MACHINE LEARNING ALGORITHMS AND APPLICATIONS

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Abstract. This papers objective is to identify the supervised and unsupervised machine learning techniques and its applications. currently the research in machine learning focuses on computer vision, hearing, natural languages processing, image processing and pattern recognition, cognitive computing, knowledge representation, and so on. These research trends aim to provide machines with the abilities of gathering data through senses similar to the human senses and then processing the gathered data by using the computational intelligence tools and machine learning methods to conduct predictions and making decisions at the same level as humans. Here the discussions are made on the development of machine learning models. Finally, we can conclude by briefly introducing the applicability of machine learning in several areas.

Keywords: Machine learning, Artificial intelligence, Deep learning, Algorithms, and models.

I. INTRODUCTION

Learning is a very personalized phenomenon for us. Nevertheless, learning is not limited to humans only. Even the simplest of species such as amoeba and paramecium exhibit this phenomenon. Plants also show intelligent behavior. Only nonliving things are the natural things that are not involved in learning. Hence, it appears that living there is hardly anything to learn. Enabling a machine capable of learning like humans is a dream, the fulfillment of which can lead us to having deterministic machines with freedom. Machines are by nature not intelligent. Initially, machines were designed to perform specific tasks, such as running on the railway, controlling the traffic flow, digging deep holes, traveling into the space, and shooting at moving objects. Machines do their tasks much faster with a higher level of precision compared to humans. They have made our lives easy and smooth. The fundamental difference between humans and machines in performing their work is intelligence. A machine cannot deal with the gathered data in an intelligent way. It does not have the ability to analyze data for benefit from previous experiences, and store the new experiences to the memory units; that is, machines do not learn from experience.

Computers are machines that follow programming instructions to accomplish the required tasks and help us in solving problems. Our brain is similar to a CPU that solves problems for us. Different persons can have different methods to do the same job. In other words, different persons can use different algorithms to perform the same task. These methods or algorithms are basically a sequence of instructions that are executed to reach from one state to another in order. An efficient algorithm enabling a program to handle full input data in cache memory will also consequently allow faster execution of program.

We can identify the speech of our friends without much difficulty. If we are asked how we recognize the voices, the answer is very difficult for us to explain. Because of the lack of understanding of such phenomenon, we cannot craft algorithms for such scenarios. *Machine learning* algorithms are helpful in bridging this gap of understanding. We write computer programs that will make machines learn and enable them to perform tasks, such as prediction. The goal of learning is to construct a *model* that takes the input and produces the desired result [1].

A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E.

II. DIFFERENT MACHINE LEARNING TECHNIQUES

Figure 1 illustrates four machine learning techniques and describes briefly the nature of data they require.

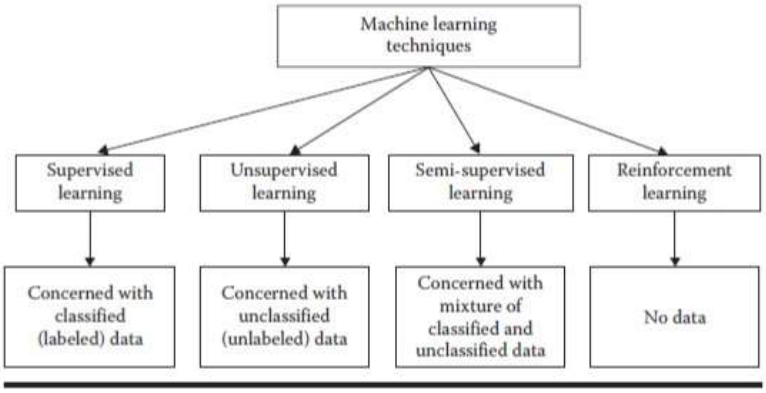

Figure 1 Different machine learning techniques and their required data

A. Supervised Learning

Supervised learning is analogous to training a child to walk. You will hold the child's hand, show him how to take his foot forward, walk yourself for a demonstration and so on, until the child learns to walk on his own.

In the case of supervised learning, you give concrete known examples to the computer. You say that for given feature value x1 the output is y1, for x2 it is y2, for x3 it is y3, and so on. Based on this data, you let the computer figure out an empirical relationship between x and y.

Once the machine is trained in this way with a sufficient number of data points, now you would ask the machine to predict Y for a given X. Assuming that you know the real value of Y for this given X, you will be able to deduce whether the machine's prediction is correct.

Thus, you will test whether the machine has learned by using the known test data. Once you are satisfied that the machine is able to do the predictions with a desired level of accuracy (say 80 to 90%) you can stop further training the machine.

Now, you can safely use the machine to do the predictions on unknown data points, or ask the machine to predict Y for a given X for which you do not know the real value of Y. This training comes under the regression that we talked about earlier [2].

B. Unsupervised Learning

In unsupervised learning, we do not specify a target variable to the machine, rather we ask machine "What can you tell me about X?". More specifically, we may ask questions such as given a huge data set X, "What are the five best groups we can make out of X?" or "What features occur together most frequently in X?." To arrive at the answers to such questions, you can understand that the number of data points that the machine would require to deduce a strategy would be very large. In case of supervised learning, the machine can be trained with even about few thousands of data points. However, in case of unsupervised learning, the number of data points that is reasonably accepted for learning starts in a few millions. These days, the data is generally abundantly available. The data ideally requires curating. However, the amount of data that is continuously flowing in a social area network, in most cases data curation is an impossible task [2].

C. Semi-supervised Learning

In this type of learning, the given data are a mixture of classified and unclassified data. This combination of labeled and unlabeled data is used to generate an appropriate model for the classification of data. In most of is in abundance. The target of semi-supervised classification is to learn a model that will predict classes of future test data better than that from the model generated by using the labeled data alone. The way we learn is similar to the process of semi-supervised learning. There are so many information about robotics to be accepted. The Robots are used in many fields like agriculture, industry, hotel, household works, hospital, school, college, banking, military etc. Understanding their working is more vital, if any problem is given, we can discover the answers by means of creating new varieties of robots [2].

D. Reinforcement Learning

Consider training a pet dog, we train our pet to bring a ball to us. We throw the ball at a certain distance and ask the dog to fetch it back to us. Every time the dog does this right, we reward the dog. Slowly, the dog learns that doing the job rightly gives him a reward and then the dog starts doing the job right way every time in future. Exactly, this concept is applied in "Reinforcement" type of learning. The technique was initially developed for machines to play games. The machine is given an algorithm to analyze all possible moves at each stage of the game. The machine may select one of the moves at random. If the move is right, the machine is rewarded, otherwise it may be penalized. Slowly, the machine will start differentiating between right and wrong moves and after several iterations would learn to solve the game puzzle with a better accuracy. The accuracy of winning the game would improve as the machine plays more and more games [2].

III. SOURCES OF MACHINE LEARNING

Work in machine learning is now converging from several sources. These different traditions each bring different methods and different vocabulary which are now being assimilated into a more fused discipline. The brief listing of some of the separate disciplines that have contributed to machine learning are [3];

(a) Statistics: A long-standing problem in statistics is how best to use samples drawn from unknown probability distributions to help decide from which distribution some new sample is drawn. A related problem is how to estimate the value of an unknown function at a new point given the values of this function at a set of sample points. Statistical methods for dealing with these problems can be considered instances of machine learning because the decision and estimation rules depend on a corpus of samples drawn from the problem environment.

(b) Brain Models: Non-linear elements with weighted inputs have been suggested as simple models of biological neurons. Networks of these elements have been studied by several researchers. Brain modelers are interested in how closely these networks approximate the learning phenomena of living brains.

(c) Adaptive Control Theory: Control theorists study the problem of controlling a process having unknown parameters which must be estimated during operation. Often, the parameters change during operation, and the control process must track these changes. Some aspects of controlling a robot based on sensory inputs represent instances of this sort of problem.

(d) Psychological Models: Psychologists have studied the performance of humans in various learning tasks. An early example is the EPAM network for storing and retrieving one member of a pair of words when given another. Related work led to a number of early decision tree and semantic network methods.

(e) Artificial Intelligence: From the beginning, AI research has been concerned with machine learning. Samuel developed a prominent early program that learned parameters of a function for evaluating board positions in the game of checkers. AI researchers have also explored the role of analogies in learning [Carbonell, 1983] and how future actions and decisions can be based on previous exemplary cases [Kolodner, 1993].

(f) Evolutionary Models: In nature, not only do individual animals learn to perform better, but species evolve to be better, but in their individual niches. Since the distinction between evolving and learning can be blurred in computer systems, techniques that model certain aspects of biological evolution have been proposed as learning methods to improve the performance of computer programs.

IV. VARIETIES OF MACHINE LEARNING

Orthogonal to the question of the historical source of any learning technique is the more important question of what is to be learned. Here, the thing to be learned is a computational structure of some sort. Variety of different computational structures are [3]:

- Functions
- Logic programs and rule sets
- Finite-state machines
- Grammars
- Problem solving systems

These methods both for the synthesis of these structures and for changing existing structures. Then change to the existing structure might be simply to make it more computationally efficient rather than to increase the coverage of the situations it can handle.

V. APPLICATIONS OF MACHINE LEARNING ALGORITHMS/MODELS

Machine learning methods can predict geometric properties from Hilbert series (HS). Repressors predict embedding weights in projective space to~1mean absolute error, whilst classifiers predict dimension and Gorenstein index to > 90% accuracy with 0.5% standard error [4].

Industry 4.0 tools permit computerized creation measures, and Artificial Intelligence (AI) approaches are pivotal in investigating the travel industry. Applying these devices to decipher User Generated Content (UGC) is fundamental to understand better client's necessities, opinions, and assumptions regarding tourism services. To develop a methodology focused on analyzing online reviews related to service robots in hotels using Machine Learning techniques to train the data collected from TripAdvisor [5].

Machine learning has proven to be a useful approach for analyzing microbial community data and making predictions about outcomes including human and environmental health. Machine learning applied to microbial community profiles has been used to predict disease states in human health, environmental quality and presence of contamination in the environment, and as trace evidence in forensics [6].

ML provides a comprehensive state-of-art review in the field of machine learning and artificial intelligence to solve oil and gas industry problems [7].

Machine learning applications for smart buildings as the learning ability of buildings with a system-level perspective and autonomous machine learning applications that make independent decisions for building energy management [8].

Machine learning models are developed to analyze the effect of physicochemical parameters on the CO2 dissolution in solvent which can be carried out in chemical reactors for separation/conversion of CO2 for environmental applications [9].

Machine learning methods are used to analyze structural neuroimaging data and potential clinical applications of brain age prediction [10].

It is very important that we have to generate the more power without disturbing the environment and whatever the generated power must be utilize effectively with minimum losses and higher efficiency. This will be possible with effective way of using the modern technology like machine learning (ML), artificial intelligence etc. [11].

Based on the importance of machine and deep learning approaches in the estimation of COVID-19 spreading trend, Adaptive neuro-fuzzy inference system, long short-term memory, recurrent neural network and multilayer perceptron are among the mostly used strategies to predict the number of new cases of COVID-19 [12].

Advances in applying machine learning to radiation oncology and integrating these techniques into the radiation oncology workflows and machine learning has key early applications in radiation oncology due to the repetitive nature of many tasks that also currently have human review [13].

Machine learning techniques and hybrid approaches mentioned are the tools for further comprehend the functionality and extend the capabilities of freight transportation, supply chain and logistics systems, enable better predictions of evolution and future states of these systems and offer robust support for knowledge discovery, planning and decision making [14].

Artificial intelligence driven by machine learning algorithms is being increasingly employed for early detection, disease diagnosis, and clinical management. The use of machine learning, driven advancements in kidney research compared with other organ specific fields [15].

Machine learning and data analytics approaches are applied to predict the sinter machine productivity. Linear regression and artificial neural network (ANN) models are developed to predict sinter machine productivity with the composition of constituent materials of the agglomerate as model inputs [16].

Machine learning algorithms outperforms the benchmark Logistic Regression model in interbank link forecasting and this is also reflected in the enhanced performance when overall network similarity measures are performed [17].

Diabetes is a very common disease affecting individuals worldwide. Diabetes increases the risk of long-term com- plications including heart disease, and kidney failure among others. People might live longer and lead healthier lives if this disease is detected early. Different supervised machine learning models trained with appropriate datasets can aid in diagnosing the diabetes at the primary stage [18].

Machine learning model is trained appropriately, it becomes able to effectively predict and make decisions. The technology is rapidly evolving and has found numerous applications in various branches of engineering due to its preponderance. This study is focused on exploring the recent advances of machine learning and its applications in reinforced concrete bridges 19].

AI/ML techniques, identify optimal designs for a single channel of a MSR and to compare the prediction accuracy of different ML methods and to decide the best estimator suitable for single channel design [20].

Machine learning technology has been extensively applied in aquaculture in recent years, providing a new opportunity for the realization of digital fishery farming [21].

The impact of four major fluid and colloids properties on the pore surface and hydraulic conductivity alteration during colloids transport were evaluated using machine learning [22].

Home energy management systems and building energy management systems have significant overlap with virtual power plants, but these bodies of research are largely separate. Machine learning has recently been applied to realize various functionalities of these systems [23].

VI. DISCUSSIONS

The present paper explains the methods and applications of machine learning, such as, Hilbert series in physics, to analyse service robots influence, in microbial ecology, human microbiome studies, and environmental monitoring, in oil and gas industry, for smart buildings, for simulation of chemical reactors in water treatment applications, for brain age prediction, in integrated power system, in the prediction of COVID-19 daily new cases, in radiation oncology, on freight transportation and logistics, in Nephrology like a Bibliometric Analysis Comparing Kidney Studies to Other Medicine Subspecialties, for prediction of sinter machine productivity, to interbank market, in diabetes prediction and development of smart web application, to the design and inspection of reinforced concrete bridges, to single channel design of molten salt reactor, in intelligent fish aquaculture, in colloids transport in porous media studies, and for virtual power plants and home/building energy management systems.

VII. CONCLUSION

Machine learning usually refers to the changes in systems that perform tasks associated with artificial intelligence (AI). This technology help to a human being and make the work easier to achieve in any of field. In this paper, we discussed the different methods and applications of machine learning in various fields.

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