

Trading System Development

An Interactive Qualifying Project

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By

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Abstract

The purpose of this interactive qualifying project is to develop a profitable auto-trading system for trading stocks which can be use in the Trade Station. This project consists of two different types of strategies --- Turtle Style Trading Strategy and 10 O'clock Bulls Strategy. Each individual system has its own rules defined to trade. Finally, two systems will lead to a system of system.

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Chapter 1: Introduction & Overview of the Research

The purpose of this interactive qualifying project is to design and implement an automated system for trading stocks. Nowadays, trading or investing becomes an essential part of people's finance management. With a good trading strategy, investing in stock market can bring a significant amount of profit. People invest either by themselves or ask their agents to invest. However, trading by themselves consumes plenty of time and requires a large amount of professional knowledge. If people ask their agents to invest, they don't have control over their own accounts and have no clue of what might happen to their money. With highly unpredictable risks, investors may even lose money. To solve this problem, an auto-trading system for equity market is developed by our group to help people better organize their wealth.

An automated system is nontrivial because people can actually have control over their own financial properties by using it. They can always have a clear clue of the trades processed within their accounts. In addition, by applying the automated trading system, people can go do other things like playing basketball instead of staying at home and staring at computer for a whole day.

The 10 O'clock Bulls Strategy is introduced by Geoff Bysshe in his book "Trading the 10 O'clock Bull" which mainly concentrates on intraday price and volume activity. It's also the descendant of concept of opening range introduced by Toby Crabel. There were two IQPs in the past elaborating about this strategy. Our group intended to take some ideas from the previous projects and develop our strategy with some new ideas. The strategy has different exit conditions and can show the corresponding results.

The Turtle Style Strategy is another trading strategy that our group analyzed. A turtle style trading system aims to implement a trend following system. It does not rely on the information of the company or most recent news. Instead, it follows the trend of the certain stock. Our group used a two-year-period to do back testing on equity market. By studying the turtle trading strategy, we want to be long term traders. In that case, we may save some time and let our algorithm do the trading for us.

By implementing both of the trading strategies, our conclusion is to allocate 60% of our capital on the 10 O'clock Bulls Strategy and 40% on the turtle one.

Chapter 2: Trading & Investing

The difference between trading and investing

Investing and trading are two methods both trying to get profit in the finance market. In many cases, investing means buying equity or other assets for a long period of time like over many years. It tends to use technical analysis to detect long-term trend. Trading usually means buying and selling equity or other assets for a short period of time. It tends to use trading system to detect short-term pattern. The advantage of trading compared to that of investing is that trading has ability to get profit no matter how the trend of whole market moves or the price of a single stock shifts.

Trend & cycle

Trend is an integrated direction which is moving over a period of time. It is a variable. The term "business cycle" describes the tendency of the economy to experience periods of rapid economic growth followed by periods of economic stagnation or decline (Gregory Hamel, Demand Media). The business cycle is a category under the trend.

Asset Classes

According to the website of Investopedia, "an asset is a resource with economic value that an individual, corporation or country owns or controls with the expectation that it will provide future benefit".¹ As for trading assets, according to the same publisher, "trading assets are a collection of securities held by a firm that are held for the purpose of reselling for a profit. Trading assets are recorded as a separate account from the investment portfolio. Trading assets may include U.S. Treasury securities, mortgage-backed securities, foreign exchange rate contracts and interest rate contracts".² People use trading assets in order to resell them in the near future. By doing that, they have the chance to make some profits from short-term price movement. There are three main types of assets including equity, bond and currency.

¹ "Asset Definition | Investopedia." *Investopedia*. N.p., 19 Nov. 2003. Web. 1 May 2016.

² "Trading Assets Definition | Investopedia." *Investopedia*. N.p., 15 Dec. 2010. Web. 31 March 2016.

Equity

Equity has different meanings depends on the context. In this paper, equity refers to a stock or any other security representing an ownership interest.³ Equity can be used to present the real value of one's gains in an investment. For example, people who hold stocks in one company use their shares to evaluate their own equity in that company.

Bond

According to the website of Investopedia, "a bond is a debt investment in which an investor loans money to an entity (typically corporate or governmental) which borrows the funds for a defined period of time at a variable or fixed interest rate. Bonds are used by companies, municipalities, states and sovereign governments to raise money and finance a variety of projects and activities. Owners of bonds are debt holders, or creditors, of the issuer".⁴ There are two features of a bond, credit quality and duration. These two elements are used to determine the interest rate of a bond.

Currency

Currency is basically referred to money which issued by national governments. Usually every country has its own currency. For example, the official currency in United States is dollar and the official currency in Japan is Japanese Yen. Also, currency is the basic element used to trade.

³ "Equity Definition | Investopedia." *Investopedia*. N.p., 18 Nov. 2003. Web. 10 May 2016.

⁴ "Bond Definition | Investopedia." *Investopedia*. N.p., 23 Nov. 2003. Web. 10 May 2016.

Chapter 3: Trading System

Trading Platforms & Brokerage Accounts

The trading platform we used is TradeStation. It is a software which provides online trading platform for financial market traders including the four basic assets. The platform can generate trade automatically by implementing strategies or allow user to trade manually. Because our group relied heavily on back testing since we all developed auto-trading systems, we utilized the functionality of this platform to test our strategies over data in history. The back testing in TradeStation helped us figure out the performance of certain strategy based on the previous data. Because of that, we were able to predict the future profit performance of that strategy. It is important to make sure that the auto-trading strategy we used can generate benefits for us.

Brokers refer to the firms that provide traders with ability to sell or buy assets, such as currency and stock. In exchange for their service, they charge a small commission fee per trade or charge different prices for buying or selling, or both.

Stock investing “styles”

Value investing

Value investing is a strategy about selecting stocks that trade for less than their intrinsic values.⁵ The goal of investors who use value investing is to find the stocks of companies which undervalued by the market. Investors believed that the movement of certain stock's price is not matching with the company's performance. Because of that, they can get profit by buying when the price is deflated. Since the investors of value investing tend to choose stocks whose prices are lower than average, they are suffering in a bull market.

Growth investing

Growth investing is a strategy whereby an investor puts high expectation on the growth potential of a stock.⁶ Investors choose companies which they think the earnings will grow higher than average rate. Also, unlike value-investing-investors, growth-investing-investors take advantage in a bull market.

⁵ "Value Investing Definition | Investopedia." *Investopedia*. N.p., 20 Nov. 2003. Web. 1 May 2016.

⁶ "Growth Investing Definition | Investopedia." *Investopedia*. N.p., 05 Jan. 2005. Web. 9 May 2016.

Support and Resistance

Support and resistance are two non-trivial attributes in technical analysis. They are related to positions when the price level of an asset tends to stop and reverse. Support is acting like a floor which prevents the price of assets from dropping under certain level. As the opposite side of support, resistance acts like a ceiling which tries to stop the price from going up. Figure 1 shows an example of support and resistance.



Figure 1: Example of support and resistance⁷

Breakouts and breakdowns

Breakouts and breakdowns represent that the price breaks above a level of resistance and heads higher and the price drops below a level of supports and heads lower. In other word, breakouts and breakdown occur when the stock's close crosses above or below the high and low of opening range. In this case, the support and resistance will be the high and low for the opening range. Figure 2 shows an example of Breakout.

⁷ Example of support and resistance. "Understanding the importance of support and resistance". *RightLine*. Web. 30 April. 2016. <<http://www.rightline.net/education/supportandresistance.html>>.

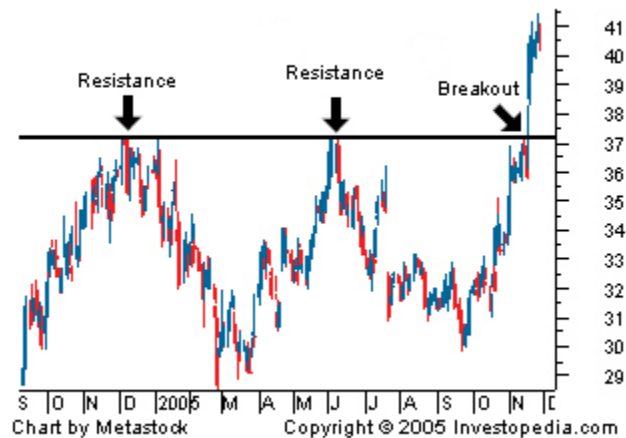


Figure 2: Breakout Example⁸

Strategies which apply the concept of breakout and breakdown are called trend following strategies. The two trading strategies developed in this project, both turtle system and 10 o'clock bulls strategy, are examples of trend following strategies.

Trading Strategies Comparison

Time Frame

Time frame usually describes the time period of a trader enters and exits the market. Time frame can vary from seconds to years based on different types of trading styles. As the name indicates, a long-term trading refers to the kind of trading within a longer time frame, such as position trading. However, on the other hand, a short-term trading concentrates on making profit within a short time frame, such as scalping trading and day trading.

⁸ Breakout Example. "Breakout Definition | Investopedia." *Investopedia*. Web. 10 May 2016. <<http://www.investopedia.com/terms/b/breakout.asp>>

Scalp trading

Scalping trading is an active form under the category of day trading. It operates frequent buying and selling in order to trace the intraday price movements. It focusses on the frequencies and uses very small gains to build the total profits. However, using scalp trading will lose a lot on the commission costs.

Day trading

Day trading is a trading style which enters and exits the market on the same day. A day trader would not hold any assets overnight and he or she can exchange the asset to cash at the end of the session.

Swing trading

Swing trading is a trading style which captures a short-term market movement. Swing traders are highly relying on the technical analysis and price movement to determine the entry and exit point. Unlike day trading, swing trading requires operating over a period of time, so trader have to hold positions overnight.

Long-term position trading

As the name indicates, position trading requires the longest trading time frame within a period of months or even years. Position traders usually combine technical and fundamental to analyze weekly and monthly price charts to make trading decisions. This kind of trading has the advantage of low commission costs. However, the money would be trapped in the market for a long period of time.

Figure 3 lists the time frame and holding period for these four main trading styles.

Trading Style	Time Frame	Holding Period
Position Trading	Long Term	Months to years
Swing Trading	Short Term	Days to weeks
Day Trading	Short term	Day only - no overnight positions
Scalp Trading	Very short term	Seconds to minutes - no overnight positions

Figure 3: Time frame and holding period for four main trading styles⁹

Manual Trading versus Algorithmic Trading

People can choose either manual trading system or auto trading system to process their trades. Manual trading means people place their buy or sell order manually. Auto trading means the trading platform place the buy or sell order based on the implementing strategy. Each trading method has its own advantages and disadvantages. Trading manually can allow people enter and exit the market whenever the user feels needed. However, trading manually require some major knowledge to operate the trade in order to gain profit. Auto trading can save traders some time. Traders can easily let computer do all the job and go to do other things instead of staying with the computer all the time. Also, auto trading can eliminate the emotion elements from people since it always obeys the rules built in the strategy.

Fundamental Trading versus Technical Trading

Fundamental trading and technical trading are both stock-picking methods to forecast the future trend of stocks. In order to evaluate securities, fundamental trading measures the intrinsic value of a stock. Analysts using fundamental trading study everything from the overall economy and industry conditions to the financial condition and management of companies. However, on the other hand, technical trading evaluates securities by studying statistics generated by market activity, such as past prices and volume. Analysts using technical trading strategy do not aim to value the intrinsic property of a certain stock. Instead, they use stock

⁹ Time frame and holding period for four main trading styles. "How To Start Trading: Trading Styles | Investopedia." *Investopedia*. Web. 26 Apr. 2016. <<http://www.investopedia.com/university/how-start-trading/how-start-trading-trading-styles.asp>>

charts to identify patterns or trends as their indicators. They follow this kind of indicators to predict the future performance of a stock.¹⁰

Personalized Objectives for Designing Trading Strategy

A certain type of trading style or trading strategy is impossible to suit every single situation. Traders must consider various factors to select a trading style and a trading strategy, including

1. Account size
2. Amount of time can be spent on the trading
3. Trading experience and knowledge
4. Personality
5. Risk tolerance

Collection of Rules

Entry Point

Entry point is the price when an investor buys an investment and enters the market. According to the website of Investopedia, “the entry point is usually a component of a predetermined trading strategy for minimizing investment risk and removing the emotion from trading decisions”. In order to make profits by trading, figuring out an appropriate entry point is the first thing to consider.¹¹

Filter

Filter is a set of criteria which helps investors to narrow down their choices for choosing financial instruments. Without the help of filter, one may not be able to identify the most profitable choice.¹²

¹⁰ "What Is the Difference between Fundamental and Technical Analysis? | Investopedia." *Investopedia*. N.p., 01 Feb. 2005. Web. 1 Apr. 2016.

¹¹ "Entry Point Definition | Investopedia." *Investopedia*. N.p., 10 Apr. 2010. Web. 24 Apr. 2016.

¹² "Filter Definition | Investopedia." *Investopedia*. N.p., 20 June 2005. Web. 10 May 2016.

Set-up price

According to the website of Investopedia, “set-up price is a price level predetermined as the point of entry into a specific security, stock, or currency. Once the setup price is broken the trader will enter the position determined by the setup. This could include shorting a stock because they think the price will drop or going long because they expect an upward movement”.¹³

Trigger

A trade trigger is usually a market condition. It can be a rise or fall in the price of an index or security. Trade triggers are utilized for automation purposes during trading, such as selling shares of a stock when the price reaches a certain level.¹⁴

Exit

Exit point is the price at which an investor sells an investment. People usually use exit strategies with a set of conditions to get out of the market. There are different types of exit strategies varying from system to system. Two common exit strategies are exit with profit and exit with loss. Exit with profit can help extend profitable positions and prevent losing profit from a stop-reverse. Exit with loss can help minimizing loss as early as possible.

Position sizing

Position means the amount of assets which is owned (long position) or borrowed and then sold (short position) by an individual, institution or dealer. According to the website of Investopedia, “a position can be either profitable or unprofitable depending by market”.¹⁵ Position sizing is a significant element in any trading system. It manages the risk as well as the return. If the size of a position is too small, it would not profit as expected even the position moves a lot. Also, position size is relative comparing in different people with account size or capital.

¹³ "Setup Price Definition | Investopedia." *Investopedia*. N.p., 15 Apr. 2008. Web. 3 May 2016.

¹⁴ "Trade Trigger Definition | Investopedia." *Investopedia*. N.p., 11 June 2010. Web. 2 Feb. 2016.

¹⁵ "Position Definition | Investopedia." *Investopedia*. N.p., 25 Nov. 2003. Web. 1 May 2016.

Order type

Market order

A market order is the most basic and popular type of trader order. It helps the broker to buy or sell the asset at the best price where currently available. Trading platforms usually have “buy” and “sell” button in the interface to make this type of order easy to operate. Figure 4 below shows an example of market order.



Figure 4: Example of market order

Trader can place market order to guarantee the trade is fulfilled. Market order is the most reliable order type allowing trader to get in or out of a trade.

Stop Order

According to the website of Investopedia, “a stop order to buy or sell becomes active only after a specified price level has been reached (the "stop level"). Stop orders work in the opposite direction of limit orders: a buy stop order is placed above the market, and a sell stop order is placed below the market. Once the stop level has been reached, the order is automatically converted to a market or limit order (depending on the type of order that is specified). In this sense, a stop order acts as a trigger for the market or limit order. A stop order is appropriate when it is important to confirm the direction of the market before entering a trade”.¹⁶

Limit Order

A limit order refers to an order to buy or sell at a specific price or even a better price. In other word, a buy limit order can only access at the specific price or lower and a sell limit order can only access at the specific price or higher. When using limit order, a trader has to specify the price instead of just press a button. As a result, a limit order cannot guarantee to get in the market since the price could be moving away from the specific price in that order.

¹⁶ "Introduction To Order Types: Stop Orders | Investopedia." *Investopedia*. N.p., 04 Sept. 2012. Web. 10 May 2016.

Condition Order

Conditional order is considered as the most basic form of trade automation. When some specific criteria are met, trade orders can be submitted or cancelled automatically. There are two common conditional orders. One is order cancel order(OCO). The other one is called order sends order(OSO).¹⁷

¹⁷ "Introduction To Order Types: Conditional Orders | Investopedia." *Investopedia*. N.p., 04 Sept. 2012. Web. 2 Apr. 2016.

Chapter 4: Optimizing and Analyzing Trading Systems

Optimization

According to TradeStation website, “strategy optimization is the process of testing a range of strategy input values to find the combination that gives the best results based on historical data using a specified fitness function. Optimization is used to enhance a trading idea; it cannot be used to develop one”.¹⁸ Notice that Only numeric inputs can be optimized. The optimization process calls for TradeStation to change the value of at least one input in the strategy, calculate the strategy rules, change the input value by a specified increment and reapply, calculate, etc., until the last value is reached. As for the users, they must specify the beginning and ending values along with the change increment for each input to be optimized. After the optimization process, a strategy optimization report will be generated. After all, optimization can help a system gets better.

Figure 5 shows an example of optimization process.

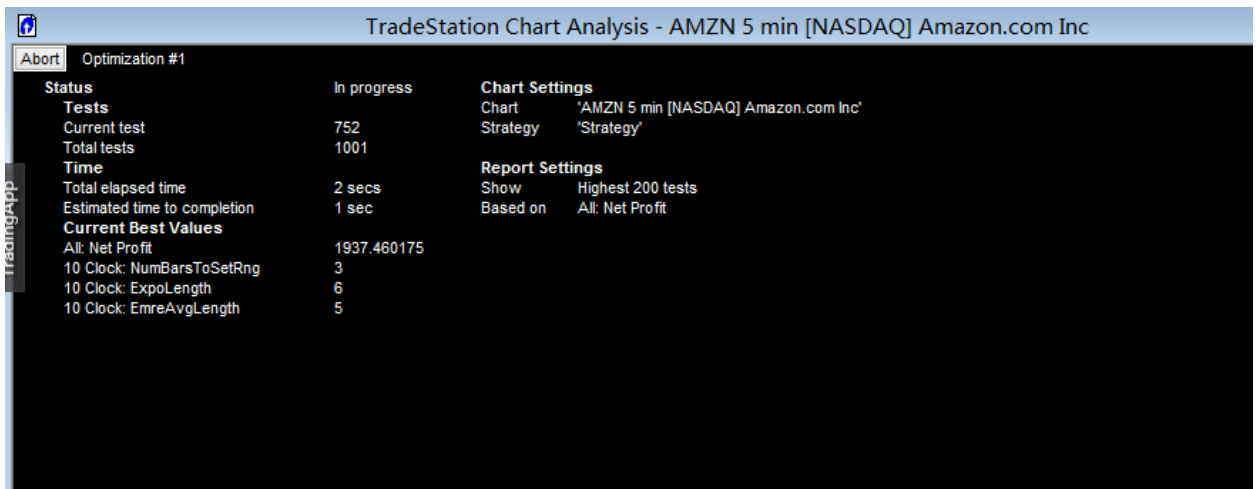


Figure 5: Example of optimization process

¹⁸ "About Strategy Optimization." *About Strategy Optimization*. N.p., n.d. Web. 10 May 2016.

Figure 6 shows an example strategy optimization report.

	10 Clock BarsToSet	10 Clock ExpoLength	10 Clock reAvgLeng	Test	All Net Profit	All Gross Profit	All Gross Loss	All Total Trades	All % Profitable	All Winning Trades	All Losing Trades	All Max Winning Trade	All Max Losing Trade	All Avg Winning Trade	All Avg Losing Trade	All Win/Loss Ratio	All Avg Trade	All Max Consecutive Winners	All Max Consecutive Losers	All Avg Bars in Winner	All Avg Bars in Loser	All Max Intraday Drawdown
1	4	14	12	695	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
2	3	14	12	694	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
3	4	13	12	688	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
4	3	13	12	687	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
5	4	12	12	681	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
6	3	12	12	680	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
7	4	11	12	674	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
8	3	11	12	673	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
9	4	10	12	667	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
10	3	10	12	666	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
11	4	9	12	660	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
12	3	9	12	659	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
13	4	8	12	653	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
14	3	8	12	652	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
15	4	7	12	646	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
16	3	7	12	645	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
17	4	6	12	639	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
18	3	6	12	638	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
19	4	18	11	632	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
20	3	18	11	631	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
21	4	17	11	625	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
22	3	17	11	624	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
23	4	16	11	618	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
24	3	16	11	617	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
25	4	15	11	611	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
26	3	15	11	610	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
27	4	14	11	604	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
28	3	14	11	603	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
29	4	13	11	597	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
30	3	13	11	596	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
31	4	12	11	590	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
32	3	12	11	589	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
33	4	11	11	583	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
34	3	11	11	582	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
35	4	10	11	576	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
36	3	10	11	575	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31
37	4	9	11	569	1,193.64	2,349.06	-1,155.42	17	88.24	15	2	501.27	-811.44	156.60	-577.71	0.27	70.21	14	1	3	25	-1,136.31

Figure 6: Example of strategy optimization report

Expectunity

Expectunity represents the profit or loss per dollar risked per year. Steps for calculated expectunity:

1. Calculate Opportunities
 $\text{Opportunities} = \text{Number of Trade in Total} * \text{Days per Year} / \text{Strategy Calendar Days}$
2. Calculate Expectancy
 $\text{Expectunity} = \text{Expectancy} * \text{Opportunities}$

Expectancy

Expectancy represents the profit or loss per dollar risked per trade. It also helps with calculating expectunity and system quality. Steps for calculated expectancy:

1. Calculate R Mult 1

$R \text{ Mult } 1 = \text{Profit or Loss in One Trade} / \text{Average Loss}$

2. Calculate Expectancy

$\text{Expectancy} = \text{sum of R Mult 1} / \text{Number of Trade in Total}$

System Quality

System Quality represents the total profit or loss per dollar risked relative to the total variability of the profit or loss per dollar risked. Steps for calculated system quality:

1. Calculate Std Dev R Multiples

$\text{Std Dev R Multiples} = \text{STDEV}(\text{sum of R Mult 1})$

2. Calculate System Quality

$\text{System Quality} = \text{Expectancy} / \text{Std Dev R Multiples} * \text{SQRT}(\text{Number of Trades in Total})$

Monte Carlo Analysis

Monte Carlo simulations are used to model the probability of different outcomes in a process that cannot be easily predicted due to the intervention of random variables¹⁹. In this project, Monte Carlo analysis reveals certain level of confidence under certain conditions about the characteristics of a trading system or a system of system, such as rate of return, maximum drawdown and etc. In other word, if Monte Carlo shows the rate of return for specific system in 95% confidence interval is 11%, we can conclude that we are 95% confident of system's actual rate of return will be 11%.

¹⁹ "Monte Carlo Simulation Definition | Investopedia." Investopedia. N.p., 24 Nov. 2003. Web. 1 May 2016.

Chapter 5: Literature Review

As for the 10 O'clock Bulls Strategy, the core part is Opening Range. Geoff Bysse had discussed about it and emphasized its importance. Opening Range will be discussed later in Chapter 6. The 10 o'clock Bulls Strategy is one of the three strategies which applying Opening Range and introduced in his book <Trading The 10 O'clock Bulls>. The basic idea of this strategy is to go long position while the system confirms a breakout and go short position while the system confirms a breakdown. The system uses the highest point and lowest point in first 30 minutes' period of the day with five-minute bar to determine breakouts and breakdowns. There is a lack of material elaborates on a comprehensive system using this strategy. However, we found two IQP are also developing this strategy with differential entry and exit rules. We analyzed the combination of different entry and exit rules which are not adopted in their projects and developed tests on that.

For the Turtle Trading Strategy, there are reviews on the mathematical theories behind the system, such as market volatility and position sizing. There are academic resources describing how the system works to make profits. In particular, both entry and exit rules can be easily found. For example, the turtle system will "open a long or short position if the price exceeds the high or the low price respectively of the past 20 periods".²⁰ There are many advantages to use this system. First, any individual can apply the basic rules of the system without the help from professionals. It is direct and simple that everyone may learn it quickly. Then, although the original turtle system used daily bars, any time frames can be used under it. The reason is that both uptrend and downtrend will occur under any time frames. Admittedly, a shorter time frame may generates a lower profit factor due to constant trading cost and uncertain profit potential.²¹ However, the system gives anyone flexibility on using different time frames. Finally, by only concentrating on trend, a person may not be distracted by other random news or ideas. In that case, trading decisions might be wiser and potential market risk might be avoided. On the other hand, however, there is a lack of material that elaborates on what kind of stock the system can handle well. We admit that the system may not be suitable for trading any stocks, so our group want to find a general principle on when to choose the turtle strategy. Because today's stock market contains unpredicted risks, it is better to think

²⁰ "Dukascopy FX Article Contest." *Dukascopy Forex Community*. N.p., n.d. Web. 16 Apr. 2016.

²¹ "Dukascopy FX Article Contest." *Dukascopy Forex Community*. N.p., n.d. Web. 30 Apr. 2016.

about whether the strategy fits this kind of market or not. In the following analysis, our group will continue explore this area.

Chapter 6: 10 O'clock Bulls Strategy

Description

We developed a 10 o'clock bulls strategy that mainly concentrates on trading stock market. The core idea of this system is using opening range to determine the high and low for a 30 minutes' period, then decided whether to go long or to go short. The 30 minutes' period will be from 9:30 to 10:00 in the morning. The first 30-minute is so powerful because it reveals the stock's bias for that day. Traders and investors are reacting to any news they have heard or analysis they have done since the close of the prior of the day (Geoff Bysshe). Also, Geoff Bysshe said that in 35% of the cases the high and low of the opening range will be the high and low for the day based on his personal experiences.

The opening range is composed with two elements - time and price. In this case, the time will be first 30 minutes of the day. The price of opening range is defined by the highest price and lowest price during the 30 minutes' time period. Figure 7 is a sample showing the opening range. The two blue lines represent the high and low of the first 30 minutes opening range.



Figure 7: Opening Range Sample

Initial rules for entry and exit

- Time >10:00 am
- Enter next bar at market if
 - Close > Opening Range High (trade long) or
 - Close < Opening Range Low (trade short)
- Exit and the end of the day

Figure 8 below is a perfect example of showing the breakout and breakdown. In the left half, a short order should be placed after the day's first breakdown below the Opening Range low takes place. In the right half of the figure, a long order should be placed after the day's first breakout above the Opening Range high.



Figure 8: Breakout and Breakdown

However, the initial rules of our strategy won't profit if the trend reverses. For example, the stock has a breakout first and then the trend reverses and goes downward. Figure 9 is showing this kind of situation. We need more rules for strategy to prevent loss of trend reverse.



Figure 9: Example of Trend Reverse

Entry Strategy: Set-ups & Triggers

Comparing Volume

The idea of this method is to confirm breakouts by comparing the volume with the average volume while the price is higher than Opening Range High. In other words, when the price is above the Opening Range High and the current bar's volume is greater than average volume, the strategy would buy long position.

Simple Moving Average

A simple moving average is calculated by adding the closing price for a number of time period and dividing the total by the numbers of time period. This method is used to prevent the

loss of the breakout is not strong and the trend reverses after the breakout. As the result, the strategy only buys long when the simple moving average line and the price both go above the Opening Range High. The disadvantage of simple moving average is that the strategy would be late to take a position and miss profit opportunities since the average line becomes more smooth. Figure 10 is an example of simple moving average.

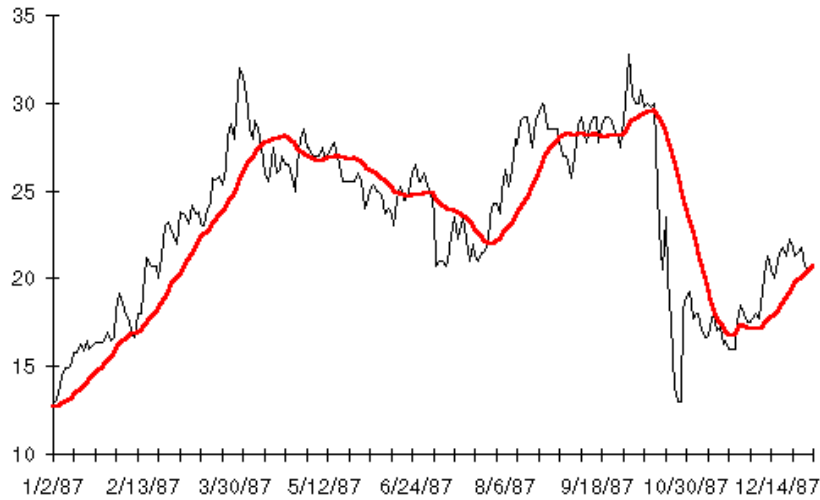


Figure 10: Example of Simple Moving Average²²

Exponential Moving Average

Similar to simple moving average, exponential moving average is also a tool which calculates the average price of an asset over a period of time. Exponential moving average is similar to Simple moving average but simple moving average focuses more on the overall data while exponential moving average focuses more on the recent data points. Figure 11 shows the method of calculating Exponential Moving Average.

To Calculate an EMA

$$EMA = (P * \alpha) + (\text{Previous EMA} * (1 - \alpha))$$

P = Current Price

$$\alpha = \text{Smoothing Factor} = \frac{2}{1+N}$$

N = Number of Time Periods

Current EMA= ((Price(current) - previous EMA)) X multiplier) + previous EMA.

The most important factor is the smoothing constant that $= 2/(1+N)$ where N = the number of days.

²² Example of Simple Moving Average. "Moving Averages." *Moving Averages*. Web. 1 May 2016. <https://www.fourmilab.ch/hackdiet/www/subsection1_2_4_0_4.html>

Figure 11: The method of calculating Exponential Moving Average²³

Base on the method of calculating EMA, recent data points weight more with the short period, and vice versa.

Exit strategy

Exit at the end of day

Using this strategy, positions will always exit at the end of a day. It's suitable for people who don't want to hold positions overnight. Also, it can prevent loss from the movement at the beginning of a day since at first 30 minutes the market might move significantly due to the news or other reasons.

Figure 12 is an example of successful prevention of loss from the price movement overnight. As showing in the figure, the price at the end of 4/26 is much higher than the price at the start of 4/27. If trader didn't exit the market, he or she would face a significant amount of loss.

²³ The method of calculating Exponential Moving Average. "Simple Vs. Exponential Moving Averages | Investopedia." *Investopedia*. Web. 1 May 2016. < <http://www.investopedia.com/articles/trading/10/simple-exponential-moving-averages-compare.asp>>



Figure 12: Example of successful prevention of loss from the price movement overnight

Percentage Trailing

Percentage trailing is a useful strategy which allows trading to continue to make profit as many as possible and exit when the trend reverses to prevent profit losing. It can be set at a defined percentage away from a stock's current market price. A trailing stop for a long position would be set below the stock's current market price. In contrast, a trailing stop for a short position would be set above the stock's current market price. There are two conditions in our percentage trailing strategy. The first one is that the position has to earn at least 2 percent of entry price in order to exit. After the first condition is satisfied, the position will exit after 5 percent of the profit is lost. These two number can be vary based on the different trend of different stocks. Trader can put larger number if the trend of stock moves significantly.

Money Management Stops

A money management stop loss strategy is used to help prevent further loss from a loss trade. A stop loss exits a trade when the trade has lost for a preset amount in total or amount per share. For example, if a trader holds 100 shares of AAPL and preset \$0.10 stop loss amount, he would exit 0.1 (SetStopLoss(0.1)) from the entry price with \$10 loss (SetStopLoss(10)).

Final Strategy Performance and Personality

Our final strategy ends up with entry rules combining volume and exponential moving average and exit rules combining exit at the end of day and percentage trailing.

Set up:

- Time >10:a.m. and time < 3:30 p.m.
- Open > Opening Range High (Long condition); Close < Opening Range Low (Short condition)
- Exponentially weighted moving average of the prices of the last 12 bars > Opening Range High (Long condition); Exponentially weighted moving average of the prices of the last 12 bars < Opening Range High (Short condition)
- Average volume of the last 10 bars > Opening Range High (Long condition); Average price of the last 9 bars < Opening Range Low (Short condition)
- The low bar > Opening Range High (Long condition); The high bar < Opening Range Low (Short condition)

Tigger:

- Buy at Opening Range High next bar
- Sell short at Opening Range Low next bar

Exit:

- Exit at the end of a day
- Trailing Stop

Also, we set the trailing stop factor relatively small so we can always exit with a guaranteed profit and prevent loss while holding the position. However, that also reduces our total profit since the strategy works like a scalping strategy with a large number of trades and

consumes a lot of commission costs. The factor can vary within different risk-tolerance. To examine our strategy, several back tests with time period of 2 years were developed in table 1.

symbol	Net profit	Long Profit	Short Profit	Profit Factor	Number of Trades	Percent Profitable	Number of Winning Trades	Number of Losing Trades
AMZN	\$30,677.44	\$30,360.72	\$316.72	1.50	1244	87.30%	1086	156
AKAM	\$31,171.14	\$23,883.86	\$7,287.28	1.26	1205	86.39%	1041	159
BIDU	\$27,134.25	\$22,085.75	\$5,048.50	1.22	1120	85.18%	954	165
RTN	\$10,371.64	\$6,656.54	\$3,715.10	1.18	1112	86.96%	967	141
MMM	\$9,756.16	\$8,140.00	\$1,616.16	1.17	1322	86.56%	1153	172

Table 1: Back testing in 2 years under 10 o'clock bulls

After observing the performance of different stocks, the system performs relatively well while the overall trend is going in one direction. However, if the trend is going up and down several times, the system would not generate any trade. Figure 13 and 14 show the examples of them.



Figure 13: Active performance with overall one direction trend

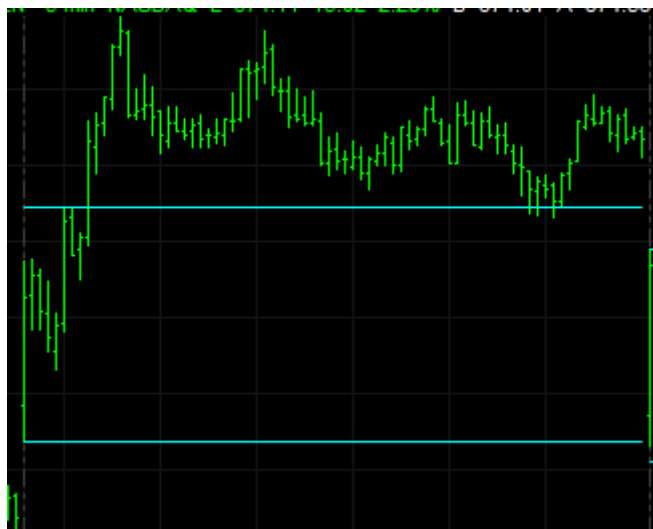
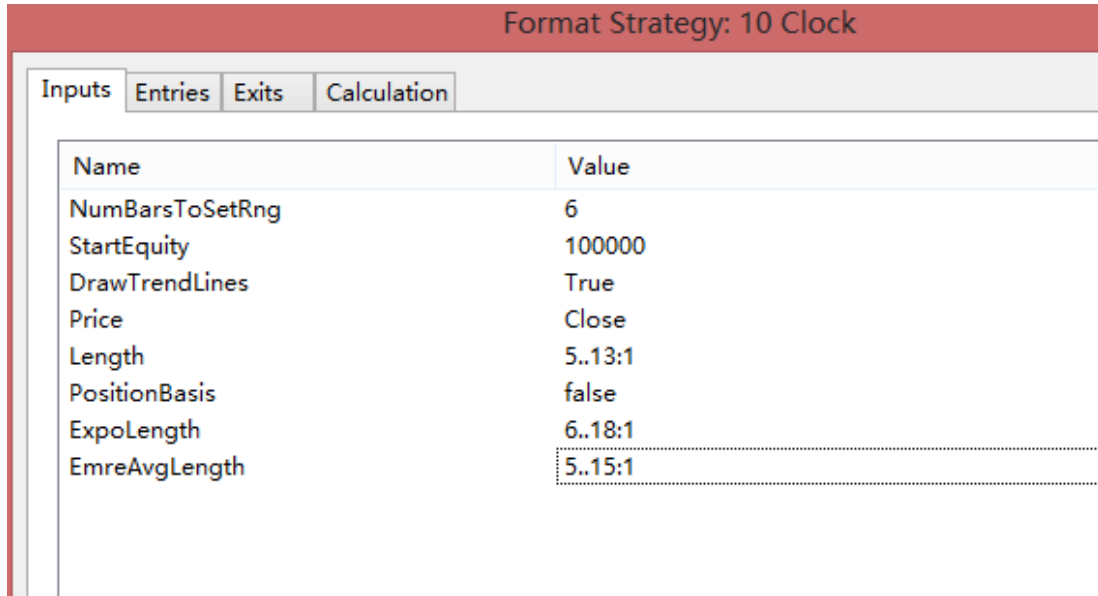


Figure 14: Non-active performance with up and down trends

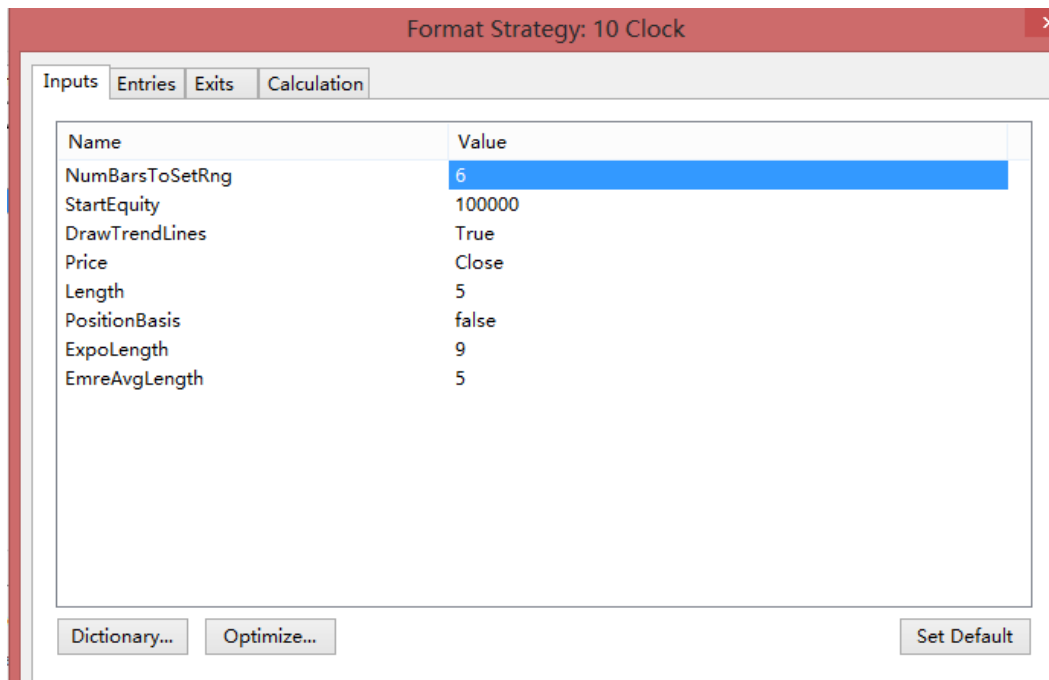
Optimization

The optimization process allows us to find the best parameter for our system's input values. Optimization setting and result of optimization are shown in Figure 15 and 16.



Name	Value
NumBarsToSetRng	6
StartEquity	100000
DrawTrendLines	True
Price	Close
Length	5..13:1
PositionBasis	false
ExpoLength	6..18:1
EmreAvgLength	5..15:1

Figure 15: Optimization setting



Name	Value
NumBarsToSetRng	6
StartEquity	100000
DrawTrendLines	True
Price	Close
Length	5
PositionBasis	false
ExpoLength	9
EmreAvgLength	5

Buttons: Dictionary..., Optimize..., Set Default

Figure 16: Result of Optimization

Table 2 is a comparison on the performance over 1 month for AMZN before and after the optimization:

	Total Net profit	Profit Factor	Total Number of Trade	Percent Profitable	Winning Trades	Losing Trades
Original Result	\$1290.56	1.30	65	84.62%	55	10
Optimization Result	\$1650.20	1.38	70	85.71%	60	10

Table 2: Comparison Before and After the Optimization

As we can see, the optimized parameters generated 5 more successful trades and earned around extra \$400 profit.

System Quality

Figure 17 is a table listing the Expectancy, Expectunity (Annualized Expectancy), Opportunities and system quality.

first trade	2014/5/12			
last trade	2016/5/6			
Strategy Calendar Days (Days)	725			
# of trade	1153			
Expectancy (Profit or Loss Per Dollar Risked Per Trade)				
	0.060	0.009		
Opportunities (Trades/Year)	580.4758621			
Std Dev R Multiples	0.576487122			
Annualized Expectancy (Expectunity) (Profit or Loss Per Dollar Risked Per Year)				
	34.8341	4.9887		
System Quality	3.534638193	Total profit/loss per dollar risked relative to the total variability of the profit/loss per dollar risked => Dimensionless		

Figure 17: System Quality Report

Due to the trailing stop, our strategy has a large amount of trades every years and the the profit per every dollar that is risked is only 0.06. It's a low return for every dollar risked, however, the system has a high opportunity to profit. Also, the expectancy is higher than zero, so people can earn profit if taking a position in the market. Expectunity shows that a dollar can profit around 35 dollars per year.

The system quality is around 3.5, which means the total profit/loss per dollar risked is about three times relative to the total variability of the profit/loss per dollar risked.

Performance report and Analysis

Figure 18 is an image of the equity curve of our strategy during trading. It has a strong average trend indicated by the red line.

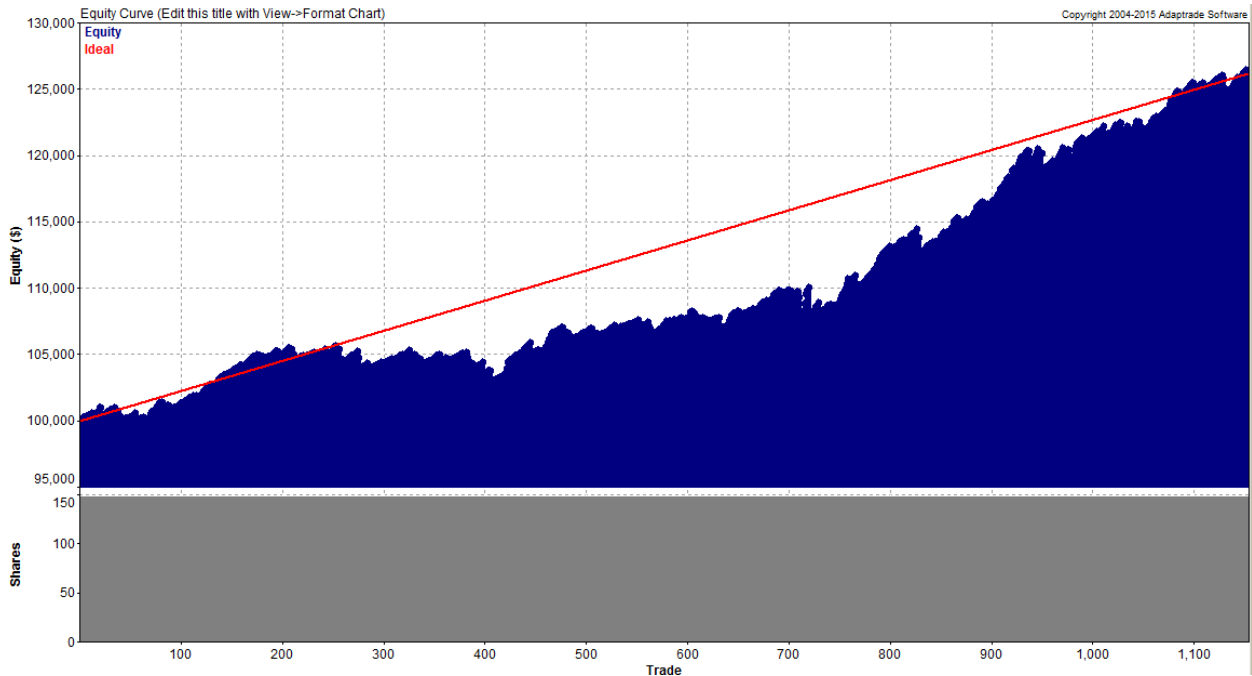


Figure 18: Market System Analyzer

Monte Carlo analysis was performed on trades generated by our strategy on AMZN with five-minutes chart from period of 2 years (2014/5/9 --- 2016/5/6). Also, The Monte Carlo analysis was performed before the optimization process as shown in the Figure 19.

Trading Parameters				
Initial Account Equity: \$100,000.00				
Trading Vehicle: Stocks				
Minimum Margin Requirement: 100.0%				
Slippage per side: \$0.00 per trade				
Commissions and fees per side: \$0.00 per trade				
Position Sizing Method: None				
No. Shares: From input data				
Number of Monte Carlo Samples: 10,000				
Key Results at Select Confidence Levels				
Confidence (%)	Rate of Return (%)	Max Drawdown (%)	Return-DD Ratio	Mod. Sharpe Ratio
50	26.15	3.662	7.140	0.1052
60	26.15	3.901	6.705	0.1045
70	26.14	4.165	6.275	0.1037
80	26.14	4.543	5.756	0.1027
85	26.14	4.837	5.407	0.1022
90	26.14	5.158	5.068	0.1015
91	26.14	5.246	4.983	0.1013
92	26.13	5.321	4.912	0.1012
93	26.13	5.455	4.793	0.1010
94	26.13	5.582	4.683	0.1008
95	26.13	5.673	4.608	0.1006
96	26.13	5.824	4.490	0.1002
97	26.12	6.019	4.343	0.09986
98	26.12	6.354	4.115	0.09940
99	26.11	7.006	3.728	0.09850
100	25.99	9.607	2.716	0.09517
Monte Carlo Results at 95.00% Confidence				
Total Net Profit: \$26,129.56		Max Number of Shares: 148		
Final Account Equity: \$126,129.56		Minimum Number of Shares: 141		
Return on Starting Equity: 26.13%		Average Number of Shares: 147		
Profit Factor: 1.449				
Largest Winning Trade: \$848.04		Largest Losing Trade: (\$2,638.84)		
Largest Winning Trade (%): 0.6831%		Largest Losing Trade (%): -2.624%		
Average Winning Trade: \$84.66		Average Losing Trade: (\$370.70)		
Average Winning Trade (%): 0.07314%		Average Losing Trade (%): -0.3428%		
Average Trade: \$22.66		Win/Loss Ratio: 0.2284		
Average Trade (%): 0.02032%		Win/Loss Ratio (%/%) : 0.2264		
Trade Standard Deviation: \$217.87		Max Consecutive Wins: 27		
Trade Standard Deviation (%): 0.2024%		Max Consecutive Losses: 4		
Worst Case Drawdown: (\$6,472.35)		Return/Drawdown Ratio: 4.608		
Worst Case Drawdown (%): 5.673%		Modified Sharpe Ratio: 0.1006		
Average Drawdown: (\$878.87)				
Average Drawdown (%): 0.7809%				

Figure 19: Monte Carlo Analysis

The analysis above shows that our strategy has a total profit of \$26129.56 profit with initial account equity of \$100,000. After analyzing 10,000 samples, our strategy has 25.99 rate of return in 100% confidence. The rate of return gets smaller as the confidence level goes higher. The percentage profitable, which shows the winning trades expressed as a percentage of the total number of trades, is 86.38%. The number shows that the system can still profit even when the average losing trade is larger than average winning trade.

The real life iteration represented by the blue line is expected to move between the red line and green line. Figure 20 shows that the interval between 5% confidence level and 95% confidence level for the expectation curve of Monte Carlo.

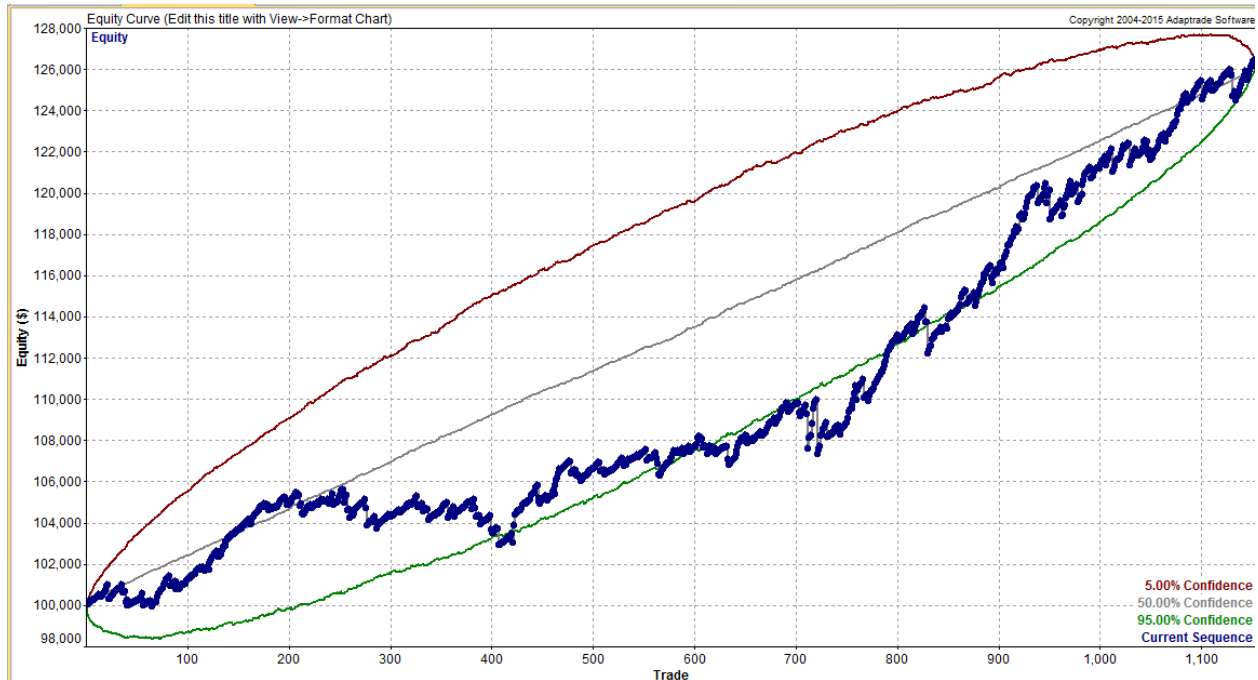


Figure 20: Statistical Oval

Version #2

While modifying the rules for short condition, we found another version of the system which performs much better on trading short. Table 3 is an analysis comparing the performances of back testing within two exit conditions. The back testing is built on the same symbol (AMZN) and with a time period of 2 years.

	Net profit	Long Profit	Short Profit	Profit Factor	Number of Trades	Percent Profitable	Number of Winning Trades	Number of Losing Trades
Version#1	\$30,677.44	\$30,360.72	\$316.72	1.50	1244	87.30%	1086	156
Version#2	\$39,344.55	\$28,626.78	\$10,717.77	1.24	2307	86.09%	1986	319

Table 3: Performance Comparison

As we can see, version #2 profits around \$9000 more than version #1 by doubling the total trades, or in the other word, opportunities. However, the profit factor also drops from 1.50 to 1.24. In addition, there are few bugs rising by ambiguous reasons. The first one is that the long profit changed even though we only modified the rules for trade short. The second one is that the system would trade short at the first bar even though there is a rule set to trader if $CurrentBar > 6$.



Figure21: Example of trade short in first bar

This bug reduces a large amount of profit. The reason we didn't move further on this strategy is that it doesn't make sense in logic. Also, this kind of performance doesn't conform to the core idea of this strategy – Opening Range do nothing. We want to fix that if we have time and build more tests to make it a good system.

Code

See Appendix A.

Chapter 7: Turtle Style Trading Strategy

Description

We analyzed the Turtle Style Trading Strategy as our second strategy in comparison with the 10 o'clock bulls. The core idea of our Turtle Strategy is to try to capture the trend of a certain stock, and the strategy trades long only. In order to make more trades for the future Monte Carlo analysis, our group uses 30-minute bar instead of daily bar. By doing that, our group found that a significantly larger number of trades were generated. Because the trend of a certain stock might not be clear over a very short time period, our group used 2-year time periods for all the back testing. As trend of the stock being the key value of our system, we only enter or exit the market when certain criteria are met. For the code of this strategy, we took the example of “_mjr_Example_7” from Professor Radzicki’s class. We changed the code of the exit condition in order to see how different exit criteria work. Then, we deleted the “if” statement for the entry condition. Our purpose is to lower the standard and make sure the system gets every single profitable trade

Figure 22 is a good example of showing how the system captures the trend of the stock and makes profit.



Figure 22: Turtle Strategy successfully captures the trend of the stock

Personalized objectives

By using our Turtle Style Trading Strategy, our group has certain expectations on its performance. Table 4 below clearly states our personalized objectives.

Personalized Objectives	
Amount of time to spend on trading	little
Trading Experience and knowledge	No experience or very little
Time span between entry and exit	Long

Table 4: Personalized Objectives for the turtle system

Entry Rules: Set-Ups

As for the entry rules, we decided a set-up price by using the technique of Average True Range(ATR). It is basically an indicator that measures the market volatility.²⁴ First, the system determines the highest price of the next 20 bars. Then, it calculates the ATR of the next 20 bars and multiply it with ATR_Long (ATR for long position) parameter. Finally, the system adds those two outcomes together to determine the set-up price of the entry condition.

Exit Rules: Exit on Relative Strength Index (RSI) Moving Average

As for the exit rules, we decided to use Relative Strength Index (RSI) Moving Average technique. Relative Strength Index is a kind of indicator which compares the magnitude of recent gains to recent losses in order to obtain the overbought and oversold conditions of an asset.²⁵ The formula of RSI is determined as the following:

$$RSI = 100 - 100/(1+RS)$$

For Relative Strength (RS), it is calculated as the “average of x days’ up closes” divided by the “average of x days’ down closes”. Figure 23 shows how RSI works to determine the entry and exit signals of a certain trend.

²⁴ "Average True Range (ATR)." [ChartSchool]. N.p., n.d. Web. 19 Mar. 2016.

²⁵ "Relative Strength Index (RSI) Definition | Investopedia." *Investopedia*. N.p., 25 Nov. 2003. Web. 1 May 2016.



Figure 23: Demonstration of how RSI indicates the change in trend²⁶

From the Figure 23, it is clear to see that there is a strong entry signal when RSI reaches around \$30 level. Similarly, there is a strong exit signal when RSI reaches around \$70 level. By using this principle, we made an assumption that a shift in direction of the stock trend will occur very close to the times when the RSI crosses above \$70 or crosses below \$30. We utilized this technique to determine whether to exit or to cover a short position.

Position Sizing

Our Turtle System uses fixed fractional position sizing method to determine how many shares to buy at a certain price. Under this kind of position sizing method, the system decides the number of shares based on the risk of the trade. This method is also known as fixed risk position sizing. The method “risks the same percentage or fraction of account equity on each trade”.²⁷ It incorporates the risk factor into calculating the size of the trade. In order to achieve this method, we set the parameter of PSMeth to 3 within the PSCalc32() function.

²⁶ Demonstration of how RSI indicates the change in trend. "An Introduction To The Relative Strength Index | Investopedia." *Investopedia*. Web. 1 May 2016. < <http://www.investopedia.com/terms/r/rsi.asp>>

²⁷ "Fixed Fractional Position Sizing : Day Trading Strategies : Forex Day Trading System : Adaptrade Software." *Fixed Fractional Position Sizing : Day Trading Strategies : Forex Day Trading System : Adaptrade Software*. N.p., n.d. Web. 1 May 2016.

Rules for Selecting stocks that are appropriate

We realized that not all stocks are appropriate to be traded by the system we designed for Turtle Style Trading Strategy. From our observation, we believed that this strategy is the best fit of the market with very clear trend. For demonstration purposes, Table 4 lists some good performing trades by Turtle Strategy. In reality, we only want to pick certain stock which is more likely to bring profit.

Symbol	Total Net Profit	Profit Factor	Number of Trades	Percent Profitable	Number of Winning Trades	Number of Losing Trades	Initial Capital
AMZN	\$11,793.63	2.328	109	74.312%	81	28	\$100,000
SBUX	\$5,909.03	2.578	102	79.412%	81	20	\$100,000
HD	\$6,666.64	2.782	110	76.364%	84	26	\$100,000
GOOGL	\$7,002.50	2.377	98	83.673%	82	16	\$100,000

Table 5: System performance of back testing on several stocks under turtle system

From table 5, the profit factors of all the trades are above 2.3, which is what we really expect. Figure 24 shows the actual back testing trade on AMZN by the system.



Figure 24: The actual back testing trade on AMZN by the turtle system

We can see that the Turtle Style Trading Strategy does a good job on capturing the upward trend of the stock. When the trend of the market is clear, the system can easily follow it and make profit. That is the advantage of this strategy. However, the strategy may not work that well when the chart swings a lot. Figure 25 shows the back testing trade on TMUS with only \$2,972.70 profit.

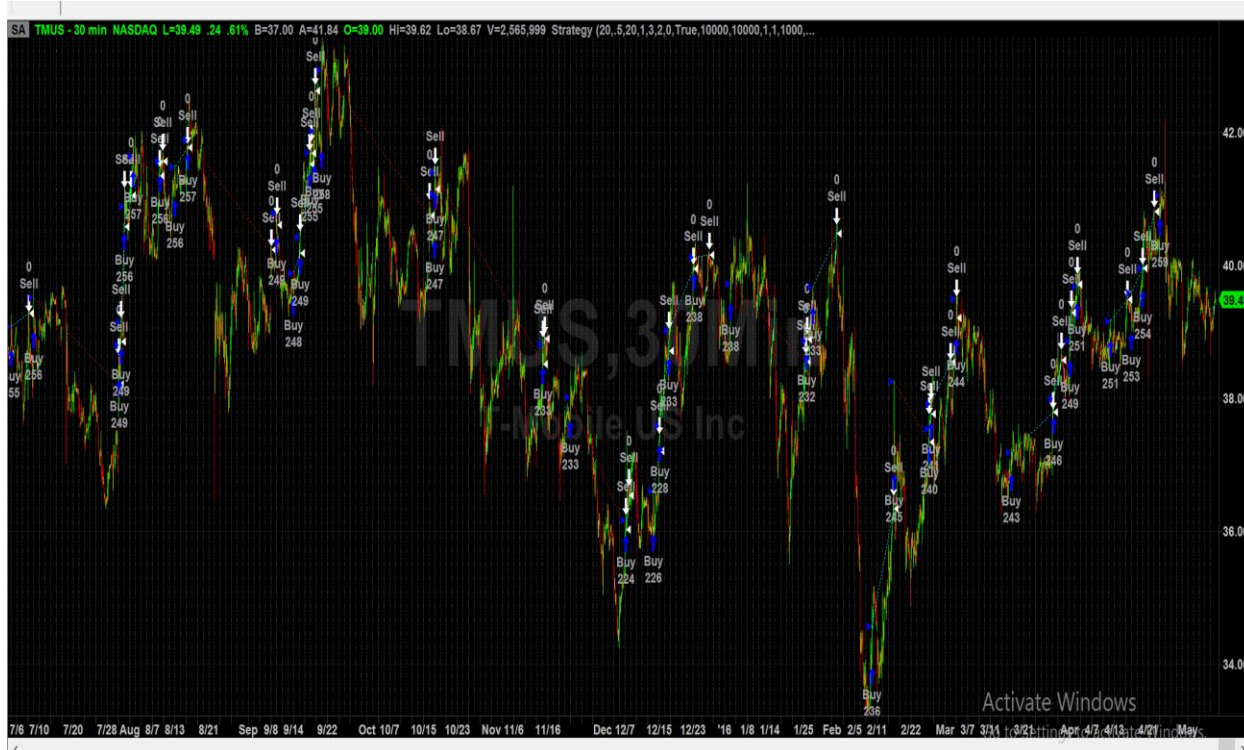


Figure 25: The actual back testing trade on TMUS by the turtle system

In conclusion, we find that the Turtle Style Trading Strategy works best with the market with clear trend.

Optimization

For the system input values, we use optimization function in TradeStation to find the best possible ones. Table 6 below shows how the system performs differently by optimizing the input values. This example is trade performance on AMZN over a two-year period.

	Total Net profit	Profit Factor	Total Number of Trade	Percent Profitable	Winning Trades	Losing Trades
Original Result	\$11,860.89	2.328	110	74.312%	81	28
Optimization Result	\$18,445.45	2.836	111	74.775%	83	28

Table 6: How the system performs differently by optimizing the input values

As the table indicates, the system generates a higher profit factor by optimizing input values. As a result, the total net profit increases by \$6,651.82.

System Quality

After seeing how optimization works for the system, it is important to value the system quality. For comparison purpose with the 10 O'clock Bulls Strategy, we analyzed the same stock (AMZN) under turtle strategy. Figure 26 shows the Expectancy, Expectunity and System Quality of the system performance on trading AMZN stock.

1st Trade	5/20/14	Expectancy	0.33807889	0.04833612	
Last Trade	5/2/16				
Strategy Calendar Days (Days)	713	Opportunities	56.3113604	Std Dev R Multiples	1.49505252
Number of Trades	110	Annualized Expectancy (Expectunity)	19.0376822	2.72187242	
System Quality	2.37169014				

Figure 26: Expectancy, Expectunity and System Quality of turtle system

Because the value of Expectancy is larger than zero, we know for sure that the system has an “edge”. Expectancy represents profit or loss per dollar risked per trade. Although the system did not generate thousands of trades, every single trade made contributed a fair amount to the total profit. In addition, the Expectunity of the system is 19.03, so a dollar can bring about 19 dollars per year. Finally, the System Quality is 2.37. We can tell that the total profit or loss per dollar risked is about two times relative to the total volatility of the profit or loss per dollar risked.

Performance Report and Monte Carlo Analysis

Figure 27 shows the equity curve of the trading. The ideal trend is represented by the red line.

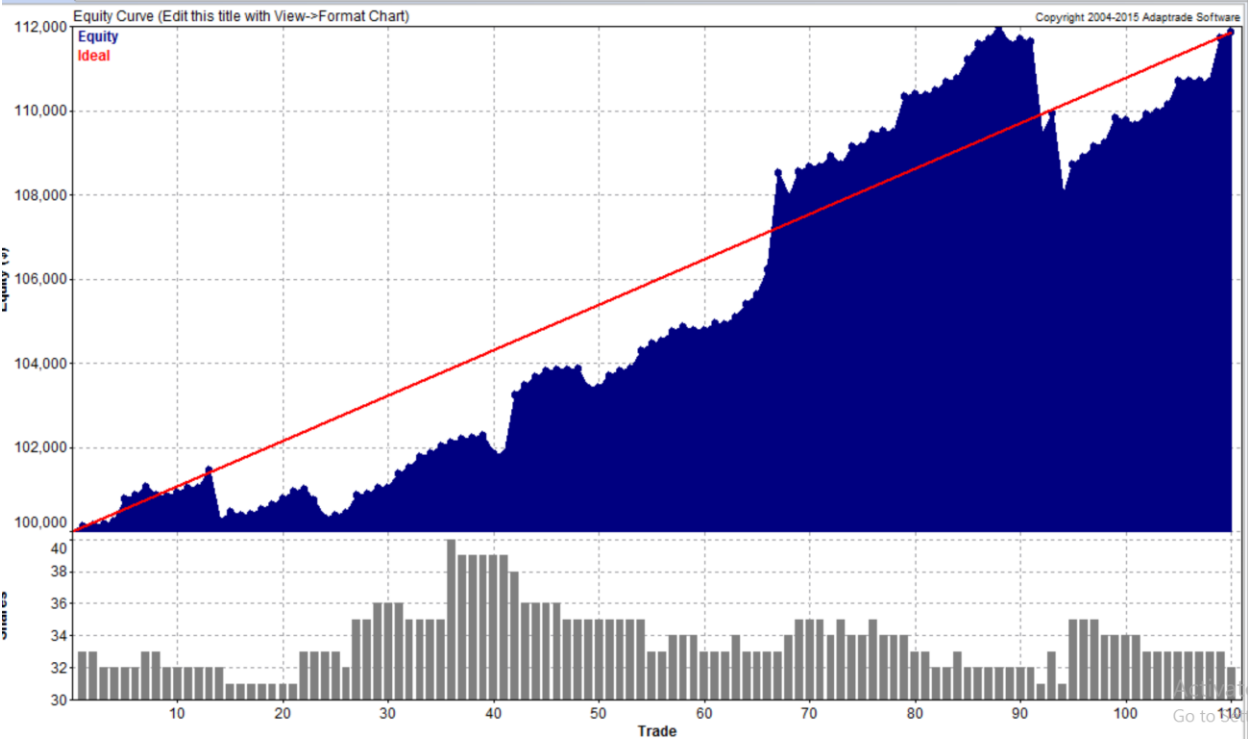


Figure 27: Equity curve of the turtle system

Monte Carlo analysis was also performed. Figure 28 gives a clear report of different parameters under different confidence interval.

Market System: list

Trading Parameters

Initial Account Equity: \$100,000.00
Trading Vehicle: Stocks
Minimum Margin Requirement: 100.0%
Slippage per side: \$.00 per trade
Commissions and fees per side: \$.00 per trade

Position Sizing Method: None
No. Shares: From input data
Number of Monte Carlo Samples: 10,000

Key Results at Select Confidence Levels

Confidence (%)	Rate of Return (%)	Max Drawdown (%)	Return-DD Ratio	Mod. Sharpe Ratio
50	11.86	2.542	4.665	0.2287
60	11.86	2.734	4.338	0.2276
70	11.86	2.986	3.972	0.2263
80	11.86	3.308	3.586	0.2250
85	11.86	3.526	3.364	0.2240
90	11.86	3.810	3.113	0.2229
91	11.86	3.875	3.061	0.2227
92	11.86	3.930	3.018	0.2224
93	11.86	3.985	2.976	0.2221
94	11.86	4.074	2.911	0.2218
95	11.86	4.157	2.853	0.2214
96	11.86	4.264	2.782	0.2211
97	11.86	4.416	2.686	0.2206
98	11.86	4.633	2.560	0.2200
99	11.86	4.948	2.397	0.2190
100	11.86	5.952	1.993	0.2147

Monte Carlo Results at 95.00% Confidence

Total Net Profit: \$11,860.89	Max Number of Shares: 40
Final Account Equity: \$111,860.89	Minimum Number of Shares: 31
Return on Starting Equity: 11.86%	Average Number of Shares: 33
Profit Factor: 2.328	
Largest Winning Trade: \$2,277.66	Largest Losing Trade: -\$2,230.76
Largest Winning Trade (%): 2.075%	Largest Losing Trade (%): -2.227%
Average Winning Trade: \$253.55	Average Losing Trade: -\$318.94
Average Winning Trade (%): 0.2364%	Average Losing Trade (%): -0.3118%
Average Trade: \$107.83	Win/Loss Ratio: 0.7950
Average Trade (%): 0.1029%	Win/Loss Ratio (%/%): 0.7847
Trade Standard Deviation: \$476.83	Max Consecutive Wins: 8
Trade Standard Deviation (%): 0.4653%	Max Consecutive Losses: 5
Worst Case Drawdown: -\$4,483.21	Return/Drawdown Ratio: 2.853

5/10/16 5:27:18 AM Page 2

Worst Case Drawdown (%): 4.157%	Modified Sharpe Ratio: 0.2214
Average Drawdown: -\$809.28	
Average Drawdown (%): 0.7586%	

Figure 28: Report of different parameters under different confidence intervals

From the report, with initial account of \$100,000, the system generated \$11,860 of profit. With 100% confidence, the system rate of return is 11.86. Notice that this Monte Carlo analysis was implemented over 10000 of samples.

Figure 29 shows the statistical oval of the Monte Carlo analysis. Although the grey line with blue dots represents the data from trading list, the line we care most is the green line. It is the 95% confident line. As this line moving upward, we are 95% sure that the equity curve will go up.

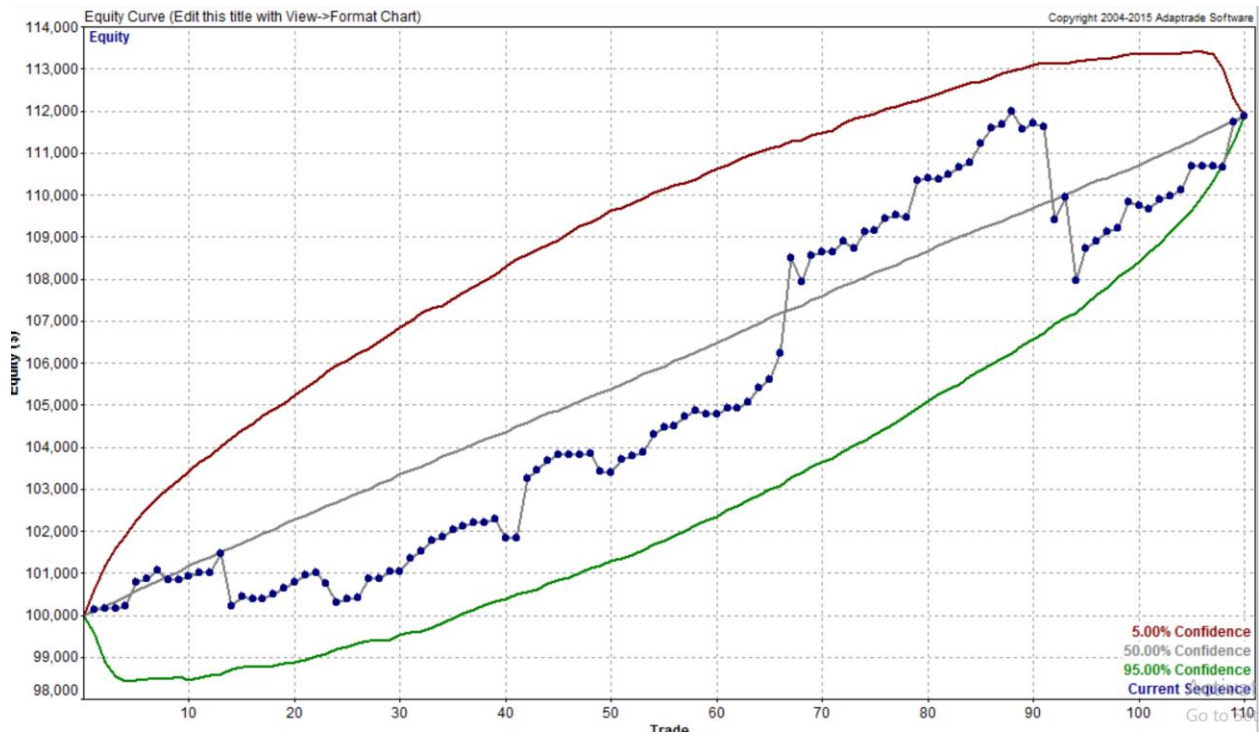


Figure 29: Statistical Oval of the Monte Carlo Analysis

Code

See Appendix B.

Chapter 8: System of Systems

In this chapter, we are going to combine both 10 o'clock bulls and turtle strategy together in order to allocate money. However, we realize that each system is designed to run independently. Although both of the systems have entry and exit rules, they apply to different time frames and it is not easy to combine them under the same environment. Due to different natures of the two trading strategies, we find two ways to implement money allocation rule. Notice that complete analysis has been done on AMZN stock under both of strategies and all the back testing is done over two-year periods. So we decide to use AMZN stock as an example for designing the system of systems.

The first way is to allocate money based on system quality. For the 10 o'clock bulls strategy, its system quality is 3.535; the turtle strategy has a system quality of 2.372. Because $3.535 / (3.535 + 2.372) = 60\%$, our group should put 60% of money on 10 O'clock Bulls Strategy. On the other hand, 40% of money would be allocated on the Turtle Style Trading Strategy. Say if the initial balance is \$100,000, we would use \$60,000 to trade 10 o'clock bull.

The second way is to do aggregate Monte Carlo Analysis. In the first month, the aggregate system receives capital and invests in equal proportions to launch our system of systems. After the first month, the return rate and maximum drawdown is calculated very month. Then the aggregate system reinvests in the two strategies in response to return percentage and return to drawdown ratio. Capital can be redistributed by changing position sizes. Table 6 shows return percentages, average drawdown percentages and return to drawdown ratios of the two systems. Because the 10 O'clock Bulls Strategy has the larger return to Drawdown ratio, we need to invest relatively more money on that strategy to make sure we can get a drawdown percentage of 0.7809%. The turtle strategy has lower return to drawdown ratio, so its drawdown percentage is lessened to 0.7586% by reducing its capital. However, if the return to drawdown ratios of both strategies change in the next month, the money allocation may need to change as well.

	Return Percentage	Average Drawdown Percentage	Return to Drawdown Ratio
10 O'clock Bulls	26.13%	0.7809%	4.608
Turtle Style	11.86%	0.7586%	2.853

Table 6: Strategy Performance

Although the aggregate Monte Carlo Analysis does not give us a definite number on how much to invest on each strategy, we conclude that the 10 O'clock Bulls Strategy is more profitable than the Turtle Style Trading Strategy. We will allocate 60% of our capital on the 10 o'clock bulls to trade more effectively.

Chapter 9: Summary & Conclusion

For the conclusion of this IQP, our group had completed two automated profitable stock trading systems that trade stocks using the TradeStation Platform. By developing this project, the group members gained valuable experiences and knowledges about stocks trading. Based on the back testing developed by individuals, two systems are all profitable systems.

Problems we encountered

Our group haven't use TradeStation before. We spent a lot of time familiarizing with the station via playing around by ourselves and asking people who had used it before (friends and Prof.Radzicki). Also, there was a lack of common knowledge of trading and programming experience with Easy Language. We overcame this problem by studying existing programs in the TradeStation forum and taking the economy ISP class held by Prof.Radzicki and Prof. Hakim.

Extensions and modifications recommended for future research

A system can never be "finished".

For 10 o'clock strategy, the most obvious issue is that the short-term trading doesn't perform as well as the long-term trading. The system doesn't recognize some good chance to profit with trading short even when the price trend is going downward. Also, the trailing stop can only exit with profit. As a result, the system would keep losing money until it exits at the end of the day. The group believes that combining other exit rules with trailing stop rule can create a better system.

For turtle strategy, our group only used fixed fractional position sizing method. However, there are other position sizing methods to be explored, such as percent volatility and fixed-dollar amount. In the future, if a comparison of all the position sizing methods could be completed under Turtle Style Trading Strategy, we might be wiser about choosing them to make profit. Moreover, our group's current turtle system does not have a money management stop. Because of that, the system will not exit the market even if it is losing a large amount of money. The system would be better if it could handle the case when it is losing money.

Appendix A

Code for 10 o'clock bulls strategy

```
Input: NumBarsToSetRng(6), StartEquity(100000), DrawTrendLines(True), Price(Close) Length(9),
PositionBasis(false);

Vars:OpeningRngHigh(0),   OpeningRngLow(0),   InitialBarNum(0),   OneTick(0),   TL_ID_High(0),
TL_ID_Low(0), Condition(true);

//calculating the minimum movement of the share or contract price for a symbol
Once
    Begin
        OneTick = MinMove/PriceScale;
    end;

    //Setting OpeningRange Function for First 30 Minutes
//if CurrentSession(0)<>CurrentSession(0)[1]then
If date<>date[1] then
    begin
        InitialBarNum = CurrentBar;
        OpeningRngHigh = High;
        OpeningRngLow = Low;
        If DrawTrendLines then
            Begin
                TL_ID_High = TL_New(Date,Time,OpeningRngHigh,Date,Time, OpeningRngHigh);
                TL_ID_Low = TL_New(Date,Time,OpeningRngLow,Date,Time,OpeningRngLow);
            end;
        end
    end
Else
    If CurrentBar - InitialBarNum < NumBarsToSetRng then
        Begin
            If High>OpeningRngHigh then OpeningRngHigh = High;
            If Low<OpeningRngLow then OpeningRngLow = Low;
        end;

//Adjust the Treadline
if CurrentBar - InitialBarNum = NumBarsToSetRng then
```

```

begin
  if TL_ID_High > 0 then
    TL_SetBegin( TL_ID_High, Date, Time[NumBarsToSetRng ],OpeningRngHigh );
  if TL_ID_Low > 0 then
    TL_SetBegin( TL_ID_Low, Date, Time[NumBarsToSetRng ],OpeningRngLow );
  end ;
if TL_ID_High > 0 then
  TL_SetEnd( TL_ID_High, Date, Time, OpeningRngHigh );
if TL_ID_Low > 0 then
  TL_SetEnd( TL_ID_Low, Date, Time, OpeningRngLow );

```

```
// ***** Trade *****
```

```

Inputs: ExpoLength(12),
EmreAvgLength(10);
Var: FirstHigh(false) ,
FirstHighValue(0),
FirstLow(false),
FirstLowValue(0),
FirstVolume(false),
ExpAvg(0),
AvgVolume(0),vVolume(0),
EmreBrkOutFactor(0),
LongTrailingPerc(5),ShortTrailingPerc(5),
trailingfactor(0.02);
ExpAvg= xAverage(Price, ExpoLength); /// exponential average

```

```
AvgVolume= AverageFC(Volume,EmreAvgLength);
```

```

If Condition and firsthigh=false and firstVolume=false and Close>OpeningRngHigh then begin
FirstHighValue=H;
Firsthigh=true;
vVolume= AvgVolume;
firstVolume=true;
end;

```

```

If Condition and firstlow=false and C<OpeningRngLow then begin
FirstLowValue=L;
Firstlow=true;

```



```

end;

// Issue Buy Orders
// After Range is Set
// Don't Order After 3:30 PM
// Buy when both price and simple moving average are greater than the opening range high
If Condition then begin
if CurrentBar > NumBarsToSetRng and
    AvgVolume > OpeningRngHigh and
    Time > (1000)and
    Time < (1530)and
    MarketPosition = 0 and
    Open > FirstHighValue and
    L > FirstHighValue and
    ExpAvg > OpeningRngHigh then
    begin
    Buy (StartEquity/Last)shares next bar at market;
    end ;

```

```

///SELL SHORT ///

```

```

If CurrentBar > NumBarsToSetRng and
AverageFC( Price, Length )< OpeningRngLow and
H<FirstLowValue and
C<OpeningRngLow and
Open<FirstLowValue and
Time > (1000)and
    Time < (1530)and
ExpAvg<OpeningRngLow
then
begin
SellShort(StartEquity/Last)shares next bar at market;
end;

```

```

// Exit If reverse through opening range low
Sell All shares next bar at OpeningRngLow - OneTick Stop ;

```

```

//Trailing Stop

```

```

if MarketPosition=-1 and (positionprofit)>= (entryprice*trailingfactor) then
SetPercentTrailing(positionprofit,LongTrailingPerc);
if MarketPosition=1 and (positionprofit)>=(entryprice*trailingfactor) then
SetPercentTrailing(positionprofit,ShortTrailingPerc);
END;
//Stop Loss
{
SetStopContract;
SetStopLoss(500);
SetProfitTarget(500);}
SetExitOnClose;
/// END OF THE DAY EXIT ///
//Exit after 3:30PM
    If Time>(1530)
        then sell All shares next bar at market;

```

Note: Some of the code are written by Mehmet Emre Cekirdekci,Veselin Iliev,Eric Gehrken , Youwei Hu , Camden Mallette and Justin Paprota.

Version#2

```
If CurrentBar > NumBarsToSetRng and
//AverageFC( Price, Length )< OpeningRngLow and
//H<FirstLowValue and
C<OpeningRngLow and
//Open<FirstLowValue and
//Time> (1000)and
    //Time<(1530)and
ExpAvg<OpeningRngLow
then
begin
SellShort(StartEquity/Last)shares next bar at market;
end;
```

Appendix B

Code for Turtle Style Trading Strategy

Inputs:

```
Len_Long      ( 20 ),
ATR_Long      ( .5 ),
ATR_Length    ( 20 ),
Frac_ATR      ( 1 ),
PSMeth        ( 3 ),           { Position sizing method, 1 - 14 }
Param1        ( 2.0 ),       { Position sizing parameter #1 }
Param2        ( 0 ),           { Position sizing parameter #2 }
BackTest      ( True ),      { True for back testing }
StEqty        ( 10000 ),     { Starting account size, $ }
CurEqty      ( 10000 ),     { Current account size, $ }
TrRisk        ( 1 ),         { Trade risk per share/unit/contract, $ }
MxLoss        ( 1 ),         { Largest 1-contract/share/unit loss, $ }
MaxDD         ( 1000 ),      { Largest 1-contract/share/unitdrawdown, $ }
Stocks        ( True ),      { True if trading vehicle is a stock }
UseUnits      ( False ),     { True for trading in even units }
UnitSize      ( 1 ),         { # Shares/contracts per unit }
UseMinN       ( True ),      { True --> # shares/contracts at least MinN }
MinN          ( 1 ),         { Minimum # of shares/contracts }
MaxN          ( 100000 ),    { Maximum allowable number of shares/contracts }
InitMarg      ( 0 ),         { Initial margin per contract for futures }
MargPer       ( 100 ),      { Margin requirement in percent for stocks }
NATR          ( 20 ),       { Period for average true range }
MALen        (20);
```

Variables:

```
ATR          ( 0 ),
MP           ( 0 ),
Trail_On     ( False ),
Fast_Ave     ( 0 ),
```

```
Slow_Ave      ( 0 ),  
Fast_Len      ( 50 ),  
Slow_Len      ( 200 ),  
This_Many     ( 0 );
```

```
ATR = Average ( TrueRange , ATR_Length ) ;
```

```
MP = MarketPosition ;
```

```
{ Entry Conditions }
```

```
This_Many = PSCalc32 ( PSMeth , Param1 , Param2 , BackTest , StEqty , CurEqty , TrRisk ,  
                    MxLoss , MaxDD , Stocks , UseUnits , UnitSize , UseMinN , MinN , MaxN , InitMarg , MargPer ,  
                    NATR ) ;
```

```
Buy This_Many Shares Next Bar at Highest ( High , Len_Long ) + ATR_Long * ATR Stop ;
```

```
{ Exit Conditions }
```

```
If MP = 1 and RSI ( C , 14 ) Crosses Above 70 Then
```

```
    Sell Next Bar at Market ;
```

```
If MP = -1 and RSI ( C , 14 ) Crosses Below 30 Then
```

```
    BuyToCover Next Bar at Market ;
```

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