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Prediction of Stock Values Based on Fuzzy Logic using Fundamental Analysis

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***Abstract*—** Due to high fluctuations in the stock market, it is difficult to predict the future movement of stock prices. Many researchers have developed technical tools to predict future price based on past patterns. However, every stock has an Intrinsic value that do not depend on market price. The approach works through phases as Data Collection, Feature Processing and Learning. The stock value is produced by Dividend Discount Model. The quality and quantity factors of stocks are mapped through fuzzy logic. Different formulas based on fundamental strategies of stock valuation gives different resulting values, which imply different degrees of inference. General fuzzy IF-THEN rules are applied. The result of approach provides a guideline about actual value of stock. System gives emphasis on value rather than price which help Investors to take decision.

Keywords- *Fuzzy Logic, Intrinsic Value, Stock Valuation.*

I. INTRODUCTION

Recently, huge work has been going on in the area of analyzing value of the stock and predicting stock prices [01]. Investment is an operation in which in depth analysis promises safety of principal amount invested and some adequate return on that amount. Most stock investors now days depend on Intelligent investing Systems which help them in predicting values based on various situations and conditions. Stock values are considered to be not so dynamic and not susceptible to quick changes for long term. By using known parameters (P/E Ratio, debt ratio etc.) and unknown factors (like Election Results, rumors etc.) an Intelligent investor would predict the stock value and buy a stock from the pessimist (who is eager to sell) and sell to optimist (who is eager to buy) before its value declines. Though it is very hard to replace the expert person in Investing by an accurate prediction algorithm, which gives high incomes for investment firms, indicating a direct relationship between the accuracy of the prediction algorithm and the profit made from using the algorithm.

A stock is not a ticker symbol or electronic bip, it is an ownership interest with an underlying value that does not depend on its share price [02]. Stock market is a pendulum that swings between optimism that makes stock value too expensive and pessimism that makes stock value cheap. The Intelligent Investor is one who knows the value and behaves according to market scenario to get adequate return. To invest in long term needed good intellectual principles for making decisions. In this paper we discuss various techniques which are applied for predicting stock price that will rise or fall. It introduces certain financial parameters that will give a stock value by applying machine learning techniques. Analyzing fundamentals such as earnings, cash flow and assets is useful in determining buyout and liquidation value of a company. Determining success of technical analysis is very difficult due its subjective nature of these practices [03].

II. RELATED WORK

Konstantinos N. Pantazopoulos *et al.* proposed neuro-fuzzy approach for predicting financial time series and shown to perform well in the context of various trading strategies involving stocks and options [04]. Lixin Yu and Yan-Qing Zhang proposed an evolutionary fuzzy neural network using fuzzy logic, neural networks (NNs), and genetic algorithms (GAs) for financial prediction with data sets from different financial domains [05]. Kai Keng Ang and Chai Quek proposes a novel rough set-based neuro-fuzzy decision model called rough set-based pseudo outer-product (RSPOP) which synergizes the price difference forecast method [06]. Ahmed, Raaffat and Nevins (2007) proposed decision support system based on fuzzy logic that helps investors to make the correct decisions [07]. Their work uses fuzzy logic and technical analysis techniques to perform the decision making process. They used only Moving Average (MA) technical indicator in the formation of rules for the fuzzy inference system that is the only drawback. Lean Yu, Huanhuan *et al.* work on evolving least squares support vector machine (LSSVM) learning paradigm with a mixed kernel is proposed to explore stock market trends [08]. Haoming Huang and Chai Quek proposed a system in which a technical indicator price percentage oscillator (PPO) is used to generate trading signals. The main task for the HiCEFS predictive model is to predict the future PPO in order to take profit [09]. Ganesh Bonde, Rasheed Khalid use genetic algorithms to find the connection weight for each attribute, which helps in predicting the highest price of the stock. The highest accuracy obtained using the genetic algorithm is 73.87% and using the evolutionary strategies is 71.77% [10]. Eisuke Kita *et al.* daily stock price and the daily prediction error is calculated using bayesien network [11]. Results shows the maximum prediction error of the present algorithm 30% in NIKKEI stock average and 20% in Toyota Motor Corporation However, the CPU time of the present algorithm is more expensive than that of the previous algorithm. Yanshan Wang and Anam-dong proposed a PCA SVM approach to predict the individual stock prices. In the model, the principal components identified by the PCA are used along with financial factors in SVM for prediction. Experiments computed the one-day-ahead predictions using

data of a long period [12]. Khalid Alkhatib *et al.* use kNN algorithm which is robust with small error ratio; consequently the results were rational and also reasonable [13]. V. Govindasamy and P. Thambudarai demonstrates the outstanding capabilities of the Probabilistic Fuzzy Logic approach for implementing decision making tasks in the stock market prediction. They implement Dynamic Probabilistic Fuzzy Relational model (DPFRM) which has indicators interconnected [14]. A fuzzy system is defined by characteristic function called as membership function. Osman Hegazy *et al.* proposed ABC algorithm, to optimize least square support vector machine (LSSVM) to predict the daily stock prices. The proposed model is based on the study of stocks technical indicators, optimizing LSSVM and historical data with ABC algorithm. Due to technical indicators long term price could not be predict [15]. Wijnand Nuij *et al.* proposed a framework for automatic exploitation of news in stock trading strategies. Events are extracted from news messages presented in free text without annotations. They test framework by technical indicators extracted events [16]. V. Govidasamy *et al.* proposes a prediction system named as PECEP. PECEP is based on Complex Event Processing (CEP) and Probabilistic Fuzzy Logic (PFL). CEP is event processing that combines data from multiple sources to infer events or patterns that suggest more complicated circumstances [17]. Fuzzy Logic in the wide sense is considered as a collection of methods, tools and techniques form modeling and reasoning about vague concepts. Fuzzy logic termed as a mathematical framework for formalizing approximate reasoning. It recognizes more than simple truth values. It represented with degrees of truthfulness and falsehood. They state that despite being largely data driven machine learning is not a knowledge free methodology. Instead, successful learning requires background knowledge and a proper modeling of the data and the underlying hypothesis space (type of model). Fuzzy logic seems very useful in this regard (incorporating expert knowledge into the learning process). Fuzzy logic found complementary to statistics and probability. Complexity Overhead is high due to repeated analysis. Hence fuzzy logic been used to reduce amount of computation involve and thereby reduced complexity of the system [17]. Desheng Dash Wu *et al.* develops sentiment ontology where the online post messages affect the stock market. The framework merge sentiment analysis into machine learning approaches based on autoregressive conditional modeling and SVM. But Sentiments are not good for the long term approach [18]. Partha Roy *et al.* use fuzzy system model that can forecast the short term momentum of the stock market. It takes 14 day historical data to predict five day momentum. The results are very promising by using fuzzy model [19].The questions that cannot be solved by using two valued logic of traditional set theory can be solved by using membership function in fuzzy logic. Data collected which is for the short period not able to predict value correctly. In proposed framework different parameters are collected from data sources for long period and the value is compared with price to take the correct decision.

Collectively all these methods are to predict stock market prediction directly shown in Table I.

Classic model is used to predict stock directly. This model considers fundamental as well as technical features as input. After that uses classification techniques to predict the stock value.

Pattern Discovery Model: It is used for discovering charts or graphs and finds certain patterns. Investors feel chart pattern discovery as a feasible solution as they can speculate the profit.

Public Information Model: This technique is based on fully public Information. If certain rumors are spread throughout the market, according to that sentimental information public takes decision [20]. The information may be textual so mining takes place in social media sites also.

Event Based Model: Input to this model is opportunities or threats from online data source and it provide you future price of stock. It analyzes cause and effect relationship [17].

TABLE I
ANALYSIS OF STOCK PREDICTION MODELS

Method	Input Data Used	Goal
Classic Model	Technical as well as fundamental factors.	Predicting stock price trends
Pattern Discovery Model	Historical Data	Chart or Graphs
Public Information Model	Public Information and stock data	Predict current trends
Event Based Model	Events	Stock Value for the nearest future

III. BASICS FOR STOCK VALUATION

"What causes stock price movements?" This is a very different question. For that we know different quality and quantity factors [02]. There are some major categories.

1. Adequate size of Enterprise (ASE): - Idea behind this variable is to exclude small companies which will be subject to more than average vicissitude especially in industrial field.(More than Rs.500 crore)
2. A sufficiently Strong financial condition (SFC): - For industrial companies current assets should be more than twice current liabilities. Also long term debenture should not exist than the net current assets.
3. Earning Stability (ES): Uninterrupted Earning for past 10 years.
4. Dividend Record (DR): Uninterrupted payment for 20 years.
5. Earnings Growth (EG): One third of increase per share earnings in past 10 years using averages at beginning and end.
6. Moderate PE Ratio (MPE): Current price is equal to or less than fifteen times it's earning of past three years [02].

7. Price to Earnings (PE) should below 15.
8. Price to Book (PB) Ratio < 1.5 i.e. current price should not be more than 1.5 times the book value last reported.
9. As a rule of thumb, the product of the multiplier times the ratio of price to book value should not exceed 22.5 i.e. PE × PB ≤ 22.5.

Fundamental feature of fundamental analysis is that actual value of company meets their financial characteristics, growth, risk and cash flows.

Intrinsic value is calculated by Dividend Discount Model (DDM). The Intrinsic value is a value which not depends on an external price i.e. it is true worth of company.

Model states that value V_0 is defined as present value of all cash payments to investor discounted according to risk adjusted interest rate k. If Intrinsic value is more than the market price than stock is undervalued i.e. if we buy a stock that will never be in loss.

$$k = r_f + B[\,E(r_M) - r_f] \quad (1)$$

k = required rate of return of stock.
B = Systematic Risk.
$[\,E(r_M) - r_f\,]$ = Risk Momentum on M.
M = Market Portfolio.

$$V_0 = \frac{E(D_1)+E(P_1)}{1+k} \quad (2)$$

V_0 = Intrinsic Value.
E (D_1) = Expected Dividend Yield.
P_1 = Stock Price at end of year.
P_0 = Current stock price.

From the formula above it can be set the following formula which represents Dividend Discount Model (DDM). [20][21].

$$V_0 = \frac{D_1}{1+k} + \frac{D_2}{(1+k)^2} + \frac{D_3}{(1+k)^3} + \cdots + \frac{D_n}{(1+k)^n} \quad (3)$$

IV. PROPOSED SYSTEM

For Investment value, some people will make estimates. Among all estimated values, one value will match with actual price in stock market and one value with true worth (price). So there are two problems, first to explain current price in stock market as it is and second what price would be right for the stock. This approach is fundamental analysis approach. This model has capability to perform fundamental analysis of incoming stock based on different parameters (attributes).

Figure 1 show fuzzy logic used in prescribed model. There are mainly three components are associated – Data Set collection, Feature Processing and Learning.

A. Data set collection:

The first component in the model is to collect the data. The drawback of the existing system is that they are collecting the data for short period of time with different parameters. With that the system is not able to get the correct processed output. Hence data is collected based on the required parameters for long time.

From web, historical prices are collected and constructed in the form of event hierarchy. It consists of set of event classes with its associated attributes. Adaptors provide the core functionality to collect data. There are numerous packages are available for the data collection.

B. Feature Processing:

Collected data has certain duplicate data and features. In order to remove that redundancy this component includes following phases.

1) Data Preparation:

Data preparation includes task to transform, map, and merge data streams into a single dataset. As per the requirement the process may also include task such as data cleansing.

Filtering**:** In data preparation, important operation is elimination of data. The data which is not further needed for the analysis that is dropped. It increases the memory utilization and performance of system.

Data Cleansing**:** Since large volumes of heterogeneous sources are involved, there is a high probability of errors in the data Therefore data cleaning is effective in construction of quality data. Windows and time based data management controls enable developers to keep existing data when missing data is detected

2) Integration:

As the time is continuously changing at each instance new data is generated. So this newly generated data must be added to the historical data. This process of combining current data with historical data is integration.

3) Aggregation:

Aggregation is an important step in Feature Processing. Iteration takes place until required event stream is found. This steps groups all relevant dataset in data sources. After that computation is done and the result is sent to the next component of the model.

C. Learning

This component consists of fuzzifier to map the various factors, knowledge base which contains rules and Inference engine for execution.

1) Fuzzifier:

A fuzzy set includes characteristic function mathematically represented asμ_p: P(E) -> [0,1]. It is also states that element P(E) belongs to set F. Membership functions selection influence performance of fuzzy logic in Input/output. Fuzzy set theory assumes membership for analysis. In the fuzzifier, crisp values are being fuzzified and converted into linguistic terms which are associated with the input linguistic variables.

To train Data Stream i.e. non fuzzy of sample space is converted by fuzzifier. The following are the membership functions which give respective $\mu_{(x)}$ for each parameter.

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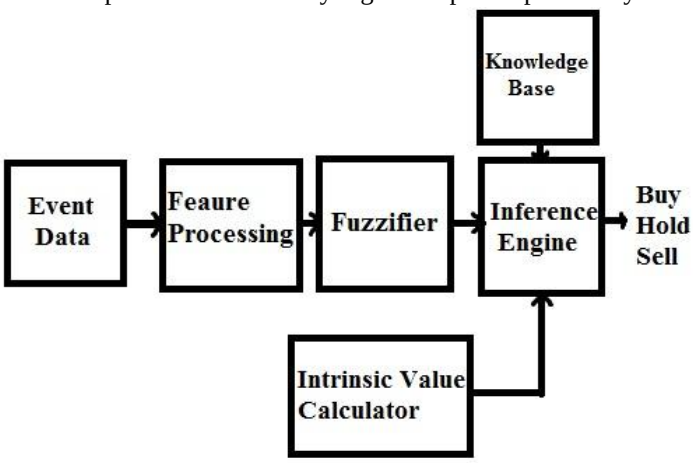

Figure 1. Fuzzy Relational model.

theory assumes membership for analysis. The membership function computed from data which is collection of different variables.

Figure 1 show fuzzy logic used in prescribed model. To train Data Stream i.e. non fuzzy of sample space is converted by fuzzifier. The following are the membership functions which give respective $\mu_{(x)}$ for each parameter.

a) $\mu(x)_{(ASE)} = \begin{cases} 1 & x \geq a \\ 0 & x, < a \end{cases}$

b) $\mu(x)_{(SFC)} = \begin{cases} 1, & x \geq 2 \\ \frac{x-1.82}{2-1.82}, & 1.82 \leq x \leq 2 \\ 0, & x < 1.82 \end{cases}$

c) $\mu(x)_{(ES')} = \begin{cases} 1, & x \geq 2 \\ \frac{x}{2}, & 0 < x \leq 2 \\ 0, & x = 0 \end{cases}$

d) $\mu(x)_{(ES)} = 1 - \mu(x)_{(ES')}$

e) $\mu(x)_{(DR')} = \begin{cases} 1, & x \geq 2 \\ \frac{x}{2}, & 0 < x \leq 2 \\ 0, & x = 0 \end{cases}$

f) $\mu(x)_{(DR)} = 1 - \mu(x)_{(DR')}$

g) $\mu(x)_{(EG)} = \begin{cases} 1, & x \geq 133 \\ \frac{x-127}{133-127}, & 127 \leq x \leq 133 \\ 0, & x < 127 \end{cases}$

h) $\mu(x)_{(MPE)} = \begin{cases} 1 & x \geq b \\ 0 & x, < b \end{cases}$

i) $\mu(x)_{(PE)} = \begin{cases} 1, & x < 15 \\ \frac{16-x}{16-15}, & 15 \leq x \leq 16 \\ 0, & x > 16 \end{cases}$

j) $\mu(x)_{(PB)} = \begin{cases} 1, & x < 1.5 \\ \frac{1.6-x}{1.6-1.5}, & 1.5 \leq x \leq 1.6 \\ 0, & x > 1.6 \end{cases}$

k) $\mu(x)_{(PEPB)} = \begin{cases} 1 & x \leq 22.5 \\ 0 & x, > 22.5 \end{cases}$

2) Knowledge Base:

Knowledge base consists of fuzzy If … Then rules. The following set of rules gives an idea, how the decision is made.

a) IF (ASE = low) and IF (SFC = low) and IF (ES = low) THEN (ID = sell).

b) IF (DR = high) and IF (EG = low) and IF (MPE = medium) THEN (ID = hold).

c) IF (PE = high) and IF (PB = high) THEN (ID = buy). …

Where ASE, DR and ID are linguistic variables and *low*, *medium*, *high* and *buy* are linguistic terms. The IF part is termed as the premise or also as antecedent, Also THEN part is termed as the conclusion or consequence.

3) Inference Engine:

Inference Engine executes fuzzy logic to map variables from fuzzy sets. When all crisp values are fuzzified into their linguistic values, using knowledge base rules inference engine generate linguistic values for output linguistic variables.

Inference engine works through two processes aggregation and composition. IF rules values are computed by Aggregation part while values of the THEN (conclusion) part of the rules are computed by composition process. Firstly the Aggregation process comes. Based on the membership degree of the related linguistic term, a degree of truth is assigned to rules IF part. There may be one or more conditions. For clipping the degree of that truth the minimum of degrees of truth for corresponding conditions are computed. Output of MIN is THEN part's degree of truth. Defuzzifier is required if the linguistic values are to be shown as crisp values. However it is optional as there is decision making process. Intrinsic value is calculated by Dividend Discount Model (DDM). The Intrinsic value is compared and appropriate decision of {BUY, HOLD, and SELL} is taken.

The following algorithm describes overall proposed framework stepwise. First it collects data which is analyzed for data sources. After data collection redundant feature are removed Data preparation step gives types of features that suits our content of message. Integration is pre analysis step. Aggregation is technical step which gives data in machine readable format. Machine learning will map events to desired actions.

Algorithm:

1. Start
2. Data set Collection
   Add objects to Data Table
   Add all Data Tables to Datasets.
3. Feature Processing
   Data Preparation
   If Data is Valid in event stream then next step else Remove Dataset.
   If Data is from reliable source then next step else Dataset is removed.
   Data Integration
   Compare and find historical Dataset.
   If historical dataset is valid then integrate current and historical dataset.
   Data Aggregation
   Group all relevant datasets in datasource.
   Compute required analytics.
4. Learning.
   Compare Computed Values.
   If Value is in range then Map action based on threshold Value.
   Else get next stream.
5. Stop.

V. CONCLUSION

This Paper elaborates capabilities of Fuzzy Logic to predict stock price. System considers fundamental approach for study. Methodology gives exact value for stock. It becomes easy to analyze that whether the given stock is worth to current price or not. Investor can easily predict the future price for long term. There are different financial instruments in stock market. They are stocks, bonds, preferred stocks etc. In this paper, a framework is proposed for stocks only. So missing Instrument's analysis should be done as future work.

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