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Sentiment Analysis for Effective Stock Market Prediction

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Abstract: The Stock market forecasters focus on developing a successful approach to predict stock prices. The vital idea to successful stock market prediction is not only achieving best results but also to minimize the inaccurate forecast of stock prices. This paper attempts to design and implement a predictive system for guiding stock market investment. The novelty of our approach is the combination of both sensex points and Really Simple Syndication (RSS) feeds for effective prediction. Our claim is that the sentiment analysis of RSS news feeds has an impact on stock market values. Hence RSS news feed data are collected along with the stock market investment data for a period of time. Using our algorithm for sentiment analysis, the correlation between the stock market values and sentiments in RSS news feeds are established. This trained model is used for prediction of stock market rates. In our experimental study the stock market prices and RSS news feeds are collected for the company ARBK from Amman Stock Exchange (ASE). Our experimental study has shown an improvement of 14.43% accuracy prediction, when compared with the standard algorithm of ID3, C4.5 and moving average stock level indicator.

Keywords: Stock market intelligence, stock data analysis, RSS Feeds, sensex points, Sentiment mining.

1. Introduction

All Stock prediction is a challenging problem in the field of finance as well as engineering and mathematics. Due to its financial gain, it has attracted much attention both from academic side and business side. Stock price prediction has always been a subject of interest for most investors and financial analysts. Nevertheless, finding the best time to buy or sell has remained a very difficult task for investors because there are other numerous factors that may influence stock prices.

In the prediction of stock market analysis a new novel approach is proposed to predict the buy or sell signal to the investors. In the proposed approach stock market forecasting is achieved by combining both stock related RSS news feed and sensex points. Based on the combined result of opinion of sentences and sensex points of moving average the investors buy or sell their products.

Sentiment classification has become a very popular task in natural language processing area, which tries to predict sentiment (opinion, emotion, etc.) from texts.

Today people are placing their comments and opinions on social media which can be shared by others also. Sentiment classification could be done in word/phrase level, sentence level and document level. Sentiment analysis has now become the dominant approach used for extracting sentiment and appraisals from online sources. Subjectivity analysis focuses on dividing language units into two categories: objective and subjective, whereas sentiment analysis attempts to divide the language units into three categories; negative, positive, and neutral.

Two types of results are achieved in the proposed system. One is without sentiment the moving average value is calculated and second one is with sentiment the moving average is calculated. Both the results will show the improvements in the stock market forecasting.

This paper is organized as follows: Section 2 surveys the related work. Section 3 discusses the Stock Market forecast. Section 4 describes the RSS

News Feeds. Section 5 describes System for Sentiment Analysis of effective Stock market Prediction using RSS News feed. Section 6 presents the experimental results. Finally, Section 7 gives the conclusion of work.

2. Related work

Many algorithms of data mining have been proposed to predict stock price. The opinion summary is explored based on the opinion sentences. This paper summarizes only factual information, and is not useful for the opinion-based summary [1]. In order to avoid the complex space modelling of various sources a tensor based information framework was introduced to predict stock [2]. Thought this framework is generalizable to other multidimensional learning problems, it does not focus on time interaction.

A model has proposed to predict the stock price based on the combining of Self-Organizing Map (SOM) and fuzzy – Support Vector Machines (f-SVM). This paper proposed the base for the extraction of fuzzy rules from the raw data based on the combining of statistical machine learning models [3].

Daily text content in Twitter is analyzed by mood tracking tools and investigated for predicting the changes of DJIA closing values, which was based on a self-organizing fuzzy neural network [4]. This approach is similar to our approach of mood tracking. A back propagation neural network with technical indicators was used to forecast fuzzy time series. The study findings showed that ANN had better forecasting ability than time series model [5]. Performs better forecasting in known patterns, but needs additional work for dealing with unknown patterns.

This research focuses the subjectivity analyses of social issues. The subjectivity of a document strongly depends on its sentences. They proposed a lexical-syntactical approach to recognize and classify subjectivity at the sentence level and consider the role of various opinion terms, especially verbs on opinions regarding social issues [6] and needs to focus on weakness and strongness of objective sentences.

Back propagation algorithm with time and profit based adjusted weight factors are applied here. They used Feed-forward neural network and simple recurrent neural network for prediction [7].

The prediction of Chinese stock market with the help of public moods is extracted from micro blog feeds [8].

A novel stock selection model with discrete and continuous variables algorithm is introduced in this paper for model optimization [9]. For further testing its generalizations there is a need to consider investment risk and other capital markets.

Different textual representations of news articles were examined to predict future stock price, which was compared to linear regression with SVM [10]. In order to achieve better accuracy, other machine learning techniques such as Relevance Vector Regression have to be considered.

Detailed descriptions of input variables were given for predicting stock market index price. They also applied different Artificial Neural Network (ANN) models for prediction and compared their results [11]. Provides good result in Nonlinear forecasting neural networks.

A procedure was described that automatically distinguished between prior and contextual polarity, with a focus on understanding the features [12]. Expansion of lexicon for acquiring the prior polarity of words and phrases improves the prediction.

In order to predict stock market Artificial Neural Network (ANN) is used and employed five fundamental input variables which were general index (GI), Net Asset Value (NAV), profit per earning (P/E) ratio, Earnings per share (EPS), and share volume. They applied these parameters to Neural Network (NN) and compared their outcome [13]. In order to produce error free predictions train this system with more input data sets.

A sentence-level summarization model is introduced to daily full-length news article summarizations for stock price prediction. This paper analyzes a generic stock price prediction framework that takes textual documents as inputs and generates predicted price movements as outputs [14]. For further enhancement, more refinements are needed for the current processing steps, such as using the sentiment analysis in the news pre-processing to construct higher level features.

One of the data mining techniques called a decision tree classifier is used to take the decision in the stock market for buying or selling stocks based on the knowledge extracted from the historical prices of stock [16]. To improve the prediction, the factors which affect the behavior of the stock markets, such as trading volume, news and financial reports are to be reconsidered which might impact stock price.

From the earlier research works, it is vivid that, analysis of sentiment helps in improving the prediction [4, 6, 8, 14, and 16]. Our work considers the sentiments reflected through news feeds for better prediction of stock market fluctuations.

Moreover, in order to enhance the accuracy, we have combined Moving Average Stock level Indicators along with sentiment mining.

3. Stock market forecast

Stock market forecasting is the method to determine the future value of company stock. Nowadays, a huge amount of valuable information related to the financial market is available on various media such as websites, twitter, Facebook, blogs and such others. In general a stock price depends on two factors. One is fundamental factor and another one is technical factor.

The fundamental factor mainly depends on the statistical data of a company. It includes reports, financial status of the company, the balance sheets, dividends and policies of the companies whose stock are to be observed. The technical factor includes the quantitative parameters like trend indicators, daily ups and downs, highest and lowest values of a day, volume of stock, indices, put/call ratios, etc. In technical factor the historical prices are considered for the forecasting. Initially the historical prices of the selected company are downloaded from the website. Various methods of stock level indicators are available to computing the stock value. Few of them are Moving Average, Stochastic RSI (Relative-Strength Index), Bollinger bands, Accumulation – Distribution, Typical Point (pivot point).

3.1 Moving average method as stock level indicators

It is a technical analysis tool in which the actual index data is compared with its average taken over a period of time. In general, there are three types of moving averages. They are Simple Moving Average (SMA), Exponential Moving Average (EMA) and Weighted Moving Average (WMA). For stocks, common time periods for moving averages are 5 days, 10 days, 15 days, 21 days, 50 days, 100 days and 200 days.

The main advantages of moving average stock level indicator is that it offers a smoothed line and also helps to cut down the amount of noise on price chart compared with other level of indicators.

The sensex is designed to reflect the overall market sentiments. It comprises of 30 prominent stocks derived from all key sectors which are traded actively in the exchange. These are large, well-established and financially sound companies from main sectors. Then moving average is applied on the sensex data in order to find whether the next day's

sensex will rise or fall. Normally the sensex is calculated using the Eq. (1).

$$Sensex = \left(\frac{sum\ of\ free\ float\ market\ capitalization}{Base\ Market\ Capital}\right)100$$

(1)

The free float market capitalization can be done by using the Eq. (2).

$$Free\ Float\ Market\ capitalization\ = Share\ price(shares\ out\ standing - locked\ in\ share)$$

(2)

The moving average is calculated by adding the closing price and then dividing this total by the number of time periods. The following Eq. (3) is applied for moving average,

$$F_t = \frac{A_{t-1}+A_{t-2}+A_{t-3}+\cdots+A_{t-n}}{n}$$

(3)

F_t = Forecast for the coming period,
A_{t-1} = Actual occurrence in the past period for up to 'n' periods,
N = Number of periods to be averaged.

The proposed predictive system considered the moving average computation for 5-days, 10-days and 15-days.
 The comparative analysis of the moving average computation is as follows.
 If the 5-day is greater than 10-day, and 10-day is greater than 15-day, then it indicates that the result is positive and the sensex goes up for the next day. If 5-day is less than 10-day and 10-day is less than 15-day, then it indicates that the result is negative and the sensex goes down for the next day.
 If the 5-day is greater than 10-day, and 10-day is less than 15-day, and also If the 5-day is less than 10-day, and 10-day is greater than 15-day, then it indicates that the result is neutral and the sensex remains no change for the next day.

4. RSS news feeds

Really Simple Syndication or Rich Site Summary (RSS) is an XML document that facilitates content syndication. It is a spam free, quick and efficient way to read the news-related

sites, Weblogs and other online publishers syndicate their content as an RSS feed to whoever wants it.

The latest headlines from different news websites are taken from RSS, and push those headlines down to the computer for quick scanning. It is a simple way to share information between sites mostly based on XML. In general RSS feed is small and fast-loading. Unlike email an RSS feed is zero maintenance, the messages will never get blacklisted or filtered. With RSS feed, users can finally separate wanted information from unwanted information.

4.1 RSS News feed Source and its effects

Most RSS news feed contains author, title, and date information in addition to link and description. Fig. 1 is an example of RSS news feed extracted from website, which illustrates major part of a RSS news feed.

```
<? xml version="1.0" encoding="ISO-8859-1"?>
<rss version="2.0">
<channel>
  <title>Yahoo Home Page</title>
  <link>http://www.Yahoo.com</link>
  <description>News tutorials</description>
  <item>
    <title>News Tutorial</title>
    <link>http://www.Yahoo.com/rss</link>
    <description>New Web tutorial

                </description>
                    </item>
                    <item>
        <title>Politics Tutorial</title>
    <link>http://www.Yahoo.com/xml</link>
        <description>New Politics tutorial

    </description>
</item>
```

Figure.1 Example of RSS News feed

The first line in the RSS news feed contains the XML declaration. The next line is the RSS declaration which identifies that this is an RSS document (in this case, RSS version 2.0). Each RSS feed contains one and only one <channel> tag. It gives overall information of a RSS feed. A channel contains one or more items. For news websites, each item represents one recent news article. The <channel> element has three required child elements. The <title> element defines the title of the channel (e.g. Yahoo Home Page). Next to <title> is the <link> element defines the hyperlink to the channel

(e.g. http://www.yahoo.com) .The <description> element is the next one which describes a short summary, or sometimes, full body of the content (e.g. News tutorials). Each <channel> element can have one or more <item> elements. The <title> tag defines the title of the item (e.g. News Tutorial). Next tag is <link> which defines the hyperlink to the item (e.g. http://www.yahoo.com). The final tag is <description> which defines the item (e.g. New Web tutorial). Finally, the two last lines close the <channel> and <rss> elements.

If there is positive RSS news feed then this tends to have a positive effect on stock markets and share prices rising soon after the news come out in the open. Positive news such as securing of new orders, healthy sales numbers, discovery of huge oil reserves in a country, excellent financial results of a company etc. should send a stock up. On the other hand, negative RSS news has negative impact on stock markets and makes the stock market values go down.

5. Proposed work

The system explores the task of automatic identification of news opinions with the help of RSS news feeds and predicts the stock market movement whether goes up or down. The Fig. 2 describes the system for prediction and analysis of stock market using RSS news feed.

5.1 RSS stock news feed

From the web pages, RSS feed reader reads the required news content such as title, description, date, author, link etc. in the format of XML document. This takes latest headlines from the stock related news website. The final information of description (sentence level) is grabbed after setting up the site parameter. Finally it parses the XML document from RSS feed list. This RSS feed helps to collect the stock market news as a dataset.

5.2 Pre-processing

In this process, it removes the incorrect, incomplete, improperly formatted, or duplicated data. Dirty data can cause confusion in the data set. Hence, this module cleans the data by filling missing values, smoothing the noisy data, identifying and removing the outliers. After pre-processing, the data are passed to the next module.

5.3 Sentence splitting module

The sentence splitting module is the one which splits the cleaned news data into parsed sentences.
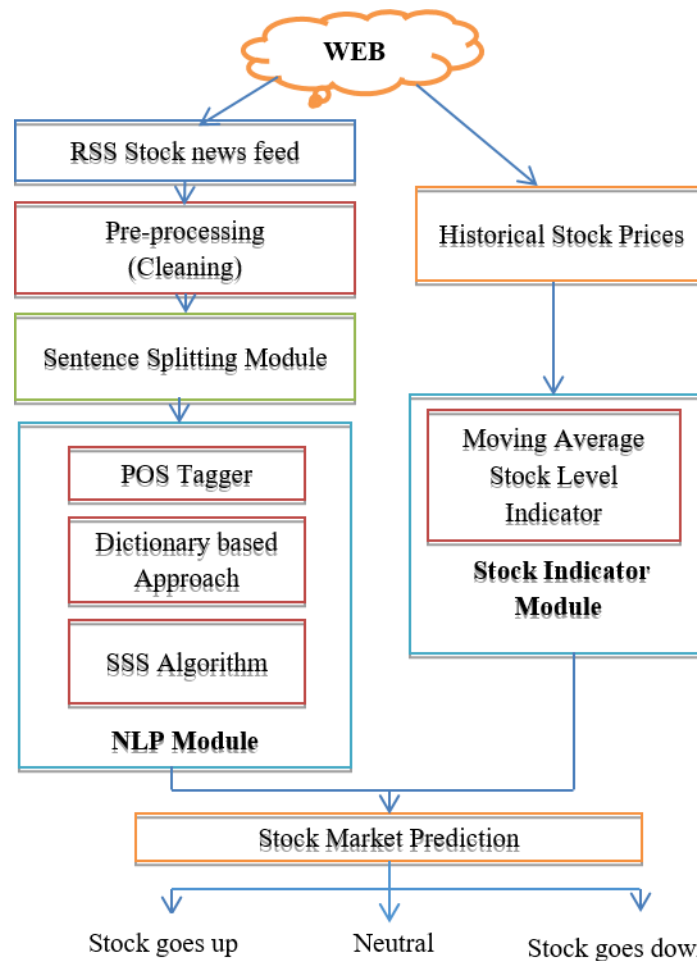
Figure.2 System for Sentiment Analysis of effective Stock market Prediction using RSS News feed.

The parsed news data are collected in a text document for the testing purpose. The document contains the RSS news data in the form of sentence by sentence.

5.4 Natural language processing (NLP) module

Sentiment analysis or Opinion mining is the process used to determine the attitude, opinion, emotion expressed by a person about a particular topic. It uses natural language processing (NLP) and text analytics to identify and extract subjective information in source materials.

In order to identify the new opportunities and to maintain the reputations, business people usually view the reviews, ratings, recommendations and other forms of online opinion.
This allows not only to find the words that are indicative of sentiment, but also to find the relationships between words so that this helps to accurately identify.

Scaling system is used to determine sentiment for the words having a positive/negative/neutral sentiment. Here the part-of-speech tagger, dictionary based approach and Sentence Sentiment Score (SSS) Algorithm are used to find the polarity of the sentence, to conclude whether the sentence is positive, negative and neutral.

Positive sentences have a positive sentiment attached to them such as happiness, enthusiasm, kindness etc. They are generally classified as having a positive sentiment. Similarly, negative sentences have a negative sentiment attached to them such as sadness, hate, violence, discrimination etc. They are generally classified as having a negative sentiment. When no emotions are implied, they are classified as neutral.

5.4.1 Part-of-speech—tagger

In general, a Part-Of-Speech (POS) tagger is also known as grammatical tagging or word-category disambiguation. It is used in many Natural Language Processing (NLP) tasks that do not require a full constituency parse tree but some information about the categories of words. Part-Of-Speech (POS) is a piece of software that reads text in some language and assigns parts of speech to each word, such as noun, verb, adjective, etc., although generally computational applications use more fine-grained POS tags like 'noun-plural'. In

this proposed work, the combination of noun-adverb has been chosen for the best result.

5.4.2 Dictionary based approach

Among the various available methods in the unsupervised technique, dictionary based approach is used to determine the orientation of sentences. The dictionary is used to determine the opinion words and their polarities. Dictionary-based techniques use synonyms, antonyms and hierarchies in WordNet (or other lexicons with sentiment information) to determine word sentiments.

This approach assigns each synset of WordNet into three sentiment numerical scores: Obj(s), Pos(s), and Neg(s) describing how Objective, Positive and Negative the terms contained in the synset are.

5.4.3 Sentence level sentiment score (SSS) algorithm

SSS Algorithm is considered for finding the overall result where for every individual sentence the analysis approach is applied and finally their results are summarized to provide the overall result of the document.

In general, the score ranges from 0.0 to 1.0 and their sum is 1.0 for each synset. Here, initially the POS tagger is applied for each word and it specifies the tag as noun and adverb in such a manner which are equivalent to words. Assign the score value to each word of a sentence and find the sum of that sentence. If the score value of that sentence is positive then that sentence is considered as a positive sentence. If score value is negative then it is considered as negative sentence. If it is 0.0, then it is considered as a neutral sentence. The following Eq. (4) is used to calculate the Sequence of words.

$$Sequence\ of\ words(W) = W_1 + W_2 + \cdots + W_n \quad (4)$$

$S(W_{+ve})$ = Set of Positive Sentiment words.
$S(W_{-ve})$ = Set of Negative Sentiment words.
n = Number of words.

5.4.4 Moving average stock indicator module

This Module collects the historical prices from the website and calculates the moving average value for that stock prices for the investors whether to buy or sell their stocks.

Table 1. Sentiment and Sensex-Moving Average Final Result Prediction

Sentiment Analysis Result	Sensex-Moving Average Result	Final-Result Prediction
Positive	Positive	Positive
Positive	Negative	Neutral
Negative	Positive	Neutral
Negative	Negative	Negative

5.4.5 Stock market prediction

To predict the stock market, the results of both sentiment analysis and Sensex are combined and analysed. Table 1 shows the final result prediction technique for Stock market.

If Sentiment analysis results and Sensex Moving Average results are positive then Final prediction is positive. If both are negative, then result is also negative. Combinations of both will results into neutral.

6. Experimental results

In the experimental study the stock market forecasting is collected for the company ARBK from Amman Stock Exchange (ASE). The Oracle database of Amman Stock Exchange (ASE) contains the historical prices of the 230 companies listed in the exchange from the year 2000. The historical prices are collected from the year 2005 to 2007. The performance of the proposed algorithm is compared with the prediction of stock market using data mining techniques [16].

The sentiment RSS news feed for Arab Bank (ARBK) Company is collected from http://investing.einnews.com/news/ase-stock and then the sensex point for the same company is collected from http://www.marketstoday.net/markets/jordan/Historical-Prices/10/en/#. The moving average is calculated for the month of April 2006. Same way sentiment is also calculated for April 2006. Finally both the results are combined and the end result is predicted for stock market according to the value given in Table 1. Fig.3 shows the selection of month and year for sentiment analysis. The following Fig.4 shows the overall positive and negative sentences of News document and the implementation shows that the news result is positive.

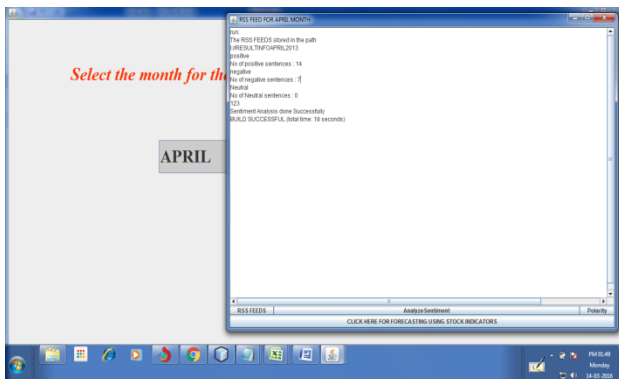Figure.3 The selection of month and year for sentiment analysis

Figure.4 Calculation of total positive and negative sentences

Figure. 5 Calculation of Moving Average for sensex points

Now, the moving average is calculated. Here the moving average is applied in the historical sensex data. The following Fig. 5 shows Selection of Moving Average for sensex points. The moving average for sensex point is calculated for 5-days, 10-days and 15-days.

The following Fig.6 (chart) shows sensex point – moving average calculation. In the below graph 5-day moving average, 10-day moving average and 15-day moving average are shown in blue color, red colour, and green color respectively.
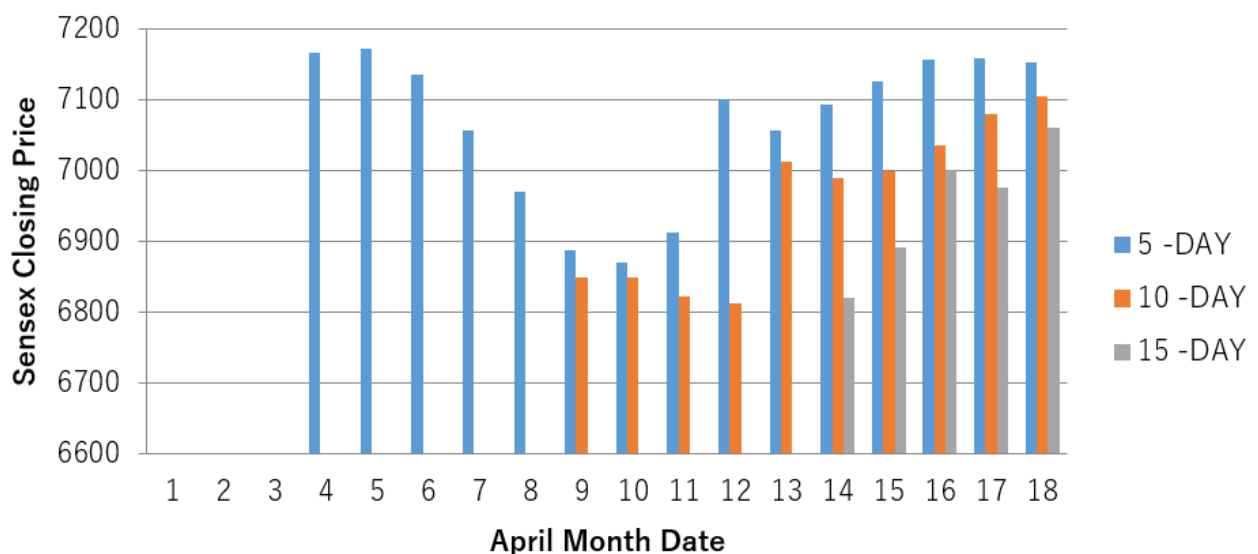

Figure. 6 Moving Average for April 2006

Table 2. Classification accuracy using the proposed method and previous methods

ARBK Company	ID3	C4.5	Moving Average	Moving Average+ Sentiment Analysis
Total Instances	499	499	499	499
Correctly Classified	233	237	321	391
Precision %	46.69%	47.49%	64.32%	78.75%

If the sensex points of 5-day moving average is greater than those of 10-day and the sensex points of 10-day moving average is greater than those of 15-day, then this indicates that the result is positive. If the result is positive then the stock is also positive.

The Table 2 shows the classification accuracy using the proposed method and previous methods. In the proposed algorithm, the calculation of sensex point moving average 499 total instances is taken from April 2006. Same way sentiment polarity value is calculated for the sentiment news data of April 2006. Without sentiment value moving average produces the accuracy of 64.32% and with sentiment value the moving average produces 78.75% with improvement of 14.43%. In the previous algorithm ID3 and C4.5 the accuracy is less than the proposed algorithm. This shows the proposed one is efficient than the previous algorithm.

The accuracy of the measure is defined by precision and recall. Precision is the ratio of true positives among all retrieved instances and recall is the ratio of true positives among all positive instances.

Precision measure is verified by how many of the returned documents are correct and the Prediction is verified by the result of precision analysis. The Equ. (4) and (5) is used to calculate the precision and recall value for instances.

$$Precision = \frac{TP}{(TP+FP)} \qquad (4)$$

$$Recall = \frac{TP}{(TP+FN)} \qquad (5)$$

From the above result it is found that the proposed system result produces the better result than the previous one.

7. Conclusion

Unlike the conventional stock market prediction systems our novel approach combines the sentiments of common people through the news feeds and sensex data to predict the behavior of stock market. The RSS news feed of the stock related news are obtained for ARBK company and sentiment polarity of the news sentences are calculated for the prediction of stock news, whether it is positive, negative or neutral. The moving average stock level indicator is used to calculate the sensex points for the stock market. Finally combination of sentiment polarity news and the sensex points provide an efficient result to the stock market forecasters when to buy or sell their stocks.

Our experimental results have shown significant improvement in the precision and correctness measures on bench marking with Moving Average, ID3 and C4.5 approaches. Our future work focuses on combination of one or more stock level indicators with RSS feed stock news which improves the accuracy. Moreover it is intended to incorporate to social contents from twitter and Facebook for effective prediction.

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