

Fuzzy Candlestick Approach to Trade S&P CNX NIFTY 50 Index using Engulfing Patterns

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Abstract

Stock market prediction is an important area of financial forecasting, which is of great interest to stock investors, stock traders and applied researchers. To determine the buy and sell time is one of the most important issues for investors in stock market. In this paper, a fuzzy approach using the famous candlestick method to stock market timing is investigated. Drawing candlesticks are very easy, but to make the system understand them is challenging. Using fuzzy logic first we try to make the system understand the candlestick formations and verify with what we can see and then we go on for forecasting the future trend using various candlestick techniques. The fuzzified candlesticks tend to represent the real market behavior more closely as done by humans. Here we have tried to develop a method by which fuzzification of candlesticks can be done and then by using the fuzzified candlesticks we can perform predictions of market movements with various candlestick patterns like Engulfing [2] and modified Engulfing (U-Turn) by establishing fuzzy rules. The type of real time data used here is the daily values of S&P CNX NIFTY 50 index used in National Stock Exchange of India for stock futures trading.

Keywords: *fuzzy-logic, fuzzy rule-base, forecasting, market-timing, candlesticks, fuzzy-candlesticks, S&P CNX NIFTY 50*

1. Introduction

Fuzzy Sets Theory was introduced by L. A. Zadeh [1] in 1965. It is different from the traditional Set Theory by using membership function to deal with the questions that cannot be solved by two-valued logic of traditional set theory. After 1965, fuzzy sets have been applied to many fields such as Decision Analysis, System Theory, Artificial Intelligence, Economics and Control Theory.

Fuzzy sets work as a way to capture uncertainty and vagueness in several systems such as fuzzy database systems. In these systems, impreciseness is generally expressed using fuzzy linguistic terms which are usually defined as fuzzy sets. Each fuzzy set is characterized by its membership function, therefore, these functions must be carefully defined. However, few studies have applied fuzzy set theories to solve some special dynamic process, especially the observations are presented in linguistic values, although this kind of dynamic process plays an important role in daily life.

There are usually three types of trends found in the stock market. The Bullish trend indicates that next few sessions might show an up trend and values may move up. The Bearish trend indicates that next few sessions might show down trend and values may move down. The Neutral trend indicates that next few sessions might show values that would be in

a range bounded around few points above and below the mid distance between highest and lowest values. This information is very useful to the short term traders who purchase and sell with in a time span of one week or so.

Candlestick Charting [2] originates back to Japan from centuries ago. It is a method of looking at data differently than has been developed in western cultures. The advantage of using candlestick charting in place of Bar charts is that we have the ability to use same techniques and analysis that bar charts offer plus the diversity and unique signals that candlesticks generate.

It gives the chart or the candlestick almost a three dimensional effect. The mystique surrounding this method is believed to be that chartist can see chart patterns more clearly and distinctly. Each “bar” is called a candle. Each candle pictured has a different characteristic that represents the difference or distance between the high, low, open and close. Candlestick charting techniques can be used from data for whatever time period you are looking at, hourly, daily, weekly or monthly. It lends itself to pattern recognition and trend line support, resistance and channel lines.

In Figure 1, the dark candle or dark filled in section refers to a market that closes below the opening range. The white or hollow candle in Figure 2 refers to a market that closes above the opening range.

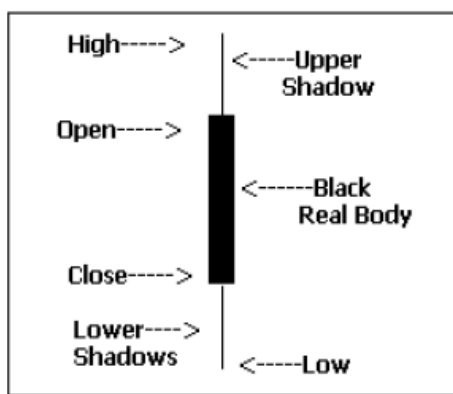


Figure 1. The Dark Candle

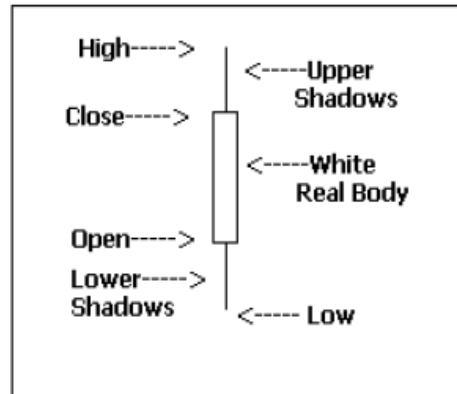


Figure 2. The White Candle

There are many candlestick patterns and it is necessary to know what is happening in each pattern. They must be combined with other forms of technical analysis to really be useful. The patterns are divided into two parts: Bullish patterns and Bearish patterns.

The Bullish patterns (Figure 3) indicate that the next move of the market would be bullish and there is an opportunity of buying the stock and selling it later at a higher price.

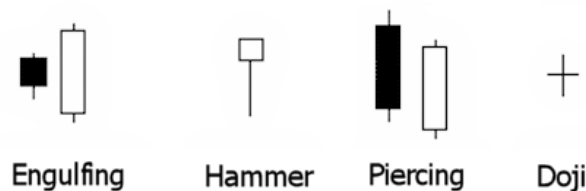


Figure 3. Bullish Candlestick Patterns

The Bearish patterns (Figure 4) indicate that the next move of the market would be bearish and there is an opportunity of selling the stock and buying it later at a lower price.

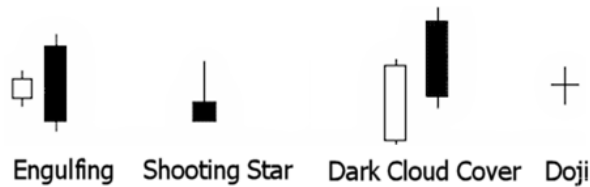


Figure 4. Bearish Candlestick Patterns

In this experiment we try to utilize the Engulfing patterns to generate opportunities for buying and selling.

The Engulfing pattern [2] which indicates bullish sentiment is indicated when a white candle's real body completely covers the previous black candle's real body. It is also relevant to note that the opening is lower than the first candle's real body and the close is above the first candle's middle portion of the body. It signifies that the momentum may be shifting from the bears to the bulls (uptrend). And the opposite pattern is signaled when a black candle's real body completely covers the previous white candle's real body. It is important to note that the opening is higher than the first candle's real body and the close is below the first candle's middle portion of the body. It signifies that the momentum may be shifting from the bulls to the bears (downtrend).

For our experiments we use S&P CNX NIFTY 50 index used in National Stock Exchange of India for stock futures trading. The real time data is collected from the websites of National Stock Exchange of India (<http://www.nseindia.com>), Bombay Stock Exchange (<http://www.bseindia.com>) and Yahoo finance India (<http://in.finance.yahoo.com>).

In the first phase of our development we fuzzified the candlestick representation of present day data namely the O,H,L,C values which represent Open, High, Low and Close values of a day using a modified S-function. Here we could create fuzzy models for the White and Black candles. Then in the second phase we developed a fuzzy model that could classify the fuzzy candles as Very-Small (VS), Small(SM), Big(BG) and Very-Big(VB). They represent the size of the candles. This identification becomes very useful in deciding the U-Turn and Engulfing.

At every phase we develop Fuzzy-Rules. The accumulated Fuzzy-Rules from every phase would become the Fuzzy Rule-base. This Fuzzy-Rule-base would guide us to decide the course of action whether to buy or sell.

This paper is organized as follows: Literature review is presented in Section 2, Fuzzification of candlesticks is explained in Section 3, Size determination for fuzzy-candlesticks is explained in Section 4, Engulfing pattern recognition is explained in Section 5 and Modified Engulfing pattern (U-Turn) is explained in Section 6. Implementation example is in Section 7 and conclusion of our work is in Section 8.

2. Literature Review

Fuzzy expert system is a general system for performing approximate reasoning. It can be formally defined as a mapping from an input space to an output space by making use of a set of IF-THEN conditional statements or rules [3].

In [4], a Takagi–Sugeno–Kang (TSK) type fuzzy rule based system using technical indexes as inputs, for stock price prediction, is presented.

Among the earliest applications of fuzzy theory are knowledge based systems. The core of such systems are fuzzy 'if-then' rules. Most of these systems derive these fuzzy 'if-then' rules from human experts [6]. Several methods have been proposed to generate these fuzzy 'if-then' rules directly from numerical data. Kosko [7] presented methods based on neural networks to achieve this goal. Later, Ishibuchi et al. [5] came out with a general purpose, easy-to-understand methodology to generate such rules from the numerical data and then they applied a genetic algorithm to determine a compact rule set with a high classification power [6].

In our approach we use the combined power of subjective and objective IF-THEN rules which are inspired from the TSK [3] models proposed by Takagi-Sugeno-Kang, 1985.

3. Fuzzification of Candlesticks

Here we fuzzify the candlestick representation of present day data namely the O,H,L,C values which represent Open, High, Low and Close values of a day using a modified S-function. Here we could create fuzzy models for the White and Black candles.

Fuzzy Sets:

A fuzzy set A [x] over a universe of discourse X is a set of pairs:

$$A = \{(x, \mu_A(x))\} \text{ such that } x \in X, \mu_A(x) \in [0, 1]$$

where $\mu_A(x)$ is called the membership degree of the element x to the fuzzy set A . This degree ranges between the extremes 0 and 1:

- $\mu_A(x) = 0$ indicates that x in no way belongs to the fuzzy set A .
- $\mu_A(x) = 1$ indicates that x completely belongs to the fuzzy set A .

Membership Grade: $\mu(x)$

To represent a White-candlestick the characteristic would be that the Open value is closer to the day's Low and Close value is closer to High of the day and addition to that the Close value should be higher than Open value of the day. So in other words the Open is bearish and Close is bullish.

To represent a Black-candlestick the characteristic would be that the Open value is closer to the day's High and Close value is closer to the Low of the day and addition to that the Close value should be lesser than Open value of the day. So in other words the Open is bullish and Close is bearish.

We propose the following fuzzy sets:

$\mu_{BL}(x)$, to represent bullish condition and $\mu_{BR}(x)$ to represent bearish condition. Here 'x' represents the Open or Close values depending upon which type of candle we want to represent. The equation 3.1 shows the membership function to represent Bullish condition. The equation 3.2 shows the membership function to represent Bearish condition. The values a and b represent the day's Low and High values respectively.

Equation 3.1 Bullish Membership Function
 $\text{MuBL}(x)$

$$\text{MuBL}(x) = \begin{cases} 1 & , x \geq b \\ \frac{x-a}{b-a} & , a < x < b \\ 0 & , x < a \end{cases}$$

Equation 3.2 Bearish Membership Function
 $\text{MuBR}(x)$

$$\text{MuBR}(x) = \begin{cases} 1 & , x \leq a \\ \frac{b-x}{b-a} & , b > x > a \\ 0 & , x \geq b \end{cases}$$

Fuzzy Rules to identify the type of Candlestick:

Rule 1.1: If Open Is Bearish AND Close is Bullish Then Formation is White-Candlestick.

Rule 1.2: If Open is Bullish AND Close is Bearish Then Formation is Black-Candlestick.

4. Candle Size Determination

After we had determined which type of candlestick we have then we need to identify the intensity or power represented by the candlestick i.e. the size of the candlestick. To accomplish this we need to know the difference between the Close and Open prices, more the difference more is the power and vice-versa. We categorize the size as Very-Small(VS), Small(SM), Big(BG) and Very-Big(VB). The respective membership functions are represented as $\text{MuVS}(x)$, $\text{MuSM}(x)$, $\text{MuBG}(x)$ and $\text{MuVB}(x)$. The Figure 4.1 represents the membership function to represent VS, SM, BG and VB.

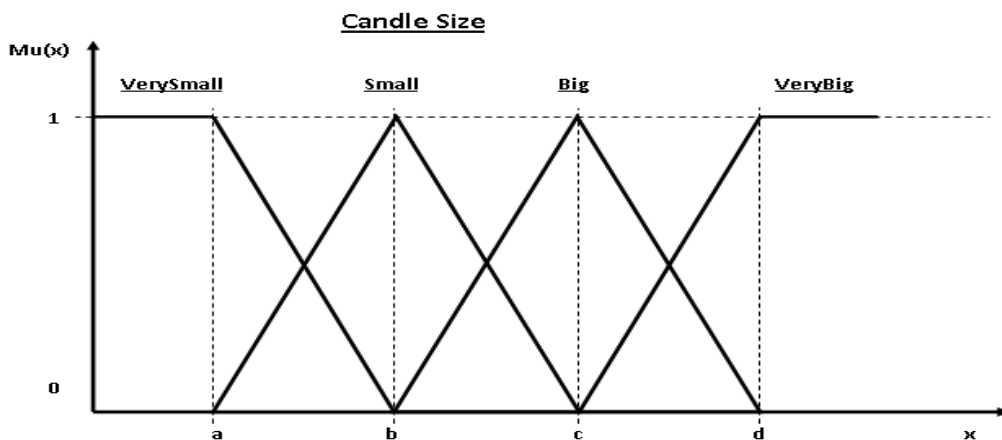


Figure 5. Membership function for $\text{MuVS}(x)$, $\text{MuSM}(x)$, $\text{MuBG}(x)$ and $\text{MuVB}(x)$

$$\text{MuVS}(x) = \begin{cases} 1 & , x \leq a \\ \frac{b-x}{b-a} & , a < x < b \\ 0 & , x > b \end{cases} \quad \text{MuSM}(x) = \begin{cases} 1, & x = b \\ \frac{x-a}{b-a}, & b > x > a \\ \frac{c-x}{c-b}, & c > x > b \\ 0, & a \geq x > c \end{cases}$$

$$\text{MuBG}(x) = \begin{cases} 1, & x = c \\ \frac{x-b}{c-b}, & c > x > b \\ \frac{d-x}{d-c}, & d > x > c \\ 0, & b \geq x > d \end{cases} \quad \text{MuVB}(x) = \begin{cases} 1 & , x \geq d \\ \frac{x-c}{d-c} & , d > x > c \\ 0 & , x \leq c \end{cases}$$

The value of ‘x’ is the difference obtained from Open and Close values. The values a, b, c and d is determined using observations at various time frames and for NIFTY it was found to be 5,10,15 and 20 respectively.

We would use these membership functions in section-6 to form the rule-base to determine the type of U-Turn.

5. Engulfing Pattern Recognition

From the exercises done in Sections 3 and 4 we can now form a fuzzy rule-base which would enable us to identify whether present data represents a Bullish Engulfing (Figure 6) or Bearish Engulfing (Figure 7).

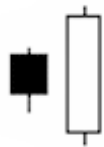


Figure 6. Bullish Engulfing



Figure 7. Bearish Engulfing

Fuzzy Rule-base to determine Engulfing:

Rule2.1: If Yesterday’s-Formation Is Black-Candlestick AND Today’s-Formation is White-Candlestick AND Today’s-Close > Yesterday’s-Open AND Today’s-Open < Yesterday’s-Close Then Engulfing is Bullish.

Rule2.1: If Yesterday's-Formation Is White-Candlestick AND Today's-Formation is Black-Candlestick AND Today's-Close < Yesterday's-Open AND Today's-Open > Yesterday's-Close Then Engulfing is Bearish.

6. Modified Engulfing Pattern Recognition

From the usual Engulfing pattern we developed a modified Engulfing pattern and named it as U-Turn. The characteristics of this U-Turn is that when this formation happens then the market would take a short up or down turn from present position, this would again create an opportunity to buy or sell for very short term.

Fuzzy Rule-base to determine U-Turn:

Rule3.1: If Yesterday's-Formation is Black-Candlestick AND Today's-Formation is White-Candlestick AND [(Yesterday's-CandleSize is VerySmall AND Today's-CandleSize is Big) OR (Yesterday's-CandleSize is Small AND Today's-CandleSize is VeryBig)] Then the U-Turn is Bullish.

Rule3.2: If Yesterday's-Formation is White-Candlestick AND Today's-Formation is Black-Candlestick AND [(Yesterday's-CandleSize is VerySmall AND Today's-CandleSize is Big) OR (Yesterday's-CandleSize is Small AND Today's-CandleSize is VeryBig)] Then the U-Turn is Bearish.

7. Implementation of Proposed Model

Following Table 1 represents the real time data containing Date, Open, High, Low and Close values of six consecutive days. The candlestick patterns are created using graphical methods and then we compare our fuzzy rule-base output with the visual candlestick charts and then analyze that using our fuzzy rule-base we can take decisions to buy or sell.

Table 1. Table Representing 6-day NIFTY Values

Day	Open	High	Low	Close
1	4788.700	4839.550	4750.400	4763.250
2	4712.800	4768.650	4673.850	4746.350
3	4752.500	4818.850	4628.200	4651.600
4	4623.150	4623.150	4555.900	4613.100
5	4635.800	4637.250	4531.150	4544.200
6	4636.450	4707.350	4601.950	4693.150

Source: <http://finance.yahoo.co.in>

Table 2. Result of Fuzzy Rule-base

Day	ENGULFING	BULLISH-U	BEARISH-U
1			
2	0	0	0
3	BEARISH	0	0
4	0	0	0
5	0	0	0
6	0	0	0

The Table 2 indicates the results from fuzzy rule-base after analyzing the 6-day data. The zeros (0) represent that there is no apparent pattern justified by the rule-base. The ENGULFING column contains the rule for checking whether the data in the table displayed in table 7.1 is indicating bearish, bullish or no signals for engulfing patterns, the BULLISH-U and BEARISH-U column contains the rule for checking whether the data in the table displayed in Table 2 is indicating bullish or bearish u-turn signals.

The Figure 8 shows the results compared with the actual candlestick graph of created from the data displayed in Table 2.

Table Representing 6-day Open, High, Low and Close values and respective outputs of fuzzy rule-base for each day

Date	Open	High	Low	Close	ENGULFING	BULLISH-U	BEARISH-U
12/14/2011	4788.700	4839.550	4750.400	4763.250			
12/15/2011	4712.800	4768.650	4673.850	4746.350	0	0	0
12/16/2011	4752.500	4818.850	4628.200	4651.600	BEARISH	0	0
12/19/2011	4623.150	4623.150	4555.900	4613.100	0	0	0
12/20/2011	4635.800	4637.250	4531.150	4544.200	0	0	0
12/21/2011	4636.450	4707.350	4601.950	4693.150	0	0	0

Candlestick graph representing the data presented in the above table



Figure 8. Comparison of our Fuzzy Rule-base Output with Actual Candlestick Formation

From the Figure 8 we find that our fuzzy rule-base output indicates that there must be a Bearish Engulfing on the third day and which is verified by the displayed candlestick chart (circled area).

Now by utilizing this output we can create short positions on the fourth day and earn good profits in the fifth day by covering the short positions. Similarly if we get a Bullish Engulfing then we can buy the next day and sell few days after and earn good profits.

Figure 9 again displays a different 6-day data and the result of the fuzzy rule-base, indicating a Bullish U-Turn, so here if a buy is initiated then in few trading sessions we could earn profits and exit.

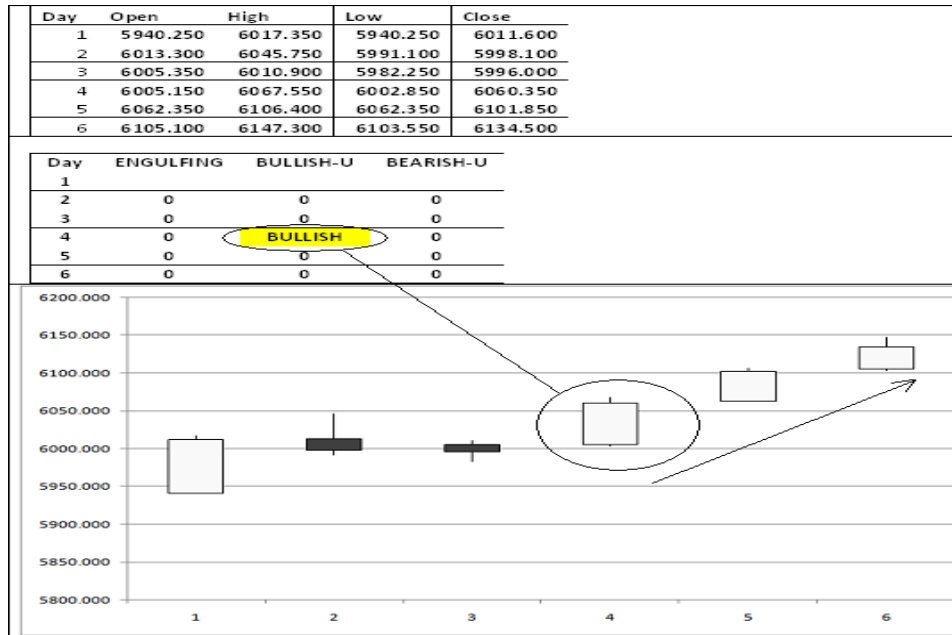


Figure 9. Displaying 6-day Data and Result of the Fuzzy Rule-base

So from the Figure 9 if we buy on the 5th day then we would get a rally up for few days, where we can sell to earn good profits. The main idea to use this system is to get into a trade immediately as the indicator tells us to and get out of the trade within 2 to 3 days. Waiting too long may result in losses.

8. Conclusion

Fuzzy candlesticks are patterns which can only be interpreted through visualization. When the expert traders see a specific formation, then they setup trades according to the candlestick formation. As the entire process is visual so it becomes very difficult to make the computer system, understand them. Thanks to Prof. Zadeh, that through fuzzy logic, human cognition can be represented in such a way that the computer systems can interpret and understand them. We have used this power of fuzzy logic that made our system recognize the candlestick patterns similar to how the humans do. We experimented with the proposed model and found that our system can identify the Engulfing and U-Turn patterns and accordingly we can perform trading giving us good returns.

Human brain creates rules through experience and uses it at appropriate instances, similarly for our system, at every phase we develop Fuzzy-Rules. The accumulated Fuzzy-Rules from every phase would become the Fuzzy Rule-base. This Fuzzy-Rule-base guides the system and helps to decide the course of action whether to buy or sell. This makes our system intelligent

in the field of candlestick pattern recognition, similar to an experienced trader who is expert in recognizing candlestick patterns visually.

Presently our system is focused on short term prediction. The methodology can be enhanced to predict the long term future trends. The proposed model is simple and easy to develop which can effectively identify the present trend and also help in predicting the immediate future trend. There is ample scope of improvement and researchers can creatively use this model for trend identification and further enhance it for further trend prediction.

The proposed future work is to de-fuzzify the trend values and achieve a crisp value of how much points the market is going to rise or fall in the short term.

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