

Assignment 2 Report

Tanat Tangun 630610737

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This report is about the result of my fuzzy logic implementation on Rust language for 261456 - INTRO COMP INTEL FOR CPE class assignment. This report will be about how fuzzy logic can help in trading securities and other assets. If you are interested to know how I implement the fuzzy logic and use it to help in trading securities and other assets, you can see the source code on my Github repository or in this document appendix.

Introduction

The term “securities and other assets” in our report include securities such as stock, bonds, currencies, and other assets i.e. crypto-currency, house price, etc. In this report, we will focus on crypto-currency such as Bitcoin and Ethereum. Before we delve further, let’s understand that we are not trying to create more profit than any other techniques but we are trying to learn how to create fuzzy logic and explore how it might be useful for trading.

Technical Indicators

According to [1], “Technical indicators are heuristic or pattern-based signals produced by the price, volume, and/or open interest of a security or contract used by traders who follow technical analysis. By analyzing historical data, technical analysts use indicators to predict future price movements.”

We are trying to use technical indicators to help decide when to entry or exit to make a profit trade. Technical indicators that we will use are RSI (Relative Strength Index) and Bollinger Bands.

RSI - Relative Strength Index

According to [2] “The relative strength index (RSI) is a momentum indicator used in technical analysis. RSI measures the speed and magnitude of a security’s recent price changes to evaluate overvalued or undervalued conditions in the price of that security.” RSI is a value in range $[0, 100]$ and the value at time t is defined as follows:

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

where RS is the relative strength of the last n sessions and its defined as:

$$RS = \frac{\text{AverageGain}_t(n)}{\text{AverageLoss}_t(n)}$$

where $\text{AverageGain}_t(n)$ and $\text{AverageLoss}_t(n)$ are the average of the gains ($\text{price}_t > \text{price}_{t-1}$) and losses ($\text{price}_t < \text{price}_{t-1}$), obtained in the last n sessions. That is, from time $t - (n - 1)$ to time t . However, these values are usually estimated using the following smoothing equations:

$$\begin{aligned}\text{AverageGain}_t(n) &= \frac{\text{AverageGain}_{t-1}(n) \cdot (n - 1) + \text{gain}_t}{n} \\ \text{AverageLoss}_t(n) &= \frac{\text{AverageLoss}_{t-1}(n) \cdot (n - 1) + \text{loss}_t}{n}\end{aligned}$$

If a session t result in gain then $\text{loss}_t = 0$ and, if results in loss then $\text{gain}_t = 0$. Common number of sessions are $n = 14$ and a common interpretation of the RSI index is that it suggests oversold at value < 30 , and overbought for value > 70

Bollinger Bands

According to [3], “A Bollinger Band is a technical analysis tool defined by a set of trendlines plotted two standard deviations (positively and negatively) away from a simple moving average (SMA) of a security’s price.” Bollinger Bands (BOLU for upper band, BOLD for lower band) at time t are defined as:

$$\text{BOLU} = \text{MA}(n) + m\sigma(n)$$

$$\text{BOLD} = \text{MA}(n) - m\sigma(n)$$

where m is number of standard deviations (usually 2), and both $\text{MA}(n)$ and $\sigma(n)$ of the last n sessions are defined as:

$$\text{MA}(n) = \frac{\sum_{i=1}^n p_i}{n}$$

$$\sigma(n) = \sqrt{\frac{\sum_{i=1}^n p_i - \text{MA}(n)}{n}}$$

where each p_i is a typical price calculated as $p_i = \frac{(\text{high}_i + \text{low}_i + \text{close}_i)}{3}$

Common number of sessions are $n = 20$ and a common interpretation is the closer the prices move to BOLU, the more overbought the market, and the closer the prices move to the lower band, the more oversold the market. For using in our fuzzy logic, we will use BOLU and BOLD as a 100% mark from MA and we will compute the difference of price from MA to use it e.g. price = 100, and $\sigma = 10$ then we calculate $100 \times \frac{\text{price} - \text{MA}}{2\sigma} = 55$ which we will use on our fuzzy logic.

Entry rules

Entry rule tell you that at a current time, should you open a position or not? and it is what we are going to make with fuzzy logic. For clarifying, a position in this report will be in these 2 types:

1. LONG, which we gain profit from price increasing.
2. SHORT, which we gain profit from price decreasing.

Classic rules

The classic rules is based on set of fixed rules where the input are exact number and the outputs are binary values (1 - yes, 0 - no). The condition is from the trader’s belief which should have some uncertainty, but the classic rules can’t include that uncertainty in the rules. An examples of classic rules can be seen on table 1 and table 2 which could be more complex and practical by adding more “useful” indicators.

	RSI			Bollinger Bands		LONG	
If	< 30	&	price – BOLD < 10	then		1	
elseif	< 30	&	price – BOLD < –10	then		1	
else				then		0	

Table 1: Examples for classic rule (LONG signal).

	RSI			Bollinger Bands		SHORT	
If	> 70	&	price – BOLU < 10	then		1	
elseif	> 70	&	price – BOLU > 10	then		1	
else				then		0	

Table 2: Examples for classic rule (SHORT signal).

Fuzzy rules

Fuzzy rule can tolerate uncertainty better than classic rule due to its nature. So, we can use imprecise linguistic terms on trading indicator e.g. $rsi \rightarrow \text{HIGH, MEDIUM, LOW}$ to help us decide when to entry. Thus, a trader can create entry rule which reflect on trader's belief or represent expert's belief on market behaviour that is vague and often lack certainty.

In this report, technical indicators and output conditions have been fuzzified as shown on fig. 1 and below is an explanation for each fuzzy set.

- RSI linguistic variable is described by 3 fuzzy sets:
 - LOW: indicating oversold situation, favor long position.
 - MEDIUM: not favor any position.
 - HIGH: indicating overbought situation, favor short position.
- Bollinger Bands linguistic variable is described by 3 fuzzy sets:
 - LONG: indicating oversold situation, favor long position.
 - WAIT: not favor any position.
 - SHORT: indicating oversold situation, favor short position.
- Long, Short linguistic variable is described by WEAK, STRONG, VERYSTONG, whose names are self explanatory.

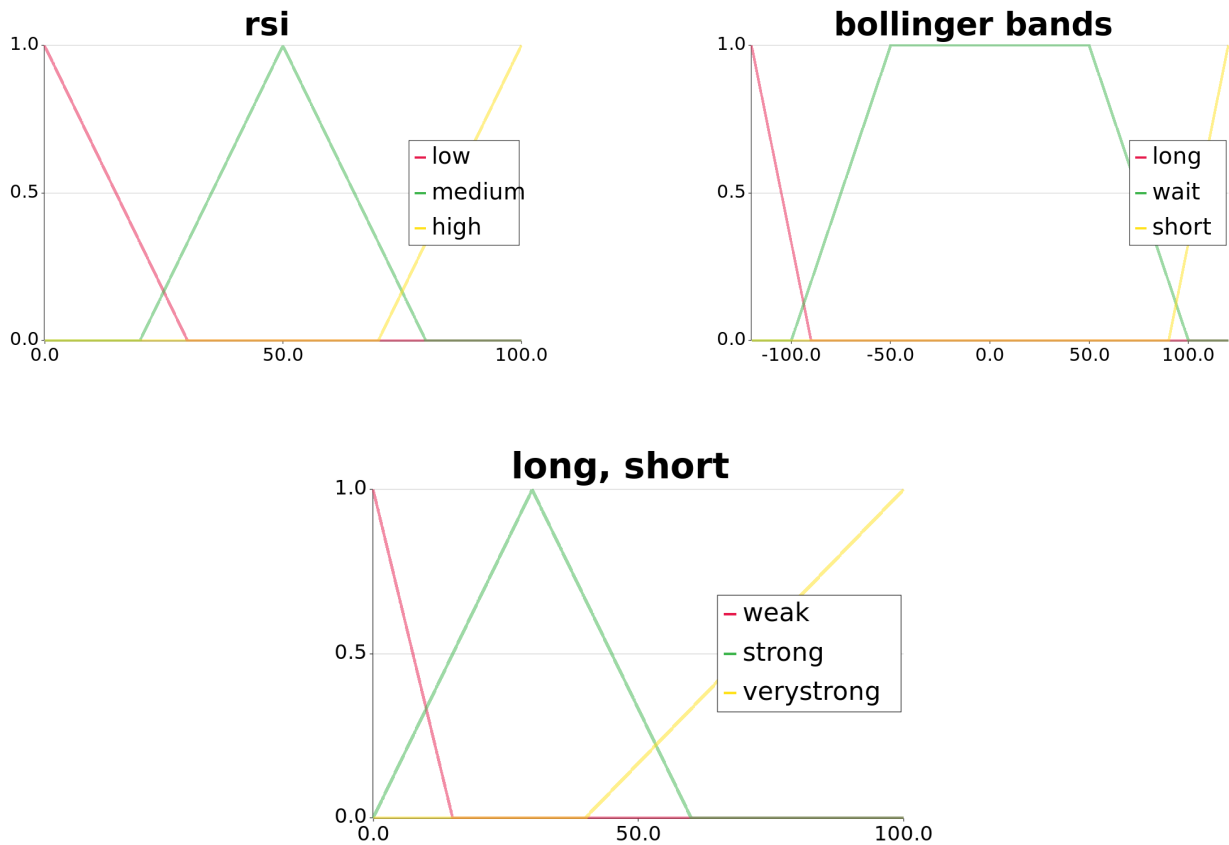


Figure 1: Fuzzifications of the indicators and outputs

RSI	Bollinger Bands	LONG	SHORT
HIGH	LONG	WEAK	WEAK
HIGH	WAIT	WEAK	STRONG
HIGH	SHORT	WEAK	VERYSTRONG
MEDIUM	LONG	WEAK	STRONG
MEDIUM	WAIT	WEAK	WEAK
MEDIUM	SHORT	STRONG	WEAK
LOW	LONG	VERYSTRONG	WEAK
LOW	WAIT	STRONG	WEAK
LOW	SHORT	WEAK	WEAK

Table 3: Fuzzy rules.

References

- [1] James Chen. *Technical Indicator*. URL: <https://www.investopedia.com/terms/t/technicalindicator.asp#:~:text=What%20Is%20a%20Technical%20Indicator,to%20predict%20future%20price%20movements..> (accessed: 02.10.2022).
- [2] Jason Fernado. *Relative Strength Index (RSI) Indicator Explained With Formula*. URL: <https://www.investopedia.com/terms/r/rsi.asp>. (accessed: 02.10.2022).
- [3] Adam Hayes. *Bollinger Bands®: Calculations and Indications*. URL: <https://www.investopedia.com/terms/b/bollingerbands.asp>. (accessed: 09.10.2022).