

**J4 Stochastic Learning
Performance White Paper**



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Executive Summary

J4's Stochastic Learning (J4 SL) outperforms tri-layered neural networks and hyperparameter optimized neural networks in accuracy, speed, and power consumption. In a financial market application, J4 Stochastic Learning is about four times more accurate, two to three orders of magnitude faster, and uses two to three orders of magnitude less power. All these factors mean that J4 Stochastic Learning will produce higher profits attributable to better product performance, and lower capital, cloud, and operating expenses.

Background

One of the hottest topics recently has been ChatGPT. GPT means Generative pre-trained transformer (GPT). *Chat* means Chatbot which is a type of chatting or talking with a computer system which virtually everyone has experienced when calling to make a reservation or to ask questions about a product. *Generative* means capable of generating new content. *Pretrained* refers to a deep learning model — essentially an algorithm (or system) built upon a mathematical model that finds patterns or makes predictions based on data it finds. *Transformer* is a deep learning model that focuses attention on the important information.

ChatGPT had over one million users within five days of its release to the public. It is an extraordinary tool. It is built on large supercomputer systems which cause the computer to follow certain rules. It essentially finds what seems to be the most appropriate text (from the data available to it) to make a response. Superficially, it bears some resemblance to the IBM system called Watson which in 2011 beat two of the greatest Jeopardy champions. Like Watson, ChatGPT makes mistakes. It does not think or reason and has no consciousness. The interaction with ChatGPT seems like having a conversation with another person, but there is no real conversation: the ChatGPT system merely parrots back to the user with what it finds to be the most appropriate response.

J4 has developed a system using its artificial superintelligence¹ and Stochastic Learning², and is applying the system to the financial markets.

The J4 predictive system was compared to two other systems to forecast the direction of the ETF (exchange traded fund) SPY (also known as the SPDR S&P 500 ETF). Using a Hyperparameter Optimizable Neural Network³, the accuracy (or the predictive accuracy) was 52.6%. Using a Tri-layered

¹ “Artificial superintelligence (ASI) is a form of AI that is capable of surpassing human intelligence by manifesting cognitive skills and developing thinking skills of its own.”
<https://www.spiceworks.com/tech/artificial-intelligence/articles/super-artificial-intelligence/>

² Stochastic Learning is a J4 proprietary artificial intelligence.

³ In machine learning, a Hyperparameter Optimizable Neural Network is a system that chooses the “factors” to optimize (that is, get the best result) for a learning algorithm (that is to construct a formula to most likely forecast the result sought). See en.wikipedia.org/wiki/Hyperparameters_optimization.

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Neural Network⁴ system, the accuracy was 52.2%. Using J4's Stochastic Learning (SL), the accuracy was 59%. In other words, J4's SL produced a result 3.5 times more accurate (meaning the increase above a 50/50 random case) compared to the Hyperparameter Optimized Neural Network system and 4.1 times more accurate than the Tri-layered Neural Network system.

But the comparisons were even more favorable for J4's SL. That system was more than 6,000 times faster than the Hyperparameter Optimizable Neural Network system and 160 times faster than the Tri-layered Neural Network system. That means that being able to "profit" from the forecasts is much more likely with J4's SL as markets move extremely rapidly. The amount of computer power (essentially electricity) needed for J4's system was 3,200 times lower for the Hyperparameter Optimizable Neural Network system and 80 times lower than the Tri-layered Neural Network system. Moreover, production artificial neural network systems run on GPUs which consume large amounts of fresh water for cooling, whereas J4's SL runs on air cooled CPUs, consuming no fresh water.

All these factors mean that J4 Stochastic Learning will produce higher profits attributable to better product performance, and lower capital, cloud, and operating expenses.

This document compares the performance of J4 Stochastic Learning to traditional neural networks using MATLAB⁵ version R2022b.

Procedure

196-dimensional data describing the state of the financial markets was presented to three classification systems: J4 SL, a tri-layered neural network⁶, and a hyperparameter optimizable neural network⁷. Classification spaces were generated by all three systems, which were then used to test the predictive ability of the classification spaces⁸. The tested implementation of J4 SL is written in MATLAB. The tri-layered neural network and hyperparameter optimizable neural network use the MATLAB Statistics and Machine Learning Toolbox⁹. All three classification systems were run using the MATLAB Parallel Processing Toolbox¹⁰. The configurations for the tri-layered neural network and the hyperparameter optimized neural networks were as follows:

Tri-layered Neural Network configuration:

Number of fully connected layers:	3
1 st layer size:	10
2 nd layer size:	10
3 rd layer size:	10
Activation:	ReLU
Iteration Limit:	1,000
Regularization Strength (Lambda):	0

⁴ Trilayered Neural Network is a system that mimics how a human brain works, by processing data (information) through a three-tier system. See discussion in

<https://www.ibm.com/docs/en/spss-modeler/18.0.0?topic=networks-neural-model>

⁵ See <https://www.mathworks.com/products/matlab.html> (Retrieved 1/17/2023)

⁶ See <https://www.mathworks.com/help/stats/fitcnet.html> (Retrieved 1/17/2023)

⁷ See <https://www.mathworks.com/help/stats/fitcnet.html> (Retrieved 1/17/2023)

⁸ For the tri-layered neural network and the hyperparameter optimized neural network see <https://www.mathworks.com/help/stats/classificationneuralnetwork.predict.html> (Retrieved 1/17/2023)

⁹ See <https://www.mathworks.com/products/statistics.html> (Retrieved 1/17/2023)

¹⁰ See <https://www.mathworks.com/products/parallel-computing.html> (Retrieved 1/17/2023)

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Standardize Data: No

Hyperparameter Optimizable Neural Network configuration:

Iteration Limit: 1,000
Standardize Data: No

Hyperparameter Search Range:

Number of fully connected layers: 1-3
Activation: ReLU, Tanh, Sigmoid, None
Regularization strength (Lambda): 2.8467×10^{-11} – 0.28467
First layer size: 1 – 300
Second layer size: 1 – 300
Third layer size: 1 – 300

Results

Hyperparameter Optimizable Neural Network Performance Attributes

Optimized hyperparameters for the hyperparameter optimizable neural network:

Number of fully connected layers: 1
Activation: Tanh
Regularization strength (Lambda): 0.0007236
First layer size: 6

Hyperparameter Optimizable Neural Network	
Accuracy ¹¹	52.6%
Speed	3,165 minutes
Power Consumption	1.6 kWh

Table 1. Hyperparameter optimized neural network performance attributes

Tri-layered Neural Network Performance Attributes

Tri-layered Neural Network	
Accuracy	52.2%
Speed	80 minutes
Power Consumption	40Wh

Table 2. Trilayered neural network performance attributes

¹¹ In the context of a financial application also “Predictive Accuracy”

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SL Performance Attributes

J4 SL	
Accuracy	59%
Speed	0.5 minutes
Power Consumption	0.5Wh

Table 3. J4 SL performance attributes

Discussion

Predictive Accuracy

J4 SL had better predictive accuracy than hyperparameter optimized neural networks by:

$$(59\% - 50\%) / (52.6\% - 50\%) = 9\% / 2.6\% = \mathbf{3.5x \text{ more accurate}}$$

J4 SL had better predictive accuracy than tri-layered neural networks by:

$$(59\% - 50\%) / (52.2\% - 50\%) = 9\% / 2.2\% = \mathbf{4.1x \text{ more accurate}}$$

Computational Time

J4 SL achieved higher predictive accuracy than both hyperparameter optimized neural networks and tri-layered neural networks and did so faster than both.

J4 SL was faster than hyperparameter neural networks by:

$$3,165 \text{ minutes} / 0.5 \text{ minutes} = \mathbf{6,330x \text{ faster}}$$

J4 SL was faster than tri-layered neural networks by:

$$80 \text{ minutes} / 0.5 \text{ minutes} = \mathbf{160x \text{ faster}}$$

Power Consumption

J4 SL achieved higher predictive accuracy, and was faster than both hyperparameter optimized neural networks and tri-layered neural networks, and did so with lower power consumption than both:

J4 SL used less power than hyperparameter neural network by:

$$1.6\text{kWh} / 0.5\text{Wh} = \mathbf{3,200x \text{ less power}}$$

J4 SL used less power than tri-layered neural networks by:

$$40\text{Wh} / 0.5\text{Wh} = \mathbf{80x \text{ less power}}$$

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Conclusion

J4 SL is more accurate, faster and uses less power than traditional neural networks. The following table summarizes J4 SL performance as compared to a tri-layered neural network, and a hyperparameter optimized neural network:

Performance Attribute	J4 SL vs. Tri-layered Neural Network	J4 SL vs. Hyperparameter Optimized Neural Network
Accuracy	J4 SL 4.1x more accurate	J4 SL 3.5x more accurate
Speed	J4 SL 160x faster	J4 SL 6,330x faster
Power Consumption	J4 SL 80x less power	J4 SL 3,200x less power

Table 4. J4 SL performance attributes as compared to tri-layered and hyperparameter optimized neural networks

The following summarizes the features and benefits of J4 Stochastic Learning:

Feature	Benefit
Higher Accuracy	Better Product Performance Higher Profits
Higher Speed	Lower Capital Expenses Lower Cloud Expenses Lower Total Cost of Ownership Faster Time to Market Higher Profits
Lower Power Consumption	Lower Operating Expense Lower Total Cost of Ownership Higher Profits

Table 5. SL features and benefits

The J4 SL used in these tests is partially optimized. It is anticipated that parallelization of the J4 SL code will result in an additional 10x increase in speed.

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Disclosures & Backtesting Results Disclaimer

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The hypothetical backtested performance does not represent the results of actual trading using client

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