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Neural Net-Based Software for Trading Initial Public Offerings

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NEURAL NET-BASED SOFTWARE FOR TRADING INITIAL PUBLIC OFFERINGS

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Abstract

Trading stocks has been used as a financial tool for increasing capital for many years. With the number of Initial Public Offerings (IPOs) issued rapidly increasing, there is more potential in developing successful trading strategies for IPOs. This Major Qualifying Project (MQP) uses characteristics of IPOs such as the greenshoe option in a combination with trading strategies for stocks in order to develop a strategy for trading IPOs. For this purpose the team used historical stock market data extracted from the TradeStation trading platform. An analysis of these data was made using a neural net program called Braincel. The program was used to form predictions on whether a stock's price would increase a certain level from an initial point. The predictions together with good money management resulted in a trading strategy with high potential.

Acknowledgements

Throughout the project the team has worked extensively with the project advisor Michael Radzicki and with the sponsor of the project Geoff Bysshe. The team would like to thank them for their supervision, advice, and help. Without their help in the past year, the team would not have been able to accomplish the completion of this project.

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Nomenclature

ATR	Average True Range
BP	Back Propagation
DDR	Decorrelator and Dimension Reducer
IPO	Initial Public Offering
MQP	Major Qualifying Project
OR	Opening Range
P/E	Price to Earnings Ratio
R/S	Reserves to Surplus Ratio
SEC	Security and Exchange Commission
USD	US Dollar

1 Introduction

The purpose of this MQP was to develop a strategy and a program for successful swing trading of IPOs. The team approached the problem of how to estimate the chance of an IPO's price to go up a certain amount, by the use of neural networks and by mimicking an open range trading strategy. That trading strategy is the 30 minute opening range strategy of Geoff Bysshe. The strategy was adapted by Geoff Bysshe's suggestion to a 30 day period for IPOs and modeled with a neural net program. The reasoning, process and results of the MQP are described in the following sections.

Historically the stock market has given an opportunity for private companies in need of capital, to generate that capital to start or improve their business. Gradually the market evolved and turned into a market place on its own where people trade stocks. The Initial Public Offerings market in particular has been growing rapidly in recent years, thus providing more opportunities for trading. Trades made could be based on fundamental principles, news, overall market conditions, etc., or on technical analysis predictions. Therefore, the team decided to research how to use different indicators for trading IPOs in particular so that profit is attained.

The end goal of the team was to analyze the characteristics of IPOs and of various 30 day open range trading strategies and thus develop a neural network program that assigns the strategies a probability factor. Specifically the result of the MQP is neural network that assigns a probability for a successful trade based on a set of pre-defined conditions. Afterwards a money management plan is set and the trades are implemented.

The paper starts with an introduction to stock markets and their connection to the economy. This background gives the reader a better understanding of the factors that are

part of the pricing of a stock. Next is a more in-depth research review on the topics of IPOs and their characteristics. In addition the literature review covers the opening range trading strategy. Next the applications of the information found in the background review are discussed with respect to IPOs. Lastly, the actual process of acquiring historical data, determining variables, and running a neural network based program for analyzing it, are described.

2 Markets - The Connection of Economics and Stock Exchange

The reason the team decided to consider IPOs as the topic of our economics major qualifying project was that there is a close relationship between economics and the stock market. Trading IPOs also seemed a not as often researched topic. The connection between these topics is described in this section.

The price of a given stock is affected by macroeconomic movements. This project is aimed at predicting the movement of an IPO stock through technical analysis. Fundamental analysis of the stock market includes many factors such as stock valuations, financial statements, companies' management and competition and the effect of markets. A further explanation of how stock prices are affected by macroeconomic movements is described in this section.

2.1 The Stock Market

To be able to trade or invest in the stock market three tools are required, namely a method for finding stocks, a platform for timing trades and lastly a method and strategy for executing trades, such as a broker and a trading plan. This project focuses in particular on developing a method for identifying profitable trades and provides a strategy for trading them. The platform that the team used was TradeStation.

Similar to the economy individual stock prices also have a trend and a cycle. Up-trends are characterized by higher highs and higher lows of a stock's price. The resulting market is called bullish. When the market is bullish the best strategy is to buy stocks and sell them when the price has gone up, or to buy call options. Down-trends are

characterized by lower highs and lower lows of a stock's price. The resulting market is called bearish. In such a market the best strategy is to sell stocks short and buy to cover when the prices have went down, or to buy put options. It is also possible to have no trend in the market in which case a stock's price oscillates. In this neutral market the most secure trading strategy is to sell call options on stocks that one owns. The team focused on IPOs and looked for bullish behavior in particular.

3 Background

In order to be able to make a more educated conclusion and to develop a holistic system for trading IPOs, the team completed background research on various topics.

3.1 Opening Range Theory

Various strategies exist for trading stocks and options and one of them that was of particular interest to the team was the specific opening range (OR) strategy used in the products of Dataview LLC, developed by Geoff Bysshe. A thorough understanding of the strategy was relevant, since it was used as a basis for the IPO trading strategy tested.

3.1.1 Dataview, LLC

Dataview, LLC, found by Geoff Bysshe and Keith Schneider in 1995, is a company that provides a professional trading tool which finds trading opportunities based on atypical volume and price activity in stocks, industries, sectors and market indexes. This project was sponsored by Dataview, LLC and supervised by Geoff Bysshe. The 30-minute opening range trading strategy that is used as a basis in this project was developed by Dataview, LLC. The team used the concepts and tested their applicability to IPO trading. One of goals of the project was also to try and develop the basis for a product for trading IPOs to be used by the company in addition to its other products.

Dataview is mostly focused on day trading and swing trading strategies, and has two main products: Market Gauge and HotScans. The products use tables, charts and graphs to display financial data in a user friendly way. *(Dataview)*

Dataview's Market Gauge is a tool for looking at different stocks, sectors and industries and how they trade. By using Market Gauge one can create scanners on their own and find stocks that at the moment behave in the particular way they are looking for. *(Market Gauge)*

HotScans is a real-time stock scanner which also provides trading strategies and offers online trading courses. It is structured to show the user stocks that conform to specific strategies. *(HotScans)*

3.1.2 The 10 O'clock Bulls

The basis of this project is the electronic book titled *10 O'clock Bulls* by Geoff Bysshe. The book aims at utilizing the first 30 minutes of the trading day to make the day profitable. The strategies are aimed at day traders and swing traders.

The driving force behind any market move is the market sentiment also known as the market mood. The market sentiment is the overall opinion of the market on the future prospects of the stock. The common saying "Buy the rumor, sell the news" explains the impact of expectations on trading. The idea behind technical trading is to identify the key price points where sentiment is likely to change. This is why traders try to forecast a stock's next move and pick best trading opportunities on an analysis of risk versus reward. *(Bysshe)*

The electronic book introduces two trading approaches, namely fundamental and technical analysis. Fundamental analysis is based on forming anticipations for the stock's future moves by focusing on the revenues, earnings, assets and liabilities of the issuer firm. The belief is a stock's price will be driven by its future earnings growth or underlying value. On the other hand, technical analysis focuses on the stock's or market's

historical price, charts, modeling techniques, patterns, time graphs showing the relationship between price and volume. The OR strategy in 10 O'clock Bulls is based on a technical analysis method, therefore in this project, mostly technical analysis will be stressed, although the importance of fundamental analysis will not be ignored *(Bysshe)*.

3.1.2.1 Basic Technical Analysis

Volume is the number of shares of a specific stock that are being traded at a given time. According to technical analysis high volume confirms the price action. If the movement in a stock's price is created by a high volume, this means the market is favorable for the price action.

The term "swing high" is used to describe the situations when there is a series of successively higher highs. This indicates a constant increase in price. Similarly, swing low is when there is a succession of lower lows. On the time charts, the number of bars in the succession determines the swing's strength.

Consecutive swing highs form an up trend, where as consecutive swing lows form a down trend. Nevertheless, it takes a second lower low to confirm the low trend. The saying "The trend is your friend" means that trading in the direction of the trend will result in better profits. It is easier to buy or "go long" in a bullish market and sell or "go short" in a bearish market.

Another important idea in technical trading is support and resistance areas. Resistance is defined as the price area that holds the stock price down. Therefore, resistance is mostly composed of swing highs. Support is the price area at which a stock's price is likely to stop going down, which is in the same way determined by swing lows. Support and resistance are areas, not points. When a resistance or support is broken, it reverses its role. This is called following through after a breakout. The significance of a

resistance or support is established by time, number of occurrences, volume, and how recently it was formed

In order to be a successful technical trader, one must avoid overanalyzing the charts. If support and resistance levels or the trend is not very clear, that stock should not be traded. This also means that looking at only support and resistance would not be sufficient.

3.1.3 Opening Range

The opening range is generally defined as the time frame between 9:30am to 10:00am EST. 10am is known for being the reversal period due to many factors including the fact that economic reports are released at ten o'clock.

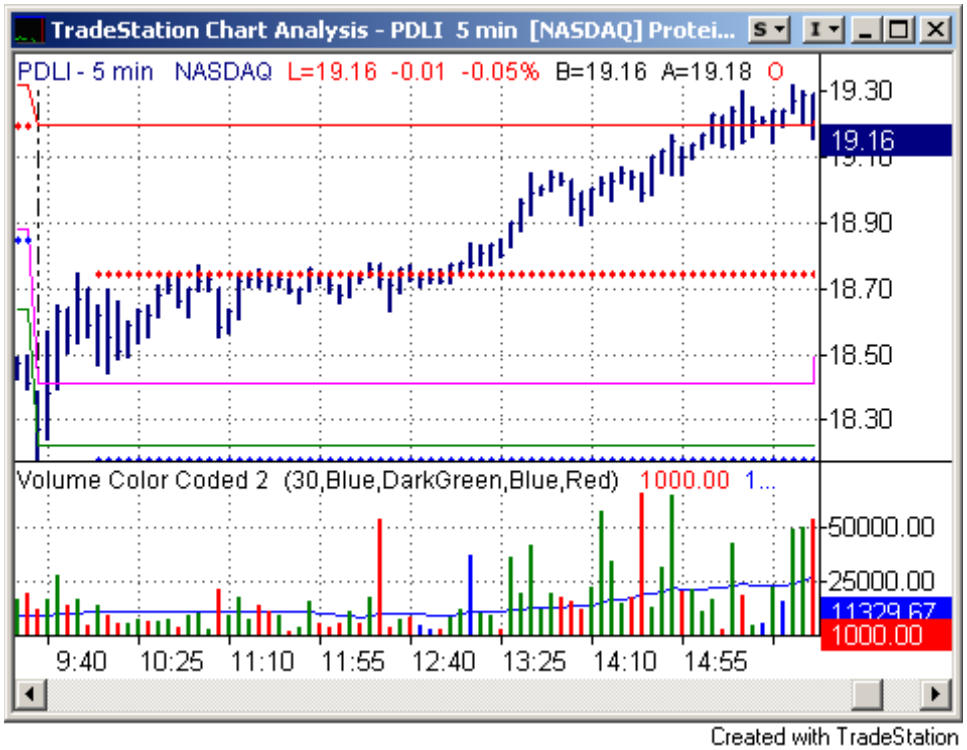
The OR is a very important part of the trading day since it defines inflection points, i.e. the most probable highs and lows of the day. These high and low levels are used to define areas of support and resistance, which are crucial for the break out theory. The OR also represents the prior day's price action, overnight news, morning economic reports, which make it an emotion filled period for traders. There is a 35% chance that the low of the OR will be the low of the trading day, and similarly high of the OR will be the high of the day. *(Bysshe)*

The OR represents an initial period of a stock's trading, which is used as a basis for the prediction of its behavior. The theory behind it is that the initial period the stock is trading is most emotionally intense and therefore it creates mental price levels for the stock. In other words, it is very likely that the stock will continue trading within the OR frame and if it breaks out, it will go far whichever side it goes. As could be seen later in this MQP this is the basis for a lot of strategies. However, one thing to keep in mind is

that there are a number of conditions which are highly recommended, if not required in order for that to happen.

3.1.3.1 Factors for Successful Breakout

In order to apply the OR strategies to trading stocks, a number of factors need to be present. These include consolidation, volume, market type, and others. These and other characteristics of the stock will be described and their importance explained. They are used as the basis for a variety of OR trading strategies. Understanding these factors was relevant for the project as some of them were taken into consideration when applying the strategies to IPO trading.



(Dataview)

Figure 1 OR Breakout

3.1.3.1.1 Good Consolidation

A good consolidation is an important factor in the basic bullish OR strategy. Characteristic of significant price levels is that when the price gets closer to them the

market becomes more intense. The bearish traders are getting ready to cover their short trades, i.e. start buying. On the other hand, the bullish traders are getting ready to rally, i.e. also buy. Therefore, when the stock breaks out of the price level, which in this case is the OR, everyone frequently starts buying and the price rises very rapidly. Figure 1 is a good illustration of a consolidation followed by a breakout.

3.1.3.1.2 Stock Type

The type of stock that is to be traded is highly relevant for the result of the trade, and thus the trading strategy. In particular, a type of stock that is highly volatile has a behavior that can give better result with the OR strategy. The main characteristic of such a stock is that its price varies hence it provides an opportunity to make more money on each one trade. If the stock does not have high volatility, it would be harder to identify a clear break out. Also the profit from the trade of a non-volatile stock would not be as much as that of a volatile one. Therefore such a stock is a good type of stock to be traded with the OR strategies.

3.1.3.1.3 Volume

The volume of a stock represents the amount of stocks traded at a particular point in time. Thus volume is an important indicator of the general interest in the stock. When there is high interest in a stock, many people trade it and thus its volume goes up. This factor is very useful for the strategies involving OR, as it is an additional confirmation that a stock will break out. As with general stocks, with the IPOs in particular volume is an important indicator.

3.1.3.1.4 Clean Breakout

A clean breakout is defined as a breakout when the price goes up very decisively above the OR high price level. In a clean breakout there is little consolidation around the

high of the OR. Thus, the price of the stock goes up rapidly, without falling too much, thus allowing for a better opportunity for profit, with a lower chance for loss. A clean breakout is confirmed by the volume and the general market condition, which is discussed next.

3.1.3.1.5 Bullish Market

In addition to the type of stocks and their characteristics, a major role in the OR strategy is played by the overall market. In order to have a clean breakout and better profit it is beneficial to have the market as a support. Therefore, a clearly defined bullish market is necessary requirement for a good OR strategy. If the market altogether is bullish it is more likely that each particular stock would have a bullish behavior, which is reinforced by the other factors during a breakout. A bullish market is defined by up-trending prices. It is also referred as very optimistic market. Determining whether the market is bullish can be done by following some general indicators such as the S&P 500 for example.

3.1.3.2 OR Strategies

Applying different factors to trading with respect to the OR leads to the formulation of several strategies. In his book *The 10 O'clock Bulls* Geoff Bysshe describes many strategies, from which the main ones are discussed in this section. Understanding these strategies and the parameters which are considered for each of them is relevant to the application of these strategies to trading IPOs. In addition they provide a range of ideas for possible improvements of the strategies. In the following strategies it is assumed that the factors necessary for a good breakout are all present. For simplicity they would be referred to as the basis factors.

3.1.3.2.1 Basic Bullish OR Strategy

Provided that there is good consolidation and all the basic factors hold true, there are several ways to trade the stock after it has broken out of the OR. The first strategy is the Basic Bullish OR strategy – in this strategy one starts buying the moment the stock breaks out and starts its rally. As was mentioned before, if there has been a good consolidation this means then it is most likely that there will be a significant rise in the price of the stock. The strategy is very straight forward and the basic assumption is that the price will not oscillate, thus with a relatively low risk, high profit will be achieved. A very important factor for this strategy is the clean breakout.

3.1.3.2.2 Buy the Second Breakout

In many cases what actually happens after a stock breaks out of its OR is that it retraces shortly after. Therefore many traders wait until after the breakout to start buying. Sometimes the price retraces back to the high of the OR and then bounces off it – that is when they start buying and in this case there is an additional assurance that the stock is going to rally. However, if the stock never retraces and just rallies, the trader has missed that trade and should drop it altogether.

3.1.3.2.3 Buy the Retracement

Depending on the situation the stock might drop after the breakout instead of going up again. What actually happens when the stock price breaks out through the OR high is that the prior resistance level becomes a support level. Therefore, when the stock price breaks through the support level it means that it is going to drop rapidly, so a good strategy is to short it. A logical exit target level in this case would be the low of the OR.

The strategy is similar to the basic bullish strategy. However, it is not as relevant to the project, since the project is focusing more on the breakout through the high of the OR.

3.1.3.2.4 Fading the OR

Fading the OR is a strategy that is used in the cases when the stock does not break out of its OR. In that case, it is very likely that the price of the stock would stay within the OR and would move between the high and low level. Therefore, the strategy is based on trading within that frame, namely buying close to the low of the OR and selling close to the high of the OR, and vice versa. The profit in this strategy is limited, but so is the loss. It is also easy to determine a stop loss point, which would be the low of the OR.

3.2 Money Management

Provided that the basic factors hold true and deciding that the stock is suitable to trade with the OR strategy, the next step is to determine a stop loss level, i.e. the point to exit the trade if the stock price moves against the initial expectations. The loss at this point is called “risk”. In essence, many traders state that money management is one of the most essential parts of the trade. The theory behind money management is that even a moderate rate of successful trades could lead to significant profit. The theory is based on making trades with positive expectancy for profit.

Provided that a trader sets a certain success rate, a risk to reward ratio can be established and consequently a stop loss price can be determined, so that overall the result is profit. For example if a trader is right in 40% of the cases and the profit to loss ratio is 2:1. That means that if 20 trades have been made only 8 of them are successful and realize a profit of 8*2 = 16. At the same time, there are 12 losing trades worth 12*1 = 12. That makes a total of 16-12 = 4 profit.

Thus if the result of this project is a prediction level, successful at identifying good trades in about 40% of the cases, that could be sufficient for profitable trading of IPOs. *(Dataview)*

3.3 Initial Public Offerings

An IPO is the first sale of stock by a company that goes public. The term emerged in the bullish market of 1990's thanks to the sudden expansion of the internet. Going public means, that the ownership of the company is changing to public rather than staying private. The company offering an IPO is called the issuer. Table 1 shows the number of IPOs made and their initial returns in different countries in a given time period. As can be seen US is the leading country that issued the maximum number of IPOs between 1960 and 2000.

Table 1 IPO Volume by Country

International IPO volume and initial results			
Country	No. of IPOs	Time period	Initial Return (%)
Australia	382	1976-95	12.1
Austria	76	1984-99	6.5
Belgium	86	1984-99	14.6
Brazil	62	1978-90	78.5
Canada	500	1971-99	6.3
Chile	52	1982-97	8.8
China	432	1990-2000	256.9
Denmark	117	1984-99	5.4
Finland	99	1984-97	10.1
France	448	1983-98	9.5
Germany	407	1987-99	27.7
Greece	129	1987-94	51.7
Hong Kong	334	1980-96	15.9
India	98	1992-93	35.3
Indonesia	106	1989-94	15.1
Israel	285	1990-94	12.1
Italy	164	1985-2000	23.9
Japan	1542	1970-2000	26.4
Korea	477	1980-96	74.3
Malaysia	401	1980-98	104.1
Mexico	37	1987-90	33
Netherlands	143	1982-99	10.2
New Zealand	201	1978-99	23
Nigeria	63	1989-93	19.1
Norway	68	1984-96	12.5
Philippines	104	1987-97	22.7
Poland	149	1991-98	35.6
Portugal	21	1992-98	10.6
Singapore	128	1973-92	31.4
South Africa	118	1980-91	32.7
Spain	99	1986-98	10.7
Sweden	251	1980-94	34.1
Switzerland	42	1983-89	35.8
Taiwan	293	1986-98	31.1
Thailand	292	1987-97	46.7
Turkey	138	1990-96	13.6
United Kingdom	3042	1959-2000	17.5
United States	14760	1960-2000	78.4

(Draho)

Companies issue IPOs mainly to raise cash. The selling of IPOs gives the company vast amount of money to invest or to build capital. There are also other benefits of going public for a company. Public companies can generally get better interest rates when they need to issue debt. Provided that there is market demand, a public company can always issue more stock when in need of cash. This eases mergers and acquisitions as well. Going public also makes possible to supply the employees with stock ownership plans, which can and is used as a very effective management strategy to increase motivation of the employees.

Companies need to hire investment banks to underwrite their IPO. The biggest underwriters are Citigroup, Goldman Sachs, Merrill Lynch, Credit Suisse First Boston, Lehman Brothers, and Morgan Stanley. Table 2 shows the total proceeds and the market share of some of the most famous investment banks in 2002 in US:

Table 2 IPO Rankings of US IPOs 2002

Underwriter rankings based on 2002 US IPOs			
Bank	Total proceeds ($m)	No. of deals	Market Share
Citigroup	8369	17	19.1
Goldman Sachs	5459	13	12.3
Merrill Lynch	3995	17	9.1
CS First Boston	3949	18	9
Lehman Brothers	3078	8	7
Morgan Stanley	3040	11	6.9
UBS	2527	12	5.8
HSBC	1427	2	3.3
Deutsche Bank	1425	7	3.3
Credit Lyonnais	949	1	2.2
Subtotal	34223	81	78.1
Grand Total	43832	146	100
Total proceeds and market share are based on all IPOs for which the bank was the lead or co-lead managing underwriter.			

(Draho)

Underwriting is selling the new stocks and raising money from the investors. Generally, bigger and more powerful investment banks are preferred due to their potential success in influencing the market and promoting the IPO. The sale of the shares of an IPO can take several forms such as Dutch auction, best efforts, bought deal or self distribution of stock. IPOs are generally sold to institutions and large retailers before they are opened to small investors.

If the IPO is large, therefore it can be underwritten by more than one investment bank. A group of investment banks underwriting the same IPO is called a syndicate and they each earn commissions based on the percentage of the value of the total shares they sell. Usually the larger the proportions of the IPO a bank sells, the more commission it gets. Commissions can climb up to 8% for some IPOs.

Another challenge in issuing IPOs is pricing. In the past IPO's have been under priced, because that was believed to increase the value of the IPO. This is a strategy not used anymore. Under pricing leads to great interest in the stock and creates enormous gains for the investors who buy the shares early. However, under pricing results in issuers losing significant capital that would have been raised if the first shares have been offered at a higher price. On the other hand, overpricing is dangerous, because if the market interest for an expensive stock is low, the underwriters may face problems meeting their commitment to sell a certain quantity of shares. Also, as a result of over pricing, if the stock decreases in value on the first day of trading, the IPO may go down in its marketability and therefore lose even more of its value. Detailed fundamental analysis and accurate investigation of financial reports are necessary for pricing an IPO. Eventually, the objective is to set an offer price which is low enough to create interest in the market, but high enough to raise sufficient capital for the company.

The issuer usually allows the underwriters to boost the size of the initial offering by up to 15%. This over allotment option can be used as a joker by the investment bank to raise the price of the shares, thus creating an artificial lower price level limit for the IPO. This price level is also referred to as a floor. This practice, presently performed with most IPOs, is called the greenshoe option. The name comes from the Greenshoe

company, which was the first issuer to allow an over allotment of 15% to its underwriter. Due to this extra 15%, the underwriter investment bank is able to control the supply whenever the price starts going down, and thus it creates an artificial support for the IPOs price. The bank that way would be short during the first month, thus allowing the IPO to have a price floor for the first 30 days. However, after 30 days, the issuer needs to buy the greenshoe, which sometimes results in a significant price movement. That dynamics makes the 30 day and the volume turnover periods important, and shows why looking at them relevant to the results.

There are many legal requirements involved with issuing of IPOs and it is common that a law firm is hired to inspect and execute the legal aspects of the process. The US laws are very strict regarding issuing of IPOs and in most cases stricter than those of other countries. Therefore in a multinational IPO issuing, the laws of the US are the ones that are stressed the most. IPO issuing and trading is regulated by the Securities and Exchange Commission (SEC) and are subject to the Securities Act of 1933.

The first step in the life of an IPO is the prospectus completed by the issuer. The prospectus is a comprehensive outline of the company's history, operations, products, risk factors, industry conditions and most importantly, finances. Both the issuer and the underwriter can be held liable for any omission or misleading statement in the prospectus.

Consequently, the SEC requires a period, usually around twenty days to investigate the material enclosed in the prospectus. During this period, called the cooling off period or the quiet period, relationships with the investors are highly restricted. The advertising of the IPO during the quiet period is limited to basic information, such as the

name of the company, the names of the underwriters and the amount of stock being offered. Any offering during this period is called gun jumping, and must be accompanied by a copy of the prospectus. At this time the prospectus is called a red herring, due to the red stamp on it signaling its non-final status.

At the end of the quiet period, when the SEC approves the offering, the date that the company will be offered to public is determined. After this date, called the effective date, the company is open to the public and starts its free riding period. At that time the IPO can be advertised with telephone calls, road shows (a series of meetings with possible investors to promote the IPO) or institutional visits.

The next period in the IPO life is the lock-up period, which usually lasts between 90 and 180 days. During the lock-up period, the insiders of the company are not allowed to sell their shares. At the end of this period, the stock price might change if the insiders decide to sell. In general, individual investors should keep in mind that IPOs are difficult to analyze technically, since there is not much historical data. In order to analyze their behavior more advanced techniques should be used. Neural networks are an example for such a technique.

3.4 Neural Networks

Work on Neural networks started in the 1940's, however one of the major breakthroughs in the area was done 17 years later by Frank Rosenblatt. He developed "Perceptron", which is the simplest kind of feed forward neural network. Neural networks take the human brain as a sample model and aim to create predictive models using past data. The term had been used to define a network of biological neurons in the past, but its modern meaning refers to the networks of interconnected artificial neurons

and nodes. Literally, a neural network technology 'learns' from the data provided to it, and models the problem accordingly. Neural networks are defined as a non-linear statistical data modeling or decision-making tool due to their ability to find patterns between inputs and outputs in a given set of data named the training data. These patterns are then used to predict outcomes, when different sets of inputs are fed to the network. A neural network's reliance, the percentage of correct predictions, is determined using the test data. Some of the most popular neural networks software packages are Stuttgart Neural Network Simulator and Emergent and Java Neural Network Simulator. *(Neural Networks)*

Neural networks are composed of neurons. When a neuron, the basic structural unit of the network, receives enough signals, it ignites the outputs. In order of their importance, each neuron weighs all the inputs it is given and the output is calculated with the threshold function the neuron receives downstream. Next is a description of how neural networks work in more detail. *(Cortex)*

3.4.1 The Feed-Forward Neural Network Model

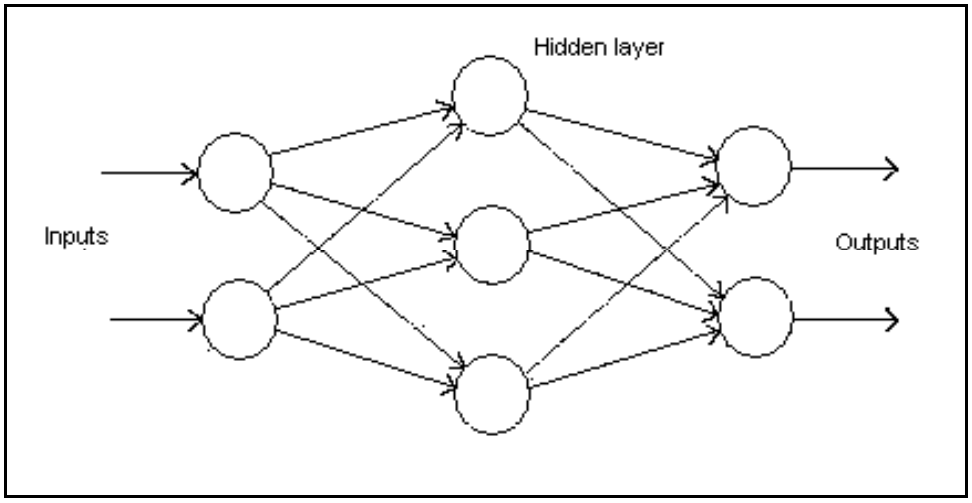


Figure 2 The Feed-Forward Neural Net Model *(Seattle Robotics)*

As mentioned above, to create an artificial brain, the scientists studied the human brain. However, given the complexity of the biological network, many simplifications had to be introduced to the electronic model. In neural nets, "neurons" are grouped in distinct layers. Each neuron in the first layer is connected to every neuron in the second layer. Similarly, each neuron in the second layer is connected to every neuron in the third layer.

Another simplification was that signals flow only in one direction across the network. Neurons and the connection points between them (called synapses) work as simple resistors and behave as analog comparators. The links between neurons have unique weighting values. This design is called a feed-forward neural network, since each layer is connected to each other and the signal can flow across the network. In summary, after all the input values are applied to the first layer of the neural net, signals can propagate through the middle layers (also called hidden layers) and we can read the output. *(McCollum, Pete)*

3.4.2 The Structure of a Neuron:

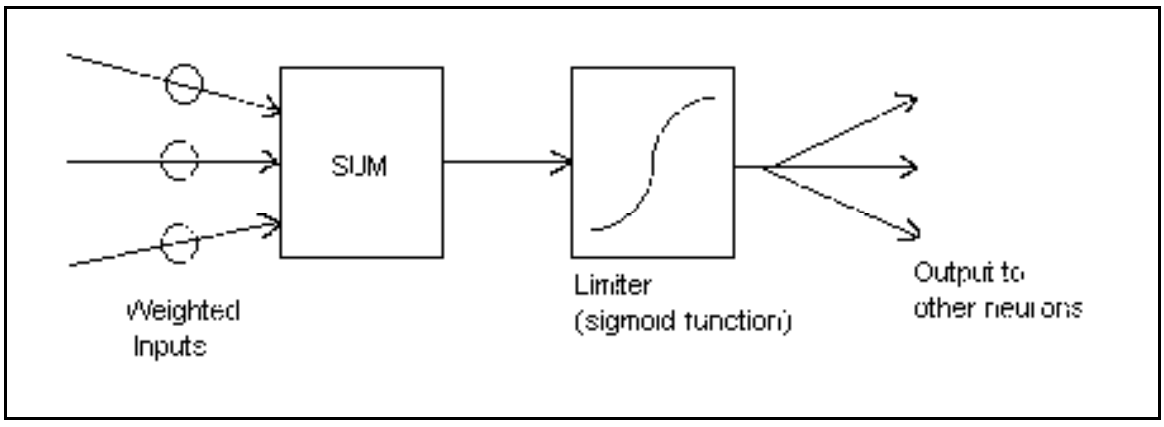


Figure 3 Structure of a Neuron ***(Seattle Robotics)***

Each neuron obtains a signal from the neurons in the previous layer. Each of these

signals is multiplied by a distinct weight value. Then, the weighted inputs are added up and the limiting function scales the output in a range from 0 to 1, so that the result is actually a probability for a certain outcome. This output is then communicated to all the neurons in the next layer.

The only unanswered question so far is how the weights for a particular problem are adjusted. This is where the "intelligence" of the neural networks comes from. The most common learning algorithm is called Back Propagation (BP), which learns by example. The user provides a training set data to the neural net. The learning set data includes the inputs and the correct outputs. Then the network adapts itself to give the known-correct output in the training set data, given the inputs.

BP produces an output for each set of inputs in the training set, based on the current weights in the synapses. Since the initial weights are specified randomly to get the training process started, the output will be random. Then, the algorithm compares this output to the known-correct output supplied in the training set. The difference between two are calculated and propagated backwards through the network. Weights are altered accordingly, aiming to reduce this difference between the guessed output and the known output. The same process is completed for each case in the training set and repeated until the difference falls below some predetermined threshold. This threshold defines how well the network learned the given problem. A final point is the results will never be exact, although they approach the correct output asymptotically. *(McCollum, Pete)*

3.4.3 Applications of Neural Nets to Trading

The benefits of neural nets include the fact that they can model non-linear relationships in order to solve problems that could not be addressed with mathematical equations. They can also work better than most systems in the presence of significant noise. The work of Paul Werbos in 1974, when he invented back propagation, significantly advanced the field. In the 1990's, many institutions invested funds to build trading strategies using neural nets. Unfortunately, most attempts failed, since engineers and neural network designers approached markets like a classical signal processing problem. They ignored all the effects of mass psychology in markets as well as the unknown and dynamic nature of finance sector.

Years later, thanks to improving technology, and computing resources getting cheaper, neural nets improved a great deal. Presently, if logical steps are followed, neural networks give reliable predictions. A critical point is; while designing a neural network, predictive inputs should be selected very carefully for each model. They should not be highly correlated with each other and they should be added to the model one by one. Preprocessing the data is thus extremely helpful to achieve better results. Last, but not the least, the training and testing sets should be kept separated to avoid data contamination. If designed correctly neural networks can be very useful in trading and help traders form sound future expectations. *(Ruggiero, Murray)*

3.5 Existing Trading Strategies

In order to gain a better understanding of how trading strategies are formed and especially those of IPOs with the use of neural networks, the team conducted background research on the topic. One of the goals was to determine what others have done on the

topic of IPO trading. Most of the information found was focused on the underwriter's reputation, underwriting cost, underpricing and the factors affecting the capital raised.

The article "The Life Cycle of Initial Public Offering Firms" by Bharat A. Jain and Omesh Kini focuses on the life cycle of Initial Public Offerings and uses logit statistical analytical models. The goal of the analysis they conduct is to determine whether a company would survive or fail and the factors considered are risk, firm size, investment banker prestige, industry R&D intensity, etc. They consider the logit analysis to be a good tool for this type of analysis *(Jain, Kini)*

This analysis focuses on the characteristics of the company or in other terms, the fundamental analysis of the IPO. In order for a strategy to be successful, a combination of technical and fundamental analysis would provide the best results. Nevertheless, this project focused on the technical aspects of the IPO trading, namely its behavior during an opening range period in combination with other factors.

In addition, the team focused on analysis using neural networks. Therefore it was valuable to identify what the published literature says about trading IPOs using neural networks. "A neural network model to predict long-run operating performance of new ventures" by Barin N. Nag and again by Bharat A. Jain, suggests that neural networks are more successful in forecasting long-run operating performance of IPOs than logit models. *(Jain, Nag)*

Another article named "Neural network models for initial public offerings" by Robertson et. al. focuses on predicting the first day return of initial public offerings using neural networks. The dataset that was used by them is for 16 variables for 1075 firms. The most important for this project of the findings of this paper is that neural network models perform well on different kinds of IPOs. *(Robertson et. al.)*

The research the team conducted, which included the above mentioned and other authors nevertheless showed that authors cover a wide area of topics, but do not cover what was of particular interest to the team, namely developing a trading strategy for IPOs by the use of neural networks after some initial period, but before the end of the lock up period. What makes IPOs different from using neural nets for trading stocks is that there is very little actual historical data for IPOs – the data up to the end of the lock-up period. Most of the techniques used for neural net based stock trading are evolving with time as more historical pricing data is available on which predictions can be made. This could not be done with IPOs, since there is a limited amount of data. In the above mentioned papers the authors focused on the usefulness of neural networks compared to other methods, and on using them for finding a particular characteristic of the IPOs or for a confirmation. With this project our team instead tried to combine this information for the purpose of trading the IPOs. Thus, the project is looking at a new application of neural networks in IPO trading.

4 Application to IPO Trading

4.1 IPO Characteristics

The processes involved in starting an IPO affect the ways at which an IPO is traded. In order for the team to develop trading strategies, an understanding of the relevance of these processes was necessary.

The influence of the greenshoe option on some companies is that after the first 30 days there is no invisible hand supporting them in case the price goes down, which has been previously done by the investment bank. Therefore, after that initial period, the unsupported IPO has a higher risk of its price dropping. This depends on a number of factors, including whether the high of that 30 day period becomes a support or a resistance level. The way IPOs are traded in that initial period is by buying against the low, because their price will be supported by the investment bank. Thus when formulating an IPO trading strategies, it was considered that the 30^{th} day is an important threshold and was used as an OR.

Another factor of particular interest when determining whether an IPO would breakout and be a successful trade is the initial offer price. Whether a stock has had a bad first day might determine whether it will be successful or not. Therefore factors such as the initial offer price in comparison with expected offer price, first day high and low, and others would be a good indicator of the IPO potential for breakout.

An important factor when making a prediction is what is the volume of a stock and how much of the greenshoe option has been used. If the greenshoe has expired before the first 30 days, then the investment bank would not provide a floor for the stock

anymore, therefore the behavior of the stock at that day and after that would be an indicator of the IPO trading strategy success.

4.2 OR Strategies

Since the main purpose of the project is to determine the factors that predict with highest probability whether an IPO stock will break out of its opening 30 day range, the team analyzed charts and looked for trends to confirm that the formed strategies are profitable.

The trend that was considered in this project was based on what was already described, namely – the OR theory. As was mentioned before, the OR does not have to be 30 days or 30 minutes or any specific period of time. With respect to the OR strategies of general stocks, the choice of the 30 minutes OR is due to the fact that the first 30 minutes of the trading day are the most emotionally intense. However other OR periods are used as well. With IPOs the OR also doesn't have to be 30 days. Nevertheless, the team chose the 30 days period, because of the greenshoe option and its effect.

5 Process and Results

The information gathered in the previous sections was used as the basis for creating a dataset for evaluating IPOs and their potential for breaking out. The team used a program called Braincel (http://www.jurikres.com/catalog/ms_bcel.htm) in order to run tests and determine whether it is feasible to trade IPOs with the 30 day OR strategy. The hypothesis was that there are certain factors which affect the direction in which the IPO goes after its first 30 days. In addition, IPOs that were considered relevant were those that after the first 30 days went up two, three, or four average true ranges (ATRs) before going down one or two ATRs, which would guarantee that the trade is not a losing one. The ATR by definition differs from an average range since it accounts for possible overnight gaps in the price of the IPO. Three values are considered for the ATR – difference between high and low for the day; the difference between high of the day and close of the previous day; and the difference between low of the day and close of the previous day. For each day the maximum of these three values is taken and the average of the maximum values for a thirty day period is the ATR.

5.1 Acquiring the Data

5.1.1 TradeStation

TradeStation is a technical analysis piece of software created and distributed by TradeStation Securities. The Windows-based application is used as a trading platform for financial markets. TradeStation supplies historical data, real-time data, and various displaying charts. It has its own programming language called EasyLanguage and although some indicators are built in, the user can code additional indicators in EasyLanguage. TradeStation can be used as a trading platform and TradeStation

securities can be used as a broker. In this project, version 8 of the software was used to gather data for testing purposes.

The extracted historical data was for 242 stocks. The period of time for which the data was extracted was from the first day of the IPO until a fixed date, which for the purpose of this project was March 2, 2007. It was relevant to have a set ending date for the data, so that external factors, such as news, market fluctuation etc., would affect all the stocks in the same manner.

After the data were obtained, it had to be analyzed. As was discussed in the background research a good tool for this purpose was a Neural Network. The process and results are described in the following sections.

5.2 Braincel

Braincel is a program distributed by Jurik Research, a company owned by Mark Jurik. The main focus of the research done by them is in the areas of finance, trading, neural networks, and financial forecasting. The products include technical and leading indicators, system development, historical data, and learning materials *(JurikResearch)*.

5.2.1 General Information

Braincel is a leading indicator product. It is a neural net add-in module for Microsoft Excel. The software requires data that is divided into a training set and a control set. The training set is a dataset that has all the information about the parameters tested as well as the outputs, i.e. information on whether the IPO broke out and how much. The neural net has an “Expert” that is run on the training set so that it can learn

from it. The output of the program run is the forecast that the neural net has done. The control set is used to determine the accuracy of the program.

There are several factors to be kept in mind when running the Braincel software:

- The training test set contain sufficient amount of data – the program gives a warning if there is insufficient information
- It is recommended that the ratio between training set and control set is 3:2 (60:40)
- The data has to be diverse in order for the neural net to be able to identify patterns. This means that a variety of inputs and output combinations should be in the training set, so that the program can learn about all possible situations. Also the data should be uncorrelated as much as possible.

5.2.2 Data Preprocessing

The Braincel software is often used in combination with data preprocessing software. As was mentioned in previous sections, data preprocessing improves the performance of models. The reason for that is that the quality of the results of neural networks depends on the data that they have been trained on. Therefore, if they are fed with too much redundant data, the output quality falls down. The data preprocessing process determines what part of the data is relevant and to what extent, thus eliminating some of the variables used in the input. The program is particularly looking for correlated variables and eliminates them, resulting in uncorrelated data. The software that the team used for this project was Decorrelator and Dimension Reducer (DDR) add-in tool for Excel, developed by Jurik Research, and working best with Braincel.

5.2.3 Application to the Project

For the purpose of this project the Braincel software was used for evaluating IPO trades. The tests were ran on 242 IPOs from a variety of sectors. All the information was taken based on the prices of the IPOs from the day they were announced until March 2, 2007. The team conducted three tests and preprocessed the data for each of them eliminating five to seven of the inputs that way.

5.3 Parameters

A variety of variables were considered and used for different tests. The variables were chosen based on the research conducted on the topics of OR trading, IPO trading, and trading in general. The data for all these variables was obtained through looking at the historical data of the IPO. The outputs were determined based on the goal of the project.

5.3.1 Inputs

- IPO – the ticker symbol of the IPO traded;
- Offer Price ($/share) – that is the predicted price for the IPO. This is an important variable, because based on the comparison of that price and the actual open price on the first day of the IPO it can be determined whether it was under or over priced. This is an indicator of the market attitude towards the stock and thus of its potential for growth;
- Market Value ($) – by definition that is the product of all shares outstanding and the offer price;

- Deal Value ($) – the value of the bought deal for the IPO, whose underwriter can be an investment bank or a syndicate;
- Shares Initial (shares) – this parameter is relevant because it represents initial volume. It is particularly important for trading IPOs because of the fact that this is the first turnover of the shares offered. It is used in combination with the daily volume of the IPO;
- First day Open Price ($/share) – this parameter is relevant in particular in comparison with the offer price, because it is the first indicator of how the market has evaluated the IPO relative to how it was supposed to be offered;
- First day High Price ($/share) – the first day high is used in comparison with the first day low price in order to identify the first day range;
- First day Low Price ($/share) – the lowest price of the IPO throughout the first day;
- First Day Close Price ($/share) – the price of the IPO at the close of the first day;
- First Day Range ($/share) – the difference between high and low of the first day;
- Lock-up Period (days)– the period during which investors can't sell their shares of the IPO, so it is not traded like general stocks yet;
- First 30 Day's Range ($/share) – basis for the OR analysis, especially if the Greenshoe option effect is considered;

- Days till break out of 30 day OR (days) – the day at which the price of the IPO goes above the 30 day high. This number is always higher than 30. In case the IPO does not break out before March 2, 2007 it is assigned a value of 1000 which is significantly higher than any other period;

- Did the first day close higher than it opened? (binary 0/1) – 1 indicates close is higher, 0 indicates open is higher, i.e. 1 indicates that the stock went up during the day and vice versa;

- 30 day high ($/share) – the highest price the IPO reached within the first 30 days;

- 30 day low ($/share) – the lowest price the IPO reached within the first 30 days;

- Is the 30 day high higher than the first day high? (binary 0/1)– this parameter compares the highest price for the first day and the first 30 days. 1 indicates that the 30 day high is higher than the first day high, which implies an upward trend in the IPO price;

- Is the 30 day low lower than the first day low? (binary 0/1) – this parameter compares the lowest price the IPO reached in the first day and in the first 30 days. A 1 indicates that the 30 day low is lower than the first day low. A 0 indicates that the IPO has not reached a lower price than the one on the first day, which could possibly mean a strong upward trend with higher lows and higher highs;

- 30 day average range ($/share) – this is the average of the ranges for the first 30 days. The daily range is defined as the difference between high of the day and low of the day;

- 30 day ATR ($/share) – the average range does not account for possibility of gapping prices overnight. Even though the market is closed, at night orders to buy and sell come in and cause the opening price for the day to be lower or higher than the closing price from the previous day. That gap stays unaccounted for in the traditional computation of average range, therefore an average true range is used. In this case it has been calculated by taking for each day the maximum of three averages - the difference between high and low for the day; the difference between high of the day and close of the previous day; and the difference between low of the day and close of the previous day. The results from a 30 day period are averaged and the result is the 30 day ATR;

- Ratio between the first day range and the 30 day average range (dimensionless) – this parameter gives a comparison of the movement of the IPO in the first day and the first 30 days;

- Ratio between the last five days and the 30 day range (dimensionless) – this indicator gives the movement of the IPO in the period day 26 to day 30 compared to the first 30 days;

- Ratio between the close of first day and the offer price (dimensionless) – as was described for the offer price, this is an important indicator of the expectation for the value of the IPO and the attitude of the market. The first day is the most important for revealing what the real value of the IPO is. Therefore, it is valuable to compare that price to the offer price (expected before the first day of the IPO) or in other words real to expected price. Thus if the real price is higher than the

offer price, this indicates a very high interest in the stock and it is more likely that it will go up and probably reach plus two ATRs or more;

- Days till turn of volume (days) – the variable represents on which day the same amount of stocks have been traded as shares initial or in other words on which day the first volume turnover occurs. Our hypothesis that the higher the volume overturns the more interest there is. This hypothesis is confirmed by the Greenshoe option theory discussed previously;

- First day volume (shares) – This parameter shows the number of shares traded on the first day of the IPO. It is an indicator of the interest in the stock on the first day. Low volume indicates low general interest so low prospect for the IPO to reach the output levels in the tests;

- Ratio of first day volume to shares initial (dimensionless) – this ratio gives a comparative look at the volume at the first day and the initial shares available for the IPO. The higher the ratio, the more interest there is in the stock;

- Ratio of price at day of first turn of volume to offer price (dimensionless) – this ratio represents the price of the IPO when the initial number of shares have been traded. This price is after that compared to the offer price. A higher ratio would represent higher interest in the IPO than it was expected when formulating the offer price;

- Did volume turnover before 30^{th} day? (binary 0/1) – For the purpose of the different tests, the information available before the buy date is important.

Therefore this variable determines whether the first turnover of the volume was before the 30th day – thus a value of 1, or 0 otherwise.

- Did volume turnover before the breakout of the OR of the stock? (binary 0/1) – If the volume turnover was before the breakout, the value of this variable is 1. This could signify that even after the greenshoe option is no longer influencing the stock price, its price is still going up, which is a potential for more profit.

- Did price on the 31st day close higher than the OR high? (binary 0/1) – In many opening range theories there is a set of conditions that have to occur in order for an event to be considered a breakout, and then there is a trigger necessary to confirm the breakout. For the purpose of one of the tests the team ran, if the price on the 31st day close was higher than the OR high, this was considered a trigger, i.e. an additional confirmation for a breakout. A value of 1 indicates that the price closed higher than the OR high and 0 means that it did not.

5.3.2 Outputs

The outputs are based on the desired results for the IPO. In order to keep losses to a reasonable level and to have a guaranteed gain two main cases are considered.

- Maximum loss of two ATRs – In this case a price gain of two, three, or four ATRs occurs before a retrace of two ATRs providing for three outputs;

- Maximum loss of one ATR – Similar to the other case three outputs come out as a result, namely profit of two, three, or four ATRs before retracing one ATR. This case can be looked at as a stricter subset of the other case. It leads to higher profit

and is less risky. However, such occasions are rarer and thus more data is necessary in order to train the neural net properly.

5.4 Tests

In order to be able to predict the direction of an IPO, the team conducted three different tests. They varied depending on the day the IPO was to be bought and each of them stresses on different IPO trading characteristics. The first test is the Thirty Day Based test which uses all the data available in the first 30 days of the trade, and assumes that the IPO is bought at open of the 31st day. The second case focuses on the greenshoe option theory and how it affects the IPO, and therefore it uses the inputs that focus on the volume turnover day, and assumes that the IPO is bought at open of the day after the volume turnover day. The last test looks at the OR theory of Geoff Bysshe. It assumes that the stock is bought at the open of the day after the IPO has broken out.

5.4.1 Thirty Day Based Test

The first test, as we mentioned before, focused on the information from the first 30 days. Therefore from all the inputs only the ones that are available at the end of the first 30 days were used. To form the outputs the ATR of the first 30 days was added to the opening price of the 31st day. For a full list of the inputs used see Appendix A. Initially there were 24 inputs. After running the DDR preprocessing software the inputs dropped to 17. The results from the Braincel test are described in Table 3.

Table 3 Thirty Day Based Test Results

	Output	Right guess successful trade/All successful trades		Right guess/All trades		Right guess non-successful trades/All non-successful trades	
		Original	DDR	Original	DDR	Original	DDR
1	2 ATRs up, 2 ATRs down	41.18%	55.26%	41.25%	53.75%	41.30%	52.38%
2	3 ATRs up, 2 ATRs down	36.67%	38.46%	51.25%	53.75%	60.00%	61.11%
3	4 ATRs up, 2 ATRs down	24.00%	13.89%	55.00%	38.75%	69.09%	59.09%
4	2 ATRs up, 1 ATR down	19.05%	12.50%	56.25%	50.00%	69.49%	66.07%
5	3 ATRs up, 1 ATR down	27.27%	13.04%	73.75%	58.75%	81.16%	77.19%
6	4 ATRs up, 1 ATR down	12.50%	0.00%	71.25%	72.50%	85.94%	84.06%

The results are for the 6 different outputs, representing that the stock will go for example 2 ATRs above the 31st day open price before they go 2 ATRs down. That would allow for a definite exit strategy – sell when price reaches -2ATRs. This is important for good money management. In the following results a successful trade is defined as one which did go up X ATRs before going down Y ATRs and a non-successful trade is one that did not. Also a right guess means that the neural net predicted accurately the outcome of the trade. Thus the first set of results ("Right guess successful trade/All successful trades") shows the percentage of successful trades that the neural net accurately guessed. The first subset ("Original") is based on the original 24 inputs, and the second subset ("DDR") on the 17 inputs determined by running the DDR data preprocessing. The next set of results ("Right guess/All trades") shows the percentage of right guesses in general, and the last set ("Right guess non-successful trades/All non-successful trades") shows the right guesses of all the non-successful trades.

For trading purposes only the successful trades are of interest to this project, since the trader would take only trades that the neural net suggests would be successful. Therefore the important numbers are the ones provided by the DDR test for outputs 1 and

2. The rest of them are much lower than 40% which makes them not as profitable. The significance of the results is discussed further in the following sections.

5.4.2 Volume Test

This test incorporated the theory about the volume turnover and its significance to the IPO's pricing. Since it is the first turnover of the IPO, how much time does it take to reach it would be an indication of how much interest there is in the IPO. Based on the discussion in previous sections the input variables that were used in this case were determined and are listed in Appendix B. One important point to make is that in the output the team defined an IPO that had its volume turnover after the lock-up period was over to be non-successful. The reason for that was that after the lock-up period, the dynamics of the market changes, therefore more information should be looked at. The results from this test are as shown in Table 4.

Table 4 Volume Test Results

Output		Right guess successful trade/All successful trades		Right guess/All trades		Right guess non-successful trades/All non-successful trades	
		Original	DDR	Original	DDR	Original	DDR
1	2ATR up, 2 ATR down	47.83%	48.00%	50.00%	50.00%	52.94%	53.33%
2	3ATR up, 2 ATR down	40.00%	35.71%	53.75%	48.75%	67.50%	63.16%
3	4ATR up, 2 ATR down	28.95%	27.03%	51.25%	50.00%	71.43%	69.77%
4	2ATR up, 1 ATR down	27.66%	26.53%	42.68%	41.25%	62.86%	64.52%
5	3ATR up, 1 ATR down	22.50%	25.81%	52.50%	61.25%	82.50%	83.67%
6	4ATR up, 1 ATR down	16.67%	17.65%	60.00%	57.50%	86.00%	86.96%

The results from this test are similar to the results from the Thirty Day Based test. As in the previous case predictions for non-successful trades are more accurate. The results from the DDR test are not much better than the original even though the inputs

were reduces from 17 to12. Again outputs 1 and 2 have a good prediction rate for successful trades.

5.4.3 Breakout Test

The last test as we mentioned before was based on the OR trading strategy of Geoff Bysshe. The team looked at whether stocks whose price broke out of their 30 day OR were successful. The way this approach was tested was through considering all the information available until the day the IPO broke out of its OR. As in the previous test, if a stock broke out of the OR after the end of the lock-up period, it was considered as non successful and out of the scope of the project. The ATR for the output is based on the last 30 days before the breakout. The set of inputs is listed in Appendix C. The results from both the original test with 24 inputs and the DDR test with 18 inputs are shown in Table 5.

Table 5 Breakout Test Results

Output		Right guess successful trade/All successful trades		Right guess/All trades		Right guess non-successful trades/All non-successful trades	
		Original	DDR	Original	DDR	Original	DDR
1	2ATR up, 2 ATR down	52.94%	56.25%	61.25%	63.75%	67.39%	68.75%
2	3ATR up, 2 ATR down	48.00%	50.00%	65.00%	66.25%	72.73%	72.41%
3	4ATR up, 2 ATR down	47.83%	28.57%	72.50%	62.50%	82.46%	74.58%
4	2ATR up, 1 ATR down	50.00%	38.46%	72.50%	68.75%	76.47%	74.63%
5	3ATR up, 1 ATR down	35.71%	23.08%	72.50%	68.75%	80.30%	77.61%
6	4ATR up, 1 ATR down	12.50%	35.71%	76.25%	78.75%	83.33%	87.88%

The results from this test are much better than from the previous two. Also the DDR run improves the results for only some of the inputs. Nevertheless, the results could be used for successful trading of IPOs.

6 Results Interpretation and Applications

In order to use the system well, it is important to understand what the results mean. In particular it is relevant to understand whether the values described above are high or low. As we mention in the section about Money Management, a strategy that is right in 40% of the cases can be very profitable as long as good money management is practiced. However, results that are better than 40% are much more desired. There is one very important reason for the relatively lower results of the successful trades. As we mentioned in the section about neural networks, the most important part of getting good results is feeding the neural net good and sufficient data. In these tests the team used information for 242 IPOs, which is much less than what is indicated as necessary for good results. As a comparison, in the background research one of the authors used more than 1600 IPOs to get results about a single characteristic of these IPOs. Moreover, in order to recognize a breakout, or as it is in the program – a 1, the neural net must have seen enough examples of 1s in the training set. However, out of the IPOs in the train set less than a third are actually reaching some of the outcomes. Therefore the lower results make sense. These factors can be confirmed by the results as well. If the goal of the project was to identify when the trades would not be successful, as can be seen form the results, the program would be successful in more than 70% of the cases for most of the tests. Also, when trying to predict outcome 1 and 2, the success rate is much higher than with outcomes 5 and 6, because outcomes 5 and 6 are much less likely to occur. Therefore, if more data is looked at it would significantly improve the results from the tests, which are profitable even in this form.

7 Prospect for Development

There are a number of ways that this program could be improved. First of all as was discussed in the previous section, feeding the program more data would guarantee more accurate and precise evaluation of the IPO. In particular breaking up the data in the different subgroups by outcomes and feeding it enough data for each outcome type would provide more accurate results. In addition, the data that is collected could be analyzed so that only relevant data is taken into consideration.

Another area that can be improved is the choice of variables. There are characteristics of IPOs that could be added to the considered values and also there could be variables that can be omitted. One of these parameters is the ATR as a representation of a moving average.

Improving the model would give better results. As was seen throughout the tests conducted, providing better and more accurate data only increases the success rate in predicting IPO break outs. A good money management plan should then be set and thus the strategy would lead to the desired results. Lastly, as with every other trading strategy it is relevant to understand that markets evolve and with the collection of more data the models should be retrained and updated for best results. Also additional inputs should be considered. Overall the strategy has a lot of potential, while having a limited risk.

8 Appendices

8.1 Appendix A

- IPO
- Offer price
- Market Value
- Deal Value
- Shares Initial
- 1st day open
- 1st day high
- 1st day low
- 1st day close
- 1st day range
- 30 day range
- 30 day high
- 30 day low
- Did 1st day close > open (0/1)
- 30 day high > 1st day high (0/1)
- 30 day low < 1st day low (0/1)
- 30 day average range
- 30 day ATR
- Ratio 1st day range/average 30 day range
- Ratio last 5 days range / average 30 day range
- Close of 1st day / Offer price
- Did volume turnover before 30 day (1/0)
- 1st day volume
- 1st day volume / shares initial
- Did 31 day close higher than the OR high (1/0)

8.2 Appendix B

- IPO
- Offer price
- Market Value
- Deal Value
- Shares Initial
- 1st day open
- 1st day high
- 1st day low
- 1st day close

- 1st day range
- Did 1st day close > open (0/1)
- Close of 1st day / Offer price
- Days till turn of volume
- Did volume turnover before 30 day (1/0)
- 1st day volume
- 1st day volume / shares initial
- Price at close of volume day / offer price
- ATR till turn of volume day

8.3 Appendix C

- IPO
- Offer price
- Market Value
- Deal Value
- Shares Initial
- 1st day open
- 1st day high
- 1st day low
- 1st day close
- 1st day range
- 30 day range
- 30 day high
- 30 day low
- Days till break out (after 30 day)
- Did 1st day close > open (0/1)
- 30 day high > 1st day high (0/1)
- 30 day low < 1st day low (0/1)
- 30 day ATR
- Ratio 1st day range/average 30 day range
- Ratio last 5 days range / average 30 day range
- Close of 1st day / Offer price
- Did volume turnover before 30 day (1/0)
- 1st day volume
- 1st day volume / shares initial
- ATR till turn of breakout day

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