algorithms with true speed using the histogram. A result recommends that speed is varying according to the histogram. This model is very accurate, but it may not execute well when the target is outside this range.

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Chapter 3
Privacy Preserving in Smart Cities Using Various Computing Technologies

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ABSTRACT

IoT has influenced our daily lives through various applications. The high possibility of sensing and publishing sensitive data in the smart environment leads to significant issues: (1) privacy-preserving and (2) real-time services. Privacy is a complex and a subjective notion as its understanding and perception differ among individuals, hence the observation that current studies lack addressing these challenges. This chapter proposes a new privacy-preserving method for IoT devices in the smart city by leveraging ontology, a data model, at the edge of the network. Based on the simulation results using Protege and Visual Studio on a synthetic dataset, the authors find that the solution provides privacy at real-time while addressing heterogeneity issue so that many IoT devices can afford it. Thus, the proposed solution can be widely used for smart cities.

INTRODUCTION

The Deployment of low-cost smart devices are widespread use of high-speed wireless networks (Gheisari, M., & Esnaashari, M. 2018) have led to the rapid development of Internet of Things (IoT). IoT embraces countless physical objects embedded with Radio Frequency Identification (RFID) tags, sensors and actuators that have not been involved in the traditional Internet and enables their interaction and cooperation through both traditional as well as IoT-specific communication protocols, Gartner estimates that around 20.4 billion 'things' will be connected by the year 2020. These pervasive and heterogeneous devices that interact with the physical and digital worlds have the potential to significantly enhance the quality of life

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for individuals interacting with the IoT. With smart home and wearable devices, users obtain seamless and customized services from digital housekeepers, doctors and fitness instructors. Smart building and smart city applications provide an increased awareness of the surroundings and offer greater convenience and benefits to the users.

Information privacy (Patil, H. K., & Chen, T. M. 2013) is a broad and complex notion as its understanding and perception differ among individuals and its enforcement requires efforts from both legislation and technologies . Privacy laws help to enforce compliance and accountability of privacy protection and make privacy protection a necessity for every service provider. Privacy enhancing technologies on the other hand support the underlying principles guided by privacy laws that enable privacy protection strategies to be implemented in engineering. In this paper, we study the privacy protection problem in IoT through a comprehensive review by jointly considering three key dimensions, namely the state-of-the-art principles of privacy laws, architectures for the IoT system and representative privacy enhancing technologies. Based on an extensive analysis along these three dimensions, we show that IoT privacy protection requires significant support from both privacy enhancing technologies (PETs) and their enforcement through privacy legislation. We analyze how legal principles can be supported through a careful implementation of various privacy enhancing technologies at various layers of a layered IoT architecture model to meet the privacy requirements of the individuals interacting with IoT systems. Our study is focused on providing a broader understanding of the state-of-the-art principles in privacy legislation associated with the design of relevant privacy enhancing technologies (PETs) and on demonstrating how privacy legislation maps to privacy principles which in turn drives the design of necessary privacy enhancing technologies to be employed in the IoT architecture stack.

Privacy

Privacy is a complex and a subjective notion as its understanding and perception differ among individuals. In this section, we review the definitions of privacy in the past, introduce the privacy laws and analyze the state-of-the-art privacy legislation. We then introduce the privacy-by-design strategies that facilitate the design of privacy-preserving systems satisfying the legal principles.

Defination

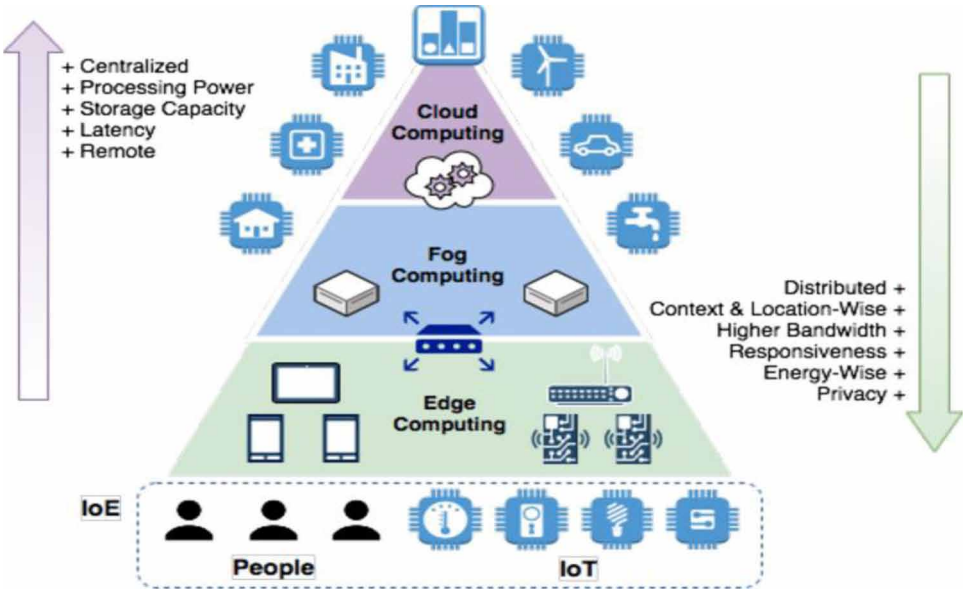
The notion of media privacy had come into being with the technical and social development, the notion of privacy successively shifted to territorial, communication, and privacy (1940s)+. Finally, in the 1960s, it was the rise of electronic data processing that brought into being the notion of information privacy (or data privacy) that has achieved lasting prominence until now. In 1890, Warren and Brandeis defined privacy as ‘the right to be let alone’ in their famous article ‘The Right to Privacy’. After that, many privacy definitions have been emerging unceasingly, but the one proposed by Alan Westin in his book ‘Privacy and Freedom’ has become the base of several modern data privacy principles and law. Westin defined privacy as ‘the claim of individuals, groups, or institutions to determine for themselves when, how, and to what extent information about them is communicated to others’, which mainly emphasized the control of the data subjects over their data. The authors in argued that Westin’s definition was too general for the IoT area and they proposed a more focused one that defines the IoT privacy as the threefold guarantee including ‘awareness of privacy risks imposed by smart things and services surrounding the data subject; individual control over the collection and processing of personal information

by the surrounding smart things; awareness and control of subsequent use of personal information by those entities to any entity outside the subjects personal control sphere'.

Privacy Protection in a Layered IoT Architecture

Several existing Internet-of-Things systems are designed using a layered architecture. In an IoT system, data is usually collected by end devices, transmitted through communication networks, processed by local/remote servers and finally provided to various applications. Thus, private data (Peleg, M., Beimel, D., Dori, D., & Denekamp, Y. 2008) as it flows through multiple layers of the architecture stack, needs privacy protection at all layers. Here, implementing proper privacy design strategies based on the roles of the layers in the lifecycle of the data is important. Otherwise, techniques implemented at a specific layer may become either insufficient or redundant (privacy has been protected by techniques implemented at other layers). In this section, we introduce the reference IoT architecture adopted in this study and present the IoT privacy protection framework that shows how to integrate the privacy design strategies in the layered IoT architecture.

Figure 1. Data processing in various computing



RELATED WORKS

Each vendor of IoT devices tends to develop smart devices based on their desires that most likely will end up heterogeneity of produced devices and possibly conflicts between a variety of produced platforms. In addition, the generated data should remain safe so that no one can steal and misuse data. In the following, we summarize some state-of-the-art research works focusing on the security and privacy of IoT applications (Yang, S. H. 2014).. Readers are invited to refer to for a survey on ontology for security and privacy challenges in various computing systems and architectures. In, the authors described a new

multi-layer cloud architectural model that was developed for interoperability of heterogeneous devices and/or services provided by several vendors in IoT-based smart homes. Furthermore, they used ontology as an alternative tool for knowledge representation to address heterogeneity issues of smart homes. They also proposed a security framework based on the ontology. They proposed the following ontology for security-preserving in smart homes. They used Semantic Web Rule Language (SWRL) to explain the reasoning rules to interoperate on the heterogeneous devices. Despite several advantages, their system has some disadvantages such as scalability and fault tolerance.

The authors(Sengupta, S., Garcia, J., & Masip-Bruin, X. 2018) in proposed a novel authentication solution for IoT environment based on identity and SDN paradigm. They also implemented a trusted certicate authority on the SDN controller of SDN architecture. They proposed a security protocol for authentication in order for each device

to authenticate by itself. One drawback of their system is that the method was not deployed and evaluated. Thus, there is no performance analysis for their method and their method would not be comparable. (Wand, Y., Storey, V. C., & Weber, R. 1999). proposed a framework for intrusion detection in IoT based on SDN paradigm and host. They tried to solve the problem of attacking against a special host. Authors minimized communication and computation costs by considering only the activity and traffic of a special node (i.e., the target host). They considered the heterogeneity of network that can be solved with SDN architecture. Their method called IoT-IDM monitors suspicious activities in the network and tries to extract features based on the network low data. They used machine learning for malicious traffic detection. In detail, they used Support Vector Machine (SVM) for classifying data and detecting abnormal hosts conditions . They also tried to select features of current attack. They used heuristic methods to extract features based on learnt signature patterns of known attacks. They tried to mitigate attack effects by loading required traf_c rules on switches and hubs. One of the drawbacks of their method is that feature selection is extracted in a static mode and not dynamically that causes distinguishing malicious ows of all kind of attacks are impossible. Another disadvantage of IoT-IDM is that it can only protect a determined host, not the whole network.

PRIVACY PRESERVING COMPARISION USING EDGE COMPUTING AND NETWORK MODEL

At first, we have a look at the IoT environment and then formulate the problem and challenge.

Network Model

Concisely, IoT means connecting machines and devices with each other through the Internet to provide high-level services . Things can be a human to monitor implant, non-human creatures or even any handicrafts that can have a unique identifer or IP. In addition to only gathering information(Gheisari, M. 2012)., the data need to be shared with other things such as re stations, BTSs, hospitals, schools to provide quality life. IoT has a great impact on our future life style. If we can address its challenges, we have stronger relish in using this technology. In IoT space, each device disseminates its data in wired or wireless mode to collaborate with other devices to provide a higher level of services with the help of using and analyzing others' data. In all IoT applications, we should not disclose the sensed sensitive data. Devices share their data to use others' data so that we must take more heed to the privacy of produced data.

Table 1. Comparision between various computing procedures.

	Fog Computing	Mobile-Edge Computing	Cloudlet Computing
Node devices	Routers, Switches, Access Points, Gateways	Servers running in base stations	Data Center in a box
Node location	Varying between End Devices and Cloud	Radio Network Controller/Macro Base Station	Local/Outdoor installation
Software Architecture	Fog Abstraction Layer based	Mobile Orchestrator based	Cloudlet Agent based
Context awareness	Medium	High	Low
Proximity	One or Multiple Hops	One Hop	One Hop
Access Mechanisms	Bluetooth, Wi-Fi, Mobile Networks	Mobile Networks	Wi-Fi
Internode Communication	Supported	Partial	Partial

Edge Computing

Edge computing is an extension of Cloud Computing. In edge computing(Pham, Q. V et.al.,2020), servers and carriers are taking pressure off their centralized data centers through edge computing solutions with the help of moving data centers to the edge of the network, closer to data owner. It speeds up the storage processing, data analysis speed without sending them back to a centralized data center that is located in Cloud Computing environment. This leads to better performance, faster average response time. Edge computing plays the role of a broker between IoT devices and cloud computing environment that leads to raising the speed of data analysis. Moreover, edge computing has a relation to the cooperative data centers. Due to the importance and advantages of edge computing compared with cloud computing, moving cloud-computing capability and functionalities to the network edge has been researched extensively over the past decade. It is worth mentioning that our approach proposed in this work can be implemented with any edge computing paradigm. There have been a number of edge computing

concepts, e.g., cloudlet, fog computing, and multi-access edge computing (MEC). There exist some similarities and differences between these concepts, as illustrated in Table 1. Let us briefly present two main differences between fog computing and MEC as follows. MEC was developed by European Telecommunications Standards Institute in 2014 while fog computing was introduced by Cisco in 2012. In addition, fog nodes are not integrated into mobile networks, whereas MEC servers are deployed as a part of mobile networks. Therefore, fog computing is usually favored by the service providers and MEC is preferred by telecommunication infrastructure companies. Regardless of the edge computing concept, our approach utilizes the proximity between edge nodes and IoT devices so that data and computations of Loaded from IoT devices can be completed within a much lower period of time when compared with traditional cloud computing.

PRIVACY PRESERVATION USING TRANSFORMATION

The straight forward solution for Privacy Preservation is transformation of sensitive data. The data is modified in such a way that sensitive data cannot be recovered. The price we pay is loss of effectiveness in data retrieval and mining as we have modified original data, this is obvious. Such techniques for Privacy Preservation are randomization, k- anonymity and l-diversity.

Randomization

It is well known that if we add noise in the data it is hard to find actual data. This concept is employed in randomization technique(Chen, H., Finin, T., & Joshi, A. 2003). The sufficient large noise is added so that mining of sensitive data becomes impossible. By adding noise we mean that the attribute value of the record is masked . Mostly this method id used in public surveys where one can find evasive answer bias. The method of randomization can be explained in such a way that on a data sets under consideration, the independent noise elements are added so the variance of noise is large enough that original data cannot be easily found. After the randomization process the individual records are dissolved and we have one distribution who has same behaviour of original data set. The real challenge is we have to modify existing data mining algorithm in such a manner that it can work on distribution rather than individual record. One key advantage of randomization is that it is relatively simple and does not require the knowledge of other records. There for we don`t need to have secure server. Any system can randomize the data as all data is being treated equally. The weakness which may be exploited by attackers is that the data other than dense region is more susceptible. One other method which is applied here in randomization is adding or dropping random items from data set. The results of this methods are shown here.

K-Anonymity

While randomization was working on single individual elements, k – anonymity (Byun, J. W., Kamra, A., Bertino, E., & Li, N. 2007)works on group. In anonymization important parameters related to identification of individual entity such as Unique Identity No (Aadhar No) is removed. But most of the times an individual entity can be identified by other identifiers like age, pincode and sex. These are known as pseudo identifiers. In k-anonymity techniques we generalize or supress such pseudo identifiers. In generalization we set the range of data sets and modify it. For example if we have presented the list of people from various cities like Jamnagar, Rajkot or Ahmedabad, we set the value of that column as Gujarat, the name of the state where these cities are located. In suppression methods the sensitive information such as name of city from above discussed example is completely removed. By using such methods we can achieve anonymization but the effectiveness of data is decreased. In we can see that the problem of k-anonymity is NP hard. The k-anonymity techniques requires that every tuple in the table is related to no fewer than k respondents in such a way that they are inseparable with other k columns. The weakness here is if the attacker has the sample of data, the identification of original data becomes at risk. The more the sample the more risk of data. this knowledge will help to decide either use anonymization or not.

l-Diversity

In k-anonymity we set value of sensitive data to some generalized value. Thus our data becomes anonymised, but the problem is such data is susceptible to attacks where background knowledge is available with the attacker. For example in Homogeneity attack attacker seeks the value which has exact same values in other words they are generalized. If attacker have some background knowledge the exact values of generalized values can be calculated. In other such case called Background Knowledge Attack an attacker tries to find relation between one or more identifiers to narrow down possible sensitive field. So due to above flow in k-anonymity the l-diversity method is introduced. In l-diversity not only group of k is maintained but the diversity of information is also maintained. Here it should be noted that if we

have n different kind of attributes we have to manage n diversity. So problem becomes challenging. To further enhance this model the t-closeness model is introduced.in t-closeness method it is required that the distance between sensitive data should not be more than the threshold value t.

CONCLUSION

With the emerging technology advances such as IoT that has supported the growth of the smart city applications, each IoT device in smart city universe yields increasing data over time. These data can be sent to the edge of the network for further analyses and satisfying real-time services. If we do not control produced data, it may lead to disclosing sensitive information and information leakage. Ontology can be applied as an encouraging tool to solve many challenges such as standardization, heterogeneity issue, interoperability and so on. In this paper, we have modeled an architecture for privacy-preserving called ECA at the edge of the network that is based on the ontology in order for system to convert to highly dynamic mode in privacy behavior aspect. ECA provides three layers of privacy protection.

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Chapter 4
A Survey on Explainability in Artificial Intelligence

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ABSTRACT

The world has been evolving with new technologies and advances everyday. With learning technologies, the research community can provide solutions in every aspect of life. However, it is found to lag behind the ability to explain its prediction. The current situation is such that these modern technologies can predict and decide upon various cases more accurately and speedily than a human, but has failed to provide an answer when the question of "how" it arrived at such a prediction or "why" one must trust its prediction, is put forward. To attain a deeper understanding of this rising trend, the authors surveyed a very recent and talked-about novel contribution, "explainability," which would provide rich insight on a prediction being made by a model. The central premise of this chapter is to provide an overview of studies explored in the domain and obtain an idea of the current scenario along with the advancements achieved to date in this field. This survey aims to provide a comprehensive background of the broad spectrum of "explainability."

INTRODUCTION

Researchers across generations have witnessed advancements in technology in every field of life. John McCarthy, in 1956 coined the term "Artificial Intelligence" (AI) (McCarthy, 1989), and even before that, it has been evolving as an elusive subject of concern in many research activities (Turing, 2009). Artificial Intelligence has been witnessing its utility in various fields for decades and attained desired

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and satisfactory achievements with the applications of Machine and Deep Learning models (Iqbal & Qureshi, 2020; Jaouedi *et al.*, 2020; Tabassum *et al.*, 2020; Rani & Kumar, 2019), etc. There have been tremendous improvements in a wide range of domains such as commercial, medical, and marketing platforms, etc. Artificial Intelligence has paved the way such that no human intervention is needed in most aspects of decision-making. With more and more advancements in learning technologies and models, the decisions or predictions made by these systems are accurate approximately 100%. Also, machine learning algorithms can correctly predict, and their accuracy may rise to 100% in some favorable cases. Patgiri *et al.* (Patgiri *et al.*, 2019) reports an accuracy of 100% in conventional machine learning algorithms. Even though with such high and satisfactory accuracies, these technologies may face trust issues related to the model and the predictions (Patgiri *et al.*, 2019; Ribeiro *et al.*, 2016). Hence, the main risk that is associated with these predictions is that even though the model can predict accurately for all the test cases, it might not work in the same accurate manner when the model is left in the wild in their respective domains to track and make life-changing decisions (some of them are discussed in other sections). Thus a gap exists between the prediction or decision made by an intelligent system and the reason associated with these decisions or predictions.

For this, the researchers have been thinking of taking their research one step ahead by picturing if the system gave its end-user a valid reason for making such decisions or predictions. Thus they developed the idea that, along with making the predictions, if the intelligent systems (making these predictions) are also able to give a proper explanation of its prediction, it would prove to be much easier and more meaningful for end-users to rely upon and trust the systems and take further actions based on these explanations.

Thus, bridging the gap between the prediction and the reason for such a prediction for the end-users to understand and interpret better is what we call an "*explainable system*." The mechanism inbuilt in the model for explaining its decision is called "*Explainability.*" The motivation behind this survey is to provide new interested researchers a clear picture of the current scenario of explainability in learning technology. This chapter is intended to bring into limelight the recent trends which the research community is following to deal with explainability.

BACKGROUND

The term "eXplainable Artificial Intelligence" is usually abbreviated as XAI. The term was first formulated by Lent *et al.* in 2004 (Van Lent *et al.*, 2004). Before that, it was addressed simply as a "black-box."

Digging deep into the matter, it is found that explainability is not a recent topic that the researchers have been focusing upon. It has been discussed for many years and have recently gained more attention and importance due to their ability to explain the predictions made by the intelligent systems, which is indeed a major concern. Recently Das *et al.* provide an extensive survey of explainability employed in Deep Learning. They analyzed the various methodologies, algorithms along with the limitations (Das & Rad, 2020). Various researchers define "Explainability" in several ways. Ribeiro *et al*. described explainability as "presenting textual or visual artifacts that provide a qualitative understanding of the relationship between the instance's components (e.g., words in a text, patches in an image) and the model's prediction" (Ribeiro *et al.*, 2016). Whereas Guidotti *et al*. quotes, "an explanation is an 'interface' between humans and a decision-maker that is at the same time both an accurate proxy of the decision maker and comprehensible to humans" (Guidotti *et al.*, 2018). Another group of researchers, Gilpin *et al*., defined it in terms of "models that are able to summarize the reasons for neural network behavior, gain the trust

of users, or produce insights about the causes of their decisions" (Gilpin *et al.*, 2018). Tim Miller describes eXplainable Artificial Intelligence (XAI) as "an explanatory agent revealing underlying causes to its or another agent's decision making" (Miller, 2019). It is noteworthy that, Adadi and Berrada, in their survey study, highlight the main concepts and terms related to eXplainable Artificial Intelligence and provides us with a structured view of these concepts (Adadi & Berrada, 2018).

On the other hand, Arrieta *et al*. defined eXplainable Artificial Intelligence (XAI) as "given an audience, an explainable Artificial Intelligence is one that produces details or reasons to make its functioning clear to understand" (Arrieta *et al.*, 2020). The rising trend of explainability in Machine Learning is also explored here. According to the authors, explainability could be achieved successfully either through transparent models, i.e., they are understandable by themselves, or by application of Post-hoc strategies to understand them. The self understandable models include Logistic/Linear Regression, Decision Trees, K-Nearest Neighbors, etc. Talking about the Post-hoc technique, the authors made a hierarchical categorization constituting the Model-Agnostic and Model-Specific methods with their respective taxonomies.

Recently, Lima and Delen performed a novel study in 2020 for predicting corruption and the reason causing it across countries at various levels using modern Artificial Intelligence and Machine Learning (Lima & Delen, 2020) The study was aimed at exploring the most predictive cause(s) behind corruption so that steps could be taken to eradicate them and, in the long run, make an attempt to make a corruption-free country-wise. They collected data from 132 countries worldwide to obtain the predictors for Corruption Prediction Index (CPI). The entire dataset was labeled into four classes. These classes were: High Corruption (Class 1), Low Corruption (Class 2), Very High Corruption (Class 3), and Very Low Corruption (Class 4). The k- fold (k=10 cross-validation technique was applied to the dataset to avoid biased model prediction, which split them into the training and testing sets. The accuracy is measured as the average of all the individual accuracy measures obtained from the k-fold cross-validation. They then employed the three popular Machine Learning approaches — Random Forest (RF), Artificial Neural Network (ANN), and Support Vector Machines (SVM). From among these models they tried to identify one model and its parameter specifications that produced unbiased and satisfactory accuracy. For comparing the three Machine Learning models, the method computed the overall accuracy and the class-wise accuracy. Upon experiment, it was found that Random Forest could attain the best overall accuracy and class-wise accuracy among the other two models. Next, for exploring the explainability of the prediction made by the Random Forest, the variable having the most predictive power is computed using the Actual Splitting Rate (ASR). The ASR computes variable importance as a ratio of the split factor to that of the candidate to split factor. This allowed for obtaining the most relevant corruption predictor. According to this ASR, Government Integrity was split 90.47% of the time compared to Property Rights, Judicial Effectiveness and Education Index, which were split 78.84%, 77.94%, and 53.93% of the times. Thus Government Integrity is addressed as the most relevant predictor for corruption. It now became evident that Government Integrity is the most suitable explanation for the corruption prediction made by the Random Forest model.

A worthy contribution for combating the COVID-19 pandemic in a trustworthy manner is a blockchain-based tracking and monitoring system (Marbouh *et al.*, 2020). It provides an information retrieval system for the government and public as well, which is trustworthy, reliable, and secured. The system is thus employed to predict the flow of fake and modified data from various sources providing data for analysis of COVID-19. The importance of explainable deep learning techniques is witnessed in the detection and analysis of X-ray images to identify the pulmonary disease and Coronavirus (Brunese *et al.*, 2020). This study is aimed at understanding and visually validating the exact regions in the X-ray image to predict

the presence of the coronavirus. We narrowed down our survey by analyzing the learning technologies for Deep Learning models such as Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), etc. Studies show that deep learning methods such as Convolutional Neural Network, Recurrent Neural Network (Jaouedi *et al.*, 2020) etc., have proven their utility to achieve great heights in predicting accuracy with complex data. But questioning on how these models generated the outputs or predictions remains unanswered. Hence, without understanding how they arrived at such solutions, it won't be relevant to employ the model for real-world applications.

WHY DO WE NEED EXPLAINABILITY?

The general architecture of a learning technology in making a prediction is visualized in **Figure 1.** Training data is fed into the learning process, and the output induces a model of the training data. This model is used to make predictions for new test data. Irrespective of the model performance, it never explains or justifies specific queries such as how or why it made such a decision, whether or not its prediction can be trusted, etc. Hence the end-user at times may be left in a confused state of mind dealing with various questions about the model and its prediction because they are unaware and unable to view anything that has been learned within the model. Hence the curious mind is one of the reasons for people seeking explanation for a prediction/decision being made.

The explainability feature comes into play in these scenarios by generating a new learning process whose output is justified with the prediction. It allows the user to interrogate the internal model working and obtain justification for a prediction. This can be visualized from **Figure 2,** where the end-user is able to gain insights into the working of the model via the explanation provided by the explainable model and the interface. The user is now aware of what the model has learned and is also clear about certain queries regarding the model and its prediction.

Hence, the development of an explainable approach is found to be relevant due to some of the following reasons listed below:

1. The explanations provide transparency and unbiased global understanding into the working model and algorithm for humans to better understand the model behavior.
2. It helps achieve interpretability by providing qualitative understanding depending on the target audience, between the input variable and the responses.
3. The faithfulness of the model can be incorporated through explainability.
4. The explanations help in evaluating the model before deploying it in the wild.
5. It also provides user trust in risky and life-changing scenarios.
6. Explanations provide instances of whether or not to trust a model prediction thus, clarifying whether to accept or reject a model.
7. The insights given by the explanation, help identify what must be done to convert an untrustworthy model into a trustworthy one.
8. The explanations also provide fairness and confidence in the decisions made by the model.
9. Based on the explanation, it also helps choose an appropriate model against several models with similar performance.
10. The explanations also provide insights for better learning on how models can be improved by suggesting instances to inspect, further enhancing the classification accuracy.

Figure 1. Conventional learning – A general learning technology that provides the user with state-of-the-art performance measures but cannot fulfill the user queries and leaves the user in a confused state of mind

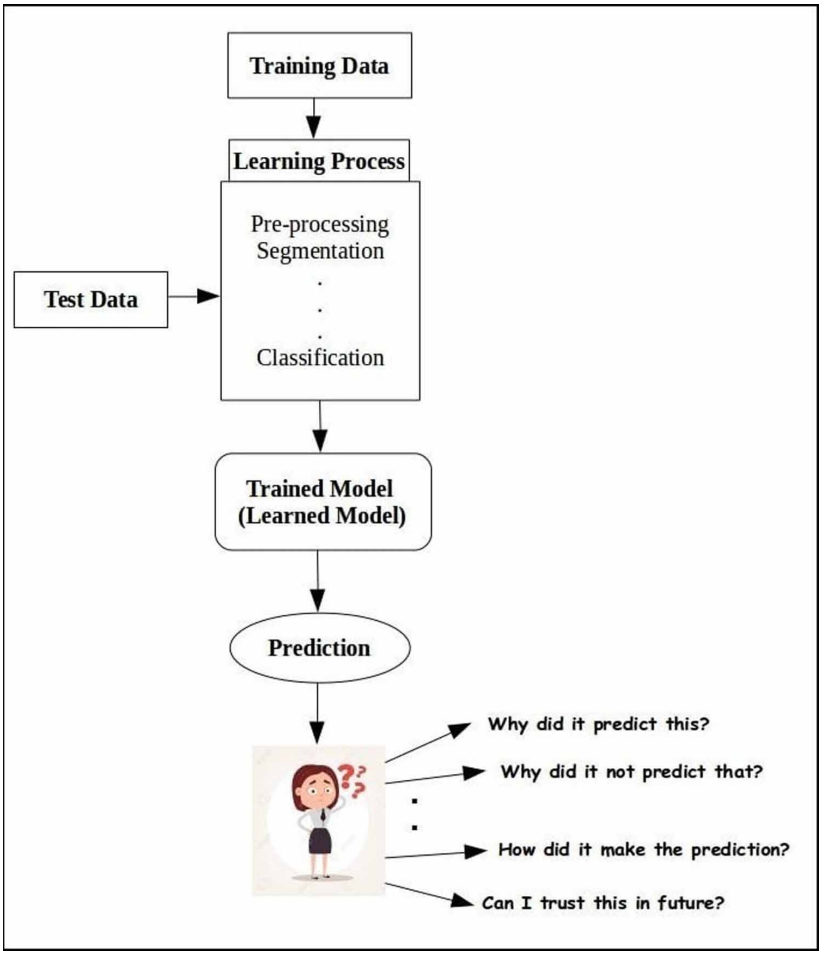
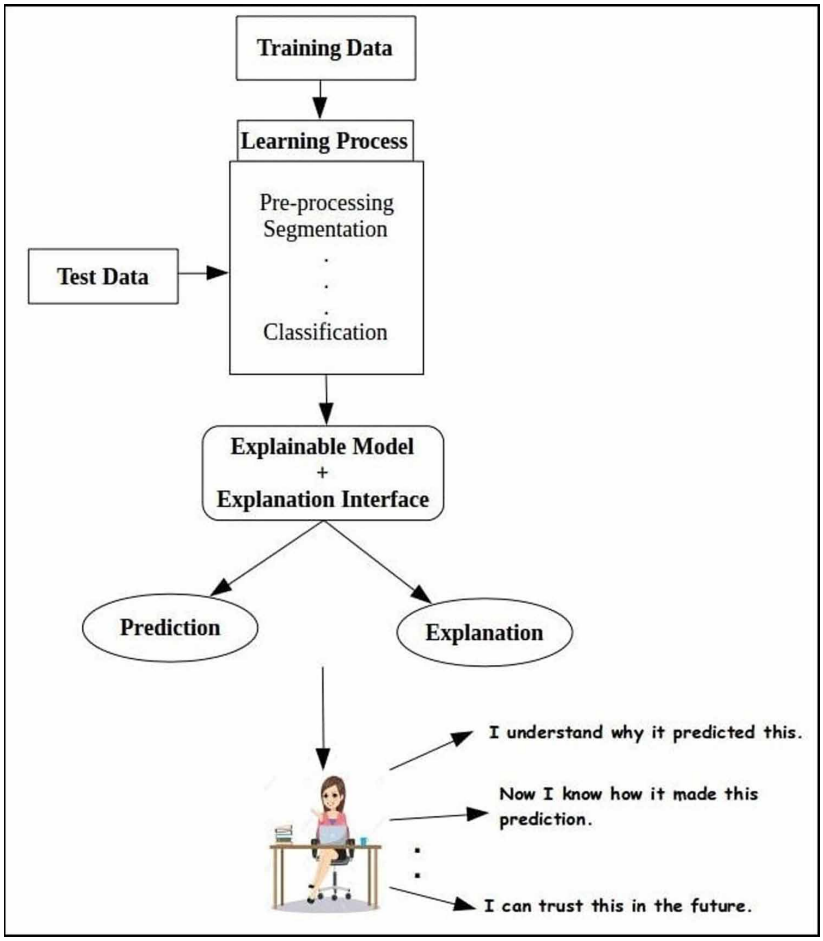


Table 1. Scenarios where classification models failed due to lack of explainability across various domains

Domain	Situation	Observation	Cause of Failure
Education (Lowry & Macpherson, 1988)	Selecting candidates for interview	Practicing sexual and racial discrimination.	Inferred information from the last name and date of birth of the candidates.
Military (Freitas, 2014; Knight, 2020)	Separating friendly and enemy tanks	Poor accuracy on the test data.	The model was trained with friendly photos were taken on sunny days while enemy photos were taking on overcast days.
Healthcare (Caruana *et al.*, 2015)	Pneumonia risk prediction	Pneumonia risk patients with asthmatic history were not considered as a serious condition; which is clinically incorrect.	Neural Network inferred that patients with asthma have a low risk of death and can be treated as outpatients.
Husky Vs. Wolf (Ribeiro *et al.*, 2016)	Distinguishing between images of wolves and huskies	Wolf not in a snowy background is predicted as Husky, and Husky in a snowy background is predicted as Wolf.	The prediction was solely based on the presence or absence of snow in the background.
Transportation (McFarland, 2018)	Self-driving car	Self-driving Uber killed a woman in Arizona	Misclassified a woman (object) as a plastic bag or tumbler in the air.

Figure 2. Learning methods with explanation –An explainable technology that is unified with an explainable model and interface along with the prediction



Need for Explainability in Various Domains

The usability and application of explainability can be seen in a wide range of domains such as healthcare, education, business, military, etc. Though Artificial Intelligence can help society in real-life decision-making, there are instances witnessed where the Artificial Intelligence model is seen to fail and is hence disowned further in such scenarios. This calls for an urgent need for a good and trustworthy explainable system that could be trusted blindly by the users or organizations employing it. Some of the scenarios that have witnessed failure due to the lack of correct explanation while taking life-changing and risky decisions are shown in **Table 1.**

1. **Education:** In the 1982s, St George's Hospital Medical School used a computer application to screen applicants for interview (Lowry & Macpherson, 1988). But the computer program is found to have discriminated against women candidates and non-European applicants and had less chance of selection for the interview. Later on, this discrimination came into notice when they learned that

the system inferred that women are more likely to ask for time off work due to their family bonds. Again the program also deduced that non-Europeans might not have sufficient command over the English language to practice medicine. But the selection of candidates based on these factors, is not valid hence, the system was abandoned by the authority.

2. **Military:** The need for an explainable model, if present, is being witnessed in an incident related to the military domain (Freitas, 2014; Knight, 2020). Alex A. Freitas tried to evaluate the performance of classification models based on predictive accuracy and comprehensibility in 2014. A simple experiment was conducted to classify images of tanks as enemy and friendly tanks. The predictive accuracy performance of the Artificial Neural Network (ANN) was observed to be high, and so they decided to set the model out for practical implementation. But it did not perform well in classifying the enemy and friendly tanks. Later on, it was reported that all the friendly photos on the training data were taken on sunny days, while all the enemy photos were taken on overcast days. Hence the learning model inferred its classification based on the color of the sky on the images. An explainable model is obvious to explain that it discriminated the images based on the color of the sky and not on the relevant features of the images. With this explanation against the classification, the authority could have decided whether or not to employ the model for practical applications.
3. **Healthcare:** To investigate the utility of Machine Learning in medical applications, Caruana *et al*. tried to study on pneumonia risk prediction to figure out the probability of death in pneumonia risk patients (Caruana *et al.*, 2015). It was to determine whether patients with pneumonia risk must be treated as severe and admitted to the hospital or simply be treated as outpatients. It turned out that while training the model with the medical history of the patients, it incorrectly learned the rule which inferred:

$$Asthma(patient) \Rightarrow Low - Risk(patient)$$

i.e., patients with asthma in their medical history and having pneumonia have a low risk of dying due to pneumonia. According to this rule, those patients with pneumonia and having a medical history of asthma are at low risk of death and need not be admitted to the hospital. But clinically, this poses a severe threat as pneumonia patients with a medical history of asthma are in a severe condition and required to be admitted to the hospital immediately and needed special medical attention. As a result, the medical authorities had to abandon the model.

4. **Husky Vs. Wolves:** A similar example was stated by Ribeiro *et al.* (Ribeiro *et al.*, 2016), while trying to figure out the importance of explanation in trusting the model. They trained a classifier to distinguish between images of wolves and huskies. At first, they used a Logistic Regression classifier to classify images of wolves and huskies. The images were picked up intentionally such that all the images of wolves were taken on a snowy background while that of huskies were taken without snow in the background. This wrong classifier was set to be tested on ten images under two scenarios — first without an explanation and second with explanation. These test images contained one wolf and husky image without and with snowy background (intentionally), respectively. So the classifier classified eight of the test samples correctly. At the same time, the two images of the wolf and husky are misclassified, i.e., the wolf without the snowy background was classified as husky, and the husky with the snowy background was classified as a wolf. In the second phase of the experiment, explanations are provided against the prediction. Evaluators are asked the ques-

tion of whether or not the model could be trusted. The result is such that, without the explanation offered, 10 among 27 trusted the model as making the correct prediction. On the other hand, after the explanation, only 3 among 27 trusted the bad classifier. So the importance of explanation in trusting a prediction can be visualized from this experiment.

5. **Transportation:** Self-driving vehicles are being welcomed in Arizona since December 2006. But it proved to be a failure in the year 2018 while taking a test drive in automated mode on the streets of Tempe, Arizona (McFarland, 2018). A Volvo SUV is reported to have hit and killed a 49 year old woman walking on her bicycle across the street in Tempe. The car's autonomous mode failed to sense and detect the pedestrian, even though the vehicle was trained and designed to detect pedestrians, cyclists, etc. (even in darkness). This was reported as a failure in classification by experts. It was found that the car's software misclassified the pedestrian to be a plastic bag or a tumbler and treated it as such. After this incident, the testing of self-driving vehicles has been suspended in the United States and Canada.

Thus it is evident that the need for an explainable model or explainability was never domain-specific. It required in almost every field where a model makes a prediction. With explainability, one may also try to modify the models employed if necessary for smooth running and prediction making in later times.

MATERIALS AND METHODS

There are several materials and methods provided by the research community in the context of explainability. These materials and methods are dependent on the application domains of the models being used. There are various explanation techniques and frameworks which researchers across the globe develop to help them attain desired results. We emphasize a few application domains of Machine Learning that focus mainly on visual explanation and feature relevance explanations. These frameworks and explanation techniques are explored in the following sections. These sections come up with a brief idea of the various frameworks and approaches employed in the relevant fields of Machine and Deep Learning, providing insights into the visualization techniques, datasets, etc.

Frameworks for Developing Explainable Models in Deep Learning

Trying to understand why a model chosen by us for a particular computation made such a prediction – is an important topic of interest evolving in recent times. Understanding the underlying reason behind such prediction may be able to incur something which is called *"trust"*. Trust is indeed an essential aspect in the learning technologies using which one can decide whether or not to employ the model for real-world applications. Explaining a prediction refers to providing a qualitative understanding of the relationship between the components of an instance and the prediction made by the model in the form of textual or visual artifacts. Developing a technique that can clearly explain the predictions made by the model is a challenging task. Models developed in literature are trying to identify the reason causing a prediction using various criteria such as feature importance, feature associations, etc.

To explain the prediction of a classifier, Riberio *et al.* developed an explainable model called **Local Interpretable Model-Agnostic Explanations (LIME)**, which can explain or detect features that contributed to a prediction (Ribeiro *et al.*, 2016). It is inbuilt with characteristics such as interpretable, local

fidelity, and providing a global perspective. To provide a global understanding and incorporating trust, the authors developed another model agnostic approach called **Submodular Pick (SP – LIME)** (Ribeiro *et al.*, 2016). They developed these frameworks with a view to answering questions such as whether the predictions should be trusted by the user and whether the explanations provided by the framework could be used in general for selection of a model from a pair. In regards to answering the query about trusting a prediction and trusting the model, the authors presented the LIME and SP-LIME frameworks, respectively. The explanation provided by LIME is represented as:

$$\Im(x) = argmin_{(m \in M)} F(f, m, \rho) + \Omega(m).$$

M refers to the interpretable models like linear models or decision trees, etc. *m* refers to the explainable model, which is provided to the end-user for explaining a prediction. *F* is the fidelity function. It measures the unfaithfulness of m in approximating the model being explained *f* in the locality represented by $\rho_x(y)$. Here $\rho_x(y)$ is a measure of proximity between y *t*o x. This helps in answering the query of trusting a prediction made by a model.

It has been observed that explanations given by LIME and SP-LIME are faithful, and these explanations help in deciding whether to trust a model and its prediction by the end-users. This study also confirms that LIME helps choose the best explainable model among the two and helps improve untrustworthy classifiers.

Since the LIME model can identify essential attributes for a particular instance, Lundberg and Lee developed the **SHapley Additive exPlanations (SHAP)** model (Lundberg & Lee, 2017) for determining the contribution of each feature using "shapely values." Shapely values are computed by taking the difference between the average prediction and the actual model prediction. Unlike LIME, which can provide interpretation by approximating locally around a prediction, SHAP can provide consistent global interpretation by computing the shapely values for each data point. Thus the main idea here is to determine the contribution of each feature to the overall prediction where each feature is assumed to be of identical weights. It thus generates explanations by the features for the individual predictions. The contribution of a feature for an instance can be visualized by plotting these shapely values of the feature against the feature value for all instances of the data.

Another framework, **Deep Learning Important FeaTures (DeepLIFT)**, proposed the idea of learning important features in a prediction as an explanation (Shrikumar *et al.*, 2017). This framework computes the score of a neuron to determine its importance in contributing to a prediction. This contributing score of each neuron is determined by taking the difference between a "reference activation" and the "activation of a neuron" (using backpropagation); thus computing the deviation of the neuron. Let *a* and $\hat{a}$ be the activation and reference activation of a neuron, respectively. The reference activation of a target neuron of interest is problem-dependent. Let Δa be the difference in activation, i.e. $\Delta a = a - \hat{a}$. We now compute the contribution score as $\sum S_{\Delta x_i \Delta a} = \Delta a$ where $z_1, x_2, \ldots, x_n$ are the neurons in the intermediate layers. Now, if $\partial a / \partial x_i = 0$ $\sum S_{\Delta x_i \Delta a}$ will be non-zero. This approach is also able to reveal dependencies among features.

Intending to investigate the prediction made by a classifier, Henelius *et al.* exploited the knowledge of attribute interactions or groupings by developing the **Automatic STRucture IDentification (ASTRID)** model (Henelius *et al.*, 2017). This model inspects the most significant subset of attributes and attains

identical accuracy when the classifier is trained on both the original attributes and a subset of attributes. It learns the interaction among two or more attributes as evidence for a prediction. These interactions are nothing but attribute associations.

Techniques for Developing Explainable Models in Deep Learning

Aiming to view and understand the path followed by classifiers in arriving at the decisions, the research community contributed their ideas by exploring them in several ways. Scholars have proposed several explanation methods and techniques used in deep learning. **Table 2** provides some of the approaches and visualization techniques employed in a few research works for providing explainability.

Table 2. Explainability studies carried out in literature for providing visual and feature relevance explanation

Authors	Approach	Visualization Technique	Dataset
Zeiler *et al.* (Zeiler & Fergus, 2014)	Fully-supervised convnet model	deconvnet	ImageNet 2012
Simonyan *et al.* (Simonyan *et al.*, 2013)	deep ConvNet	Class Model and Image-Specific Class Saliency visualization	ILSVRC-2013
Bach *et al.* (Bach *et al.,* 2015)	Taylor-type decomposition and Layer-wise relevance propagation	Heatmap	PASCAL VOC 2007, MNIST, ImageNet, synthetic image of geometric shapes.
Mahendran *et al.* (Mahendran & Vedaldi, 2015)	Inverting Representation	Feed-forward & discriminatively trained CNN	ImageNet ILSVRC 2012
Li *et al.* (Li *et al.*, 2015)	Soft-spectral clustering and Bipartite-matching		ILSVRC 2012
Goyal *et al.* (Goyal *et al.,* 2016)	Visual Question Answering Model	Guided back-propagation and occlusion	VQA dataset
Nguyen *et al.* (Nguyen *et al.,* 2016)	Activation Maximization	DGN-AM	ImageNet, MIT Places dataset
Selvaraju *et al.* (Selvaraju *et al.,* 2016)	Grad-CAM	Heatmap	PASCAL VOC 2007
Liu *et al.* (Liu *et al.,* 2016)	CNNVis	Hybrid	MNSIT, CIFAR – 10
Samek *et al.* (Samek *et al.,* 2017)	Sensitivity Analysis(SA) and Layer-wise Relevance Propagation (LRP)	Heatmap	ILSVRC2012, 20Newsgroup, HMDB51
Brunese *et al.* (Brunese *et al.*, 2020)	Grad-CAM	Heatmap	COVID-10 image data collection (Cohen *et al.*, 2020; Ozturk *et al.*, 2020) ChestX-ray8 (Wang *et al.*, 2017)

The effectiveness of a Convolutional Neural Network (CNN) (LeCun et al., 1998) in classification is well known to all across domains such as (Mehmood *et al.*, 2021; Özyurt *et al.*, 2019; Rani & Kumar, 2019; Gupta & Katarya, 2021) and many others. A hybrid CNN architecture is utilized to study the interpretability of eXplainable Artificial Intelligence in (Tjoa & Cuntai, 2021). The behavior of the CNN

model is interpreted by understanding the constituent structures and components making the system. Intending to know why and how the Convolutional Neural Networks can provide such good accuracies, Zeiler *et al.* studied a visualization technique to peek deep into the internal layers of the network (Zeiler *et al.*, 2011). They used a multi-layer Deconvolutional Network, precisely the "deconv" model, to perform a reverse mapping from the feature activations to the input space of pixel values to determine the specific input pixel value that resulted in the activation of the feature map (Zeiler & Fergus, 2014). So a deconv net is attached after every convnet layer.

Simonyan *et al.* (Simonyan *et al.*, 2013) devise two visualization techniques — Class Model visualization and Image-Specific Class Saliency visualization aimed at visualizing the class models and highlighting the areas of interest of the particular class of the image.

Bach *et al.* (Bach *et al.,* 2015) proposed a general technique applicable to both multilayered neural network models and Bag-of-Words (BoW) models for understanding the prediction by visualizing the pixels or prominent attributes that resulted in the prediction. They employed "heatmap" as a visualization technique for learning the contribution of each pixel for the classification. They proposed two pixels-wise decomposition approaches — Taylor-type decomposition and Layer-wise relevance propagation approach.

Explanations based on the visual context of the image were developed by Mahendran *et al.* (Mahendran & Vedaldi, 2015). They discovered a method to address the question of recovering an image based on a given encoding. The developed the "inverting representation" approach that is used to compute the inverse representation of the image. They experiment was conducted on the ImageNet (Russakovsky *et al.*, 2015) dataset and works better than the recent trends (Vondrick *et al.*, 2016).

While posing the question of whether different deep neural networks trained with different initialization can perform "convergent learning," Li *et al.* (Li et al., 2015) could gain insight into deep learning models. They used a matching approach or a soft-spectral clustering approach to align the units from different networks.

Goyal *et al.* (Goyal *et al.,* 2016) propose two visualization techniques for the Visual Question Answering (VQA) (Lu *et al*. 2015; Lu *et al.*, 2015), which explains a prediction. The two techniques are Guided Backpropagation (Springenberg *et al.*, 2015) and Occlusion. These techniques are used to interpret and find out the pixels or words in an image or sentence primarily focused upon while answering the questions in the Visual Question Answering model. The guided backpropagation and occlusion techniques are employed respectively to analyze important words or pixels (in a sentence or image respectively) and to observe changes in the prediction probability by occluding the input, respectively.

Nguyen *et al.* (Nguyen *et al.*, 2016) used Activation Maximization (AM) as a feature relevance explanation method and visualized it using a Deep Generator Network (DGN). This Activation Maximization is used to synthesize the preferred input neuron.

Authors Samek *et al.* (Samek *et al.,* 2017) developed two approaches for visualizing the deep learning models. They are — Sensitivity Analysis (Baehrens *et al.*, 2010) for explaining a model prediction via the locally evaluated gradient of the model and Layer-wise Relevance Propagation (LPR) (Bach *et al.,* 2015) for explaining the decision of the classifier using decomposition technique. They used three different classification approaches to obtain an explanation for the decisions being made — annotated images (Russakovsky *et al.*, 2015), text document classification (Mitchell, (n.d)), and activity recognition in videos (Kuehne *et al.*, 2011).

Another notable explainable deep learning method is recently proposed by Brunese *et al*. to analyze how the network arrived at detecting Covid positive patients along with highlighting the regions in the X-ray image that is symptomatic of the disease (Brunese *et al.*, 2020). They employed the Gradient-weighted

Class Activation Map (Grad-CAM) (Selvaraju *et al.*, 2017) algorithm to highlight areas in the X-ray, providing an explanation for the prediction. The authors developed a deep learning technique to identify COVID-19 patients using X-ray images. The entire experiment was conducted in three phases: initially, they concentrated on determining if the X-ray belongs to a person with pulmonary disease or a healthy person; then they worked on recognizing whether it is of a COVID- 19 patient or a Pneumonia patient; and finally, if it is of a COVID-19 patient, they are to detect the areas in the X-ray image symptomatic of COVID 19. This was performed with the Grad-CAM algorithm that highlighted areas in the X-ray, providing explanation for its prediction. In addition to this, verification of the explanation is confirmed by a radiologist, which further confirmed the trustworthiness of the model. Some other noted surveys and experiments carried out in the medical domain in the context of explainability or eXplainable Artificial Intelligence are (Holzinger *et al.*, 2017; Ngan *et al.*, 2019; Tjoa *et al.*, 2020).

EXPLAINABILITY AND ACCURACY

Debugging the intelligent system is an integral part of research. This helps developers in several ways — correct the mistakes and shortcomings in the system, invoke trust in the system, etc.

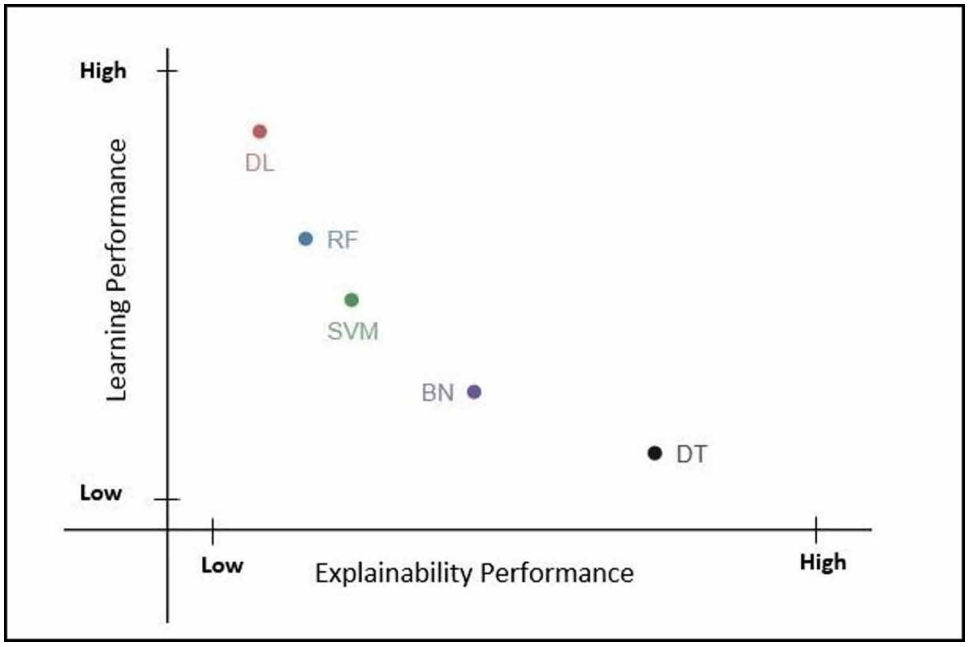
Authors Kulesza *et al*. performed a study on how the models equipped with explainable models should explain their prediction to the users (Kulesza *et al.*, 2013). They analyzed their study with two critical aspects of explanation — "Soundness" and "Completeness." They interpreted soundness as the truthfulness associated with each component of the system and completeness as the ability to describe all the intrinsic systems. In their attempt to answer some of the research queries, they experimented on a music recommendation system under four different circumstances, described as High Soundness and High Completeness (HH), Medium Soundness and Medium Completeness (MM), High Soundness and Low Completeness (HSLC) and Low Soundness and High Completeness (LSHC). They tried to answer queries relating to impact of soundness and completeness on the end user's mental health; beneficial information; obstacles; cost-benefit trade-off and trust. Most complete models are proven to be beneficial for the mental health of the model. Complete systems also proven to be associated with low cost and high benefit incurred. Complete systems are incorporated with trust associated with the model. Hence, the result indicated that completeness is inferior to soundness when the model tries to explain how it arrived at the prediction.

With the development of the concept of explainability as a new learning technology, various myths and misconceptions are also found to associate with it. Most of these remain unobserved, which may pose a threat to the conclusions made by the model. Most of the misconception, as highlighted by many research studies, including the Defense Advanced Research Project Agency (DARPA) (Gunning & Aha, 2019) and others, such as (Rudin, 2019), is the trade-off existing between the accuracy computed by the model along with the explanation it provided.

The accuracy of a model is, in most cases, independent of the complexity of the model. Most of the research community believes that more complex structured algorithms produce more accurate results, i.e., the more complicated the model, the higher the accuracy. This is not always true when one has to deal with structured and meaningful data. While dealing with such data, both the simple and complex structured models show similar accuracy; but their explainability may vary.

In Computer Vision applications, the Deep Learning models show higher performance in accuracy with less ability to provide a good explanation. But there are also situations witnessed in Machine Learning where explainability and accuracy in the account are directly proportional with slight variation in their performance (Hand, 2006). To visualize these scenarios, the DARPA (Defense Advanced Research Project Agency) project for eXplainable Artificial Intelligence (XAI) has provided a graphical view of the relationship of the Machine Learning models with regards to explainability and their performance. The Machine Learning models such as Deep Learning (DL), Random Forests (RF), Support Vector Machine (SVM)s, etc. have high accuracies and less explainability; other models like Bayesian Belief Network (BN)s, Decision Tree (DT)s, etc. have high explainability while lagging in achieving high accuracies at the same time compared to the XAI models. This is evident from the approximation graph provided by the DARPA project depicted in **Figure 3.**

Figure 3. Relationship between explainability and performance measure among the various learning models. This is an approximation graph presented by the DARPA project on their study on eXplainable Artificial Intelligence. (DL- Deep Learning, RF- Random Forest, SVM- Support Vector Machine, BN- Bayesian Networks, DT- Decision Tree). Source (Gunning & Aha, 2019).



So, with eXplainable Artificial Intelligence (XAI), the researchers need to develop or modify their models such that they attain higher accuracy along with providing a reasonable explanation measure. Thus, one needs to increase explainability such that the accuracy results are not sacrificed.

INTERACTIVE EXPLANATION IN MACHINE LEARNING

Whenever a model explains, it may not be the case that the model's explanations are always correct and can be blindly trusted. It may sometimes go wrong when the question of delivering a valid explanation is concerned. Providing a wrong justification or visualization for a prediction being made is a severe threat to the learning models. In such a scenario, the end-users can contribute to these justifications in many possible ways, which are being explored in literature. Studying the role of the end-users in Machine Learning models is found to explicitly promote better learning and performance of the model. Many studies suggest that Machine Learning models and end-users can work together to increase the models' understandability, trust, and accuracy (Stumpf *et al.*, 2009; Amershi *et al.*, 2010; Vig *et al.*, 2011).

Though the involvement of the end-users is negligible in developing a model for various objectives, Amershi *et al*. carried out an extensive study that signifies the contribution of end-users. Making the Machine Learning models more interactive and understandable yields relevant explanation as required by the user using them for their practical tasks (Amershi *et al.*, 2014). The authors present different instances highlighting the significance of involving the end-user in building a powerful, interactive and efficient model.

Kapoor *et al*. proposed a way for interactive computation among the users and machines. They developed a system — ManiMatrix — that can effectively control the performance of the Machine Learning models following the user preference (Kapoor *et al.*, 2010). Using this application, the users can modify the decision boundary parameters in the confusion matrix via an interactive round of classification and visualization.

While another literary work by Kulesza *et al*. proposed a "*Why-oriented approach*" for the end-users that allows them to question a model prediction, get the explanation, and later on modify the model for it to provide more preferable explanations in the future (Kulesza *et al.*, 2011). They also discuss the barriers faced by the end-users while trying to fix the faulty behavior of the intelligent system. These barriers include — design, selection, coordination, use, and understanding. The why-oriented approach works by combining three crucial aspects: firstly, it allows end-users to question a prediction made by the system; secondly obtains explanation against each prediction that provides both the current logic as well as the execution state; and thirdly gives authority to the end-users to manipulate the explanations directly and fix the system logic whenever needed. Another idea was again further propounded by Kulesza *et al*. (Kulesza *et al.*, 2015), where they suggested personalizing a prediction made by the model using the *"Explanatory Debugging"* approach (an idea proposed in Kulesza *et al*., 2011). Explanatory Debugging is a controllable and satisfying approach as it focuses on users who make corrections back to the model explaining the predictions. It is a task that is performed from the user's end to modify these models effectively. Though difficult to exercise, imbibing personalized machine learning systems into the learning model is found to increase understandability by 52%. It is a system that explains to the user about the predictions it made, and the user debugs it for any correction in the learning model, thus personalizing the Machine Learning model's behavior. The user tries to identify and correct the faults in the system's reasoning responsible for the predictions that failed to meet the user's expectations. So the user and the learning model work as a unit and share their understanding and influence one another.

Miller *et al*. suggest that the explainable module does not consider the social science viewpoint while developing the explainability framework that may head up towards failure in later times (Miller *et al.*, 2017). Therefore one also needs to emphasize how people, rather than the developers, define, generate,

select, evaluate and present their explanations. While trying to explain and analyze this fact, Miller *et al*. cite "*beware of inmates running the asylum*."

Researchers, while developing a model that can explain, follow the trend of considering only their psychological viewpoints in almost every case. But in the actual scenario, it does not apply so. Since they are developing the explainable model for the audience and not for themselves, the research community should focus on people's psychology and physiological condition in general, keeping in mind that the explainable model would provide these explanations to the audience. Hence the authors suggested that, while building the explainable model for the audience, the social and behavioral science of the people should be incorporated within the model. In later times, the audience is to be given to evaluate the quality of the model (based on the explanations); since the end-users are to believe and trust these explanations. This trust and belief are largely dependent on the people's opinion along with other psychological conditions.

Thus, the research practitioners should also consider the psychological and behavioral aspects of the people in general rather than explaining the developer's perspective. Claiming whether an explanation offered is a *"good"* or *"bad"* one is determined only by the researcher's point of view or perception, which may not always succeed in real-time. It can be viewed from other perspectives such as —philosophy, psychology, or social science of the people in general.

So Tim Miller suggested that the explanations provided by the explainable model would prove to be beneficial only when the explanations are derived from the psychology of the audience – keeping in mind their ways of thinking, selection, presentation, etc (Miller, 2019).

DISCUSSION

The Machine Learning algorithms have been achieving good results in decision-making and predicting tasks. But they cannot guarantee that the models and algorithms will always provide correct and reliable predictions and hence remain doubtful whether or not they can be blindly trusted on real-world data. This is so because, since the discovery of various prediction models and algorithms, one never gains insights into the internal structure and the models' working. It is mostly imagined as a black-box with no understanding of the inner workings. With the ability to peek into this black-box and exploring its contents and working, one can explain the reason behind any prediction made by the model. In later times, one can also try to modify its content to smooth running, prediction making, and explaining.

Undoubtedly, the explainable models developed and proposed by researchers across the globe aim to provide us with the clear concept of explainability, but one could not find an agreement on the term. It is also evident that the research community is somewhat failing to present a satisfactory and standard level of understanding of the importance, properties, etc., of explainability in various domains.

Explainability is, of course, a powerful tool for exploring and unboxing the working model actively involved in the prediction making. It helps the end-users make various risky and life-changing decisions, which incorporates trust in a model. Without the progress in explainability, diverse life-changing incidents were witnessed, as discussed in later sections.

In this survey, we intend to give new researchers a clearer picture of explainability, by walking through the approaches, tools, and models developed so far in literature. The explanations provided by the various developed models and techniques are usually made with the complete knowledge of all the features. But studies and experiments can also be carried out to investigate the influence of latent

features in explanation. One such work can be found in (Lakkaraju *et al.*, 2017). where they worked on latent and unobserved features.

The importance and necessity of the end-users in debugging the intelligent system's prediction is also an essential aspect of the survey. Ways of debugging the systems have also been explored, which brought to light the various challenges faced in the context.

The role and importance of the psychological aspects of the people proving to be beneficial for explainability models are also brought to light. Addressing these barriers completely remains an unsolved research question yet to be looked upon.

CONCLUSION

This survey explored the broad spectrum of explainability employed in Artificial Intelligence, Machine Learning, and Deep Learning. Some of the noted contributions are marked and toured in this regard. Understanding explainability and its need is a primary concern that is highlighted in this study. We have presented some of the application domains that require explainability since the actions taken after relying on the model's prediction are life-changing and risky. Introspecting through this survey will guide the upcoming researchers in the field of explainability and serve as a reference in future research.

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Chapter 5
An Improved Model for House Price/Land Price Prediction using Deep Learning

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ABSTRACT

House price predictions are a crucial reflection of the economy; sometimes house prices include the land prices and demand of the place and location. The house price and land price are two different things, but both are important for both buyers and sellers. This chapter introduced the combination of ML and DL approaches to predict the house price with the updated regression algorithm. The algorithm named as 'Mopuri algorithm' reads the 14 attributes like crime rate, population density, rooms, etc. and produces the cost estimation result as a prediction. The proposed model accurately estimates the worth of the house as per the given features. The results of the model tested with the different datasets existing in the Kaggle data source using Python libraries with the Jupyter platform and continuation of the model using the Android OS to develop the smart home web-based application.

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INTRODUCTION

Data Science to solve real-time problems like house price/land price prediction. Estimation of the housing price/land price is a crucial issue and decision making is a challenging task while considering the various parameters to predict the house price/land price (Phan, T.D., 2018). The various study (Alfiyatin, A.N., et al., 2017; Feng, Y., & Jones, K., 2015; Lu, S., et al., 2017) proposed to solve this problem like a prediction of house price/land price used machine learning algorithm still there is a gap and uncertainty to design in the probabilistic and methodology (Alfiyatin, A.N., et al., 2017). The prediction of house price/land price will help the users to invest in a property without approaching an agent. It also decreases the risk involved in the estimation of property and misassumptions by both buyers and sellers (Feng, Y., &Jones, K., 2015). The regression methodology is the best way of estimating house prices or land prices but the correct way of estimation is not existing, regression is a methodology that observed the target variable and independent variable. The independent variable gives the prediction, there are various types of regression analysis techniques are existing such as linear, logistic, ridge, lasso, polynomial, and Bayesian. But every regression technique can be classified as three ways such as no. of independent variables and dependent variables (Lu, S., et al., 2017). There is a lack of probabilistic methodology in ridge and lasso regression a greater number of regression types are invented. The multilinear regression is the most appropriate to invent the house price/land price prediction but these models contain the risk involved in the estimation of price, and lack of customer satisfaction. The result displayed that the approach of the issue needs to be successful but still there is looking for comfortable application (Lu, S., et al., 2017). The multilinear regression has the ability to operate predictions (Li, Y., et al., 2016) The various datasets are available in the Kaggle data source (Lu, S., et al., 2017), and huge real estate data are existing but exact prediction not developed so far, in India skandhanshi real estate's Pvt. Ltd. Announced 1,25,068 constructions agreed on the overall India (Thamarai, M., &Malarvizhi, S. P., 2020). Every advertised contains commercial complex, villas, apartments and also includes the plot for selling and buying (Thamarai, M., & Malarvizhi, S. P.,2020). Several researchers suggest data science and its applications must improve the healthcare industry, business, e-commerce, transportations, security and data science and its applications must be useful in every aspect in home automation. Data Science and its applications improve the lifestyle of human life (Geo, G., et al., 2019). In Indian government of Andhra Pradesh construct the houses and donates the people whose poverty below 2 lakhs rupees as per the Indian currency (Thamarai, M., & Malarvizhi, S. P., 2020). House construction with the rooms to provide to maintenance shops, self-financed business, and restaurants for hotels, where charities and individuals can contact establishment of houses for orphans' societies and function halls, to celebrate parties and socialgatherings, and many other social activities in the present scenario (Thamarai, M., & Malarvizhi, S. P.,2020). Several organizations start the business to construct the houses, independent house construction is not that easy task for the poor and middle-class peoples (Thamarai, M., &Malarvizhi, S. P., 2020). The current framework of the ML&DL algorithms to estimate the house price needs the internet-based application that provides all specific features that provide the estimation and house price prediction (Piao, Y., et al., 2019). The estimation of house price prediction of the current mechanism of most essential product and works as perthe demands and needs to benefit of society. Mallikarjuna, B., & Reddy, D.A.K., (2019) worked out health care application works on smartphones they developed application runs on Android operating system used IoT devices connected the cloud and access the healthcare data, these types of applications are most needed for society. The house price/ land price

prediction framework would establish a shared communication platform, Mallikarjuna, B., et al.,(2013) worked out face detection mechanism by using genetic algorithm, but present most advanced technology startup the real-time applications, Mallikarjuna, B., et al., (2020a) solved the groundwater prediction by using-based binary predictions, groundwater can be estimation and prediction can passible with the SVM.

MOTIVATION

The buyers and sellers needed to find the best application for book the property, register the property and sell the property there is no best application in the present scenario (Ghosalkar, N. N., & Dhage, S. N., 2018). The buyers and sellers needed for satisfaction for their property to answers to their questions for prediction of house price and choose the property needed for best application, to property search, to post the advertising the property needed to predict the house price (Zhao, Y., et al., 2019). The house price prediction platform provides a forum and read the all requirements of the customer that links GPS service availability, the proposed model improves the quality of life of people at all levels of society. The current economic crisis has increased the number of people living in the society needed for house. Supply chain management process gives the path ahead for an interconnected collection of different attributes needed to satisfy the building of new house, some places completely polluted, depends up on the crime rate, nearer to the highways, garbage bins, these types of attributes much more effect of the buying price and selling price of the house. There is necessity to develop deep leaning algorithms for the prediction of the house price/ land price.

OBJECTIVE

The proposed algorithm design and implemented the combination ML and DL approach to make the regression from the existing statistical data with fixed target variable, Data Science applications concerning the image analysis and data processing, training, classifications and regression models and various deep learning models to solve the house price prediction depends up on the number of dependent attributes like number of bed rooms, and length of the rooms, calculate the house valuation based on the geographical area to predict the house price and land price and further extended to Android framework was developed in which people can send things according to their capacity and the application often enables associations to set up their demands, assuming, for instance, things they need. Much of today's population uses sophisticated smart phones with complex web connections, which is the fundamental prerequisite for the proper operation of this object.

CONTRIBUTIONS

Data Science tools for real estate and business applications presents the leading-edge research on house price/ land price prediction. This chapter integrates the Python and Android studio for implementation of house price prediction. The open-source datasets are available from Kaggle data base, any dataset the following 14 attributes are primary attributes are shown in the table 1 as a sample dataset.

Table 1. Primary attributes of house price prediction

S. No.	Features of house or land	Yes/No
1	Size of the land area	
2	Old of the house (No. of years the house constructed)	
3	Where is location of the land	
4	Connectivity of house location with airport/railway station/ bus station	
5	Distance from the market	
6	No. of floors of the house	
7	Material used while constructing the house	
8	Availability of the swimming pool	
9	Availability of interior facility of the house	
10	Availability of terrace	
11	Availability of water and electricity	
12	Availability of car parking area	
13	Playing area for kids	
14	Availability of security	

In this chapter consider specifically consider the 14 attributes for house price/ land price prediction and estimate the comparison between the actual and predicted price

Table 2. Sample dataset and description of each attribute

S.No	Attribute	Description
1	CRIME	Crime rate of the corresponding land location and house location
2	ZIP	Residential land zoned and house zone
3	INDUS	Industrial area estimation cost (depends upon industrial region)
4	VRD	Variable for region development (0 for river areas 1 for otherwise)
5	PANA	Polluted area and non-polluted area (depend up on population)
6	AVRM	Average number of rooms if is a apartment
7	NOH	Number of years old of the house
8	DIS	The house distance between the railway station/bus station/ air port
9	AH	Accessibility of highway
10	TR	Tax rate of the property
11	DH	Demand of the house (depends up on the number of people living in the region)
12	NBT	Number of blacked regions in the town
13	MPR	Minimum population in the regions
14	AOH	Average value of owner occupied the house.

RELATED WORK

Das, S. K., et al., (2002) study said ML and DL algorithm can predict the any real time problems and proposed the MaVHome architecture, the MaV is a smart home mobile application used with the IoT devices, the agent estimate the house price and prediction, this application not appropriate and specifically relevant to the house price/land price prediction. Mallikarjuna, B. (2020c) proposed feedback based smart home application used the IoT and cloud computing architecture to transmit the data effectively from IoT devices to the cloud architecture. De Nadai, M., & Lepri, B., (2018) utilize the hazard premium prediction values and estimate the house price and obtain the real estate prices the prediction value different from the urban environment and rural environment, but this work shows the same prediction price for botn environments.

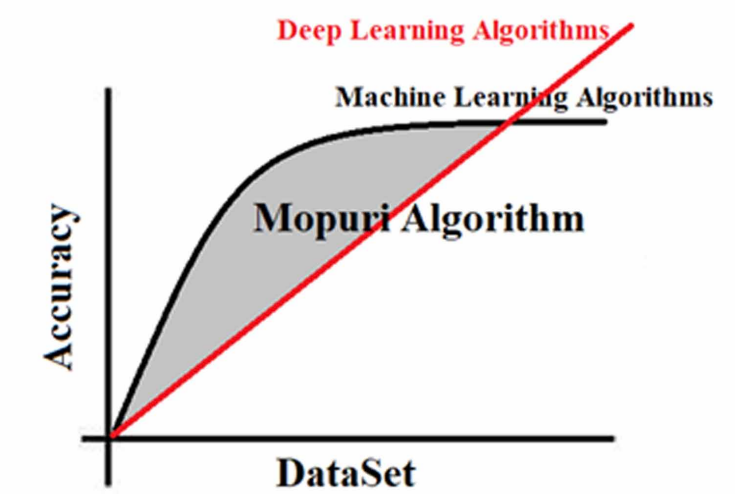
Durganjali, P., & Pujitha, M.V., (2019) using classification algorithms and many ML algorithms to prove the prediction but all attributes are independent and got the accurate result. (Phan, T. D., 2018; Alfiyatin, A.N., et al., 2017) The authors used Bayesian regression, they determine monthly rent for the house, and forecast of the house price yearly basis. They used XgBoot algorithm in the the concept of data mining and obtain the accurate result but these are current trend technologies, but the concept house price prediction is same.

(Feng, Y., & Jones, K., (2015); Lu, S., et al., 2017) There is huge literature worked exploratory models used in multilayer neural networks and predict the house prices from 2001 to 2013, these values depend up on population and senses values depend upon the region. (Li, Y., et al., 2016; Geo, G., et al., 2019; Piao et al., 2019) they proposed NN approach to determine house prices and used 530 sample datasets to get the accurate result, there no need for any agent to purchase or selling a house, in USA region they worked out different datasets and obtain the accurate value shows the 90% accuracy in terms of user satisfaction. Ghosalkar, N. N., (2018) notes those lodging showcase predicted eight of the ten post the quotation house price prediction is a benefit for the user. Basetty, M., et al., (2012) identify the human object while driving car by yawn detection technique using genetic algorithms, at present this is most real time problem in deep leaning approach. Basetty Mallikarjuna, (2020b) deep neural network classification to identify the gait, the neural network approach has provided the best solution while increasing the attributes. This chapter provides the better outcome with the combination of ML and DL approach and improved the existing regression model.

DESIGN AND IMPLEMENTATION

Deep Learning is the subset of the machine learning, deep learning decisions and data classifications are refined at each and every stage, in machine learning algorithms the user giving the dataset in deep learning algorithms the dataset takes from different sources in the training stage itself. The mopuri algorithm is the combination of ML and DL approach, the machine learning algorithms does not provide the more 80% of accuracy, the deep learning provides more than the 80% of accuracy as shown in Figure 1.

Figure 1. Combination of DL and ML approach



The combination of machine leaning and deep learning algorithms also required for medical applications and real time problems, it provides the effective tools for intelligent recognition, predictive analyzes and even deep transformation and estimation house price to get prediction and forecasting of data. In the proposed model used the fourteen parameter each parameter is independent variable nature there are 200 samples used in the training features used in R programming, that generates the feature selection and forecasting, the proposed model used forecast selection used in the package of R programming that derived by the feature selection package and forecasting package in R programming. The Boston housing dataset provides the complete data set of all attributes are input 4 nodes in hidden layer and 1 node in output layer as shown in Figure 2.

The algorithm works with deep learning nature and follows the two primary steps, in the first set step, it gathers the data, it collects the data from different sources and second step as per collected data it analyzed the house condition and land location. Let k_0 and k_1 is the parameters of the model $f_k(x)= k_0(x)+ k_1(x)$ function parameterized by $k=(k_0, k_1)$ the liner regression of the model of 14 attributes works with the learning approach and predict the housing price as characterized as shown in the Figure 3.

The dotted points as shown the different feasible prices of the house but the red line indicates the best feasible price that gives the prediction of the house price or land price observation. This chapter improves the linear regression model in terms of deep learning approach, the first step of the process gathers the data from different sources of real time data for the house price or land price prediction. In the second step it read the data from the input layer of the different attributes of the what customer needs and generate the new features and fixed the target variable as a sales price. The third set determines the new features and it governs the feature extraction. The fourth step performs the feature extraction as a deeper module, it creates histograms and generates the actual prediction.

Figure 2. Architecture of house price and land price prediction

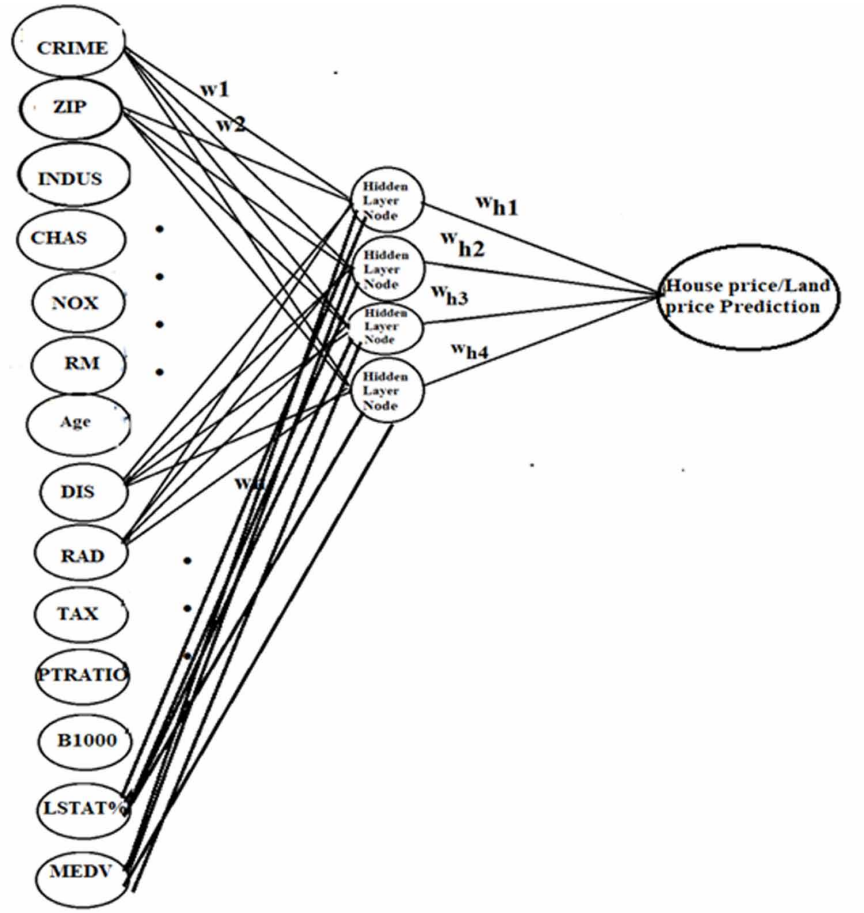
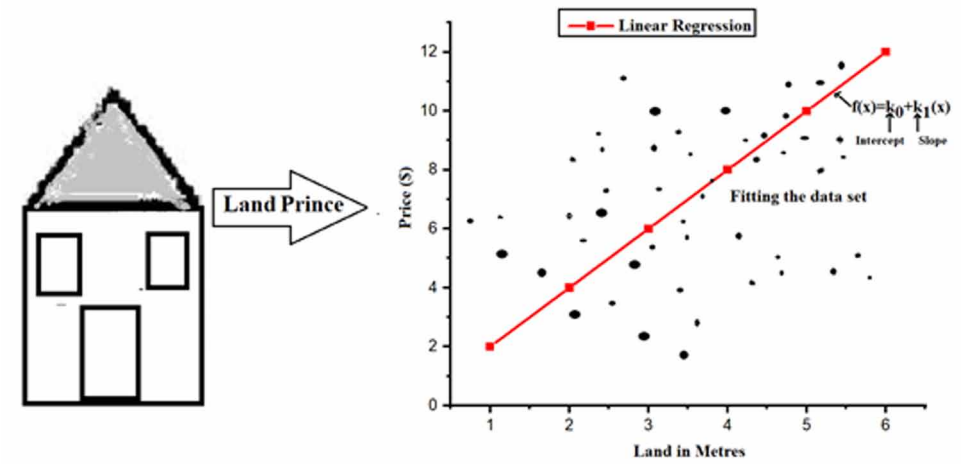


Figure 3. Linear regression model for land price prediction



Algorithm 1: Mopuri Algorithm

Input: The network collected the 14 attributes a[x,y]=[k_1,k_2,----------k_{14}]
Output: P=a+b[$k_{1,}$ k_2……k_{14}]

Step 1: Compute the a and b vectors and minimizing the error $\sum_{i=1}^{n}(p_i - a - bk_i^2)$

Step 2: Compute the vectors a and b and identify the mopuri error rate as follows $\sum_{i=1}^{n}\frac{(y_i - a - b_{k_i})^2}{\sqrt{(1+b^2)}}$

Step 3: Compute the prediction

$$p = P_{t+1}\ to.....do\ //Start\ for\ forecasting$$
$$if\ (p\%P_R) == 0\ then\ calculate\ the\ coeffecient\ a\ and\ b$$
$$e < -a(p - P_R : p) + b(p - P_R - P_L : p - P_R)$$
$$\rho_N < -a(p - P_R : p) + b(p - P_R - P_L : p - P_R)$$
$$\phi_p < -a(p - P_R : p) + b(p - P_R - P_L : p - P_R)$$
$$\left[k_{1,}k_2 \ldots\ldots\ldots\ldots\ldots k_{14}\right] < -[e, \rho_N, \phi_p]$$
$$P = a + b\left[k_{1,}k_2 \ldots\ldots\ldots\ldots\ldots k_{14}\right]$$

The Mopuri algorithm has different features, that differentiate the existing regression algorithm, like Debauched: It reads the real time data and process ii) Reliable: The proposed model has has reliable nature and it contains the deep learning charactersitics iii) Precise: The proposed model has precise nature and produce the litter amount of error rate. Iv) The algorithm trained at the end it provides the order of error recovery.

The following algorithm extends with the web-based application and works with the select a property, view the property details through the images videos and book the property. It describes the steps as follows:

1. **Login and Registration**: For both the buyer and the seller deals with the property deals, property care and tenancy management. this stage involves all services of related property with the login and enlistment. By preserving separate documents for each customer, the subtleties of the buyers and sellers are kept classified. The buyer and seller can only see the subtleties of the enlisted parameters.
2. **Services**: This stage requires the buyers and sellers can able to get the services like property deals, tenancy management and property care. The buyer and seller can able to access the buying procedure and selling procedure and registration procedure.
3. **Vendors**: In vendors module, the buyer needs to choose the right property required lot of time and effort and it over seek keeps up the specialist subtleties to match the seller subtleties.
4. **Service Provider Module**: In this module, the application runs with the android-based, generated using java and xml on Android Studio, requires web association and will offer contributors and searchers a stage after they register effectively in the system. He/she should express something unique in the document needs to provide home loan and employment details, hassle free account

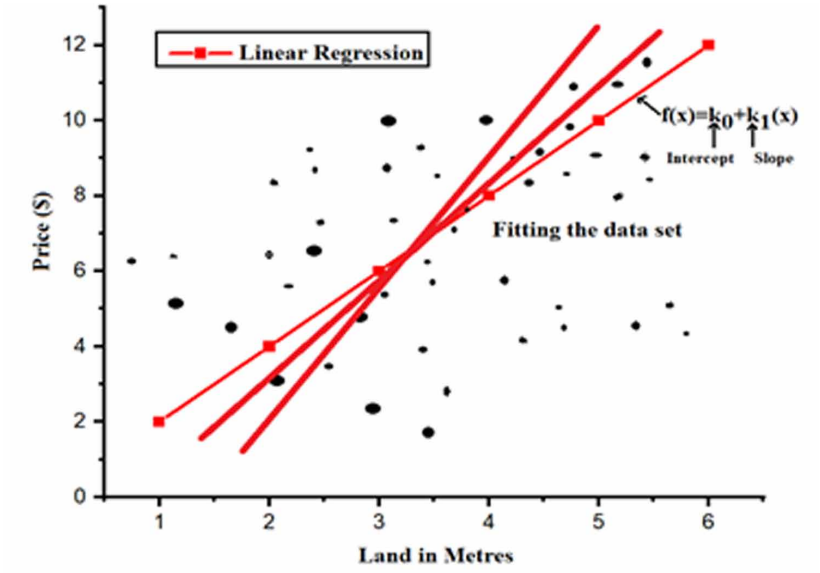
creation for needs to upload the properties with images. This notification would process to the list of buyers who are register in the community. This message would be stored in the database on the backend. This framework's UI will be simple and easy to access the services, and Android is based on the framework. The proposed model hoping to refresh and refine the needs of buyers and sellers and efficiently useful for buyers and sellers and the proposed model limited to Android Smart phones with Android OS and higher renderings.

To load the data to obtain the linear regression, in Python programming to read the libraries upon 'pd' varaibale and access the data through the following functions

```
Train_data = pd.read_csv("/dataset/Land_Information/traininfo.csv")
Test_data= pd.read_csv("/dataset/Hou_HouseInformation/testinfo.csv")
```

The missing values and clean the string variables are to process the exploration storage. The new feature to add the dataset during process stage is called as feature engineering. It normally distributes all variables closed to the target variable to filtering the dataset to develop the better relationship between the independent variable and targeted variable as sales price as shown in the Figure 4.

Figure 4. Linear regression to filtering the dataset



The proposed model train the algorithm as per the given datset and evaluated the suitable error as residual sum of squares to improve the accuracy and performance of the proposed algorithm. The algorithm evaluated the and improved the performance of the fixed target vaitlabe as sales price. Let assume that n observations and estimation of the each medical parameter y_i, the mean of error sqaured fitting the occurrences and adjust the parameter

$$Mean\,of\ Error\ Squared\,(MES)=\frac{1}{n}\sum_{i=1}^{n}(y_i-\vec{y})^2\,,$$

here y_i is the predicted value of the particular meters $\vec{y}$ provides mean value of y_i, to compute the root mean squared error

$$\mathrm{Re}\,sidual\,Sum\,of\ Squared\ \ (RSSE)=\sqrt{MES}\,,$$

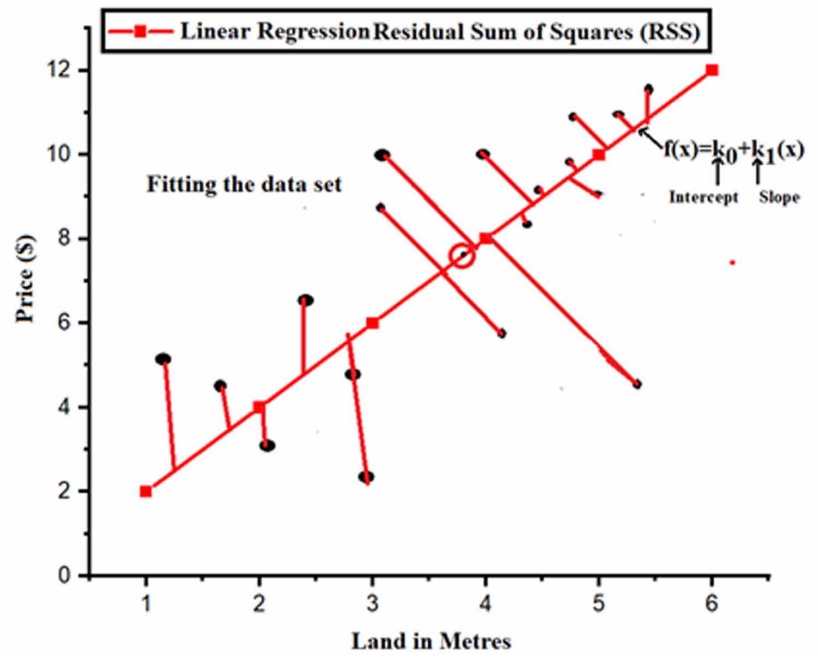
the Total Square Error (TSE) = n x MES

$$Sum\,Squared\,Error\,(SSE)=\sum_{i=1}^{n}(y_i-\vec{y}_i)^2$$

then $R^2=1-\frac{SSE}{TSE}$

$$Accuracy=\frac{R^2\,(R\,Squared\,Parameter)}{True\,Value}*100$$

Figure 5. Linear regression to reduce the RSS error to improve the accuracy



CONCLUSION

The proposed approach would estimate the house price and land price prediction by using DL and ML approaches. And there is a great deal for buyers and sellers to provide the services and described and satisfied all the modules of services illustrated to develop the web-based application by using Android studio. The model can be implemented by using Python with Jupyter Notebook and easy to establish the web-based application the proposed model easily carries to establish the Android OS to develop the web-based application. Yet this application provides flexibility and huge future demand and it is possible to extends the realistic and powerful arrangement for the interior decoration of the house.

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Chapter 6
An Effective Video Surveillance System by using CNN for COVID-19

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ABSTRACT

An effective video surveillance system is a challenging task in the COVID-19 pandemic. Building a model proper way of wearing a mask and maintaining the social distance minimum six feet or one or two meters by using CNN approach in the COVID-19 pandemic, the video surveillance system works with the help of TensorFlow, Keras, Pandas, which are libraries used in Python programming scripting language used in the concepts of deep learning technology. The proposed model improved the CNN approach in the area of deep learning and named as the Ram-Laxman algorithm. The proposed model proved to build the optimized approach, the convolutional layers grouped as 'Ram', and fully connected layers grouped as 'Laxman'. The proposed system results convey that the Ram-Laxman model is easy to implement in the CCTV footage.

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INTRODUCTION

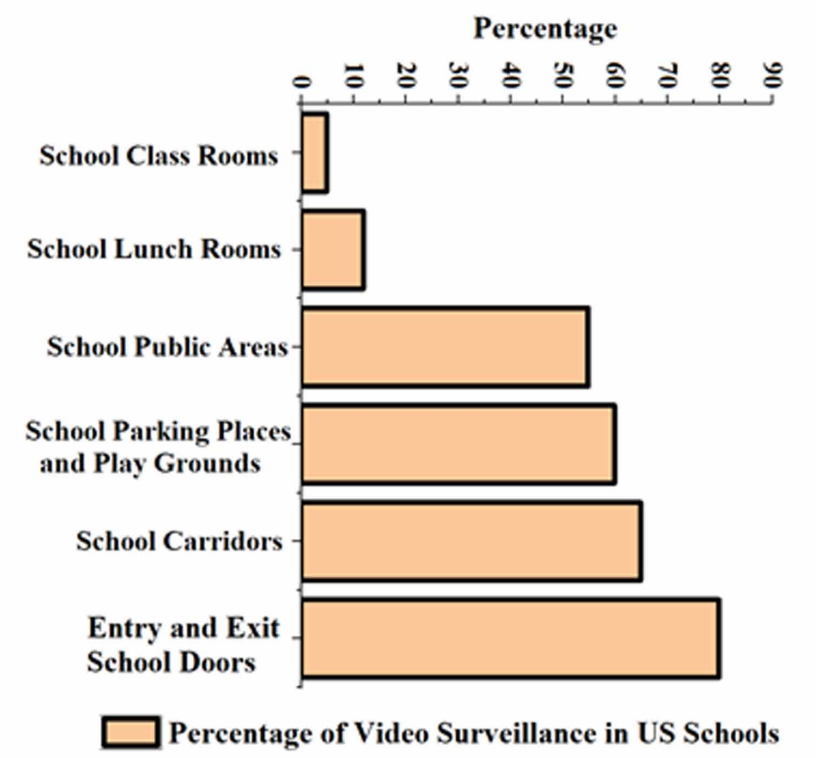
This chapter introduces the effective video surveillance system for mask detection and social distance maintenance in this COVID-9 pandemic, people unintentionally forget the mask detection and social distance maintenance in public places (Zou, L., et al., 2020). The proposed mechanism most necessary to implement in mobile applications and CCTV footages to alert the people in this COVID-19 epidemic situation, that would be a great helpful for people and the public in the identification of mask detection and they are maintaining the social distance or not maintaining the social distance in schools, movie theaters, hospitals, temples etc.. (Pan, X., et al., 2020).

The use of a face mask helps avoid the transmission of diseases and protects the person from contracting infectious germs in the air (Kimball, A., et al., 2020). If someone cough, chat, sneeze, they will leak germs into the air that will affect anyone in the vicinity. Masks are recommended as clear filters to discourage respiratory gouts from getting into the air and to other individuals as they wear the mask coughs, sneezes, speaks, or lifts their voice. Face masks are part of an infection management plan for the avoidance of cross-contamination (Li, R., et al., 2020). Wearing a mask in COVID-19 pandemic to avoid to spreading virus from person to person who are in close contact. If new scientific research becomes available, CDC Mask Guidelines will be revised (Furukawa, N., et al., 2020). CDC acknowledges that in some case or with certain individuals it might not be possible to wear masks. Wearing a mask in certain cases provides the confidence and gives the physical or mental health conditions and not only stop the transmission of COVID-19 virus and stop the various affected infections. And also wearing a mask provides various difficulties like hearing problems and breathing problems, when climbing the steps, it's difficult to breath(Oran D.P., & Topol, E, J., 2020). Dream by using a transparent mask in this case. If there is no visible mask, consider whether you are able to talk by writing, use a closed underline or minimize sound noise when wearing a mask that covers the lips (El Baz, S., & lmziln, B., 2020). Persons involved in high stress sports cannot wear a mask, such as racing, as it creates breathing difficulties. If the mask cannot be worn, recommend carrying out the operation at a venue with improved airflow and air circulation for instance indoor vs. outdoor (Huang, G, B., et al 2008).

Motivation

In USA implemented the effective video surveillance system and operate the active CCTV footage, the administrators of the individual organizations keep on identifying the video surveillance footage (Zou, L., et al., 2020). The surveillance system strictly following at the elementary schools, middle aged schools and high school campuses. Many schools of USA, UK and Japan and city polices observed the live CCTV footage (Pan, X., et al., 2020). The middle-income countries like India plan to establish the observation of live CCTV footages in schools and class rooms. The high-income countries like Andorra, Bahrain counties established the live CCTC footages at the schools and observed the safety measurements and also prevents the crime rate. According to educational researchers provides the two types of operational feasibility in COVID-19 such as uncontrolled mask application environment and controlled mask application environment, no one has evaluated the video surveillance in schools wash rooms and school buses. In addition, some of the schools which use CCTV video surveillance but are not considered the security measurements (Kimball, A., et al., 2020), the following Figure 1 describes the video surveillance system graph which used in USA schools and maintained the security precautions Lin, K., et al., (2020).

Figure 1. Percentage of video surveillance system used in USA Lin, K., et al., (2020)



Lin, K., et al., (2020) proposed face mask identification using R-CNN method, this method based on image processing and segmentation technique this method one among the foremost important system required during this epidemic. Jiang, M., & Fan, X., (2020) invented face mask detector that identifies the face detection applications which are some things that helps in recognition. to realize better detection, Ahmed, I., et al., (2020) proposed a deep learning context attention social distance detection monitoring method but not clarity of the reinforce the detection ability. Zhu, T., (2020) used the emotion detection in while mask it not possible to detect the emotions. Rezaei, M., & Azarmi, M. (2020) invented social distance monitoring and face mask detection using the CNN.

Objective

Social distance maintenance is compulsory for the COVID-19 pandamic and most of the study anlsysed that face mask is also essential, this study only integrates the combination of single application. Ptrovic, N., & Kocic, D., (2020) proposed the indoor safety mechanism, but this model used useful in lock down period, this model not at all applicable for public places like movie theater, schools etc.. Similar model proposed Rahman, A., et al., (2020) used deep learning system with IoT devices but not focus much on social distance.

It has been recommended by the CDC that the virus whic h causes COVID19 can be transmitted before symptoms a rise, for example, coughing or even snoring. In this manne r, it may be used to eliminate the virus that causes COVID -19, even though it has other variations in social ties. Due to their

low cost and ready availability, facial coverings were recommended. It protects surgical masks and 95 masks by means of fabri c face coating for medical staff who are entitled to direct c are for COVID19 patients (Jiang, M., & Fan, X., 2020). I use my face cover to shield you from me and you use yo ur face cover to protect me from you, so our chance of C OVID19 virus transmission can be greatly decreased. This is necessary to avoid the spread of COVID19 in combinat ion with social removal and regular hand washing and/or use of hand sanitizers (Ahmed, I., et al., 2020). Various types of face masks are surgical face masks, N95 masks, and cloth masks. The primary purpose of a face mask is to trap the droplets that are discharged from a person's mouth while communicating, sneezing, or coughing (Zhu, T., 2020). For a face mask to be effective, it should cover the mouth and the nose to trap the water droplets. The face mask should not be brought down to the chin. If done so, the face mask will get contaminated as it comes in asso- ciation with the exposed chin (Rezaei, M., & Azarmi, M., 2020). The combination of mask detection and social distance maintenance are most essential in COVID 19 pandemic which solvable by using deep learning algorithm.

Contributions

The proposed model built up on live video camara to detect a person wearing a face mask, and maintain the social distance or not, this model train the automatic social sources of datasets and perform the two resultants attributes like Ram and Laxman. The convolutional layer depends up on 'Ram' attribute and Fully connected layers depend upon 'Laxman' attribute. The certain tools are supported to build this model like TensorFlow, Keras and OpenCV.

Structure of the Chapter

This chapter organized as motivation, objectives and contributions described in section 1 and related work described as second section and proposed methodology as describes third section and section four evaluated the results and discussions and this chapter ends with the conclusions.

RELATED WORK

Loey, M., et al., (2020) study gives the fighting against COVID-19, the deep leaning models only possible to build the applications against COVID-19. Deep learning and its applications understanding and incorporating data sets in COVID-19, exploring data, send the proper and exact data to the end user and selecting data and fine-tuning suitable models with data science applications. Examples like automatic social distance maintenance, weather a person wearing mask or not, the precautions to reduce the positive cases, and more healthcare issues in COVID-19 pandemic chin (Rezaei, M., & Azarmi, M., 2020)..

Deep learning provides the statistical techniques to give data analysis and their related methods in order to understand and analyses the COVID-19 data and the end user receives the integrity of the data. Continuous data availability on COVID-19, it is necessary for health care industry for awareness of end user and patient monitoring. Scalability of the data faults in database and errors may occur in the sharing the data and not sufficient storage space required additional capacity of storage data, the system can failure while downloading the data (Zhu, T., 2020).. Data Science provides the mathematics, statistics,

computer science and domain knowledge of COVID-19 and also detection, mitigation, treatment and elimination of COVID-19.

Deep learning and its applications improve the health care industry by using various new data science applications. Face Mask Detection and social distance maintenance is the one major important applciation required during this Covid -19 epidemic. Loey, M., et al., (2020) proposed that face detection and social distance maintenance might be the key link of subsequent face-related applications which are some things that helps in recognition. Raamkumar, A.S., et al., (2020) study realized that better face mask detection, they proposed context awareness attention detection head and a cross class object for social distance maintenance. Ramchandani, A., et al., (2020) this work derives thereto Mask detection are often enhanced by using certain algorithms. The CNN algorithm is used for image recognition and segmentation methods have made it possible to extract even the pixel details of face mask detection. Sheetal, A., et al., (2020) study on machine learning algorithms, some persons waring the face mask correct position and some persons wearing the face mask wrong position and social distance maintenance for 1M used for distance measurement algorithm as shown in Figure 2.

Figure 2. Wearing face mask (Sheetal, A., et al., 2020)

The machine learning algorithms provides the accuracy not more 75% to 80% but deep learning algorithms provides the accuracy more than 95% used the applications like face mask detection and social distance maintenance (Sheetal, A., et al., 2020). The artificial intelligence algorithms and its applications wider in the health care industry and most appropriate in Internet of health care things (IoHT) and used in social distance maintenance as shown in Figure 3.

Rothe et. al., (2020) study gives the transmission of COVID-19 disease with asymptotic solution for wearing face mask, the detection of face mask possible with the machine learning algorithms and binary face classifier which may detect any face present within the frame regardless of its alignment as mentioned (Jesmin, S., et al., 2020).

Many people wearing a mask is risk of health-related illnesses or cause hazard protection problems (such as straps stuck in machinery) may contact a health and safety professional to identify the correct mask to be used. When in direct interaction with others, as in group travel or shift-meeting, external workers should make use of masks as a matter of priority and drop masks when social distancing is necessary. Masks are a vital prevention mechanism and are most useful in times of challenging social distance. As per the statistics of USA, number of people wearing a mask as per statistics as shown in Figure 4.

Figure 3. Social distance maintenance (Jesmin et al., 2020).

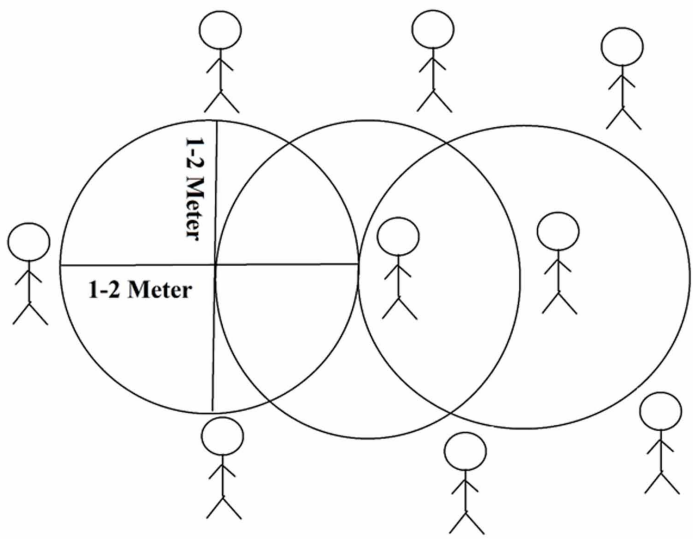
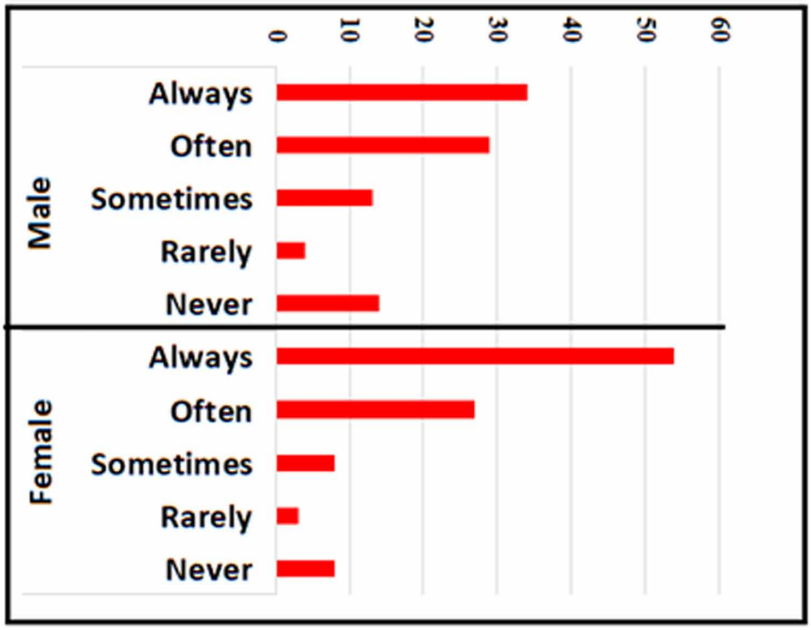


Figure 4. The number of people wearing a mask in USA



To build the proposed system demands the combination of two applications wearing a mask and social distance maintenance, it creates the environment safety and precaution among the public, It can cause best options for during this epidemic. has to build the unique application has given appropriate need in the COVID-19 pandemic.

PROPOSED METHODOLOGY

Detecting masked faces at the same time detecting social distance is a challenging task, any deep learning model so far cannot detect the accurate model for face mask detection and social distance maintenance. The advanced technology with deep learning approach, the improved result of CNN needs for detecting masked faces and social distance measurement both at a time with the proposed approach 'Ram-Laxman algorithm'. In the epic Hindu story of 'Mahabharat', Ram and Laxman are two brothers, the entire proposed model follows the two steps, identification of face mask and social distance. Identification face mask comes under Ram adjacent, and social distance maintenance comes under Laxman adjacent.

The Ram layer annotates location of faces and detect the face orientation of the mask, if the face mask detected the identify the correct method or wrong method (left, right, left front, right front), and deeply observe the orientation degree of the mask (close over the mask nose to chin and mouth)

To build the model into two phases: training face mask detector and implementing face mask detector. The training and detection phase of our face mask detector model. The dataset is loaded for the model to be trained and the model is realized in the training phase. Further, the trained model is loaded, the faces are de- tected in images and video streams and then the region of interest (ROI) is extracted. Finally, the face mask detector is applied and the images or faces in the video streams are classified as with a mask, improperly worn mask, without a mask. The Kaggle dataset consisted of 15 images of improperly worn masks, 10 masked images, and 10 images without a mask. The detailed description of face mask identification description as shown in Figure 5, to train the model using Keras/TensorFlow dataset as the training stage. The face mask detector trained then perform the deployment, under deployment identify the mask wearing the correct position or not and classify with mask or without mask of the face.

The Kears, Pandas, OpenCV and Tensorflow libraries build the train the model, the initial learning rate is 4 and the number of training epochs is 20. The data is then pre-processed. The images are resized to 227x227x3 pixels in tensities in the input image. After this, the model was compiled to be trained and then the model was evaluated on the test set. The accuracy and iteration curves were plotted. After the model was trained, an image was loaded as an input to distinguish of mask improperly. The input image is then loaded and pre- processed. To localize wherein the image all faces are mapped and identified the who wearied the face mask and who does not wearied the face mask, face detection and automatically identified the social desistence by using interest (ROI). The recognized face masks in real time video streams as per the step-by-step procedure described as follows.

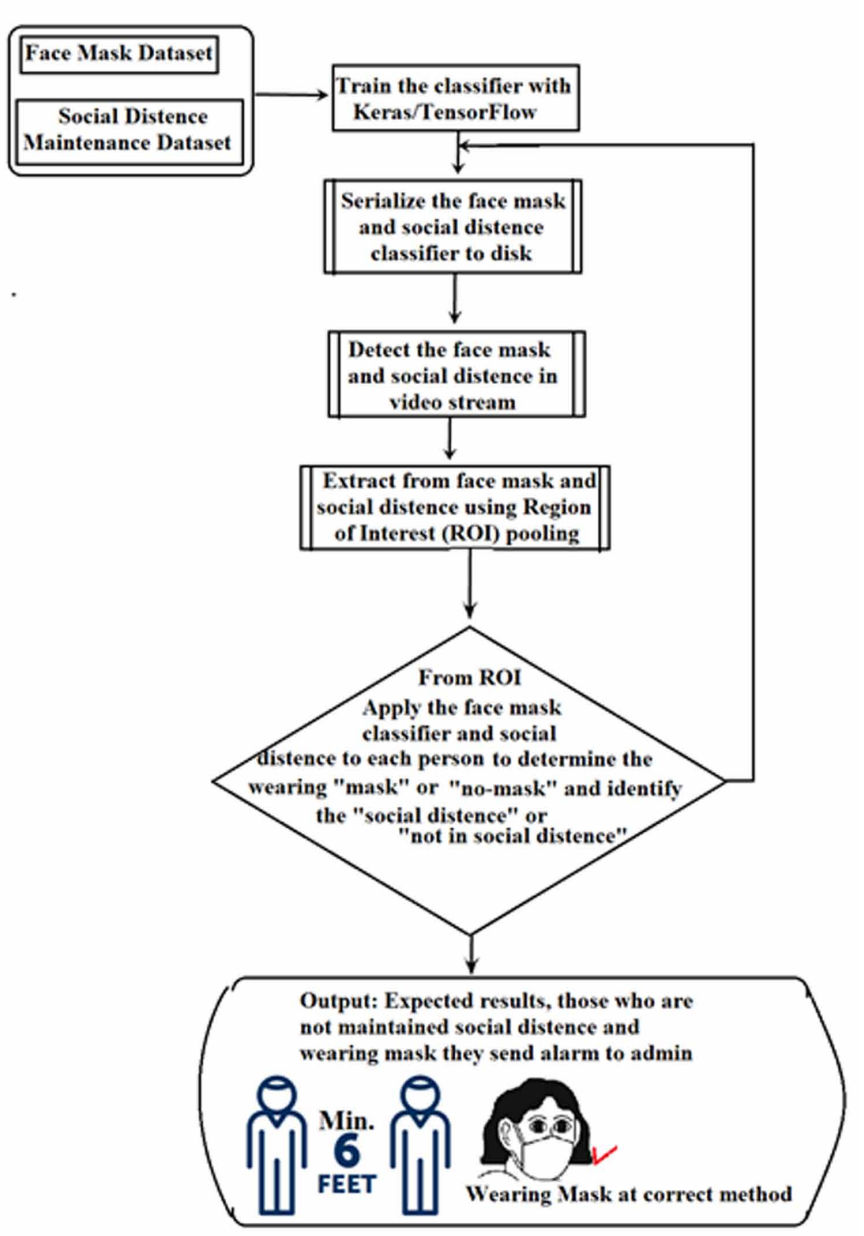
Algorithm 1: Automatic face detection and social distance maintenance

Step 1: Insert the library's CV2, numpy, keras and input considered from the live video streams

Step 2: Face mask and social distance detector from the dataset labels, if the feature extraction detects as follows.
if it is a object then image (with_mask) ←[1]
image (without_mask) ←[0] or distance between image1 and image 2 (social_distance) ← [1] (without_social_distance)← [0]

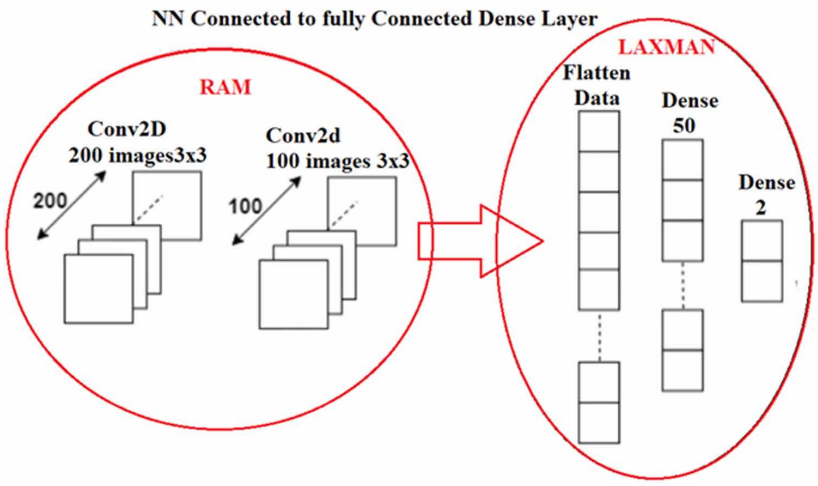
Step 3: Make the list to target the data used NumPy arrays and pre-processed data. The input of the data is neural network architecture and saved npy file

Figure 5. The design architecture of the effective video surveillance system.



Step 3a: Build the network architecture model that convolutional pooling layers grouped as 'Ram', the output is given to the fully connected layers grouped as 'Laxman' the output of the probabilities for a person identification of mask maintained the social distance or not maintained the social distance, the architecture of the network as shown in the Figure 6.

Figure 6. Ram-Laxman architecture of deep neural network



Step 4: Split the data and fix the target into the model. The accuracy of the model as shown in more than 90% accuracy the training data is fitted in the model and prediction can be observed.
The prediction of the final output produces by the dense layer, it generates the prediction feature values

$$\bar{p} = p_0, p_1, \ldots\ldots\ldots\ldots\ldots\ldots p_{i-1}, p_i, \ldots\ldots\ldots\ldots p_{i+1}$$

that gives the non-linear relationship as per the received input images, the social distance and wearing mask works with the principle of shallow, it identifies all dependencies such as known, hidden, short term and long term dependencies, the dependencies carry forward the value as per the expert knowledge system. The evaluation of pre-training and denoising techniques this model gives the better generalization and less over fitting. The denoising auto encoders receives the noise images (x) that encodes the cleaned version (N) by using the Gaussian additive noise (σ) as shown in eq.(1).

$$\sigma = x + \mathrm{N}(0, \sigma^2 I) \tag{1}$$

To making noise images (MN) of the probability (P) calculates the $\bar{x} = MN(P)$, the encoding scheme as described in eq. (2)

$$E(\bar{x}) = SoftSign(\bar{b} + W\bar{x}) \tag{2}$$

The decoding obtained by the eq. (3).

$$D(\bar{x}) = g(h(\bar{x})) = SoftSign(\bar{c} + W^T h(\bar{x})) \tag{3}$$

The aforementioned encoding and decoding equations $\bar{x}$ be the input vector $h(\bar{x})$ be the hidden layer are $\bar{b}$ and $\bar{c}$ are bias vectors and W be the weights of the matrix to calculate the SoftSign as follows in eq. (4).

$$SoftSign(.) = \frac{x}{1+|x|} \tag{4}$$

The autoencoders building by layer by layer error detection and recovery technique, all layer trained accordingly as per the autoencoders and trained weights produced the final result, the forecasting layer activate the liner function, the whole neural network variate the multivariate approach. Each periodic information to be predicted through the past observations this process carried out through the iterative forecasting. The F is the forecasting model and H be the number of predictive samples and I be the number of past samples S taken as input and also it generates the multi-input and multi-output approach (MIMO) as shown in eq. (5).

$$S_{t+1}^{A+H} = F(S_{t-I+1}^{t}) \text{ eq.} \tag{5}$$

For social distancing we just take the image of 1st person using human detection (Skeleton) approach. The human detection skeleton data provides by the training data, the proposed approach compute the social distancing as described in algorithm 2.

Algorithm 2: The effective surveillance mechanism

Step 1: distance by checking the window size of one image to another image they have some fix ratio as 1 to 2 meters that value stored in the K.

Step 2: The K value calculated distance of two image objects as determined as

K (Constant) ← Social distance of

ImageObject1← WindowSize(ImageObject1)

ImageObject2←WindowSize(ImageObject2)

$$K(Cons\tan t) >= \frac{\mathrm{Im}\, ageObject1}{\mathrm{Im}\, ageObject2}$$

Step 3: if (not_maintained(social_distence))

Send(alert)

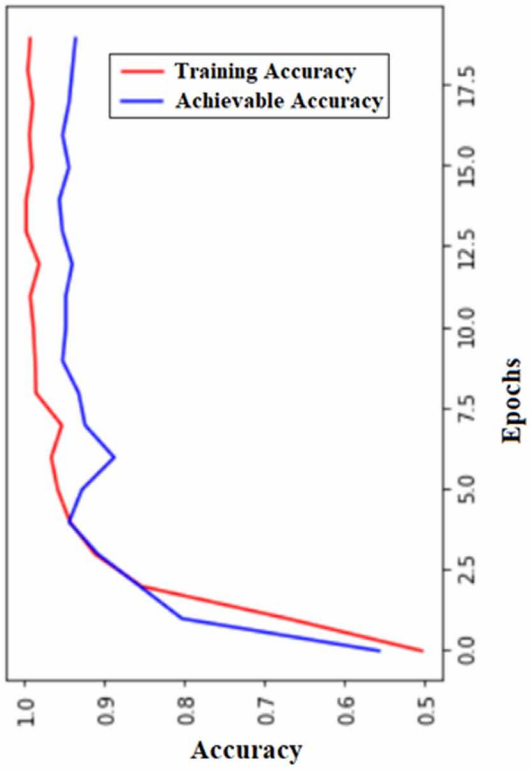
Repeat the step 1 and step 2 and send the alert message to surveillance team.

The proposed model most suitable for social distance maintenance and mask identification and easy to establish the video surveillance stream monitoring application, the application uses the PyQT5/PyQT4 for front-end which is a part of python which is opensource environment, this model needs lighting, some places lighting relatively low, such cases accuracy relatively low. This approach is most appropriate in public places like railway stations, movie theaters, temples etc… But identification face mask should be the face to be recognize should catch over the camara.

RESULTS AND DISCUSSION

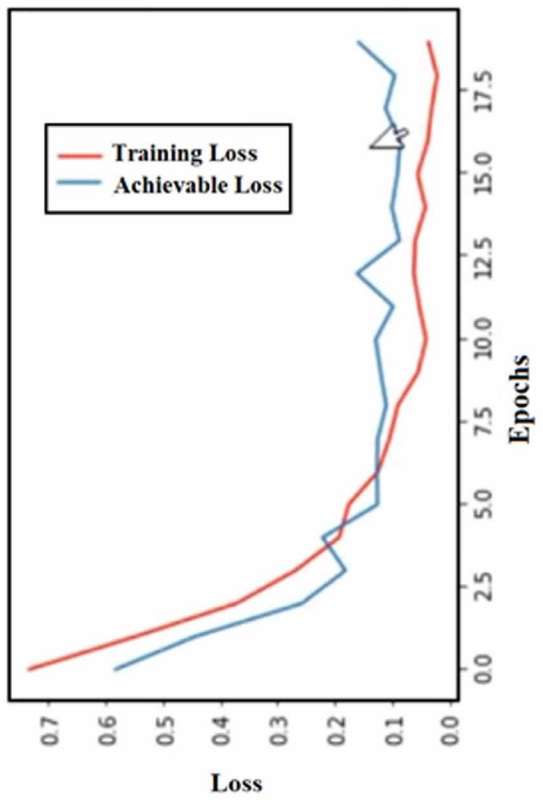
The proposed Ram-Laxman algorithm model tested with CloudX LAB using Python Scripting language PyQT5/PyQT4 (frontend) on Windows 10 operating system and OpenCV database (backend). The system will be build with the help of OpenCV, TensorFlow and Deep Learning technology. There are certain tools used to build the model like Tensorflow, Keras and OpenCV. The proposed approach also test the software on a live video streaming. The face mask detection and social distance maintenance used two convolution layers, one convolution layer for to detect the face mask and one convolution layer to detect the social distance. The accuracy of the proposed model showed in in the following Figure 7, the epochs (dataset) passed to the input and obtain the achievable accuracy 90%.

Figure 7. Accuracy graph generated by the Python programming



Each time the achievable accuracy is changing depends up on the input, however the achievable accuracy not less than 90% which has been proved with the training loss as shown in Figure 8. The result shown that training loss and achievable loss with in the same pipeline. Hence the proposed model most suitable for the video surveillance system who are not maintaining the social distance and wearing the face mask.

Figure 8. Loss graph generated by the Python programming.



CONCLUSION

The proposed model is the combination of the face mask detection and social distance maintenance (at least 6feet), the proposed model used the training model of the dataset of the facemask detection and social distance maintenance, the results of the proposed model obtain the accuracy of 90% achievable accuracy. The proposed model is feasible to establish in face mask detection and social distance maintenance used in CCTV footage to detect whether the person is wearing a mask or does not wear mask, if the person wearing a mask to detect rectify whether it is the correct method or the wrong method and also identify the social distance of 6 feats or 1 to 2meters of minimum distance. The proposed model is most useful to establish in railway stations, schools, markets, colleges, public places, etc... The future work of the proposed model to reduce the complexity and optimize the model and easy to establish in CCTV footage and also improve the accuracy of the model.

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Chapter 7
An Improved Deep Learning Algorithm for Diabetes Prediction

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ABSTRACT

This chapter introduces the novel approach in deep learning for diabetes prediction. The related work described the various ML algorithms in the field of diabetic prediction that has been used for early detection and post examination of the diabetic prediction. It proposed the Jaya-Tree algorithm, which is updated as per the existing random forest algorithm, and it is used to classify the two parameters named as the 'Jaya' and 'Apajaya'. The results described that Pima Indian diabetes dataset 2020 (PIS) predicts diabetes and obtained 97% accuracy.

INTRODUCTION

The healthcare industry manufactured the health care products and services to the patients for the treatment and rehabilitation. Diabetes is a disease that affects blood glucose levels or blood sugar levels are too high (Mujumdar, A., & Vaidehi, V., 2019), there can be a lot of factors that can contribute to the risk to detect the diabetes and prevention in the early stage of life (Mercaldo, F., et al., 2017). Genetics of the human body and family history are some of the reasons to get the disease of diabetes (Kavakiotis, I., et al., 2017). Machine learning and deep learning (ML&DL) algorithms build a solution for diabetes,

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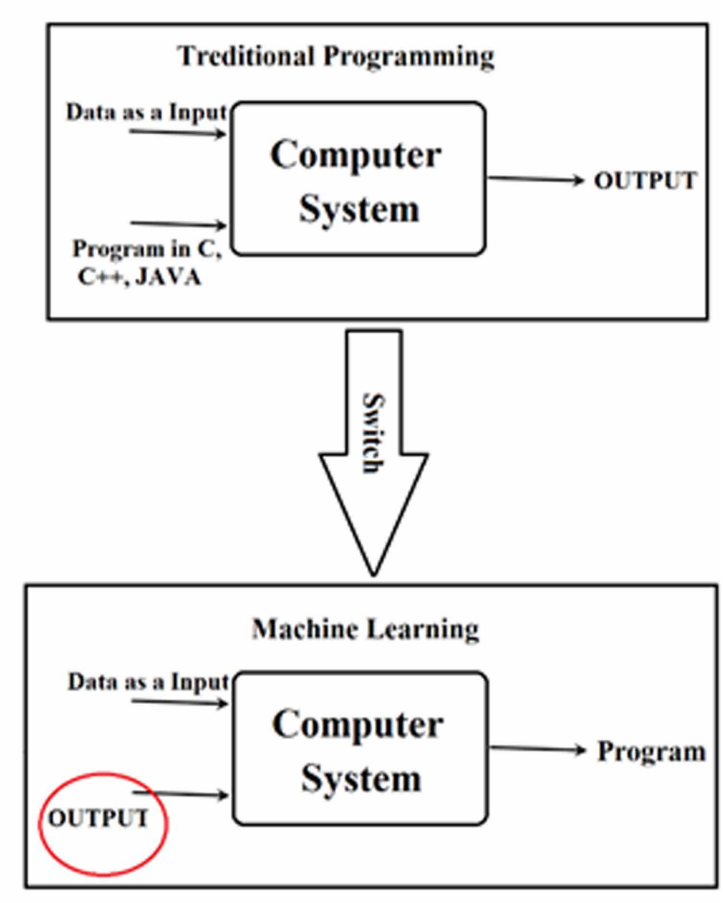
ML and DL read the sample datasets, known as "training data", in order to make predictions, these algorithms are being explicitly programmed (Sai, P.M.S., and Anuradha, G., 2020) using these algorithms can predict diabetes (Soumya, D and Srilatha, B., 2011).

Presently traditional programming shifted to machine learning, as per traditional programming, program and data as the input and produce the output, in Machine Learning dataset and output as the input and produce the program as the output (Mujumdar, A., & Vaidehi, V., 2019). In ML performs the automates analytical model and building the model as shown in Figure 1. It is kind of AI to identify patterns and make decisions without human interactions.

Figure 1. Traditional program switched to machine learning (Mercaldo, F., et al., 2017).



The diabetes prediction problem using machine learning algorithms with respect to economic, technical, legal, and scheduling considerations (Mercaldo, F., et al., 2017). Basetty Mallikarjuna, et al., (2020b) used deep neural networks and implemented a novel approach for gait identification. ML and DL focuses on the development of computer programs reads the dataset as input. Machine learning is divided in supervised learning and unsupervised learning (Papatheodorou, K., et al 2015). Basetty, M.,

et al., implemented genetic algorithm to recognize the human object. The majority of work in ML using supervised approach (Mamykina, L., et al., 2017). Diabetes prediction is a challenging research work, to predict BMI and blood glucose levels in diabetes, and how-to physicians give precautions to patients. It is complex process to give all the data to read as much as ML algorithm (Mallikarjuna, B., & Reddy, D. A. K. (2019). Mallikarjuna, B., et al., (2020) said, ML algorithms are most suitable for ground water prediction. Kumar, et al., (2017) combined data mining with ML algorithms and proved effective accuracy levels of prediction. Mallikarjuuna, B., (2013) used genetic algorithms for face detection. By using DL algorithms to estimate the blood sugar levels (Ayon, S.I., & Islam, M., 2019). Non-insulin-dependent diabetes easy to estimate the accuracy by using the ML algorithms.

Motivation

To detect the diabetes at early stage is most important, there are two types of diabetic patients' insulin diabetic patients and non-insulin diabetic patients (Papatheodorou, K., et al 2015). The various study made by using ML algorithms which results are predicting the diabetes, and compare the various algorithms with accuracy (Suresh, K., et al., 2020; Vijayalaxmi, A., et al., 2020). Each algorithm has its own limitations as well as advantages. Diabetes disease effect on blood glucose levels, or blood sugar levels are too high (Papatheodorou, K., et al., 2015; Mamykina, L., et al., 2017). By using ML and DL algorithms can predict the diabetes individual by using the 'Pima India Dataset 2020' (PIS) and it has the most recently updated data so that the maximum accuracy to obtain the proposed approach.

Objective

The objective of the proposed approach used to detect the early detection of risk of diabetes with possible maximum rate of accuracy that approach is most helpful for physicians and medical practitioners to predict the risk of developing diabetes as early stage as much as possible (Nnamoko, N., et al., 2018; Shetty, D., et al., 2017; Sarwar, M.A., et al., 2018; Gupata, S. C., & Goel, N., 2020).

Contributions

The diabetes prediction using deep learning using the python (language use to give commands for doing analysis) scripting language and including R language (language use to give commands for doing analysis) most flexible to work with the PIS Indian diabetes dataset 2020 which is open-source dataset and feely available in the web site (Kaggle sample database) the sample dataset as shown in Table 1. In the dataset considered as nine medical parameters are used including outcome of each parameter, all parameters are independent variables and one parameter outcome is dependent variable

And also analyze the dataset using various libraries which supports in Python programming language like Matplotlib, Keras, Pandas, TensorFlow etc.. And also plotting the graphs using Matlab (platform used for doing analysis and generate graphs) with R studio (platform used for doing analysis and generate graphs).

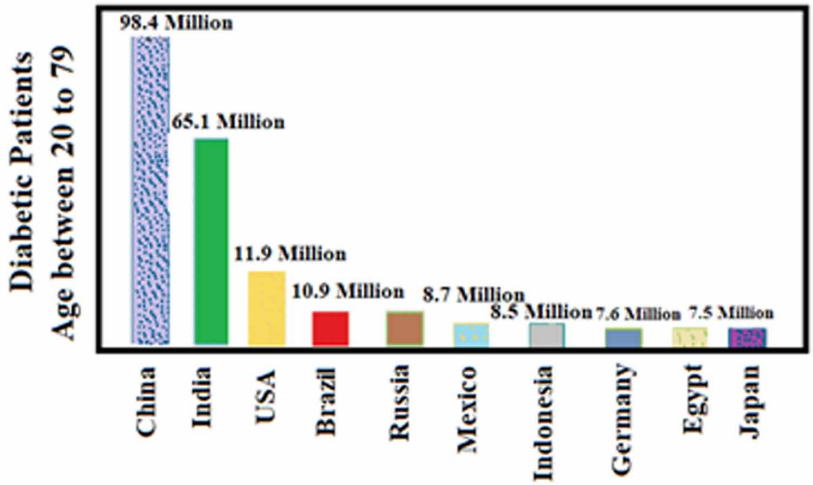
Table 1. The sample diabetes dataset

S. No	Pregnancy	Glucose level	Blood Pressure	Skin Thickness	Insulin	BMI	Pedigree Function	Age
Patient1								
Patient2								
Patient3								

RELATED WORK

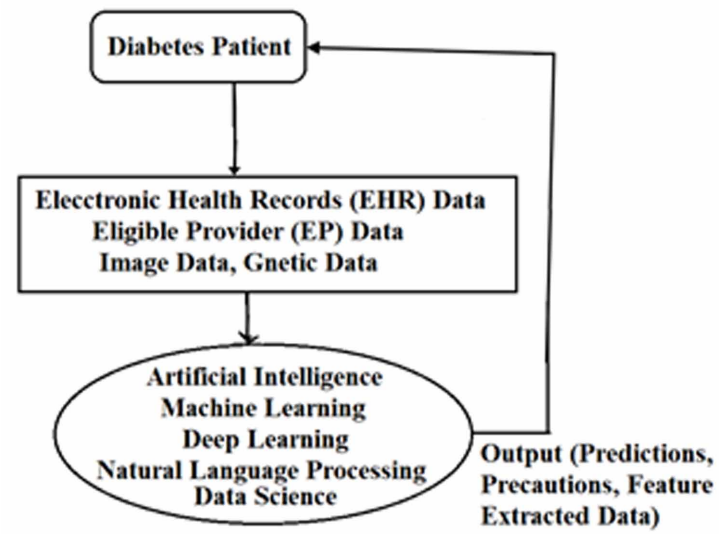
In deep learning architecture consist of multiple layers under input layers, hidden layers and output layer, in diabetic prediction huge literature available in machine learning algorithms in the healthcare domain (Mujumdar, A., & Vaidehi, V., 2019). Most of the articles presenting the knowledge about the use of most advanced machine learning algorithms for the early prediction but not considered the huge training dataset and not analyzed the forecasting and feature enhancements and extracted data (Papatheodorou, K., et al 2015; Mercaldo, F., et al., 2017). A report from WHO analyzed over the inherited properties of the people (Chow, N., et al., 2020). The following Figure 2 shows the top 10 countries in the world suffering from the diabetes, China has highest population suffering from the diabetes, in India 65 million people suffering from diabetes.

Figure 2. Population suffering from diabetes (Chow, N., et al., 2020)



It is estimated that by 2042 there will be around 700 million cases of diabetes around the world (Papatheodorou, K., et al 2015). The physicians are eligible providers (EP) needs healthcare applications, that applications gives the precautions to the patients and help to give medicine to the patients, deep learning and artificial intelligence algorithms are most helpful especially in medication of diabetic patients as shown in Figure 3 (Mujumdar, A., & Vaidehi, V., 2019).

Figure 3. AI and DL algorithms are improved the model of diabetes prediction (Mujumdar, A., & Vaidehi, V., 2019)



Kumar et al., (2017) proposed J48 algorithm using classification and datamining concept and implemented WEKA tool kit, it performed tree pruning approach, it works with the two count gain values entropy and gain functions, it obtain the accuracy value 99.87% . The proposed does not have the clarity of the explanation of the algorithm and does not suitable for present ML and DL algorithms. Suresh, K., et al., (2020) proposed the diabetes prediction using random forest algorithm and compared with various existing ML algorithms and obtain the 77% accuracy. Vijayalaxmi, A., et al., (2020) defined that DL algorithms are most suitable for diabetes prediction, they got higher accuracy using random forest algorithm and compared the proposed models to various existing machine learning algorithms. SVM vector based supervised ML model provide 70% to 80% accuracy, every ML algorithms having its own merits and demerits of the diabetic problems. Naive Bayes is a different classification model then SVM and better accuracy and it is independent of the variables approach. Decision Tree also supervised approach and fast training approach then SM and Naïve bayes. Nnamoko, N., et al., (2018) used supervised learning approach and classified the aggregate output, they ensembled as meta heuristic function. Shetty, D., et al (2017) they used separate database and not work with specific dataset, this study works with the Bayesian algorithm and KNN algorithm analyzed the attributes but shown the accuracy and prediction with KNN simple to compute the distance fucntion. Sarwar, M. A., et al., (2018) shown as various machine learning algorithms and executed the diabetes prediction, that comparison shown which algorithm is best and which algorithm is the best and which model is suitable. Ayon, S. I., & Islam, M. (2019) study proposed the 98% accuracy by using the deep learning, but they are not used the which algorithm to support to the solve the prediction. Gupta, S. C., & Goel, N. (2020) proposed the enhancement of KNN algorithm for diabetes prediction and implemented the tested positive rate and tested negative rate but implemented as medical parameters.

Table 2. Different ML and DL algorithms for diabetic prediction.

Author	Proposed for Diabetes prediction	Advantages	Limitations
Kumar et al., (2017)	J48 Algorithm	Improved the accuracy	They used Data mining approach
Suresh, K., et al., (2020)	Random forest algorithm.	Accuracy shown 77%	This model existing in ML, but not specific algorithm, needed to improve the accuracy
Vijayalaxmi, A., et al., (2020)	Enhancement of Random forest algorithm.	Predict the diabetes effectively	The model needs effective dataset, and not considered as training dataset.
Nnamoko, N., et al., (2018)	Supervised learning approach	Prediction with higher accuracy	It is not used specific algorithm.
Shetty, D., et al (2017)	Bayesian and KNN	Analyzed the medical attributes	This model lack of the prediction.
Sarwar, M. A., et al., (2018)	All machine learning algorithms	The comparison of diabetes prediction.	There is no specific model to predict the diabetes
Ayon, S. I., & Islam, M. (2019)	Deep Learning	98% accuracy for prediction	Not Specific Algorithm.
Gupta, S. C., & Goel, N. (2020)	Using ML algorithm	Comparison with many algorithms and shown as accuracy.	Not Specific Algorithm.

The ML algorithms in the diabetic predictions are in the present healthcare industry, the diabetic survey says about 1.2 million deaths are due to the uncontrolled stage of health lead to death. About 2.2 million deaths occurred due to the risk factors of diabetes like a cardiovascular and other diseases (Chow, N., et al., 2020). The following Figure 4 shows that the most of the similarities are existing as per the survey. (Suresh, K., et al., 2020)

DL algorithms are gain its own strength even though ML algorithms are capability of managing a large amount of data to combine data from several different sources, the proposed methodology provides the more accurate value.

DESIGN AND IMPLEMENTATION

Deep learning approach most needed for medical applications like diabetic prediction, the aforementioned literature said that various techniques used to solve the diabetic prediction and concludes that random forest and decision tree are the best approaches and obtain the 95% accuracy in the overall performance. In the proposed model used the nine training medical paprameter each parameter is independent variable nature there are 200 samples used in the raining features used in R programming, that generates the feature selection and forecasting, the proposed model used forecast selection used in the package of R programming that derived by the feature selection package fscaret package in R programming. The PIS dataset provides the complete data set of each patient as per the preference of pregnencies, 9 independent variables are input 4 nodes in hiden layer and 1 node in output layer as shown in Figure 5 (9x4x1).

Figure 4. Performance of ML algorithms (Suresh, K., et al., 2020)

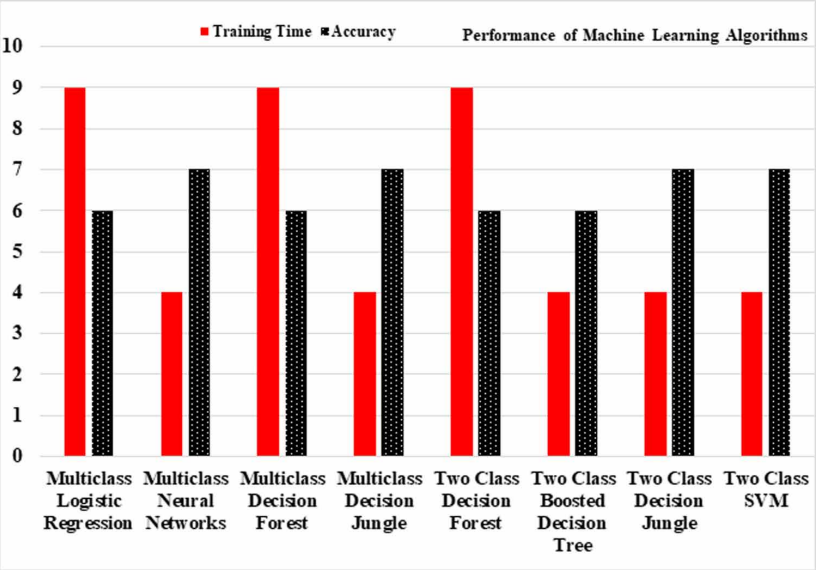
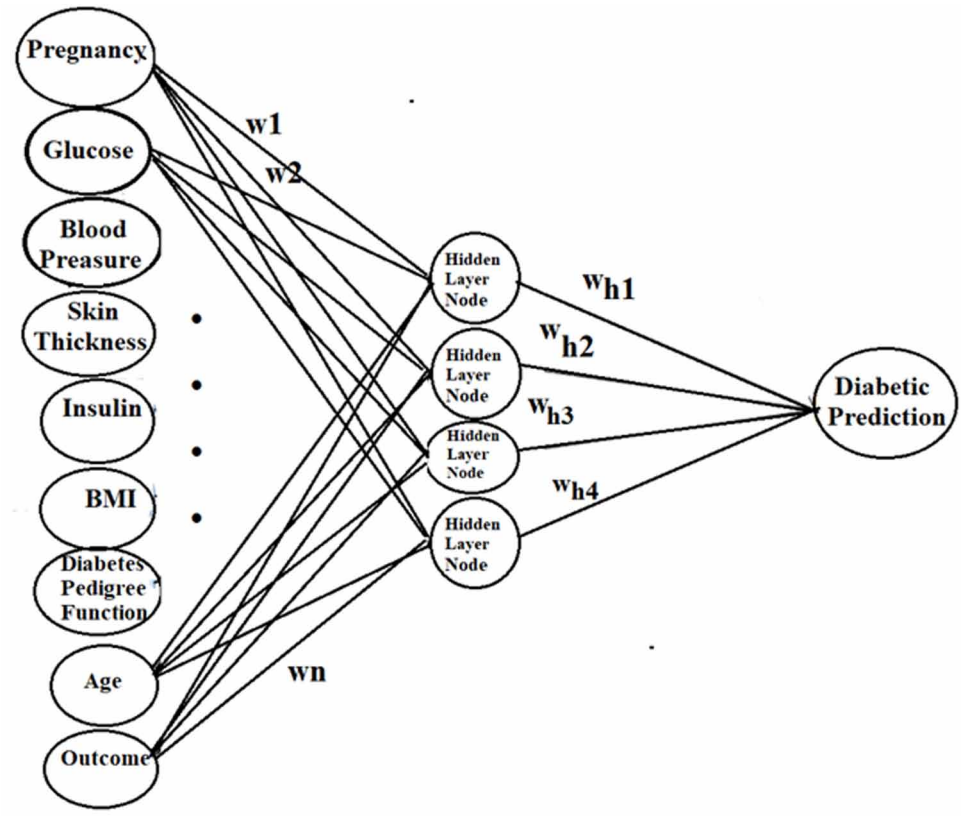


Figure 5. Architecture of diabetic prediction using deep learning approach



Every ML algorithm as per the literature needed to get the maximum accuracy, but huge libraries involved in ML algorithms. to predict the huge datasets for risk of diabetes for a patient. The current model named 'Jaya-Tree Algorithm' the word 'Jaya' as Sanskrit word means that winner of its all characteristics at any circumstances, the proposed algorithm used two parameter approach, named as 'Jaya' and 'Apajaya', if Apajaya parameter reached the highest value then the Jaya parameter then chance to get the positive diabetic as a result of Jaya algorithm, if Jaya parameter reached the highest value when compared the Apajaya parameter then chance to get the negative diabetic as a result of Jaya Algorithm. The best prediction always overcome the number of samples in the training dataset. The description of Jaya Algorithm as Follows. The Jaya-tree algorithms existing some similarity of random forest algorithm, like its name implies, consists of a large number of individual decision trees that operate as an ensemble. Each label like 'Jaya'/'Apajaya', the tree spits out the class prediction.

Algorithm 1: Jaya-Tree Algorithm

Step 1: Perform the classification as per the given dataset contains class labels, to find the attribute vectors that works with instances.

Step 2: Fix the target variable and generate the tree structure as per the attributes generates vector to behave like a number of instances.

Step 2a: Each training instance of a class generates the new training instance become the children of a class Then measure the order of the data to fix the labels jaya and apajaya

$$Jaya = \sum_{i=1}^{n} \log(\frac{N_v}{T_v})$$

$$Apa\,Jaya = \frac{1}{n}\sum_{i=1}^{n} \log(\frac{N_v}{T_v})$$

Step 3: The algorithm performs the pruning process, the attribute generates the missing value of every leaf node to make the classification of the data. The tree generates the children based on the targeted value of every leaf node perform the pruning, this type of classification generates the flexibility and accuracy of the tree.

Step 4: Every node generates the potential value, that value generates every attribute.

Step 4a: The best value becomes the root node as per the selection criteria applied in every branch of the tree.

$$T_{Jaya} = \frac{Jaya_{Value}}{Jaya_{Value} + Apajaya_{Value}}$$

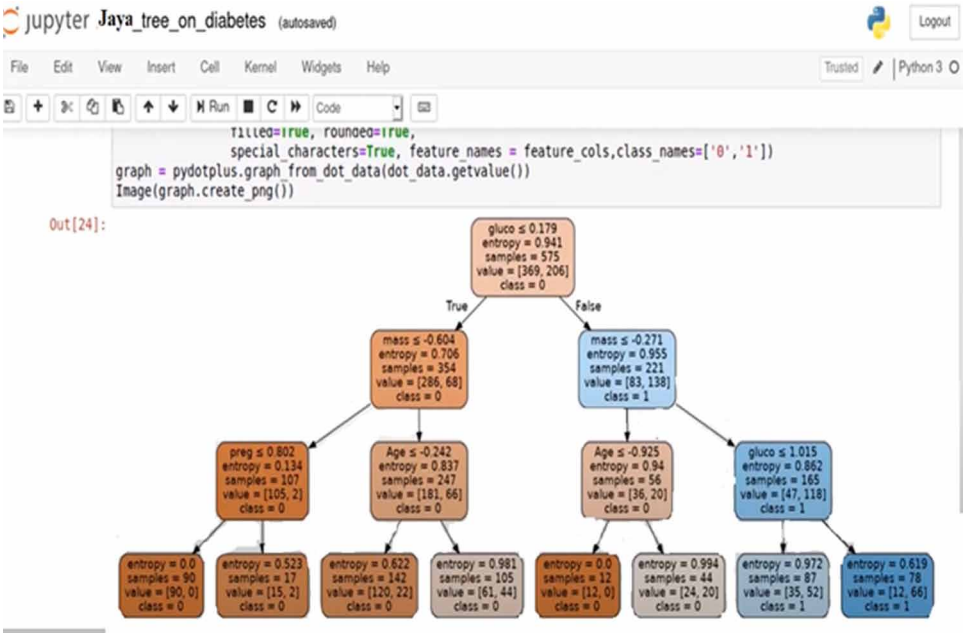
$$T_{Apajaya} = \frac{Apajaya_{Value}}{Jaya_{Value} + Apajaya_{Value}}$$

Selection criteria (bestparameter(jaya, Apajaya))

$$T_{Accuracy} = \frac{Jaya_{Value} + Apajaya_{value}}{Total\ value\ of\ weight}$$

The Jaya-Tree classification is the process Jaya and Apajaya values of building a model of classes. It is the similarity of random forest follows attributes-vector works like instances. The major strength of the algorithm to detect the continuous attributes, and also the algorithm handles the missing values. The newly generated instances are shown in Figure 6. This algorithm generates the rules for the prediction of the target variable and also remove the branches which are not reaching the leaf node. The tree structure helps to the classification and critical distribution of the data and also compute the total accuracy.

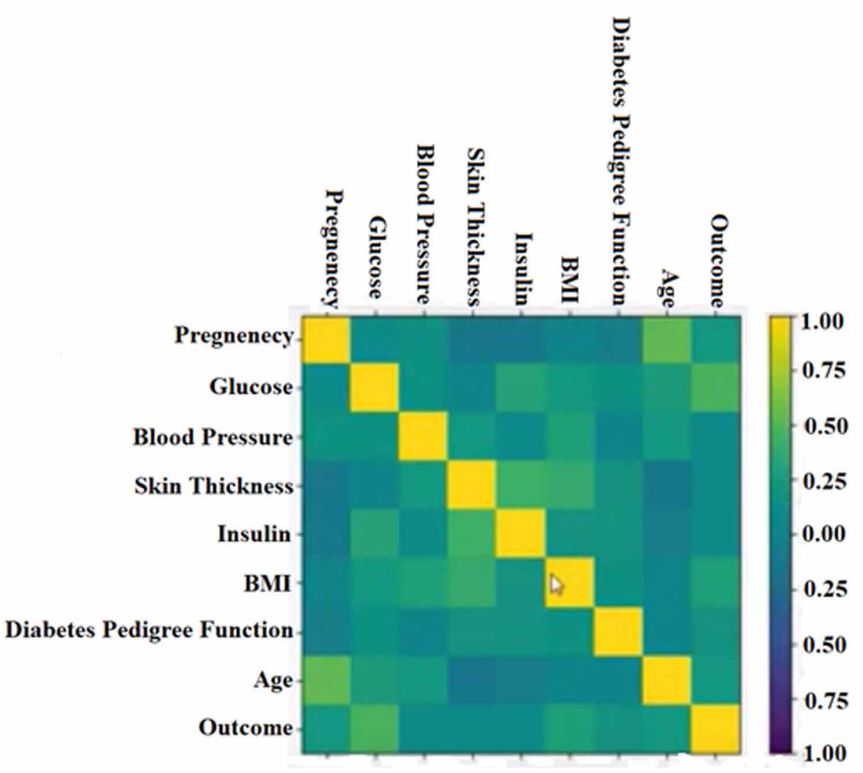
Figure 6. Jaya- tree classification



RESULTS

The proposed model tested with Anaconda navigator under Jupyter notebook and spider environment with Windows 10 operating system and also used opensource Python scripting language under CloudxLAB. The proposed model analysed the given PIS dataset of different number of patients. The Pregnancy has the important parameter considered as the value 1 and insulin given to the least value, the correlation matrix can be formed as shown in Figure 7.

Figure 7. The correlation matrix with PIS dataset



The correlation matrix fixed the targeted value 1, age and glucose levels are given the preference after the pregnancy, all parameters are targeted to the insulin, that value set to 0. The pregnancies medical parameter analyzed the number of times pregnancies in the rage of 0 to 17, the diabetes prediction rate of 178 pregnancies the diabetes prediction rate 1.70 to 3.40, the 125 pregnancies prediction rate 3.40 to 5.10, the count value 11 pregancies the tue positive rate of prediction 11.90 to 13.00.

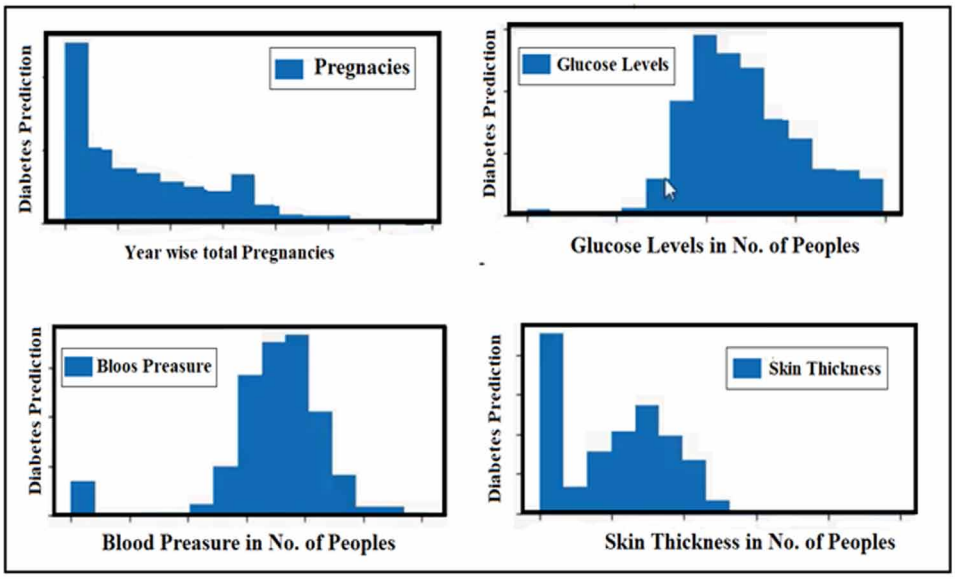
The Glucose level medical parameter analyzed in the range of 0 to 122, to measure the glucose levels in the Plasma glucose concentration 2 hours in an oral glucose tolerance test, 32 peoples prediction rate 59.70 to 79.60, 211 peoples prediction rate 99.50 to 119.40, 95 peoples prediction rate 139.30 to 159.20, 46 peoples prediction rate 179.10 to 199.00.

The blood pressure medical parameter in the rage of 0 to 122, the Diastolic blood pressure measured in terms of “mm Hg”. The blood pressure, if count 35 the diabetic prediction rate 0 to 12.20, if count 107 prediction rate 48.80 to 61.00, if count 243 prediction rate 73.20 to 85.40, if count 14 prediction rate 97.60 to 109.80.

The skin thickness medical parameter in the rage of 0 to 99, to measure the skin thickness in terms of “Triceps skin fold thickness (mm)” . The skin thickness prediction rate, if count 231 prediction rate 0.00 to 9.90. if count 165 prediction rate 19.80 to 29.70, if count 78 prediction rate 39.60 to 49.50.

To plot the histograms of pregnencies, glucose levels, blood pressure and skin thickness as shown in Figure 8.

Figure 8. Performance of diabetes prediction for pregnencies, glucose levels, blood preasure, and skin thickness



The BMI medical parameter in the range of 0 to 67.1, to measure the Body Mass Index in terms of (weight in kg/(height in m)^2. If count 15 prediction rate 13.42 to 20.13, if count 268 prediction rate 26.84 to 33.55, If count 224 prediction rate 33.55 to 40.26, If count 12 prediction rate 46.97 to 53.68.

The diabetic pedigree function parameter in the range of 0.008 to 2.42. If count 318 prediction rate 0.08 to 0.31, if count 136 prediction rate 0.55 to 0.78, if count 25 prediction rate 1.01 to 1.25, if count 15 prediction rate 1.25 to 1.48.

The insulin level medical parameter analyzed in the rage of 0 to 846, to measure the insulin 2-Hour serum insulin (mu U/ml). If insulin count 487 prediction rate 0.00 to 84.60, if count 70 prediction rate 169.20 to 255.80, if count 30 prediction rate 253.80 to 338.40, if count 09 prediction rate 423.00 to 507.60.

The age medical parameter analyzed in the range of 21 to 81 years, to measure age in terms of years. If count 360 prediction rate 21.00 to 27.00, if 92 prediction rate 33.00 to 39.00, if 34 prediction rate 51.00 to 57.00, if 16 prediction rate 63.00 to 69.00.

To measure the final out output of diabetic outcome of number of peoples measured the 500 class labels variable (0 or 1) 268 of 768 as shown in Figure 10. ‘0’ occurrence negative diabetic ‘1’ occurrence positive diabetic.

Figure 9. Performance of diabetes prediction for BMI, pedigree, insulin and age.

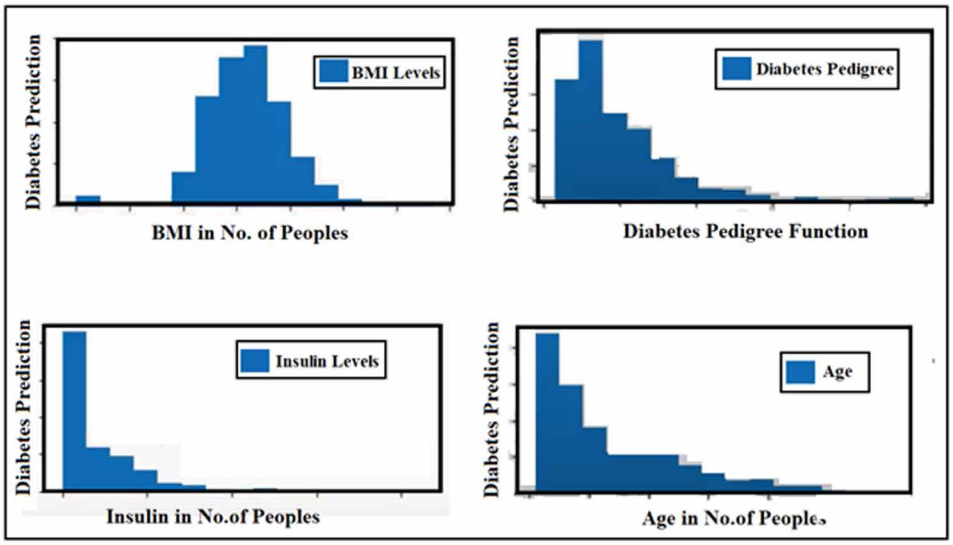
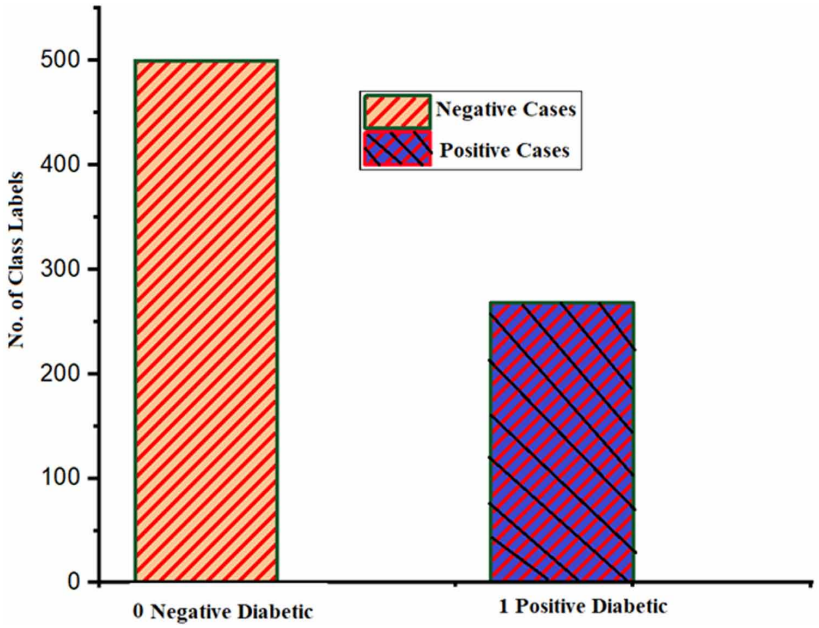


Figure 10. Outcome of the diabetic prediction



Let assume that n observations and estimation of the each medical parameter y_i, the mean square error fitting the occurrences and adjust the parameter

$$Mean\,Squared\,Error\,(MSE)=\frac{1}{n}\sum_{i=1}^{n}(y_i-\vec{y})^2,$$

here y_i is the predicted value of the particular meters $\vec{y}$ provides mean value of y_i, to compute the root mean squared error

$$Root\ Mean\ Squared\ Error\ (RMSE) = \sqrt{MSE}\ ,$$

the Total Square Error (TSE) = n x MSE

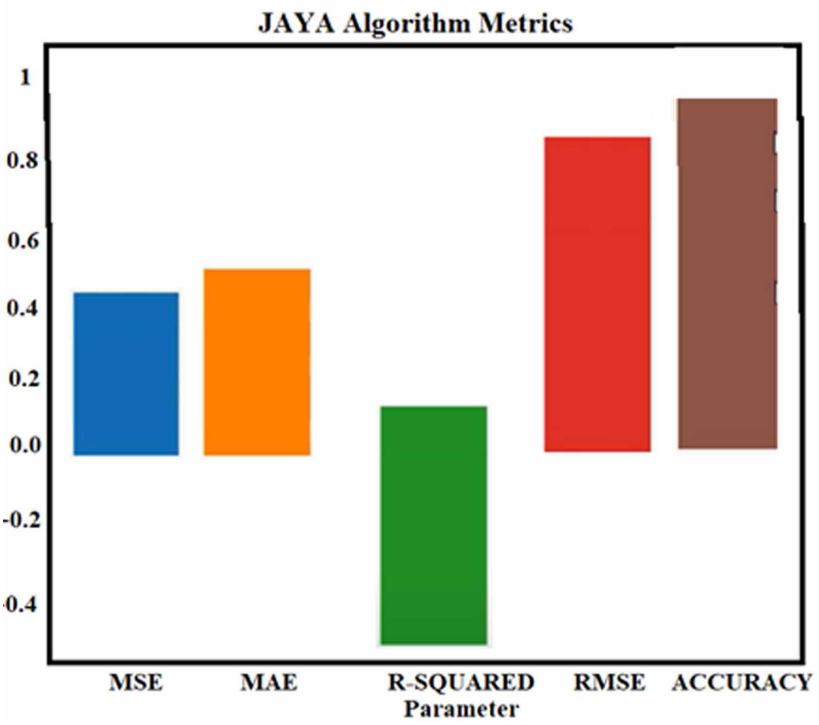
$$Sum\ Squared\ Error\ (SSE) = \sum_{i=1}^{n} (y_i - \vec{y}_i)^2$$

then $R^2 = 1 - \frac{SSE}{TSE}$

$$Accuracy = \frac{R^2\ (R\ Squared\ Parameter)}{True\ Value} * 100$$

All the metric values are measured in the following Figure 11.

Figure 11. Metrics evaluation.



The Jaya-Tree algorithm produce the better probability in terms of volume of data and reads the given PIS dataset and generates much larger training dataset and predictive feature parameters BMI, insulin, diabetes pedigree function and age and generate high accuracy rates as shown in Figure 12.

Figure 12. Accuracy level of Jaya-Tree algorithm

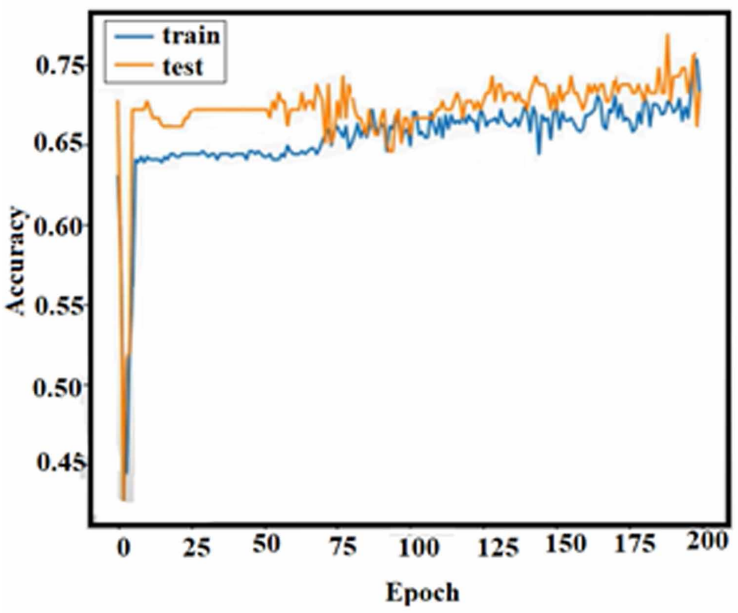
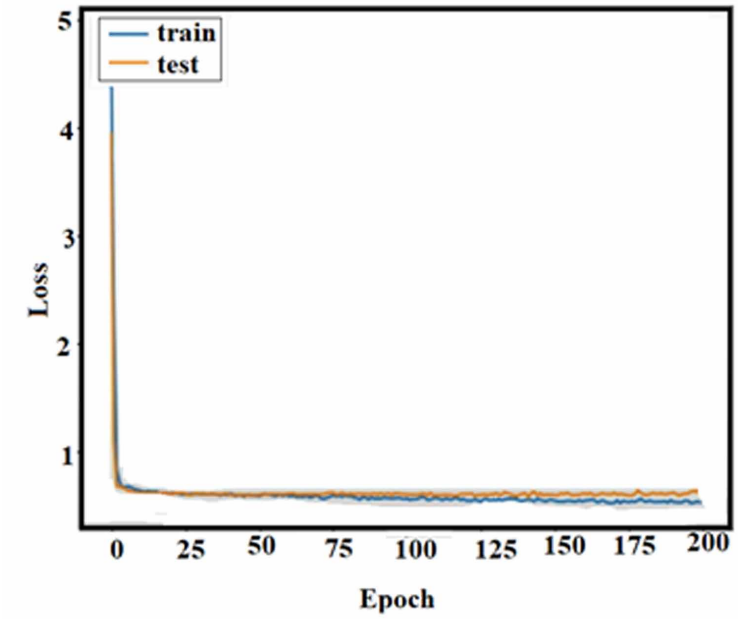


Figure 13. Accuracy level of Jaya-tree algorithm wit training and testing dataset.



Each time with different outputs shown with the same epoch as output, the Figure 13 provides the training and testing data are same pipeline of same epoch.

CONCLUSION

The proposed methodology shows the clear picture of the DL approach used to detect the risk of having diabetes with around 97% accuracy named as Jaya-Tree algorithms which use the patient's family history and genetics as well as their daily habits. As compared to early methods for predicting risk, the proposed method proved to be more accurate.

Table 3.

Analyzation of Error	Achieved Accuracy
MSE	45%
MAE	50%
R-Squared Parameter	Reached the targeted value 1
RMSE	82%
Accuracy	97%

The proposed model most comfortable for physicians and patients for identified to face the risk of diabetes that could be made precautions. The proposed model most useful for earlier stage of the diagnosis and most needful for the long-term outcomes. In future, to predict the diabetes in children with effective model.

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Chapter 8
Medicinal Plant Identification Using Machine Learning Techniques:
Automatic Recognition of Medicinal Plants

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ABSTRACT

In this world there are thousands of plant species available, and plants have medicinal values. Medicinal plants play a very active role in healthcare traditions. Ayurveda is one of the oldest systems of medicinal science that is used even today. So proper identification of the medicinal plants has major benefits for not only manufacturing medicines but also for forest department peoples, life scientists, physicians, medication laboratories, government, and the public. The manual method is good for identifying plants easily, but is usually done by the skilled practitioners who have achieved expertise in this field. However, it is time consuming. There may be chances to misidentification, which leads to certain side effects and may lead to serious problems. This chapter focuses on creation of image dataset by using a mobile-based tool for image acquisition, which helps to capture the structured images, and reduces the effort of data cleaning. This chapter also suggests that by ANN, CNN, or PNN classifier, the classification can be done accurately.

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INTRODUCTION

In the world there are so many plant communities, so many plants have therapeutic and healing values. By using these medicinal values, they are preparing different medicines especially in Ayurvedic medicines only plant species are used. To use the plant species for medicinal purpose, this is necessary to recognize and classify plants correctly. Identification of Anonymous plants is a challenge to everyone. Based on morphological characteristics, plants can be easily identified manually by the botanist, consumers, forestry services, taxonomists, physicians, pharmaceutical laboratories. But this process of identification is time consuming and also need so many labors. So much of Research had been done on recognizing medicinal plants, as a result no there are so many methods of identification of the medicinal plants by using machine learning is available.

In this paper, we deal with two methods of feature extraction, one is Automatic Recognition of Medicinal plants, here first should take photograph of every leaf with white background, then remove any noise. Next different basic features of the leaf image have to be extracted, based on these features compute derived features. The formulae are also given below.

Another one is Image processing technique to identify Medicinal plants. Here first need to take photograph of both front and back side of the image. We may extract features by using green leaves or by using dried leaves also, but dried leaves are somewhat difficult to extract features. First need to find out Centroi-radii distance, after that need to collect different features of the image.

After extracting the image features then need to classify the medicinal plants. This paper proposes Artificial Neural Networks, Convolution Neural Network and Probabilistic Neural Network. Because images are non-linear, Neural Networks is best classifier to deal with non-linear problems. It is very reliable and exhibits more accuracy. It extract and identifies the features concurrently, it recognizes very fast. These three are very robust classifiers. Even though all have benefits, this paper proposes to CNN, it can do concurrently. By using altered featured vector CNN can able to process on damaged samples also and able to give accurate results.

RELATED WORK

Manojkumar P. Surya C et al (Begue et al., 2017) used Machine Learning algorithm with Weka tool for identification of Medicinal Plants, collected 20 random Ayurvedic leaves, extracted Texture and Color features from the color and binary images. Based on the features SVM and Multilayer perception classifiers are used to identify the Medicinal Plants, got 94.5% accuracy.

Adems Begue et al (Sona & Jaya, 2015) used Automatic Identification of Medicinal plants to identify leaf features. Tried different classifier, got 90.1% of accuracy from Random forest classifier.

Sona O M and R Jaya (Sandeep, 2012) developed a Mobile App, based on leaf images, this system identifies Medicinal Plants. They used Gray-Level Co-occurrence Matrices (GLCM) for taking out the texture features of the plant image and also used for plants species image processing technique for classification of the plants. Got 94.7% accuracy by the combination of The SGD, DT and k-NN classifiers

For identification of Medicinal plants Iyan Mulyana et al developed an automatic system in Indonesia. By using fractal dimension and fractal code methods leaf features was extracted. Based on fractal code (79.94%) and fractal dimension (85.04%) Clusteing Fuzzy C-Means classifier used for plants species

PROPOSED WORK

In this paper we proposed two methods for identify Medicinal plants. One is Automatic Recognition of Medicinal Plants and the other is Image processing of leaf images.

1. Automatic recognitions of Medicinal plants (Adames, 2017) is a method used to identify Medicinal plants. Here first collected different leaves images. The petiole of every leaf was removed, then placed all leaves in a white paper one by one, after that should take images of those leaves, by using smart phone. The images are stored in a jpeg format. But there is a drawback in this method is while taking images with phone there may be chance to get shadow on the image. If we use scanner we do not get shadow. If we have shadow then the result may be not correct, so first we need to convert the image into HSV format then split into different color channels. Next should perform thresholding operation, it clears small noisy pixels on the image. Here it performs two operations Erosion and dilation. Dilation enlarges the image and Erosion reduces the size of the foreground pixels. Before performing these two operation, it coverts the image into binary image that is black and white pixels.

Next step is to extract features from the image. Those features are area of the leaf, number of vertices, original color of the image that is RGB values of each pixel. Width and Length of the leaf, Perimeter of the leaf, area of the bounding box of the leaf, hull area and perimeter etc. using the length and width the image's bounding box can be calculated. Hull is the smallest polygon, which contains the leaf. Hull can be used to calculate the number of vertices in the leaf. If we find out the contour liner then the perimeter of the leaf can be easily calculated. Calculate the area of the leaf corresponds to the white space inside the green contour line. Have to create horizontal distance map and vertical distance map as well as radial distance map. The image must be dividing into equal strips, so that the intercepts the contour line of the leaf can be easily find out. The distances between the intercepts are then computed. Number of Derived features can be calculated by using the base features extracted from the image.

$$AR = W / L \tag{1}$$

$$WAR = (BBA - A) / BBA \tag{2}$$

$$Reg = W * L / A \tag{3}$$

$$S = A/HA \tag{4}$$

$$C = HP / P \tag{5}$$

$$HR = HA / HP \tag{6}$$

$$RG\ ration = R/G \tag{7}$$

$$RB\ ration = R/B \tag{8}$$

BG ration = B/G (9)

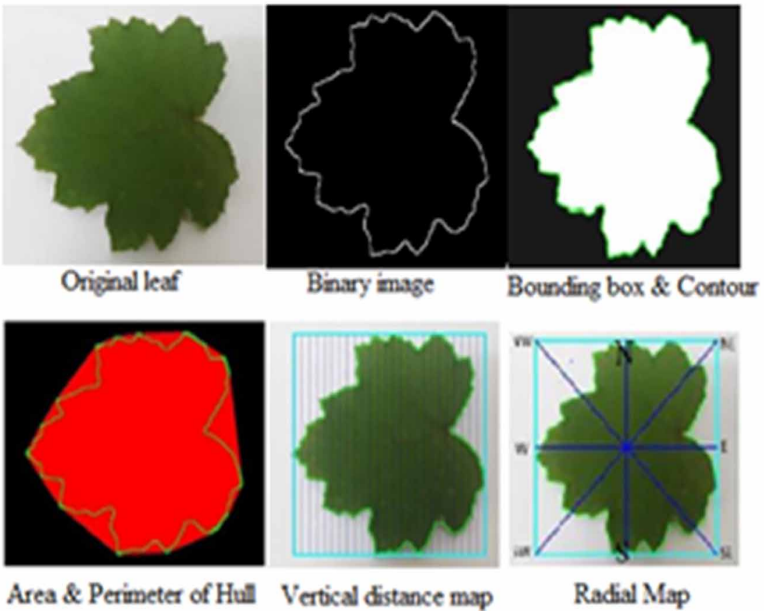
VD ratio = L of leaf line/W (10)

HD ration = L of leaf line/L (11)

Circularity / roundness = area(P * P) (12)

Where AR is ration of Aspect, 'w' is length, 'L' is length, 'A' is area, 'WAR' is ratio of White area, 'BBA' is area of Bounding Box, 'Reg' is Rectangularity, 'S' is Solidity, 'HP' is area of the Hull, 'C' is Convexity, 'HP' is perimeter of the hull, 'P' is perimeter, 'R' is Red, 'G' is green, 'B' is blue, 'VD' is Vertical Distance, 'HD' is Horizontal Distance.

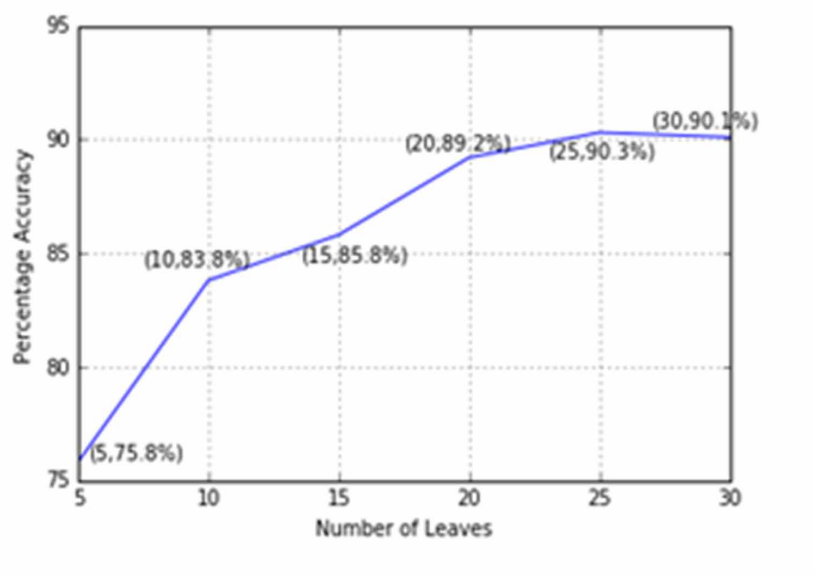
Figure 1.



It shows positive impact on the classification accuracy (Rebert et al., 2017), if we increate the leaves per plant species. 25 leaves per plant is the peak performance. This result is very important to the researchers and Scientists to decide how many number of samples that they must be collect to study.

2. Reorganization of the Medicinal Plants by Image processing of leaf images is a technique to identify the Medicinal plants. First we need to extract the features of leaf image from the front and back side too. We can extract features in two ways one by using green leaf images and the other by using dried leaf images. But the identification of the dried leaf images is little difficult.

Figure 2. Number of leaves per plant Vs Percentage



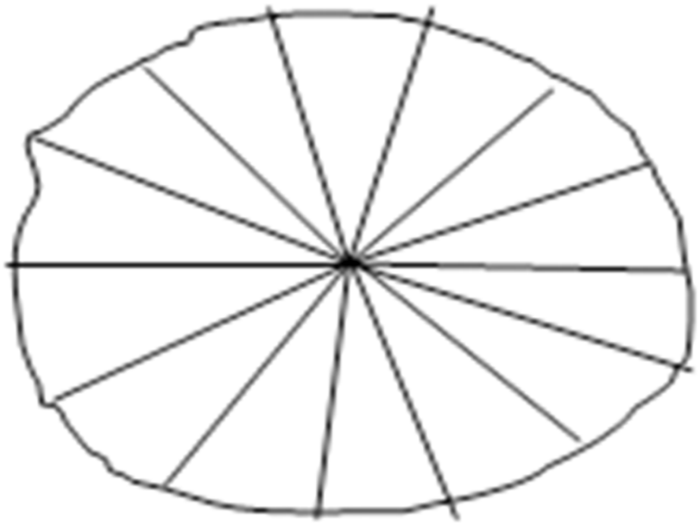
The following are the Morphological feature, which should be extracted from the leaf image, to better identification the images.

The line segment connecting the base and the tip of the leaf is called Major axis length. Perpendicular to the major axis is called as Minor axis length. The number of pixels in Convex image is called Convex are. The total number of pixels is known as Filled area. The ration of the distance between the foci of the ellipse and its major axis length is called the Eccentricity. To differentiate the rounded leaf and the long one then the Eccentricity feature can be used. The distance around the boundary of the region is called perimeter. Perimeter can be calculated by fining the distance between each adjoining pair of pixels around the border of the region. Solidity means the proportion of the pixels in the convex hull. Orientation means the angle between x-axis and the major axis of the ellipse. Extend is called as the ration of pixels in the region to pixels in the total bounding box. The center of the mass of the region is called Centroid, in this x-coordinate is the first element and y-coordinate is the second element. The diameter of a circle with the same area as the region is called Equiv Diameter. The roundness or circularity ratio is defined as Roundness=A / P2, where 'A' is the area of the leaf and 'P' is the perimeter of the leaf. The roundness can be used to differentiate between the rounded leaf and the long one. Dispersion is ratio between the radius of the maximum circle enclosing the region and the minimum circle that can be contained in the region.

First we need to find out Centroid-radii distances, after that we need to collect 'Geometrical' features, 'Color' features, 'Texture' features, 'HU' invariant moments and 'Zernike moments'. After extracting all these values then it has to be stored in Excel file in 'csv' format, and then we may use for further processing. To extract Geometrical, Color and Texture features we can use Weka, because so many preprocessing and visualization tools available, not only these Weka also contains classification, regression, association rules and clustering tools also. We can also use these tools in graphical user interface.

To calculate the centroid radii distance, first need to convert color image into grayscale from that to binary image. To remove noisy like dots and cracks, need to perform morphological erosion and dilation process, from the binary image, boundary is extracted, which contains a series of boundary points. The radius has to define then joins all the boundary points with the radius. Here the equal angles between the length of the radii and regular intervals are taken as the discriminate feature. Individual radii lengths can be calculated, by using which, dissimilar shapes in leaves can differentiate from each other

Figure 3. Centroid radii vector's schematic representation



Features of Geometrical: Geometrical features are Equivalent Diameter, Solidity, Eccentricity, Extent, Compactness, Aspect Ratio, Entirety, P/L + W Ratio.

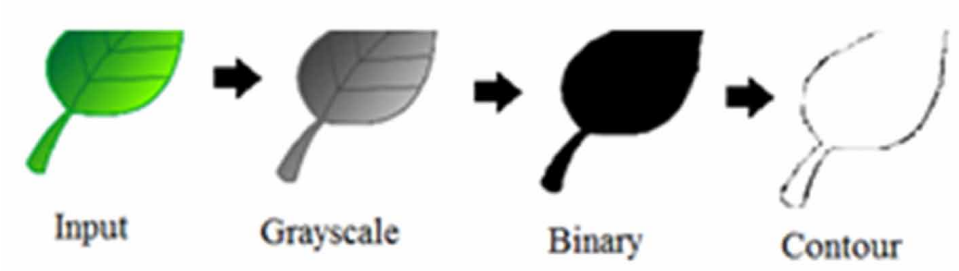
$$\text{Equivalent Diameter} = \sqrt{\frac{4\ X\ area}{\pi}}. \tag{13}$$

$$\text{Solidity} = \frac{Convex\ area}{Original\ area}. \tag{14}$$

In the Convex Image, there are number of white pixels will present; the total of white pixels is called Convex area. Convex image is the binary image, which is specified in a polygon, that contains a region in which all the pixels are filled. By dividing convex area by original area we can get solidity. Similarly Eccentricity an Extent can be calculated as shown below.

$$\text{Eccentricity} = \sqrt{1 - \frac{Minor\ axis\ length^2}{Major\ axis\ length^2}}. \tag{15}$$

Figure 4. conversion of original image to contour



$$\text{Extent} = \frac{No.\ of\ pixels\ in\ region}{No.\ of\ pixels\ in\ bounding\ box}. \tag{16}$$

Features of Color: Color features that are extracted from color information on the leaf image, which can be represent as color moment. In this color feature, need to calculate Mean Standard Deviation, Skewness and Kurtosis, so that we need to take the color value of each column and row and have to take the Dimension of the image. Along with these two we need to calculate 12 types of color features like Horizon Mean, Vertical Mean, Horizontal Standard Deviation, Vertical Standard Deviation etc. The formulas are

$$\text{Mean } (\mu) = \sum_{i=0}^{m}\sum_{j=0}^{n}\frac{P(i,j)}{MN} \tag{17}$$

$$\text{Standard Deviation } (\sigma) = \sqrt{\sum_{i=0}^{m}\sum_{j=0}^{n}\frac{\left(P(i,j)-\mu\right)^2}{MN}} \tag{18}$$

$$\text{Skewness } (\theta = \sqrt{\sum_{i=0}^{m}\sum_{j=0}^{n}\frac{\left(P(i,j)-\mu\right)^3}{MN\sigma^3}} \tag{19}$$

$$\text{Kurtosis } (\gamma = \sqrt{\sum_{i=0}^{m}\sum_{j=0}^{n}\frac{\left(P(i,j)-\mu\right)^4}{MN\sigma^4}} \tag{20}$$

Where, ‘m’is image height, ‘n’ is image width, and ‘Pij’ is color value.

Features of Texture: Gray Level Co-occurrence Matrix(GLCM) can be used to calculate the 10 features like Correlation, Contrast, Sum of Average, Sun of Entro etc., Here ‘G’ is the gray levels number used and ‘P’ is the probability distribution in the GLCM. We can also be calculate the Angular Second Moment, Contrast, Inverse Different Moment, Entropy, and Correlation.

$$\text{Correlation1} = \frac{H_{XY-}H_{XY1}}{\max[P_x(i)logP_x(i)P_y(j)logP_y(j)} \tag{21}$$

$$\text{Correlation2} = \sqrt{1-e^{-2(H_{xy2}-H_{xy}}} \tag{22}$$

$$H_{xy} = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1}P(i,j)\log P(i,j) \tag{23}$$

$$H_{xy1} = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1}P(i,j)\log(P(i,j)P_x(i),P_y(j)) \tag{24}$$

$$H_{xy2} = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1}P_x(i),P_y(j)\log(P_x(i),P_y(j)) \tag{25}$$

$$\text{Contrast} = \sum_{n=0}^{G-1}\{\sum_{i=0}^{G-1}\sum_{j=0}^{G-1}P(i,j) \tag{26}$$

$$\text{Entropy} = \sum_{i=0}^{2G-2}P_{x+y}(i).logP_{x+y}(i) \tag{27}$$

Zernike Moments: The projection of the image function into the orthogonal basis functions is called Zernike Moments. It's rotation invariance is simple, it produces higher accuracy for detailed shapes, Orthogonal. it contains less information redundancy and is much better at image recognition.

$$A_{mn} = \frac{m+1}{\pi}\int_x\int_y f(x,y)\left[V_{mn}(x,y)\right]^* dxdy \tag{28}$$

Where $x^2 + y^2 <= 1$

HU Invariant Moments: It is used to match the images. It is a greatest that central moments are translation invariant. We would like to calculate moments that are invariant to translation, scale, and rotation to do all these things we can use HU Invariant moments.

$$\mu 1 = M(2, 0) + M(0, 2) \tag{29}$$

$$\mu 2 = \mu 1^2 + (2M(1, 1))^2 \tag{30}$$

$$\mu 3 = (M(3, 0) - 3M(1, 2))^2 + (M(0, 3) - 3M(2, 1))^2 \tag{31}$$

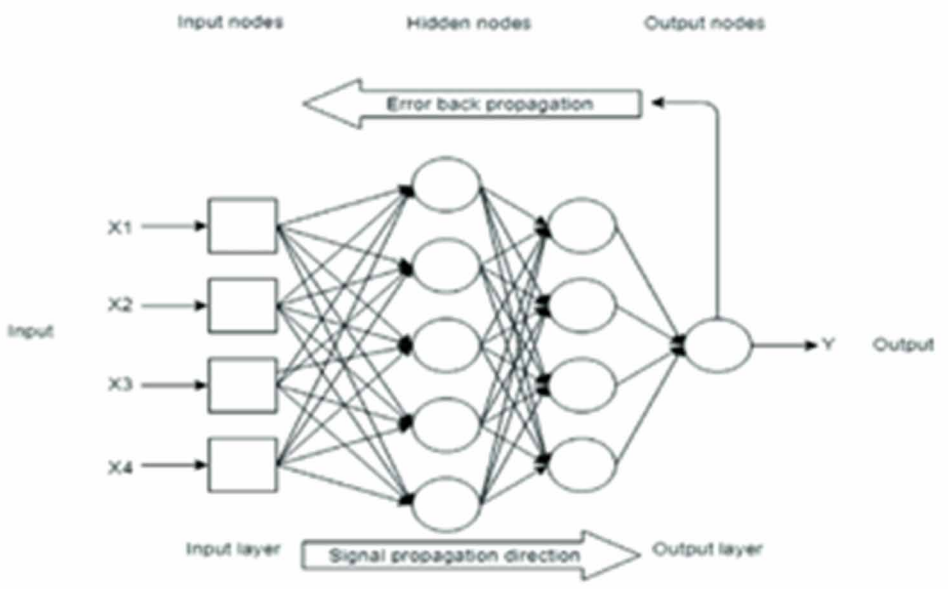
CLASSIFICATION

After extracting leaf image features, we get lot of information which is also called feature vector, Next step is to perform classification. There are many classifiers, but in this paper we consider Neural Networks.

Artificial Neural Networks: Leaf Recognition is a Non-linear problem. ANN (Munisami et al., 2015) is best classifier to deal with non-linear problems, because ANN is superior in terms of accuracy. To generate output, there are so many interconnected nodes connected to each other in ANN. Utilization of ANN is more reliable, because it exhibits more accuracy exceeding 90%.

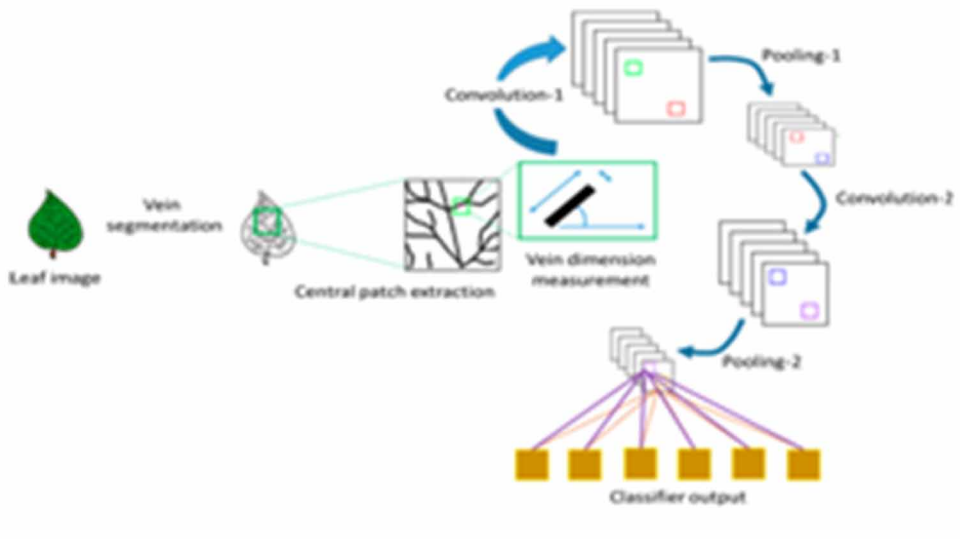
This is called feed-forward back-propagation method because the data processing is directed from the front, where as the information prompts at the back. From the extracted features input nodes can be determined. Based on the number of plants, the number of nodes of the output layers would be determined. By utilizing back propagation method the classifiers would be trained. The weights of the links should be altered to reduce the error between the actual and expected output.

Figure 5. Mechanism of Back Propagation and Feed Forward in ANN



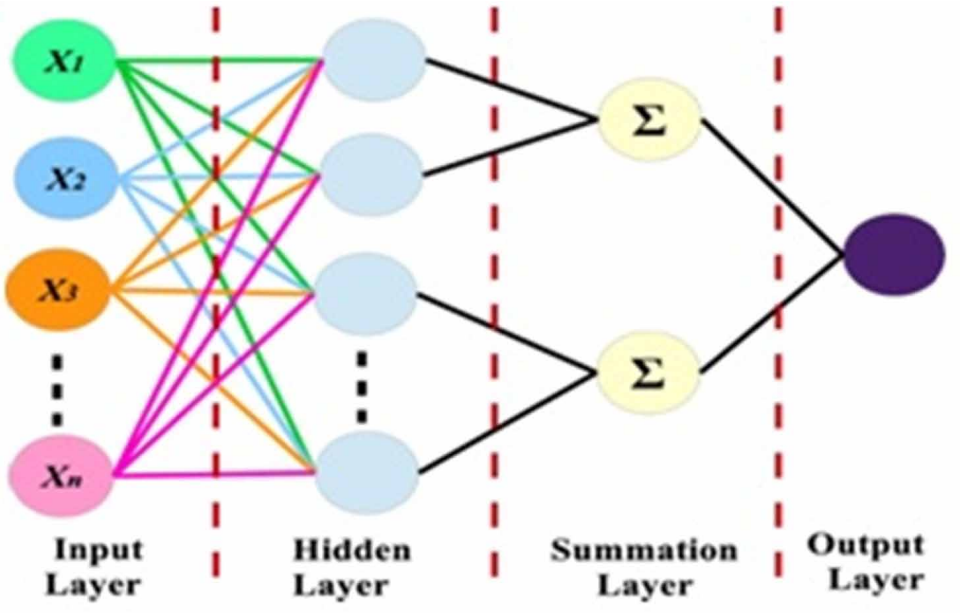
Convolution Neural Network (CNN): CNN (Munisami et al., 2015) is a faster recognition process, it extracts and identifies the features concurrently, but it requires numerous sets of training data before it is consider for application. CNN can also be able to process even damaged samples with altered feature vector effectively and manages to recognize Medicinal plants and reaches above 94% of accuracy. CNN can implement from deep learning to machine image processing in order to classify images of leaf samples. CNN uses multiple convolution synchronously, decreases number of parameters.

Figure 6. Pattern detection of Leaf with CNN



Probabilistic Neural Network: Line CNN, PNN (Munisami et al., 2015) is another branch of ANN, it uses radia basic function, it measures nonlinear variable in shape of bell. Compared to ANN, PNN trains the loaded feature vectors with higher speed rate. PNN is a robust classifier because it predetermines the characteristics of the features, so that the classification step becomes easy and straightforward.

Figure 7. Mechanism of PNN



CONCLUSION

Before perform classification, feature extraction is very important. If the features extracted correctly, then it is easy to classify those image. So this paper proposed Automatic recognition of Medicinal plants or Image processing of leaf images to extract features. In both the methods, first need take photograph of the leafs, then by using Erosion and Dilation reduce the noise. Then need to covert the images into binary format. Then find out some basic features, after that by using different formulas need to extract derived features. This paper also proposed classifiers, if has proposed different types of Neural Networks, among those CNN are best suited for classification, because is fast and it extract and identifies features concurrently. It can able to process on numerous sets of training data. To decrease parameters it used multiple convolution synchronous. It also performs on damaged samples also and get above 94% of accuracy.

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Chapter 9
Enhanced PMF Model to Predict User Interest for Web API Recommendation

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ABSTRACT

Many methods focus solely on the relationship between the API and the user and fail to capture their contextual value. Because of this, they could not get better accuracy. The accuracy of the API recommendation can be improved by considering the effect of API contextual information on their latent attribute and the effect of the user time factor on the latent attribute of the user through the deep learning-based matrix factorization method (DL-PMF). In this chapter, a CNN (convolutional neural network) with an attention mechanism for the hidden features of web API elements and an LSTM (long-term and short-term memory) network is introduced to find the hidden features of service users. Finally, the authors combined PMF (probabilistic matrix factorization) to estimate the value of the recommended results. Experimental results obtained by the DL-PMF method show better than the experimental results obtained by the PMF and the ConvMF (convolutional matrix factorization) method in the recommended accuracy.

INTRODUCTION

The Internet of Things (IoT) manages the data supply of devices connected to the internet, controls commands, and manages data collected by the sensor using the communication technology of an innovative computing model found in Web 2.0. IoT is commonly used to improve the computing process and efficiency of sense, as well as video surveillance, intelligent manufacturing, and in many cases manufacturing. In this process, every part of the system is maintained and monitored when large-scale

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equipment is used, through software collection. An effective way to do this is to obtain and obtain public service application programming interfaces (APIs) across a variety of platforms. Without understanding the deployment process, developers can use different APIs to run IoT devices. The workflow approach makes it easy to know how, where, and where the target APIs should be initiated and configured. So industrial systems can be rapidly developed through a powerful tool called API also known as service on the web. But finding suitable APIs has become a big problem due to the tremendous increase in the number of API's Consumers have faced a variety of major difficulties due to the use of big data and the huge explosion of online information entry in this new age. Also, developers are failing to retrieve the required information through communication technology (Ramathulasi & Rajasekhar Babu, 2020) from the big data in the shortest possible time. This method can overcome the problem of data overload, in addition to providing different personalized services to different users. It is highly publicized that this order is recommended by a mature and highly researched cooperative filtering method. It is mainly divided into model-based and neighborhood-based methods (Zhang, Yao, Tay, Sun, & Tay, 2018). Recommended results obtained through model-based methods collaborating with SVD and PMF may yield better results than recommendations obtained through neighborhood-based methods (Koren & Yehuda, 2008). PMFs and SVDs play a key role in establishing the probability factor as well as gradually improving the recommended effect. The PMF not only succeeds in finding the latent characteristics of consumers and s using the rating matrix in terms of user and but also fails to make effective use of the helpful information in the user, information description.

Collecting implicit attributes from the elements and perceiving the exact, real needs of the customers are challenges as per the current objectives. We have integrated the PMF model with Deep Learning for this. The recommendation for text descriptive science was then adapted to this system. The whole process in this process takes place in three stages. The first is to learn the implicit features of the elements, the second is to learn the users' implicit features, and finally, these two are merged into the PMF to train the implicit features as a whole. In this paper, we will add a mechanism that pays special attention to CNN to accurately and better understand the implicit nature of the description of the elements (Seo S, 2017; Chen J, 2017). It pays attention to learning the user's implicit features and filters useless information into the process from the description of the services. In this paper, the user's implicit features are adapted by LSTM to know their exact and true needs (Twardowski & Bartłomiej, 2016; Chen, et al., 2017). In the process of learning this latent feature, the impact of time use on the consumer's tastes, as well as on prehistorical discussions of issues between consumers, is taken into account. Finally, it is possible to estimate the user's preference for the content using both the latent attributes of the user and the elements in conjunction with the PMF. To check the improved efficiency of the DL-PMF algorithm proposed by us in this case for great improvement beyond the recommended accuracy of PMF and ConvMF, experiments were performed on a crawled dataset from programmableweb[1].

BACKGROUND

In this case, many researchers have applied the knowledge gained from their in-depth study to the recommendation system. As a result, a new recommendation system has been developed that addresses the shortcomings of the traditional recommendation method and makes effective use of support information, but some shortcomings have been observed. Two parallel CNNs (convolutional neural networks) were created using factorization machines to extract latent features from the underlying elements and

customer evaluation description information (Zheng, 2017). The timing factor in this model does not take into account what effect it will have on consumer tastes. We were able to get a better recommendation by combining the latent factor model and the stacked denoising autoencoder that did not effectively learn the supporting information in the CDL model (Wang, 2015) approach proposed later in the series (Hierarchical Bayesian model).

The above methods have failed to take into account the meanings of the content and the relevant information due to the above research. CNN and PMF have been combined to determine the implicit characteristics of object content based on their descriptive information, as described in the research paper (Kim D. P., 2016) and (Kim D. P., 2017). But because of this, it was not possible to find their implicit features from the information of the users. The model, which combines CNN and Latent Factor (Shen, 2016) to collect object and consumer attributes and optimize object implicit attributes, has not been able to improve user-optimized latent attributes. RNN (Repeated Neural Network) is provided as an input to detect user information anomalies, considering the user's previous browsing history as a helpline as mentioned in (Okura S, 2017). And the latent factors are recommended as news messages. Dimensionality needs to be optimized as the output dimension size of these news messages is similar to the input dimension in the feature learning process. The model (Devooght R, 2017) proposed by the RNN-based collaborative filtering algorithm collects user implicit features and also takes into account the time it takes to utilize them. This model failed to fully collect the implicit features of the elements in this order.

METHODOLY OF ENHANCED PMF MODEL

A potential solution for PMF has been considered as a model of matrix factors. Uses a potential combination of a low-dimensional feature vector to describe a user's preference for a service, mapping some potential attributes from the information of services and customer elements to a low-dimensional mapping space based on the angle of probability. We will first use the PMF model as a potential solution in the process of finding matrix factors. It uses the Dimensional Low Feature Vector to help customers map important information related to the potential characteristics of service information to a smaller dimensional mapping area. This simple combination made it possible to explain the customer's preference for particularly recommended services. The main purpose of the DL-PMF model proposed in this script and to achieve better results is that primarily services and customers can discover hidden feature vectors using the PMF approach through a continuous iteration method. The step-by-step sequence of this model can be seen in the Table 1 below and the procedure in Figure 1below.

Since the network in the DL-PMF model has a CNN based interest process, we use Attention-CNN to find hidden feature vectors in the service information. The Attention-CNN network can give accurate results following the performance of the natural language processing approach in applications such as text emotion analysis and classification. The potential characteristics of global information can be better used using CNN [3-6]. Each aspect of customer information is focused on the characteristics of one or more aspects of the service's information, following human attention and visual approach. These features and their meaning can be obtained as part of the attention process based on in-depth study. Not only is it easier to get better features with a combination of focus approach and CNN, but it is also possible to filter out useless features from global information. In the DL-PMF model we use LSTM which has a memory function to

Figure 1. The framework of the DL-PMF model

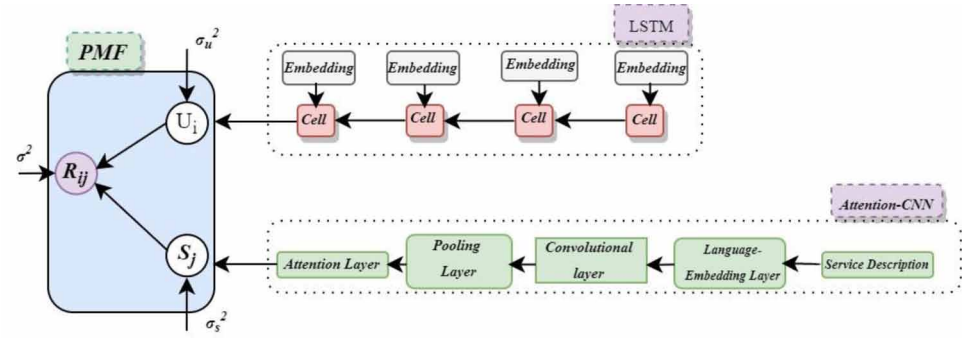


Table 1. The sequence of steps in the proposed algorithm

Algorithm	:	The sequence of steps to follow for the proposed model
Step 1	:	Generate a rating matrix R and randomly configure the variables U and W_S.
Step 2	:	Update S by Attention-CNN as per R and U.
Step 3	:	Train S according to the PMF algorithm by Attention-CNN as well as U by LSTM;
Step 4	:	Continue steps 2 and 3 until reaching the loop convergence.

retrieve the hidden feature vector from the user information. It helps customers with record information to remember their past and present interests, the implicit connection features between the services related to them, and to provide accurate guarantees to customer perceptions on time.

RESULT ANALYSIS

The value for each matrix was initially indicated as 0 or 1 in the experiments we did to equate the suggested process results with the performance of the other four conventional methods. That is, it is marked as 1, if the user follows any API, and if not, it is marked as 0.

- **Data Set:** By crawling API data from a programmable web site that provides comprehensive information about existing APIs, we used an API dataset package. For this, we crawled for a total of 17412 APIs to collect data. This entails a series of names, a quick summary, a post date, and a list of developers and followers for each API. But we do not collect consumer information from the web here. For any API, we have found an attribute called Follow. In the consumer description set, we treat this as equal to the function of their objects. We received 140,000 users for this as followers of the 17412 APIs. In Table 2, we have included the related details.

Table 2. Crawled dataset statistics

Crawled Dataset	*Count (#)*
# of users	17412
# of API's	22032
# of invocation records	248530

The crawled dataset is divided into training, validation, and test sets to evaluate the experiments we perform on our model. Here we have randomly selected all the data as training sets on 90%, 80%, 70%, 60%, and 10% data settings respectively, and separated into validation and test sets. In this launch analysis, we first compose the training, validation, and test set density as 90, 5, and 5 percent respectively for the next four data settings as the 10% validation set and the remaining data as a test set. i.e. training, certification, and test set concentrations for example 10%, 10%, and 80% respectively. Thus 10 times were performed for each group experiment and we obtained the results of all group experiments in the form of Root-Mean-Square Error (RMSE).In this case where over-fitting is a problem, we randomly selected 80% of the total data as training sets, as well as 10% and 10% as validation and testing sets, respectively.

A recommended method for estimating a type has been introduced. For this, we aim to find the predictive accuracy of the experiments performed for the API recommendation estimates. We have used two evaluation criteria RMSE. In this model, we selected the Root Mean Square Error (RMSE) evaluation indicator to calculate the accuracy of the recommendation and the difference between the actual rating and the rating found. The recommended accuracy is better because the values obtained by the experiment result are lower. The values of RMSE were calculated according to the following method.

$$RMSE = \sqrt{\frac{1}{N}\sum_{i,j}\left(R_{ij} - \widehat{R}_{ij}\right)^2}$$

Here the number of tests is denoted by N, the rating given by the user to service *j* by R_{ij} and the estimated rating for service *j* by the user using the specified method by $\widehat{R}_{ij}$.

- **Results Analysis:** Any item related to the service description information in the processed data set where the maximum length is assumed to be 300 and the average length taken to be 200 The word vector size is set to 100 for previous training. We initiated the bias and mapping matrix through the Gaussian distribution system in the LSTM and Attention-CNN network mentioned above.

The measurement of latent features and the kernel numbers associated with the convolution network in the web services dataset have an effect on the performance of the model We have verified the performance of the model from Figure 2 and Figure 3. We take a large amount of these to remember the feature of each service through the training of the model. This helps to refine the implicit features of the low-kernel convolution service. In this case the size of the latent attribute is set to the number 60 and the number evolution kernel is set to 65 in subsequent experimental validation.

Figure 2. Dimension value impact on RMSE

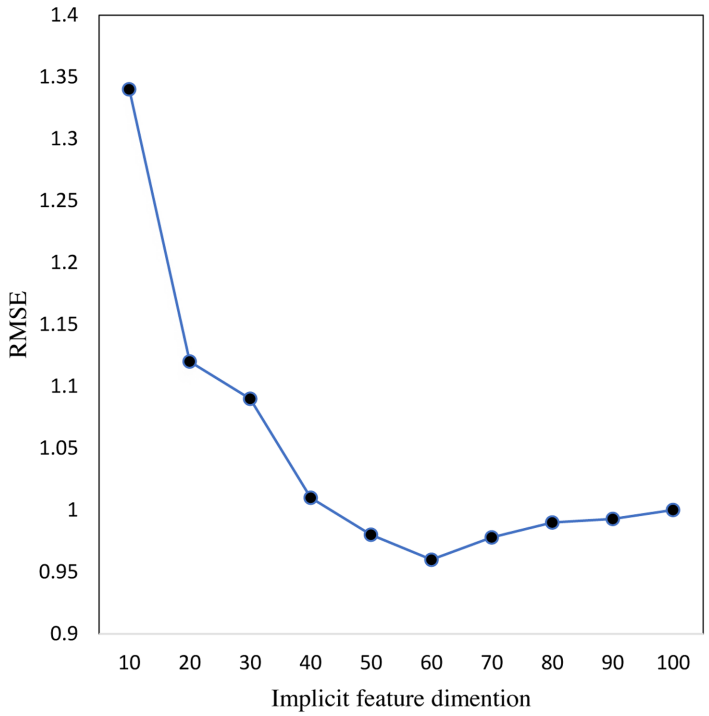


Figure 3. Kernel number value impact on RMSE

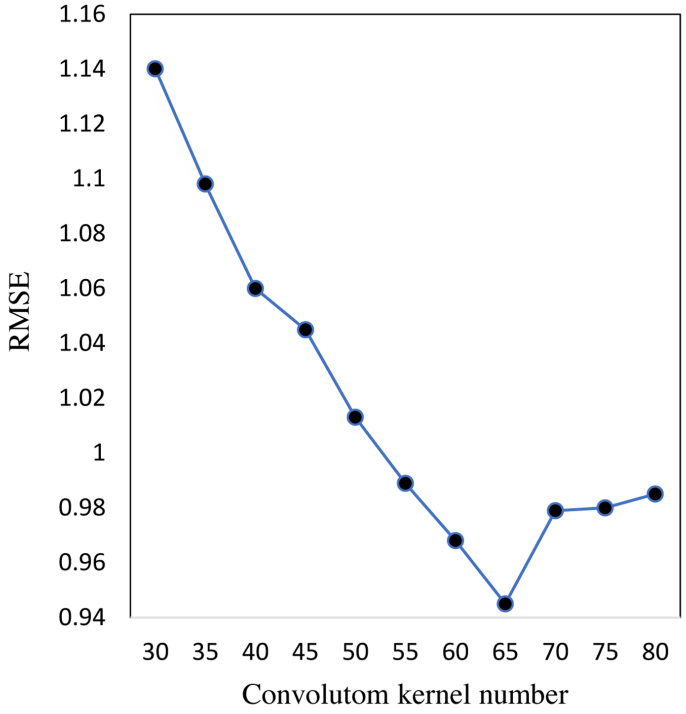
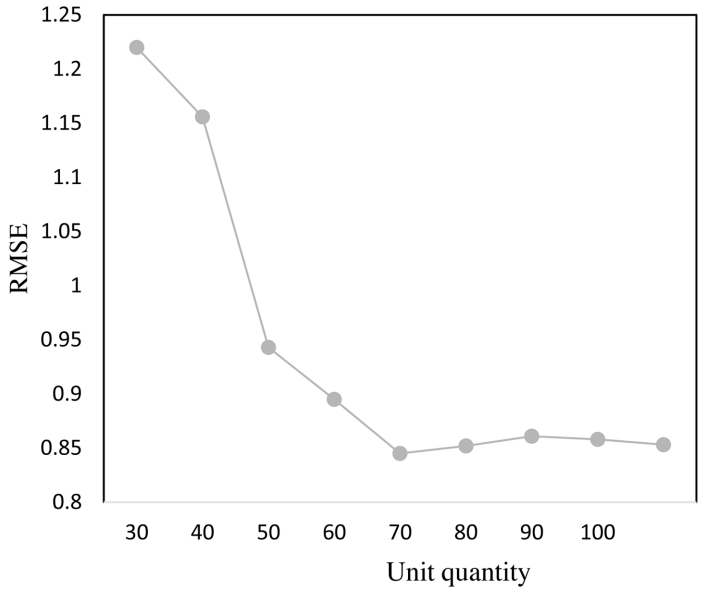


Figure 4. Unit quantity value impact on RMSE



The number count of neurons used within the LSTM cell structure influences the user's latent trait learning process. In the data set its values are set to different numbers and the model is trained, the results are shown in Fig.6. When the number of neurons in a cell is greater than 70 it can accurately give the user a latent feature, and the parameter value settings are shown in the Table 3 *below.*

Table 3. RMSE results with parameter values

Model	Parameter Values	RMSE Result
PMF (Mnih & Salakhutdinov, 2008)	0.1,0.1,1	0.9534
ConvMF (Kim D. P., 2017)	100,10, -	0.8522
DL-PMF (proposed model)	100,9.5, -	0.8430

The parameters used for the training, evaluation of the model, and the RMSE values of the results are included in Table 3. The results of the DL-PMF are that the recommended accuracy values are greater than the other two basic models (Mnih & Salakhutdinov, 2008; Kim D. P., 2017). It filters out interference information through a careful approach and considers the customer's interest as well as the contextual information in the service description according to the timeline. It has also proven to be able to better access the latest features of the service.

CONCLUSION

In this chapter, the author proposes that improving the efficiency of the recommendation is done by obtaining the latent feature of the customer and service elements through the algorithm of the DL-PMF model. This algorithm considers contextual information by filtering interference information from the information of the service item description. Launch results have proven that the DL-PMF model can make a definite improvement in the recommended performance by gaining effective latent features of customer and service elements. Although the services may consider potential latent features from the information of the item description, the acquisition of semantic information along with it should be considered in future work.

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ENDNOTE

[1] https://www.programmableweb.com/

Chapter 10
Impact of Social Media Network Data on Conservation of Bioresources

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ABSTRACT

The effectiveness of the transmission and sharing of data and information among people has been revolutionized by the internet and digital technology. Social networks have shortened the communication space among the technology users. Their relatively easy access through computers, cell phones, and many other devices has made them easy to use, so they are probably the most widely used today. Social network and internet media (SIM) has revolutionized providing useful resources for scientific research, especially in engaging citizen scientists in research. There are also various possible drawbacks in spite of the benefits of the SIM. With the increasing use of social media worldwide, sites with rich species diversity face potentially the greatest anthropogenic threats (resulting from high numbers of visitors), which results in the extinction of valuable species from the native area. Despite shortcomings, SIM can provide conservation education and awareness and also reconnect to the natural world.

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INTRODUCTION

All biological forms in the world are variable at all hierarchical levels (genetic, species and ecosystem). Obviously, biodiversity has provided the basis for several hundred million livelihoods, communities and economies, including farmers, fishermen, forest residents and handicraft workers. It offers raw materials for a range of nutraceutical and healthcare systems. It also provides a genetic foundation for the ongoing improvement of crop technology, fisheries and vital discoveries in research, industries and other sectors. Globally, biodiversity is steadily declining (Wagtendonk & de Jeu, 2007). It is because a major part of human activities such as deforestation, land degradation, hunting, forest fire etc. directly and indirectly related to the present rate of extinction and depletion of the gene pool (Stevens et al, 2013).

According to the Millennium EcoSystem Assessment, by the end of the century, climate change is potentially one of the main drivers of loss of biodiversity. In addition the IPCC Fourth Assessment Report cautioned that in the immediate future more worsening climate-related events will occur. The nature and the usefulness of the new tools in conservation initiatives or efforts required to be critically evaluated by current legal and institutions frameworks. Rapid and precise identification is therefore important for successful biodiversity research and management. At this critical moment, social media outlets tend to be one of the key forces for more action to tackle all these problems. It has an immense role to play in raising public consciousness about the sustainable use of natural resources and biodiversity conservation for the existence of human race. We can improve our conservation efforts and establish better strategies for the efficient protection of biodiversity by disseminating knowledge about environmental activism, awareness, and education through social media. Digital technology has an increasing impact on how people experience, think and deal with nature (Kahn, 2011 ; Verma et al, 2015) Conservationists also embrace the innovations of the information era with hope because they offer more data, faster processing, improved accessibility to information, new communication paths, exciting visual representations which empower decision-making support systems. Keeping in view of the benefits of social media this emphasis centred on the current state of global diversity and the conservation function of social network data to sustain it

ROLE OF SOCIAL MEDIA IN CONSERVING BIORESOURCES

As other programmes, social media plays an enormous role in preserving biodiversity by building knowledge and exchanging ideas for better policy making, thereby encouraging conservation of biological sources, and their sustainable use, equal distribution of advantages (ICRISAT Annual Report 2012). Social media has now become a necessity in our society. It is estimated that 29 percent of the world's population utilize social media sites. Through social media, individuals are more linked with one other and other global/local concerns. Thanks to the emergence of social media which has resulted in a visible change in the lives of many people. Global Web Index has shown that the typical social media user spends 2 hours and 25 minutes per day utilizing social networks and microblogs. With billions of active Facebook users, Facebook tops the list in terms of number of users, reach and scope. A very astonishing thing is Facebook is accessed by mobile devices by 83 percent of the world's users. It's a direct result of cheaper smart phones being introduced in recent years. Social network and Internet media (SIM) has revolutionised the supply of tools helpful to scientific research, in particular to engage and empower individuals in research to interact beyond geographical or social border.

Social media platforms give a forum for exchanging biodiversity related material and postings about natural encounters. Platforms like Facebook, Twitter, Panoramio, and Flickr are becoming increasingly important in conservation science (Stafford et al., 2010; Casalegno et al., 2013; Wood et al., 2013; Barve, 2014; Daume et al., 2014; Roberge, 2014;Richards and Friess, 2015). It's also worth noting that the majority of social media sites give a way to extract knowledge from the billions of postings made by millions of individuals across the world. Building correct understanding of the identification (Species knowledge), geographic distribution, and evolution of living species is critical for both human development and biodiversity conservation. Woefully, such fundamental information is very little available to professional stakeholders, instructors, scientists and people and is frequently deficient for the most diverse ecosystems. Due to this sparse information most people cannot identify living plants or animals. Even professionals, such as farmers, fisherman or foresters face difficulty in doing so since the identification of species by conventional keys is time-consuming and complex due to a lack of standardization and the use of specific scientific terms frustrating for non-experts. One of the key ecological concerns to be addressed is this taxonomic gap. In this context, an important role is played by Social Media in the sustainable use of natural resources and biodiversity conservation. Bridging the taxonomic gap, language neutral multimedia image-based identification tools regarded to be one of the most promising approaches for species identification (Gaston & Neill, 2004; Joly et al, 2014;Wäldchen et al, 2016). According to Valliammal and Geethalakshmi, 2011 In recent years, there has been a growing interest in automating the identification process of species. Digital pictures effect and impact on the modern civilization is significant. Automated species identification has become a reality with the recent developments in digital devices/equipment and network bandwidth/storage capacity, remote access to databases, multimedia data output and new techniques in image processing and pattern recognition.

Nature observers began to produce amazing collections of multimedia records in line with the development of citizen science and social networking platforms (e-bird, xenocanto, Tela Botanica, etc.). Facebook has tremendous potential to generate volunteers of environment and biodiversity conservationists at the grassroots level. More crucially, to share each other's experiences and difficulties to promote better conservation of biodiversity via improved communication. Diverse stakeholders must be made aware of the study findings and success stories relating to biodiversity protection through the use of social media platforms.It is feasible to snap a photograph of a plant / animal/location instantly using a mobile device's built-in camera and one can analyse the information with an installed identification program for species identification. The pervasiveness of Smartphones make it possible for both expert and unskilled individuals to submit data on biodiversity (Van der Wal et al., 2015a).

Digital devices and software, notably smartphones and associated apps, are becoming increasingly important in citizen science, which is developing a paradigm of its own within the field of environmental protection (Silvertown et al. 2015). Experts and non-experts can utilize electronic field guides which may replace bulky volumes to identify species (Farnsworth et al. 2013). With the help of a computer-aided identification system, even non-professionals can take part in this activity. No wonder then that so many research studies are devoted to automating the identification of plant and animal species. The Image CLEF plant/bird/fish identification challenge has been running since 2011 and is one of the foremost visual image retrieval campaigns.

More, better and faster data collection about nature is now feasible because to high-tech sensors and related technologies (Koh and Wich 2012; Will et al. 2014). Humans carry multi-sensor equipped smart phones, while animals wear satellite tags. Other technologies include camera traps, drones, deep-ocean submersible and space satellites that are used to monitor the environment from afar. We can monitor the

natural environment more often, at a finer resolution, on a greater scale in unreachable or dangerous areas. certain cases, this has resulted in near-real-time monitoring of environmental conditions (Blumstein et al., 2011; Van der Wal et al., 2015b). Conservation research and management stand to gain from such advancements in the future (Pettorelli et al., 2014; August et al., 2015).

Robots that mimic the movement of jellyfish, such as the iTuna or Cyro, can be used to monitor aquatic ecosystems. Once triggered, these technologies require little or no human intervention (Waddle et al., 2003; Wagtendonk & De Jeu 2007). It is possible to produce new types of data from 'data on nature'. It is also possible to identify or analyze illicit timber logging or poaching of wild animals using data from equipment such as web traps and embedded cameras, GPS tags, drones, and satellites. According to Saar and Thomas, 2002 similar monitoring systems may also be utilized to watch value chains and product lifecycles, laying the groundwork for energy and waste reduction or to prevent illicit wood trafficking. The use of social media in locations with limited resources for field work and data collection might potentially assist save money and allow professional data gathering to be directed to the regions which are less-known or more difficult-to-reach. For SES (social–ecological systems) research, including issues of biodiversity conservation (Di Minin et al.,2015;Toivonen et al., 2019) and urban sustainability (Ilieva & McPhearson, 2018), the fine resolution and broad extent of social media data and the potential novel insights it can provide into individuals' responses to and influence on the environment make it an exciting data source. The major contributions of social media in conservation programmes are increasing public awareness about the importance of biodiversity, increasing involvement of people and responsibility, expanding the scope of institutional linkages and creating a forum for knowledge sharing and transfer among stakeholders.

SCOPE/ OPPORTUNITIES OFFERED BY BIG DATA

A number of projects have been launched to encourage the standardisation and interoperability of heterogeneous data sources, including the Open Data Initiative (Stein, 2008). A relatively new discipline, 'bioinformatics' aims to create quickly accessible an e-infrastructure that can be shared by the whole biodiversity research community (Hardisty and Roberts, 2013). Following are the few data sources with different information facility.

1. GBIF - At the beginning of June 2015, the Global Biodiversity Information Facility (GBIF) gave access to more than 500 million records on approximately 1.5 million species.
2. Darwin Core project - aims to provide one body of standards for publishing and integrating biodiversity information
3. Speciesbank.com - is a central platform and database for biodiversity market participants
4. Open Air Laboratories (OPAL),eBird, the iNaturalist App,the Atlas of Living Australia and WikiAves - not only provide scientists with data, but also allow people to become part of a community through uploading observations of flora and fauna, inspecting sightings by others, and fostering discuss on and learning about the natural world.

New types of analysis are required when dealing with big data. Conservation methods may benefit from more complex analysis and models for scientific and managerial objectives, aided by fast computer processors and cloud computing (Chapron, 2015; Kelling et al., 2015). Lay people and specialists may

now self-organise and exchange ideas and footage using social media sites (Bombaci et al., 2015). Many disciplines of study have made considerable use of social media data, from detecting crime hotspots to assessing foreign policy dynamics (Zeitzoff et al., 2015) or monitoring public health.

DRAWBACKS IN USING DIGITAL TECHNOLOGIES

Despite their potential, technical obstacles may prevent deployment of sensors and associated technologies. This is due to a number of difficulties with deployment, operation and data handling of lower-end camera traps in conservation and wildlife management studies (Meek et al., 2015). As a result of technological advances, humans and nature may be adversely affected. A recent study by Sandbrook (2015) reveals that drones might have serious societal repercussions and severely influence humans, wildlife and conservation efforts (Ditmer et al., 2015). Also, more resources and energy are consumed, as well as more electronic trash is generated (Fuchs, 2008). Conservationists can utilize the same technology for reasons that are in contradiction with conservation goals. As an example, technology such as video traps and drones might be used to assist illicit hunting and resource depletion in maritime areas (Roberts, 2007). There are concerns concerning who should be allowed to deploy such devices (e.g., public or private organisations), where they may be deployed (on public or private property), and whether individuals need to be told about, or agree to, data gathering. There are issues regarding the responsibility of people who possess such data, how data may be retained or utilized and by whom. The control of data is one of the difficulties that are associated with it. When databases are targeted by hackers (e.g., poachers employing web-linked imaging devices to find rare species in real-time) or developers pose a threat to nature protection when databases are targeted (e.g. using conservation datasets to support natural resource extraction planning).

Li et al. (2013) note that the volume of user created material is quite large, but that most of it is produced by a small number of highly active individuals. Many postings may also include inaccurate or missing location information, depending on where they are located. Some of these issues may be addressed by exploring who the social media users are (Longley et al., 2015), filtering out spatially irrelevant or biased observations (e.g., clusters near accommodation with WiFi inside parks), and sampling/normalizing data based on user profiling or geographic distribution of observations. Due to issues of bias and interpretation, there are questions regarding the capacity of social media data to give meaningful insight into socio-environmental processes (Di Minin et al.,2015;Toivonen et al., 2019; Ilieva & McPhearson, 2018). It's further hampered by the fact that the geographical or temporal resolution of the data or the scope of the data characterizing significant natural and social processes are not always in sync. Light and McGrath (2010) note that there are a number of ethical concerns that should be addressed before employing social media data in conservation research (privacy, free speech, data leakage, and exposing users' identity, for example, in relation to unlawful actions).

INTERDISCIPLINARY APPROACHES FOR DIGITAL CONSERVATION PRACTICES

Many digital applications, especially those requiring big data, require large-scale cooperation, whereas ecology has been defined as an individual-driven culture (Kelling et al., 2015). Nature conservation is

an area where social scientists might play a major role in multidisciplinary digital innovation efforts. Volunteers (naturalists and others), biologists, ecologists, social scientists, and policy-makers are all involved in nature conservation today, and the group continues to expand. It is well acknowledged that the most effective co-operation occurs in multidisciplinary teams (Galán-Daz et al., 2015; Jepson and Ladle, 2015). There is potential for greater contact and increased cooperation between conservationists and academics (Galán-Daz et al., 2015). Innovating to find grass-root answers to local problems seems to hold true both at the macro-level between huge companies and at the smaller group of individuals. In terms of digital conservation, a scientific subject such as human–computer interaction may have a lot to contribute. There are no simple answers to transdisciplinary science and practice (Pennington 2011). Interdisciplinary collaborations, if they prove to be a success, might lead to richer learning environments as well as deeper insights and more efficient functioning. But the speed of change will be slower in the early stages of the relationship.

CONCLUSION

Green ecology contends that ecosystems and individual species should be conserved at any cost, regardless of their use to humans or if their ongoing existence would be detrimental to humanity. This stems from the notion that all living things have the right to exist and should be protected. As a result of deforestation, land degradation, poaching and forest fires, India is experiencing a severe loss of biodiversity and a shrinking of its gene pool. Platforms of social media seem to be one of the primary driving forces that can assist allow more quick action to solve all of these concerns at this moment of critical importance. Because both the sustainable use of natural resources and the conservation of biodiversity are impacted by social media. We can enhance our conservation efforts and better create plans for successful biodiversity conservation by disseminating information on environmental activism, awareness, and education using social media. Digital technology in environment conservation should be viewed as neutral. It is a force that will alter the work of conservation scientists, protected area managers, and conservation organizations. Broad multidisciplinary scientific and academia-practice collaborations are essential for the long-term development of digital conservation. To improve their monitoring role when visiting natural areas, social media users might be made more aware of the data gathering process. This might lead to a greater number of individuals becoming active in data collecting and becoming more aware of biodiversity conservation issues. Citizens might also be targeted more directly through social media sites. Together with other types of information, social media data might give novel ways of addressing future conservation information demands.

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Chapter 11
Role of Information Technology in Environmental Communication:
Green Communication

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ABSTRACT

Environmental communication emerged in the United States in the 1980s and reached multiple milestones in the area of environmental protection and management. Information and communication technological advancement took a quantum leap in supporting environment-related problems through internet. Involvement of ICT in protecting the environment led to the development of 'green websites', which are associated with policies to improve, conserve, recycle, and check the carbon emissions and for the development of eco-friendly products. Environmental nature communication is the exchange of information observed during interaction of plants with ecosystems. It was discovered that organs of the plants communicate when in danger to protect themselves from predators. Application of communication devices likes drones, collars, Wifi, usage of software servers for data collection, monitoring will be a way forward to conserve bioresources. Therefore, environmental communication will analyse data for scientific studies in protecting our earth. The chapter provides an overview of environmental communication.

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INTRODUCTION

Environmental communication is the application of technology for the management and protection of environment. It is a multidisciplinary subject with diverse areas like environmental studies, communication, sociology, risk analysis and management. Through communication technology exchange of information and knowledge on environmental issues is done for mitigating environmental problems. Six essentials components exist in environmental communication, ecological laws, cultural dimension, effective networking, usage of media, environmental ethics practice and resolution (Flor & Alexander Gonzalez, 2004). Living beings will communicate in three ways known as systems theory, i.e., exchange of knowledge with the world and other living systems, exchange of materials and exchange of energy for their survival. Technological advancements has connected environment with researches through the use of computers, satellites, communication devices to gather environment information. Information Technology is used in various environmental studies for monitoring, analysing and mitigating the changes through Remote Sensing technology, Geographical Information System (GIS) and Global Positioning System (GPS) that gives early identification of changes in forecast and provide a warning system to the users. GIS is an established technology with software databases gathers information through remotely located satellites for environmental surveys for management and communication of ground level resources.

A number of softwares databases on environmental information have been developed for environment protection and communication. Database consists of gathering data on different topics. It is a computerised format which can be retrieved whenever necessary. Database information can be retrieved very quickly in the computer. Computer databases information can be of various types like database of wildlife, a conservation database, a database of forest cover, etc.

1. **National Management Information System (NMIS):**
   This database provides information projects related to research and development collected by NMIS of Department of Science and Technology, also have the information on research scientists and staff involved.
2. **Environmental Information System (ENVIS):**
   Government of India has established Environmental Information System (ENVIS) in 1982 under Ministry of Environment which is a decentralized network system for data collection, data storage and data retrieval, this information can be used by the scientists, researchers and environmentalists for future studies. Environmental Information System (ENVIS) has established 25 different centres all over the country, with its headquarters in New Delhi these centers in various organizations of the country which focuses on high priority areas of environmental aspects like toxic chemicals, pollution control, mangroves, corals and lagoons management. clean technology, remote sensing, coastal ecology, biodiversity, Western Ghats and Eastern Ghats environment protection, renewable energy, desertification, Himalayan ecology, mining etc.,
3. **Remote Sensing**
   Satellite imagery provides us with real knowledge by remote sensing about different physical and biological resources and also, to some degree, on their state of depletion in digital form through remote sensing. Digital information is gathered on environment aspects like water logging, desertification, deforestation, urban sprawl, river and canal network, mineral and energy reserves and so on.
4. **Geographical Information System (GIS):**

Environmental management on GIS has proved to be a very efficient tool. GIS is a technique of superimposing various thematic maps using digital data on a wide range of interrelated or interdependent aspects. Several useful software products have been developed to work in the field of GIS. Different thematic maps containing digital information on a variety of aspects such as water supplies, industrial development, human settlements, road networks, soil type, forest land, crop land or grassland, etc. are superimposed in a layered form using software in computers.

Such details may be focused on GIS for contaminated areas, degraded lands or diseased croplands, etc. Planning is now being performed using GIS by planning the Zoning Atlas for the location of suitable areas for industrial development. GIS is used to track unplanned growth and helps to provide accurate, credible and verifiable data on forest cover, conservation efforts progress, etc.

They also provide information on atmospheric phenomena, such as monsoon approach, ozone layer depletion, and several new oil reserves; remote sensing minerals, etc., and GIS play a key role in resource mapping, environmental protection, management, planning, and evaluation of environmental impacts.

They also have data on atmospheric phenomena such as monsoon approach, ozone layer loss, phenomena of inversion, smog, etc. With the help of information generated by remote sensing satellites, we can discover many new reserves of oil, minerals, etc. Remote sensing and GIS therefore play a key role in resource mapping, protection of the environment, management and planning.

5. **The World Wide Web:**
   With materials, classroom activities and digital photo files, power-point lecture presentations, videos, online exercises and quizzes on every topic, it has proven to be extremely useful for both students and teachers. (*Role of information technology in environment and human health, 2014*).

FUNCTIONS OF ENVIRONMENT COMMUNICATION

Environmental communication consists of two functions.

- **Pragmatic Communication**: It is the communication with the environment that connects people and organisations to accomplish the objectives through communication to do things with coordination and exchange of knowledge through awareness programmes and education.
- **Constitutive Communication**: It is the human interpretation and understanding of nature and environmental issues.

Climate communication is the major subfield of environment communication which focuses on anthropogenic climate change information, traditionally communication on climate changes is done by news reports and information dissemination (Nisbet, 2009). Environmental communication between people is called pragmatic for achieving goals related to issues such as climate change, pollution and status on endangered species. Constitutive communication is fundamental which helps in understanding the environmental issues and nature by conducting awareness programmes, instructing, persuading, and integration.

LAWS OF ENVIRONMENTAL COMMUNICATION

Environmental communication has four major Laws

1. All living systems are interconnected
2. Everything must go somewhere.
3. Nature knows best.
4. There is no such thing as a free lunch.

ICT's ROLE IN ENVIRONMENT MANAGEMENT

ICTs can play a key role in faceing the unprecedented increase in economy, production and consumption due to population growth. In enhancing the environmental performance of ICT-related operations, governments should play significant role in fostering the broader implementation of ICTs. Green growth plans have, in particular, been part of larger economic and industrial policies (*Towards Green ICT Strategies*, n.d.)

GREEN ICTs

Green ICTs have beneficial effects both directly and indirectly on environmental efficiency and habitats, directly through minimising energy inputs in their manufacture, usage, recycling and disposal and indirectly by their broader utility in other ICT equipments and systems.

Green ICTs include the development of pioneering websites called Green Websites to disseminate information and awareness of environmentally friendly services, green goods, eco-conscious products, recycling of waste and covers all aspects of life.

Green Websites main objective is to provide information and awareness on natural resources, improvement and utilization of renewable sources, limiting carbon credits, minimizing energy consumption (Antonopoulos et al., 2019; Murugesan & San, 2008). Which contribute to solve climate issues and help to be more eco friendly.

Some of the Green websites providing information on environment communication on one click include (*The Green Websites, 2011*[REMOVED HYPERLINK FIELD]).

- Tree Hugger (https://www.treehugger.com/gogreen.php): The site provides information on sustainability of resources. Strives to go green easier with green news, solutions, and product information.
- Recycling Guide (https://www.recycling-guide.org.uk/): Provides guidelines in a step wise manner on recycling of by-products to be implemented by everyone.
- Free Cycle (https://www.freecycle.org/): Reusing of commodities and exchange of green products among people is been encouraged through this website. The main aim is to make use of the unused products by someone, which can be useful for others instead of dumping in the environment as waste.

- Ecosia (http://ecosia.org/about.php): This website uses the revenue, 80% profit generated through the search engine activities for planting trees around the world to protect environment and to increase the green cover of our earth.
- Water Use it Wisely (http://www.wateruseitwisely.com): Provides ideas, strategies and information on how to increase the water table in conserving water source.
- Print What You Like (https://www.printwhatyoulike.com/): Gives information on online free editor tools to stop extra advertisement printouts, which saves paper and ink wastage for protecting forest bioresources.
- The Daily Green (http://www.thedailygreen.com): Emphasis the importance of green products use in our daily life.
- Free Green (http://www.freegreen.com): This web search gives information of free greenhouse designs. Also motives people in building eco-friendly houses for a better sustainability.
- 1800 Recycling (http://1800recycling.com): Easy recycling suggestions and information is provided in this website by their own, which can be easily followed by anyone to decrease waste.
- Green Leaf Goods (http://www.greenleafgoods.com): Eco-friendly products information is available in the green website.
- Elephant Poo Paper (http://elephantpoopaper.com): Organic paper manufacturing ideas are available in this search engine.

Impact of Information Technology on Environment

The scientific technological advancements often lead to environmental disturbance. ICT impact on environment is of two types, direct and indirect. Direct impacts are energy consumption and e-waste accumulation which varies and depends on the area and spread of energy use related industry. It is estimated that ICT equipment usage and production is equivalent to emissions of global CO_2 by 1 to 3% and emissions of greenhouse gases by 2 to 2.5%. through the use PCs, Monitors, Data Centres, Mobile telecommunications and printers (Kumar & Mieritz, 2007). Indirect impacts are due the constructions of buildings, transport technology and Smart Grid technology which controls, computers, automation, and new technologies and equipment working together.

Based on ICTs interaction with environment, three levels of impacts can be categorized, direct, enabling and systemic impacts. Direct impacts are more focused rather than enabling and systemic impacts. Based on ICTs levels of impacts on environment, three levels are categorized are elaborately (Graham Vickery, 2010) discussed they are

1. Direct Impacts
2. Enabling Impacts
3. Systemic Impacts

a. **Direct Impacts:** ICT affect directly the environment during production and operation of infrastructures and vehicle fleet management from acquisition to disposal which reduces cost and improve efficiency and ensure compliance. There can be more or less environmental effects on all of these manufacturing activities. Consumers can prefer ICT devices that are energy-efficient and certified "green" over other items.

b. **Enabling Impacts:** Influence of ICTs on production, design, increased consumption of energy, disposal of goods is the second level of impact which need to be assessed to reduce the effects on environment.

   Four key ways, ICT products will influence the environmental footprint of other products:

   i. **Optimization:** ICTs will lower the environmental impact of another product. Examples include investments in fuel-efficient vehicle embedded systems, 'smart' energy.

   ii. **Dematerialization and Substitution:** It is possible to substitute physical goods and processes with digital goods like physical music, film media and teleconferences to decrease its impact on environmental.

   iii. **Induction Effects**: Use of ICT increases demand on other products like efficient printers require high-quality paper so high quality paper requirement show its impact on raising the paper making resources like forestry, even though the production and operation of printers are reduced by the direct use of resources.

   iv. **Degradation**: Disposal management is difficult for ICT devices which are embedded in non-ICT products. Recycling process is very complex and costly which contribute to the emissions into the environment. Ex. Automobile tyres, bottles, cardboard and smart tags.

c. **Systemic Impacts:** The structural environmental impacts of ICTs are embedded in changes in attitudes and behaviour. Green ICT applications have positive structural effects which primarily rely on a variety of ways. ICT implementations have structural implications such as

   i. **Information Disclose:** Internet facilitates and Information technology with sensor based servers collect data and interpret to analyse rainfall, forest cover and desertification in the field of agriculture.

   ii. **Dynamic Pricing and Enhancing Real-Time Price Sensitivity:** Provides information on supply of energy or marketing of farm products by ICT applications. When renewable energy is scarce, electricity consumers can utilize in limited way.

   iii. **Changing Technologies Impacting Consumer and User Behaviour:** With the technological advancements there is a leap in the evolution of devices from desktop to PCs, laptops to netbooks and to tablets which is shifting customer choice with significant effects on the exploitation of raw materials and the use of power, influenced by digital music, Internet networking, social networks and teleconferencing technology, which significantly influenced the traditional ways of communication like music, messages, gathering and travelling.

   iv. **Triggering Rebound Effects:** "Rebound effects" from increased micro-level use can result in greater macro-level use of resources. It is the difficulty of medium and long-term evaluations of technological transition, development and consumption.

ROLE OF GOVERNMENT IN ENVIRONMENT PROTECTION

In general, governments have limited emphasis on making ICTs more environmentally positive for direct production, usage and disposal. Initiatives have mainly focused on greening ICTs rather than using ICT implementations to combat global warming and environmental degradation. On one side, investments to promote the production and utilization of renewable technology have been an important component of government economic stimulus packages in recent years. Also government support on environmental effects of ICTs for economic recovery in ICT policies is its main important goal. At all stages, govern-

ments need to focus on all problems. Government "green ICT" like energy-use industries can significantly provide environmental benefits for a better economy. Government should prepare a 10 point checklist on how ICTs resource efficient applications, knowledge and cooperation can highlight the importance in R & D and innovation and to provide a strategy to decrease ICTs impact on environment.

STRATEGIES FOR EFFECTIVE USAGE OF ICTS IN ENVIRONMENT COMMUNICATION

Communication leads to the consolidation of principles, as well as to the development of multicultural and multisectoral discourse with regard to natural areas. Despite its relevance, the understanding and methodology of communication and education is relatively new in the environmental field. There is a need to increase improvised uses of education and communication. Following strategies are to be followed consequently regarding communication and environmental protection.

- From its inception and across the whole period of initiatives, incorporation of education, services, projects, and communication is must for the development and management of the regions.
- In the technological perspective and decision-making frameworks of the organisations, sufficient space is created for communication to work at its maximum level.
- Communication and education must be allocated sufficient economic resources and administrative support.
- At the same time, initiatives are to be taken for continuous implementation of research on communication strategies for better understanding.

KEY PRINCIPLES OF STRATEGIC COMMUNICATION

An important management mechanism of Strategic communication is to make meaningful improvements and goals. In strategic communication, main concepts and recommendations for good practise involve engaging leaders for taking decisions; forming partnerships; capacity building in organisational communication skills; and undertaking rigorous monitoring and assessment (IUCN, 2004).

Quality of communication can be improved through the following steps:

- **Strategic Positioning:** Management decision-making processes at the appropriate location is established for proper communication.
- **Training:** Training is to be given to communicators to enable them to be specialised and to enhance their interpersonal communication skills. Communicators should have a sound basic information on sustainable development and conservation aspects.
- **Strategic Planning:** It is necessary to have strategic planning exercise in the programmes, to increase quantity and quality of planning..
- **Research:** This is important to enhance the degree of certainty with regard to needs (perceptions, resistance, awareness, multicultural aspects) and to take effective action strategies (media, languages).

- **Evaluation:** It is important to identify the impact of education and communication and to verify the actual contribution made by interventions in the areas of protection.
- **Ethics:** It is necessary to consider ethical factors in the application of communication. The media and content must respond to the objectives of the conservation of the areas and not to the interests of individuals.

A cross-cutting process to achieve the objectives of conservation and sustainable development of the environment and to contribute to ensuring the participation of all related parties and social groups must be regarded as a communication process. Communication and education are mechanisms that create information. They must be given due strategic value, and it must be understood that there are two mechanisms that are of importance in promoting social activities that provide proper management of the environment.

Communication by means of leaflets, brochures, posters or videos for school use or distribution in visitor places is more advantageous. Distribution of scientific information can be integrated into a total different management approach in communication. Public-private partnerships can be established to deal the consequences of conservation and development methods. By added value of strategic communication, a variety of internal and external communication strategies will bring about improvements in awareness levels through strategic planning meetings, training seminars and resources, interactions with supervisors and colleagues (Internal Communication) and groups, gatherings, personalised information through ads, sign boards, etc. are external communication interventions.

ICTs promote a crucial role being played by information networks (Houghton, 2010) these are

- **The Arid Lands Information Network** (ALIN) The network disseminates information to the people on who to adjust to the climate change. This knowledge helps people to improve their living habits, empowers and reduces poverty for proper progress and development during changed climate conditions. Also gives information on new ideas, practices and information on opportunities and new technologies.
- **RANET**: This internet portal is used for communicating news on hydrometeorological data by using radio and Internet for rural development, and sends SMS by emergency altering systems and community-based weather observation.
- **The Open Knowledge Network (OKN)** and open **ENRICH** provide information regularly on adaptation to environmental changes.

ICTs have specific applications in monitoring the climate change and can detect the warming of weather, flood arrival, earthquake occurrence and tsunami arrival also has application in energy efficiency methods like smart grids, smart transport systems and smart building systems. ICTs can access the broadband networks and services to operate and provide holistic approach to monitor ecosystem.

Fundamentally, ICT has a vital role in collecting, analysing, interpreting data and which is later transformed into information to be communicated to the people which educates and provides knowledge about the area.

Climate Change Monitoring through ICT's

Following networks play a critical role in monitoring the unprecedented environment changes which bring disasters on the earth.

- The Famine Early Warning Systems Network (FEWSNET) is an information network which provides information on issues related to food security at International, National and Regional levels.
- Distant Early Warning System for Tsunami (DEWS) is an open sensor platform gives information on occurrence of Tsunami and also works as a warning system of Tsunami in the Indian Ocean. This warning system sends SMS via cell phones and through mail. Also this sensor system identifies earth quakes, sea level rise, ocean plate tectonics movements.
- Prevention Web provides information to Disaster Risk Reduction (DRR) for the development of technological tools for risk management through exchanging of information and collaboration.

CONCLUSION

Environmental communication plays a significant role in implementing environmental policies with the leading ICT information by following and understanding the issues and problems. Better environmental communication policies like go green, eco-conscious products utilization, clean renewable energy sources, minimizing the carbon emissions and following innovative technological approaches to deal with environmental issues will bring sustenance in the environment. In order to bring ecological sustainability some major changes in our views and beliefs to the natural world is necessary. ICT in a positive way can emerge as a major field for a better environmental protection factor.

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Chapter 12
The Benefits and Limitations of Telemedicine During COVID-19: An Overview

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ABSTRACT

Telehealth is effective in preventing, treating, and taking precautions to avoid spreading of coronavirus. Telehealth allows people with symptoms to stay at home by helping them to communicate with doctors through the internet. This decreases the spreading of corona virus to large number of people and hospital staff. But when it comes to treatment of patients, telemedicine does have some limitations. Medicines given through telemedicine may not be consistent to patients who have chronic disorders and makes the patients' conditions serious, which leads them to hospitalization. The most significant limitation of telemedicine is that some hospitals do not have equipment to deliver care in this manner. In the present situation of COVID-19, the existing telemedicine has to be modified for helping quick testing and to diagnose the infection to take care of the patients. Hence, some of the benefits and limitations of telemedicine have been summarized.

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INTRODUCTION

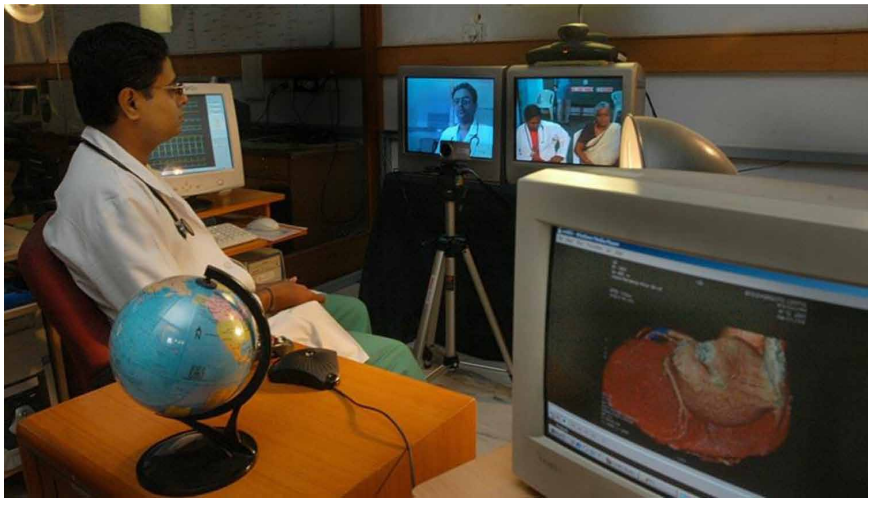
Coronavirus disease is a infections disease which is caused by a virus. So far 75,536,181 infections have been reported leading to 1,673,132 deaths worldwide. Almost 2.5 million people got infected by the virus leading to 17500 deaths worldwide. Number of infected people and death rate has been increasing day by day. Maintaining social distance is reducing transmission from person to person and the number of infections and death rate (Chen, 2020, WHO, 2019, Poletti, 2009). The distance between people is difficult to maintain more than 1-m in the area of high density populations. Hence countries having dense population will have more risk of corona infection (Rockloy & Sjodin, 2020). The healthcare systems face difficulties in capacity and accessibility in the countries which are having low resources. Hospitals which are not provided with ventilators, ICU beds and sufficient staff can not handle the pandemic. As many healthcare personnel are being infected, many hospitals are not willing to give their services fearing that they might be exposed to coronavirus (Ishita Mandrekar, 2020). Hence people with other illnesses are avoided without providing any treatment. However, in chronic ailments like diabetes, lung diseases, heart problems, cancer and mental health problems regular medical check up is needed. It is a great challenge to ensure primary healthcare needs in the present COVID-19 situation.

Telemedicine plays a major role in providing primary healthcare needs in many countries during this crisis. Telemedicine is a technology which provides consultation with a doctor from a distance place and doctor can establish a two-way communication by using the information and communication technology.

The doctor provides health advice to the patient who is residing in a remote place after discussing with the patient (figure.1). The conversation can be audio visual through tablets, smart phones, laptops or desktop computers. This helps the doctor and patient to see each other, which looks like a real health consultation. Apart from this communication can also be done through audio communication or text messaging through mobile phones.

The main objective of present article is to make the people aware about the benefits and limitations of telemedicine in the present situation of COVID-19.

Figure 1.
Source: https://indiaincgroup.com/the-age-of-telemedicine-in-india/



Projects Supported by Central Ministries of Government of India (GOI)

The major initiative in establishing several telemedicine nodes all over the country is steered by the Department of Information Technology (DIT). Ministry of Communications and Information Technology, and the Indian Space Research Organization (ISRO) in collaboration with the state governments, various premier technical, and medical institutions of the country. DEPARTMENT OF INFORMATION TECHNOLOGY, MINISTRY OF COMMUNICATION, AND IT Some of the successful telemedicine pilot projects implemented by DIT in various states are the telemedicine network in West Bengal for diagnosis and monitoring of tropical diseases, the Oncology Network in Kerala and Tamil Nadu, the network for specialty healthcare access in rural areas in Punjab, Maharashtra, the hilly state of Himachal Pradesh, and the North-Eastern region. DIT also established links among the three premier institutions, namely, The Sanjay Ghandi Postgraduate Institute of Medical Sciences (SGPGIMS), Lucknow, All India Institute of Medical Sciences (AIIMS), New Delhi, Post Graduate Institute of Medical Sciences (PGIMER), Chandigarh which in turn connected to the state level hospitals. INDIAN SPACE RESEARCH ORGANIZATION ISRO's satellite-based Telemedicine network through Indian Satellite System (INSAT), which started in 2001 under the GRAMSAT (rural satellite) program now includes 315 hospitals: 271 remote/rural district hospitals/health centers connected to 44 superspecialty hospitals located in major cities. Ten mobile tele-ophthalmology units are also part of this network. This has been implemented in the remote areas of north eastern states of Tripura, Nagaland and in the southern state of Karnataka in its tribal belt. District hospitals of Andaman and Nicobar Islands are linked to specialty hospitals in mainland India.

Ministry of Health and Family Welfare (MOH and FW)

MoH&FW4 has implemented Integrated Disease Surveillance Project networking of all district hospitals with medical colleges of the state to strengthen the public health system, particularly focusing on disease surveillance. It has now adopted telemedicine into the National Rural Health Mission, aiming at providing healthcare access to the rural population, National Rural Telemedicine Network (NRTN) Project, and has launched tele-ophthalmology pilot projects in many states under the National Blindness Control Program. State Governments of India Various states, now realizing the advantages and benefits of telemedicine technology in modern-day healthcare delivery, are cooperating with the central government in establishing state wide telemedicine networks to strengthen the healthcare facilities in their states. Some have also started owning the projects and integrating them into their health system.

5–11 Academic Medical Institutions and Corporate Hospitals SGPGIMS, a premier academic institution in the public sector, started telemedicine activities in 1999 with funding support from various government agencies. The institute is now networked with 24 national and international partner institutions and has been carrying out tele-education and telehealth activities. Various departments have integrated telehealth and tele-educational services. Two other premier institutions of India, the AIIMS, New Delhi (linked with hospitals in Jammu and Kashmir, Haryana, Orissa, and North Eastern states) and PGIMER,Chandigarh (linked with 20 district hospitals of Punjab and Himachal states) have been leaders in telemedicine programming and dissemination. Sri Ramachandra Medical College (SRMC), Chennai (linked with 35 national and international nodes), Tata Memorial Hospital, Mumbai (linked with 30 nodes) Christian Medical College, Vellore are also involved in similar activities. In the corporate sector, the major players are the Apollo Hospital Group (linked with 64 nodes), Amrita Institute

of Medical Sciences (AIMS), Kochi (linked with 23 nodes), Asia Heart Foundation (AHF), Bangalore (telecardiology and mobile van), Fortis Hospital, New Delhi (linked with 27 nodes), Narayana Hrudayalaya, Bangalore (linked with 55 nodes), and Escorts Heart Institute and Research Center (linked with 17 nodes). Sir Ganga Ram Hospital (SGRH), New Delhi has launched its telemedicine centers in Haryana and Rajasthan states.

Mobile Telemedicine

With the support of ISRO, Shankar Nethralaya at Chennai, Meenakshi Eye Mission and Aravinda Eye Hospital at Madurai and four other corporate eye hospitals have launched mobile teleophthalmology service for early diagnosis and treatment of ophthalmic diseases under National Blindness Control Program. SGRH, AIMS, SRMC, and AHF have launched mobile telehospitals for rural access of specialty healthcare services. Andhra Pradesh state government has launched mobile clinics that would daily visit two villages to check health parameters of people and also carry out telemedicine through "104 services.". In Maharashtra, BPL Mobile has launched the value added service to provide a virtual channel that will give subscribers instant access to quality medical assistance, real-time interaction with doctors anytime and anywhere. Gujarat government's health department has announced an e-medicine scheme for rural areas.

Global Telemedicine Projects Initiated by India

The Ministry of External Affairs (MEA) has undertaken a global telemedicine initiative in Africa and South Asia to extend its telemedicine-enabled healthcare and educational services under a South Asian Association for Regional Cooperation (SAARC) and PanAfrican e-Network Project.

SAARC Telemedicine Network

The SAARC, created as an expression of the region's collective decision to evolve a regional cooperative framework, received a major impetus during the 14th SAARC Summit held in New Delhi in April 2007. The preparatory work for a pilot project connecting one or two hospitals in each of the SAARC countries with the super specialty hospitals that include AIIMS, New Delhi; SGPGIMS, Lucknow; PGIMER Chandigarh and CARE Hospital, Hyderabad of India has been complete. Jigme Dorji Wangchuck National Referral Hospital, Thimphu, Bhutan has been connected to SGPGIMS, Lucknow and PGIMER, Chandigarh under this project, which was inaugurated in April 2009.

Pan-African E-Network Project

The MEA is implementing this project through Telecommunications Consultants India, Ltd. (TCIL) to establish a VSAT infrastructure for 53 African Countries of the African Union by a satellite and fiber-optic network that would provide effective tele-education, telemedicine, Internet, videoconferencing, and voice over Internet Protocol services. Ten super specialty hospitals in India have been identified to provide telehealth services to 53 remote African hospitals.

E-Learning in the Health Sector

Online Open Access Bibliography

Two government agencies, National Informatics Centre (NIC) and Indian Council of Medical Research (ICMR), have established the Indian Medical Literature Analysis and Retrieval System (MEDLARS) Centre to cater to the information needs of the medical community of India. This ICMR-NIC Centre for Biomedical Information has developed various Web-based modules such as a union catalogue of journal holdings of medical libraries of India, a bibliographic database of Indian biomedical journals, and full texts of Indian biomedical journals.

Collaborative Knowledge Sharing

Toward professional knowledge sharing, premier academic medical institutions, namely, AIIMS, New Delhi, PGIMER, Chandigarh, SGPGIMS, Lucknow, Christian Medical College (CMC), Vellore and AIMS, Kochi are actively involved in sharing their academic activities over the telemedicine network.

National Digital Medical Library Consortium

National Medical Library's Electronic Resources in Medicine Consortium is an initiative taken by the Director General of Heath Services (DGHS) to develop nationwide electronic information resources in the field of medicine. Seventy-six (76) centrally funded government institutions including 10 under DGHS, 28 laboratories of Indian Council of Medical Research, and AIIMS libraries are selected at the initial stage as its core members. The MoH&FW aims to provide funds required for the purchase of electronic journals under this consortium project.

Medvarsity

Apollo Hospitals Group, in association with NIIT Ltd., has launched Medvarsity to provide the platform for online delivery of continuing medical education and offers variety of courses for doctors, nurses, and other paramedical personnel.

BENEFITS OF TELEMEDICINE

- **Provides healthcare for life style diseases during lockdown:** Telemedicine can be helpful in treating lifestyle diseases such as diabetes, hypertension and chronic endocrinological disorders which need regular check-ups. Without the medical assistance for longer periods can increase their health risk. Early action can save patients from later complications. Hence telemedicine plays a great role in maintaining health during COVID-period.
- **Lowers the risk of infection in normal patients:** Visits of patients without corona infection to the hospitals increase the risk of infection. Most of the corona patients were not tested as there is a lac of testing kits. Many of them are asymptomatic. Such patients can spread infection to the visiting patients with non-corona virus. Hence risk of infection can be reduced by treating the

other diseases through telemedicine. Telemedicine can make PPE kits available to the healthcare professionals by reducing the use of kits in hospitals.

- **Effective use of time:** The doctor's infected by corona virus at the time of their duties are required to stay in home quarantine. These doctors can provide consultation to patients by using telemedicine.
- **Optimizes the Doctor's workload:** In most of the developing countries majority of the population lives in rural areas. However, the absence of qualified doctor's in villages leads to an imbalance of doctor's workload.
- **Effective in reducing mental health conditions:** The anxiety created due to COVID-19 and its impact is showing lot of stress in most of the people. Many of them are facing mental health problems and depression is seen with the social distancing(World health Organization, 2019).

Limitations of Telemedicine

Telemedicine is not suitable for all patients. Some of the limitations include (Bashshur et al., 2016; Ohannessian, 2020; Greenhalgh et al., 2020)

- **Communication through Video**: As actual visits can not be made, communication through video can help partially and improve clinical judgment.
- **Absence of closeness**: Telemedicine acts as a supporting tool because of the absence of closeness with a doctor to identify the problem which can only done by physical examination.
- **Lac of internet facility:** It may mislead the doctor as it is a remote visit by video call or through phone. Lac of smart phones and also high speed internet facility.
- **Insurance**: Insurers are not covering telemedicine to reimburse the money spent on telemedicine and the laws related to reimbursement often keep changing.
- **Protection of the data related to medicine:** The medical data of the patients may be accessed by the hackers, when medicine is accessed in public internet places by the patient.
- **Delayed treatment:** Through telemedicine a doctor can not give care and can not conduct diagnosing tests virtually when an emergency care is needed for a person.
- **No requirement of Telemedicine in high risk and mild infections:** The patients with serious condition may not require telemedicine as these patients need to be attended immediately by the doctor. COVID-19 data shows that most of the patients are with mild infection and telemedicine is not required.

Limitations Faced by Healthcare Providers

- **Lack of arrangements:** The most significant limitation to telemedicine is that most of the hospitals are not provided with necessary arrangements. Only a few hospitals are equipped to give care through telemedicine.
- **Lack of hardware:** Lack of necessary hardware like cameras and sound system provide telemedicine.
- **Access to broadband:** Some of the hospitals are not having quality internet connection and they are facing difficulty in finding good internet facility. Quality care can not be given through a weak

connection of the internet. The telemedicine programme provided by clinicians must be secure followed by all privacy laws.

- **Acoustics within a building:** Rooms constructed by concrete tiles will generate echo's where it will be difficult to talk to a patient.
- **Need of credential new doctors:** To provide patient care, staff with proper credentials and license are needed, which is lacking in present situation.
- **Issues related to license:** Each states law may vary, hence clinicians can not practice outside the states as they do not possess license for outside states.
- **An inability to examine patients:** During telemedicine session clinicians must depend on patients self reports. This helps doctors to enquire more about the health condition of a patient.

Future Perspective of Telemedicine in India

- The Government of India is planning and implementing various national level telemedicine projects and deploying mobile and fixed tele centres within the country to provide healthcare facilities to the remotest and poorly accessible areas of the country.
- ISRO telemedicine nodes are expanding and are also planning to launch a dedicated satellite, HEALTHSAT, for healthcare delivery.
- Encouraged by the success of the Kerala ONCONET project, MoH & FW is planning to implement the "OncoNET" India project, which will network 27 Regional Cancer Centres with 100 Peripheral Cancer Centers to facilitate National Cancer Control Program.
- NRTN48 is another major initiative coming up under National Rural Health Mission. A major national initiative—the National Medical College Network Project is coming up in the field of e-learning—to establish a national telemedicine grid for networking all the medical colleges to implement the recommendation of the National Knowledge Commission.
- Few tertiary care academic medical institutes from different regions of the country will be identified as Medical Knowledge Resource Centers (Regional Hub), each of which will be connected to medical colleges (Nodes) in that region. One of these regional hubs will be identified as the Central Hub, which will have overall responsibility to coordinate the National Network in addition to providing infrastructure for the Central Content Development Center. Under DIT support, the National Resource Center for Telemedicine & Biomedical Informatics has been established at the School of Telemedicine and Biomedical Informatics, SGPGIMS, Lucknow. The Department of Information Technology is planning to launch various other projects in collaboration with government organizations: Development of a Web-Based Telemedicine System for Chronic Diseases, E-Health Visualization and E-Health Associated Field, Advanced ICT for Health Care, Proof of Concept Project in District by NIC State Center, Hyderabad and Access to Quality Healthcare in Tamil Nadu through a Pilot Telemedicine Network. The National Knowledge Commission, which is a high-level advisory body to the Prime Minister of India, with the objective of transforming India into a knowledge society, is planning to develop the Indian Health Information Network. In the international collaboration area, DIT is also collaborating with the European Union (EU) in various fields including e-governance and e-health. Bridging Europe's Electronics Infrastructure to Expanding Frontiers–Education and Research Network, India's project proposal, has also been approved under EU's FP6 IST program. This is an e-Infrastructure Research Proposal for development of a reliable and robust grid infrastructure worldwide and would help to build and

promote an effective communication network platform to forge alliances between academics and industries. A Memorandum of Understanding was signed between the Government of India and Afghanistan to set up a telemedicine facility in Afghanistan with the support of GoI that would be implemented by TCIL.

CONCLUSION

Telemedicine is convenient to people who cannot go to hospitals for check up during this COVID-Period. However, it is necessary to check the credentials of doctor who is giving care. As laboratory tests and physical examination is not needed in telemedicine it can be suitable for any kind of conditions. Telemedicine can also provide psychotherapy. Even though, as telemedicine has some limitations it should be used as a support for traditional medicine, because the doctor can't examine the patient physically to know the ailment in many of the countries. People are least aware of telemedicine. Hence such countries should make people get awareness by servicing frequently through telemedicine.

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Chapter 13
Design and Development of an Internet of Things (IoT)–Based Anti-Theft System in Museum Cultural Relics Using RFID

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ABSTRACT

Art colonnades and museums all over the world are the first option for individuals to visit for the enhancement of the cultural life of people. To ensure their safety, museums have established numerous cultural security measures. Traditional strategies do not obstruct their pace entirely. They only use a computer in the museum to check individuals at the entrance and exit. Therefore, the authors proposed a gallery anti-stealing device created on the internet-of-things (IoT) technology that ensures security through passive readers/writers of RFID. Radio frequency identification (RFID) remains a system that practices isolated data storing and recovery and offers object tracking with a unique identity code. The system then sends sound and light warning information, while the photographic camera structure is triggered to capture a picture at the same time. The recognition of the accuracy in the hardware component of the device can be additionally enhanced by the use of this technology to increase the safety of museum equipment.

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INTRODUCTION

His increasing interest in and concern for his artistic heritage is an important aspect of our community. The overall number of museums in our nation reached 5,136 at the beginning of 2019. Museums have often treated non-profits and public welfare as a common understanding for a long time. Museums necessity be available to the community free of responsibility in many nations. G. Ke & Q. Jiang (2019) reported that over 20,000 exhibits were held in the National Museum in 2018, approximately 1.5 million people went addicted to the museum, then go to see the museum had become a method of life. This also life changes leftovers a part of the illicit elements in the museum. A new kind of robbery has arisen in recent years: burglary and the illicit selling and purchase of creative and historical artefacts have risen to an alarming degree. This situation, which concerns all those who are important for overall or private collections, is increasingly endangering cultural heritage. Since theft and trafficking occur, action must be taken against them while a deeper understanding of these phenomena is required in order to do so. The museum equipment was locked at the earliest level. Now we can see several unopened exhibition areas hanged with a major lock in the Forbidden Zone. R. Tesoriero et al. (2008) reported that the most traditional locking system, however, has many shortcomings due to the continuous growth of society, and robs can effortlessly open the padlock. Advanced, sound waves are the high-end technology device of the anti-theft museum structure. Through the continuous growth of the technology sector, by electronic sensors, individuals may detect different kinds then occurrences of wide-ranging waves, accordingly that wide-ranging-proof anti-theft devices come into being. Burglar alarm, microwave infrared detector, glass break detection system, microwave objective motion detector, and door electromagnetic detector, which have been applied in different industries, are the most commonly used anti-theft devices. The implementation of anti-theft warning systems in the financial industry, such as banks, Automatic teller machines and other locations, will reduce the incidence of criminal cases like theft. Maximum data need to be appropriately kept secret in military camps, and defiant-theft devices can notice when doubtful persons remain encroaching. In areas through heavy stream of traffic movement, such by means of train positions then schools, offenders and unknown people can be alerted to the blacklist by adopting face recognition technology. In command toward ensure the protection of peoples breathes and belongings, such successful methods will curb the incidence of ferocious occurrences and illegal happenings. N.-A. Çayirezmez et al. (2013) reported that Ultraviolet microwave detectors produce warning signals only when they simultaneously activate an infrared detector and a microwave detector, linked with other conventional defiant-theft apprehension devices. Industrial ultraviolet microwave sensors are fitted with different noise instruments towards notice the grade of hurt by varying angles in order to satisfy different needs. The microwave board motion sensor has actual very-high-frequency radio waves with identical quick wavelengths compared to the infrared waves detector, that implies that microwaves are effortlessly reflected by additional substances. The benefit of these systems is that the device will warn if the observed intensity is offset and during detection phase, even uncertainty the robber prudently implements the theft. The downside of this device, however, is that it can receive intrusion from outward reality data, such by way of sound then rain, talking noises, etc., then it is informal to trace. O. B. Sezer et al. (2018) reported that in museums, cameras have recently been mounted to recognise collections in museums and to use image processing techniques for security.

Statement of The Problem

Security is important in each and every field. In order to ensure the safety of the museum, different steps to safeguard cultural relics are in place to ensure their safety. D. E. Kouicem et al. (2018) reported that however, as a result of many shortcomings in current security policies, fraud is still a major issue. One among them is receiving interference from external Real data is public to contact, such as lightning and rainfall, talking noises, etc. With these conditions we cannot protect the historical collections in museums all the time. G. Jayendra et al. (2007) reported that this drawback affects the society in different ways. As museums progress into an age of technology, there are numerous security and business challenges that can be overcome via RFID applications.

Motivation

In this modern world, museums are the best place for people to explore the priceless ancient artefacts. The stealing of objects is also something citizens in museums do not want to see. The proposed antitheft scheme which is based on Internet-of-things (IoT), ensures safety of the artefacts over the submissive RFID readers/writers. M. Burhan el al. (2018) reported that the IoT based technology highly reduces the risk of theft by providing various functionalities.

Scope

S. B. A. Hamid et al. (2012) reported that the main scope of this project is to use the RFID (Radio Frequency Identification) which is an IoT technology to achieve the security needs of the museum. One of the important features of this RFID is we can track and identify artefacts in museum by using RFID tag and reader within reader range. It reads the tag information and compares with data in database which is already prepared. It also helps to activate the alarm when theft is happened in museum.

Objectives

To activate the alarm when artefact is stolen. In order to safeguard the collection from theft and injury, museums need adequate alarm systems when in exhibits, exhibitions, and working or storage areas and in transit. To close the doors of museum when the tag is not detected within time. This feature helps security of museums to catch the thief within no time. To identify the stolen artefact within short range and also to send warning messages to the security person of the museum on alarm.

Proposed System

In proposal and execution of anti-theft system in museum, the RFID tag plays a prominent role in preventing the theft of artefacts present in museum. In this system initial servo motor is open. Here servo motor acts as door for the antiques. As long as the RFID card is read against the reader, the servo motor rotates in clock-wise direction. If the RFID card is not read for more than 30 seconds then the servo will rotate in closing position as the door closes and the buzzer will ON. Y. C. Shen & S. Q. Shen (1999) reported that the alert messages are sent to the museum security and police department via GSM module

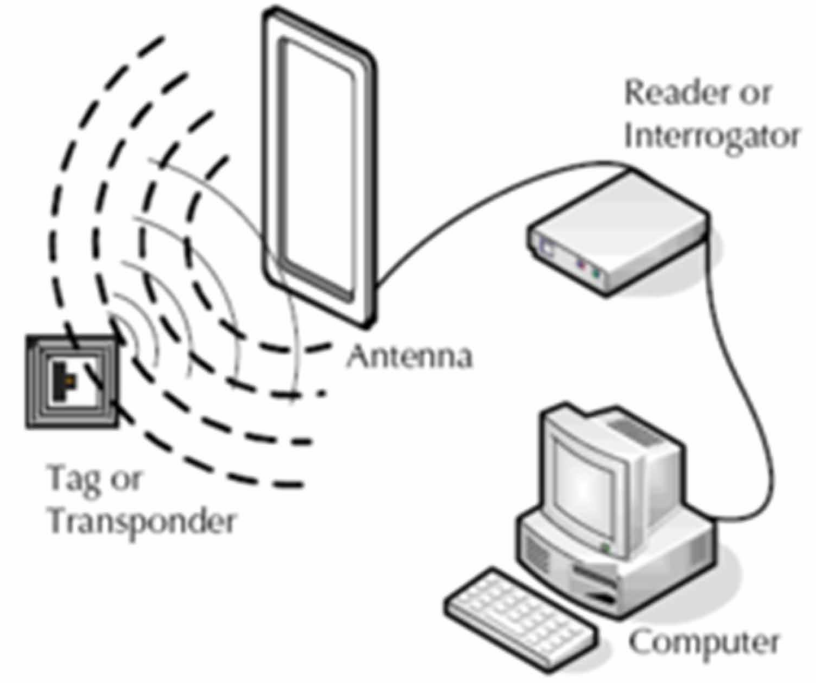
and Wifi Module so that we can alert that theft is happened. LCD is used for displaying the status of the artefacts. Additionally, a touch sensor is used to identify and recover the correctness of the organization.

Radio Frequency Identification (RFID)

By usage of radio surfs to understand and detention data deposited on a tag can be read is Radio-Frequency Identification (RFID). From up to the several feet away, a tag attached to an object.

An RFID system has two aspects: a tag or sign and a reader. Embedded with RFID tags or labels are a transmitter and a receptor. On the tags, there are two parts of the RFID element: a microchip that holds and processes information and an antenna that receives and transmits a signal. The tag contains a serial number that is exclusive to one particular object. In order to decode the information stored on a tag, a two-way radio transmitter-receiver called an interrogator or a writer emits a signal to the tag using an antenna. The tag reacts to the items published in its memory bank. The investigator would then share updated reading findings to an RFID software program. **Figure 1** demonstrates the mechanism of RFID two-way contact.

Figure 1.



RFID Based Anti-Theft System in Museums

Radio Frequency Identification (RFID) is a technique that enables distant data loading and recovery to provide an identity code for items that are being tracked. E. Valero et al. (2015) reported that in particular, an RFID reader, antenna, and RFID tag are included. Depending on the individual objects and storage

capacity, the standard classification code table is stored in the RFID tag as an identity code, while other data about the items being tracked is also stored in the tag. The RFID reader checks the tag in the research institutes in a typical application to transmit the identification details. Data collection, data processing and data transmission processes are carried out in real time. Y. Ma et al. (2018) reported that the anti-theft system suggested is primarily made up of a PC, an RFID reader and an empirical equation.

RFID is inductively combined with the reader in the security access system. Amplified data from the chip is sent to the processor when the card is swiped against the reader, which is in turn fed to the microcontroller. The card used is a person's identification card and carries his or her information. If this data matches that stored in the microcontroller 's database, access to the protected area is given to the person. This is indicated by flipping on a light. The status of the person's authority is also reflected on a microcontroller-interfaced LCD.

F. Sahba (2014) reported that on the basis of RFID technology, museum ticketing and visitor management systems have been implemented. The museum will be operated more effectively and arranged in an orderly manner through this method. R. Tesoriero et al. (2008) reported that in addition to fulfilling the basic ticket sales feature, tourist behaviour can also be captured, statistical analysis carried out and cultural values applied in a targeted manner. The advertising activities are in accordance with the features of the museum., In Particular the following three suppliers must be fulfilled.

1. One individual of one vote, a verification visit, and a free opportunity to visit the basic show of the museum.
2. In order to plan for services including such ticket checking, data gathering and selection, visitors to the real-name system must provide the required confidential info during the ticket booking process and retain valid identity documentation during the ticket buying and admission process.
3. The best receiving capacity and optimum reception capacity should be thoroughly considered, and also the comfort and protection of the visit, depending on the size and accessibility of the building site.

At the very same time, we may set the museum's maximum processing capacity as per the museum's regular reception capacity and the specific distance travelled.

Z. Meng & Z. Li (2016) reported that the RFID opens the door to a collection of thrilling self-service museums that handle the transport and show of exhibits efficiently for employees. Through simple wired headset scanning and RFID-enabled personal digital assistant information, members can view multimedia data of interest to individuals. A stimulating museum is open to the public under the direction of high-tech missions, and RFID will be widely recognised by the public. RFID has to be injected by the modern technology museum. The museum community should exchange hints, broaden ideas, face future challenges, and build the digital vision that is expected.

EXPERIMENTAL SETUP

The hardware components required for the implementation of the system are connected through the connectors. A touch sensor is used to identify the unauthorized touching of the artefacts. The Arduino IDE is used for programming and its latest version is installed. The GSM and WiFi Modules are used for sending the alert messages.

Procedures Adopted

The procedures that are adopted are RFID and IoT. The RFID is a Radio Frequency Identification device that recognises or records the tags attached to objects by using magnetic waves. When triggered from either the neighbouring RFID Reader System by the electromagnetic interrogation signal, the tags react by sending back to the reader a digital data that is normally a specific RFID tag identification. This ID is given to the RFID tag at the time of manufacturing. So, this technology is used to track the museum artefacts. It is possible to identify RFID systems by the form of tag and reader. The RFID technology that will be introduced in the theft detection system for museums is an Active Reader and Passive Tag. The Internet of Things is a collection of interrelated computer devices, mechanical and digital devices with specific IDs and the ability to move data to computer interactions over the internet with human intervention. The IoT now becomes the buzz word in the revolution of technology. Sudip Misra et al. (2011) reported that the IoT will be of greater use in the field of tracking and identifying when combined with RFID technology.

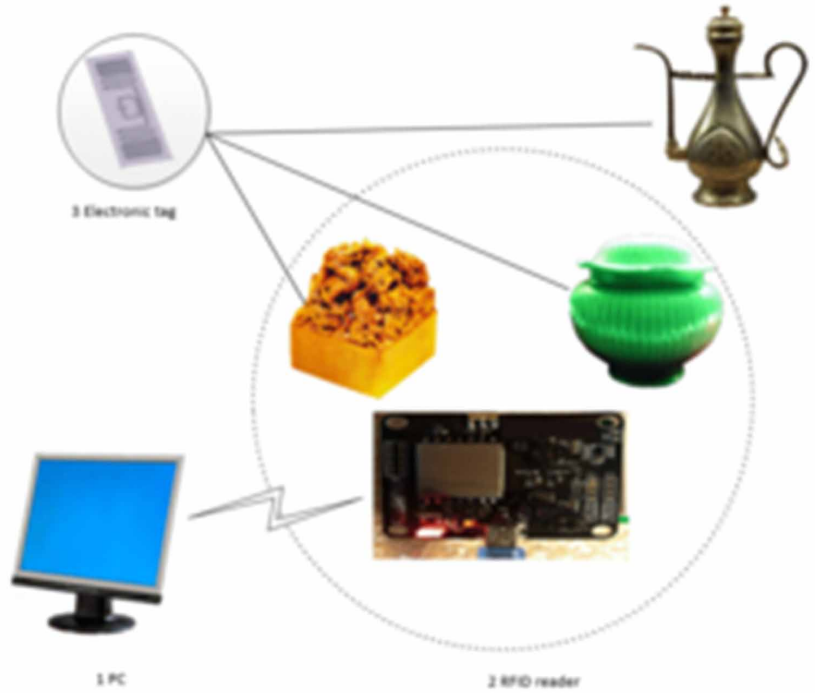
Techniques Developed and Implemented

X. Liu et al. (2017) reported that the RFID technology with IoT is implemented in the museums where the theft of artefacts can be identified within short range and with better accuracy. If any theft is identified then the system will send messages to the security person of the museum using the GSM module. J. Landt & C. Barbar (2001) reported that the touch sensor identifies unauthorized accessing of artefacts. By implementing all these, the theft of artefacts can be reduced.

Composition of the RFID System

The above **Figure 2** shows the configuration of RFID classification. The Radio Frequency Identification system is mainly composed of two components. A) RFID Reader and B) RFID Tag. K. Michael & L. McCathie (2005) reported that the RFID reader comprises of a radio frequency transmitter and a control unit. In order to easily recognise and monitor the RFID objects. the tags contain, the RFID reader utilizes electromagnetic fields. Cash, apparel and belongings can be added to the RFID tags. In this method, to deter and understand wealth management, we will apply RFID tags to the artefacts in the museum. A tiny radio transmitter, a status role and a transmitter make up the RFID tag. 2 categories of tags exist. R. Colella et al. (2015) reported that the Passive tags are driven by energy through interrogating radio waves from of the RFID reader. Effective tags are operated by a battery, so they can be read from of the RFID reader at a greater range, up to thousands of yards. J. Shi (2006) reported that the tag does not need to be beyond the reader's line of sight, unlike a barcode, so it can be embedded in the sensor. In this proposed method, we'll be using passive RFID tags. When electromagnetic interrogation pulses are sent by an RFID reader, the tag typically transmits digital data back to the reader with an identification number unique to all the tags. There are two data areas in the tag, first one is used to store unique ids that are created during the tag's manufacture, and the other is able to store user information that can be changed or removed. As per the power size and application, the reading range of RFID readers may be set. Each museum artefact in our proposed model consists of Tags.

Figure 2.



The RFID reader sends signals at regular intervals to check whether the artefacts are in the reading range or not. The tags respond with their unique ids. It checks for all the artefacts in the database. If any artefact does not respond for certain amount of time then the system sends signals that the artefact has been moved and it is in the danger of theft. The alarm can be used to indicate the theft has been taken place so that the museum authorities and the police department can be alerted.

The modification that can be created is that the servo motor can close the doors when a burglary actually occurs and the alarm begins to signal the doors so that the thief cannot escape. A servo system consists mainly of three basic elements: a managed computer, a feedback system, and an output sensor. This is a closed loop device that is automated. Instead of using a variable contribution sign to control a device, the device is skilful by a response signal created by contrasting the output sign and the orientation input sign. The main objective of a servo mechanism is to hold the productivity of a device in the presence of disturbances at the anticipated price. The theft can be detected within a short time and range with this device than the conventional approaches that can only identify the theft when the artefact is interpreted at the entry or exit.

Flow Graph

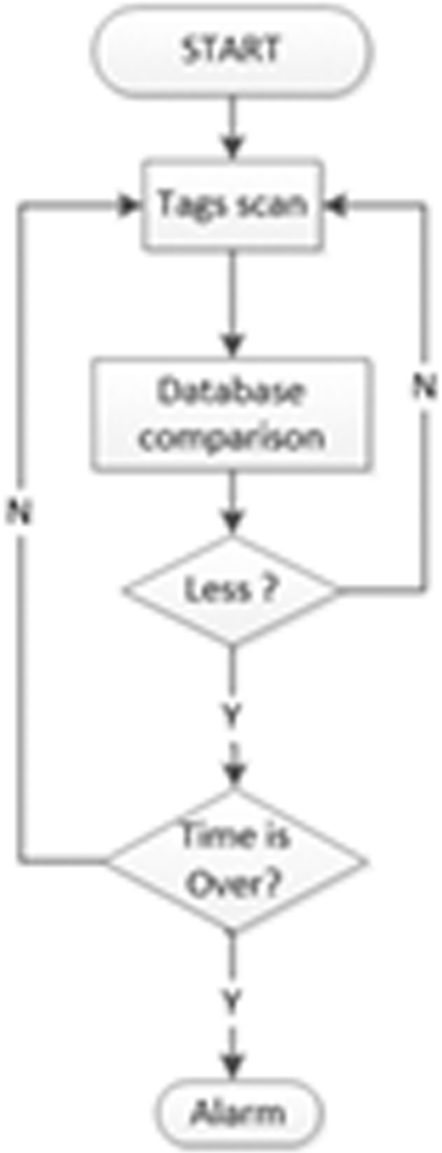
Simulation Modelling is defined as the method of constructing and evaluating a digital prototype of a physical object to predict its success in the real world. It is used to assist engineers and designers understand whether a component will fail and what loads it can withstand, in what situations and in what ways. Without tremendous losses, simulation modelling can also help to predict mistakes. By applying

simulation software, it analyses the estimated working conditions. It is a risk-free environment that saves money and the highest accuracy is also given by time.

The traditional anti-theft museum utilizes only a scanner at the museum entrance to inspect visitors. When the unit is inadvertently disconnected from the museum entry or exit, a warning is released. If the object is lost or stolen, but has not passed through the entrance and exit of the museum, an alarm message will not be given. To overcome these limitations in the traditional methods we used RFID tags using IoT technology. With this technology we can be able to find the artefacts within the short range.

The flow graph is shown in **Figure 3**

Figure 3. Museum-anti-theft organization flow chart.



In the above diagram, the design scheme used in this approach is shown. The alarm begins, which has more detailed considerations, Before the RFID device identification spectrum is left, arrange the RFID system around the cultural relics. For this reason, the anti-theft mode of the electronic cyclic scan tag is programmed and the time taken for the whole anti-theft function to be performed is determined by the number of devices seen in the museum. If during the scanning period, the corresponding device is scanned multiple times at regular time intervals and the corresponding device is not detected, the warning processing begins and a buzzer is emitted. In addition to the warning, the gates are automatically closed to detect the system within a short range.

The viewer / author in the Taguchi experimental design system is related to the interaction controller in the system application. They get the orders from the operator and return the output of the execution of the command to the controller. Basically, an RFID module consists of two sections, namely, a tag and a reader. An antenna, a transceiver and a transponder (RF tag) make up a standard RFID system. The transceiver reads the radio frequency and passes the information to a computer to be further processed. In the RF tag or transponder, the information (the specific serial number) to be transmitted is stored. A chip and an amplifier mounted on a substrate are included in the transmitter. The chip transmits the related data through the antenna. The electromagnetic waves sent by the RFID reader are also received by the antenna. For microcontrollers to receive these serial signals, a Serial Level Converter is required. To interface the RFID tag with the microcontroller, IC MAX232 was used for this purpose.

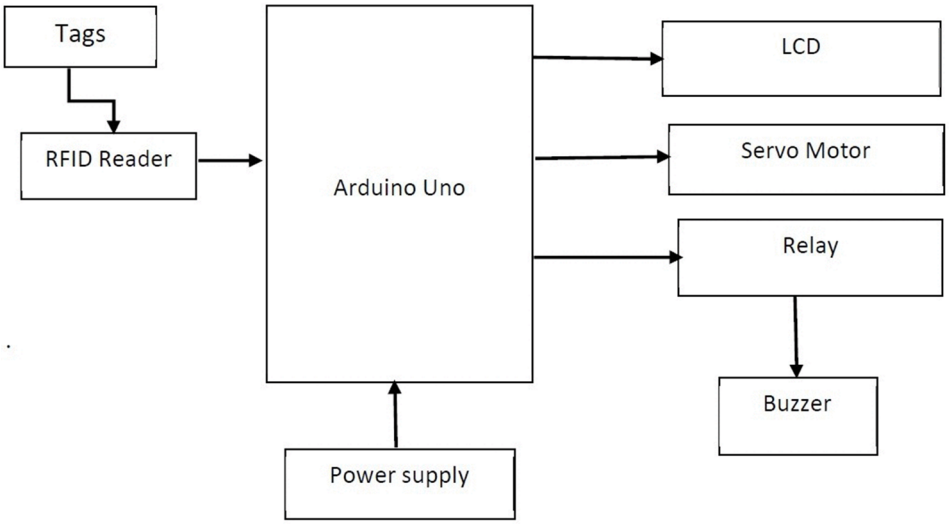
In this method the simulation process takes the input as tag used to scan by RFID reader. Then it compares with the RFID's present in the database that is previously stored. If the tag is read then the process is continued at regular time intervals. But, if the tag is not read then the alarm is automatically generated using the power supply and the gates get closed automatically once the alarm is activated using a servo motor. A servo device consists mainly of three basic elements: a managed computer, a feedback system, and an output sensor. This is a closed loop control device that is automated. Instead of using a variable input signal to control a system, the process is powered by a feedback signal created by contrasting the output signal and the input signals signal. The primary task of a servo mechanism is to hold the output of a device in the presence of disturbances at the desired value. We will be able to locate the artefact with high precision in the close distances with the help of this tool.

Physical Model

The Figure 4 shows us the block diagram of theft detection in Museum. The main component of the system is Arduino Uno which controls the system communications. The power supply will be provided to the Arduino Uno for its working. H. Liu et al. (2008) reported that the RFID tags will be attached to all of the artefacts in the museum within the RFID reader range so that it can detect all the artefacts.

The RFID reader will be connected to the Arduino Uno and will send the electromagnetic signals at regular intervals. The tags respond to the electromagnetic signals and send their unique id back to the RFID reader. Here comes the PC in which the database checking of all the artefacts will be taken place. If all the tags present in the museum respond to the reader then all the artefacts are safe and are in their positions. The LCD will display the status that Artefacts are safe. If any of the tag didn't respond to the reader it again sends the electromagnetic signals. The RFID reader will wait for certain amount of time for the tag to respond. After the time is over the servo motor will rotate in the direction to close the door and the relay will send signal to the buzzer. The LCD now will show the status that theft detection. The buzzer will be in active state until the artefact tag is read. If the Arduino Uno sense that buzzer is in on

Figure 4. Block diagram of the Museum Anti-theft system



state, it is programmed such that the notification will be sent to the museum manager and the police department for searching of artefact. The doors will be closed by using the servo motor. A servo system mainly consists of three basic elements: a managed computer, a feedback system, and an output sensor. This is a closed loop control device that is automated. Instead of using a variable input signal to control a device, the process is powered by a feedback signal created by comparing the output signal and the reference input signal. The primary task of a service company is to hold the output of a device in the presence of disturbances at the desired value. Compared with the traditional museum theft scheme that only inspects individuals at the entrance and exit. Such system has low level of accuracy and in the meantime the thieve can escape easily. The advantage of this proposed system will be that door closes immediately so that thieve can't escape and the theft and theft can be detected within short time and range.

RESULTS AND DISCUSSION

Use of RFID in museums can not only improve the security of artwork, but overall guest experiences as well. In order to stay relevant in the ever-expanding world of automation, museums are turning to RFID. In the experiment we checked whether the tag is valid or not, and to check this condition physically which means that is visible to naked eye we used a buzzer. Result of this experiment is based on two conditions, they are: i) If the tag is valid, then the buzzer remains silent and the door remains opened, ii) If the tag is invalid, then the buzzer will be activated and the door gets closed automatically, iii) And it can send out an alert to the security to take the action immediately without any delay. Review the recent thesis to understand the operation of a standard RFID scheme. Basic RFID consists of a transponder, transceiver and antenna. The antenna transmits radio signals to trigger the tag and to read and write data to it. Based on the radio frequency and power output used, the reader emits radio waves ranging from one to 100 inches. The RFID tag detects activation signals from readers when travelling through the electronic magnetic field. The tag sends radio waves back to the reader, driven by its inner battery

or by reader signals. These waves are received by the reader and the frequency is defined to produce a unique ID. The Reader then decrypts and sending information encoded in the embedded tag circuit to the computers for use. We also used Arduino along with RFID, which has the potential to crunch software as well as communicate through its input-output pins with the outside world.

CONCLUSION AND FUTURE WORK

The system's-built scheme meets the expected specifications, and the IoT technology-based museum anti-theft system is achieved. Museum protection systems have often been handy. The primary security systems used are old style locks and keys. Nowadays, close-circuit cameras are used. But they've got the downside of being pricey. Another thing that comes with them would be that people have to sit in front of monitors watching the feed continuously. The stealing of a valuable item would be undetectable if this was done while no one was watching or if the watcher failed to notice the incident. Adding another layer of protection to especially sensitive items will significantly increase their safety and decrease security lapses due to human error. When enabled, the proposed system is completely automated. It does not need anyone to stand guard continuously. And if an assault or robbery happens would the authorities be alerted. Without increase, it adds protection without increasing the work of the security tasked staff. Since the proposed system is unique to space and objects, when an alarm goes on, officials will immediately know where to concentrate their attention. As the device is relatively inexpensive, without a big investment in new equipment, it can add extra protection.

Future Scope of Work

Of course, the device has achieved the intended objectives, but further study and analysis are required with the constant progress and advancement of RFID technology. For the potential scope of the work, the following extensions are recommended: To enhance the protection of museum equipment, the discovery correctness of the hardware component of the device can be further enhanced. The RFID system has a restricted scope of detection that helps protect taken social substances and reply in time to apprehensions. But it needs more of this equipment for the whole museum, subsequent in an increase in total energy usage, power ingesting, and arrangement. Tags cannot be read well when placed on metal or liquid objects, or when these objects are between the reader and the sign. To enhance the protection of museum facilities, this extension should be resolved.

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Chapter 14
Telugu News Data Classification Using Machine Learning Approach

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ABSTRACT

Mining Telugu news data and categorizing based on public sentiments is quite important since a lot of fake news emerged with rise of social media. Identifying whether news text is positive, negative, or neutral and later classifying the data in which areas they fall like business, editorial, entertainment, nation, and sports is included throughout this research work. This research work proposes an efficient model by adopting machine learning classifiers to perform classification on Telugu news data. The results obtained by various machine-learning models are compared, and an efficient model is found, and it is observed that the proposed model outperformed with reference to accuracy, precision, recall, and F1-score.

INTRODUCTION

Natural Language Processing-NLP is a sub-extent of Artificial Intelligence that describes communications between computers and languages of people. Recently numerous individuals accept online multimedia platforms such as blogs, online shopping review websites, feedback forums, social networking sites – Facebook, Twitter, WhatsApp, Instagram, LinkedIn and so on to mention their opinions and perspectives on a particular thing. The *Sentimental Analysis* is a significant portion of NLP and is the study of analyzing opinions, sentiments, emotions, appraisals, evaluations and attitudes of human being on specific

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objects such as topics, products, events, firms, people, point outs, services and properties (Liu & Bing, 2012). It helps us in understanding the sentiments, in most cases the opinions. Document, Sentence, and Aspect/Feature level are three distinct levels of opinion mining can be applicable to text. These levels of analysis respectively evaluate the document-wise polarity, sentence-wise polarity in specified document and word-wise polarity of aspects in specified sentence or entire document.

Greater part of research in the field of opinion classification has been worked out in English language than the contribution of work for Indian regional languages. Indian dialects are mostly morphologically capable and agglutinative that creates job of producing specific tool for proficient language tricky and grave. Authors are concentrating on one of the territorial spoken language Telugu transcendently in Andhra Pradesh and Telangana states and exist approximately 93 million native speakers of Telugu all over the world ("List of languages by total number of speakers", 2020). At present majority of the sites, web journals, twitters and so forth, about news are wealthy in Telugu content. Hence there is a necessity to analyse the sentiments of news in Telugu language.

Data Mining techniques have been employed to natural language processing with some success (J.Sultana et al., 2019). Knowledge Discovery in Real time applications, for example, clinical analysis (J.Sultana et al., 2018, 2019) in business of marketing utilizing Association Rule mining (J.Sultana & G.Nagalaxmi, 2015) and system of education (Jabeen et al., 2019) require lean toward information disclosure ways to deal with comprehend the prediction algorithms. The initiation of learning machine and deep learning in the area of NLP was made arduous and troublesome assignment of preparing opinions simple and conveniently.

In this work, News in Telugu text translated into English by using *Google Translator* library available in Python. Finding sentiment score and labeling as positive or negative by using different tagging techniques. After that, attempted to classify the polarity value of Telugu news statements utilizing several Machine Learning classifiers namely Naive Bayes, Random Forest, Passive Aggressive Classifier, Perceptron and SVM (Support Vector Machines). The authors built two models for classifications: one is a binary-class and another is multi-class. In binary classification, the system classifies the sentiment as positive and negative polarities whereas in categorise(multi-class) task, the system furtherly classifies the sentiment into business, editorial, entertainment, nation and sports. Performed the results on test data through performance parameters.

Next, this paper is organised as sections as follows: Section II explains literature and related research work about NLP problems on Indian dialects. Section III explains the dataset description, translation and pre-processing of data. In Section IV, discuss the methodology by propose a frame work which includes feature selection, different classifiers and tools used, training & testing the data by using machine learning models and performance metrics. Section V discuss the results. Final Section VI conclude with future work.

LITERATURE WORK

Research analysts have exposed the attention of sentiment analysis with regards to Indian dialects, for example, Hindi, Malayalam, Telugu, Odia, Marathi, and so on. In Malayalam, the corpus is gathered from the Malayalam sites to do the sentiment classification. But, the most important problematic with corpus is user's feedback containing spelling mistakes which will enormously influence the accuracy of the analysis. A rule-based approach is proposed by Deepu S. Nair and Co. (Deepu et al., n.d.) on resulting

the sentiments either positive, negative and neutral of Malayalam movie reviews. Sahu et al. (Sanjib et al., 2016) suggested an empirical study on classifying Odia movie reviews using supervised classification techniques. A system has been developed to classifies the Odia text from Odia movie reviews as positive and negative sentiments by performing supervised learning methods. They have considered three supervised classifiers namely, Logistic Regression (LR), Naive Bayes (NB) and Support Vector Machine (SVM) and followed the framework NLTK to perform the task by developed program in Python.

Sarkar et al. (Kamal Sarkar et al., 2015) built up a system for sentiment analysis of Hindi tweets and Bengali tweets using the classifier Multinomial Naïve Bayes and used selection features are unigrams, bigrams and trigrams. For Telugu language, Naidu et al. (Reddy Naidu et al., 2017) proposed sentiment analysis in two-phase using Telugu SentiWordNet for Telugu e-News sentences. At First Phase, the sentences are divided into Subjectives and Objectives. Objectives don't have any sentimental value, so they are treated as neutral sentiment. In next phase, Subjectives are furtherly classified as positive & negative sentiments.

Mukku et al. (S.S.Mukku et al., 2016) proposed a frame work for Telugu sentiment analysis. Indian Languages Corpora Initiative (ILCI) provided raw corpus was used for preprocessing and to train the Doc2Vec model. Python module *Genism* provided a tool Doc2Vec for giving semantic representation of dataset sentence that have been used. Trained the system for classification by using ML (Machine Learning) techniques such as LR, NB, Decision tree (DT), Random Forest (RF), SVM and Multi-layer perceptron (MLP) neural network. Done the experiments on both binary and ternary sentiment classification.

Theoretical work on Telugu data and developed SentiWordNet. Others have done some basic classification algorithms and Classification on sentiments for Telugu text using various Machine Learning techniques. None of their data was made available to the public (Sandeep et al., 2017). Their approach follows the mix of methodologies such as handling negation effectively, feature selection by common info and word n-grams. Hence, this improved the accuracy. People working on Telugu depend on translators and traditional ML methods and word vectors because Telugu is a low-resource language. Many approaches were proposed to capture the sentiment in texts; each of these approaches addressed the issue at different levels of granularity. One of the authors (R.Naidu et al., 2017) built Telugu SentiWordNet on the news corpus to perform sentiment analysis tasks.

Both traditional Deep Learning (DL) and ML approaches compared for predicting sentiments on student's educational data. To observe that obtained the best outcomes by MLP (J.Sultana et al., 2018). And also, analyzed the educational tweets and classified as positive, negative and neutral classes by using deep learning methods (Jabeen Sultana et al., 2020a, 2020b).

Soman et al. (Saini Jacob et al., 2018) have been considered Five Indian languages namely Tamil, Malayalam, Telugu, Hindi and Bengali and compared the challenges encountered in the analysis of Twitter sentiments in those languages and English Language. The different challenges Sarcasm Detection, Thwarted Expression, Negation Handling, Scarce resource language, Subjectivity detection, Domain Dependence, Multilingual subjectivity detection, Microblogging data encountered in Sentiment Analysis of Indian Regional Language Tweets and English language tweets are reviewed to analysed. It concluded that Tweets in English language could be analysed for its sentiments with lesser difficulty when compared with that of Indian Regional Languages.

Badugu et al. (Srinivasu et al., 2020) used 2994 annotation review sentences on movies to pre-processed then classify these reviews using 3 machine learning algorithms are Support Vector Machine (SVM), Naive Bayes (NB), and Logistic Regression (LR) and shows the SVM had the best accuracy. Tammina

(S.Tammina, 2020, pp.1-6) employing Telugu SentiWordNet Lexicon based approach to identified the subjective sentences from the Telugu corpus and utilizing machine learning algorithms - SVM, Naïve Bayes and Random Forest to categorized the sentiment in the corpus.

Samuel et al. (Samuel et al. 2020) furnished a methodological evaluation of two vital machine learning (ML) classification methods, in the context of textual analytics, and compare their effectiveness in classifying Coronavirus Tweets of variable lengths. Observed a robust classification accuracy of 91% for short Tweets, with the Naïve Bayes method and the logistic regression classification method gives an affordable accuracy of 74% with shorter Tweets. Sudha et al. (D Naga et al., 2021) used semi-supervised learning methods to investigate the effect of n-gram feature selection on news article text classification. In that TF-IDF Vectorizer outperformed the count-based vectorizer to consider the value of a word in the text and proposed a model to compares three machine learning methods are Naive Bayes, Logistic Regression, and SVM for categorising Telugu news stories. This work shows that SVM gives the best results.

From this above literature, the authors thought of analyzing Telugu news sentiments using machine learning techniques.

DATASET DESCRIPTION, TRANSLATION & PRE-PROCESSING

Dataset Description

News acts as a vital aspect in exhibiting reality and takes a strong influence on social practices and a lot of news in Telugu generated has less attention within the Sentiment Analysis community. These reasons motivated to select news dataset. The Telugu News dataset was collected from Kaggle (SRK, 2020). This dataset contains total of 17312 document sentence heading in Telugu and the news statements belongs to five interesting zones as are taken class labels: business, editorial, entertainment, nation and sports.

Figure 1. Shows some of the instances of Telugu news dataset

heading	topic
ఐడిబిఐపై ఆర్‌బిఐ నజర్	business
బ్యాంకింగ్ చీఫ్‌లతో నేడు జైట్లీ భేటీ	business
కీలక వికెట్ తీసిన జడేజా..	sports
మరో రెచ్చగొట్టే చర్యకు దిగిన పాకిస్థాన్	nation
గోవాలో కొడుకుతో కలిసి అల్లు అర్జున్ స్విమ్మింగ్!	entertainment

Translation

The news statements in Telugu language translated into English by using GoogleTranslators API and removing the duplicate instances, unnecessary columns in the data frame which is needed to efficiently classifies this data.

Figure 2. Shows Telugu news heading converted into English

heading	Tidy_Tweets
ఐడిబిఐపై ఆర్‌బిఐ నజర్	RBI looks at IDBI
బ్యాంకింగ్ చీఫ్‌లతో నేడు జైట్లీ భేటీ	Jaitley met with banking chiefs today
కీలక వికెట్ తీసిన జడేజా..	Jadeja takes key wicket
మరో రెచ్చగొట్టే చర్యకు దిగిన పాకిస్తాన్	Another provocative move by Pakistan
గోవాలో కొడుకుతో కలిసి అల్లు అర్జున్ స్విమ్మింగ్!	Allu Arjun swimming with his son in Goa!

Pre-Processing

Pre-processing is an essential stage to remove noise data and to increase consistency so that the cleaned data can be applied to text mining or opinion mining task efficiently (E.Haddi et al., 2013). Above represented translated data was cleansed by removing extra spaces, extra new lines, quotation marks, and other garbage values. Later *Word Segmentation* is done where this data was split into individual words.

METHODOLOGY

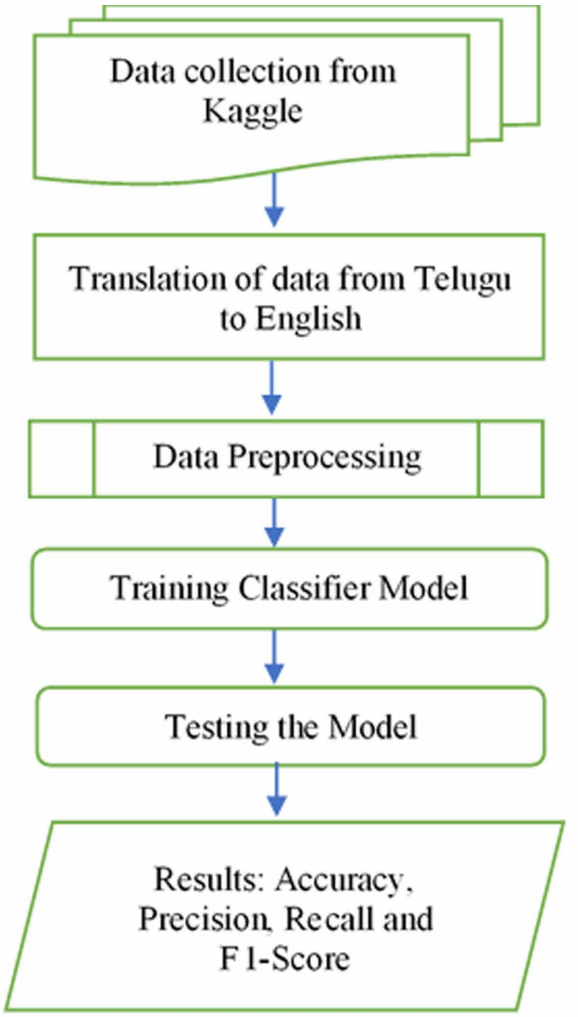
This section describes the proposed approach in detail and suggested frame work for analysing news multi-class sentiments as shown in Figure 3.

After translation and preprocessing of data, then need to select feature extractors for training classification models.

Feature Extractor

The task in ML and DL domain is necessity to take inputs in numbers for training and validating algorithms. The following two text vectorization methods are used to perform this task.

Figure 3. Frame work



1. Count Vectorizing (One-Hot Encoding)
   Count Vectorizing method represents words in numerical values as a vector. Each unique word of corpora has a unique dimension and will be represented by a 1 in that dimension with zeros elsewhere in a vector.
2. Tf-Idf Vectorizing
   Term frequency (Tf) Inverse document frequency (Idf) is a different way of converting words into numbers which is used to fit machine learning algorithms for prediction. Each unique word represents the value calculated by multiplication of their term frequency and their inverse document frequency.
   TF = Number of times word (W) appears in a document / Total number of words in a document
   IDF = log (Total number of documents / Number of documents with word (W))

CountVectorizer and Tf-IdfVectorizer are feature extractors has been used in this work to convert words of heading feature into numbers in the form of vector (or Matrix). These feature selectors provide

accurate output values to find opinion words in given statement and taken as bigrams and trigrams rules for combination of words. Then, Count vectorizer and Tf-Idf vectorizer generated word vector values feed into machine learning algorithms.

Classifiers

By using following machine learning approaches, to build a sentiment classifier model. Multinomial Naïve Bayes, Random Forest, Passive Aggressive Classifier, Perceptron and SVM: Linear support vector classification (Linear SVC) machine learning algorithms are used in this work. Each and every one of these algorithms has been worked on news dataset in *Python Jupyter Notebook* by importing ML built-in package *Scikit-learn*.

Naïve Bayes

Naïve Bayes is fast, uncomplicated and probabilistic classification technique that works on Bayes Theorem. More number of machine learning tools and NLP libraries including NLTK, Scikit-learn and Weka provides accessibility of Naïve Bayes classifiers. Specifically, Multinomial naïve bayes model (Rennie et al., 2003) useful to classification of whole document in NLP through feature vectors denoting the presence of each word in entire document or not. In this case of work, feature vectors generated by count vectorization and Tf-Idf weights to produce multinomial naïve bayes classifier to classify the news multi-class sentiments.

Random Forest

Random Forest is an ensemble classifier that built up with combining number of individual decision tree classifiers on randomly chosen subsets of dataset at the time of training and resulting class is *mode (averaging)* class. Each and every decision tree learned from arbitrary sample at training time and these samples of dataset will be used number of replacements to single decision tree is known as bootstrap method followed by Random Forest. This leads to improve predictive accuracy and control *overfitting*.

Passive Aggressive Classifier

The passive-aggressive (PA) algorithm is fast, easy implemented online learning algorithm to classify massive streams of data for example Twitter. Intuitive explanation is Passive: when correct classification occurred then retain the models; Aggressive: when misclassification occurred then modify incorrect classified samples. The algorithm will retain learning when the samples from same data generating distribution, but when the samples from entirely different level of distribution, then the weights will gradually *fail to recall* preceding one and learnt newly generated distribution (Giuseppe Bonaccorso, 2017). Scikit-Learn implements Passive Aggressive algorithm in Python used to classify news sentiments.

Perceptron

Perceptron is a supervised learning technique for binary classification that means to classify data (set of input signals) into two parts: “yes” and “no”. By using binary classifier function to decide whether

an input vector in numbers fits to appropriate class or not. It makes predictions on basis of a linear predictor function to combine a feature vector with set of weights. And also, this algorithm generalizes for *multiclass classification* to training data. Let, X as input and Y as output taken from random sets. A function f(X,Y) mapping I/O pair to a fractional valued finite-dimensional feature vector. Formerly, the feature vector is multiplied by a weight vector W. Again {\displaystyle {\hat {y}}=\operatorname {argmax} _{y}f(x,y)\cdot w.}Learning repeats over the samples, predict an output for each. Whenever the predicted outcome reaches the target then leave the weights unchanged, otherwise changed weights. Perceptron training mostly used in tasks like *part-of-speech tagging (POS tagging)* and *syntactic parsing* in an extent of NLP (Collins, 2002) . By using python library Scikit-Learn to import perceptron linear model over the news statements for classification. In this work sklearn.linear_model.Perceptron() class was used to train the model and assigned class_weight to 'balanced' mode so that it uses the values of y to automatically adjust weights inversely proportional to class frequencies in the input data.

Support Vector Machines (SVM)

Support Vector Machine is the most powerful machine learning technique primarily useful to classification of both binary and multi class analysis. SVM identifies the optimal decision boundary called hyperplane for segregating classes in dataset, that has a maximum margin between the support vectors (data points closest to optimal hyperplane). SVM helpful in text categorization, classification of images, Face detection etc.

Created the SVM classifier to linearly divisible data. Though, to alter it to arbitrary data. After that, to build the classifier model on training dataset. Now, the performance of the SVM classifier shown that how many wrong predictions occurred when compared with the other classifiers.

Training

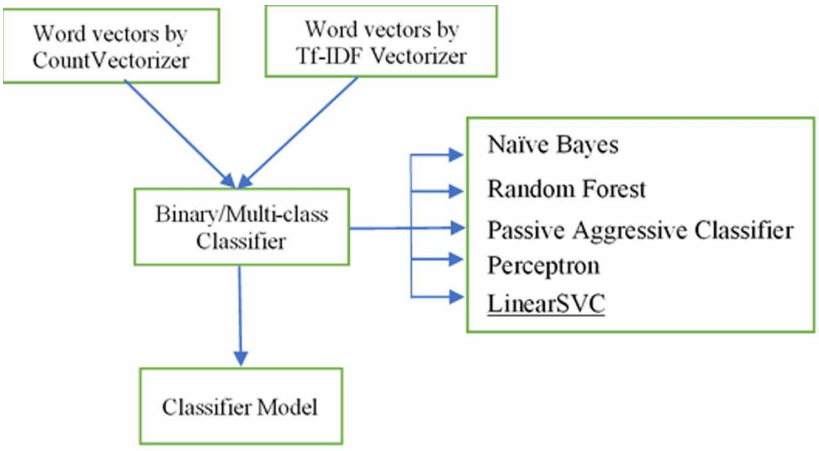
Above mentioned machine learning Binary/Multi-class classifier models are trained using word vectors generated by Count Vectorizer and Tf-Idf Vectorizer with their corresponding tags attached respectively. Evaluated the models by using machine learning classifiers with 10-fold cross-validation where the dataset is divided into train dataset and test dataset in the ratio of 80:20. Hence, the model obtained is chosen by given best performance results.

Table 1 Showing the summary details of the dataset that is the number of instances existed in the dataset used for training and testing by splitting the dataset. After pre-processing, to fetch 17169 records from total number of records 17312. In that, 15425 records were used for training, 859 instances for validating and 858 instances to testing.

Table 1. Showing the number of instances existed in dataset

Total no. of news statements	17312
After pre-processing no. of news statements	17169
No. of news statements for training	15425
No. of news statements for Validation	859
No. of news statements for testing	858

Figure 4. Training



Performance Metrics

After trained models obtained that an evaluation of the performance of these models be needed. By using confusion matrix analyse the accuracy of the models. A confusion matrix displays the actual and predicted classifications with True Positives (TP), True Negatives (TN), False Positives (FP), False Negatives (FN) values as shown in Table 2.

Table 2. Confusion matrix

		ACTUAL	
		Positives(1)	Negatives(0)
PREDICTED	Positives(1)	**TP**	**FP**
	Negatives(0)	**FN**	**TN**

And then to calculate the performance metrics are **Accuracy** is the number of correct predictions made by the model over all kinds predictions made, **Precision** (Positive predictive value) is the fraction of relevant instances among the retrieved instances, while **Recall** (Sensitivity) is the fraction of relevant instances that were retrieved and **F1_Score** is a measure of a test's accuracy calculated as the harmonic mean of the precision and recall.

Accuracy = (TP+TN) / (TP+TN+FP+FN)
Precision = TP / (TP+FP)
Recall = TP / (TP+FN)
F1_Score = 2 x Precision x Recall / (Precision + Recall)

The Table 3 explores the confusion matrix of the proposed model for Telugu news categorization along with Natural Language processing. The model categorizes the Telugu news into five different categories such as Business, Editorial, Entertainment, Nation, and Sports and shows their respective predicted values.

Table 3. Confusion matrix of Telugu news categorization

		Actual				
		business	**editorial**	**entertainment**	**nation**	**sports**
Predicted	**Business**	**94**	0	5	19	3
	Editorial	2	**12**	7	34	2
	Entertainment	6	2	**219**	20	4
	Nation	12	4	24	**300**	5
	Sports	1	1	8	12	**63**

RESULTS AND DISCUSSION

The results are evaluated with reference of Accuracy, Precision, Recall and F1-Score. Table 4 and Table 5 are showing the results while using Multinomial Naïve Bayes, Random Forest, Passive Aggressive, Perceptron and SVM: Linear SVC machine learning models on news dataset by using Count vectorizer and Tf-Idf with bigram features respectively.

Table 4. Results of multinomial NB, random forest, passive aggressive, perceptron and SVM

Parameters	Multinomial Naive Bayes	Random Forest	Passive Aggressive	Perceptron	SVM
Accuracy	76	69	78	78	**79**
Precision	0.77	0.69	0.77	0.78	**0.78**
Recall	0.76	0.69	0.78	0.78	**0.79**
F1-Score	0.74	0.67	0.77	0.78	**0.78**

Table 5. Results of multinomial NB, random forest, passive aggressive, perceptron and SVM

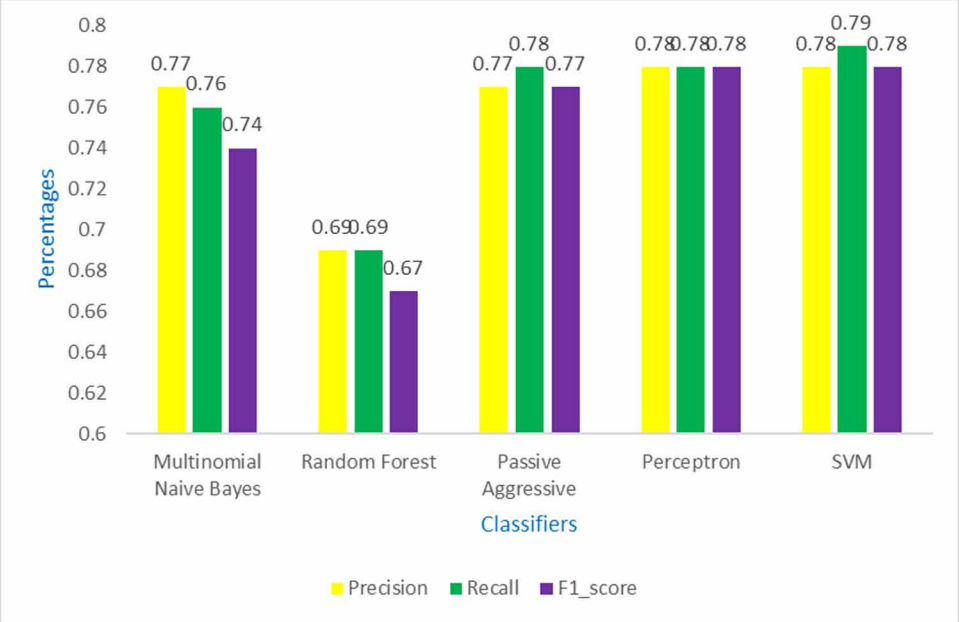
Parameters	Multinomial Naive Bayes	Random Forest	Passive Aggressive	Perceptron	SVM
Accuracy	70	69	**80**	77	78
Precision	0.77	0.69	**0.79**	0.76	0.77
Recall	0.70	0.69	**0.80**	0.77	0.78
F1-Score	0.65	0.68	**0.79**	0.76	0.77

Comparatively, Passive Aggressive Classifier algorithm attained 80% of highest accuracy value on vectorizing feature using Tf-Idf, whereas SVM scored 79% on count vectorizer feature, Perceptron scored 78% on Count vectorizer feature, Multinomial Naïve Bayes scored 76% on Count vectorizer feature, and Random Forest achieved 69% by using both features.

Figure 5 describes the comparison of accuracies obtained among the classifiers on news data. Figure 6. describes the comparison of Precision, Recall and F1_score obtained among the classifiers on news data.

Figure 5. Accuracy on news data by specified classifiers

Figure 6. Precision, recall and F1_score obtained by specified classifiers



CONCLUSION AND FUTURE WORK

The authors research work approaches the problem of classifying news sentiments in Telugu language using ML classifiers like Multinomial Naïve Bayes, Random Forest, Passive Aggressive Classifier, Perceptron and SVM. Dataset is gathered from open source platform Kaggle. Five sentiment classifiers have been proposed and Passive Aggressive Classifier achieved highest accuracy of 80% with Precision value 0.77, Recall value 0.78 and F1_score is 0.77.

Moreover, the authors will plan to make use of several pre-trained word embeddings such as Glove, Word2Vec, Doc2Vec to transform text into numerical values as inputs for understanding the sentence structure and semantics. And DL techniques viz. Recurrent Neural network – Long Short Term Memory model will be used to find the sentiments. Also, work can be extended to analyze the sentiments of Malayalam, Kannada, Tamil and Urdu news sentiments.

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Chapter 15
Performance Analysis of MCOD Algorithm With Varying Parameters

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ABSTRACT

Outlier detection has become one of the prominent and most needed technologies these days. Outliers can be anything in our daily life like credit card fraud, intrusion in a network, aberrant condition detection in condition monitoring data. There are numerous methodologies to detect outliers. In the past few years many tools have come up in the outlier detection in data streams. In this chapter, the authors discuss the tool MOA (massive online analysis) to detect anomalies and the best performing algorithm amongst the prescribed algorithms of MOA. The authors elaborately discuss that MCOD (micro-cluster-based algorithm) is one of the best in the prescribed algorithms of the MOA (massive online analysis) tool which outperforms all other algorithms. In this paper, the authors will deeply discuss the performance of MCOD algorithm. The authors will also discuss which factor of MCOD separates its performance from others and also what the different parameters that influence the performance of MCOD are.

INTRODUCTION

What is an Outlier?

An outlier is a data point that differs from significantly different from normal observations. It can be so because of the change in the measurement or because of the error in the experiments conducted. But an outlier can give difficult problems in any statistical analysis.

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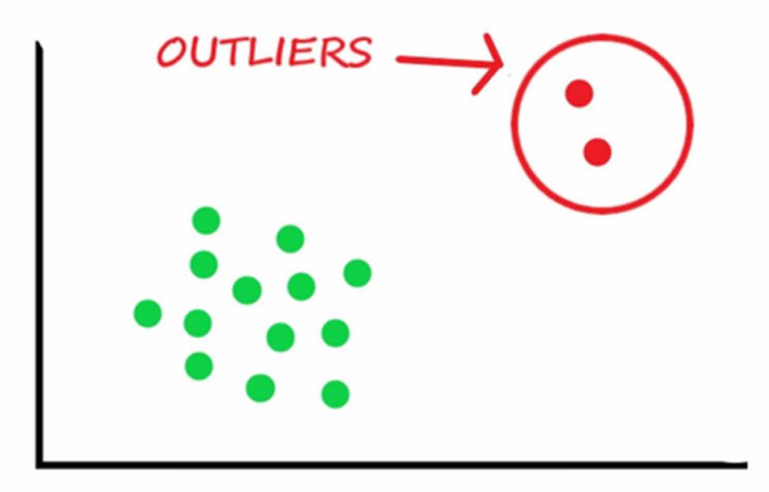
Figure 1. Example of an outlier



Not all outliers are the same. Some cause serious outbursts in the data, some have very strong influence on data and some are actually valid and significant values. For example take animal health monitoring data, there might be a situation where we observe that certain values are far away from the normal values, but actually the animal must be very healthy. So, there might be another reason that it generated that type of data or its usual in this case.

Therefore, we need a strong monitoring device which actually detects the outliers based on the pattern.

Now, let us see how many types of Outliers are there.

There are three basic classification of outliers

1. Global Outliers
2. Contextual Outliers
3. Collective Outliers

Global Outliers: An observation or a reading or a data point can be considered as a Global Outlier when it is found far away from the data set entirely.

Contextual Outliers: Any data point is called a Contextual outlier when it deviates from the rest of the normal data points. Sometimes these Contextual outliers can be inliers also based on the context. Usually time series data has Context outliers.

Collective Outliers: If a set of data points are deviating as a whole from the normal data points in the data set, then such data points are called as Collective Outliers. But, within themselves they are not called as Outliers or anomalies to each other.

There are several approaches to detect outliers like Machine learning Algorithms, Distance based Clustering, Statistical, Artificial Neural Networks etc. (Santoyo, 2017)

DATA STREAMS AND OUTLIERS

What is a Data Stream?

Any data which is generated sequentially, continuously, from any given source is called a data stream.

Figure 2. An example of a data stream

Data Streams can be any data flow generated by all types of data sources like Networking devices, Banking transactions, Time series data, GPS data etc. The applications that process this type of data streams need to process one packet at a time or one time stamp at a time.

There are two major functions the data stream processing applications should be performing:

1. Processing
2. Storage

Storage should be large enough to store humongous amounts of data in a sequential and consistent manner whereas the Processing should be able to communicate with storage and perform computations on the data.

Challenges in processing data streams:

Adaptability to Increase: There might be a sudden increase of the data flow because of some aberrant condition at the source. Therefore the data stream management system should be able to scale itself for large amounts of data coming from the source.

Sequence of the Data: In a data stream where there are several sources, imagine a scenario where there is no order to the arrival of the data packets. The packet generated a long time back reaches the data stream management system at the latest. This makes the job of keeping track of the sequence very difficult. Therefore, there should not be any scope of discrepancies in time stamps and clocks of the data generating systems. (confluent.io/learn/data-streaming/, n.d.)

Data consistency, Durability, Fault tolerance are few other challenges the data stream management systems will face.

DISTANCE BASED APPROACH TO DETECT OUTLIERS

The general idea behind the distance based approach to detect outliers is we judge a data point as an outlier if it is distantly far away from all other points in that dataset. Also, one more assumption is that

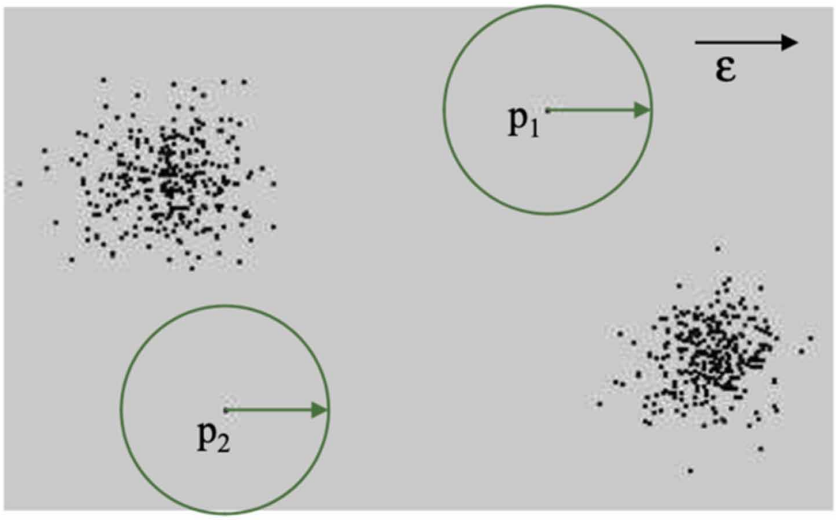
all normal points usually are densely populated and so outliers are far apart from neighbours and or have very less number of data points in and around its neighbourhood. (Lahoti, 2017)

The basic rule that distance based approaches is:

Every data point has a radius *r* around it. And there is a minimal distance ε within which the no. of neighbours are detected. The basic method proposed by Knorr and Ng 1997 is as follows

- Given a radius ε and a percentage and a percentage π
- A point p is considered an outlier if at most π percent of all other points have a distance to p less than ε

Figure 3. Visualisation of outliers



The algorithms in Distance based approach are categorised into following

- Index - based
- Nested - loop based
- Grid - based

Some of the Distance based algorithms are:

- General approaches
  - Naive approach: In this approach for each object, we compute kNNs sequentially scanning the each object
- Partition based
  - Allowing the partitioned Micro- clusters to prune those which do not qualify when searching for the kNNs of a particular data point.
- Nested loop

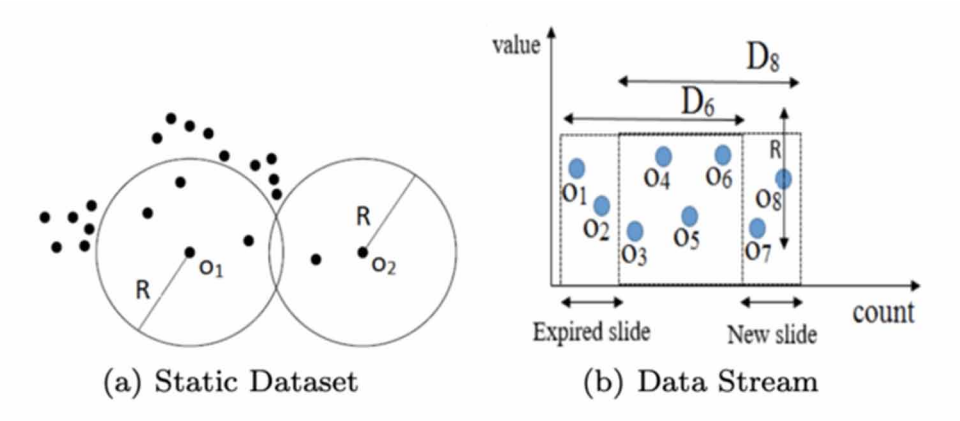
- A simple Nested loop algorithm (Ramasamy et al 2000) where kNN queries have index support.
- Based on the linear time complexity a partition based algorithm
- A simple kNN model

Likewise there are several distance based algorithms to find outliers. One such algorithm is MCOD - Micro Cluster based Outlier Detection algorithm

MICRO CLUSTER - BASED OUTLIER DETECTION MCOD ALGORITHM

As we are about to discuss the MCOD algorithm and its performance, one need to understand that the Distance based algorithms that are used to detect anomalies on static data are different from that of those used in data streams.

Figure 4. Comparison of static and data stream



As we are aware that data in data streams is always evolving and changing the algorithms that we use to detect outliers in static data are not effective.

Therefore, we have considered the algorithms like STORM, AnyOut, MCOD etc for our evaluation.

- There were a lot of studies that were carried on Distance - based Outlier Data streams. The recent algorithms in Distance based algorithms are
- COD
- MCOD
- Abstract C
- EXACT - STORM
- Anguilli - STORM

In this paper we discuss how MCOD outperforms all other algorithms listed above. A clear evaluation of all the algorithms taking the same dataset is shown.

- A comparative study of all the above algorithms
- The performance evaluation metrics we checked are processing time per object and memory usage.

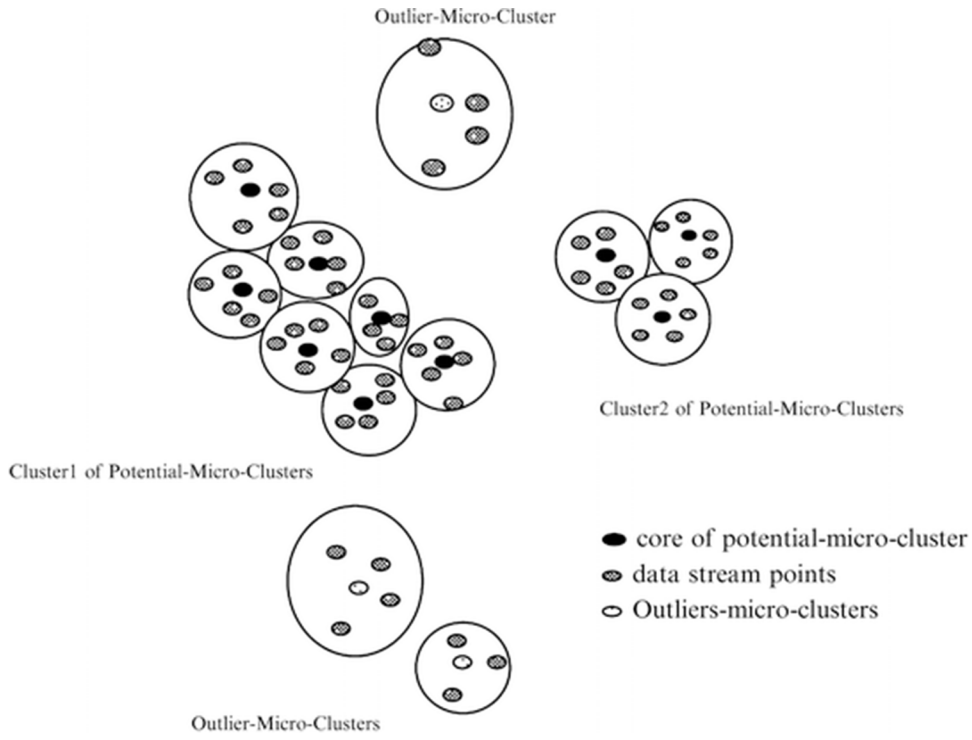
All the Distance based algorithms follow a similar pattern i.e, whenever there is a window slide, the following three steps are performed.

1. Processing the expired slide
2. Processing the new slide
3. Report the outliers

In the scenario of data streams, where there is large data carrying out range queries can be very costly.

The neighbouring data points are stored in Micro - clusters in order to eliminate the requirement of range queries in MCOD algorithm. Every Micro cluster should have minimum k+1 points. With a radius of R/2, a Micro cluster is centered at one data point. The distance between any given pair of data points in a Micro cluster is ≤ R according to the triangular inequality in metric space. That is why all the points in a Micro cluster are inliers. (Luan Tran, 2016)

Figure 5. Example of micro – clusters
Source: Amineh and Wang, 2011



Now, let us observe the above steps in accordance to the MCOD algorithm functioning.

1. Processing the expired slide: When the current window slides the data points that are expired are separated from micro - clusters and PD. The event queue is updated. If there are less than k+1 points in a micro - cluster then it is distributed and all the unexpired members are called as new data points.
2. Processing the new slide: There are three possibilities for a given data point *p* it can be the centre of its own Micro cluster or, it can be added to a Micro cluster, or added to the PD and the event queue. If *p* is located with a distance of R/2 to the centre of any nearest neighbour Micro cluster then it is added to that Micro cluster. Else MCOD sweeps the PD for any *p'*s which have distance of R/2 from the centre of any Micro clusters. If there are a set of (*k*) data points found around *p* then all those points along with *p* form a new Micro cluster.

If all the above possibilities are not happened then *p* is added to PD and event queue stating *p* as probable outlier.

3. Outlier reporting: After step 1 and step 2 are processed then all the data points in PD if are less than *k* data points are termed as outliers and reported.

If you observe the above Fig1.5 you can understand that some points are not in any of the Microculsters. They are called either outliers or inliers of a different micro - clusters. Such data points which have to be decided whether they are outliers or inliers are fed to a list P.D. An event queue to store ambiguous inliers or probable outliers is maintained by MCOD.

PERFORMANCE ANALYSIS OF MCOD ALGORITHM

Now, let us see the performance of MCOD in comparison with other algorithms. We used MOA tool to check the performance evaluation of the algorithms.

We have taken evaluation metrics like CPU processing time and total range queries

As you can see that when compared to other algorithms the processing time is significantly less than other algorithms. The parameters that are taken are *k*=30, Window size = 1000

Now, we will try and change the value of k to 70 and check the performance evaluation with other algorithms

The no. of range queries is comparatively less than other algorithms

The CPU processing time is also less than all other algorithms, when we have changed the k value to 70.

So, after observing the above graphs and the performance evaluation of MCOD we have identified that MCOD out-rates all other algorithms.

We further checked MCOD with varying parameters on various data sets and the following are the results we obtained.

Therefore, by observing the above graphs we understood that all the processing time values and range queries are less. So, we have concluded that MCOD outperforms all other algorithms with different values passed to the parameters like k and window size.

Figure 6.

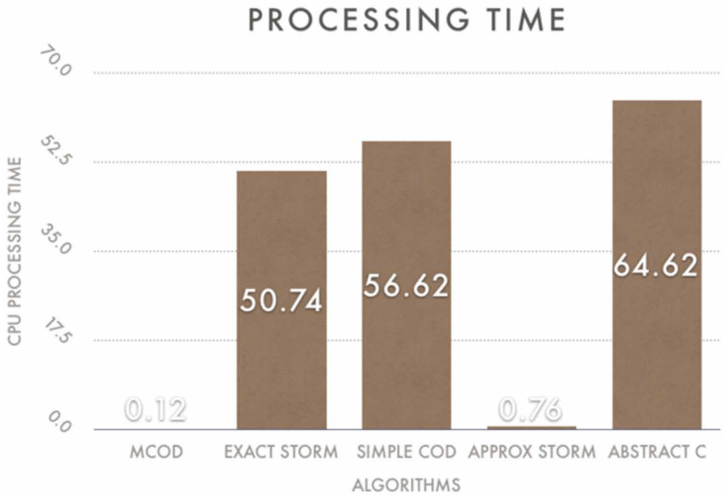


Figure 7.

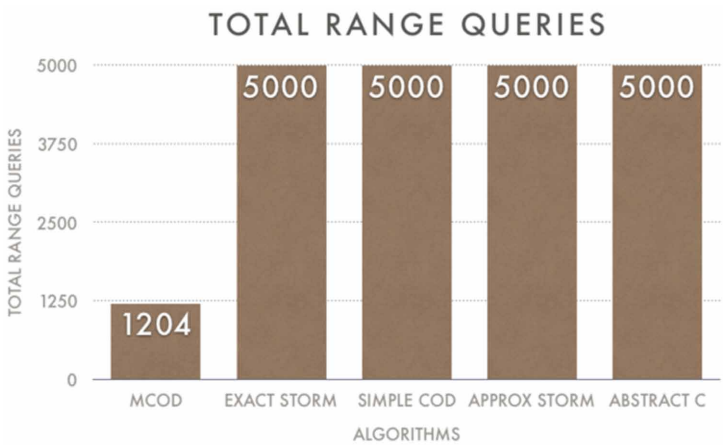


Figure 8.

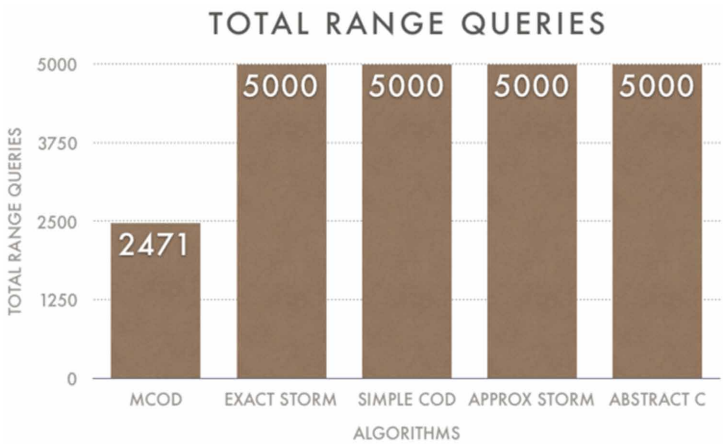


Figure 9.

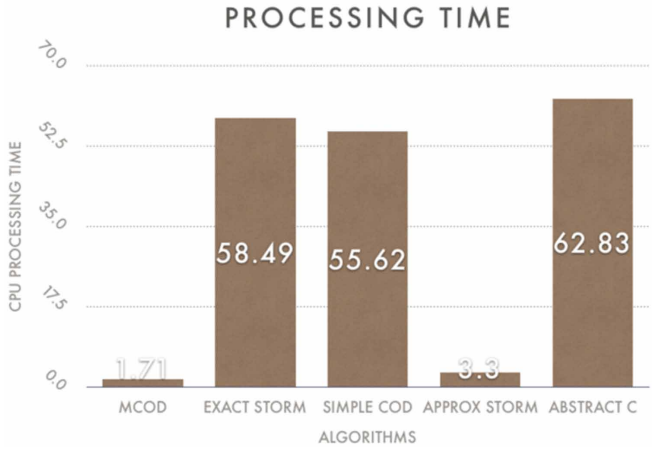


Figure 10.

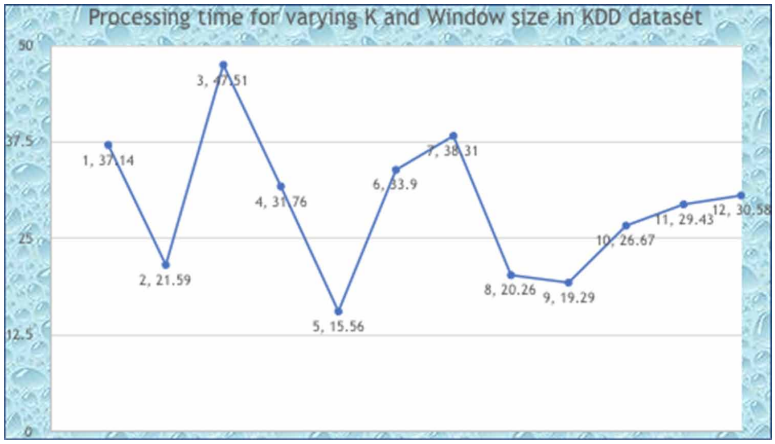
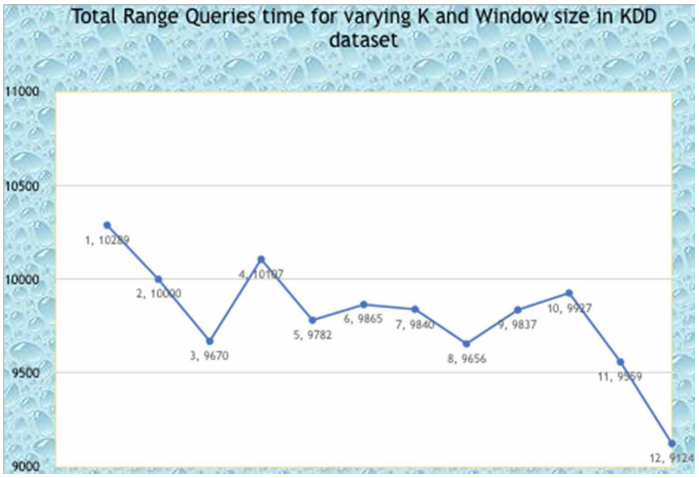


Figure 11.



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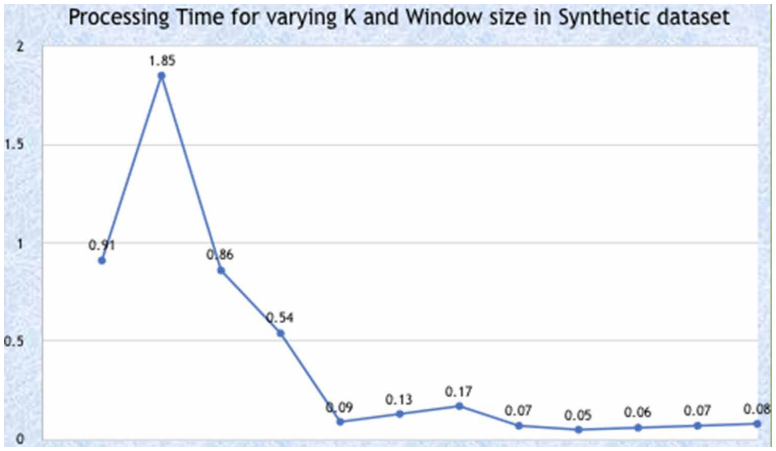

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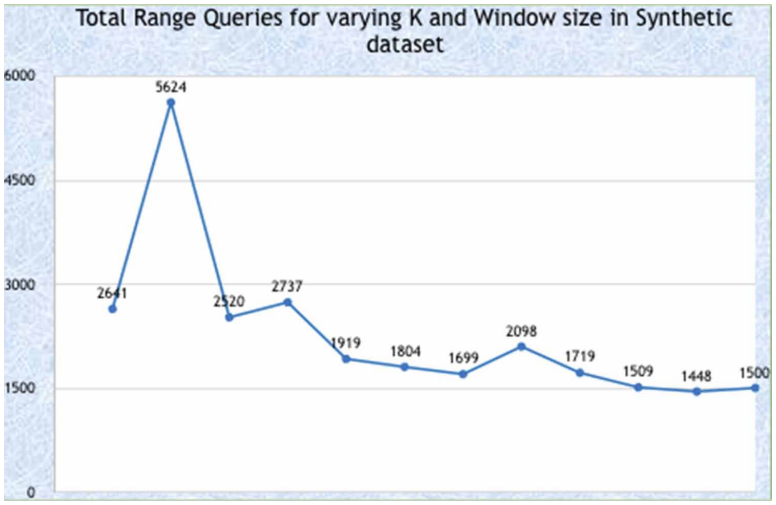


Figure 14.

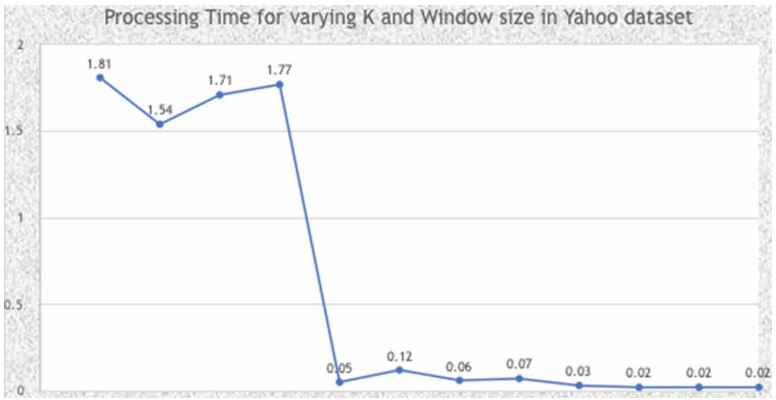
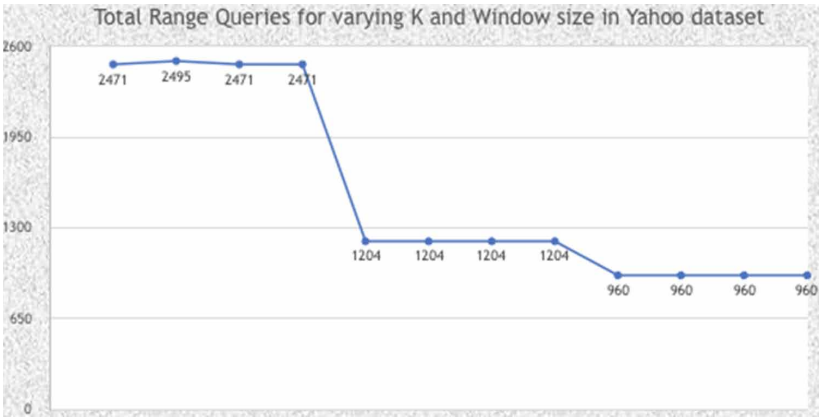


Figure 15.



CONCLUSION

We now conclude that in the set of Distance based Outlier Detection algorithms MCOD was the one that has given the best results. It can further be explored with the scope of considering the expiry time of Micro clusters when there is a window slide in MCOD to minimise the number of removed clusters.

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Chapter 16
Assessment of Electric Consumption Forecast Using Machine Learning and Deep Learning Models for the Industrial Sector

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ABSTRACT

Power demand forecasting is one of the fields which is gaining popularity for researchers. Although machine learning models are being used for prediction in various fields, they need to upgrade to increase accuracy and stability. With the rapid development of AI technology, deep learning (DL) is being recommended by many authors in their studies. The core objective of the chapter is to employ the smart meter's data for energy forecasting in the industrial sector. In this chapter, the author will be implementing popular power demand forecasting models from machine learning and compare the results of the best-fitted machine learning (ML) model with a deep learning model, long short-term memory based on RNN (LSTM-RNN). RNN model has vanishing gradient issue, which slows down the training in the early layers of the network. LSTM-RNN is the advanced model which take care of vanishing gradient problem. The performance evaluation metric to compare the superiority of the model will be R2, mean square error (MSE), root means square error (RMSE), and mean absolute error (MAE).

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INTRODUCTION

Machine Learning (ML) and its sub-fields like Deep Learning (DL) are contributing remarkably in the field of the energy sector. ML plays a significant role in predicting energy demand forecasting. The prediction of power load forecasting contributes to important factors, such as the energy capacity increase-decrease, distribution load for a specific time interval. An accurate demand forecasting of energy consumption helps energy providers to combat energy management and improves consumption efficiency during peak load hours efficiently. To forecast the energy demand, it is crucial to first estimate the current energy consumption. By the advent of Advanced Metering Infrastructure (AMI), it has become very easy to collect the usage data of each customer along with a detailed timestamp (Wang, Chen, Hong, & Kang, 2018). The data provided by AMI can be used for descriptive - current status; predictive-future aspects and prescriptive -solutions for energy management (Wang et al., 2018). Researchers are these days combining DL along with ML to forecast energy consumption with higher accuracy (Kong et al., 2017) (Yan, Li, Ji, Qi, & Du, 2019). These hybrid models are proving to be an efficient method to forecast the energy load.

Energy forecasting is basically divided into three ranges, namely; short term forecasting, medium-term forecasting, and long-term forecasting. There are various methods to forecast energy demand forecasting. The first method is physical methods. It predicts the result based on various weather conditions variables, like temp, humidity, wind speed, etc, along with electricity consumption. These values used as input to do the model and predict the output. These types of methods take a long time to collect the data and to process the result also. Secondly, statistical methods, predict the consumption based on the past consumption record of the energy along with the weather affecting variables. Some examples of the statistical method of predictions are Simple Moving Average (SMA), Auto-Regressive Integrated Moving Average (ARIMA). The third method is Machine Learning methods, which are becoming more popular these days. These methods give more accuracy on the prediction of the energy demand forecasting (Yang, Li, Gulliver, & Li, 2019). With the rapid development in the field of AI, hybrid algorithms are more in use.

There are many approaches to predict the consumption of energy by the customers. For accurate prediction, it is important to consider the consumption of the energy on an hourly, daily, weekly and monthly basis. A smart meter is one of the best ways to collect data concretely. It records the energy consumption after every 15 – 30 minutes timestamp (Wang et al., 2018). There are many classifiers and regressors used to predict consumption. In this paper, we will implement fundamental machine learning algorithms and a deep learning algorithm to compare the prediction accuracy. For energy prediction, the regression algorithm is being used as the data is of numerical type. One of the authors (Peng, Xu, Li, Xie, & Zhang, 2019) proposed a hybrid method with linear regression (LR) to improve the accuracy of the prediction in a real-time dataset with time-series. It gives a remarkably better accuracy as compared to the traditional method. Random Forest (RF) regression is another popular regressor used in electronic load forecasting. It evaluates the data with its iterative process of making various decision tress before giving a result. It traverses various time through training and testing data, before predicting the final results, hence gives better accuracy (Mukherjee, Mukherjee, Dey, De, & Panigrahi, 2020). Decision Tree Regression (DTR) is another traditional regressor which helps to decrease the problem of overfitting of the data (Bouktif, Fiaz, Ouni, & Serhani, 2018). After going through the literature for energy consumption forecasting, we decided to implement the traditional regressor such as Decision Tree Regression (DTR), Linear Regression (LR), and Random Forest Regressor (RF) and a deep learning model long

short-term memory (LSTM) model. The evaluation of the model performance will be done based on R^2, Mean Absolute Error (MAE), Mean Square Error (MSE), and Root Mean Square Error (RMSE). The same dataset will be implemented on Deep Learning Algorithm, long short-term memory LTSM neural network based on Recurrent Neural Network (RNN). LSTM is based on Recurrent Neural Network (RNN) and was initially developed by Horchreiter et al. in 1996 to recall weights that are forward and back-propagated through layers. LSTM-based on RNNs has gained popularity in research where time-series data is involved. It recognizes a complex non-linear pattern to provide end-to-end modelling and automatic feature extraction (Hochreiter & Schmidhuber, 1996).

This paper covers the implementation of ML and DL algorithms in real-time data collected from Himachal Pradesh State Electricity Board for the industrial sector. Smart meter data of consumption is collected from Jan'18 to July'19 with the timestamp for 84 industries in the time interval of 30 minutes. Section 2 of the paper presents a literature review related to the work done in the field of electric consumption prediction with ML and DL models. Section 3 of the paper elaborates on the methodology followed for the research work. Data description and LSTM model architecture are covered under subsection of section 3. Results and discussion for the research are covered under section 4 of the paper.

RELATED WORK

Fumo and Biswas (Fumo & Biswas, 2015), proposed a linear regression model for residential electricity consumption forecasting. Timeseries of the data are considered to see the performance of the model. Another model was also used to predict the daily consumption of energy by using multiple regression models in combination with genetic programming (Amber et al., 2017). They considered five variables after removing the unnecessary features and apply them in the proposed prediction model. But the correlation of independent variable creates a problem called multicollinearity, and hence not recommended for electricity prediction. Poojitha et al. also used a linear regression model to speed up the process before applying the ARIMA model. It took less time and resources for prediction as compare to ARIMA and LSTM (Amin, Poojitha, Ludmila Cherkasova, Rob Aitken, and Vikas Kache, 2019). Nikolas et al. (Paterakis, Mocanu, Gibescu, Stappers, & van Alst, 2017) also used LR from Scholt Energy Control, to predict the day-ahead consumption and electricity price of the Dutch Electricity Market. The evaluation metrics taken into consideration were RMSE, NRMSE, and MAPE. The linear regression gave competitive results as compare to other traditional ML models.

An approach based on the random forest was also proposed (Bogomolov et al., 2016), which forecast the subsequent week's energy consumption by using human dynamics. The RF model avoids overfitting by using an ensembled method and helps to decrease the computational complexity of the input data. A. Mukherjee et al. (Mukherjee et al., 2020), also used RF for short-term load forecasting models. The accuracy of the model was evaluated based on fitting sore and RMSE. This model gives the accuracy up to 89% and RMSE score of 0.2239, which is considered to be a competitive score. One of the authors (Bouktif et al., 2018), used RF as a testing benchmark for machine learning models to compare with LSTM, for short and long-term energy forecasting for companies. It gives a competitive score of RMSE as 0.98, which was best as compare to the other machine learning regressor.

In the present scenario, electric consumption prediction models are using deep learning techniques extensively. In reference (Kong et al., 2017), the author implemented a deep learning sequential model for predicting electricity consumption for residential buildings and predicted a very high accuracy. Boukfit

et al., make use of the LSTM-NN model to predict short to medium term aggregated load forecasting for companies' energy consumption. This model gives a higher performance as compared to the machine learning model. It used extra features along with the LSTM-NN model. The model is evaluated based on MAE (Mean Absolute Error) and RMSE (Root Mean Squared Error) for medium to long-range forecasting. LSTM with RNN variation is also used for time-series by considering the historical energy consumption data. S.Kumar et al. (Kumar, Hussain, Banarjee, & Reza, 2018) proposed LSTM with GRU (Gated Recurrent Unit) with three layers of RNN for time-series prediction of energy consumption. The RMSE evaluation metric is considered to rate the accuracy of the model. Fourteen months data was taken for a residential building where 12 months of data were considered for training and 2 months of data was for testing purposes. Nevertheless, the ANN model was also used for a considerable energy-forecasting task due to its model nonlinearity (Sundararajan, Hernandez, & Sarwat, 2020). According to a review done by Hippert, et al., there are various structures of ANN used to improve the accuracy of the model (Hippert, Pedreira, & Souza, 2001). Worth mentioning the most common structures exploited to improve the accuracy of the are the fuzzy neural (Papadakis, Theocharis, Kiartzis, & Bakirtzis, 1998) , wavelet neural networks (Bashir & El-Hawary, 2009), fuzzy wavelet neural network (Kodogiannis, Amina, & Petrounias, 2013) and self-originating map (SOM) and neural network (Fan & Chen, 2006).

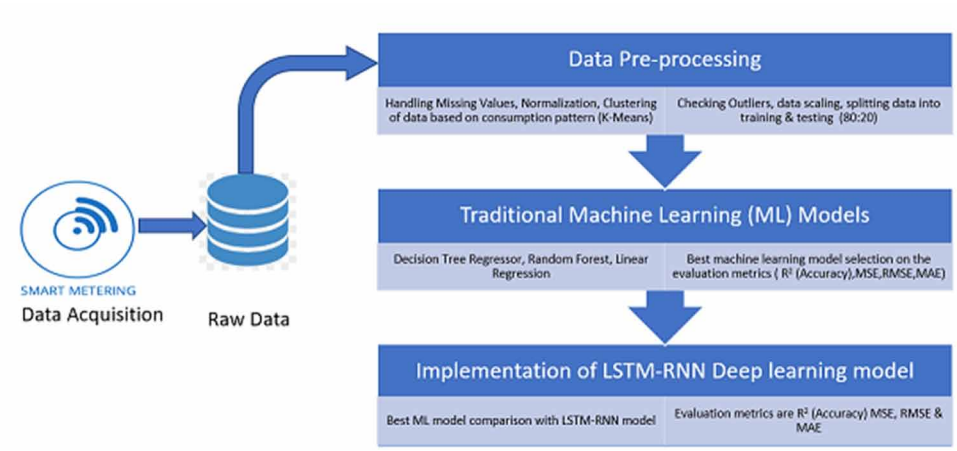
Machine learning models are being used for prediction purposes for a long time. While using machine learning approach, if model lacks features, it generates a very complex decision boundary. Sometimes the ML model gives overfitting problems. If the overfitting of the model is a problem, it greatly affects the prediction result. So, for better prediction of energy consumption and to overcome the above-discussed problem, there is a crucial need for improvement. From the above discussion we can conclude that by incorporating deep learning models, we can increase the accuracy and stability of prediction. In this paper, we will be using traditional machine learning models; Linear Regression, Random forest, and deep learning model LSTM-RNN to predict energy consumption by the industrial sector. Before, implementing the LSTM model, an introduction to the architecture of the LSTM cell is also discussed. The performance metric is MSE, RMSE, and MAE.

METHODOLOGY

Data Collection: The data acquisition process is the first phase of the methodology. Under this phase, the dataset used in the study is collected from Himachal Pradesh Electricity board for the period of Sep'18 to Nov'18. This is the energy consumption smart meter data at the granularity of 15 min from the industrial sector, Kala Amb, Himachal Pradesh. There are very few papers that extend the research towards the consumption of industrial sector data. Most of the research is based on energy consumption in residential buildings. The dataset was thoroughly reviewed to the seasonality, but it does not show considerable variation. So, the feature considered for the research is meter_id, timestamp (dd/mm/yyyy hh:mm:ss), and consumption in terms of kWh. Data collected was normalized and checked for missing values. Outlier detection was also conducted to scale the data properly. The total number of companies was 84. We clustered the whole data depending upon the total energy consumption into 4 clusters (Bhawna Dhupia, M. Usha Rani, 2020). For implementation, we selected 5 companies, one from each cluster and one company is chosen randomly. Total data samples from 5 companies used for analysis

are 43,200. Three features of the dataset are considered, meter number for identification, timestamp to consider the granularity of electricity usage and consumption of the energy in KW/H. Due to security purposes, the meter number is taken as M1 to M5. The dataset is tested with three traditional Machine Learning algorithms namely; DTR, RF, and LR and compared with a deep learning algorithm, LSTM for 3 months of data. Fig.-2 will elaborate on the methodology of the research in a better manner.

Figure 1. Methodology to compare the energy consumption prediction with machine learning models and deep learning models

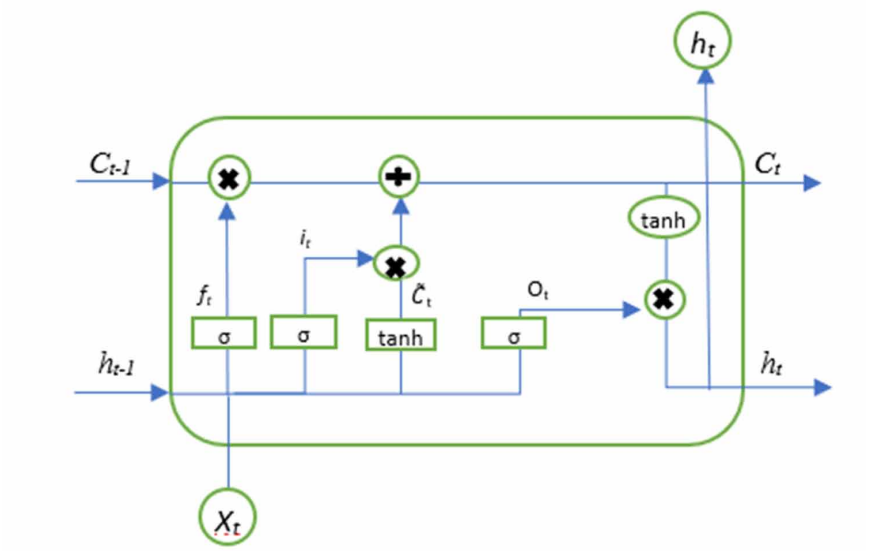


LSTM (Long Short-Term Memory) Neural Network

LSTM is a special kind of model based on RNN, which is capable of learning long term dependencies. In an LSTM model, four layers are interacting with each other in a very special way through the process. The LSTM can add and remove the information with the help of three gates. These gates are responsible to filter the information to pass through them. The combination of a sigmoid neural net layer and a pointwise multiplication operator make a gate. A sigmoid layer gives the result in 'Zero and Ones', to pass the information into the gate. Zero will not allow the information to pass on and one passes the information through the gate to the next level. The decision made by the sigmoid layer is called the "forget gate layer". This layer allows unwanted information to be removed from the memory.

The next step is to decide, the information that needs to be saved in the cell. In this gate, a sigmoid layer is called the "input gate layer" which decides the data to be updated in the cell. Each sigmoid layer contains the value in the range of zero and one. These values decide to pass on the data from the layer. An estimation of zero value denotes that nothing will pass through, on the other hand, one indicated that everything will pass through the layer. After that, a tangent hyperbolic *tanh* layer creates a vector of a new candidate value, which would be added to the state of the cell. After this step sigmoid layer and *tanh* layer combined to get a new state. Finally, the last gate called as "output gate layer" gives a filter version of the result. This layer exposes the final state of the cell. This layer generates a vector of probabilistic output values and the minimum error rate value is got selected.

Figure 2. Diagram LSTM cell architecture



The overall sequence of the LSTM process is defined as the recursive process applying on a function f to update the hidden state of vector h_t each timestamp t. The LSTM maintain a separate hidden memory cell c_t and three gating mechanisms as explained in fig.-1. In fig.-1 i_t denotes input gate at timestamp t, f_t and o_t denoted forget gate and output gate respectively. $\tilde{C}$ denotes the state of the cell and ó denotes the sigmoid function.

Performance Metrics for Evaluation: Generally, performance metrics for dataset evaluation are mean squared error (MSE), mean absolute error (MAE), root mean squared error (RMSE) and mean absolute percentage error (MAPE) [9]. MSE is the average of the squared difference between the target values and the predicted by the regression model. Another widely used metric is RMSE considered for regression analysis. It is the square root of the target value and the value predicted by the model. It penalizes the larger error terms and tends to become increasingly larger than MAE for outliers. MAE is the absolute difference between the target value and the predicted value. All these metrics are explained as the equation for better understanding:

$$MSE = \frac{1}{n}\sum\left(y_i - \widehat{y_i}\right)^2 . \tag{1}$$

$$RMSE = \sqrt{\sum_{i=0}^{n} \frac{\left(y_i - \widehat{y_i}\right)^2}{N}} . \tag{2}$$

$$MAE = \sqrt{\frac{\sum_{i=0}^{n}\left|y_i - \widehat{y_i}\right|}{n}} . \tag{3}$$

where $\widehat{y_i}$ is the predicted and y_i is actual energy consumption.

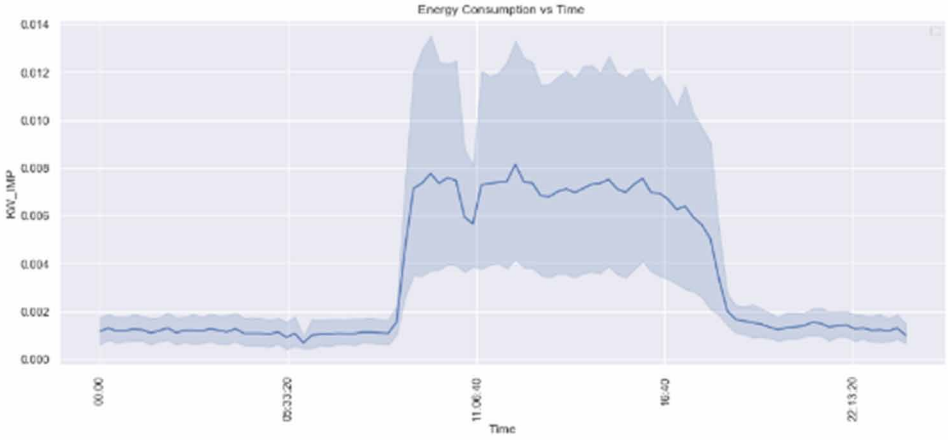
All the ML algorithms and LSTM-RNN are implemented in Python using googlecolab. Google colab provides 16 GB of RAM. It helps to process the data fast. The deep learning model LSTM-RNN was implemented using Python with Keras library using the TensorFlow backend. The data were divided into training and testing with a ratio of 80:20 respectively. For LSTM, data were processed using a sequential layer, Dropout, and dense layers as defined in the LSTM cell architecture. To make a powerful model, 2 dense layers were introduced. Dropout helps to avoid overfitting of the model, which highly affects the prediction. The evaluation metrics considered for the model were R^2, MSE, RMSE, and MAE. We compared the result of DTR, RF, and LR in terms of all the metrics. RF was found to be the best from all the traditional ML models. Then, LSTM results on all the metrics are compared with that of RF. After comparison, LSTM outstands the RF model. The detailed result of the implementation is shown and discussed in the subsequent section.

RESULT AND DISCUSSION

The best result based on R2 and RMSE is shown by LSTM-RNN on our data. We have clustered all the data collected based on energy consumption patterns. Four companies were selected from the four clusters and one is chosen randomly. The pattern of energy usage for all selected companies daily are shown figures 3-7

Figure 3-7 M1-M5 energy consumption pattern for a day. x-axis showing the Time Series and y-axis energy consumption kWh

Figure 3.



After this selection process, the data for three months is taken for further research. All the machine learning models evaluated on R^2, MSE, MAE, and RMSE for five different companies. R^2 gives the accuracy of the model after comparing the actual and predicted value by the model implemented. The following table gives a descriptive detail for each company:

Figure 4.

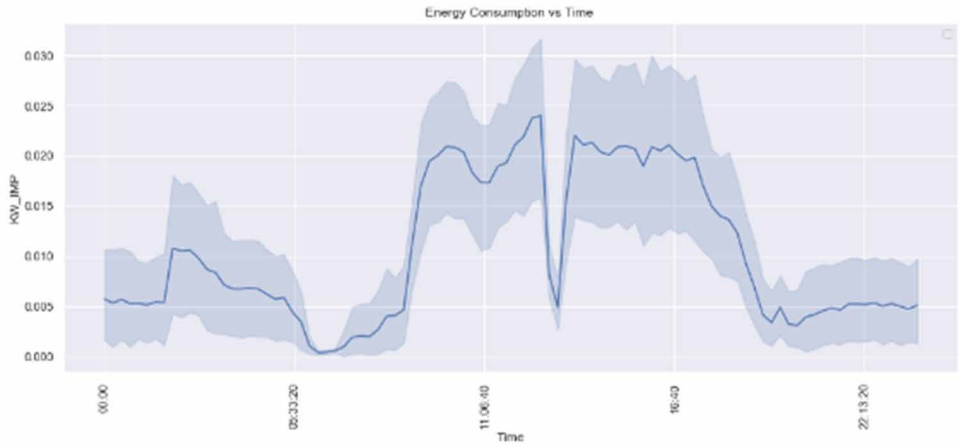
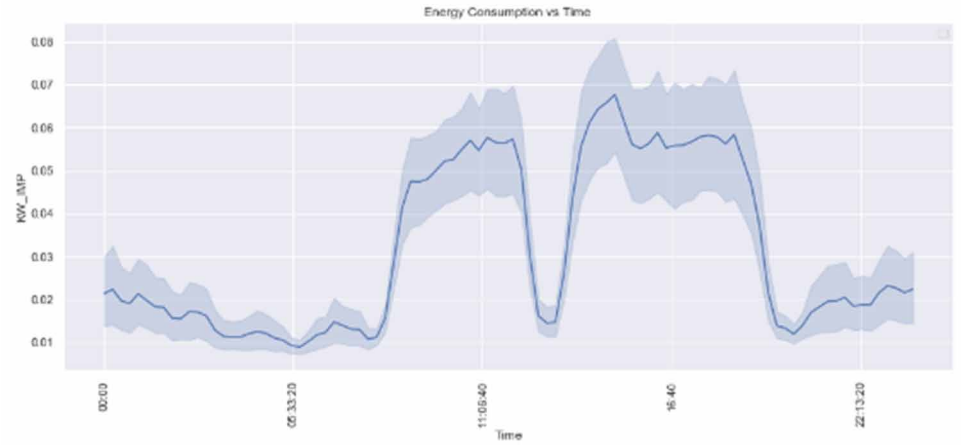


Figure 5.



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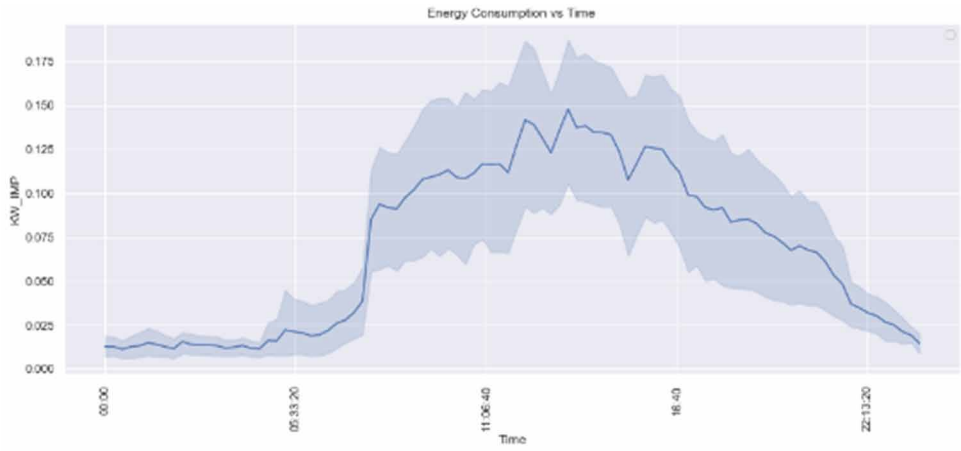


Figure 7.

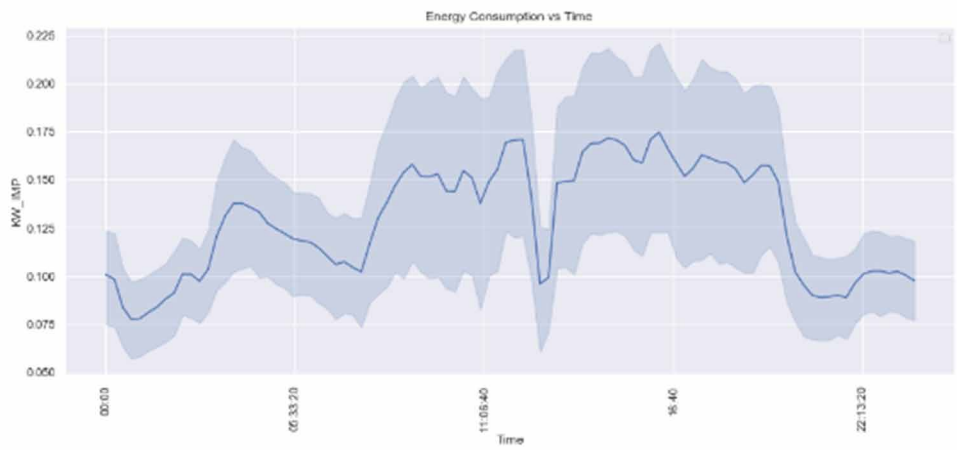


Table 1. Evaluation Metrics For Traditional Regressor Models For 5 Companies On 3 Models

Meter_id	Decision_Tress_Regressor				Linear_Regression				Random_Forest			
	R2	MAE	MSE	RMSE	R2	MAE	MSE	RMSE	R2	MAE	MSE	RMSE
M1	0.901	0.028	0.005	0.071	0.944	0.018	0.003	0.053	0.941	0.027	0.003	0.055
M2	0.827	0.056	0.012	0.111	0.870	0.051	0.010	0.098	0.886	0.476	0.008	0.090
M3	0.770	0.065	0.015	0.122	0.850	0.053	0.010	0.098	0.873	0.048	0.009	0.097
M4	0.911	0.049	0.008	0.088	0.923	0.044	0.008	0.091	0.953	0.360	0.004	0.064
M5	0.874	0.058	0.013	0.113	0.928	0.042	0.007	0.085	0.933	0.046	0.007	0.082

From the above analysis, it is discovered that the RF is the best model in terms of all the evaluation metrics. In some cases, LR is also giving competitive results. But DTR is not suitable for this dataset. R^2 gives you the result that how good is the prediction given by the model. Figur-2 visualizes the results of three models based on R^2. From table-1 it is evident that RF is the best-fit model on this dataset.

The best metric to evaluate the regression model is RMSE. The low value of RMSE denotes the best fit of the model. the square root of the variance of the residuals is denoted by RMSE. It indicates the absolute fit of the model to the data–how close the observed data points are to the model's predicted values.

From the above two comparisons, it is found that RF is giving the best results based on R^2 and RMSE. Now, we move forward with the implementation of the same dataset in the LSTM model. This is one of the most competitive Deep learning models being used by most of the researchers for the time series dataset. Here, we compared LSTM with RF as in first analysis RF proved to be the best among other models compared.

Table-2 is the result of the analysis done on the same dataset. LSTM model is implemented using 50 epochs with 2 hidden layers. The evaluation metrics are R^2, MAE, MSE, and RMSE. It shows a tremendous increase in all the metrics. The figure below shows the comparison of RF and LSTM based on R^2 and RMSE.

Figure 8. Comparison of R2 of 5 companies for competitive models

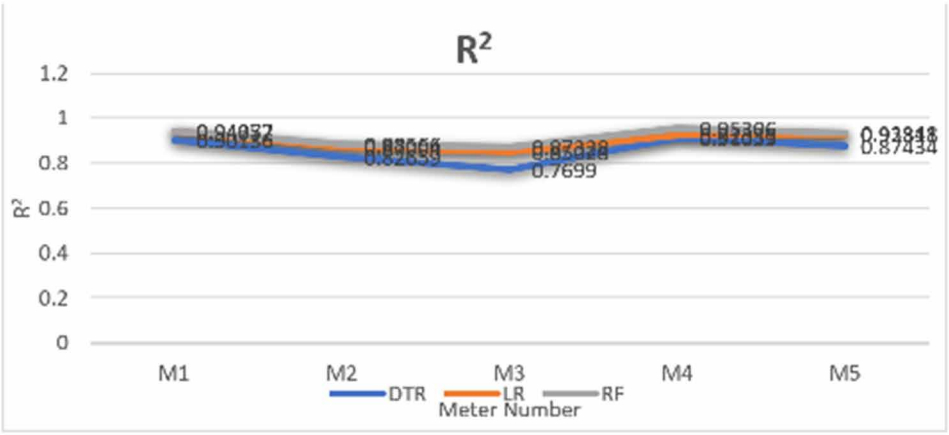


Figure 9. Comparison of RMSE for 5 companies based on competitive models

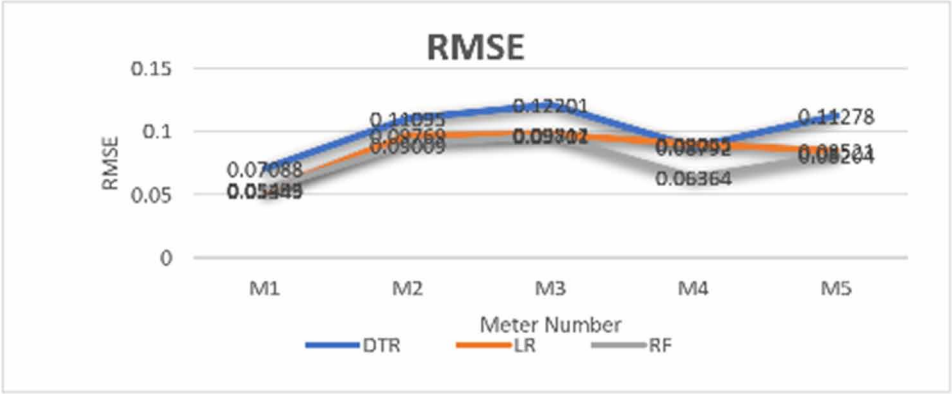


Table 2. Evaluation Metrics for LSTM Models for 5 companies

Meter_id	LSTM			
	R^2	MAE	MSE	RMSE
M1	0.961	0.009	0.001	0.023
M2	0.899	0.002	0.000	0.011
M3	0.885	0.008	0.000	0.014
M4	0.955	0.008	0.002	0.041
M5	0.931	0.014	0.001	0.025

Figure 10. Comparison of R2 of 5 companies for competitive models

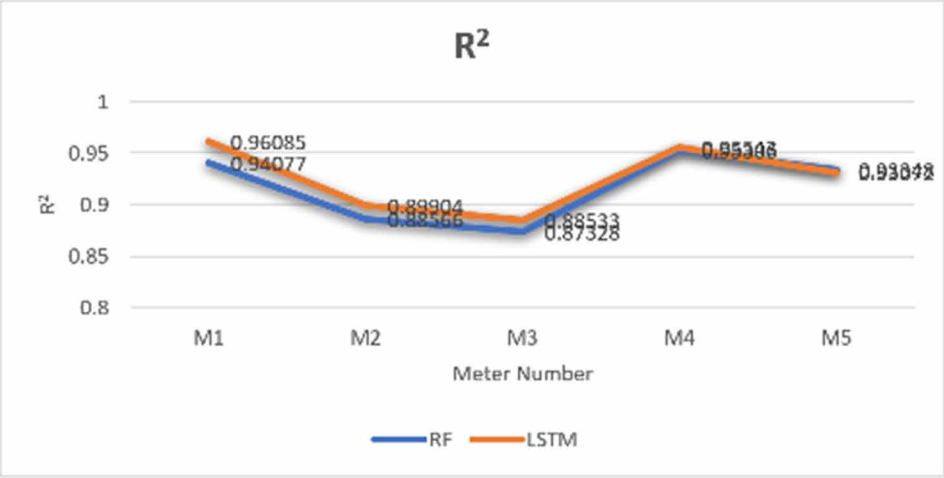
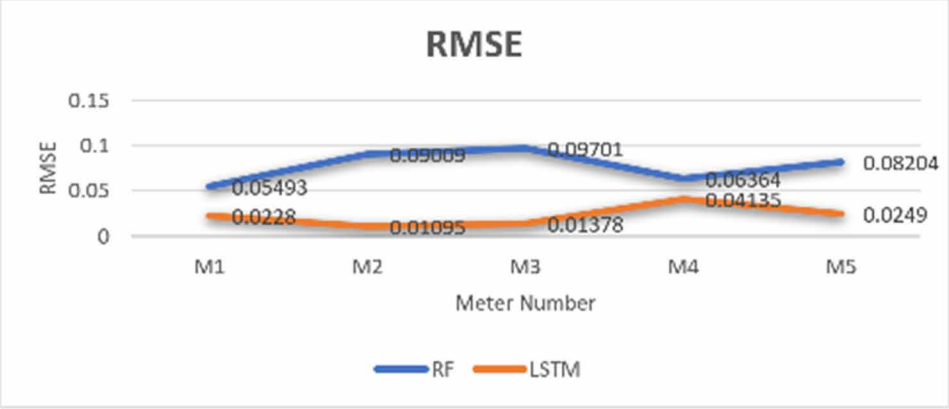


Figure 11. Comparison of RMSE for 5 companies based on two competitive models



It is clear from the analysis done, that the LSTM model shows more accuracy with very less RMSE score. In traditional regressors, RF also gives a competitive score but cannot overrun the LSTM deep learning model. Although when we compare the time complexity of the model, LSTM takes a little long but gives the better accuracy with less error percentage.

CONCLUSION AND FUTURE

For a sustainable energy system, accurate energy forecasting is an essential part. In this research, we took traditional machine learning models, LR, and RF for predicting the energy consumption for the short and medium-term. The evaluation metric considered were MSE, RMSE, and MAE. On all the metrics, the RF model proved to be the best in comparison with LR. RF gives a better accuracy rate with a very

less RMSE score. Deep learning models are very popular these days. They are being used in almost all the fields where prediction is required. In the next step, we compare the results of RF with one of the popular deep learning model LSTM-RNN for predicting energy consumption. The metrics to evaluate the model were the same as above. It was found that LSTM-RNN proved to be superior to all the metrics. So, we can conclude that while predicting energy consumption, LSTM-RNN is the best model to be used. LSTM-RNN proved to be the best model for predicting energy consumption forecasting. The research will further move towards employing various other LSTM model to improve the accuracy of the prediction such as GRU units with LSTM, Feedforward Neural network (FNN), LSTM with stochastic gradient descent technique, Backpropagation and CNN.

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