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Artificial Intelligence (AI) versus Machine Learning (ML) versus Deep Learning (DL)

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***Abstract*—** *Due to the fact that businesses are embracing artificial intelligence (AI), machine learning (ML), and deep learning (DL) to create intelligent devices and apps, these technologies have emerged as the most talked-about ones in today's business sector. And even though these terminologies predominate in business conversations throughout the globe, many individuals find it challenging to distinguish between them. You may discover more about AI, machine learning, and deep learning in this paper, as well as how they differ from one another*.

***Keywords*—** *Artificial Intelligence: AI: Machine Learning: ML: Deep Learning: DL.*

I. INTRODUCTION

I'm sure we can all agree that one of the hottest trends in today's market is machine learning. According to Gartner, by 2022, teams working on new application development projects will need machine learning co-developers on their roster for at least 40% of those projects [6]. Isn't it adorable to think about the magnitude that these projects are predicted to bring in about $3.9 trillion in revenue? global need for machine learning is on the rise.

The five different topics that make up the machine learning will be briefly discussed. We will begin with an introduction to machine learning in this first topic. We'll talk about things such as what precisely is machine learning? how does it vary from artificial intelligence? and what types of applications there are? The second topic focuses on statistics and probability. We discuss sub-topics like descriptive and inferential statistics. Supervised learning [22] is the third topic. Well, supervised learning is a subset of machine learning that mostly focuses on classification and regression-type issues. It works with label data sets, and its algorithms include random forest [24], decision tree [25], logistic regression [23], and linear regression [8]. Unsupervised learning [9] is the topic described later in this paper. It largely focuses on using the algorithms that are a part of dealing with unlabeled data sets. The fifth topic includes the k-means method and the a priori algorithm. Here, reinforcement learning [12] is at work. Finally, we will go into depth on the Q-learning algorithm [11] and cover reinforcement learning.

As you are aware, we live in a world where both humans and machines exist. Although humans have been growing and picking up knowledge from the past for millions of years, the age of machines and robots has only recently arrived in the modern world. Typical machines act as though they need programming before they will truly carry out your orders. But what if the machine began to pick up knowledge on its own? This is where machine learning enters the picture. Machine learning is at the heart of many cutting-edge technological developments in our day and age. And today, machine learning is being used in many different ways, as evidenced by Sophia [20], Apple Siri [10], and Tesla's self-driving automobile [21].

What precisely is machine learning, then? Well, machine learning is a branch of artificial intelligence that focuses on creating systems that can learn from experience and make predictions based on that experience, or data in the case of machines. Machine learning empowers computers to act and make data-driven decisions rather than relying on intuition. These programmes are specifically coded to perform a specific task, but they are also intended to learn and get better over time when they are exposed to new information.

Let's address one of the main sources of misunderstanding among people nowadays. They believe that all three—artificial intelligence, machine learning, and deep learning—are interchangeable, but this is untrue.

For the avoidance of doubt, artificial intelligence is the ability of machines to perform tasks more intelligently. It includes everything that makes the computer be as functionally adaptive as possible. Use the well-known Turing test to ascertain whether or not a computer is able to reason similarly to a person. You are already pretty close to that if you are speaking to Siri on your phone and she responds. As I've already stated, machine learning is a branch of artificial intelligence that is now being used. It is founded on the notion that machines should be able to acquire data and learn from previous experiences. It belongs within a category of artificial intelligence. Is that related to the data set's pattern extraction. Because of the advancements in computer science and parallel computing, many of the algorithms involved have been known for decades or even centuries, proving that the machine is capable of more than just discovering the rules for optimal behaviour. They are now capable of handling enormous data quantities. A subset of machine learning called "deep learning" uses comparable machine learning techniques. Deep learning was used to improve accuracy in situations where machine learning wasn't functioning up to par.

In Section II we outline Machine Learning as a prelude to Section III which details AI, ML and DL. The conclusion is given Section IV.

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II. MACHINE LEARNING

Let's now look at machine learning in general. One method is to train the machine learning algorithm using a collection of labelled or unlabelled training data to create a model, then introduce additional input data and have the system make predictions based on the model. The prediction's accuracy is assessed, and the machine learning algorithm is put into use if the accuracy is satisfactory. The machine learning algorithm is now checked repeatedly with an argument from a training data set to evaluate if the accuracy is not acceptable. This was only a high-level illustration because there are other additional factors and steps involved.

Machine learning can be divided into three categories—supervised learning, unsupervised learning, and reinforcement learning—examine let's each one and how it operates.

With supervised learning, you use an algorithm to learn the function that maps the input to the output when you have input variable Xi1, i2, … ,in and output variable Yj. To roughly approximate the mapping function is the aim of learning. You want to forecast the output variable (Yj+1) every time you had new input data (Xin+1, in+2, … , in+m). So that we may better comprehend the mathematical definition, let me define supervised learning as a machine learning approach where each instance of a training data set is formed of a different input attribute and an expected output. A training data set's input attributes may consist of any type of data, including an image pixel. It can be a data base row value or even an audio frequency histogram that is set up correctly for each input instance and the desired output values. The associated value may be discretely reflecting a category or it may, in either instance, be a real or continuous value. Once the algorithm has been trained, it may be used to anticipate the proper output of a never-before-seen input. The algorithm learns the input pattern that generates the predicted output. Observe that we are feeding the algorithm's raw inputs, such as an image of a pear, as a component of the process. We have a supervisor who continuously trains the machine or corrects the machine. The machine continues hearing from the supervisor that, indeed, it is a pear or no, it's not a pear or anything similar. As a result, the process is repeated until we have a completely trained model.

When the model is completely trained it can quickly estimate the right result from an unknown input. For instance, you will see that when feeding the computer a picture of a green pear, the computer quickly recognises that the image is a pear and provides the accurate answer.

An outcome of the supervised learning process is a prediction model that can associate the label pear with the data. The resulting predictive model can now be deployed to the production environment, one step closer. A smartphone app is one possibility. Once the app is deployed, it is prepared to immediately recognise the new images. Supervised learning gets its name because, if we know the right answers (if a picture is a pear or not), the process of an algorithm learning from the training data set can be compared to a teacher monitoring (or supervising) the learning process. While training predictions are made iteratively while using the training data, is corrected by the teacher, and learning stops once the algorithm performs to a satisfactory level.

Let's continue and look at some of the well-known supervised learning algorithms. Therefore, we have support vector machines, random forests, and linear regression. Just for your knowledge, these. These algorithms will be covered later. Let's look at some of the common supervised learning use cases. Your voice is used to train automation in your cell phone, and after some practise it begins to function as intended. Assume that this is supervised learning in action. When you say Hey Siri, call Tam or OK Google, call Tam, you get a response, an action is taken, and Sam receives a call automatically. The weather is brought up next based on some of our existing information, such as the fact that when it is sunny, the temperature is high. Given that we are giving the computer data and instructing it to predict the temperature when it is sunny, this is also an example of supervised learning. Next, supervised learning is used in the banking industry to predict a credit card holder's credit worthiness by creating a machine learning model to search for faulty attributes by feeding it data on delinquent and non-delinquent customers. This allows the machine learning model to validate your future input and can identify you. The healthcare industry comes next in the list. By using information about the patient's therapy, a regression model can be built to predict the patient's readmission rates.

Let's discuss the next type of machine learning: unsupervised learning, which is defined mathematically as learning where the only input is a set of data X and there is no corresponding output variable.

Unsupervised learning aims to learn more about the data by simulating its underlying structure or distribution. The data instances in a training data set do not have an intended output associated with them in an unsupervised learning approach; instead, an unsupervised learning algorithm finds patterns based on inherent features of the input data, which is an example of a machine learning problem.

In a task, related data instances are grouped together by unsupervised learning in order to detect data clusters. As an example, the original input can consist of various car types, fully electric, electric-hybrid, CNG (compressed natural gas), CNG-hybrid and gasoline. Now the model is given this set of cars as input X. The model can be trained using an unsupervised learning approach. On the basis of its training data, the model will produce clusters. It will grasp related cars and group them together. The cars cannot have labels added by the algorithm. The method can only determine which data examples are comparable; it is unable to determine the significance of this group. Algorithms are left to their own devices to find and convey the fascinating structure in the data because there is no right or wrong response, and there is also no teacher. Hence, the name unsupervised learning.

Now let's look at some of the well-known unsupervised learning algorithms. Now that we have the hierarchical clustering algorithm [15], the k-means algorithm [4] and Apriori algorithm [1]. Let's go on and look at some examples of unsupervised learning. Imagine that a golfer invites you to his golf club for a practice competition in a different district.

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All the golfers in this district are complete strangers. Now that you have no prior information about them, you will classify them using unsupervised learning. This classification can be based on factors like gender, age group, skill level, handicap, or any other factor you choose. This learning method differs from supervised learning because you didn't use any prior information about the individuals you were classifying; rather, you continued to do so as they continued to play in the competition. Based on your assessment you will place some golfers under one category and others under another category, and so forth. It is utilised in the banking sector and the healthcare sector to segment clients by behavioural features. It is used to divide the MRI data into normal and pathological categories. It builds a model using deep learning techniques that learns from various visual attributes to identify various patterns. On the basis of their prior purchases, it is utilised to make product recommendations to customers. This is accomplished by creating a collaborative filtering model based on their prior purchases.

Reinforcement learning is a kind of machine learning technique that enables software agents and machines to automatically identify the best behaviour within a certain situation to maximise performance. The reinforcement learning process involves the interaction of two components: the learning agent and the environment. The learning agent uses a mechanism called exploration. Exploration refers to when a learning agent behaves based on trial and error, whereas exploitation refers to when it acts based on information learned from the environment. Now that the agent is rewarded for taking the right course of action, which is a reinforcement signal, the agent may better understand its environment and decide which course of action to do next. For example, the machine may be unsure about whether the object is an pear or not before applying reinforcement learning. It renders a decision based on a policy and decides how to proceed. A bonus is received if it is correct and is penalised for giving an incorrect answer. The machine will adjust its policy, and this process will continue until the machine obtains an ideal policy, at which point it will recognise that the picture is a pear or not a pear. Thus, upon completion of the training the machine can easily tell which of them is a pear.

Before we look at some reinforcement learning use cases, let's take a look at how Pavlo trained his dog. Specifically, let's look at how he used the reward approach. Pavlo included education in four phases. In the beginning, Pavlo gave his dog the treat, and in response to the treat, the dog started salivating. He then tried making a sound with the bell, but the dog did not respond. In the third attempt, he tried to condition the dog by using the bell and then giving him the food, and when he did, the dog began salivating immediately upon hearing the bell even though no food had been given to him. The dog was trained through reinforcement to expect food immediately upon the master's ringing of the bell. Moving on, let's examine how reinforcement learning is used in the banking, healthcare, and retail industries. Let's start with the banking industry. In the banking industry, reinforcement learning is used to build a predictive model that learns over time when users accept or reject offers made by the sales staff. In the retail sector, where resources to handle various types of use cases (Behavioral analytics [3], Recommendation engines [2], Inventory optimization [17], Predictive pricing [5], Smart merchandising [14]) are built using a Markov decision process [12] that learns treatment strategies for each type of use case. For example, it can be used to reduce excess stock with by building a dynamic pricing model that are just the price based on customer response to the offers.

III. AI VERSUS ML VERSUS DL

If you two are among those who are perplexed by these terms, let me to clear it up for you. Machine learning and deep learning are under the larger category of artificial intelligence, and deep learning is a subset of machine learning, so you could say that all three of them are related. Deep learning, machine learning, and AI are all subsets of one another. Let's proceed and learn the precise ways in which they differ from one another.

Let's begin by talking about artificial intelligence. In 1956, the phrase "artificial intelligence" was first used. Although the idea is rather ancient, it has lately become more well-known. But why? Well, the reason is because previously, we had very little data, and the data we did have were insufficient to anticipate the outcome. However, there has been a great rise in the amount of data recently. According to statistics, the total volume of data will grow from 94 zettabytes to around 572 Zettabytes, or 572 trillion bytes, by the year 2030. As a result, we now have more sophisticated algorithms, high-end processing power, and storage that can handle such a massive volume of data.

AI is nothing more than a method that makes it feasible for machines to behave like people by mimicking their behaviour and natural tendencies. Artificial intelligence may be used to complete certain jobs by digesting vast amounts of data and spotting patterns in them, while machines are merely their reactions depending on fresh information, doing human-like activities. AI include learning algorithms, and other components that intelligent systems someday will incorporate. The Apple series chess-playing computer, Tesla's self-driving car, and many more are instances of artificial intelligence in our daily lives. These examples are based on deep learning and natural language processing.

Machine learning first emerged in the late 1980s and early 1990s, but before we explore them individually in the context of statistics, let's first consider the problems that individuals faced at the time. In the fields of computer science and artificial intelligence, the issue was how to effectively train huge complicated models. The issue was how to train an AI system that was more similar to the functioning of the human brain studied in the field of neuroscience. Thus, the researchers' challenge was how to create an operational model of the brain. These therefore were some of the problems that had the biggest impact and gave rise to machine learning.

Machine learning has turned away from symbolic methods. It had inherited from AI and was moving toward models and procedures. It had taken inspiration from probability theory and statistics. Machine learning, a branch of artificial intelligence, gives computers the ability to act and make data-

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driven judgments in order to do certain tasks. These algorithms and programs are created in a way that allows them to develop over time when presented with fresh data. Let's look at a machine learning illustration. Let's imagine you want to develop a system that estimates a plant's height based just on rainfall levels. The first step is to gather the data. To begin, we may draw a simple line to estimate the height based on the rainfall level for each point on a graph containing real data. We may construct a forecast by using a simple line, height (H) in centimeters and rainfall level in millimeters. Our major objective is to narrow the gap between estimated and real values. Therefore, in order to do it, we make an effort to minimize the mistake by drawing a straight line that passes through each of these various spots.

Our primary objective is to reduce mistake and make it as little as possible by minimizing the gap between actual value and estimated, or the error. Value improves the model's performance on additional data points. the better we gather. By including more variables and developing distinct manufacturing lines for them, our model will be improved. once the line has been drawn. Therefore, going forward, if we input the model new data, such as the rainfall level, it will be able to estimate the data for you and will inform you of what the potential height of the plant.

Consider a deep learning system as a mega engine, with the enormous quantity of data we give it as fuel. Although deep learning is not a new idea, recently its excitement has grown and it is receiving more attention. The functioning of our brain's neurons, which gave rise to the idea of an artificial neural network, inspired this specific branch of machine learning. All of the artificial neurons' data connections are simply taken into account, and they are then adjusted in accordance with the data pattern. When the size of the data is huge, more neurons are automatically added learning at various abstraction levels. This makes it possible for a system to learn complicated function mapping without relying on a particular algorithm. You know, right now you may refer to a neural network as a "black box" since no one truly knows what goes on inside of it or why it functions so effectively. Let's talk about a few deep learning examples to better grasp it. I'll start with a straightforward example to demonstrate how things work. Let's also try to comprehend conceptually how you might distinguish a square from other shapes. Checking if a figure has four lines linked with it or not should be the first thing you do, correct? If so, we then verify that they are both closed and connected. Finally, we verify that it is perpendicular and that all of its sides are equal. if every requirement is met. Yes, a square it is. Actually, it is nothing more than a hierarchy of nested constructs. What we did was break down the difficult process of finding a square in this example into smaller, more manageable tasks. Let's look at an example of a machine that can identify animals. The machine's job is to determine if the provided image is of a dog or a cat. Deep learning now accomplishes the same thing, but on a wider scale.

What would we do first if asked to tackle the identical problem using the theory of machine learning? Check if the animal has whiskers or not would be one of the characteristics we would define. Whether the animal has pointed ears or not, as well as whether its tail is short and straight or curled. When it comes to deep learning, it takes this one step further because deep learning automatically finds are the feature which are most important for classification as opposed to machine learning where we had to manually give out that features up until now. We will define the facial features and let the system determine which features are more important in classifying a particular animal.

Knowing that deep learning is a more specialised kind of machine learning makes understanding the distinction between the two concepts much simpler. It represents the next step in machine learning. Let's compare machine learning and deep learning using a few key parameters. The performance of deep learning compared to machine learning as the volume of the data increases is the most significant difference between the two, starting with data dependencies.

While machine learning algorithms may effectively function with smaller data sets, deep learning algorithms require a vast quantity of data to fully grasp it. The hardware prerequisites are the following. While machine learning algorithms can function on both low-end and high-end machines, deep learning algorithms heavily rely on high-end machines. This is due to the fact that GPUs (graphics processing units) [18] are necessary for the operation of the deep learning algorithm. The Deep Learning technique needs GPUs since it performs several matrix multiplication operations that can only be effectively optimised on a GPU because it was designed for this use.

One of our three parameters will be feature engineering, which is the act of using domain expertise to lessen the complexity of the data. Increase the visibility of patterns for learning algorithms. In contrast to machine learning, this approach is challenging and time- and expertise-intensive because the majority of additional attributes must first be manually written according to the domain and the data type. The performance of the majority of machine learning algorithms depends on how accurately the features are identified and positioned, whereas deep learning algorithms attempt to learn high level features from the data. As an illustration, the features can be a pixel value, shape, texture, position, orientation, or anything else.

Deep learning is far more advanced than conventional machine learning because of its highly specific characteristic. Deep learning streamlines the process of creating new feature extractors for every issue. For example, in the CNN algorithm, the low-level features of the image, such as edges and lines, are first attempted to be learned before moving on to the components of people's faces and then, finally, to the high-level representation of the face. Therefore, when employing a standard machine learning algorithm to solve a problem, our next parameter is the issue-solving strategy. It is typically advised that we first divide the problem into smaller components, address each one separately, and then eventually combine them to get the desired outcome. The machine learning algorithm approaches the problem in this way, but the deep learning method resolves it completely. Take this as a case study. Assume you are given the duty of multiple object

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detection. Your job is to make a decision on what the object is, and where does it appear in the picture. Let's examine and contrast. How, starting with machine learning in a standard machine learning method, would you address this problem utilising the ideas of machine learning and deep learning.

To start, you would split the task into two steps: object detection and object recognition. A bounding box detection method could be used initially. Using a sample, search the picture for all potential items. Once the items have been identified, you will apply an object recognition algorithm to identify the pertinent objects. Finally, you would be able to recognize the outcome when you combine the two tasks. On the other hand, a deep learning technique can determine what the item is and where it is located in the image.

Let's now discuss our fifth comparison factor, which is the execution time. A deep learning algorithm often requires a lot of time to train because to the large number of parameters it contains. As a result, training may take up to two weeks or more in some cases. Machine learning requires far less time to train than fully from scratch does, with training times as little as a few weeks. Now. When it comes to testing data, the execution time is entirely flipped, and the Deep learning algorithm runs considerably more quickly. The test time grows as the quantity of the data increases when compared to a KNN method, which is a sort of machine learning algorithm. Last but not least, interpretability is a criterion to consider when comparing machine learning with deep learning. This fact is the major cause of deep learning still being used today even though it was discovered ten years ago. Let's look at a hypothetical case. We utilise deep learning to automatically score two essays. The results are pretty good and are quite close to human performance, however there is a problem. It does not demonstrate that White really calculated and provided that score.

Although it is feasible to determine which node of a deep neural network was activated, we do not yet understand what these layers of neurons are trying to mimic or what they are doing collectively. In order to evaluate the results, machine learning algorithms like decision trees provide us with clear guidelines for empty and watered-down choices. As a result, algorithms like decision trees and linear or logistic regression are generally employed in industry for interpretability since they are particularly simple to understand the logic behind. To put it simply, machine learning employs algorithms to analyse data, learn from the data, and make wise decisions based on what it has discovered. While both machine learning and deep learning are subfields of artificial intelligence, deep learning is typically what underlies the most human-like AI. In the past, scientists used lab notebooks to test progress, results, and conclusions. Now Jupiter is a substitute for the lab notebook in that it structures algorithms in layers to create artificial neural networks that can learn and make intelligent decisions on their own. Now, the IPython project [19] that the iPad and Jupiter product [16] were a part of was leveraged to create interactive online access to Python over time.

It became advantageous to communicate with other data analysis tools, such as those that are separated from Python in the same way as the tool team in Jupiter's present appearance.

IPython is still a useful tool that remains active today. The words Julia and Python are combined to create the name Jupiter. While Python is a necessity for downloading the jupyter notebook itself now that you have downloaded jupyter notebook, Jupiter executes code in many different programming languages. On their official website, there are a few options. Installing Python and Jupiter using the python-containing Anaconda distribution is highly advised. I'm not sure what book and other popular software programs are utilized for data science and scientific computing.

Allow me to connect you to real-world and outline all the things that machine learning techniques can help you do. Thus you can quickly get the answers to inquiries like what sorts of houses fall under this category, how much this property is worth, or whether this email is considered spam or not? These are some of the questions you may pose to the machine, but in order to receive a response to these, you need some sort of method, and the machine must be trained using some sort of algorithm.

The next question is how will you pick the appropriate algorithm at the appropriate time? Our best course of action is to investigate each one separately. In order to answer questions like "Is this individual a male or a female?" or "Is this spam or not?" the first step is to use a classification algorithm where categories are predicted based on the data. These kind of questions would be classified as spam by the categorization system. Speech organisation and handwriting recognition are some examples of classification challenges. Classification is a supervised learning strategy in which the computer programme learns from the input supplied to it before using this learning to categories future observations. Biometric identification should be used for document categorization, etc. The anomaly detection method comes next, when you find the unexpected data point. It is, in fact, a method used to spot outliers, or odd patterns that do not match predicted behaviour. It can be used for a variety of business purposes, such as intrusion detection, system health monitoring, spotting suspicious network traffic patterns that may indicate hacking, spotting a deadly tumour on an MRI scan, detecting fraudulent credit card transactions, and operating environment fault detection.

The clustering method is used to group the data based on a comparable criterion. You may now find out what kind of homes are in this category or what kind of consumer purchases this goods. The clustering job involves grouping the population or data points so that more of the same groups have more of the same data points. The objective is to separate groups with comparable traits and place them in clusters. The objective of clustering is to divide the population or data points into a number of groups so that the data points in the X group are more similar to the other data points in the same group than the other group. Alternatively, objective is to separate the groups with comparable qualities and place them in various clusters. An illustration will help you comprehend this. Imagine you are the owner of a vehicle rental business and you want to know what your customers want so you may expand. So, is it feasible for you to analyse every aspect of every consumer and create a special business plan for each

one? You may classify all of your consumers into ten distinct groups depending on their purchase patterns, and then utilize a different approach for each of these ten groups of clients.

The next method is regression, where the data is used to forecast the query. This sort of model can answer questions like "What is the market worth of this house?" and "Will it rain tomorrow?" Therefore, one of the most significant and often used machine learning and statistics tools is regression. By understanding the connection between the properties of your data and some observed continuous valued response regulation, it enables you to create predictions from data. You are aware of the various machine learning algorithms and how stock Iris prediction can currently be done using regression.

The following gives more examples of AI, ML and DL. An excellent illustration of what is made feasible by artificial intelligence is self-driving automobiles. A self-driving automobile is essentially a machine that picks up driving skills much like humans do (and maybe even better). Due to the fact that it still requires some input from humans, it could not be what some refer to as pure machine intelligence. But by employing image recognition to navigate through traffic and make important judgments, it really performs a fairly good job of imitating human intellect. Other instances of AI include robots employed in manufacturing, digital helpers that can remember your choices, smart home appliances that can comprehend what you're saying and provide context and safety equipment that can identify and classify faces

A well-known use of machine learning is image recognition. Consider how Facebook can identify your pals or how certain applications might make purchase recommendations to you based on the contents of a photo you've taken. Large quantities of input data in the form of random pictures are fed to a machine learning algorithm during the training phase for this programme. Every time the system successfully connects two distinct photos, it is rewarded using a reinforcement learning approach. Machine learning algorithms eventually have the ability to recognise individuals and objects in photos fairly accurately. Additional instances of machine learning applications include program for recognising speech, tools for predictive analysis and a translation program.

Without deep learning, it would be impossible to create virtual assistants like Siri. In essence, a virtual assistant is a piece of software that can do the difficult task of conversing with a human while displaying natural language understanding. Only by employing a tiered framework of machine learning algorithms that process fresh inputs and figure out what the proper answers are each time can it accomplish that. Building with deep learning also involves automated illness identification with MRI image data, examining trends in current pharmaceutical goods to find novel medications, and recommender systems that automatically colour photographs by first detecting the things in them, like those used by Netflix and Amazon Products.

IV. Conclusion

The goal of the vast area of AI is to make it possible for computers to mimic human intellect. Machine learning is an area of AI that focuses on creating models and algorithms that can assist software in learning from and seeing patterns in massive amounts of data. The field of deep learning may be categorised as an AI discipline. For data analysis and learning, the discipline employs layers of learning networks. In future work AI, ML and DL algorithms can be tested against swarm intelligence [13] analogues.

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