Improved Trend Following Trading Model by Recalling Past Strategies in Derivatives Market

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***Abstract*—Unlike financial forecasting, trend following (TF) doesn't predict any market movement; instead it identifies a trend at early time of the day, and trades automatically afterwards by a pre-defined strategy regardless of the moving market directions during run time. Trend following trading has a long and successful history among speculators. The traditional TF trading method is by human judgment in setting the rules (aka the strategy). Subsequently the TF strategy is executed in pure objective operational manner. Finding the correct strategy at the beginning is crucial in TF. This usually involves human intervention in first identifying a trend, and configuring when to place an order and close it out, when certain conditions are met. In this paper, we proposed a Trend Recalling model that operates in a computer system. It works by partially matching the current trend with one of the proven successful patterns from the past. Our experiments based on real stock market data show that this method has an edge over the other trend following methods in profitability. The results show that TF however is still limited by market fluctuation (volatility), and the ability to identify trend signal.**

Keywords- Trend Following; Automatic Trading System; Futures Contracts; Mechanical Trading

I. INTRODUCTION

Trend following (TF) [1] is a reactive trading method in response to the real-time market situation; it does neither price forecasting nor predicting any market movement. Once a trend is identified, it activates the trading rules and adheres rigidly to the rules until the next prominent trend is identified. Trend following does not guarantee profit every time, but nonetheless in a long term period it may probably profit by obtaining more gains than loses. Since TF is an objective mechanism that is totally free from human judgment and technical forecasting, the trends and patterns of the underlying data play an absolutely influential role in deciding its ultimate performance.

It was already shown in [2] that market fluctuation adversely affects the performance of TF. Financial cycles are inevitable phenomena and it is a controversy whether cycles can be predicted or past values cannot forecast future values because they are random in nature. Nonetheless, we observed that cycles could not be easily predicted, but the abstract patterns of such cycles can be practically recalled by simple pattern matching. The formal interpretation of financial cycle (or better known as economic cycle) refers to economy-wide fluctuations in production or economic activity over several months or years. Here we consider it as the cycle that run continuously between bull market and bear market, some people refer this as market cycle (although they are highly correlated), In general a cycle is made of four stages, and these four stages are: "(1) consolidation (2) upward advancement (3) culmination (4) decline" [3]. Despite being termed as cycles, they do not follow a mechanical or predictable periodic pattern. But similar patterns are observed to always repeat themselves in the future, just as a question of when, though in approximate shapes. We can anticipate that some exceptional peak (or other particular pattern) of the market trend that happen today, will one day happen again, just like how it did happen in history. For instance, in the "1997 Asian Financial Crisis" [4], the Hang Seng Index plunged from the top to bottom (in stages 3 to 4); then about ten years later, the scenario repeats itself in the "2008 Financial Crisis" [5].

Dow Theory [6] describes the market trend (part of the cycle) as three types of movement. (1) The "primary movement", main movement or primary trend, which can last from a few months to several years. It can be either a bullish or bearish market trend. (2) The "secondary movement", medium trend or intermediate reaction may last from ten days to three months. (3) The "minor movement" or daily swing varies from hours to a day. Primary trend is a part of the cycle, which consist of one or several intermediate reaction and the daily swings are the minor movements that consist of all the detailed movements. Now if we project the previous assumption that the cycle is ever continuously rolling, into the minor daily movement, can we assume the trend that happens today, may also appear some days later in the future?

Figure 1. Intra-day of 2009-12-07 and 2008-01-31 day trend graphs

Here is an example for this assumption; Figure 1 shows respectively two intra-day 2009-12-07 (top) and 2008-01-31 (bottom) trend graphs of Hang Seng Index Futures, which are sourced from two different dates. Although they are not exactly the same, in terms of major upwards and downwards trends the two graphs do look alike.

This is the underlying concept of our recalling trading strategies that are based on searching for similar patterns from the past. This concept is valid for TF because TF works by smoothing out the averages of the time series. Minor fluctuations or jitters along the trend are averaged out. This is important because TF is known to work well on major trending cycles aka major outlines of the market trend.

II. RECALLING PAST TRENDS

An improved version of Trend Following algorithm is proposed in this paper, which looks back to the past for reference of selecting the best trading strategy. The design of a TF system is grounded on the rules that are summarized by Michael W. Covel, into the following five questions [7]:

1. How does the system determine what market to buy or sell at any time?
2. How does the system determine how much of a market to buy or sell at any time?
3. How does the system determine when you buy or sell a market?
4. How does the system determine when you get out of a losing position?
5. How does the system determine when you get out of a winning position?

The first and second questions are already answered in our previous work [1]. The third question is rather challenging, that is actually the core decision maker in the TF system and where the key factor in making profit is; questions 4 and 5 are related to it. Suppose that we have found a way to identify trend signal (to buy or sell), and we have a position opened. Now if the system along the way identifies another trend signal, which complies with the current opened position direction, then we should keep it open, since it suggested that the trend is not yet over. However, if it is counter to the current position, we should probably get a close out, regardless whether you are currently winning or losing, as it indicates a trend reversion.

Our improved TF algorithm is designed to answer this question: when to buy or sell. It is a fact that financial cycles do exist, and it is hypothesized that a trend on a particular day from the past could happen again some days later. This assumption supports the Recalling trading mechanism, which is the basic driving force that our improved trend following algorithm relies on. The idea is expressed in Figure 2. As it can be seen in the diagram there's four major processes for the decision making. Namely they are Pre-processing, Selection, Verification and Analysis. Figure 2 shows the process of which our improved TF model works by recalling a trading strategy that used to perform well in the past by matching the current shape of the pattern to that of the old time. A handful of such patterns and corresponding trading strategies are short-listed; one strategy is picked from the list after thorough verification and analysis.

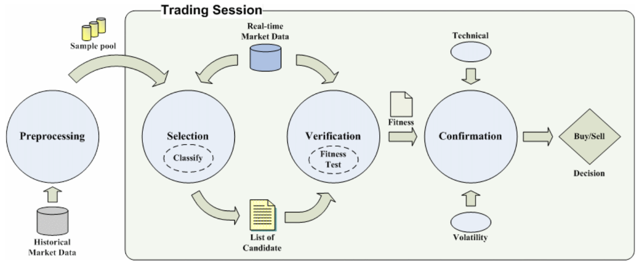

Figure 2. Improved TF process with Recalling function.

A. Pre-processing

In this step, raw historical data that are collected from the past market are archived into a pool of samples. A sample is a day trend from the past with the corresponding trading strategy attached. The trend is like an index pattern for locating the winning trading strategy that is in the format of a sequence of buy and sell decisions. Good trading strategy is one that used to maximize profit in the past given the specific market trend pattern. This past pattern which is deemed to be similar to the current market trend, is now serving as a guidance to locate the strategy to be applied for decision making during the current market trade session.

Since the past day trend that yielded a great profit before, reusing it almost can guarantee a perfect trading strategy that is superior than human judgment or a complex time series forecasting algorithm. The past samples are referenced by best trading strategies on an indicator that we name it as "*EDM*" (exponential divergence in movement). *EDM* is a crisp value indicator that is based on two moving average differences.

$$EDM_{(t)} = f\left(EMA_{s(t)} - EMA_{l(t)}\right),$$

$$EMA_{(t)} = \left(price_{(t)} - EMA_{(t-1)} \times \frac{2}{n+1}\right) + EMA_{(t-1)}$$

where $price(t)$ is the current price at any given time t, n is the number of periods, s denotes a shorter period of $EMA(t)$ at time t, l represents a longer period $EMA(t)$, $f(.)$ is a function for generating the crisp result. The indicator sculpts the trend; and base on this information, a TF program finds a list of best trading strategies, which can potentially generate high profit. The following diagram is an example of pre-processing a 2009-12-07 day trend that shows the *EDM*. As indicated from the diagram the program first found a long position at 10:00 followed by a short position at around 10:25, then a long position at 11:25, finally a short position around 13:51 and closes it out at the end of the day, which reaps a total of 634 index points. In Hong Kong stock market, there is a two hours break between morning and afternoon sessions. To avoid this discontinuation on the chart, we shift the time backward, and joined these two sessions into one, so 13:15 is equivalent to 15:15.

B. Selection

Once a pool of samples reached a substantial size, the improved TF with recalling mechanism is ready to use. The stored past samples are searched and the matching ones are selected. The goal of this selection process is to find the most similar samples from the pool, which will be used as a guideline in the forthcoming trading session. A foremost technical challenge is that no two trends are exactly the same, as they do differ day by day as the market fluctuates in all different manners. Secondly, even two sample day trends look similar but their price ranges can usually be quite different. With consideration of these challenges, it implies that the sample cannot be compared directly value to value for a simple match. Some normalization is necessary for enabling some rough matches. Furthermore the comparison should allow certain level of fuzziness. Hence each sample trend should be converted into a normalized graph, and by comparing their rough edges and measure the difference, it is possible to quantitatively derive a numeric list of similarities. In pattern recognition, the shape of an image can be converted to an outline like a wire-frame by using some image processing algorithm. The same type of algorithm is used here for extracting features from the trend line samples for quick comparison during a TF trading process.

In our methodology, each sample is first converted into a normalized graph, by calculating their technical indicators data. Indicators such as RSI and STC have a limited value range (from 1 to 100) which is suitable for fast comparison, and they are sufficient to reflect the shape of a trend. In other words, these indicators help to normalize each trend sample into a simple 2D line graph. We can then simply compare each of their graphical difference by superimposing these line graphs on top of each other for estimating the differences. This approach produces a hierarchical similarity list, such that we can get around with the inexact matching problem and allows a certain level of fuzziness without losing their similarity attributes. Figure 4 shows an example of two similar samples trend graphs with the RSI displayed.

Figure 3. Example of EDM and preprocessed trend of 2009-12-17

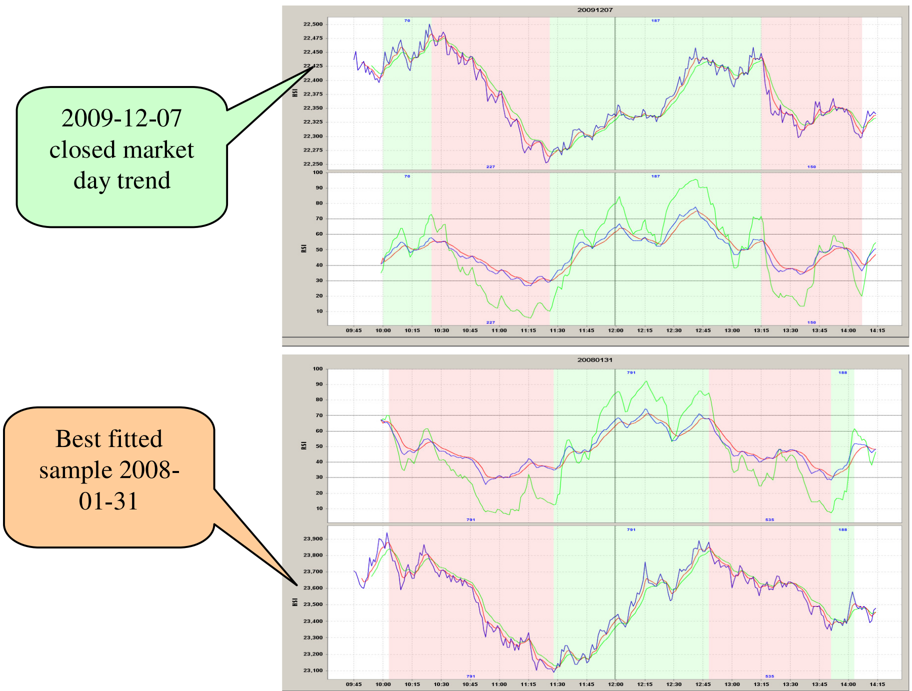

Figure 4. Example of 2009-12-07 sample with best fitness (2008-01-31) day trend and RSI graph.

C. Verification

During this process, each candidate from the list will be tested against the current market state. Ranking from the top smallest number as the most similar, they will be passed through fitness test. Each trend sample is corresponding to a specific trading strategy (that was already established in the pre-processing step). Each trading strategy will be extracted and evaluated against historical data and calculating how well it performed as a trial. Each of their performances will be recorded. The trial performance will be used as a criterion to rearrange the list. Here we have an example before and after the fitness test, which was run on the 2009-12-07 during the middle of simulated trade session.

List of Candidate	
Rank	**Sample**
0	**2008-01-25**
1	2008-03-07
2	2009-08-18
3	2008-01-23
4	2008-11-10
5	2007-08-29
6	2008-04-16
7	2007-09-13
8	2008-12-15
9	2008-02-01
10	2009-11-25
11	2008-01-31
12	2008-02-21
14	2007-12-05
15	**2009-03-17**

List After Fitness Test		
Sample	**Fitness**	**Rank**
2009-03-17	**373**	**15**
2007-09-13	357	7
2008-12-15	341	8
2008-02-01	339	9
2008-01-31	326	11
2007-12-05	305	14
2008-01-25	**300**	**0**
2008-02-21	296	12
2009-08-18	294	2
2008-01-23	273	3
2008-11-10	270	4
2007-08-29	179	5
2009-11-25	165	10
2008-03-07	143	1
2008-04-16	3	6

Figure 5. Fitness test applied on 2009-12-07 at the time 14:47

Verification is needed because the selection of these candidates is by a best effort approach. That is because the market situations now and the past may still differ to certain extent.

D. Confirmation

After the verification process is finished, the candidate list is re-sorted according to the fitness test results. The fittest one will be used as the reference of subsequent trading strategy during the TF decision making. In order to further improve the performance on top of the referencing to the past best strategy, some technical analysis is suggested to be referenced as well. By the advice of Richard L. Weissman from his book [8], the two-moving average crossover system should be used as a signal confirmation. (The two-moving average crossover system entails the rise of a second, shorter-term moving average.) But instead of using simple moving average, EMA - exponential moving average with RSI should be used, that is a short-term RSI EMA and a long-term RSI EMA crossover system. When a trend is identified and it appears as a good trading signal, the crossover system must also be referenced and check if it gives a consistent signal. Otherwise the potential trend is considered as a false signal or noise. For example in our case the trading strategy from the recalled sample hints a long position trade. We check if RSI crossover system shows a short-term EMA crossing over its long-term EMA or not.

In addition to validating the hinted trading signals from past strategy, market volatility should be considered during decision making. There are many ways to calculate volatility; the most common one is finding the standard deviation of an asset closing price over a year. The central concept of volatility is finding the amount of changes or variances in the price of the asset over a period of time. So, we can measure market volatility simply by the following equation:

$$Volatility_{(t)} = SMA_n\big((\ln(price_{(t)}) - \ln(price_{(t-1)}))\times C\big),$$

$$SMA_{(t)} = \frac{Close_{(t)} + Close_{(t-1)} + ...Close_{(t-n+1)}}{n}$$

where ln(.) is a natural logarithm, n is the number of periods, t is the current time, C is a constant that enlarges the digit to a significant figure. By observing how the equation responds to historical data, we can find the maximum volatility as ±15. Base on the previous fluctuation test result, we can define it as the following fuzzy membership.

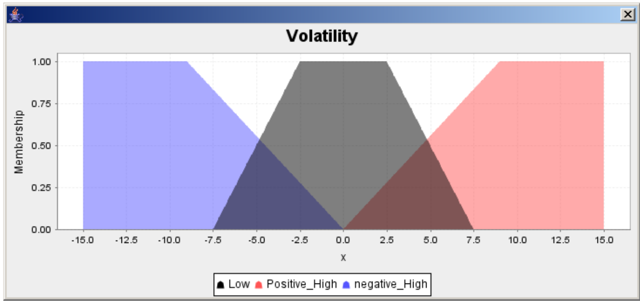

Figure 6. Volatility membership defination.

During the trading session, volatility will be constantly referenced while the following rules apply at the TF system:

IF volatility is too positive high and long position is opened THEN close it out

IF volatility is too positive high and no position is opened THEN open short position

IF volatility is too low THEN do nothing

IF volatility is too negative high and short position is opened THEN close it out

IF volatility is too negative high and no position is opened THEN open long position

These rules have a higher priority over the trade strategies, such that when the condition has met any of these rules, it will take over the control regardless of what decision that the trade strategies has made. We now summarize these four processes as pseudo codes shown in Appendix.

III. EXPERIMENT

The improved TF algorithm with recalling function is programmed as an automated trading simulator, written in JAVA. All trials of simulations are run on historical market data within 2.5 years prior to the year of 2010. A price that spread between bid and ask price is considered on each trade.

In the simulation each trade is calculated in the unit of index point, each index point is equivalent to 50 HKD, which is subject to overhead cost as defined by Interactive Broker unbundled commission scheme at 19.3 HKD per trade. ROI is the prime performance index that is based on Hong Kong Exchange current Initial margin requirement (each contract 7400 HKD in year of 2010).

From the simulation result, we observed as shown in Table 1 that a 333% ROI is achieved at the end of the experimental run. This is a significant result as it implies the proposed TF algorithm can reap more than three folds of whatever the initial investment is over just 2.5 years of trading. The trading pattern is shown in Figure 7 that shows overall the trading strategy is ever winning in a long run. Figure 8 shows a horizon of trading results, overall there are more profits than losses.

TABLE I. RESULTS OF THE OVERALL SIMULATION RUNS

Simulation	STF
Total Index Point	5867
Net Worth (HKD)	293350
Total Trade	1216
Cost (HKD)	46938
P&L (HKD)	246412
ROI (Year)	333%

IV. CONCLUSION AND FUTURE WORKS

Trend following has been known as a rational stock trading technique that just rides on the market trends with some preset rules for deciding when to buy or sell. TF has been widely used in industries, but none of it was studied academically in computer science communities. We pioneered in formulating TF into algorithms and evaluating their performance. Our previous work has shown that its performance suffers when the market fluctuates in large extents. In this paper, we extended the original TF algorithm by adding a market trend recalling function. Trading strategy that used to make profit from the past was recalled for serving as a reference for the current trading. The trading strategy was recalled by matching the current market trend with the past market trend at which good profit was made by the strategy. Matching market trend patterns was not easy because patterns can be quite different in details, and the problem was overcome in this paper. Our simulation showed that the improved TF model is able to generate profit from stock market trading at more than three times of ROI. Our next step is to test the algorithms on other stock market data.

REFERENCES

[1] Fong S. and Tai J., "The Application of Trend Following Strategies in Stock Market Trading", The 5th International Conference on Networked Computing, 25-27 August 2009, Seoul, Korea, pp. 1971-1976.

[2] Fong S., Tai J., and Si Y.W., "Trend Following Algorithms for Technical Trading in Stock Market", Journal of Emerging Technologies in Web Intelligence (JETWI), Academy Publisher, ISSN 1798-0461, Volume 3, Issue 2, May 2011, Oulu, Finland, pp. 136-145.

[3] Stan Weinstein's, Secrets for Profiting in Bull and Bear Markets, pp. 31-44, McGraw-Hill, USA, 1988.

[4] Wikipedia, 1997 Asian Financial Crisis, Available at http://en.wikipedia.org/wiki/1997_Asian_Financial_Crisis, accessed Sep-2010.

[5] Wikipedia, Financial crisis of 2007–2010, Available at http://en.wikipedia.org/wiki/Financial_crisis_of_2007, accessed Sep-2010.

[6] Schannep J., "Dow Theory for the 21st Century: Technical Indicators for Improving Your Investment Results", Wiley, USA, 2008.

[7] Covel M.W., "Trend Following: How Great Traders Make Millions in Up or Down Markets", New Expanded Edition, Prentice Hall, USA, 2007, pp. 220-231.

[8] Weissman R.L., "Mechanical Trading Systems: Pairing Trader Psychology with Technical Analysis", Wiley, USA, 2004, pp. 10-19.

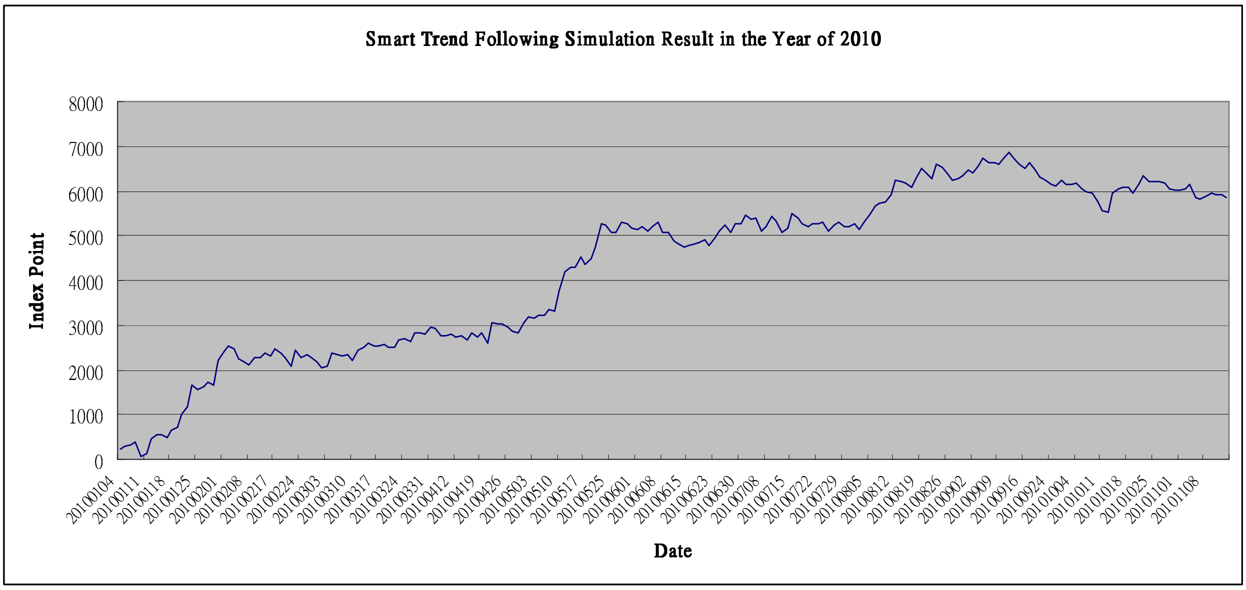

Figure 7. Performance of the improved TF algorithm with recalling function

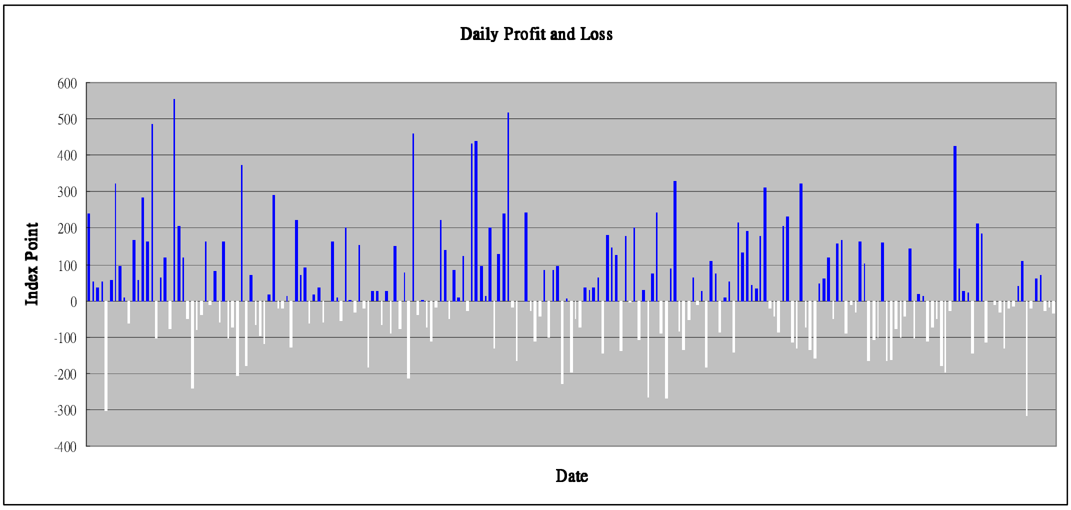

Figure 8. Daily profit and loss diagram.

Appendix

```
Loop all historical data
        Loop each minute within each day
                Compute and save technical data
                Compute EDM

                Found all the turning point according to EDM
                For each two connected turning point
                        Found their respective position
                        Calculate P&L according to the position
                        If P&L is positive
                                Save position and each point time line
                        Else
                                Adjust each point time line
                End-loop
        End-loop
End-loop
```

```
Loop each minute until end of market
        Compute technical data
        Compute volatility

        For each sample in pool
                Compare sample technical data with current market technical data
                Save their similarity into list
        End-loop

        Sort the list with most similar on the top

        For 1 To 20 in the list
                Apply fitness test on each sample with current market trend
                Save their performance into list
        End-loop

        Sort the list with most fitness on the top

        Extract strategies from the top fitness sample

        Reference RSI crossover system

        Apply fuzzy sets

        If fuzzy sets not fire
                If no position is opened
                        If strategy shows long position and confirm with RSI crossover
                                Open long position
                        Else if strategy shows short position and confirm with RSI crossover
                                Open short position
                Else if long position is opened
                        if strategy shows short position and confirm with RSI crossover
                                Close long position
                                Open short position
                Else if short position is opened
                        if strategy shows long position and confirm with RSI crossover
                                Close short position
                                Open long position

        If end of the day
                Close any opened position
End-loop
```