FinRL Contest Task II: Real Time Order Execution - A Fast Tick-level Trading Strategy

Wei Wang
zach@quantfox.com.au
QuantFox Pty Ltd
Ryde, New South Wales, Australia

ABSTRACT

This report introduces a comprehensive real-time order execution strategy that integrates the Relative Strength Index (RSI) and Moving Average (MA) Slope analysis. By combining the momentum and condition insights from RSI and Slope, with the trend direction from slope analysis, this strategy aims to optimize entry and exit points in trading. It offers a unique, multifaceted approach to understand and react to market dynamics.

KEYWORDS

RSI, CCI, MA, Fourier Transform, Slope, Tick, Trading

1 INTRODUCTION

In the dynamic and often unpredictable world of financial markets, traders continuously seek robust strategies to navigate the complexities of buying and selling assets. This report introduces an innovative trading strategy that interweaves three key technical analysis tools: the Relative Strength Index (RSI), the Commodity Channel Index (CCI), and slope analysis. These methodologies, each with their unique attributes, converge to form a cohesive and potent approach to market timing.

The Relative Strength Index (RSI) [4] serves as a momentum oscillator, gauging the speed and change of price movements, thus providing insights into overbought or oversold conditions. The Commodity Channel Index (CCI) [3], on the other hand, is a versatile indicator that helps in identifying new trends or warning of extreme conditions. Slope [1] analysis, a less conventional but equally crucial component, allows the identification of the direction and strength of market trends through the study of angle and direction in price movements.

By harmonizing the signals from these three indicators, the strategy aims to pinpoint optimal entry and exit points in the market,

reducing the element of unpredictability and enhancing the potential for profitable trades. This report will demonstrate how these indicators are utilised in tick-level real-time order execution.

2 METHODOLOGIES

As noted in the introduction, we employ the Relative Strength Index (RSI) and Slope as key indicators, all of which traditionally analyze candle bars. However, we adapt these indicators to work effectively with tick data. By treating each tick as a 5-minute bar, we can apply these indicators in tick-level order execution.

2.1 Applying RSI

For the RSI, the methodology involves data collection over different time frames within a period, starting from single tick. This approach, termed the 'Temporal Character for Prices', allows for a multi-dimensional analysis of price movements. The RSI tracks the frequency of price crossing above 70 or below 30 within these intervals. This is crucial to understanding market trends: if prices continuously rise, they are likely to rebound back above 70 even after minor pullbacks, indicating a strong uptrend. Conversely, frequent crossings below 30 suggest a downtrend. This methodology aids in differentiating between bullish and bearish market states and forms the foundation for applying deep learning algorithms in our model.

The RSI is calculated as follows:

$$RSI = 100 - \frac{100}{1 + RS}$$

Where:

$$RS = \frac{\text{Average Gain over N periods}}{\text{Average Loss over N periods}}$$

'N' is typically 14 days (14 ticks in this scenario), but can be adjusted. The RSI value ranges between 0 and 100. As mentioned above, we define *RSI* greater than 70 as a bullish signal and smaller than 30 as a bearish one.

2.2 Applying Slope

Our trading strategy employs slope analysis of moving averages to identify market trends. The slope is determined by the angle of the moving average line; a positive slope angle exceeding a set threshold indicates a bullish trend, while a negative slope below a certain value signals a bearish trend. This technique, while slightly lagging due to its reliance on historical price data, is highly accurate in signaling the market's direction.

The formula to calculate the Slope of a moving average is as follows:

$$\text{Slope} = \frac{\text{MA}_{\text{current}} - \text{MA}_{\text{previous}}}{\text{Time Period}}$$

Where:

- $\text{MA}_{\text{current}}$ is the current value of the moving average.
- $\text{MA}_{\text{previous}}$ is the value of the moving average at a previous point in time.
- Time Period is the number of time units (a number of ticks in this report) between the current and previous points.

This slope indicates the rate of change of the moving average, with a positive value suggesting an upward (bullish) trend and a negative value indicating a downward (bearish) trend.

This slope analysis is pivotal for our position opening module. By setting specific angle thresholds for the moving averages, the strategy discerns the prevailing market momentum, guiding the timing for trade entries. The slope's direction offers clarity in differentiating significant market trends from mere price fluctuations, thereby enhancing the decision-making process for opening positions.

3 STRATEGY

In our trading strategy, the decision to open positions is primarily based on the Relative Strength Index (RSI) and further refined by the slope of moving averages.

The RSI is utilized with a standard 14-period setting. The criteria for opening positions are straightforward:

- A sell signal is generated when the RSI exceeds 70.
- A buy signal is generated when the RSI falls below 30.

The algorithm is shown below:

Algorithm 1 Position Opening Strategy

1: **Input:** RSI(14), Moving Average Slope
2: **Output:** Position Opening Signal
3: **if** RSI > 70 **then**
4:     **if** Moving Average Slope > Threshold + 0.5 **then**
5:         Open Short Position or Sell Out
6:     **end if**
7: **else if** RSI < 30 **then**
8:     **if** Moving Average Slope < Threshold - 0.5 **then**
9:         Open Long Position
10:     **end if**
11: **else**
12:     No Action (Market in Consolidation)
13: **end if**

To further refine these signals, we implement a simple filtering condition based on the slope of the moving average. If the slope is above the preset value ± 0.5, we consider the market in a trend suitable for opening long positions; conversely, if the slope is below this threshold, it indicates a trend for short positions. When the slope is within this range, we interpret the market as being in a consolidation phase or experiencing choppy conditions, and thus, we do not open new positions.

4 FURTHER EXTENSION

The strategy mentioned above is a simplified one that relies on both RSI and Slope. However, in the real-world financial market, we could integrate more indicators to the order execution strategy.

In this section, we will leverage Moving Average (MA), Comidoty Channel Index (CCI) and Fourier Transform to generate more complicated trading signals.

4.1 Advanced Application of Moving Averages (MA)

In this trading strategy, Moving Averages (MAs) are used in a sophisticated manner, incorporating spatial translation, slope analysis, and Fourier theory. This multifaceted approach allows for a deeper understanding of market dynamics. The methodology is detailed as follows:

1. Spatial Translation of MA Figure 1 demonstrate the spacial translation of MA on a stock.

- The MA200 is applied with both leftward shifts for high prices and vertical shifts at specific intervals: +860 to +6336 and -860 to -6336. These shifts create key levels around the central MA200.

2. Market Dynamics around Translated MAs:

- Outer lines (±6336, ±5280) indicate potential reversal zones—longer price stays, higher the reversal likelihood.
- Mid-level lines (±2880) serve as 'necklines', showing the endpoints of price momentum.
- Inner lines (±1440, ±860) typically suggest price consolidation areas.
- The central MA200 acts as a midline, providing a reference without direct bullish or bearish connotations.

3. Integration of Fourier Theory and Deep Learning

- These translated MAs help create a 'price scale', aiding in the identification of market cycles and rhythms.
- Deep learning algorithms analyze the time spent by prices at these levels, estimating probabilities for market reversals or breakthroughs.

This approach not only utilizes MA as a trend indicator but also as a comprehensive tool for uncovering deeper market insights, combining technical analysis with advanced computational techniques.

4.2 Application of CCI

The CCI's role in our strategy is more straightforward but equally vital. It serves as an early warning system and a predictor of market movements. The CCI 24 Tick level, set at ±240, is used in our algorithms to calculate the probabilities of price movements reaching or reversing at these levels. The probabilities are determined using the 'Interests Algorithm', inspired by the RSI, and the Hodges conjecture model.

The CCI is calculated using the following formula:

$$\text{CCI} = \frac{TP - SMA(TP, N)}{0.015 \times \text{Mean Deviation}}$$

Where:

Figure 1: Sample Figure of Spatial Translation of MA

- TP (Typical Price) is calculated as: $\frac{\text{High+Low+Close}}{3}$. In this report, we simply use **individual tick's price** instead.
- $SMA(TP, N)$ is the Simple Moving Average of the Typical Price over N periods.
- Mean Deviation is the average of the absolute differences between each period's TP and the $SMA(TP, N)$.
- N is typically set to 20 periods.
- 0.015 is a constant factor.

This indicator is designed to identify cyclical turns in commodities, but it can be applied to other markets.

4.3 Application of Fourier Transform Theory

Fourier Transform theory [2] is another extended strategy to analyze the frequency domain of price movements around moving averages. This approach provides a unique perspective on market dynamics:

1. Fourier Transform Application: We use Fourier Transform to interpret time-domain patterns and frequency-domain insights in market prices, particularly around moving averages.

2. Indicator Analysis: The strategy examines how prices oscillate around various moving averages. This involves contrasting longer-term trends with short-term price movements for a comprehensive market view.

3. Machine Learning for Price Oscillation Analysis: Machine learning algorithms analyze these price oscillations, focusing on identifying significant peaks and troughs. This analysis aids in making precise buy or sell decisions, especially in scenarios involving market divergences.

4.4 Integration

Our extended trading strategy integrates indicators mentioned above as advanced filtering conditions to optimize the decision-making process for entering trades:

1. RSI Analysis: Begins with RSI equity calculations, identifying potential buy signals.

2. MA Spatial Analysis: onfirms price within reasonable oscillation ranges based on MA translations.

3. Ensures the price isn't at potential reversal extremes.

4. Fourier Sentiment Analysis: Uses Fourier analysis to confirm positive market sentiment for buying.

When these conditions align, the strategy executes a contract purchase, ensuring decisions are based on a comprehensive market analysis.

5 SUMMARY

This report outlines an straight forward trading strategy combining various technical analysis tools: Relative Strength Index (RSI), Moving Averages (MA) and slope analysis. These indicators are modified to suit the real-time order execution scenario.

In addition, this report discussed more advanced indicators involving: 1. RSI for initial buy signals; 2. MA spatial analysis for price oscillation range validation; 3. CCI for checking market extremes; and 4. Fourier analysis for market sentiment confirmation.

REFERENCES
[1] Investopedia. 2022. Adjusting Strategies to Moving Average Slopes. https://www.investopedia.com/articles/active-trading/120315/adjusting-strategies-moving-average-slopes.asp
[2] Investopedia. 2022. Fourier Analysis: What it Means, How it Works. https://www.investopedia.com/terms/f/fourieranalysis.asp
[3] Investopedia. 2022. What Is the Commodity Channel Index (CCI)? How To Calculate. https://www.investopedia.com/terms/c/commoditychannelindex.asp

[4] Investopedia. 2023. Relative Strength Index (RSI) Indicator Explained With Formula. https://www.investopedia.com/terms/r/rsi.asp