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Deep Learning: A Vision for Computer

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Abstract: Artificial intelligence (AI) is countered to be one of the most trusted techniques to cope with variety of issues. Researchers are delving deeper by using the techniques of AI, such as Machine learning (ML) and deep learning (DL). ML has attained a high attraction in the industry and it is utilized by many applications. Due to drastic increase in data, these techniques are becoming popular amongst the researchers. Long with this, deep learning is the branch of ML which outperformed the conventional techniques of machine learning. This paper presents the brief account on ML and DL. It reviewed how machine and deep learning are utilized and perform different operations. Along with this, a literature survey is presented on the basis of three different domains: Security, Health Management and Big data. This paper gives an overview on Machine learning and deep learning along with the work proposed in this domain.

Keywords: Machine learning, Deep learning, Feature processing, Training data.

I. INTRODUCTION

These days, internet is countered as the significant part of the life. It is used by people for different purposes like business, education, entertainment etc. Internet is particularly used as an imperative component of business models [1]. The increasing integration of the Internet and social life leads to change the lifestyle of the people. Along with this, significant number of problems are also arising. Artificial intelligence is the technology which has attracted the interest of the researchers to resolve the issues such as security, healthcare detection, prediction in agricultural activities; big data etc [2]. Now days, efficient intelligent models are required to be designed and developed in order to deal with the future demands that are in line with various issues. Artificial intelligence (AI) is the domain of the computer science that accentuates the formation of intelligent machines. These machines perform operations and respond like humans. It is opted by a number of researchers as effective technique to be used to resolve different problems. Further, ML is the branch of AI which is widely used.

Machine learning is a concept in which study of using computers for simulating human learning activities is carried out. Also, in ML methods for computers' self-improvement are studied so that novel skills and more knowledge can be attained and also to identify existing knowledge, and to enhance the effectiveness and achievement. In machine learning, various algorithms are utilized for the extraction of the patterns from raw data so that a typical decision can be made. The simplest algorithm form all the machine learning algorithms is logistic regression which assists in providing decision of using cesarean delivery decision for patients [1]. Furthermore, Naive Bayes is the tool which is used to split the spam emails from valid email [3]. Most common ML algorithms are K-nearest Neighbors (KNN), Support Vector machine (SVM), Decision Tree, and Bayes. The primary model of machine learning includes four steps that are demonstrated in figure 1.

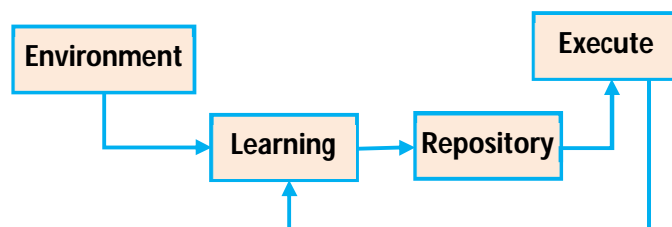


Figure 1: Basic model of machine learning

In addition to this, Deep learning (DL) is the branch of ML that carries deeper inner hidden layers cascaded into the network. DL is responsible for making the machines that understand and performs like a human brain. [5-10].

Deep Boltzman machine (DBM), Convolutional neural network (CNN), and Long Short-term Memory (LSTM) are some of the models used in deep learning. A number of parameters like number of nodes and layers that enhance the model and its integration. [4]. AI has been utilized in various fields to carry out automation processes like automated labor, detection of audio and picture,

scientific research assistants and in decision making [11]. In DL, computational models of multiple layers of processing are allowed to study and represent data with multi-level abstraction that mimics the working of brain in recognizing and understanding multimodal information, and therefore it completely captures complex structures of large-scale data. Deep learning includes various methods, hierarchical probabilistic models, neural networks, and a range of feature learning algorithms [12].

II. MACHINE LEARNING AND DEEP LEARNING

This section presents the detailed view on AI, ML and DL. Firstly, AI is a novel technology in which many theories, methods and mechanisms, applications are studied and developed which simulate human intelligence [13]. It is domain which deals with production of novel machines that performs and gives response like a human brain. Researchers utilized AI in robotics, nature language processing, computer vision, and expert systems.

The information process of human consciousness and thinking can be imitated by using AI. In actual, it is not human intelligence, but it thinks like a human. Machine Learning is the type of AI and is directly associated to computational statistics. It bears the responsibility of taking using computers. ML is comprised of mathematical optimization which assists in delivering the methods, applications and theory in certain domain to the industry. ML can be referred to as the amalgamation with data mining [14], however, the other subfields focus on investigative data analysis and is called to be unsupervised learning. Machine learning can be unsupervised which is furthermore used to study and develop profiles with baseline behavioral for a variety of entities and eventually, these profiles are used to locate meaningful anomalies [15].

Machine Learning is developed by Arthur Samuel. According to Arthur, "ML is an area of study the enables the computers to learn without performing any programming tasks." Basically, ML emphasizes on classification and regression which is carried out on the basis of previously extracted features from training data. Although, DL is the novel domain in machine-learning research, it is based on establishing neural network that emulates the human brain to perform logical and analytical learning. It behaves like the mechanism of a human brain for data interpreting such as pictures, audios and texts [16].

Hinton et al. [17] introduced the notion of DL which is based on the deep belief network (DBN). Hinton proposed an unsupervised greedy layer-by-layer training algorithm to cope with the optimization concern of deep structure. Afterwards, for multilayer automatic encoder, the deep structure is designed. In addition, the first real multi-layer structure learning algorithm is CNN which is presented by Lecun et al. [18]. CNN used a space relative relationship to decrease the number of parameters so that training performance can be enhanced. Thus, DL is a technique of a machine-learning which is derived from characterization of data learning.

An input like an image can be expressed in various forms such as a series of edges, vector of each pixel intensity value, a region of a particular shape. By using different representation methods, the tasks can be easily studied. In the same way to the ML methods, DL methods as well have supervised and unsupervised learning (explained in the next section). DL has the advantage that it can use any feature learning and hierarchical feature extraction to manually replace the features with efficacy [19].

ML and DL has different roles in many aspects which are explained below:

A. Data Dependencies

The data is utilized in both ML and DL for prediction of certain process. Machine learning performs well using small volume of data whereas deep learning is designed to handle the huge amount of data to comprehend the data efficiently. Moreover, machine learning if uses established rules gives better results [16].

B. Hardware Dependencies

Manu matrix operations are required by the algorithm of deep learning and these operations are optimized by using graphic processing Unit (GPU). Consequently, DL performs efficiently using GPU. ML algorithms do not require any kind of additional hardware. GPU along with the machines giving high performance are used in deep learning to achieve accuracy [20].

C. Feature Processing

ML and DL plays important role in feature extraction and processing. It is the process in which the certain knowledge is sent to the feature extractor so that data intricacy can be diminished and eventually, the extractor generates the patterns which are used to attain the better performance of learning algorithms. Though, this process consumes more time and also particular knowledge is required to carry out different operations. The process involved in ML and DL is delineated in figure 2. In ML, experts bear the responsibility of determining the most characteristics and subsequently, are encoded as a data type.

Features of the input can be of any type such as textures, shapes, locations, values and orientations. ML's effectiveness is dependent on the accuracy of the features extracted however, in Deep learning, feature extraction and classification are performed together. No extra efforts are required to design the feature extractor [19].

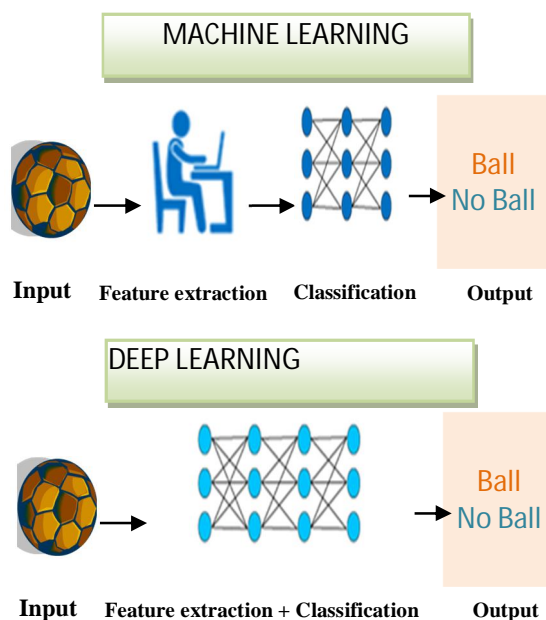


Figure 2: Concept of machine learning and deep learning

D. Problem-solving Method

The methods used by ML and DL to solve the issue are different from each other. While using the machine learning approach, the problem is firstly divided in sub-problems. These sub-problems are solved and eventually, final results are achieved. However, in deep learning, direct end-to-end method is applied to solve the problem.

E. Execution Time

DL algorithm utilizes more parameters which results in more time for training data. The ResNet is most advanced DL algorithm which consume exactly two weeks for the completion of a training session, but time taken by training in machine learning is typically less (only seconds or hours). On the other hand, the test time taken by both learning techniques is exactly the opposite of the training time of ML and DL.

III. STEPS INVOLVED IN MACHINE LEARNING

The ML algorithms offer précised rules for their selection. Thus, reason behind the decision can be explained easily. Following are the four steps which are included in the ML mechanism [14]:

- 1) *Feature Engineering*: The first step is the selection of the choice of the features or the attributes. The prediction will be performed on the basis of selected features.
- 2) *Selection of Algorithm*: Afterwards, the algorithms of machine learning are selected which are suitable for the type of attributes. The algorithms such as classification or regression algorithm and based on high complexity or fast can be selected.
- 3) *Training*: the data is trained and then evaluation is carried out on the basis of different algorithms in order to check the efficiency of the model. The model with best performance is chosen.

Finally, the trained model is used for the classification or the prediction of the unknown data.

In deep learning, the steps involved are very much similar to ML except the manual feature extraction. Unlike ML, DL uses automated feature extraction process. Selection of model in DL is based on constant trial and error process and it entails a suitable ML / DL algorithm according to the types of tasks.

A. Types OF ML/DL Techniques

There are three types of ML/DL approaches: supervised, unsupervised and semi-supervised shown in following figure. These learning techniques are responsible for performing different operations.

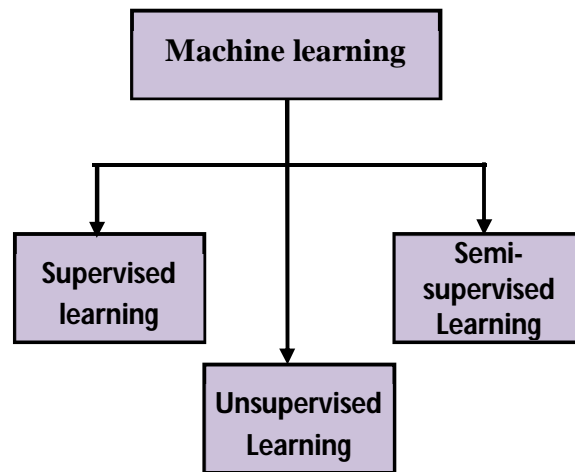


Figure 3: Types of learning

- 1) *Supervised Learning*: Each instance, in supervised learning, comprised of an input sample and a label. The algorithm of supervised learning examines the training data and uses its results to map novel instances.
- 2) *Unsupervised Learning*: It is a machine-learning process that presents the explanation of hidden structures from unlabeled data. Due to unlabeled sample, it is impossible to analyze the accuracy of the output cannot of the algorithm. In this type of learning, just key features of the data are précised and explained.
- 3) *Semi-supervised Learning*: This type learning is the amalgamation of both supervised and unsupervised learning. In Semi-supervised learning, enormous amount of unlabeled data is utilized while making use of labeled data for pattern recognition. This method is better as, it decreases the efforts used for labeling and also helps in attaining high accuracy and better effectiveness.

IV. RELATED WORK

Machine learning and deep learning has been widely used by the researchers to cope with different concerns in various fields. This section presents the literature survey carried out in three different fields namely, security, health management and big data. These three areas play significant role and many researchers have delved deeper to deal with issues in such fields.

A. Security

As the development in the field of internet and other technologies is increased rapidly, security is raised as the main concern. Researchers have proposed different works to provide Cyber-security or the security in the appliances and application. This section presents the literature review of some anticipated works.

ML algorithms are used to design a system for detecting any concealed cyber-attacks [4].

Morita et al. [21] designed an automatic detection system by using ML techniques. The simulation was carried out by taking a simple plant and the calibration is performed by flowing the hot water from one tank to another. A SCADA system [22] and operators were used specially for both the tanks. Principal component analysis (PCA) has been used to detect any abnormality.

The security in power systems is provided by [23]. Machine learning technique is used by the authors for the detection of the stressed condition in power system. Discrimination function is defined by using decision tree which classifies the state of system to either as stressed or safe.

The classifier is trained by Potential predictors, i.e., voltage magnitudes, angle differences, etc. In [24], the classification is performed using decision tree that eventually predicts the reliability balance of the proposed scheme. The decision tree splits the attributes that determine the locations where Phasor measurement unit PMUs have to be utilized. As complexity and uncertainty is growing at fast pace, ML is providing the solutions to cope with the challenges of the developing and operating future power systems with a satisfactory security level.

B. Health Management

These days, the increasing technology has effect on the human health and the detection of the health status using artificial intelligence has become common. Naïve bayes, SVM, CNN, and KNN are common techniques used to detect various diseases such as breast cancer, heart disease, diabetes, thyroid etc.

In United States, Williams et al. [25], proposed a mechanism to detect the risk of breast cancer by utilizing j48 and Naive Bayes. Parthiban and Srivatsa [26] and Iyer [27] proposed ML algorithms for detection and analysis of heart disease and diabetic disorder respectively. [26] used support vector machine and [27] utilized decision tress to achieve better performance.

Senturk et al. [28] and Otoom [29] used several classification models like Support Vector Machine (SVM), Naive Bayes (NB), K-nearest neighbor, and Decision tree (DT) for diagnosing breast cancer and heart disease respectively.

Ash et al. [30], Rao et al. [31], Spina et al. [32], Bajwa and Kulkarni [33] proposed a method by using decision tree. The prediction is made by making use of branches. These approaches are simple and can be easily understandable. No specific parameters are used by the authors to predict the health status that ensured the simplicity of the proposed algorithms.

Jakubek and Strasser [34], Kobayashi and Simon [35], Marsland [36], McDuff et al., [37], Zhang and Ganesan [38] presented neural network i.e. deep learning in order to manage the health status of the patients. The mechanism used number of parameters which are optimized for training system.

C. Big Data

One of the most crucial concerns of the researchers is the bug data. A massive amount of data is produced everyday which is needed to be stored and used in the digital world. There are various multi-model DL models that have been projected for heterogeneous learning of data representation.

Ngiam et al. [39] proposed a multi-modal DL frame to perform feature learning of audio-video objects. Restricted Boltzmann machines are used by the author to study the features for audio and video independently. Srivastava and Salakhutdinov [40] proposed a multi-model deep learning design and it was given a name as bi-modal deep Boltzmann machine. This model was used for text image objects feature learning. Ouyang et al. [41] proposed a model to determine the poses of the human. This model aimed at learning non-linear representation through various information sources.

A data mining approach was proposed by [42] for solving the inverse problem in which the task is to infer inventory trees from a database of environmental factors.

To decrease the cost related to screening the life-cycle assessments (LCAs), [43] proposed a model that treats LCA as a data mining concern and automated the assigning process of impact factors to the components of inventory.

[44] gave the review of large-scale data-intensive fields, relating to the model efficacy that include computational needs in learning, and data-intensive areas structure and design, and it also introduced novel algorithmic approach in which minimum memory is reduce the computational cost, while maintaining the accuracy and stability of classification.

V. CONCLUSION

Machine learning and deep learning are the branches of the artificial intelligence. These techniques are used to design the intelligent machines that mimic the human brain. Several issues in various fields are solved by using such mechanism. ML and DL performs efficiently during prediction. Deep learning is précised version of machine learning that reduces many efforts involved in the algorithms of machine learning. Researchers delved deeper in the field of health management, security, big data, agriculture, power systems etc. An over view on machine learning and deep learning is presented along with the literature survey. Researchers used SVM, KNN, CNN, decision trees, ML algorithms, and multiple deep learning models according to the type of the concerns that are needed to be solved.

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