Outline

## Abstract

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.

## Thesis and support summary

### Thesis

A combination of GP and ANNs as described in [1] and expanded with selective combination as described in [2], [3] may be a more effective method for market prediction.

#### Overview of current methods

## Concepts and Current Methods

### Statistical approaches

#### What is it?

Formally, Statistical approaches to prediction use deterministic mathematic models to predict the market.

#### English Example

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.

#### Prior research

Generally in the market when a statistical method is used it is taking advantage of a statistical phenomenon that is moldable. [4] and [5] are examples of this. In [4] and [5] the models developed take advantage of the fact that humans will take more aggressive risks then may be wise.

#### Why Not

While in [5] 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.

* Generally bad at adapting to new situations. [5]
* Will never learn from failures.
* Generally only applicable to deterministic systems [6]

#### WHY

* Deterministic. (You know what it will do when presented with any given situation)
* Expressible as a mathematical model.
* Fairly simple to implement. (This is because the structure of the model is just a set of formulas no complicated structuring of data is generally needed.)

### Genetic Algorithms

#### What Is it?

Formally, Genetic Algorithms (abbreviated as GA or GP) are used to solve problem where there are to many variables to find the exact answer in a reasonable amount of time. GP accomplishes this by making a set of guesses as to the answer, evaluating how close each guess is, and then finally merging the best guesses in a variety of methods.

#### English example

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.

#### Why Not

* Can be slow
* As with any AI GP can get stuck in what it thinks is the best solution but in reality is not.
* GP that is not able to adapt to new situations is not only slow it is inaccurate [7].

#### WHY

* It is possible for GP to adapt to new situations [1], [7].
* Instances of GP agents can share information and help each other evolve more quickly (social learning) [1].
* GP can be constructed in a way that makes it possible to see what the agent has learned [7].

#### Prior research

* [7] 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).
* [1] 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.

### Neural Networks

#### What Is it?

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.[8]

#### English example

ANNs roughly approximate how neurons work in nature. The simplest way to understand neural networks is to look at diagram of one and interact with one (insert diagram here and brain.js example from github.com).

#### Why Not

* Difficult to explain
* Difficult to implement
* Nearly impossible to reclaim learned information
* Difficult for ANNs to share learned information
* Can get extremely large

#### WHY

* Parallel (each neuron can have it’s own processer since it does not need to know anything about the state of the other neurons [8].)
* The information gathered is Inductive [8] (later evidence is presented that the market is driven by inductive decisions [9]).
* Can be quickly trained [1].

#### Prior research

In the research reviewed for this paper ANNs were almost always used in conjunction with GP [1], [7], [10], [11]. The research that used ANNs alone were studying the nature of different type of neural networks [12] or using ANNs to identify more useful indicators for use in other agents [13].

### Dynamic Model vs. Non-Stationary Probabilistic

#### Dynamic model

This model of the market assumes that the market can theoretically be deterministically modeled in a manner that accounts for all of the behaviors expressed [14], [6]. A dynamic model means that the system is extremely diverse in it’s 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.

#### Non-Stationary probabilistic model

This model views the market as a subjective entity, it’s nature changes with the beliefs of the individuals [9]. 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[9].

#### WHy use non-Stationary model

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 [9], [15].

## Basis

### Social Learning

The methods presented in [1] compensated for many of the downfalls of GP.

* Having multiple agents all learning with different indicators and then sharing information the efficiency of evolution was greatly increased. [1]
* ANNs are effective in short term situations [13] where genetic algorithms alone are less so [7]. Combining the approaches helps compensate.
* Each agent managing multiple indicators enables them to throw out old strategies and avoid local maxima [1], it also classifies the agents as SFI GPs which are always more effective at market prediction[7].

## Argument

### Problems with social learning

* 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 [1], [6], [9]. This may skew the efficacy of a network
* Only one ANN gets published at a time, the reason an agent was successful could have been do the composite effect of multiple networks.

### Improvement

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 [3], and [2] the methods presented in , and publish the group of ANNs that are used most instead of just the single most accurate ANN.

* Enables the Agents to recognize more complex patterns
* ANNs are not wasted are readily.
* Combining results of ANNs has been shown to improve overall accuracy and help to avoid local minima [3].

## Conclusion

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 [9], [5].

Using ANNs alone works especially in short term predictions [13].

Using GP works [7] 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 [8].

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 [1], and that combining neural networks is effective [16], [2], [3]

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