A STUDY OF NEURAL NETWORKS IN SOCIETY

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Analysis

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Introduction

Since computers were first created, the complexities of computers have grown from simple calculations to word processing, and to communication and file sharing around the world. Along side these developments, has been a constant quest for the creation of something more real, something more in touch with human nature. Something more, intelligent.

Neural networks are the backbone of this drive, they are the buildings blocks of artificial intelligence, and they drive the development of “intelligent” technologies today. We see implementations of artificial intelligence in self-driving cars, image generation and manipulation, and in the medical industry.

As artificial intelligence is implemented across the board, it is important to understand what drives these intelligent applications and devices, or at least, what makes them present themselves as “intelligent”.

Artificial Intelligence vs Neural Networks

With the rate in which A.I products have become available to consumers around the world, it would seem to be the case that people are losing sight of what artificial intelligence actually is. Before exploring the functionality of neural networks, I must therefore highlight the difference between the two concepts.

Artificial intelligence is an umbrella term that surrounds the usage of neural networks, and large datasets. The implementation of neural networks and datasets is what powers an A.I technology and create what is considered to be computer intelligence.

Neural networks are logic based algorithms that are trained on datasets to calculate outcomes based on inputs, they are adapted over time by either the programmers themselves, or machine learning functionalities.

Machine learning is the process of programming a neural network in a fashion that allows for the input of data, the response to be validated by a human, and subsequently re-defining the actual correct output for the neural network, thus, educating the neural network by instructing it what the correct output is if it had returned the wrong output.

These three processes are commonly mis-interpreted and combined under the over arching concept of Artificial Intelligence, it is important that when analysing and exploring the processes of a neural network, that we keep a clear distinction between them even though they all work together to create Artificial Intelligence technologies.

The Structure of Neural Networks

A neural network can be visualised as a spreadsheet, rows representing an input, and the columns each row passes through, represents the different calculations or adjustments made to the input until the data reaches the final column, the output. Whilst this analogy allows a simplistic visualization of the process, it is important to note that neural networks are structured differently depending on their purpose, desired runtime (time to complete a calculation), and the volume of data anticipated to pass through a network.

When considering analogies for neural networks, its essential to be aware of the three common layers to a network, these layers are the Input layer, the hidden layer(s), and the output layer. Combined they are capable of processing an input and designating the appropriate output based off the networks previously provided training data.

It is important to note that the number of hidden layers depends on the functionality of the network and the complexity of the problem the network is designed to solve. We can think of the hidden layers as the aisles in a shop, and the nodes within each hidden layer as the different products in those aisles, each product is unique, but only one item in each aisle of the shop meets the appropriate criteria on the shopping list.

Types of Neural Networks

Feedforward Neural Networks

Feedforward neural networks follow the most simplistic topology of all, they work step by step moving layer to layer until reaching the output layer. They follow the standard topology of an input layer, many hidden layers, and the output layer. They are suitable for a range of tasks from image recognition, speech recognition, and natural language processing. Most notably, natural language processing is the process of generating text in the same typography and grammatical structure of the natural language model provided to the network. An example of this behaviour is that of ChatGPT from OpenAI. ChatGPT makes use of an extremely advanced neural network with a large natural language model to respond to users in the style of a human.

In feedforward neural networks, data is passed into the network, and it travels through each hidden layer, visiting each node/neuron in the layer where they perform a weighted sum of the inputs, apply an activation function, and pass the output to the next layer of the network.

These neurons have weights and biases applied to them, these are values which effect the behaviour of the nodes or entire layers, and often the entire network. The weightings are edited and adjusted either on the creation of the network, or by the machine learning capability of the model which allows it to adjust its own weightings and biases as deemed fit, to improve the accuracy of outputs from the network.

Perceptron

Perceptron networks are the earliest known development of neural networks, they were first developed and implemented in 1958 and operate in a more simplistic style. They are singly layer networks which take an input, pass through one layer, then output the results. These networks are useful for extremely simple tasks, but are not considered implementable in Artificial Intelligence, and do not present themselves as an intelligent resource, rather an algorithmic process.

The implementations of these networks, however, is vast, they are used for image recognition, signal processing, and other complex tasks by repeating the usage of the same network. However, the network have difficulty working with complex problems due to the concise single layer nature of the networks. Furthermore, the network can only work with problems whereby the data is able to be separated into two categories. This is known as a linearly separable problem, and with the growth and demand for more complex problem-solving capabilities, these networks are becoming less applicable as the demand for more complex networks increases.

Similarly to the feedforward networks, these networks apply weights and sum calculations and make use of activation functions to return an output. Alike the feedforwarding networks these networks activation functions have thresholds which return incremental values between 1 and 0.

Multilayer Perceptron (MLP)

A multilayer perceptron network is a more commonly used network, the principal is simple, it's a layered network consisting of multiple more simple perceptron networks. They therefore fall into the classification of being a feedforward network.

The layers in an MLP are simplistic and feed the output from each layer directly into the next, they are each responsible for converting their inputs into the most accurate prediction available.

However, the MPL networks are considerably less efficient than some feedforward networks due to the stacking of the perceptron networks, gradually decreasing efficiency as repetitive tasks are looped.

Recurrent Neural Network (RNN)

These networks are built to convert sequential data. They are necessary for text and speech processing. The structure makes use of recurrent neutrons. These store data on previous input data and provide what appears to be memory or previous data points. This is extremely useful for conversational networks and other textual content.

It is most likely that OpenAI makes use of a RNN for the processing on ChatGPT, as it allows the model to remember previous data points and communicate in the same way as before.

RNN's can be manipulated by machine learning to train the network to improve its own performance as more data travels through the network. This confirms the validity of the outputs as they become incrementally more accurate as machine learning processes the outputs.

Implementations of Networks

Whilst networks are a concept which are under considerable work and research, we are able to see the possibilities and implementations which networks are revealing. The implementations have the potential to change the way in which we interact with one another socially, and to improve efficiency and development of technology. The potential with neural networks is arguably infinite as the networks develop the possibilities are being rapidly unveiled.

It is important to note that neural networks can be used without implementing in Artificial Intelligence instances, the performance of these networks is often considerably more accurate for their specific functions than a combined artificial intelligence technology.

Some of the implementations of neural networks involves profiling, validation and verification, and prediction. These implementations are a few of many.

Profiling

Neural networks can perform a range of tasks as detailed above, but one of the most controversial is that of profiling, whether it be human profiling, or profiling of objects and data, the topic of profiling is of concern to many individuals as it moves towards categorising items and potentially people by analysing their personality traits or in some instance physical appearances and heritage.

A system example of a profiling network could be extremely beneficial to law enforcement or advertising services, allowing for selecting the appropriate individuals based on their identity.

An example of social profiling could involve a vehicle crime prediction system. Road ANPR cameras make use of a neural network to analyse traffic that passes through the cameras, acquiring the colour of the vehicle, the identity of the driver, the model of the vehicle, the speed, and the time. By feeding these values into a neural network, law enforcement technology could automatically predict the likelihood of a vehicle committing a crime, and subsequently notify officers of the presence of likely criminally involved vehicles in the crime radius after a crime, thus allowing officers to narrow down potential suspects.

A use case like this can be seen as invasive and stereotyping, whilst this may resonate with some truth, it is important to consider that many technologies already performed by law enforcement and other services follow similar agendas. The only difference here is that the technology is performed by a network as opposed to humans.

Validation and Verification

Validation and verification are tasks often performed by humans for government processes due to the sensitive nature of data, however, with a powerful neural network, validation and verification is a process that could be automated. The nature of the improvements are that of increased privacy and security for individuals as their data is not being seen by government employees. This removes the risk of both human error and fraud.

Whilst this increases the risk of failures in the system, this is only in the short term, as the longer the network is in action for, the better the performance gets if machine learning is implemented in the system.

It is again important to consider the other ranges of implementations of neural network validation in commercial applications. Social media platforms and businesses often need to validate customers, and by implementing neural network validation would remove security risks across the board. Allowing for a faster, safer, and more accurate process in validation and verification of identity.

Despite protest by a portion of society to remove the computational implementation of technology in public services, it is possible to suggest that it has never been more important to consider these implementations for financial gain and time saving aspects alongside the safety increase.

Prediction

Prediction is a key functionality of neural networks and has possibility for implementations from both commercial and government services. Installing neural networks in insurance businesses and other such commercial applications, can allow insurance agencies to charge less for insurance as they are able to make more accurate and improved predictions with neural networks as opposed to referencing potentially old and unchanged assumptions. Inherently machine learning ensures that networks are updated in line with new accuracy, so as the correct outcomes change, the model changes to support them. Therefore, if younger individuals became more careful drivers, then insurance agencies could accurately lower insurance premiums by using their neural network which updates to support the new data.

Government implications of neural network prediction can range from weather prediction for warning citizens of climate threats to biological hazards alerts. Personally, these implications significantly outweigh the risks involved with neural networks of invalid predictions and the machine learning curve involved.

Whilst many services can be predicted with simplicity, it will be interesting to see how neural networks progress into society, we can except to see unusual implementation of neural networks in extremely specific use cases across the field.

Conclusion

The implementation of neural networks in society has created a transformation, impacting how we live, work, and interact. As shown by their presence in fields ranging from healthcare to finance, from entertainment to transportation, neural networks have emerged as indispensable tools driving innovation and progress.

One of the most remarkable aspects of neural networks is their ability to learn complex patterns and relationships from vast amounts of data. This capacity has revolutionized industries by enabling increasingly accurate predictions, faster decision-making, and enhanced efficiency. In healthcare, for instance, neural networks are assisting medical professionals in diagnosing diseases, personalizing treatment plans, and predicting patient outcomes with unprecedented accuracy. Similarly, in finance, these networks are being leveraged to detect fraudulent activities, optimize trading strategies, and assess credit risks, thereby enhancing the stability and transparency of financial systems.

Moreover, the integration of neural networks into everyday devices and applications has simplified access to advanced technologies. From virtual assistants that understand and respond to natural language to autonomous vehicles that navigate complex environments, neural networks are increasingly shaping our interactions with technology. This enhance functionality not only enhances user experience but also fosters inclusivity by making sophisticated tools accessible to a broader segment of the population.

However, the widespread adoption of neural networks also raises ethical, social, and economic considerations that warrant careful attention. Concerns surrounding data privacy, algorithmic bias, and job displacement underscore the need for robust regulatory frameworks, ethical guidelines, and responsible deployment practices. Moreover, as neural networks become more autonomous and sophisticated, ensuring transparency, accountability, and human oversight becomes imperative to mitigate potential risks and safeguard against unintended consequences.

In conclusion, the implementation of neural networks in society represents a double-edged sword, offering immense opportunities for progress while posing significant challenges and responsibilities. By fostering interdisciplinary collaboration, promoting ethical principles, and prioritizing human-centric design, we can harness the full potential of neural networks to create a more equitable, inclusive, and sustainable future for all.