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An Improvement to Market Prediction

Predicting finical markets is a problem that is very lucrative. With over 4 trillion dollars of assets flowing through just the foreign exchange daily, a successful prediction model can be extremely useful. In this essay we try choose a direction in which to continue research to effectively predict the market. The following will be the format that this paper takes. The major approaches to forecasting the market and the concepts needed to grasp a basic understanding are reviewed. After each approach support and counterarguments as to their use are given. Concluding the section on prior knowledge the difference between modeling the market as a dynamical system and as non-stationary system and the significance this decision has on the development of future agents is discussed. Culminating with a more in-depth explanation and expansion of social learning and supporting arguments as well as counter arguments towards its use versus the other possible methods. The Paper concludes with a short summary of why each method alone is not optimally effective and why social learning with selective combination is possibly a more effective method of prediction.

Statistical analysis has been used for the longest period time because it does not require a computer. Formally, Statistical approaches to prediction use deterministic mathematic models to predict the market. This is essentially using math to predict the market in the same way that you would solve some algebra.

It is common knowledge that when a card is drawn from a deck there is a 1/52 chance that the card drawn will be any given card, and as the deck gets smaller or the cards that are left become known this probability improves. When a blackjack player is counting cards he is constructing a statistical model of the deck in his head so that he knows when there is a low enough risk for him to bet.

Currently research is being done on using statistical analysis for market prediction. The research I review was specifically about how humans are affected by the knowledge that there is a computer using a statistical model trading against them. Generally in the market when a statistical method is used it is taking advantage of a statistical phenomenon that is consistent. (Calafiore, Monastero, and Torino) and (Grossklags and Schmidt) are examples of this. In (Calafiore, Monastero, and Torino) and (Grossklags and Schmidt) the models developed take advantage of the fact that humans will take more aggressive risks then may be wise.

Since statistical analysis is expressible as a mathematical model, it is fairly simple to implement. Beyond being simple to implement statistical analysis has the advantage of being deterministic (every time you run the same model with the same parameters you will get the same answer) this allows you to use previous answers to help construct the next step of your model making the system much less computationally intensive.

While statistical analysis does have advantages it also has significant disadvantages. In (Grossklags and Schmidt) the statistical model was successful for some time, when the humans involved in the trading were notified of the strategy being used the humans modified how they were trading to compensate and the statistical model quickly became nearly useless. Further statistical models are bad at adapting to new situations (Grossklags and Schmidt), are unable to learn from failures due to being a static mathematical model, and only simulate deterministic systems well (Iokibe, Murata, and Koyama).

Neural Networks (abbreviated as ANN) are systems for learning a pattern from a set of data and then recognizing the pattern again. This is accomplished with a structure of layers of “neurons”. Each neuron in each layer is connected to every neuron in the next layer through “synapses” that are weighted. When a signal enters the network it is converted to a value by the entry layer and then scaled by each layer and synapses it encounters on its way out of the network. When the value exits the network if it is a above a certain threshold it is interpreted as a recognition of the pattern.(“Introduction to artificial neural networks”)

A real world approximation of neural networks can be seen in the brain. In nature neurons are deeply interconnected just as they are in artificial neural networks. Just as ANNs are pattern recognition machines our brains do the same thing (our ability to survive depends on our ability to recognize situations that have happened in the past, whether that be a face we have seen or a sequence of events.)

In the research reviewed for this paper ANNs were almost always used in conjunction with GP (Kendall, Su, and Kendali), (Kampouridis, Chen, and Tsang), (Hai-ru, Guo, and Li), (Hayward). The research that used ANNs alone were studying the nature of different type of neural networks (Saad et al.) or using ANNs to identify more useful indicators for use in other agents (Wang, Phua, and Lin).

ANNs have significant advantages over many other algorithms for dealing with complex systems like the stock market. ANNs are Parallel (each neuron can have it’s own processer since it does not need to know anything about the state of the other neurons (“Introduction to artificial neural networks”).), The information gathered is Inductive (“Introduction to artificial neural networks”) (later evidence is presented that the market is driven by inductive decisions (Arthur, “Complexity in Economic and Financial Markets”)), and Can be quickly trained (Kendall, Su, and Kendali) ( the process required for the ANNs to be able to recognize patterns.)

All of the aforementioned advantages do not how ever completely compensate for the problems that the users of ANNs have to deal with. Due to the evolution of the theory behind ANNs diverging farther and farther from the model of operating like a real set of neurons due they have become increasingly difficult to explain. A related issue is how difficult they can be to implement, this is partially caused by how difficult they are to understand completely. Aside from the conceptual difficulties there are also implementation difficulties. ANNs make it extremely difficult to reclaim patterns that have been learned, making it difficult to share information with other instances of neural networks or make small tweaks to the pattern recognition abilities that an ANN possesses.

The final method that I explored for use is genetic algorithms (GP). GP was based off of how animals adapt to new situations over generations. Evolution is a perfect example of a genetic algorithm, the “best” animals of each generation mate and produce a set of offspring that is a mixing of the qualities of both parents then the process is repeated thereby continually optimizing the quality of the population.

There is heavy research going into using GP for a variety of problems, market prediction is among them, I primarily focused on two papers. (Kampouridis, Chen, and Tsang) Explores how to classify GP algorithms and which classes are most effective, examples of how to implement GP are also given along with what indicators are used inside of the algorithms. The paper concludes that a class of GP called SFI (which simply means that they can adapt to new situations are much more effective a predicting the market). The second paper (Kendall, Su, and Kendali) presents a method of using hybrid GP and ANN agents in a manner where they are able to share information. This method proves to be significantly more effective than the traditional manner.

GP has a list of qualities that make them very well suited to the problem of market prediction. GP is very effective at adapting to new situations (Kampouridis, Chen, and Tsang; Kendall, Su, and Kendali). Further, Instances of GP agents can share information and help each other evolve more quickly (social learning) (Kendall, Su, and Kendali). And finally, GP can be constructed in a way that makes it possible to see what the agent has learned (Kampouridis, Chen, and Tsang).

While GP is well suited to market it has a few downfalls that will have to be overcome, GP can be slow, as with any AI GP can get stuck in what it thinks is the best solution but is reality is not, and GP that is not able to adapt to new situations is not only slow but inaccurate for market prediction (Kampouridis, Chen, and Tsang).

The most successful method of using GPs that I was able to find was presented in (Kendall, Su, and Kendali). While this method was moderately successful it had some problems. Processing time (and possibly knowledge) is wasted when ANNs are thrown away. The ANNs only can have a limited view of the market because it is either dynamical or non-stationary (Kendall, Su, and Kendali), (Iokibe, Murata, and Koyama), (Arthur, “Complexity in Economic and Financial Markets”). This may skew the efficacy of a network. And finally, only one ANN gets published at a time, the reason an agent was successful could have been do the composite effect of multiple networks.

Before continuing to the improvement that should be made to GP and social learning it is necessary to review the abstract models used to think about the market, the dynamic model and the Non-stationary probabilistic model, and why of the two model the Non-Stationary model is a better choice.

The dynamic model of the market assumes that the market can theoretically be deterministically modeled in a manner that accounts for all of the behaviors expressed (Narendra and Levin), (Iokibe, Murata, and Koyama). A dynamic model means that the system is extremely diverse in its outputs relative to the variation of its inputs. Another example of a dynamic model is the weather, a very small change in climate be it temperature or pressure can have massive effects on the rest of the system (Think about the proposed effect of global warming, just a few degrees difference massive change). This model is generally used for Statistical agents.

Conversely the non-stationary probabilistic model works as follows. This model views the market as a subjective entity, it’s nature changes with the beliefs of the individuals (Arthur, “Complexity in Economic and Financial Markets”). This model appear here because economy is driven by humans which make subjective decisions and so it cannot be accurately predicted how they will react in the long term(Arthur, “Complexity in Economic and Financial Markets”).

With both of these models it is important to acknowledge the reasons that the non-stationary probabilistic model is better suited to market simulation. Humans drive the market. Subjective decisions are made constantly. When the standard (Dynamic or Simple) model is forced to take into account investors viewing the market differently they break down (Arthur, “Complexity in Economic and Financial Markets”), (Arthur, “Complexity and the Economy”).

Some of the problems that I have reviewed with GP have already acknowledged and by synthesizing research in other papers I have developed a hypothesis as to how to create a better prediction algorithm. Having multiple agents all learning with different indicators and then sharing information the efficiency of evolution was greatly increased (Kendall, Su, and Kendali). ANNs are effective in short term situations (Wang, Phua, and Lin) where genetic algorithms alone are less so (Kampouridis, Chen, and Tsang). Combining the approaches should help compensate for the specialization of each of these algorithms. And finally by each agent managing multiple indicators the agent will be enabled to throw out old strategies and avoid local maxima (Kendall, Su, and Kendali) because the agent will have more than one prospective to work with, it also classifies the agents as SFI GPs which are always more effective at market prediction(Kampouridis, Chen, and Tsang).

Beyond just improving GPs I suggest that using social learning but with the following modification would be optimal. Composite the results of the ANNs using selective combination (only acknowledging the results of a few of the networks to help minimize the effect of failures on the group) as presented in (Ahmad, Technology, and Tyne), and (Sharkey) the methods presented in , and publish the group of ANNs that are used most instead of just the single most accurate ANN. This will enable the agent to recognize more complex patterns, prevent ANNs from being wasted as quickly by the evolution of the agent, and improve the overall accuracy and help avoid local minima (Ahmad, Technology, and Tyne).

In conclusion, the methods reviewed all have problems but compositing some of them may lead to a much more effective system. In particular, using Statistical modeling alone is not effective because while it is effective at exploiting a short term patter, it does not take the subjective nature of the market into account well and does not evolve with the changes in behavior that other agents will exhibit (Arthur, “Complexity in Economic and Financial Markets”), (Grossklags and Schmidt). Some of the algorithms did have high points though. Using ANNs alone works especially in short term predictions (Wang, Phua, and Lin). Using GP works (Kampouridis, Chen, and Tsang) when the GP is able to evolve with the changes in the market. But is inherently slower than ANNs and is not parallelizable as easily (if at all) as ANNs (“Introduction to artificial neural networks”). Finally, The use of social learning and selective combination of ANNs may result in more effective predictions. This is supported by evidence that social learning works (Kendall, Su, and Kendali), and that combining neural networks is effective (C.-Y. Lee and J.-J. Lee), (Ahmad, Technology, and Tyne; Sharkey).

Ahmad, Zainal, Control Technology, and Newcastle Upon Tyne. “A Comparison of Different Methods for Combining Multiple Neural Networks Models.” 828-833. Print.

Arthur, W Brian. “Complexity and the Economy.” *Science* 284.5411 (1999): 107-109.

---. “Complexity in Economic and Financial Markets.” *Complexity* (1995): 20-25.

Calafiore, Giuseppe C, Bruno Monastero, and Politecnico Torino. “Experiments on stock trading via feedback control.” *Information and Financial Engineering (ICIFE), 2010 2nd IEEE International Conference on*. 2010. 494-498. Print.

Grossklags, J, and C Schmidt. “Software agents and market (in) efficiency: a human trader experiment.” *Systems, Man, and Cybernetics, Part C: Applications and Reviews, IEEE Transactions on* 36.1 (2006): 56-67. Print.

Hai-ru, G, Hai-ru Guo, and Zhi-min Li. “A method of improving generalization ability for neural network based on genetic algorithm.” *and Intelligent Systems (ICIS), 2010 IEEE* (2010): 4-7. Web. 21 May 2012.

Hayward, S. “Setting up performance surface of an artificial neural network with genetic algorithm optimization: in search of an accurate and profitable prediction of stock trading.” *Evolutionary Computation, 2004. CEC2004. Congress on*. Vol. 1. 2004. 948-954 Vol.1. Print.

“Introduction to artificial neural networks.” *Electronic Technology Directions to the Year 2000, 1995. Proceedings.* 1995. 36-62. Print.

Iokibe, T, S Murata, and M Koyama. “Prediction of foreign exchange rate by local fuzzy reconstruction method.” *Systems, Man and Cybernetics, 1995. Intelligent Systems for the 21st Century., IEEE International Conference on*. Vol. 5. 1995. 4051-4054 vol.5. Print.

Kampouridis, M, Shu-Heng Chen, and E Tsang. “Investigating the effect of different GP algorithms on the non-stationary behavior of financial markets.” *Computational Intelligence for Financial Engineering and Economics (CIFEr), 2011 IEEE Symposium on*. 2011. 1-8.

Kendall, G, Y Su, and Graham Kendali. “Learning with imperfections - a multi-agent neural-genetic trading system with differing levels of social learning.” *Cybernetics and Intelligent Systems, 2004 IEEE Conference on*. Vol. 1. 2004. 47-52 vol.1. Print.

Lee, C.-Y., and J.-J. Lee. “Adaptive Control for Uncertain Nonlinear Systems Based on Multiple Neural Networks.” *IEEE Transactions on Systems, Man and Cybernetics, Part B (Cybernetics)* 34.1 (2004): 325-333. Web. 21 May 2012.

Narendra, Kumpati S., and Asriel U. Levin. “Regulation of Nonlinear Dynamical Systems Using Multiple Neural Networks.” n. pag. Web. 21 May 2012.

Saad, Emad W et al. “Comparative study of stock trend prediction using time delay, recurrent and probabilistic neural networks.” *Neural Networks, IEEE Transactions on* 9.6 (1998): 1456-1470. Print.

Sharkey, Amanda J. *Combining Artificial Neural Nets: Ensemble and Modular Multi-Net Systems*. 1st ed. Ed. Amanda J. Sharkey. Secaucus, NJ, USA: Springer-Verlag New York, Inc., 1999. Print.

Wang, Xiaohua, P K H Phua, and Weidong Lin. “Stock market prediction using neural networks: Does trading volume help in short-term prediction?” *Neural Networks, 2003. Proceedings of the International Joint Conference on*. Vol. 4. 2003. 2438-2442 vol.4. Print.