

Identifying Short Term Market Turns Using Neural Networks and Genetic Algorithms

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On March 26, 2008, in the *Wall Street Journal* page one article [Stocks Tarnished By "Lost Decade"](#), E. S. Browning reported that the stock market was right where it was nine years ago, having been one of the worst investments during that period. The buy-and-hold investor would have done better investing in US Treasury bonds. Although there are academic theories which state that market movements are random and therefore unpredictable, others believe that market timing can increase returns over buy-and-hold strategies.

Numerous fundamental and technical indicators have been discussed in relation to financial market timing. It may be that no single indicator is by itself useful in this task. In his recent book, *The Only Three Questions That Matter*, Ken Fisher takes some time to show that even widely touted factors such as the direction of interest rate changes by the Federal Reserve Bank are of little use in predicting market direction.

If one accepts that no single indicator has predictive value, one must next ask if some combination of factors is predictive. While both fundamental and technical indicators influence long term market trends, as one turns from monthly and weekly bars to daily and hourly bars, technical indicators come to dominate. The reason is simply that, with the exception of episodic events, fundamental changes in financial instruments occur too slowly to significantly affect intraday or swing trading intervals. Given the dominance of technical factors in short term trading, the trader using technical analysis may find this trading environment more suitable than longer term trading.

Japanese candlestick charting is a longstanding technique which uses

colored bars to indicate the relationship of the opening and closing prices of a bar. A vertical line indicates the low and high of the day, while the bar indicates the difference of the open and close, with a dark bar indicating (close < open) and a lighter bar indicating (close > open). A number of candlestick patterns have been rigorously defined and categorized into patterns which indicate continuation or reversal of the existing trend. Although they are touted as a visual, chart based tool, candlestick patterns have precise, mathematical definitions, and are suitable for use in algorithmic trading systems.

The following patterns are thought to indicate a bullish reversal -- that is, a downtrending market now turning upwards:

- Belt Hold (bullish)
- Breakaway (bullish)
- Doji Star (bullish)
- Engulfing Pattern (bullish)
- Hammer
- Harami (bullish)
- Harami Cross (bullish)
- Homing Pigeon
- Inverted Hammer
- Kicking (bullish)
- Ladder Bottom
- Matching Low
- Meeting Line (bullish)
- Morning Doji Star
- Morning Star
- Piercing Line
- Stick Sandwich
- Three Inside Up
- Three Outside Up
- Three Stars in the South
- Three White Soldiers
- Tri Star (bullish)
- Unique Three River Bottom
- White Hammer

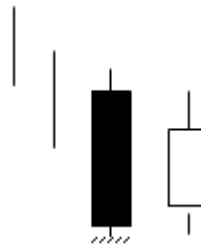
The following patterns are thought to indicate a bearish reversal -- that is, an uptrending market now turning downwards:

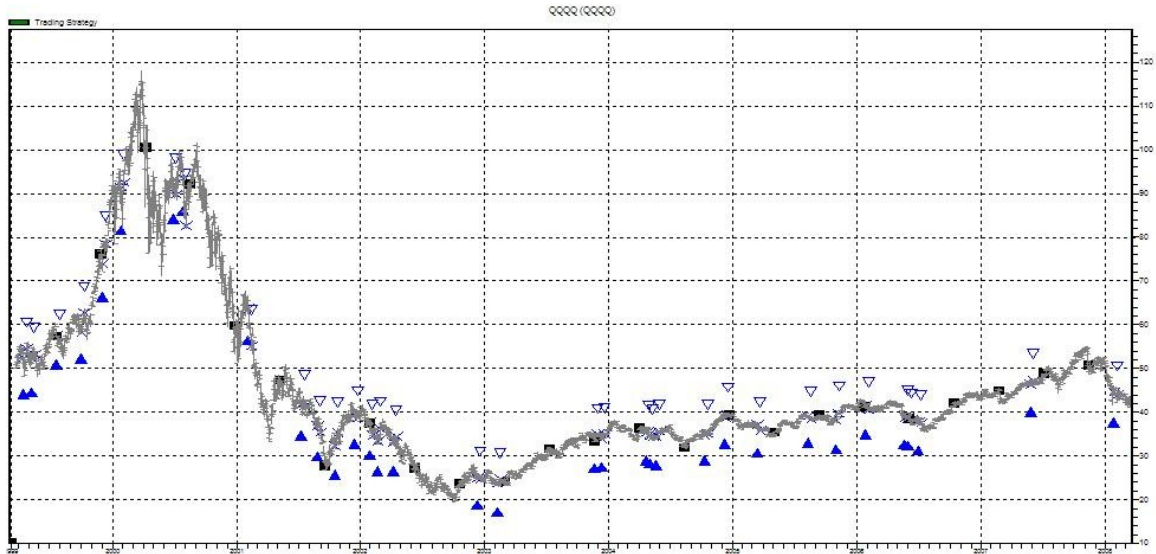
- Abandoned Baby Top
- Advance Block

Belt Hold (bearish)
 Black Hanging Man
 Breakaway (bearish)
 Dark Cloud Cover
 Deliberation
 Doji Star (bearish)
 Engulfing Pattern (bearish)
 Evening Doji Star
 Evening Star
 Hanging Man
 Harami (bearish)
 Harami Cross (bearish)
 Identical Three Crows
 Kicking (bearish)
 Meeting Line (bearish)
 Shooting Star
 Three Black Crows
 Three Inside Down
 Three Outside Down
 Tri Star (bearish)
 Two Crows
 Upside Gap Two Crows

Consider a definition of a Harami (pregnant woman) bullish candlestick, a
 bullish (turning upward) reversal signal:

Downward Trend 1 bar ago
 AND Long Black Day 1 bar ago
 AND Short White Day
 AND Closing Price < Opening Price 1 bar ago
 AND Opening Price > Closing Price 1 bar ago
 AND $(\text{Closing Price} - \text{Opening Price}) / (\text{Opening Price} 1 \text{ bar ago} - \text{Closing Price} 1 \text{ bar ago}) < 0.7$
 WHERE Downward Trend = $(\text{ExpAvg}(\text{Closing Price}, 9) < \text{ExpAvg}(\text{Closing Price}, 9) 1 \text{ bar ago})$





As the chart above shows, over a nine year period ending in March, 2008, trading the Nasdaq-100 exchange traded fund (QQQQ, formerly QQQ), 34 trades were triggered by Harami (bullish) formations (solid up arrowheads). Using a defined exit five days after entry, this resulted in an annualized gain of 4.5%. The total time in-market over nine years was 170 days. While this is not a spectacular return, the Nasdaq-100 was actually down over this period. Furthermore, the limited time in market reduced overall risk.

Reversal signals, in part due to their rigid definition, do not occur frequently for individual financial instruments. When using a single reversal signal and waiting for it to occur for a single stock, very few trades would result. Furthermore, because of the way in which these signals are defined, they do not tend to coincide with other reversal signals. Finally, it is uncommon that a reversal signal in one direction is followed by a reversal signal in the opposite direction quickly enough to lock in a profit from the first signal.

There are two approaches that will result in an increased number of trades. The first approach is to use existing candlestick reversal signals, such as those listed above, and:

- Scan multiple financial instruments
- Look for one of multiple reversal signals for each financial instrument
- Use exit criteria other than the occurrence of candlestick reversal signals to exit trades

This approach results in additional trades and increases average return on account. The percentage of losing trades increases, as does time-in-market, and therefore risk.

The second approach begins with reviewing trades defined by candlestick reversal signals, either a single signal or a combination of signals. Even considering that multiple candlestick patterns are scanned for over multiple stocks, a relatively small number of trades results. Closer examination of the candlestick charts with trades superimposed shows that profitable trades are missed when chart actions closely approximate but do not exactly match the criteria of reversal candlestick patterns. What if some leeway were allowed in the definition of a reversal pattern? What if the degree of allowed leeway was determined by the market conditions surrounding the candidate pattern?

Referring to the criteria of the Harami (bullish) signal shown above, it can be seen that both binary and qualitative criteria are listed. What if some flexibility in the definition of the signal was allowed? For example, what if the specification:

Closing Price < Opening Price 1 bar ago

were now allowed to read:

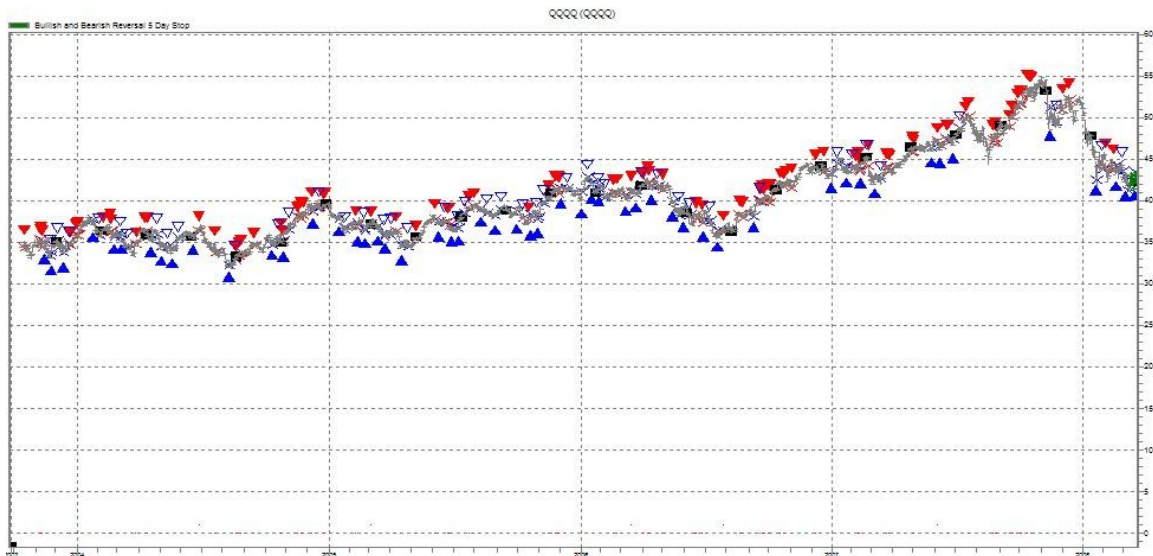
Closing Price <= (1.05)(Opening Price 1 bar ago) ?

What if the signal would fire if only five of the six criteria were met? What if the six criteria were combined in some way other than a simple **AND** statement? The tasks of selecting criteria and valuing parameters could be performed by a genetic algorithm, while combining the resulting parameters in a non-linear fashion could be performed by an artificial neural network. Details of how genetic

algorithms and neural networks could accomplish these tasks can be found in earlier papers in this series (Fishbein, www.neuroquant.com, 2001-2007).

As a proof-of-concept, a system was constructed using the first four bullish and bearish reversal signals listed above. Each signal was modified to allow selection and combination of criteria by a hybrid genetic algorithm/neural network system. Trades were triggered when any of the modified signals fired. No effort was made to further select or combine the modified signals. If a reversal signal did not occur within five bars, the trade was exited. The system was tested over a five year period with both the Nasdaq-100 and S&P 500 exchange traded funds (QQQQ and SPY).

The results were encouraging. The QQQQ system returned an annualized yield of 17.2%, with 60% of trades profitable. The SPY system returned an annualized yield of 9.8%, with 64% of trades profitable. These results improve on both the buy-and-hold and straight candlestick reversal systems. Theoretical risk is increased by virtue of the fact that more trades are triggered and the system is in-market for longer periods, but actual drawdown increased by less than 0.1% over the straight candlestick reversal system.



Candlestick reversal system using genetic algorithms and neural networks to modify candlestick reversal criteria

There are several ways in which this proof-of-concept system could be improved upon. Additional traditional candlestick reversal signals could be used as a starting point. Rather than accepting any signal firing as a trade trigger, signals could interrelate based on their temporal proximity to other signals. Exit criteria, treated very simply in this study, could be examined more formally. These suggestions are but a few of the possible improvements.

Candlestick charting has earned a well deserved reputation over a long period of time. The use of genetic algorithms and neural networks can extend its usefulness and increase the ability to adapt to changing markets.