

History of Machine learning Algorithms submitted to Liverpool Hope University

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Abstract

Machine Learning algorithms have evolved to solve ever more sophisticated problems. Write about the history of machine learning, including a discussion of important algorithms

This essay will discuss the history of Machine learning, how it evolved, how its used in todays world and how it works. The area of focus will consist of what is a machine learning algorithm then follow with the 4 main types of algorithms, what they are, what they do. The results and findings section will give a brief description on the most popular machine learning algorithms as of 2020 such as K-means, linear regression and more. While the analysis section will discuss how these algorithms are used in today's world particularly in the health sector. The future of machine learning will also have a brief discussion on how it may have an impact on future jobs and the technology itself.

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Intro & Background

This research paper will discuss the history of Machine learning algorithms, this includes when it was first created, why it was created and how it evolved. In addition to this there will also be a discussion of the important algorithms. Machine Learning is extremely important for both research and business in today's world. With the use of algorithms and neural network models computer systems performance is progressively improving.

The History of Machine Learning Evolving

Machine Learning (ML) is partially based on a model of brain cell interaction; the model was created in 1949 by Donald Hebb. However, the term ml was invented in 1952 by the American computer scientist Arthur Samuel. Arthur developed a computer program for playing checkers and made use of alpha-beta pruning as the program has a very small amount of computer memory. The program would make use of the minimax strategy which evolved into the minimax algorithm. After designing a number of mechanisms allowing the program to become better, the program remembered all positions it had undertaken in what he called rote learning. In 1957 Frank Rosenblatt combined Donald Hebb's model with Samuel's Machine Learning efforts and created the perception. The software was installed on a custom machine which had been named Mark 1 Perception. It had been constructed for image recognition, this machine is described as the first successful neurocomputer however it developed some problems. What seemed promising could not recognize many visual patterns, this stalled neural network research after 7 long years investors and funding faded. Machine learning research struggled until a resurgence in the 1990's.

The Nearest Neighbour Algorithm was first conceived in 1967 Marcello Pelillo had been given credit for the invention. The algorithm was used for mapping routes, which was one of the earliest algorithms used in finding a solution to the problem of the travelling salesperson's problem of finding the route that is most efficient. However, this isn't the only discovery of the 60's that deserves note as this was also the decade upon which the next step was provided, the discovery of Multilayers. The discovery and use of multilayers opened a new path in neural network research. The discovery had determined that using two or more layers in perception provided a huge boost to processing power rather than using a single layer. This opened doors for new neural networks to be created making use of this discovery which led to feedforward neural networks and backpropagation.

In the 1970's, Backpropagation was developed which allowed the network to adjust the hidden layers of neurons/ nodes to adapt to new situations. Backpropagation is now used to train deep neural networks. In the late 1970's/ early 80's AI had changed its approach, now it would focus on logical knowledge-based approaches in place of algorithms and thus neural networks research had been abandoned by the researchers and scientists. ML and AI finally take their separate paths. The ML industry drastically changed as a reaction to this, large numbers of technicians and researchers had been transferred to different fields which led to a long decade of struggle. As the internet began to grow in the 90's the ML industry had its focus on neural networks which flourished., as the internet was an ever-growing abundance of digital data and the ability to share across the net, this created the perfect recipe needed for ML.

A considerable problem with ML was always that of bias in data and once the next stage of evolution in ML was discovered the weak algorithms had been converted into strong learners, this discovery was Boosting. The Concept of boosting had been first established in a paper in the early 90's by Robert Schapire. Majority of the boosting algorithms are cultivated from weak learning classifiers that are repetitive, which are then combined to a strong classifier.

Speech recognition is seen everywhere in today's world be that a desktop, mobile, watch or even a tv and currently a lot of that would not be possible without the use of Long Short-Term Memory, this neural network model was first considered in the 1997 by Jürgen Schmidhuber & Sepp Reiter. Something that's important for speech is the ability to learn tasks that need a memory of the events that happened many discrete steps earlier, and that is something that the Long Short-Term Memory has the ability to do. Fast forward 10 years later the Long Short-Term Memory began to be more effective than traditional speech recognition. When used in the Google speech recognition program it had been reported that there had been a huge jump of performance to approximately 49% using the Long Term-Short Memory model.

The Face Recognition Grand Challenge was a National Institute of Standards and Technology program they had a primary goal in which was to promote, and advance facial recognition technology designed to support existing face recognition efforts to the US govt. In 2006 they evaluated a lot of the popular algorithms for facial recognition of the time. They tested many different things such as the 3D face scans, high-resolution face images and even iris images. They had discovered some interesting findings that suggested the accuracy of algorithms had become ten times more reliable than those algorithms of the year 2002. In addition to this they discovered they were 100 times more precise than those of 1995 even some of the algorithms studied and tested appeared to be able to outperform the human participants in recognising human faces and could even accurately identify identical twins.

Machine Learning at Present

ML has been defined by Stanford University in recent years as follows "the science of getting computers to act without being explicitly programmed." Many major advancements in technology are a direct result of ML, such as the new industry of self-driving cars. ML has also prompted many new concepts such as chatbots and analytic tools. ML has become essential for big business in today's world doing things such as Analysing sales data, Fraud detection by detecting a change in pattern, dynamic pricing that creates flexible pricing based on need and/or demand and much more. The models have become extremely adaptive in continuously learning, increasing their accuracy the longer they operate. ML algorithms combined with new technologies promote scalability and improve efficiency, combining this from a business point this increases funding and investors. With the technology and investments one thing is clear: Machine learning will continuously develop and progress.

Area of focus

The History and evolution have now been covered however this section of the paper will answer what is Machine Learning? This section will also explain the types of Machine Learning Algorithms.

What are Machine Learning Algorithms?

Machine learning (ML) is often, incorrectly, mistaken for Artificial Intelligence, however Machine learning is a subset of artificial intelligence, ML is also often referred to as predictive analytics, or predictive modelling. It is defined as a computer's ability to learn without being explicitly programmed. Essentially ML uses programmed algorithms that receive input data and then analyse that data to predict output values within an acceptable range. The algorithm will optimise and learn its operations to improve performance, this is achieved as the algorithm is supplied with new data therefore developing "intelligence" over time. This is just a run down there are many factors and other steps involved. There are 4 different types of algorithms which will be discussed below.

Types of Algorithms

Supervised learning

This is when the machine is taught by example. Supervised learning gets its term from the idea that an algorithm learns from a training dataset, a good way of thinking of this is a teacher. The user provides the ML algorithm with a known dataset that includes both the inputs and outputs, then the algorithm will find a method to locate the inputs and outputs. As the user provides the algorithm with the essential data, they already know the correct answers, however the algorithm detects patterns in the data, learning from the observations giving it the ability to make predictions. This is an iterative process as the algorithm makes the predictions the user will correct them, this process will continue for as long as necessary until the algorithm acquires an acceptable level of accuracy.

Supervised learning applications are usually dissected down into two categories which are classification and regression. Classification is the process where the ML algorithm must observe values and determine the category upon which the new values belong, an example of this would be classifying an email as spam or not. Regression is when the ML algorithm must estimate and understand the relationships between the variables; an example of this would be predicting property price. Common supervised machine learning algorithms are Linear regression, Decision trees and Random forests.

Unsupervised learning

Unlike Supervised learning, Unsupervised learning has the luxury of not requiring the developer to have direct control. Another major difference is that with supervised learning the developer sorts out the data, as the data is known/understood. However, with unsupervised learning the results are unknown and undefined. Unsupervised machine learning algorithms can be used for a lot of things such as getting valuable insights or finding a pattern. Essentially what it does is goes through information and makes sense of it to then describe the information.

Unsupervised learning makes use of two techniques to describe the data, clustering and dimensionality reduction. Clustering explores data used to break it into groups that make sense. This is done entirely based on patterns no other information is given beforehand of the group. The groups will be defined by how similar the data is, it can also detect anomalies by inspecting how unlike the other data it may be. Unsupervised algorithms are typically used for digital marketing, Common supervised Machine Learning algorithms are K-means clustering, Association rule and PCA.

Semi-supervised learning

The semi supervised learning model combines aspects from the supervised and unsupervised models. It trains itself by using a limited set of sample data that's been labelled in order to get an idea of the operation. These methods exploit the idea that even though the group memberships of the unlabelled data are unknown, this data carries important information about the group parameters. Semi-supervised learning makes use of the process classification, this lets it locate data assets. It also uses the clustering process to group them into distinct parts.

Reinforcement learning

Reinforcement learning is a self-sustained system, this system improves itself through trial and error sequence. Making use of labelled data and interacting with incoming data is how reinforcement learning improves itself. The technique used by reinforcement learning is called exploration, it works by observing the consequences of an action that takes place which in turn then the reinforcement learning will consider the next action based on the previous results.

The algorithms are guided in some form by signals which will be activated after completing the tasks in specific ways known as positive reward signals. There are also Negative reward signals which essentially work the opposite of positive reward signals. Essentially the algorithm will aim for positive rewards as much as possible and attempt to avoid the negatives. The signals could be classified further; it all depends on the requirements of an operation given and this is why the reward signals may vary.

Reinforcement machine learning algorithms have a multitude of uses. One such use is video games, particularly modern NPC'S. The reason this particular type of algorithm is used is due to the flexibility it provides which is necessary for video games AI reactions to the players actions. One example of this use would be in Grand Theft Auto when a player collides with vehicles or NPCs in game the reactions are a result of reinforcement learning. Common reinforcement learning algorithms are Q learning, Temporal difference and Asynchronous actor-critic agents

Results and findings using data

Now that the history and understanding of Machine Learning Algorithms, what Machine Learning is and the types of ML algorithms have been discussed, this section will discuss some of the important ML algorithms explaining why they're important in addition to the use they have. There are many different ML algorithms however some stand out to be used more often than some and these are the ones that will be discussed. Furthermore, their effectiveness using data will also be discussed.

The most common and popular machine learning algorithms?

Linear Regression

The task that linear regression performs is the prediction of a dependent variable value based on a given independent variable. With this data this technique aims to discover a linear relationship of both the dependent and independent value. The reason this model is so popular is the simplicity of it. Some ways the linear regression algorithm is used are in salary forecasting, real estate predictions and financial portfolio predictions

Logistic Regression

Logistic regression is used for classification problems. It's used to assign observations to a discrete set of classes, essentially a predictive analysis algorithm in the form of probability. The popularity of logistic regression is due to it being used by banks for online fraud determining whether or not its fraud additionally it's used for emails spam or not spam. These are modern problems that thanks to Logistic regression now have a modern solution.

Decision Tree

Decision trees are a graphical representation of possible answers to decisions based on specific conditions. The reason it's called a Decision Tree is due to the nature of a tree having branches. The diagram is similar in this way as it begins with a single box which then branches into a number of options that are available just like a tree.

K-Means

K-means is one of the simplest and popular unsupervised machine learning algorithms. The popularity is a direct outcome of its simplicity and efficiency. The algorithm identifies the K number of centroids (thus the name) and follows by allocating every data point to the nearest cluster while simultaneously keeping the centroids as small as possible.

Random Forest

Random forests algorithm is quite similar to the Decision tree algorithm essentially it is multiple decision trees merged together for a more accurate and stable prediction. The idea was that a combination of learning models would increase the overall result.

Analysis

This section of the paper will discuss the future of Machine Learning algorithms. This includes new theoretical technologies that may replace it or come from it. In addition to this the discussion of how its importance will change in the expanding world of business.

How Machine learning is used in the world today

Machine learning has had serious implications on the industry and workforce alike. Some consider this an extremely helpful utility in today's world reducing cost while simultaneously increasing efficiency. However, others see it as a catastrophe as the algorithms replace people's jobs and this increases unemployment and wealth. Google, amazon and Netflix use ML algorithms to deliver meaningful results on their sites by analysing the users search history. This lets them refer to what they are looking for using prediction which saves the user time and earns these companies money.

Health

Machine learning algorithms have been a great help in the healthcare sector, now being used on a daily basis particularly being used to help diagnose patients quicker. Along with this is predicting potential health issues a patient may have based on age, history etc this is how ML has been helping with disease prevention. The programs analyse and cross examine symptoms using databases containing millions of additional cases, illnesses and diseases. This is wonderful as less team required to diagnose a patient means more time to treat them which saves lives. ML algorithms have been implemented into radiology scans to accurately detect tumours in addition to analysing moles for skin cancer. Furthermore, ML has been used for research into medicines and cures including cancer.

Law

Law firms have been leaning towards ML algorithms to process enormous amounts of legal data. A fine example of this would be the use of the software named COIN aka control intelligence by J/P Morgan. It reviews previous case files and documents in seconds whereas without COIN this would take approximately 300,000-man hours.

The Future of Machine Learning Algorithms

The future that ML algorithms could bring is exciting, as mentioned previously ML is already being used to help with medication research which over time will create cures saving a multitude of lives and research hours. Machine learning has also been a great step into self-driving vehicles by using all the data collected making them more and more efficient the more they are used for now humans tend to be better drivers however in the years to come maybe driving accidents will be a thing of the past. A major concern however is and always will be the loss of jobs to ML and with self-driven vehicles this could soon be the reality for delivery trucks that carry cargo across the country. However, like with the industrial revolution this could in turn create new jobs that we yet aren't aware of or even require additional workers in a lot of other fields.

Conclusion

To conclude this essay the journey of ML algorithms has been a long and hard one. What first started with a small game in the early 1950's has been transformed into a global tool for industry, medicine and even everyday life. However, the journey for ML is far from over in ways which we can't understand yet. Particularly with the rise of IoT gaining more traction daily in addition to 5G the future of all these technologies combined will transform the world and our daily lives.