History of Machine Learning with Its Advantages and Its Applications

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Abstract: The discipline of machine learning, which is simply the ability for computers to successfully predict the future based on past experiences, has recently shown significant growth thanks to the quick rise in computer storage and processing power. Machine learning techniques have been widely used in bioinformatics as well as many other fields. For this application field, complex machine learning methods have been developed due to the complexity and expense of biological analyses. The foundational ideas of machine learning, such as feature evaluation, supervised versus unsupervised learning, and various classification techniques, are initially covered in this chapter. Then, we highlight the key difficulties in creating machine learning experiments and assessing their efficacy. We conclude by introducing a few supervised learning techniques.

INTRODUCTION

While working at IBM in 1959, Arthur Samuel, a pioneering American in the fields of artificial intelligence and video games, invented the phrase "Machine Learning." "The field of study that gives computers the ability to learn without being explicitly programmed," was how he defined machine learning. Machine learning typically refers to modifications made to systems that carry out artificial intelligence (AI)-related tasks. These include activities like prediction, planning, robot control, diagnosis, and recognition. The "changes" could be either improvements to already functioning systems or the creation of new ones from scratch.

Definition:
A data analysis technique called machine learning automates the creation of analytical models. It is a subfield of artificial intelligence founded on the notion that machines are capable of learning from data, spotting patterns, and making judgments with little assistance from humans.

The Early History of Machine Learning:
A model of how brain cells interact is one of the foundations of machine learning. Donald Hebb developed the paradigm in his 1949 book "The Organization of Behavior." Hebb's thoughts on neuronal transmission and excitement are presented in the book.

The First Neutral Network with Electric Circuits-1943:
Warren McCulloch and Walter Pitts created the first neutral network with an electric circuit in 1943. The network's objective was to find a solution to a dilemma that John von Neumann and others had raised. This prototype demonstrated that two computers could communicate without any human involvement. This incident is significant because it laid the door for the advancement of machine learning.

Turing Test-1950:
Alan Turing, a mathematician, developed the Turing Test as a measure of artificial intelligence. It entails figuring out whether a machine can behave just like a human or whether people can't discern the difference between responses provided by a human and a machine. The test's objective is to find out whether machines have the capacity for both intellectual thought and emotional expression. The questioner's perception of the answer as human is more important than whether it is true or incorrect.

Computer Checkers-1952:
Arthur Samuel, a machine learning pioneer, is credited with developing the first computer program that could play checkers at a high level. His algorithm, which he created in 1952, measured the likelihood of winning a game using a method known as alpha-beta pruning. Today's games still frequently employ this technique.

Samuel further created the minimax algorithm, a method for reducing losses in games.

Frank Rosenblatt -The Perceptron-1957:
Frank Rosenblatt was a psychologist most known for his work on artificial intelligence. He created the perceptron, a machine learning method, in 1957. One of the earliest methods to make use of artificial neural networks, which are frequently employed in machine learning, was the perceptron.

The Nearest Neighbor Algorithm-1967:
Large datasets can be automatically searched for patterns using the Nearest Neighbor Algorithm. This algorithm seeks to identify similarities between two objects so that it may determine which one is most similar to the pattern in the other item. Finding connections between various data sets or making predictions about the future based on the past can both benefit from this.

The Backpropagation-1974:
In the beginning, backpropagation was intended to aid neural networks in learning to recognize patterns. It has also been utilized in various machine learning applications, such as performance optimization and generalizing from data sets to fresh instances. Backpropagation aims to increase a model's accuracy by changing its weights so that it can predict future outputs more correctly. In 1974, Paul werbos published his dissertation, which is featured in the book "The Roots of Backpropagation," and it served as the inspiration for this method of machine learning.

The Stanford Cart-1979:
A robot with independent space movement, the Stanford Cart can be remotely controlled. It was initially created in the 1960s, and in 1979 it passed a crucial stage in its development. The Stanford Cart's goal is to avoid obstacles and go to a certain location. In 1979, "The Cart" became the first machine to successfully navigate a room full of chairs without human assistance in 5 hours.

Types of Machine Learning:
These ML techniques support the resolution of numerous business issues, including clustering, associations, forecasting, classification, regression, and others.

Machine learning is primarily split into four types based on the techniques and modes of learning, which are:
1.Supervised Learning.
2.Unsupervised Learning.
3.Semi-Supervised Learning.
4.Reinforcement Learning.

1.Supervised Learning
Supervised machine learning is based on supervision, as its name suggests. In the supervised learning technique, this means that we train the machines using the "labelled" dataset, and then the machine predicts the output based on the training. Here, the labeled data indicates which inputs have already been mapped to which output. More precisely, we may state that after training the machine with input and related output, we ask it to predict the outcome using test dataset. The main goal of the supervised learning technique is to map the input variable(x) with the output variable(y). Some real-world applications of supervised learning are Risk Assessment, Fraud Detection, Spam filtering, etc.
Advantage and Disadvantage of Supervised Learning:

Advantages:
- Since supervised learning uses a labelled dataset, we can precisely identify the object types.
- These algorithms are useful for making predictions about the results based on past performance.

Disadvantages:
- Complex problems cannot be solved by these algorithms.
- If the test data differs from the training data, it might anticipate the incorrect outcome.
- To train the algorithm, a lot of computation time is needed.

Applications of Supervised Learning:
1.Image Segmentation
Algorithms for supervised learning are employed in image segmentation. With the use of pre-established labels, picture classification is carried out in this method on various image data.

2.Medical Diagnosis

In the medical field, supervised algorithms are frequently employed for diagnostic purposes. It is done utilizing historical data with labels for disease conditions and medical photos. The machine can diagnose a disease for new patients using such a procedure.

3.Fraud Detection
Algorithms for supervised learning are used to identify fraudulent customers, transactions, etc. In order to find the patterns that could point to potential fraud, historical data is used.

4.Spam Detection
Algorithms for categorization are employed in the detection and filtering of spam. These algorithms determine whether an email is spam or not. The spam folder receives the spam emails.

5.Speech Recognition
Speech recognition also makes use of supervised learning methods. Voice data was used to train the algorithm, and it may be used to identify a variety of things, including voice-activated passwords, speech commands, etc.

2.Unsupervised Learning:
Unsupervised learning is distinct from the supervised learning method because, as its name implies, supervision is not required. In unsupervised machine learning, this means that the system is trained on an unlabeled dataset and makes output predictions without any human supervision. The unsupervised learning algorithm's primary goal is to classify or group the unsorted dataset based on commonalities, patterns, and differences. The hidden patterns in the input dataset are to be found by the machines.

Advantage and Disadvantage of Unsupervised Learning:
Advantages
- These algorithms, as opposed to supervised ones, can be utilized for more challenging problems because they operate on unlabeled datasets.
- For a variety of jobs, unsupervised techniques are preferred since it is simpler to obtain the unlabeled dataset than the labelled dataset.

Disadvantages
- Since the dataset is not labeled and the algorithms are not trained using the exact output in advance, the output of an unsupervised algorithm may be less accurate.
- Working with unsupervised learning is more challenging since it uses a dataset that is not mapped to the output and is unlabeled.

Applications of Unsupervised Learning:
1.Network Analysis
When analyzing text data for scholarly papers using document network analysis, unsupervised learning is utilized to detect plagiarism and copyright.

2.Recommendation Systems
Unsupervised learning techniques are frequently used by recommendation systems to create suggestion applications for various web applications and e-commerce websites.

3.Anomaly Detection
Unsupervised learning is frequently used for anomaly detection, which can find out-of-the-ordinary data points in the dataset. It is employed to find erroneous transactions.

4.Singular Value Decomposition
SVD, also known as singular value decomposition, is used to extract specific data from the database. Taking information on each user who is present in a specific location, for instance.

3.Semi-Supervised Learning:
Between supervised and unsupervised machine learning, there is a form of method known as semi-supervised learning. It uses a combination of labeled and unlabeled datasets during the training phase and stands in the between of supervised learning (with labeled training data) and unsupervised learning (without labeled training data) technique. While semi-supervised learning acts on data that contains a few labels and is a middle ground between supervised and unsupervised learning, the majority of the data it uses is unlabeled. Labels are expensive, however for corporate needs, there might not be many labels. Because supervised and unsupervised learning are dependent on the presence or lack of labels, it is entirely distinct from those methods. The idea of semi-supervised learning is introduced to address the

shortcomings of supervised learning and unsupervised learning algorithms.

Advantage and Disadvantage of Semi-Supervised Learning:

Advantages.

- It is simple and easy to understand the algorithm.
- It is highly efficient.
- It is used to solve drawbacks of Supervised and Unsupervised Learning algorithms.

Disadvantages:

- Iterations results may not be stable.
- We cannot apply these algorithms to network-level data.
- Accuracy is low.

Applications of Semi-Supervised Learning:

1.Image and Speech Analysis

This is the most popular example of Semi-supervised learning models. Images and audio files are usually not labeled. To label them is an arduous task that is expensive as well. With the help of human expertise, you can label a small data set. Once the data is trained, we can then implement SSL to label the rest of the audio and image files and thus improve image and speech analytic models.

2.Web Content Classification

SSL can help by labeling the content and classifying it, thus improving the user experience. Many search engines, including Google, use a Semi-supervised learning model to label and rank web pages in their search results. There are billons of websites on the internet with different classified content. To make this information available to web users requires a vast team of human resources who can organize and classify the content on the web pages.

3.Banking

The framework is prepared based on current samples and algorithms presented by the developer. Semi-Supervised algorithms work best here with control data. SSL can help in banking for various activities. For sample: To identify cases of extortion. Here, the developer can use some examples of extortion cases as a labeled data set.

4.Reinforcement Learning:

With reinforcement learning, an AI agent (a software component) automatically explores its surroundings by striking and trailing, acting, learning from experiences, and increasing performance. Reinforcement learning operates on a feedback-based method. The objective of a reinforcement learning agent is to maximize the rewards since the agent is rewarded for every good activity and penalized for every bad action.

The Markov Decision Process (MDP) can be used to formalize a reinforcement learning problem. In MDP, the agent continuously engages with the environment and takes actions. The environment reacts to each action and creates a new state.

Advantage and Disadvantage of Reinforcement Learning:

Advantages

- It helps in solving complex real-world problems which are difficult to be solved by general techniques.
- The learning model of RL is similar to the learning of human beings; hence most accurate results can be found.
- Helps in achieving long term results.

Disadvantages

- RL algorithms are not preferred for simple problems.
- RL algorithms require huge data and computations.
- Too much reinforcement learning can lead to an overload of states which can weak the results.

Applications of Reinforcement Learning.

1.Video Games.

RL algorithms are widely used in gaming software. It is utilized to perform at a superhuman level. The video games Alpha GO and Alpha GO Zero are examples of well-known RL algorithms.

2.Resource Management.

In order to reduce average job slowdown, the "Resource Management with Deep Reinforcement Learning" study demonstrated how to utilize RL in computers to automatically learn and arrange resources to wait for various jobs.

3.Robotics.

Robotics applications employ RL extensively. In the industrial and manufacturing sectors, robots are deployed, and reinforcement learning is used to increase their power. The development of intelligent robots utilizing AI and machine learning technologies is a goal shared by many sectors.

4.Text Mining.

Text-mining, one of the great applications of NLP, is now being implemented with the help of Reinforcement Learning by Salesforce company.

CONCLUSION

Both supervised and unsupervised machine learning are possible. Choose supervised learning if you have fewer data points with well marked training data. For huge data sets, unsupervised learning would typically perform and produce superior outcomes. Consider using deep learning techniques if you have a sizable data set that is easily accessible. Additionally, you studied Deep Reinforcement Learning and Reinforcement Learning. You now have a better understanding of neural networks, their uses, and their drawbacks. The title and abstract inclusion screening procedure might benefit from the application of machine learning techniques used in systematic evaluations of complicated research topics, such as quality improvement. The accessibility of the current evidence is a special problem of the study field quality improvement, and machine learning technologies are of particular relevance in light of the continually rising search outputs.

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