CHALLENGES AND OPPORTUNITIES FOR DEEP LEARNING APPLICATIONS IN INDUSTRY 4.0

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CONTENTS

PREFACE

The book aims to take the reader on a technological voyage of deep learning (DL) highlighting the associated challenges and opportunities in Industry 4.0. The competence of DL for automation and manufacturing sector has received astonishing attention during past decade. The manufacturing industry has recently experienced a revolutionary advancement despite several issues. One of the prime hindrances is enormous increase in the data comprising of various formats, semantics, qualities and features. DL enables detection of meaningful features that were far difficult to perform through traditional methods so far. The goal of this book ***"Challenges and Opportunities for Deep Learning Applications in Industry 4.0"*** is to present the challenges and opportunities in smart industry. The book also discusses the prospective research directions that focus on the theory and practical applications of DL in industrial automation. Hence, the book aims to serve as a complete handbook and research guide to the readers working in this domain. The target audience of this book will include Researchers, IT Industry, Research Agencies, and industrialists *etc*.

ORGANIZATION OF THE BOOK

The book is organized so as to include related rudiments and applications of deep learning in various industries *viz*. healthcare, transportation and agriculture *etc*. The book comprises of nine chapters. A brief description of each of the chapters of this book is as follows:

Chapter 1 discusses the Machine Learning Approaches to Industry 4.0. Inclusion of this chapter in the book augments the belief that Manufacturing plays a prominent role in the development and economic growth of countries. However, transformation in the Industry 4.0 also faces several challenges. Fortunately, Machine Learning can prove to be the essential tool and optimize the production process owing to its capability to respond quickly to the changes and market demand. Hence, it can predict certain aspects to improve performance and thus Machine Learning can prove its effectiveness by enabling 'Predictive quality and yield' and 'Predictive maintenance.'

Chapter 2 provides a comprehensive survey of IOT in Industry 4.0. IoT becomes a topic of paramount importance as we are entering into the new generation of computing technology where IOT plays a crucial role impacting the life around us in homes, healthcare, education, and transportation *etc*. There are more than 14 billion digital devices which are interconnected in the world in IOT which is more than twice the population of the world. IoT makes our lives more comfortable as it does not require any physical interaction between the machine and humans. IoT is widely used to exchange information either remotely or locally with the help of sensors. These IoT devices, then process the information according to their needs. The chapter provides an overview about the recent technologies in the field of IOT and discusses some of its very relevant applications. It also provides an opportunity for the young researchers to gather more and more information in this domain.

Chapter 3 discusses the scope of cloud computing in Industry 4.0 as it has transformed the traditional mass production model to mass customization model. The vision of Industry 4.0 is to make machines that have the capability of self- learning and self-awareness for improving the planning, performance, operations and maintenance of manufacturing units. This chapter discusses the fundamental technologies behind success of cloud computing in great detail. The chapter additionally presents numerous applications along with various issues and challenges.

Chapter 4 presents the Deep Learning Models for Covid19 Diagnosis and Prediction, a current pandemic that has shaken the entire world. The motive behind employing deep learning is its competence to improve the advanced computing power across the globe in various industries. In this chapter, authors provide a review of existing deep learning models to study the impact of artificial intelligent techniques on the development of intelligent models in healthcare sector specifically in dealing with SARS-CoV-2 coronavirus. Additionally, authors also highlight major challenges and open issues.

Chapter 5 presents a model for Air Pollution Analysis using Machine Learning and Artificial Intelligence. Here, authors focus on discovering patterns and trends, making forecasts, finding relationships and possible explanations, mapping different causes of Air Pollution in Delhi with various demographics and detecting patterns. During the implementation, some interesting results have been obtained related to COVID-19 pandemic.

Chapter 6 predicts the current trend using machine learning. The release of cryptocurrency like Bitcoin has started a new era in the financial sector. Here, authors examine the prediction of prices and the model predicts prices of Bitcoin using machine learning. The current work is described in detail in the chapter.

Chapter 7 performs a Bibliometric Analysis of Fault Prediction System using Machine Learning Techniques. Software fault prediction (SFP) is crucial for the software quality assurance process and is applied to identify the faulty modules of the software. Software metric based fault prediction reflects several aspects of the software. Several Machine Learning (ML) techniques have been implemented to eliminate faulty and unnecessary data from faulty modules. This chapter gives a brief introduction to SFP and includes a bibliometric analysis. This chapter can be beneficial for young researchers to locate attractive and relevant research insights within SFP.

Chapter 8 presents a COVID-19 Forecasting model using machine learning. The epidemiological dataset of coronavirus is used to forecast a future number of cases using various machine learning models. This chapter presents a comparative study of the existing forecasting machine models used on the COVID-19 dataset to predict worldwide growth cases. The machine learning models, namely polynomial regression, linear regression, support vector regression (SVR), were applied on the dataset that was outperformed by Holt's linear and winter model in predicting the worldwide cases.

Chapter 9 discusses the application of AI in agriculture as it has the potential to boost the social and economic wellbeing of farmers within the medium to long run. The study highlights that AI-based farm advisory systems play an immense role in solving the farmers' problems by enabling them to require proactive decisions in their respective farms. Various applications of Artificial Intelligence (AI in harvesting, plant disease detection, pesticide usage, AI-based mobile applications for farmer support *etc*.) have been discussed in this survey in detail.

Thus, the aim of this book is to familiarize researchers with the latest trends in deep learning ranging from rudiments to its applications in Industry 4.0.

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CHAPTER 1

Challenges and Opportunities for Deep Learning Applications in Industry 4.0

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Abstract: Manufacturing plays a prominent role in the development and economic growth of countries. A dynamic shift from a manual mass production model to an integrated automated industry towards automation includes several stages. Along with the boost in the economy, manufacturers also face several challenges, including several aspects. Machine Learning can prove to be an essential tool and optimize the production process, respond quickly to the changes and market demand respectively, predict certain aspects of the particular industry to improve performance, maintain machine health and other aspects. Machine Learning technology can prove its effectiveness when applied to a specific issue in the sector— such as filtering out the primary use cases of Machine Learning manufacturing specifically, 'Predictive quality and yield' and 'Predictive maintenance.' Supervised Machine Learning and Unsupervised Machine Learning may provide the accuracy to predict the outputs and the underlying patterns.

Keywords: Artificial Intelligence, Instance-Based Learning, Intelligent Manufacturing System, Machine Learning, Manufacturing.

INTRODUCTION

Currently, the automotive sector is prone to massive shifts. This shift is triggered by various increasing global innovations, such as globalization, urbanization, individual autonomy, and demographic shifts. However, the coming years will significantly challenge the industrial manufacturing environment [1]. Increasing

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Vaishali Mehta, Dolly Sharma, Monika Mangla, Anita Gehlot, Rajesh Singh and Sergio Marquez Sanchez (Eds.)

globally connected business operations, on the one side, will increase the difficulty within production networks. On the other side of the table, the production and scheduling procedures will also be affected by market conditions and customized products.

These demanding specifications will force businesses to adapt their complete production approach, including structure, processes, and product lines.

It is possible to trace the origin of manufacturing back to 5500-3500 BC. The term manufacturing or manufacture did not even reveal before 1567, even though manufacturing got emerging in 1683, about 100 years later [2]. The Latin terms' manus' and 'facere' means 'hands' and 'to make' respectively were used to generate the word. Both were merged in Late Latin to create the term manufactus, implying 'made from hand' or saying 'hand-made' in short. Indeed, the terms' factory' and 'production' were introduced, taking 'manufactory' as the base word. Manufacturing is described in its broadest and most specific sense: "The translation of objects into stuff" [3].

In the Collins English Dictionary (1998), however, it is described in more succinct terms: transforming or manufacturing any final product using the raw materials, particularly in a large-scale production utilizing machines and technology.

This description can be extended in a new sense: The produce, according to a comprehensive schedule, of goods from raw materials using various methods, machinery, activities, and workforce. The raw materials undergo adjustments during manufacturing to become such a component of a commodity or product. It must have a demand in the market and future, or the product's value must be worth it after processing. Production is nothing but' adding value' to the raw form of material. To make the company profitable and smooth running, the value-added as worth to the product by manufacturing is always required to be strictly higher than the production cost or manufacturing of the products. It is then possible to describe the additional value as increased consumer value resulting from a shift in the shape, location, or supply of the goods, minus the expense of the products and services involved.

Eventually, an organization's income is most often alluded to the added value or gross revenue, measured by deducting the sales revenue's overall expenses. Companies focused on this concept of value-added throughout the past. Companies have used executive benefit or reward programs.

One of the most critical aspects of today's production is increasing sophistication, expressed in manufacturing systems and in the goods to be produced, processes, and business's architectures.

A preliminary prediction from another study [4] can be applied to the idea of Intelligent Production Processes (IMS). IMS is identified in another seminal paper by its next generation of manufacturing systems, all of which were created to solve, within some limits, unparalleled, unexpected problems based on even imperfect and inaccurate knowledge, using the outcomes of AI technologies.

The concept of learning, which is most commonly quoted, derives from [5]: "Learning signifies improvements in performance that are adaptive in the context that they make the system the next time to perform certain tasks or activities taken from the very same group more efficiently." As described [6], we need modern computer technology concerning advanced manufacturing automation that could produce, log and retrieve data, ingest and encode information into knowledge and better reflect this knowledge to help decision-making. It should be stressed that knowledge is closely associated with learning, and an essential characteristic of IMSs must be learning capacity.

HISTORY OF ML IN MANUFACTURING

In 1983, looking at the critical steps in the evolution of manufacturing systems (ONC, FMS, CIM), Intelligent Manufacturing Systems (lMSs) were identified as the next generation that, using the results of artificial intelligence (AI) study are supposed to solve unprecedented problems within certain limits, even based on incomplete and imprecise knowledge.

Hatvany pointed to the absence of such AI strategies in this essay, which seemed indispensable for designing individual systems. In specific, there was a shortage of successful situational rehabilitation and learning skills.

The concept of learning most commonly quoted comes from [7]: "Learning denotes improvements in the system that are adaptive in the sense that they make the system the next time to perform the same job or tasks taken from the same population more effectively." As regards to advanced automated engineering, as described in [8], "we need modern computing technologies that are not only capable of generating, recording and retrieving information, but also of digesting and synthesizing information into knowledge and properly representing that knowledge to help decision-making."

It is required to draw concern regarding that knowledge is closely associated with literacy, where an essential characteristic of lMSs must be learning ability.

CHAPTER 2

Application of IoT–A Survey

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Abstract: Internet of Things (IoT) is surely a term that gives us the thought that everything is related to the internet. IoT is an assembly of machines that can share and transfer data. In this way, IoT can make our lives more convenient and easy because no physical interaction is required between machines and humans. As there are so many benefits of this technology there arise some challenges too. In today's scenario, humans rely very much on the smart applications of the IoT, which will affect our lives to the core. IoT is widely used to exchange information either remotely or locally with the help of sensors. These IoT devices can then process the information according to their needs and can take necessary steps as well. For example, IoT devices can sense the temperature and if the temperature rises above a certain level, they can act as actuators. This chapter provides us with an overview of the recent technologies in the field of IoT and to learn more about some of its very relevant applications. However, this document provides an opportunity for young researchers to gather more and more information about the Internet of things.

Keywords: Artificial Intelligence, Deep Learning, Internet of Things, Wireless Sensor Networks.

INTRODUCTION

Internet of Things (IoT) is an advanced technology that connects various computing devices or mechanical machines without any physical interaction among them by using wireless sensor networks. Internet of Things is a catchphrase in the world of computing. IoT can affix acumen in heartfelt global matters and connect it with another. Technologies such as Wi-Fi (Wireless Fidelity), Bluetooth, Wireless Sensor Networks, RFID (Radio Frequency Identification), *etc.*, have a significant impact on IoT services in making them reliable, accurate, and time-saving. IoT has observed significant employment in the world of healthcare. IoT also lends itself to smart monitoring and tracking system for patient's health, treatment history, diet plan, *etc.* [1]. Wearable fitness

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Vaishali Mehta, Dolly Sharma, Monika Mangla, Anita Gehlot, Rajesh Singh and Sergio Marquez Sanchez (Eds.)

bands enable personalized attention, including calorie count, variations in blood pressure and heart rates, *etc.* In a comprehensive view of all these, this chapter reviews the latest IoT based applications in the domain of the healthcare sector. Massive studies have been done for the exploration of different technologies such as Information Technologies (IT) in complementing and amplifying offered healthcare services in the present generation. In particular, the IoT has been extensively functional to interlock these checkup possessions and endow the more reliable, helpful, and smart healthcare assistance to the elderly and patients with a habitual illnesses [2]. Continuous evolution in the healthcare sector has led the way to the invention of wireless devices. Nowadays, a wide-ranging view of the patient's whole health preserve can be obtained through the prototypes of the next generation monitoring that has not only a look at the patient's health but also provides the prevention measures, diet plan for the patient, recovery state of patient's health, *etc.* IoT technology facilitates intercommunication that can alert the hospital personnel based on the patient's vitals in case of any emergency. It transforms the healthcare sector to be more efficient and economically feasible, and thus enhances the quality of service. Currently, the modern advancements in the healthcare field have resulted in a towering range of data which further needs more technologies to organize and use it in the best way possible [3].

Healthcare organizations take the services of technical persons and engineers to create a luring future in healthcare by inventing advanced equipment and thus, making this sector a more accurate and effective one. They are also very well allied with gigantic Internet-connected things/devices that engender vast amounts of data that can be used in different ways. An upper-level healthcare system outcome is the leading objective joint by hospitals, clinics, and health organizations across the world. Healthcare vitals collected through IoT drives the innovation of medicinal assistances in addition to cost reduction, precision improvement, and providing this ample butter of the healthcare advancements to more and more population.

Despite all these advancements in the healthcare sector, several problems have been unleashed during the current pandemic Covid-19. The best solution for this today is social distancing. This paper gives an innovative and needy solution promoting the idea of social distancing to prevent the spread of the pandemic. Here, a brief description of the methodology and working of this system is also given. We have also given some ideas for its applications keeping in mind today's requirements due to this outbreak.

IoT IN MANUFACTURING

Internet of Things (IoT) is a way to digital transformation in manufacturing. IoT employs a number of sensors to collect the data and uses cloud software to turn this data into valuable information. The main adoption drivers for the IoT include:

- **Cost reduction**. Due to optimized asset and inventory management, companies *reduce operational costs and create new sources of revenue.*
- **Shorter time-to-market**. Efficient manufacturing and supply chain operations allow reducing product cycle time.
- **Mass customization**. Tracking the inventory and the manufacturing operations is difficult and sometimes, it is not feasible. IoT is used to track a source of real-time data required for *shop floor scheduling and routing.*
- **Improved safety**. IoT addresses safety issues in potentially hazardous environments. It can be used in health care sectors, for instance.

IoT technologies are changing the way production systems are constructed and run, driving degradation in three ways: They are; visibility into shop floor and field operations, visibility into the manufacturing supply chain and visibility into remote and outsourced operations.

LITERATURE SURVEY

The internet of things helps the world to live their lives more comfortably and work smartly in both their personal and professional lives. With the revolution of technology in the past few years, IoT has completely changed the lives of humans, if it is getting the groceries sitting on your couch or ordering food from the restaurants while watching the T.V., or switching on our air conditioners before arriving at the houses or commanding 'Alexa' to inform us about the happening around the globe. OT has completely changed the way of our living and has made our lives so easy and comfortable that now we can't even imagine our life without it.

IoT [4 - 8] has been very useful for the business and corporate world as it provides companies to look more efficiently in the company's work chain and process of working. It helped a lot to take the work to a more automatic level rather than working manually, which significantly lowers the labor cost and wastage and thus provides efficient working in the manufacturing unit. IoT also provides better transparency to the customers as everything is working automatically, so there are always fewer chances of error and there is a proper record of every single product in the database [9, 10]. IoT has changed the market to a whole another level. In today's scenario, it is very difficult to survive if

CHAPTER 3

Cloud Industry Application 4.0: Challenges and Benefits

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Abstract: The latest advancements in the manufacturing industry due to ICT (Information and Communication Technologies) has promoted the wave of Industry 4.0 in today's world. This has transformed the traditional mass-production model into the mass customization model. The vision of Industry 4.0 is to make machines that have the capability of self-learning and self-awareness for improving the planning, performance, operations, and maintenance of manufacturing units. This paper analyses the fundamental technologies behind the success of I4.0, namely Cloud computing and big data analysis, in great detail. The Cloud is the heart of Industry 4.0. It is the primary enabler of innovative, more efficient, and practical strategies in business processes by using artificial intelligence, intelligent sensors, and robotics. It has additionally examined numerous applications where this concept is being used along with various issues and challenges.

Keywords: Big Data Analyses, Cloud Computing, Cloud Manufacturing, Cyber-Physical Systems, Digital Shadow of Production, Healthcare, Industry 4.0, Nine Pillars.

INTRODUCTION

An industrial revolution of the 18th century known as the 1st revolution marked the beginning of the steam engine. The 2nd revolution gave rise to the mass production epoch with industrial electrification. Information Technology (IT) with computers and embedded hardware resulted in the 3rd revolution in the 20th century. Now, the 4th revolution, which is marked by Industry 4.0, gives a novel organization hierarchy and control over the industrial value chain. It is embarked by using the potential of IT (Information technology) in various production processes to make everything digital. Since the 1st revolution, it is evident how technology has evo-

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Vaishali Mehta, Dolly Sharma, Monika Mangla, Anita Gehlot, Rajesh Singh and Sergio Marquez Sanchez (Eds.)

lved to make the manufacturing procedure more automated and sustainable for its easy and effective use [1].

With the worldwide integration of the industries and digital transformation, there is a paradigm shift from mass production to mass customization (MC). MC's production approach provides personalized products and services designed explicitly by modularized and flexible methods with the integration of supply chain members [2]. This focuses more on value creation than merely reducing the production costs by fulfilling the client's needs and increasing responsiveness. The fast evolution of IT, cloud computing, and the Internet of Things (IoT) have embarked on Industry 4.0 and Cloud Manufacturing, where the things (or machines) are interconnected but can communicate and analyze the data to make intelligent decisions.

The vision of Industry 4.0 is to make machines that have the capability of self-learning and self-awareness for improving the planning, performance, operations, and maintenance of manufacturing units [3]. Furthermore, it aims at developing intelligent manufacturing units for client-specific applications [4]. Data monitoring and tracking the status and locations of products in real-time are the basic needs of this industry [5]. CM is the latest service-oriented paradigm that works along the same lines as that of cloud computing. However, both of them represent different business theories but work for the same purpose. These new unfolding philosophies are connected, where Industry 4.0 takes up the concept of manufacturing as a service from CM, and CM borrows the idea of an intelligent factory from Industry 4.0.

Intelligence and digital transformation of manufacturing units is a new wave that has revolutionized the entire business. So, if you will not dive into it, you will be left behind. Therefore, for all industries, it is imperative to consider the new technologies and adapt their policies to comply with the expectations of the modern world. Ever since the evolution of the latest technology in the business world, businesses have never been more fickle. Digitization is all around us, whether the automobile industry is moving towards driverless cars or the consumer industry unfolding the various technologies in the form of smart homes. According to [6], approximately nearly 7 billion things were connected to the internet in 2014, and this number is expected to reach nearly 25 billion in 2020. Cloud computing is a pivot in all contemporary business companies and institutes. It means to get the computing services like storage, databases, networking, analytic, servers, and access to data all over the Internet rather than on your system. Furthermore, it provides the flexibility to offer a “pay–as–you–use” feature that allows the industries to pay for only those services that they have

used. This helps them reduce their operational costs, run their infrastructure more efficiently, and scale the business as per the requirement.

In India, cloud-based services have become omnipresent. This is so much that it is challenging for some businesses to manage their work without cloud computing. It is essential for small industries as it decreases operational costs and improves speed and accuracy. It helps the industry hold its position on a worldwide platform by providing them with software solutions, scaling, flexibility, big data analytics, and collaboration. Top Biggies also boast this concept, wherein they are using the culture of work from home that is only possible due to cloud computing. They also rely on cloud computing to store their crucial and critical data as it provides very high security.

Many industries have reached new heights by adopting cloud computing in their business processes. Many new technologies have evolved, but nothing could take away the strategic significance of cloud computing. It is the pivot of all technologies as it gives location and device independence, network virtualization, scalability, reliability, faster recovery, reducing ownership costs, offline accessibility, and many more. It has its footprints in all industries, whether entertainment, banking, or the marketing sector, by providing innovative and better services to the targeted clients. The cloud market is expanding very quickly and, as per NASSCOM reports, will reach $ 7.1 billion in 2022 [7]. On the other hand, we could see little advancement like wafting away modular and social software with low-cost hardware soon. According to many industrial reports around the world, it is believed that cloud technology is one of many technologies that are driving the fourth industrial revolution by providing innovative business ideas.

FUNDAMENTAL CONCEPTS

Industry 4.0 (I4.0)

Smart Factory, Factories of the Future, Intelligent Factories, or Industrial value chain Initiative are interchangeably for Industry 4.0. It is the digitization of production or manufacturing units with control over the value chain in the industry. It is marked by more automation, a digital and physical world collaboration by cyber-physical systems, customization of services or products, and a tremendous shift from traditional industrial systems to modern control systems. To fully understand this concept, one must know the entire value chain from the origin of raw material to supplier and things required for intelligent manufacturing and the ultimate destination of production units. In a nutshell, it led to the substitution of autonomous systems with cyber-physical systems either

CHAPTER 4

Uses And Challenges of Deep Learning Models for Covid-19 Diagnosis and Prediction

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Abstract: Recent advancements in artificial intelligence and machine learning, specifically in the domain of natural language and computer vision, involve deep neural networks. Deep learning technology is evolving rapidly to enhance the advanced computing power across the globe in every industry. The uses of deep learning technology are becoming more apparent as the amount of available data is increasing enormously. It is being used to solve numerous complicated applications in real life with surprising levels of accuracy. Besides all the benefits, the large-scale deployment of artificial intelligence and deep learning-based models has several associated challenges due to the huge and rapidly changing data and its accessibility to common people. In this study, the authors provide a review of existing deep learning models to study the impact of artificial intelligence on the development of intelligent models in the healthcare sector, specifically in dealing with the SARS-CoV-2 coronavirus. In addition to reviewing the significant developments, the authors also highlight major challenges and open issues.

Keywords: Artificial Intelligence, Covid 19, Deep Learning.

INTRODUCTION

Artificial Intelligence is gaining popularity in every domain. AI is becoming an essential part of our daily life with the emergence in the field of microprocessors that are available with high computational power and large memory. People are now able to perform complex tasks with personal computers, which were only

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Vaishali Mehta, Dolly Sharma, Monika Mangla, Anita Gehlot, Rajesh Singh and Sergio Marquez Sanchez (Eds.)

possible with supercomputers in the earlier decade. General-purpose GPUs (Graphics Processing Units) are the core of such complex systems with which authors can perform parallel processing in a combination of CPUs [1]. GPUs are capable of faster graphical data processing and are also used in scientific computing. Starting from very simple applications to very complex computing systems or decision-making devices, authors can see the usage of AI everywhere. A lot of toys are also designed and developed with AI technologies nowadays. Before detailing Deep Learning (DL), one must be aware of Machine Learning (ML). Machine Learning is a branch of Artificial Intelligence in which machines (or computers) are trained by providing a defined set of features extracted from given data or images. At the time of feature extraction, one needs to be extra cautious for selecting the features by which authors can train the machines and later on can be used for predicting the test data. However, Machine Learning works faster than Deep Learning, but there is a limitation that authors have to extract the features for ML and then only it will be working fine. On the other hand, Deep Learning accepts the images directly and produces results after making complex computations over the input. Deep Learning is a specialized branch of Machine Learning (ML) that requires fast computational machines and a large set of images for processing or making decisions. Not only for computer vision, deep learning algorithms are gaining popularity in Natural Language Processing, specifically speech recognition. Some of the powerful applications of deep learning technology include Automatic Text Classification, Automatic Translation of Text and Automatics Image Caption Generation. It works on the general data and is not dependent on any task-specific algorithm. Data itself makes the ways to provide the solutions to any problem. A high level of accuracy can be achieved with Deep Learning at the cost of specialized hardware consisting of high memory and computation speed [2].

Due to the continuous advancements in the field of artificial intelligence and machine learning, authors can see a significant improvement in the medical sector as well. There is a revolution in diagnosing, screening, prediction, medication, and treating several severe diseases. Covid19 is one such harmful disease that has been threatening the world since its origin. The researchers in artificial intelligence and data analytics are working day and night to fight this and develop a vaccine for its cure. Several models have been developed to reduce human intervention in the entire process, starting from disease diagnosis to final treatment. However, maximum models are not completely deployed to show their actual operation in real problems, but to tackle the SARS-Covid19 epidemic, they are still beneficial for healthcare professionals. But on the other hand, deep learning and machine learning algorithms for disease diagnosis and prediction are still vulnerable to various types of security attacks.

In this chapter, the authors present a study on different deep learning and AI-based models developed to fight the covid19 pandemic. Section 2 discusses the working of deep neural networks and the privacy issues involved in employing such models. In section 3, authors present a survey on the recent research in deep learning models for covid19 and other severe diseases. Finally, in section 4, authors discuss the challenges and issues involved in deploying such models and possible ways to minimize them.

WORKING OF DEEP NEURAL NETWORK

One can consider Deep Learning as Artificial Neural Networks (ANNs) that are designed by taking into consideration the natural human neurons. Artificial neurons are just like natural neurons that pass the signal to the next neuron in the body and, in turn, are used for making any decision or performing any action. Deep Learning is used in many application areas such as Image processing, categorization of images or patterns, speech recognition, predictions, decision-making, modeling, natural language processing, computer vision, and big data analysis [3]. Nodes in the network are connected in such a way that input layer nodes are connected with the first hidden layer nodes, the first hidden layer nodes are connected to the second hidden layer nodes, and so on until authors reach the final output layer nodes. Each connecting edge has some weight that is used to multiply with the input and summed at the node of the next layer. Then the summed value is passed to the Mathematical activation function so that error can be calculated easily at each node and then this error is minimized by changing the values of weights. In most cases, tan-hyperbolic or sigmoid activation functions are used. Each layer creates a mesh with the adjacent/next layer so that each input node will contribute to the generation of intermediate/final output from the nodes. Tan hyperbolic and sigmoid activation functions also play an important role in converting the range of inputs into a narrow range *i.e.*, -1 to +1 OR 0 to 1, respectively [4]. The output of the final layer is considered as the solution to the problem. A structure diagram of Deep Neural Network [5] is shown in Fig. (**1**) below:

Deep Neural Networks in Fig. (**1**) shows 8 inputs, 3 hidden layers of 9 nodes each, and 4 outputs. For Deep learning, the number of hidden layers may be greater than 150 and in some cases, it may be few thousand depending on the computation complexity of the network.

CHAPTER 5

Currency Trend Prediction using Machine Learning

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Abstract: The field of cryptocurrency has witnessed exponential growth in popularity in recent years. Almost ten years ago, the release of Bitcoin marked the beginning of a new era of innovation in the financial sector. In this work, we outline what exactly defines a cryptocurrency, describing fundamental concepts, underlying technologies such as the blockchain, and subsequently the viability of this new digital financial asset. Building on this knowledge, we examine the infamous volatility of cryptocurrency prices, analyzing pricing data and the likelihood of these currencies, specifically Bitcoin, being in the midst of a financial bubble. We examine the prediction of prices, or rather the inability to do so, before introducing the Currency Analyzer web application developed as part of this work. Containing up to date prices, this application predicts the prices of Bitcoin using machine learning. The research, planning methodologies, technologies, and design and evaluation of this application are described in detail in this chapter, followed by a conclusion and future scope.

Keywords: Bitcoin, Blockchain, Currency Trend, Machine Learning.

INTRODUCTION

There is no method to accurately predict the prices of any cryptocurrency. However, there are certainly trends in prices, which can be examined and attempted to forecast using various new technologies. Building on the information, we will now examine the applied element of this work: an application for displaying Bitcoin prices and predicting future values of Bitcoin. The prices of crypto-currency can be extremely unstable. For example, data taken from CoinDesk on April 12th, 2018, shows that in the space of one hour (11:00-12:00 GMT) the price of Bitcoin spiked from just under $7000 to just under $8000. There are countless occurrences of this happening throughout the lifetime of Bitcoin. Another example of this volatility is when the currency reached its

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Vaishali Mehta, Dolly Sharma, Monika Mangla, Anita Gehlot, Rajesh Singh and Sergio Marquez Sanchez (Eds.)

highest price on December 16th, 2017, of over $19,300, before plummeting to $13,800 a mere five days later - a drop of almost 30%. The sheer instability of crypto-currency prices and the rate at which they change determine there will never be a dependable method of predicting prices. However, one can consider a variety of things when considering buying or selling crypto-currency to determine if the time is right. It is important to clarify that the price is solely governed by demand, but there are indeed a great number of factors that may indirectly influence the price of crypto-currency.

Price of Bitcoin

Due to its popularity, the price of Bitcoin often affects the price of other crypto-currencies. One could argue that if the price of Bitcoin is affected by the same events as other crypto-currencies, its price will change in tandem with those of other crypto-currencies. However, the size and popularity of Bitcoin lead many to look to its data when considering buying or selling any crypto-currencies. For example, consider a sudden increase in negative media content related to Blockchain technology [1]. If the majority agree with the negative content, most of the market could decide to sell their investments. Bitcoin, with an estimated market dominance of 40-45%, also the majority, would subsequently decline in price. If most of the majority sold their Bitcoin, owners of other crypto-currencies would be likely to sell due to the majority of the market decline. By comparing graphed data of the prices of a given cryptocurrency against those of Bitcoin, it becomes clear that Bitcoin activity does have a bearing on other cryptocurrency prices. See Fig. (**1**) below, detailing the prices of Bitcoin and Ethereum over one week.

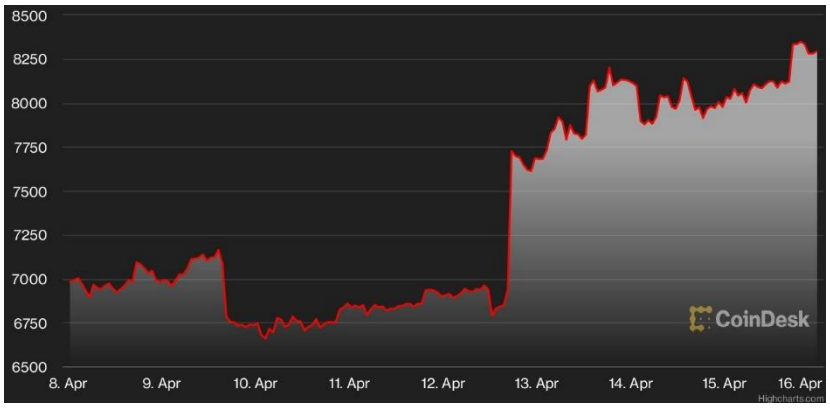

Fig. (1). Bitcoin and Ethereum Prices, Apr 8 - 15 2018.

While one could consider this pure coincidence, with a week arguably not being long enough to decipher any relationships between the two, the same can also be seen for a longer period of three months. Consider Fig. (**2**) below.

Fig. (2). BTC and ETH Prices, Jan 15 - Apr 15, 2018.

In both instances, the prices of both Bitcoin and Ethereum follow roughly the same path. Bitcoin prices can be seen to be much more volatile, rising and falling more severely and in shorter spaces of time than Ethereum prices. For example, one should consider the sharp rise in the price of Bitcoin shortly after April 12th, 2018, against the slightly more dulled rise of Ethereum. This can also be observed in the rise and fall of the prices from February to March 2018; the price of Bitcoin is seen to be more erratic, detailing many sudden increases and decreases. Ethereum follows the same general path with less sharp changes, implying that Bitcoin leads to increased buying or selling of Ethereum.

Background Information

The beginning of the rise of crypto-currency can be pinpointed in 2009 when the first major crypto-currency was released to the public. Much like traditional currency, any crypto-currency is an asset, designed to be traded in exchange for goods and services. Crypto-currency is based on cryptography, the study of breaking or creating codes and ciphers to either encrypt plain text or decrypt the ciphertext, to keep the exchange of digital information safe and secure. Based on Coin Market Cap figures, one of the most widely used websites for tracking the size and price of various crypto-currencies, there are currently just over 1500 cryptocurrencies in existence today, with some of the most popular being Bitcoin, Ethereum, Litecoin, and Ripple. When compared to the relatively small number of the 180 traditional currencies in circulation throughout the world, one might think

CHAPTER 6

A Bibliometric Analysis of Fault Prediction System using Machine Learning Techniques

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Abstract: Fault prediction in software is an important aspect to be considered in software development because it ensures reliability and the quality of a software product. A high-quality software product consists of a few numbers of faults and failures. Software fault prediction (SFP) is crucial for the software quality assurance process as it examines the vulnerability of software products towards failures. Fault detection is a significant aspect of cost estimation in the initial stage, and hence, a fault predictor model is required to lower the expenses used during the development and maintenance phase. SFP is applied to identify the faulty modules of the software in order to complement the development as well as the testing process. Software metric based fault prediction reflects several aspects of the software. Several Machine Learning (ML) techniques have been implemented to eliminate faulty and unnecessary data from faulty modules. This chapter gives a brief introduction to SFP and includes a bibliometric analysis. The objective of the bibliometric analysis is to analyze research trends of ML techniques that are used for predicting software faults. This chapter uses the VOSviewer software and Biblioshiny tool to visually analyze 1623 papers fetched from the Scopus database for the past twenty years. It explores the distribution of publications over the years, top-rated publishers, contributing authors, funding agencies, cited papers and citations per paper. The collaboration of countries and co-occurrence analysis as well as over the year's trend of author keywords are also explored. This chapter can be beneficial for young researchers to locate attractive and relevant research insights within SFP.

Keywords: Analysis, Bibliometric, Fault Prediction, Machine Learning, Scopus, Software engineering, Software metrics, Testing.

INTRODUCTION

Software engineering is concerned with discovering and implementing engineering methods in the development of effective and reliable software. The Institute of Electrical and Electronics Engineers (IEEE) describes software

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Vaishali Mehta, Dolly Sharma, Monika Mangla, Anita Gehlot, Rajesh Singh and Sergio Marquez Sanchez (Eds.)

engineering as "the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software; that is, the application of engineering to software" [1].

The increased demand for software systems has also increased the demand for good quality software. So, testing is a crucial stage of the software engineering process that assures a high-quality software product [2]. Software testing can depict the presence of errors in the software rather than showing its absence [3]. Testing software is a costly process as about one one-third to one one-half of the expense is spent on developing a project. Software testing plays a significant role in Software Development Life Cycle (SDLC).

The interests of software engineers in tasks of quality assurance like testing, verification, validation, fault tolerance and fault prediction are increasing in the domain of software engineering [4]. The software testing field has various issues, such as the generation of effective test cases and their prioritization, that needs to be tackled. These problems require time, effort and cost of the testing phase which can be tackled by different proposed techniques and methodologies. Out of the total, 6% of the respondents agreed that test automation can fully replace manual testing, while 45% of the total practitioners believe that modern test automation tools offer a poor fit for their demands [5].

Testing is done either manually or automatically with the help of testing tools and it is discovered that automated software testing is better than the testing of software manually and on the other hand, very few tools of test data generation are commercially available today [6]. The automatic generation of test data or test cases is done by various techniques such as neural networks, genetic programming, fuzzy logic, or evolutionary computation.

The modification of faulty modules requires more effort and cost once the software is developed. So, predicting the faulty modules at an early stage is beneficial as it reduces overall software costs [7]. The faults present in the software degenerate its reliability and quality, thus, leading the system towards failure. So, SFP is considered an important aspect because it enhances the software quality and efficiency to reduce cost and time. In SFP, the actions required to tackle the faulty module are developed before. The consequences may disrupt the original result of the software if the major faults are not solved for a long period [8]. SFP uses approximately 50% of the resources of software system development [9]. Therefore, fault detection is emerging as an essential prospect for cost and time estimation of the development process at an early stage.

Many strategies are available to predict whether the model is faulty or not. Among them, the most popular strategies are statistical strategies and machine

learning strategies. Machine learning strategies are more preferred than traditional statistical strategies because they give better results. Approaches to fault prediction are needed when the software company requires delivering a complete product well on time and within budget after testing it. Also, in the before-mentioned circumstances, recognizing and testing the faulty components of the system are reasonable. The prediction models are used for improving the quality of software by utilizing available resources. So, the basic aim of SFP is to increase the quality of the test process to detect fault-prone modules by reaching a state of highly dependable system [10].

Artificial Intelligence for Software Testing Association (AISTA) conducted a survey in 2017 to emphasize the demand for data specialists and AI engineers in the development as well as testing teams. At that moment, only 22% of the members of AISTA knew AI or ML technologies. Also, at the same moment, 76% of the members believed that AI can have consequences on manual testing in the upcoming three years [11]. ML will transform software testing as it makes judgments quicker based on more data. Also, no part of software testing will be left unaltered by ML [12].

Machine learning algorithms play an essential part in software testing by getting more accurate results and saving cost and time. ML-driven testing will commence a new age of quality assurance in the future. The product quality can be enhanced by using AI/ML techniques in the software development life cycle [13]. ML has many algorithms and techniques that can be used in the process of software testing. These techniques and algorithms are different from one another in terms of their working, implementation of mathematical and statistical models, features, assumptions, accuracy, advantages and disadvantages, and solving categories as if they resolve classification, clustering, regression, or other problems.

The cost and time of the testing phase can be reduced by fault prediction methodology. ML techniques can be used in SFP to make fast decisions on larger datasets. Techniques like Artificial Neural Network (ANN), Logistic Regression (LR), Decision Tree (DT), Genetic Algorithm (GA) and many more have been used to predict faults within the software. These techniques use software metrics like weighted methods per class, depth of inheritance tree, number of children, *etc.* Some probabilistic graphical models are used for optimization and prediction, such as Bayesian Networks (BN), Naive Bayes, Markov models with their extensions in dynamic BNs, Tree augmented Naive Bayes, *etc.* These models are used in monitoring product and system quality, predicting fault and identifying the faulty module within the software [14].

CHAPTER 7

COVID-19 Forecasting using Machine Learning Models

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Abstract: The global pandemic due to the novel coronavirus (2019-nCoV) is responsible for millions of deaths worldwide. It has been caused by a syndrome related to respiratory organs, namely Coronavirus 2 (SARS-CoV-2), believed to have originated in Wuhan. Pattern analysis of the spread of COVID-19 is critical to provide proper guidelines to the public for their safety and health. The epidemiological dataset of coronavirus is used to forecast a future number of cases using various machine learning models and validated concerning the complete count of globally present cases. The dataset has been compiled using different datasets from Johns Hopkins University, National Health Commission, and the World Health Organization (WHO). The prediction has been able to observe the total cases in 222 nations globally. This paper presents a comparative study of the existing forecasting machine models used on the COVID-19 dataset to predict worldwide growth cases. The machine learning models, namely polynomial regression, linear regression, and Support vector regression (SVR), were applied to the dataset that was outperformed by Holt's linear and winter model in predicting the worldwide cases. However, Facebook's Prophet Model gave the best results. The value of the Root means square error (RMSE) was observed to be 5387.741339, with the Mean absolute percentage error (MAPE) value and correlation coefficient calculated to be 0.0020933 and 0.99998, respectively. Hence, Facebook's Prophet Model is the most promising approach and this prediction of COVID-19 cases can be used for the risk evaluation and safety measures to be taken in corresponding areas globally.

Keywords: Confirmed Cases, COVID-19, Coronavirus, Forecasting, Pneumonia.

INTRODUCTION

The outbreak in December 2019 of a deadly virus similar to pneumonia leads to a life threat globally. The main cause was identified as the seventh member of Ortho Coronaviridae subfamily different in structure from the SARS-CoV and

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Vaishali Mehta, Dolly Sharma, Monika Mangla, Anita Gehlot, Rajesh Singh and Sergio Marquez Sanchez (Eds.)

MERS-CoV called coronavirus (2019- nCoV) [1]. On 12, December 2019, the Chinese Center for Disease Control and Prevention (CDC) recognized a recently developed pneumonia structure with the help of cell cultures and molecular techniques followed by testing that concluded that it was a non-SARS nCoV. This newly developed Coronaviridae family is responsible for causing colds and diseases such as diarrhea as it consists of big-sized, single as well as plus-stranded RNA viruses [2, 3]. The first case of coronavirus was reported in Wuhan's wet market, a province in Hubei, China, in December 2019, and the number of cases is increasing rapidly globally since then [4], causing the virus to spread from one human to another [5, 6]. The deadly virus was renamed Coronavirus disease (COVID-19), and the world-renowned World Health Organization (WHO) gave this name and on March 11, 2020, it was declared a global pandemic. The WHO released the situation report-106 on May 5, 2020, according to which there are 3,517,345 COVID- 19 cases and 243,401 deaths globally. There were nearly 84404 cases and 4643 deaths in China. With an increasing number of cases every day, WHO has declared COVID-19 as a global pandemic; hence it is vital to analyze the data and patterns to forecast the spread of the virus in a particular region and globally. This will help create awareness among the people, and the governments can take strategic measures to avoid its spread on a larger scale. It can lead the health and security officials to research more in this area to mitigate the lifetime effects of COVID-19. The total number of confirmed cases of COVID-19 from 29 April 2020 to 5 May 2020 have been highlighted in Fig. (**1**) [7].

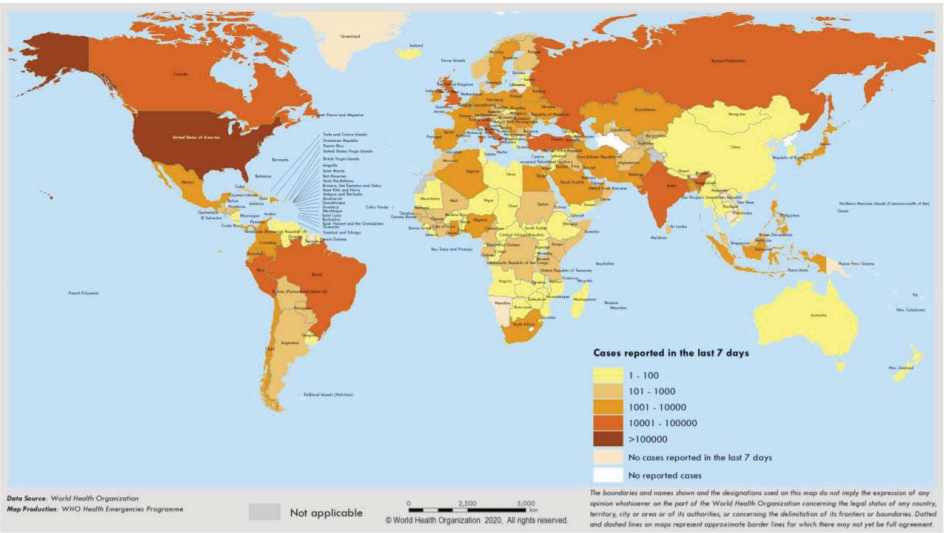

Fig. (1). Confirmed COVID-19 cases from 29 April 2020 to 5 May 2020 [7].

The term forecasting refers to a technique dependent on historical information for predicting the outputs to find out trends for the future. It is an essential task in data science. A particular company's goals or disease prevention depends on knowledge used for better forecasts [8]. A significant part of forecasting is to properly observe the time series for making reliable predictions enough for a better consideration of confirmed COVID-19 cases.

The following section describes the dataset of 222 nations used for the forecasting and various methodologies used to foretell the count of COVID-19 cases worldwide.

Dataset Description

The time prediction using the models of machine learning was observed using an open dataset of 2019-nCoV that has been contributed by Johns Hopkins University as a dashboard. It gathered nearly 222 nations' information and represented it in the form of 8 columns, and 21866 rows and graphs of total confirmed COVID-19 cases, recovery cases, deaths, mortality, and recovery rate. The university has also made this data accessible to the public in the form of Google sheets that have timely updates on the different cases [9]. The researchers could utilize this data for the analysis of the pattern through which the novel coronavirus spread. The prediction algorithms used the dataset from 22 January 2020 to 5 May 2020 for training. The dataset has been taken from the following link: https://doi.org/10.1016/S1473-3099(20)30120-1. Table **1** represents the column-wise description of the novel coronavirus dataset used for the prediction of COVID-19 cases.

Table 1. Description of the novel coronavirus dataset.

S.No.	Index Number
Observation Date	Date of the observation of COVID-19 cases
Province	Province/Location of observation
Country	Country or region of COVID-19 observation
Last Update	Time at which the data is last updated
Confirmed	Count of cases that are confirmed for a province or country.
Deaths	The number of deaths for a province.
Recovered	The number of recovered cases for a province or country.

CHAPTER 8

An Optimized System for Sentiment Analysis using Twitter Data

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Abstract: Progression in technology and innovation increases internet users, who post their perspectives on social media platforms regarding any product or service. It brings forth significant terms, *i.e.*,"feedback of users," termed as sentiments and plays a substantial role for commercial organizations to analyze and find polarity related to their respective services. In Sentiment Analysis, the feature extraction phase is a crucial one that affects the entire process's processing. In the case of high dimensional Real-Time data, it leads to a sparse feature matrix and gives rise to steady processing. In this exploration work, we have proposed an Improved Optimized Feature Sentiment Classifier for Big Data (IOFSCBD) System, which deals with advancing the classifiers by giving improved values in each sort of dataset. Results show better execution of the Improved Optimized Feature Sentiment Classifier for Big Data system System.

Keywords: Ant Colony Optimization (ACO), BAT, Big Data, Natural Language Processing (NLP), Particle Swarm Optimization (PSO), Support Vector Machine (SVM).

INTRODUCTION

Sentiment Analysis is when clients' opinions are altogether considered and deduced to a conclusion, *i.e.*, the polarity of views. It is a significant field as it is straightforwardly or in a roundabout way related to customers and has the principal role in each NLP field, *i.e.*, marketing intelligence text classification. Sentiment Analysis combines two definitions, "Sentiment" and "Analysis."The word sentiment represents a feeling that can be euphoric, cofounding, irritating, and distracting and based on certain attitudes and opinions and abstract nature sentiments [1]. The view implies an emotion usually motivated by a person's perception. The psychologists attempt to present a multitude of emotions classified into six distinct classes: joy, love, fear, sadness, surprise, and anger. The

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Vaishali Mehta, Dolly Sharma, Monika Mangla, Anita Gehlot, Rajesh Singh and Sergio Marquez Sanchez (Eds.)

emotions based on sadness and joy are experienced daily at different levels. We are mainly concerned with sentiment analysis detecting a positive or negative response or opinion [1]. The major significance of sentiment analysis is that every emotion linked to human perception forms an ingrained part of all humans which means that every human can generate different opinions acting as a tool for sentiment analysis. Sentiment analysis is defined as information extraction and natural language processing task to positively or negatively gain the writer's feelings based on requests, comments, and questions analyzing large datasets or documents. It means to define a writer's feeling about a specific topic based on the writer's own choice [2]. It models a branch that can provide a judgment over distinct fields. The measurement of sentiments is a biased technique with it is complex to achieve high accuracy of automated systems.

The term sentiment analysis (S.A.) is popularly known as opinion mining which is a process of emotion classification usually conveyed by a text that may be positive, negative, or neutral. The terms sentiment analysis and opinion mining can be used interchangeably [3]. This process is a part of text classification, which examines users' posts and concludes their sentiment. Positive sentiments concluded through words like 'wonderful, good', and negative sentiments concluded through 'rude and bad'. 'The Conclusion drawn by analyzing these posts can be useful for business purposes and marketing. This concept developed a unique research area for real-world text analysis problems. Lot of problems were encountered during sentiment analysis, *i.e.*, spam opinion or fake reviews, negation handling, domain independence and NLP overhead, Sarcastic or irony nature, and the last one is feature engineering. In Feature engineering, feature selection is a crucial stage where the main focus is to reduce the data dimensionality by discarding non-relevant features. In the latest research, lots of work was done using different feature selection protocols. In feature engineering, one of the significant problems is sparsity. This research work has developed a hybrid optimization system that deals with the same problem and utilizes machine learning algorithms.

LITERATURE REVIEW

The Literature review discusses the related work in the field of sentiment analysis. This section provides an insight into the origin, process, and different types of sentiment analysis, followed by the importance of social media in sentiment analysis. This section also shows the research done on semantic orientation also [4]. Sentiment analysis was introduced in 2001 when authors first used the process for finding the trend of small investors by using web sources. They designed a classification algorithm to classify the sentiments for better prediction. Some real-life categorization cases had the aim to find out the polarity. In such

types of problems, non-topic-based categorization methods failed. Due to categorization methods, it can't extract the meaningful output, *i.e.*, data's polarity. Thus, the need for S.A. merges intending to remove the polarity of classified data. In this research work [5], the authors have supported the same experimentally. They have taken movie review data that gives text polarity by classification and sentiments of texts compared to the topic's sentiments. The objective was achieved using supervised techniques, *i.e.*, Naïve Bayes, Support vector machine, Maximum Entropy, and feature extraction techniques like unigram, bigram, and combinations of both used and analysis. Experimental results showed that SVM is a better classifier. After this study, S.A. termed a classification problem that uses preprocessors, classifiers, feature selectors, and many more to complete the task. After being termed as a classification problem, more other researchers define S.A.'s objectives and decide S.A.'s hierarchy, and the same is explained in the following research. One important aspect related to S.A. is its relationship with opinion mining. In this research work [6], authors dealt with the same issue and briefly described the three components of opinion mining, *i.e.*, source, evaluation, and view related to opinion. In this research work, the focus is given on the representation of text and experimentally proved that it plays a major role by changing text's overall polarity. Thus, the need for sentiment emerges to extract the polarity of categorized or classified data. The author started to use supervised learning-based Sentiment analysis techniques to access data for different applications, *i.e.*, user reviews about the movie. With the emergence of new terms and technologies, *i.e.*, Big Data, Hadoop, Machine learning, it comes into play. Many social media platforms, *i.e.*, Twitter, review the product on online shopping portals, blogs, datasets, review sites, microblogging act as a rich source of data. Researchers expand the idea of S.A. on a large scale for better classification. Many social media platforms release their APIs for researchers to carry out research. The following section discussed research work, levels, and social media used in sentiment analysis. In this research work, researchers discussed S.A. levels and termed these levels as document, sentence, and aspect [6]. In this research work, the authors described how the internet and social network came into existence and proved a rich sentiment analysis data source. A comparative analysis of different data sources is achieved by a comparative analysis explained in the following research work [7]. Researchers performed a comparison between different social media, and the result, shows Twitter emerged as the most popular one to carry out research.

Now the problem arose: collecting the data from different social media. When different social media platforms release their APIs, they can resolve this. API's provide a strong foundation by collecting massive online data. Research showsTwitter as the most popular social media platform. The following research gives a detailed study of APIs, . Twitter released three APIs termed REST API,

CHAPTER 9

Applications of AI in Agriculture

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Abstract: AI based applications are used for farm-based advisories regarding sprays, forecasting, usage of drones within the farms, infrastructure for humidity and temperature updates to the farmers, *etc.* Thanks to this, the losses of farmers have begun to decline. Therefore, considering the aims of the government regarding doubling the farmers' income, the losses of the farmers must be minimized using AI practices. AI intervention has the potential to boost the social and economic well-being of farmers within the medium to long run. The adoption of AI is useful in agriculture as it can bring industrial revolution and explosion in agriculture to feed the growing human population of the world. The study highlights that AI based farm advisory systems are playing an immense role in solving the problems of the farmers by enabling them to require proactive decisions on their respective farms. Various applications of Artificial Intelligence (AI in harvesting, plant disease detection, pesticide usage, AI based mobile applications for farmer support *etc.*) have been discussed in this survey in detail. Finally, the overview of Deep Learning and its application in agriculture is given.

Keywords: Agriculture, Artificial Intelligence, Deep Learning, Machine Learning, Pretrained Models, Transfer Learning.

1. INTRODUCTION

The worldwide population will be more than nine billion by 2050, requiring growth in horticultural creation by approx —70% to satisfy the needs. Nearly 10% growth in creation may be originated from accessing new terrains & for the remaining 90%, we need to improve our current creation. In this scenario, utilizing the most recent innovating trends for making cultivation more productive

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remains probably our most specific need. Using artificial intelligence, we can develop smart farming to reduce farmers' losses and supply them with high submissions. Using computing, one can gather significant amounts of information from government and public websites or real time monitoring of varied data using the IoT (IoT) [1]. The term "Artificial Intelligence" (AI) is a buzzword nowadays for several sectors, service, manufacturing, and agriculture.

It is noted that the service and manufacturing sectors have begun to adopt AI practices and are ready to solve several challenges in this competitive environment. However, the agriculture sector is still within the evolving phase of using such AI practices. The agriculture sector's concerns are a low-income generation for the farmers, climatic dependence, lack of awareness among farmers, *etc.* But developed nations in Europe and the USA can reap rich dividends thanks to AI intervention in agriculture. Such AI-based applications are used for farm-based advisories regarding sprays, forecasting, drone usage within the farms, infrastructure for humidity and temperature updates to the farmers, *etc.* Thanks to this, farmers' losses have begun to decline [2]. Therefore, considering the government's aims regarding doubling the farmers' income, the farmers' losses must be minimized using AI practices. The industrial revolution of the last two centuries, which was driven by fossils and fuel-powered mechanization of mining, manufacturing, and its rapid expansion in other areas, has brought societal changes, mostly good yet with unintended consequences like urbanization and increase, the challenge remained a way to feed and clothe the growing population unless agriculture production and productivity could keep step.

In the last 50 years, approximately, the world population doubled. With the technological advances and agronomic advances, cereal assembly like wheat, rice, and maize got tripled with a touch increase in a cultivated area. In the last 20 years, the introduction of genetically modified seeds has reduced the usage of chemical pesticides and herbicides in vital crop, which has helped crop efficiency besides helping sustainability. Technology and agriculture research keep evolving, the same time the global population keeps increasing at a faster rate than agriculture production, the pace remains on, and it's predicted that by 2050, the planet population will be around 9.8 billion, 30% over today's level and this increase will come from developing countries like India. Those countries' income levels will keep rising; hence, the challenge is to feed huge, urban, and affluent mouths where the food habits, lifestyle, and environmental challenges are much more intense. In the rapid urbanization era, the mounting challenge is: will climate challenges and industrialization feed the globe of 2050 [3]. Will we need a 2nd green revolution? The answer is undoubtedly – Yes, but this revolution should be a smarter one – must provide scope, for the effective and efficient agronomy solution, judicious use of inputs, more informed agriculture decisions, a

quantum jump in productivity, more crop per drop, more produce from the field and a sustainable income to the grower. Better plant and varieties are one aspect of technology, which were feasible through improved farm machinery and agronomy management driven through information technology, IoT, real-time data, predictive farm advisory, machine learning can bring farm automation, farm management and walk delivery efficiency, can only be driven by "Artificial Intelligence" [4]. Demographically agriculture is the broadest economic sector, and it plays an excellent role in India's socio-economic fabric. India contains a large and diverse arable land of 159.7 million hectares, but the yield level of most of the crops is much lesser than the world average; this is often largely thanks to unsustainable agriculture practices. Thanks to the lack of quality extension services, data delivery, and data transfer regarding plant protection, nutrient management, and marketing [5]. The complex operation of agriculture needs a pool of knowledge that is too timely and farmers to rely on diverse sources for this ranging from their own experiences, fellow farmers, agriculture specialists, advisors, input suppliers, and input dealers, the relevance and usefulness of all this information remain worthful if it is available on time, which always remain a limitation. To beat this can be an "Expert System" to create available information, advice [6]. This is often where computer science orientation comes into play. The agriculture sector in India is moving against tides; it is a sort of agriculture emergency because of lack of attention, land reforms, inefficiency in agriculture commerce, disorganized agriculture extension system, access to information and technology critical for higher cognitive process, farmer income is under tremendous stress and falling year after year [7]. The visible information and knowledge gaps make agriculture less profitable and attractive. To concur with this issue, the way of doing agriculture should be made intelligent. The adoption of technology like computer science (AI) based advisory systems by the farmers may be beneficial and might help scale back their losses. The AI techniques have contributed to assorted areas in the last twenty years, including agriculture. The term 'artificial' in AI are often taken as non-biological, and 'intelligence' as a capability to accomplish complex activities and actions Tongue Processing (NLP), Robotics, Machine Learning (ML), Automated Reasoning, Knowledge Representation, Expert Systems, Computer Vision, Speech Recognition, Automated Data Analytics, video game, Augmented Reality, Internet of Things (IoT), Cloud Computing, Statistical Computing, Deep Learning, *etc.* are some major sub-areas of AI having huge potential in solving complex problems of agriculture, of this technology is effectively leveraged for providing information to growers on soil management, time of sowing, spray schedule of various pesticides and knowledge on congenial conditions for pest infestations [8-10]. This can help farmers to be informed decisions and ensure better management and efficiency in agronomy [11]. It will also help the planet counter the emerging

SUBJECT INDEX

A

B

C

D

E

F

G

H

I

J

L

M

N

O

P

R

S

T

U

V

W