Machine Learning using Unconventional Methods

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1 Introduction

What do healthcare patient analysis systems, aerospace control systems, social media recommendations, and weather forecasting all have in common? They all use machine learning, an evolutionary algorithm mimicking human way of learning that benefits from the extreme speed and vast knowledge bases of modern computers. [10]

Evolutionary algorithm refers to an algorithm capable of self-correcting and self-improving, achieved by Darwinian-like natural selection, reproduction and mutation. [2]

The main three machine learning methods are Supervised, Unsupervised and Reinforcement. Each of these methods are designed to tackle specific types of problems.

Supervised learning is where we tell the computer "this is an input and this is the expected output". It requires immense amount of data and manual labelling. Can be used for converting handwritten text into digital text.

Unsupervised learning is used to analyse patterns in data and doesn't require manually labelling. DNA pattern analysis, fraud detection or predictive maintenance is where this method shines. A popular algorithm for this is K-means clustering, [11] [13] it is grouping data together into K-number of groups, by the use of heuristics. Which simply give the algorithm a measure of progress.

In other circumstances we have a general idea of what the problem is, but would like the computer to come up with its own solution. One example could be making a user of a social media app stay as long as possible. This is known as reinforcement learning. It uses a "reward" and "punishment" system to give feedback to the network, which it uses to self-configure. [6]

However neural networks on their own cannot learn complex data as the output of a neuron cannot be interpreted as an input to another. This is a problem that activation functions solve. They are used to make the network non-linear, without it inputs will be proportional to the output in a linear fashion, cancelling any progress. Additionally it helps converge to a stable output much more quickly. [4]

Machine learning has seen a huge popularity rise in the recent years, because they are the only algorithms capable of understanding and processing data, which was previously known only to be understood by humans. A similar problem of interpretation also arises for human-specific data.

2 What Changed?

Images, speech, text are forms of data that are especially difficult for computers to interpret. However for humans these 3 data types are vital. We are social creatures heavily dependent on all forms of verbal and non-verbal communication. [8] Machine learning allows computers to easily deal with these types of data opening new possibilities for synergistic relationships in previously human exclusive fields.

Facebook has around 350 million photos being uploaded daily. [8] It would be impossible for employees to manually scan every photo individually for any explicit content. At this scale utilising multiple neural networks is not only faster but also gives more accurate results. This technology is called deep learning, which uses three or more layers of network, drastically increasing the learning potential. Each layer simplifies the problem for the next, gradually lowering complexity. [14]

Other notable example of deep learning is Apple Face ID which is a system that unlocks the phone if a familiar face is detected. The most impressive part of this technology, is the ability to detect faces even after having major changes in appearance, such as growing or shaving facial hair, wearing sunglasses or a face mask. It uses infrared cameras allowing the network to recognise a face even in the darkness. [5]

Google heavily uses deep learning in its translation system. The problem with languages is that we cannot translate each word verbatim as context can massively influence the translation. This system is able to understand context and translate sentences with high accuracy. This is extremely important as it helps people communicate with other cultures and opens up the amount of information we can understand on the internet.

Natural language processing systems are extremely complex. System needs to understand context of the sentence and each individual word. GPT-3 is currently the biggest deep learning system [16] which aims to solve all problems relating to natural language processing. It has been trained on 45TB [7] of text data (for comparison the whole harry potter book series is 13MB [3]). It has already proven to be extremely viable in simplifying survey answers to speed up data analysis [16], creating a unique interactive story for anyone to experience [1], simplify search queries for customers [16]. It's prominent usage is the backbone of GitHub's Copilot which helps programmers with tedious and repetitive code. On top of the 45TB of training data, it also makes use of open source code to learn the structure of programs.

Image tagging systems are used in various systems, like allowing users to search social media for specific keywords or people. Android uses this to automatically create albums or let the user search the gallery. It uses computer vision to assign common tags such as "cat", "animal", "sunset", "vehicles" or "food" which can be filtered. It is very fast so can be used for searching large amounts of pictures proficiently.

Programming has evolved from doing math and transforming that into logic which then controls systems, to using evolutionary systems that adapt to what kind of output we expect. However deep learning isn't a solution to everything, it lacks the idea of "creativity" as it follows strict rules.

3 What Now?

Generative Adversarial Networks (GANs) are a special kind of neural network, highly capable of creating information that fits into the context of the data. [15] One of examples is restoration of old photos. It is not only capable of fixing damaged or corrupted parts of an image, but also restoring the color making it more realistic.

It consists of two networks, the generator G(x) and the discriminator D(x). Generator's job is to create images that are similar enough to the training data, so that it fools the discriminator. Whilst the discriminator tries not to be fooled by the generator, by identifying fake data from real data. D(x) returns 1 when data is real, and 0 when data is fake. The idea is to have a generator that maximizes output value of D(x). [12] Comparably this can be used to restore videos, as we can extract individual frames and feed them into G(x), saving the output and recreating the video from newly generated images. This is commonly used to generate more frames in a video resulting in higher (smoother) frame rate. Combining this with super resolution GANs we can substantially enhance the overall quality.

Famous example of GANs being used in the real world, is a movie "The Irishman". It has used deep-fake technology to de-age Robert De Niro in a very convincing manner. Similarly if an actor gets sick or dies in the middle of movie production, they can be replaced with a deep fake allowing to continue filming.

4 What the future might look like?

With advancements of computing power slowing down, and Moore's law becoming obsolete, new methods of computing are being developed. Quantum computing has a huge potential to increase potential of machine learning [18]. It allows for simultaneous operations massively increasing data processing speed.

> "The technology giant's Sycamore quantum processor was able to perform a specific task in 200 seconds that would take the world's best supercomputer 10,000 years to complete." [17]

4.1 Medicine

Current disease prediction models use simple variables such as: gender, age, height, weight but machine learning is capable of finding relationships between thousands of variables at the same time, increasing the potential for extremely accurate disease detection. [9] There is a huge potential to create a deep learning network capable of mapping symptoms to potential illnesses, given medical history.

4.2 Self-Driving Traffic Systems

Humans are flawed-machines, there is always a potential for error no matter how much we train and learn. Some errors might even be fatal. It is quite obvious that self driving cars are the future of automotive industry, but I think that traffic management will be greatly improved with machine learning. Nearby cars would communicate with each other, removing the need for traffic lights and enhance efficiency of travelling.

References

[1] Ai dungeon. https://play.aidungeon.io.

[2] Evolutionary algorithm. https://www.cognizant.com/us/en/glossary/evolutionary-algorithm.

[3] Harry potter: The complete collection (1-7) by jk rowling. https://www.barnesandnoble.com/w/harry-potter-jk-rowling/1123152409.

[4] What if we do not apply activation to the hidden layers and only to the output layer of a feed forward neural network? 2018. https://stackoverflow.com/questions/46659525/what-if-we-do-not-apply-activation-to-the-hidden-layers-and-only-to-the-output-l.

[5] About face id advanced technology. 2021. https://support.apple.com/en-us/HT208108.

[6] Joseph M. Carew. Reinforcement learning. 2021. https://www.techtarget.com/searchenterpriseai/definition/reinforcement-learning.

[7] Kindra Cooper. Openai gpt-3: Everything you need to know. 2021. https://www.springboard.com/blog/ai-machine-learning/machine-learning-gpt-3-open-ai/.

[8] Adit Deshpande. The last 5 years in deep learning. 2017. https://adeshpande3.github.io/The-Last-5-Years-in-Deep-Learning.

[9] Homin Lee Young-Jin Kim Yeongsic Kim Young Hoon Park Dong Jin Park, Min Woo Park. Development of machine learning model for diagnostic disease prediction based on labolatory tests. 2021. https://www.nature.com/articles/s41598-021-87171-5.

[10] IBM Cloud Education. Machine learning. 2020. https://www.ibm.com/cloud/learn/machine-learning.

[11] Dr. Michael J. Garbade. Understanding k-means clustering in machine learning. 2018. https://towardsdatascience.com/understanding-k-means-clustering-in-machine-learning-6a6e67336aa1.

[12] Shweta Goyal. Gans — a brief introduction to generative adversarial networks. 2019. https://medium.com/analytics-vidhya/gans-a-brief-introduction-to-generative-adversarial-networks-f06216c7200e9.

[13] Lynn Heidmann. Unsupervised machine learning use cases. 2020. https://blog.dataiku.com/unsupervised-machine-learning-use-cases-examples.

[14] Jason Brownlee PhD. Crash course on multi-layer perceptron neural networks. 2016. https://machinelearningmastery.com/neural-networks-crash-course/.

[15] Jason Brownlee PhD. 18 impressive applications of generative adversarial networks (gans). 2019. https://machinelearningmastery.com/impressive-applications-of-generative-adversarial-networks/.

[16] Natalie Pistunovich. Gpt-3 powers the next generation of apps. 2021. https://openai.com/blog/gpt-3-apps/.

[17] Paul Rincon. Google claims 'quantum supremacy' for computer. 2019. https://www.bbc.co.uk/news/science-environment-50154993.

[18] Olha Zhydik. What does the future of machine learning look like? 2021. https://eleks.com/blog/future-of-machine-learning/.