Advanced International Journal for Research (AIJFR)
E-ISSN: 3048-7641 ● Website: www.aijfr.com ● Email: editor@aijfr.com

An Expert System Shell for Strengthen the BSE Prediction and Knowledge Representation Using Backward Reasoning Approach

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Abstract

The stock market is characterized by uncertainty, which makes it difficult to convey knowledge and make predictions. Another well-known method that facilitates quick problem-solving and thoughtful decision-making is the expert system. Over the past few decades, a variety of tools and methods have been created for expert system shells. These methods and tools have completely failed to illustrate information and draw conclusions in an efficient way, which is the foundation of an expert system. In this direction, the expert system's backward reasoning method to knowledge representation and stock market prediction is used. One of the Artificial Intelligence (AI) languages that is especially well-suited for expert system applications is LISP (List Processing). The application and testing of the backward reasoning approach to stock market problems is the primary emphasis of this research study. To accomplish this, we use the common lisp 3.0 editor.

Keywords: Stock Market, Artificial Intelligence, BSE, Expert System, Backward Reasoning, Common Lisp 3.0

1. Introduction

One of the most innovative and well-known study fields of the past few decades is artificial intelligence (AI). This field's sole goal is to figure out how to make machines intelligent. As a result, numerous scientists and researchers have worked to accomplish the goal of enabling machines to exhibit some level of intelligence similar to that which humans do [1][2]. Numerous fields, including computer vision, neural networks, robotics, expert systems, etc., are supported by AI.

One of the most widely used AI techniques, expert systems have emerged as a significant innovation over the past forty years due to their demonstrated use in producing both intriguing research tools and profitable commercial solutions [3].

Some of the descriptions were written by those with actual experience in this sector. To put it simply, an expert system is a computer program that uses a variety of artificial intelligence (AI) approaches and

techniques to solve problems [4][5]. Stated differently, an expert system is a product of artificial intelligence.

Expert systems have demonstrated efficacy and effectiveness in a variety of issue domains in recent years, including business and finance, engineering, chemistry, biology, law, and military operations. Solving problems in these disciplines requires a great deal of expertise. Numerous sources, including newspapers, journal articles, periodicals, books, and databases, can provide expert information [5][6].

The acquired knowledge necessitates extensive training and specific subject experience. After a substantial amount of expert information has been gathered, it needs to be encoded in some way, added to a knowledge base, and continuously improved and tested over the system's lifetime [7].

The fastest-growing economy and the desire to profit from shares make the stock market a topic that people are always interested in. Nonetheless, the sector of stock markets also noted the necessity of designing and developing expert systems [8]. However, the fundamental issue with the stock market is its high degree of ambiguity, which makes forecasting extremely difficult. The stock market is filled with numerous technical rules, factors, and procedures. Although an expert system has many different parts, its inference engine is its most potent decision-making element. It is sometimes referred to as the expert system's brain. It has the ability to achieve a certain objective with a good justification [9] [10]. The main issue with inference engines, however, is that they need a great deal of experience, training, and expertise to solve problems.

2. Literature Review

Over the couple of decades, stock market field has greatly shown the need of an expert system due to increasing economic loss or even fatal loss of life in some domain applications. Here we have presented some significant researchers work.

Niderlinski (2010) [11] has suggested an expert system shell based on a model. He designed and developed the shell using the two most crucial methods, forward and backward reasoning. The system's ability to reason with any knowledge base is its most significant feature. It has about 24 rules with an uncertainty factor that ranges from -1 to +1. He modelled the uncertainty factor using the modified conventional certainty factor algebra. Lastly, the system can automatically check rules and make inferences based on the information provided. Additionally, the system generates a diagnosis report that can be utilized for further investigation or for record keeping.

Zarandi et al. (2012) [12] have proposed an expert system approach for assessing intellectual capital that is based on fuzzy rules. To ascertain the degree of qualitative assessment and expert criteria, they used fuzzy linguistic variables. The different company samples are taken into account while calculating intellectual capital. Various regulations based on capital structure, market share rate, employee knowledge, customer capital, etc. are included in their knowledge base. The experimental findings demonstrated that the system provided many accurate assessments of linguistic variables while also expanding the system's potential for further research on a variety of membership functions in terms of linguistic words.

Mohamed et al. (2014) [13] have proposed multiple-imputation type framework for the estimation of time series data using forward and backward forecasting methods. However, the model relies on iterative successive backward and forward forecasting of the missing values. The experimental results showed that

proposed model has been tested on numerous linear and non-liner times' data and has been succeeded to achieve better prediction accuracy.

Ajlan (2015) [14] has presented a comparative study of forward and backward reasoning methods for academic field. He used various academic performance indicators like grade point, attendance to draw Graduate Admission Expert system (GAES). The knowledge base consists of 12 rules, and experimental results showed that forward reasoning is a better strategy than backward reasoning in terms of deriving goals.

Stephen (2015) [15] has presented an artificial intelligence approach to investing in corporate bankruptcy. He designed expert system prototype for corporate bankruptcy analysis. His system consists of various production rules based on indebtedness ratios (i.e. financial leverage ratio, general indebtedness ratio, global financial autonomy ratio etc.). The exsys corvid @R tool is used to draw expert system prototype. The experimental results showed lower training time, prescription to refine performance.

Kamley et al. (2016) [16] have proposed a comparative study between forward and backward reasoning strategy over global stock exchanges such as India, US, Japan and China. Their studies consist of several fundamental, macroeconomic and technical factors. The expert system consists of 50 production rules.

Jain and Vanzara (2023) [17] have offered a thorough analysis of the new developments in AI-based stock market forecasting. Their study primarily analyses the advantages and disadvantages of the primary ideas, methods, and strategies used in AI-based stock market prediction. They did, however, assess how well various AI-based models performed in forecasting stock market patterns. Ultimately, they came to the conclusion that AI-based methods performed better than conventional methods.

Souza et al. (2018) [18] showed that AI-enhanced moving average strategies can outperform market averages in BRICS countries.

Bhunia (2025) [19] have discussed the impact of artificial intelligence (AI) on stock price prediction in India, focusing on the application of Long Short-Term Memory (LSTM) networks and hybrid models. They have considered data from the Bombay Stock Exchange (BSE) including stock prices, trading volumes, and sentiment data from social media and news, the study compares AI-based models with traditional methods. Their research study aims to determine whether AI models offer superior predictive accuracy using RMSE, MAE, and MAPE. The findings suggest that AI models, particularly LSTM and hybrid approaches, outperform traditional models in forecasting accuracy, offering a significant advantage for stock market prediction in India.

In this study, backward reasoning approach is considered for the stock market expert system design and development.

3. Proposed Methodology

Stock market database is increasing day by day. In this environment there is a need of such kind of inferences and formal procedures which can be search effectively in the database and return results in an effective manner. ***Backward reasoning*** is the ***goal driven*** reasoning in which the procedure starts from the goal (a hypothetical solution) and inference engine attempts to find the evidence to prove it [1] [2] [20]. In this procedure, first the knowledge base is searched to find rules that might have the desired solution. If such a rule is found i.e. IF (condition) part matches data in the databases THEN (action) part is to be executed [21]. Finally, we can say that the rule is fired and the goal is proved. The Figure 1 shows the flow chart of backward reasoning.

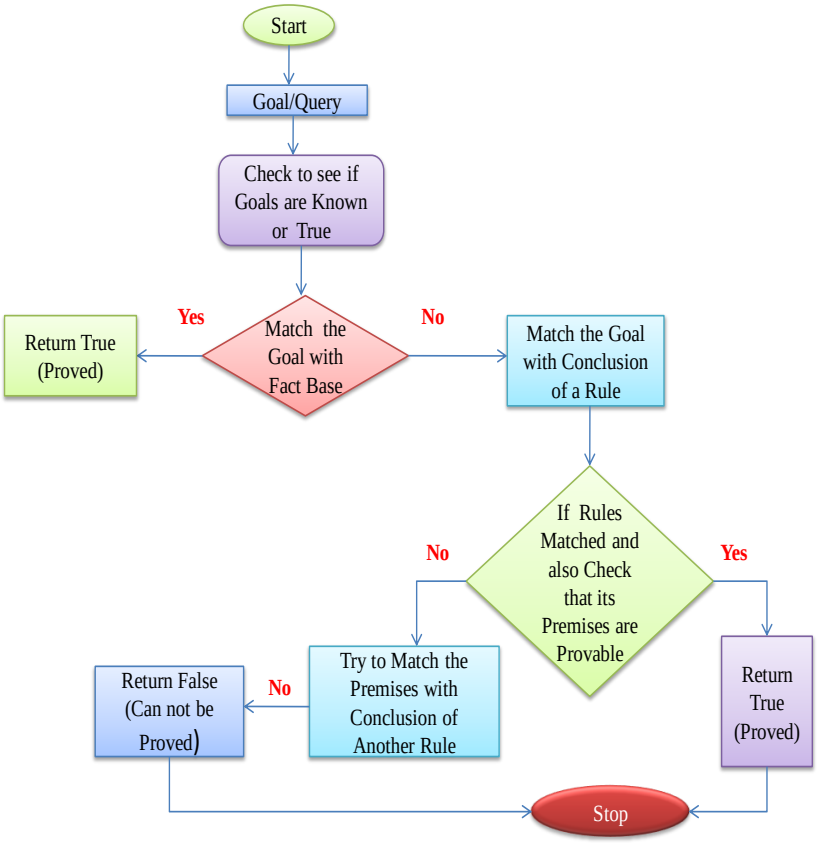

Figure 1: Flow Chart of Backward Reasoning [2] [21] [22]

Figure 1 shows that backward reasoning system starts with goal stack then finding rules that can conclude the information needed by the goal and trying to make if parts of those rules satisfied. The algorithm 1 shows the backward reasoning procedure in more detail manner [1] [2] [23].

Algorithm 1: Backward Reasoning Inference Procedure

1. Start with goal (top goal specified in goal stack) and try to match the conclusion of a rule with fact base. If it is found in fact base then return true i.e. proved.
2. In step 2 try to match the goal with conclusion of a rule with knowledge base (consist a set of rules) one by one. If one of the rules satisfied then checks it premises are provable. If it is yes then return

true (proved). It is also possible if more than one rules are applicable then declare "conflict strategy". In this situation randomly select one of the rules.

3. Try to match the premises with conclusion of another rule (this step repeated recursively until premises don't match with conclusion). If it is yes then return true (proved) otherwise go to step 4.
4. Finally return false (cannot be proved).

The overall procedure of backward reasoning can be understood by following example.

Example 2.1: A famous example of ***cup book*** is considered. Initially we have following information [2] [23] [24].

(1) If X is on top of Y then Y supports X.

(2) If X is above Y and they are touching each other then X is on top of Y.

(3) A cup is above a book.

(4) Cup is touching a book.

Prove that: **"book supports cup"**

Above information is divided into two parts ***fact base and rule base.*** Statements having $\rightarrow$sign are called rules and statements does not have $\rightarrow$sign are called fact base. However, fact base and rule base equally consist two facts and rules.

Fact base:

(1) above (cup, book)

(2) touch (cup, book)

Rule base:

(1) supports (Y,X)

IF Top (X, Y)

(2) Top (X, Y)

IF above (X, Y) and Touch (X, Y)

So let's now starts with goal **Supports (book, cup)**

1st Iteration:

(1) Supports (book, cup) not matched with fact base but it is matched with conclusion of rule 1with X/cup and Y/book. Now its premise is Top (cup, book).

(2) Top (cup, book) is not matched with fact base but it is matched with conclusion of rule 2 with X/cup and Y/book. Now it's premises are:

above (cup, book) and Touch (cup, book)

(3) above (cup, book and Touch (cup, book) matched with fact 1 and fact 2. So it will return true that means support (book, cup) is proved.

4. Experimental Results

The last 10 years (2015 -2025) ***Infosys*** Company data of ***Bombay Stock Exchange (BSE) of India*** is considered for study purpose [25]. The data set employed consists of four important variables like close price, open price, low price and high price. Stock market behavior is volatile in nature which makes the prediction process very complicated. So, making prediction with these variables is not sufficient. Moreover, other five important variables like oil prices, interest rate, US dollar prices, earning per share and dividends are also considered which affects the share market performance. These additional variables data are downloaded from ***Reserve Bank of India (RBI) site*** [26]. First important task for stock market prediction is generation of fact base and rule base. Initially database consists of some facts and rule base also consist some important rule. ***LISP*** is symbolling oriented language which is very flexible for knowledge representation task [27]. The stock market useful facts and rules are designed from ***common LISP environment 3.0*** [28] [29]. Figure 2 shows generation of fact base.

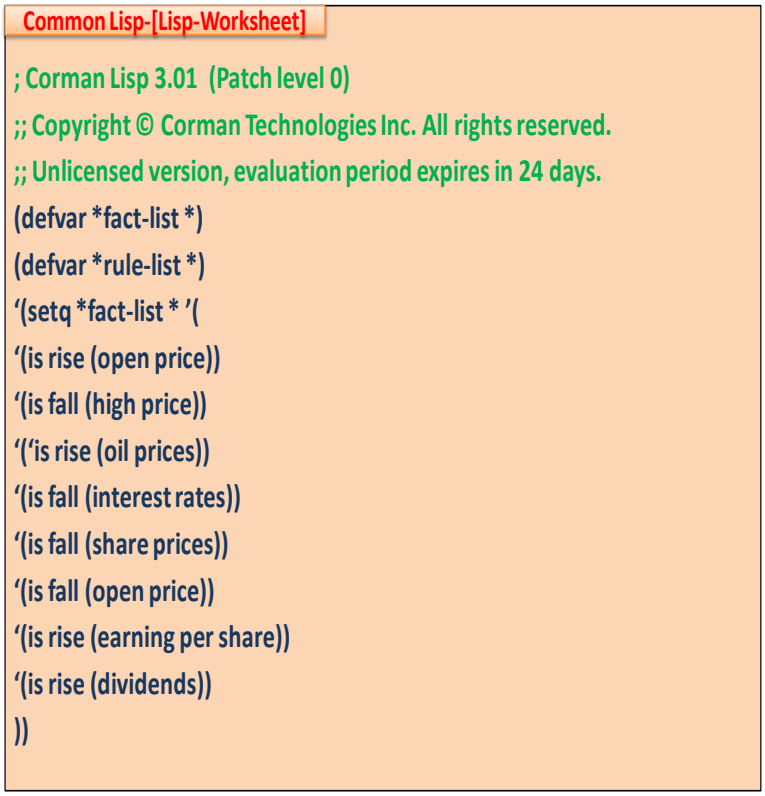

Figure 2: Fact Base Generation

Now main task is to design the rule base. Figure 3 and Figure 4 shows the generation of rule base.

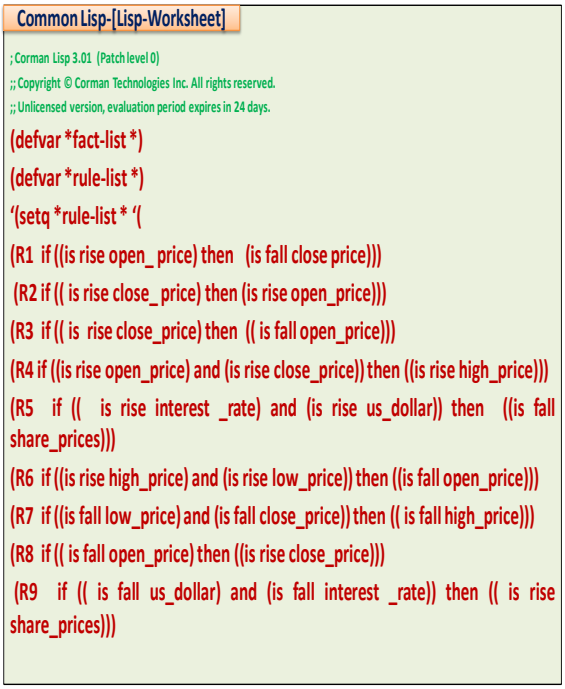

Figure 3: Rule Base 1 Generation

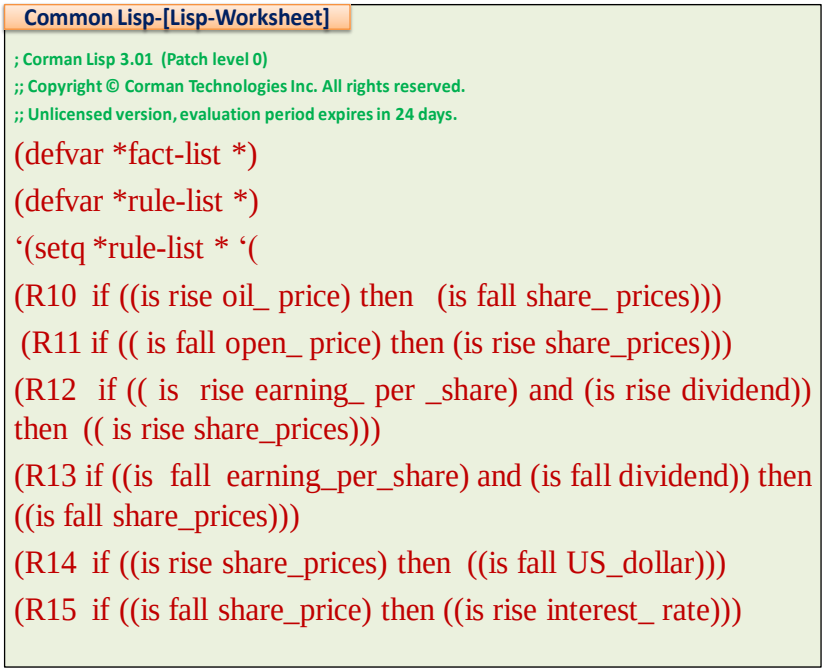

Figure 4: Rule Base 2 Generation

The next task is to specify the goal from Lisp environment. The goal is "**will share price rise in near future?** The following command is used to specify goal.

(setq goal '(is rise share prices))

After specifying the goal, the role of inference procedure starts i.e. goal firstly will be matched in fact base and then rule base. As results new facts always added in database that will be helpful for searching the goal. The Figure 5 shows execution of inference procedure.

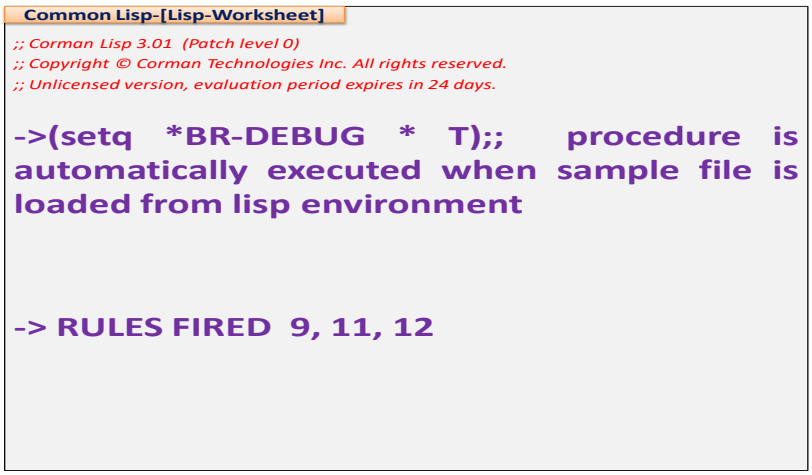

Figure 5: Execution of Inference Procedure

The output of Figure 5 can be described in more detail manner. The question asked "will share prices rise in near future?" So specified goal firstly tries to match with fact base but it is not matched with fact base. Next it will be tried to search in rule base. Therefore, rule no. 9, 11 and 12 fired and most applicable rule no. 9 is selected by inference procedure. The premises of rule number 9 are:

fall (US_ dollar) and fall (interest_rate)

Now our next sub goal is fall (US_dollar) and fall (interest_rate). However, take first fall (US_dollar) and matched with fact base. It is not matched with fact base but it is matched with rule base. Now its premises are rise (share_prices). It will be added in the data bases because one of it premises fall (open_price) already in databases. Therefore, fall (interst_rate) will be matched with fact base. Finally, our goal rise (share prices) is proved. However, we can say that investing money for Infosys share will be fruitful and certain profit can be achieved. The Table 1 shows the statistics of overall inference procedure.

Table 1: Statistics of Inference procedure

Input Variables	No. of Rules	Rules Fired	Goal Found	No. of Iteration
3	15	5	fall open price	1
4	15	8,13	fall share prices	2
5	15	6	fall high prices	1
7	15	4	rise high prices	1
9	15	9,11 and 12	rise share prices	2

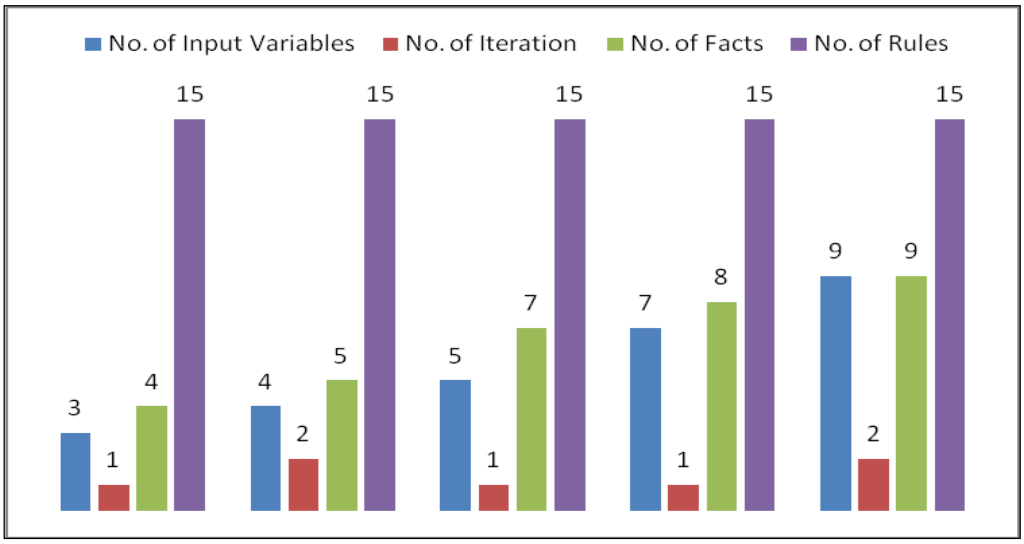

Figure 6: Graph Representation of Backward Inference Procedure

5.

Figure 6 shows graph of backward inference procedure which clearly stated that when variable size increases then maximum two iterations could be taken by inference procedure to find the goal. Figure 7 shows inference tree diagram for goal.

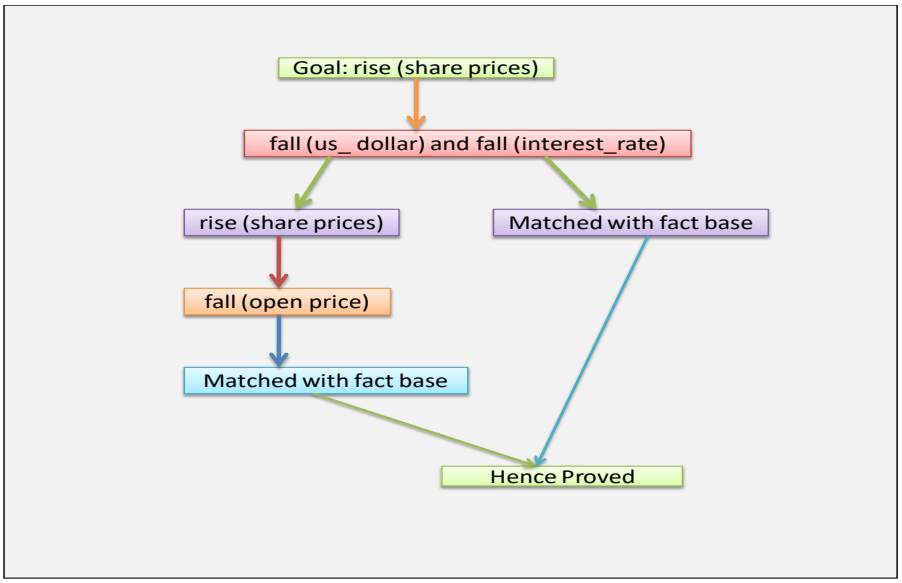

Figure 7: Inference Tree Diagram for Goal

5. Conclusion and Future Scopes

In this study last ten years ***Infosys*** company data is considered. The backward reasoning method of expert system is employed which seems to be very expressive method for stock market prediction and knowledge representation system. However, the system is designed in the very straightforward way, and proposed systems is better than other systems in a number of ways like no. of variables, no. of facts, no.

of rules, no. of iterations, and most important in terms of inference power. The experimental results shows that method has better prediction results and could be able to find the certain gain or loss in stock market environment and the system could be able to predict the stock price's pattern accurately. Finally based on the findings we conclude that share prices rises and most important underlying factors which directly affect the stock market performance are US dollar rate and interest rate. In future, some frame-based approach for stock market study will be considered.

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