# Intro

## Quick introduction of the methods available (ANN, GP, Statistical)

grab reader with an something about this research not only being interesting but unlike most academia possibly lucrative, tell story of how I became how I got to this topic.

# Neural Network (ANN) research

## Article: "Setting Up Performance Surface of an Artificial Neural Network with Genetic Algorithm Optimization: In Search of an Accurate and Profitable Prediction of Stock Trading" (S. Hayward ) ( RefWorks:23 )

### Info: Intro to hybrid GP/ANN methods

### Info: There is no best predictor… it may be better just to pick indicator statistics that work most of the time and save the computation

### Critical Info, Direction: The basic form of an agent being broker, and trigger

### Direction: Use a hybrid method

## Article: “Stock Market Prediction using Neural Networks: Does Trading Volume Help in Short-Term Prediction?”(Wang, Phua, & Lin, 2003)

### Direction: Use MSE, MAPE statistics to compare and state efficacy of my trader

### Info: Analysis of an implementation of TDNN

### Info: An instance where while there is a relationship between a variable and the outcome of the value of an instrument, the relationship is one that is to weak to be observed in a way that can predict the futer values with any consistency past what could be done without analyzing said variable

### Direction: Don’t depend on any single variable for all predictions

### Info: More evidence is presented on the dangers of over specialization

### Possible design info: references 3 and 10 talk about the implantation and merits of a well know TDNN in the context of trading

### Critical Info: Most “fundamental factors” (eg. Trade volume) have to weak an effect on the market to be use in circumspect.

## Paper "Comparative Study of Stock Trend Prediction using Time Delay, Recurrent and Probabilistic Neural Networks."(Saad, Prokhorov, Wunsch, & II, 1998)

### Direction: Helped identify what type of neural network to use

### Design Direction: Specified all of the applicable neural network types and difficulty of implementation (RNN, TDNN, SNN)

## In all papers ANNs are successful at predicting short term patterns

# GP research

## “Investigating the Effect of Different GP Algorithms on the Non-Stationary Behavior of Financial Markets” (Kampouridis, Chen, & Tsang, 2011)

### Info: Introduces concept of SFI (Santa-Fe Institute) (GPs that learn to construct rules for new situations then reuse them when the same situation comes up again) vs. N-Type model (GPs learn what preset strategies to apply new situations).

### Direction: My TDNN will be driven by a SFI GP

### Info and possible direction: Use MA, TBR, FLR, Vol, Mom, MomMA as indicator with reasonable success…

### Design: Have GP output evolutionary stat in human readable text

## “Learning with Imperfections - a Multi-Agent Neural-Genetic Trading System with Differing Levels of Social Learning” (Kendall, Su, & Kendali, 2004)

### This paper was the most interesting of the lot

### Perspective: The because the market is so complex it has to be treated as imperfect system to gain useful information

### Method Used (and possible design): Have multiple agents each trained with similar data or with different evolutionary parameters examine the same training set and then let them communicate with each other to decide on triggers and trade volume. Personal: this is like having a team of people with different experience work together to solve the same problem.

### Method Used (and possible design): While agents are communicating allow them to convey their surety of a situation and their experience

### Method Used (and possible design): Let agents acquire some of their peers knowledge to help combat over specialization. Personal: This is important because if all of the agent have very narrow experience and a lot of it they will never really collaborate they will just let one agent decide… this may not be terrible but I have a bad feeling about it

# Statistical

## Exploration of algorithms that don’t change over time and statistical methods that may be used in conjunction with ANN and GP alogs

## Paper: "Experiments on Stock Trading Via Feedback Control"

### Method and evidance: Barmish-Iwarere (BI) trading algorithm is used with moderate success

### Personal: Use BI as a method the GA can use

### Personal: Use BI as a benchmark

### Evidence: Even extremely simple non-evolutionary algos can work because humans take risks thereby presenting an for the algo to take advantage of

### Method: Ito (a formula for simulating a system similar to the market) process for simulation

### Open Question: How to optimize risky investments for BI to take.

## Paper: "Prediction of Foreign Exchange Rate by Local Fuzzy Reconstruction Method"

### Perspective: the market is a chaotic system and as such concepts that apply to chaos should be applicable to analyzing the market.

### Info: Deterministic Chaos, this is a extension (though not intentionally by the author) and restriction of the idea of an imperfect system discussed in the multi-agent paper.

### Info: Takens’ Embedding theorem is a method for finding the location an attractor in a chaotic system

### Info and method: Local Fuzzy Reconstruction Methods (LFRM) are methods for finding the approximant probable location of an attractor in a chaotic system.

### Evidence: LFRM is used with moderate success to predict short term positions in the market

### Personal: Combining LFRM with a TDNN may be a good idea.

## Paper: "Software Agents and Market (in) Efficiency: A Human Trader Experiment."

### Info: Human traders are more effective when they have the knowledge that a computer is exploiting a failing they have

### Perspective: Trading algos work by exploiting the mistakes and shortcomings of humans

### Parallel: Sniping sites for ebay, this principle is what some algos work on

### Critical Design: “passive arbitrage-seeking” or arbitrageur and was developed by Grossklags, it is effective in situations where traders are much more prevalent then agents and acts on the imperfections of human traders. The arbitrageur can be consider a passive, and rather parasitic agent. Personal: I will use this as one of the methods that the driving GP can employ if I either have time to implement it or can find a implementation of it, low priority though

# What Now Thesis

## State that \*this\* is my working thesis and my extrapolations from my research.

# What Next

## Overview of what am i going to do to continue the progress of this paper?

### Do analysis on multi-agent paper

### Do further research into what ANN to use

### Do research to determine wether my hypothesis that GA are decent at course prediction is correct.

### Justify using a GA to drive ANN

## What is my plan to complete the research phase of this paper?

### Find a programming language and framework that gets the most work done and finish up verification research detailed above

# How it works:

# Two time spans are taken into account a short time and a long time (the long time being many times longer then the short time)

# At the beginning of every long time span “social learning” occurs as described in (Kendali) over long term

## Modification: Every agent has multiple ANNs for different situations

## Modification: If an agent has seen a situation that there exists a published ANN for it will replace it’s own if the public ANN is superior.

## Modification: Every time a ANN is taken from the pool the agent that created is awarded points.

## Modification: The parameters that each agent has for creation of new ANNs are mutated with the highest scoring agents, and the lowest scoring agents with the lowest efficacy are eliminated.

# “Individual Learning” is performed as described in the Multi-Agent paper (Kendali) over short term

## Modification: that the agent keeps statistics about the short time spans

## Modification: according to the agents parameters new neural networks are created for situations that do not fit into the statistical bounds that have been established by training previous ANNs.

# Overview: Each agent consists of a collection of parameters determining: how ANN is created, when an ANN is mutated, when an ANN is to be used, and a decision tree for the specifications of the orders that it will place, and a collection of ANNs along with their statistics.

# Operation: Every “short term” statistics are gathered and the pertinent ANNs are mutated. Every “long term” the agents get to publish their ANNs that are effective above an established bound, when an agent takes a published ANN to replace a bad one that they have the publishing agent gets points. After ANNs have been exchanged the lower scoring agents parameters are “breeded” with the high scoring agents and replaced by the offspring. Every moment the agents are running the ANNs that match the current statistics to determine triggers and make trades

# Why: By using this method patterns for recognition are constantly changing there by allowing the agents to mutate with the market, and overspecialization is taken advantage of by only having ANNs work in situations they have proven to be good in yet it is controlled by the evolution of the agent parameters. Furthermore it is been shown many times that neural networks are good at predicting short term positions this method takes advantage of that fact and should extend it to be even more pronounced because the situations in which the ANNs have to preform less broad. This method tries to reduce the amount of chaos that a ANN has to deal with when deciding to buy or not thereby making them more effective

# Central Question: How do I profitably automate trading in a chaotic (possibly imperfect) environment?

# Thesis:

# Address the chaos by having multiple agents with different parameters and triggers that are mutated with the other agents to better model of the market and to model the market better in the future. Decrease the amount of chaos that the agent has to deal with by splitting the situations that an agent has to evaluate into roughly statistically similar situations. Then optimize what roughly statistically similar means and what to do in each situation.