# Researching Stage 9 – Improving Predictions

## Machine Learning

Guresen, Kavakutlu, and Daim (2011) explored comparing the performance of the traditional multilayer perceptron (MLP), the dynamic artificial neural network (DAN2), and a hybrid neural network which uses generalised autoregressive conditional heteroscedasticity (GARCH) for predicting daily exchange rate values of the NASDAQ stock exchange index. This study was done because it is widely accepted that with the correct level of training artificial neural networks achieve more accuracy than traditional methods in the majority of scenarios, but they are rarely compared with each other. The conclusion was that the multilayer perceptron was superior at the time, but they predicted that DAN2s may surpass them in performance with improved architecture. The MLP had a difference of just 0.54% between predicted and real values.

Jiang and Liang, (2017) attempted to use reinforcement learning to predict cryptocurrency value changes with a convolutional neural network but concluded that their experiment less successful than previous studies.

Persio and Honchar (2016) compared the use of a multilayer perceptron, a convolutional neural network, and a long short-term memory recurrent neural network as a means to predict S&P 500 historic time series (investing.com UK, 2018) prices based on previous days’ values. A multilayer perceptron was selected as the most basic neural network implementation appropriate for a continuous function that maps real number inputs to real number outputs (Csáji, 2001). A convolutional neural network was selected as it works similarly to a multilayer perceptron but with the added benefit of breaking an input vector down into subsets of higher level features. This allows it to learn during training instead of requiring sophisticated pre-processing. Finally, a recurrent neural network (specifically, the long short-term memory architecture) was selected as their neurons are able to send feedback signals to each other to consider sequential information. The result of their study indicates that convolutional neural networks were the superior method for predicting stock market data when comparing the architectures that were considered, with the long short-term memory neural networking performing marginally worse.

Considering the above research, it would appear that a multilayer perceptron is required if a neural network implementation is to be used to improve the prediction accuracy of the project. Using a convolutional or long short-term memory architecture should further improve the prediction accuracy.

## Researching approaches

As with any project, taking an approach where everything is developed from scratch by the development team can be both extremely useful and wasteful simultaneously. Each component developed for an application gives the team a fuller, more insightful understanding of how it works and thus a superior ability to quality assure, expand, or change the product. However, this also means that each complex component will require significantly more implementation time. If this project were to be assigned a greater amount of time then it would be highly desirable to develop a neural network in Java from scratch, however in its current state time is very finite and so the following solutions have been researched.

### TensorFlow

TensorFlow (2018) is an open-source software library released by Google that can be used for machine learning. It is Java compatible and the website has a variety of information available including Maven installation instructions, tutorials for starting both convolutional and recurrent neural networks, and it is used to power a large number of well-known companies’ products. Unfortunately, the Java compatible version of the technology does not have backwards compatibility guarantees afforded to the C API.

### DeepLearning4J

Deeplearning4j (2018) is an open-source software library released by Eclipse that can be used for machine learning. It is written specifically for Java and Scala, and the website has a variety of information available including Maven installation instructions, tutorials for long short-term memory, convolution, and recurrent neural networks, and a more basic deep learning tutorial for beginners which even assist in selecting the correct neural network for a given problem.

### MATLAB

MATLAB (2018) is an IDE and programming language that specialising in the manipulation of matrices and arrays with mathematical equations. It has a neural network toolbox which provides neural networks and prescribes recommendations for which kind to use on a variety of problems. Using MATLAB would be a reasonable decision due to Plymouth University having a license, but purchasing a commercial license is expensive so it would be prudent to use an open-source solution.

## Selection

If given infinite time to continue the project, it would be preferable to continue by designing and developing a neural network without any library assistance. If given more time to continue the project but less time than required to do this, DeepLearning4J would be the preferable option because its purpose is to be used with Java applications.

# References

Csáji, B. C. (2001) Approximation with Artificial Neural Networks. Eötvös Loránd University, Hungary.

Deeplearning4j. (2018). *Deeplearning4j: Open-source, Distributed Deep Learning for the JVM*. [online] Available at: <https://deeplearning4j.org/> [Accessed 10 May 2018].

Guresen, E., Kayakutlu, G., and Daim, T. (2011). Using artificial neural network models in stock market index prediction. *Expert Systems with Applications*, 38(8), pp.10389-10397.

investing.com UK. (2018). S&P 500 Historical Rates - Investing.com UK. [online] Available at: <https://uk.investing.com/indices/us-spx-500-historical-data> [Accessed 9 May 2018].

Jiang, Z. and Liang, J. (2017). Cryptocurrency portfolio management with deep reinforcement learning. *2017 Intelligent Systems Conference (IntelliSys)*.

MATLAB. (2018). *MATLAB - MathWorks*. [online] Available at: <https://www.mathworks.com/products/matlab.html> [Accessed 10 May 2018].

Persio, L. D. and Honchar, O. (2016). Artificial Neural Networks architectures for stock price prediction: comparisons and applications.

TensorFlow. (2018). *TensorFlow*. [online] Available at: <https://www.tensorflow.org/> [Accessed 10 May 2018].