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A Report of the History of *Deep Learning for AI*

*Deep Learning for AI* by John D. Kelleher serves to provide its readers fundamental knowledge - and history - of the workings of deep learning. Deep learning is a field of artificial intelligence (AI) that focuses on creating and designing algorithms to make data-driven decisions. In particular deep learning thrives when the dataset given, in regards to the inputs into the algorithm to its output, is complex and easy to generate. Examples are datasets of medical images such as X-rays or summarized game data such as chess or Go. This report describes the three periods of innovation in the history of deep learning as this outlook into the past shows our proud progression to the present day and the potentials of the fascinating future.

The first innovation occurs in the early 1940s to 1960s when threshold logic units were developed. Threshold logic units are simple neural networks that estimate a Boolean output from Boolean inputs. In this period, researchers wondered what the true potential of artificial learning was and started trying to figure the inner mechanisms of AI using limited knowledge (e.g., Rosenblatt’s learning rule). Then, the development of neurons or simple processing units improves the algorithm’s learning capability by taking in input values from the dataset and converting them into potentially accurate output values. These neurons work by calculating the input values’ weighted summations and using a nonlinear function to process the summation.

The second boom of deep learning starts in the early 1980s to 1990s when connectionism revived the field of AI. Connectionism is the concept that the activity between neurons can model intelligence. This became an underlying foundation for Hopfield networks and backpropagation. The purpose of the Hopfield network is to operate as an “associative memory”. This means that once a neural network is trained, it could ignore corrupted inputs and continue to function properly. The backpropagation algorithm is a gradient descent algorithm that, to this day, is one of the more important algorithms of deep learning. Furthermore, it works by taking in random inputs from the dataset, calculating its output using training data, and then reverse-calculating the input using the found output. When backpropagation reverse-calculates the input value, it finds the error for each neuron (that calculates the output). This allows effective updating of all the neuron weights in the learning algorithm using each node relationship. This algorithm is considered revolutionary. The reason why backpropagation was able to be developed is due to activation functions becoming differentiable. Previously, threshold activation functions were discontinuous at the threshold of the output function (thus being technically infinite at that point). Sadly, backpropagation has its downsides. It can be inaccurate or take an inordinate amount of time to run large networks (i.e., algorithms with multiple neuron layers). This happens when calculating the error for each neuron as the error to update each weight slowly devalues to become smaller and smaller with each step that stacks negatively in large datasets and causes the neurons to be trained at a very slow pace.

The third (and present) innovation period begins in the mid-2000s when researchers started to focus more on deep learning as algorithms were being built using more neurons with more layers. Currently, technology in general is rapidly improving and research shows that previous limits (like the vanishing gradient problem) can and may be overcome. Additionally, technology has progressed to such a great degree that previous inefficient calculations can now be done because of increases in computational power. Large companies such as Facebook and Google are realizing the profit in using deep learning in their business structures (e.g., online advertising) and contributing large amount of funding for deep learning research and development to incentivize advances in this area.

In conclusion, deep learning is a prominent field of AI. It has three periods of innovation that continues today to showcase the trials and tribulations of its past. Knowing how deep learning waned and rose in the past with its corresponding achievements to each period is fascinating. Now deep learning is an incredibly powerful field and continues to affects our lives on a daily basis.