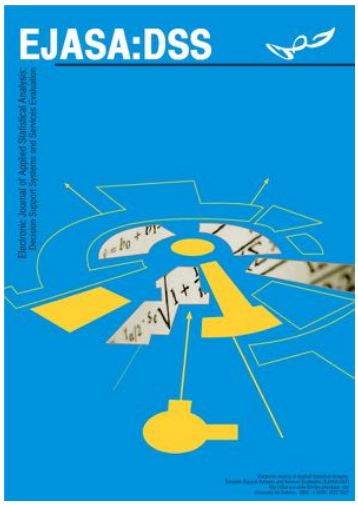

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Designing a decision support system for stock exchange selection based on serious games simulation

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A model for designing of decision support system is a simulation that induces reality and uses different models to describe the complex reality. It also concerns uncertainty and can help users to achieve a conceptual and detailed description of the reality. Serious game is being used as a tool for developing model for a long time. Producing serious games simulation environments is one of the best options in data collection, trial and error, and learning and decision-making for the investment markets that rapid change of the rate increases the risk. A virtual system will provide better aid by using actual data foe a better management of the financial resources and offer options for users at every level of decision. Entering the stock market is possible for everyone but the possibility of selecting a stock portfolio that results in achieving a good profit is very difficult and hard, due to rapidly changing customer markets is becoming more difficult. That is it's a high-risk environment for investors. Indeed people do not have sufficient experience and training in this field.

The aim of this paper is to design a simulated environment that is similar to the stock for the brokers and enthusiasts to help them to choose an appropriate portfolio. Moreover it should have an interactive graphical environment that even novice users can find the necessary training in this area. Creating a Simulation environment in serious games requires rebuilding and finding the principles and a framework that not only involves the world standards accepted by experts in the field but also, according to Iran's investment conditions, becomes localized and in practice, will be efficient.

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keywords: Decision support systems, serious gaming simulation, neural network, fuzzy neural networks, Java, MATLAB.

1 Introduction

Today's business environment and the concept of Business and employment have been changed. In today's changing and turbulent world finding the best options for investment and funds management is the main concern of managers and investors. Instantaneous changes in financial markets make it difficult for managers to make decisions. Indeed increasing the attractiveness of the financial markets is the main reason that many people tend to investment and experience this new environment for making profit. Although Investors maybe do not have enough experience in this field, they want to try it in practice. An environment that is so popular now and a large number of managers, investors and ordinary people interested in investing in it is stock exchange market. Many executives and investors Regardless of capital market laws come to present and invest. They, by chance, may gain some Business profits, but certainly in the medium term the Potential losses and capital loss or failure will be a lot. Designing an Exchange environment in a serious game environment simulator is a key strategy in this area. A model for designing of decision support system is a simulation that induces reality and uses different models to describe the complex reality. It also concerns uncertainty and can help users to achieve a conceptual and detailed description of the reality. Serious game is being used as a tool for developing model for a long time. Producing serious games simulation environments is one of the best options in data collection, trial and error, and learning and decision-making for the investment markets that rapid change of the rate increases the risk. The whole design can be summarized in Figure 1.

- The Knowledge Base Management subsystem: Using Java and MATLAB code.
- The data management subsystem: My SQL database and using primary data in Excel.
- The model management subsystem: using simulation (Serious Games Simulation).
- User Interface: Design GUI in Java and MATLAB software.

2 Review of the Literature

Our goal is to design a decision support system same as virtual system by using a serious game simulation for exchange environment that, with a high interactivity, provides customers and directors the chance of training, selecting and presenting an offer to pick stocks. They can use serious gaming capabilities to reach the aim. For this purpose we need to offer a conceptual framework for designing games. Variety of Investigations, research and investment has been done in designing decision support system, Simulation Serious Game as well as Portfolio selection. In the following we mention just some of

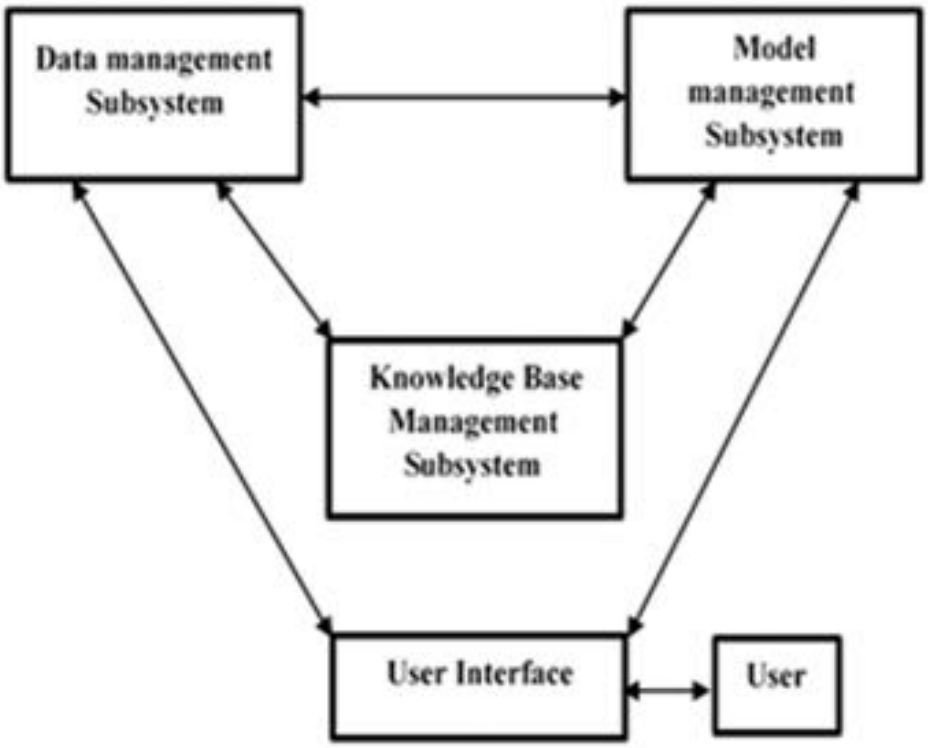

Figure 1: Design decision support system

them: Clark Abt presented the idea and the term "serious games" in his book (Abt (1970)). Gunter et al in investigating The penetration rate of serious games in motivating individuals found that If the content of the game is essentially a place of higher education it can produce the best environment for fulfilling this task (Gunter et al. (2006)). Mockus et al, could Create a decision support system by designing a stock market simulation game environment, using some players, Nash equilibrium and the neural network. For this aim they analyzed simulation results obtained from the serious games and Explored models for time series prediction in this game and simulation environment. The serious game can be a great help in Understanding the concepts of investment and portfolio selection by using real data and showing the simultaneous Impact of some multiple choices (Mockus and Raudys (2010)). Otoiu In an essay investigated simulation game as A potential method for teaching a graduate course in Human Resource Management (Otoiu (2012)). Akcetin et al. in Turkey investigated Serious Games in

graduate level for International Trade Training in Schools marine business. He included that by using serious games international skills and knowledge increased (Akcetin and Akcetin (2012)). Bellotti et al. in an investigation designed a Simulations to stimulate entrepreneurship by serious game in higher education (Bellotti et al. (2012)). Also Hauge and Riedelby designing two simulated environment tried training engineering. They used serious games for teaching Risk management, engineering process from design to production to sales, awareness of risk and risk management skills (Hauge and C.K.H. Riedel (2012)). Durk-Jouke van der Zee, in an article with the subject of Conceptual modeling for simulation based serious game state that Serious games based Simulation developed for Managers to support management decisions and in fact a supporting system of decision making can be created by it. They also proposed some principles for designing serious games by reviewing a case study about Retail management inventory control (Durk-Jouke et al. (2012)). Bhattacharyya et al.by applying a fuzzy approach and by using genetic algorithm offered A model for portfolio selection Bombay Stock Exchange. This model is considered to be part of decision support systems (Bhattacharyya et al. (2014)). Mortara, et al. Designed a serious game as a new tool for learning cultural content. This cultural content involved education and training to support the cultural heritage for example in musume. Finally they designed a A serious game for training in cultural heritage. They include that Serious games as a tool for learning cultural content was attractive. Choice and game design was also considered challenging (Mortaraa et al. (2014)). Lancaster designed a serious game for training simulators and tests the drug on 79 patients and found significant changes before and after using this game. He also found that by using this simulator, serious games will discover talents, education, increased self-confidence and user satisfaction. The experience is of a virtual environment rather than real. He finally reaches the conclusion that the use of serious games simulator training is emerging as a new approach to high efficiency (Mockus and Raudys (2010)).

3 Methodology: Designing simulation

3.1 Serious Games

One way to design the decision support system is Using simulation that imitates reality and by using different models describes the complex reality and uncertainty. It helps users to achieve a descriptive conception form reality. Serious game is a concept that has existed form long time ago. Is has been used as a tool. The term "serious games" had been used long before the introduction of computers and electronic entertainment devices (Abt (1970)). Today it has become one of the tools of education and experience in the virtual environment. Serious games are Simulation of real-world events or are processes designed to solve a problem. Interaction with the user and helping to achieve the objectives are the main purposes of these games (Lancaster (2014); Mortaraa et al. (2014); Susi et al. (2007)).Although serious games can be fun, The main purpose is training and user experience (Bellotti et al. (2012)). They may have other purposes such as marketing or advertising. Basically, these games are designed for serious pur-

poses (Susi et al. (2007)). Serious games can be used for many purposes for example: E-learning, training, simulation environments, teambuilding, collaboration, social networking, advertising and business model. Also they are in widespread attention in many sectors and industries such as: Defense industry, military, education, trade, scientific exploration, health care, emergency management, urban planning, engineering, religion, politics, tourism and cultural heritage and virtual conferences (Akcetin and Akcetin (2012); Gorman and King (1997); Mockus and Raudys (2010)). In all mentioned simulation models User master on the data is required. Users with different levels of knowledge don't have the ability to use this educational and learning environment comprehensively. a serious game simulation environment can be used if the Use qualitative and quantitative simulation software, the ability to interact with the user would be its main goals. Serious game is a Powerful and effective way to learn and develop the skill sets of users. In fact the simulation model of a serious game is as Figure 2 (Durk-Jouke et al. (2012)):

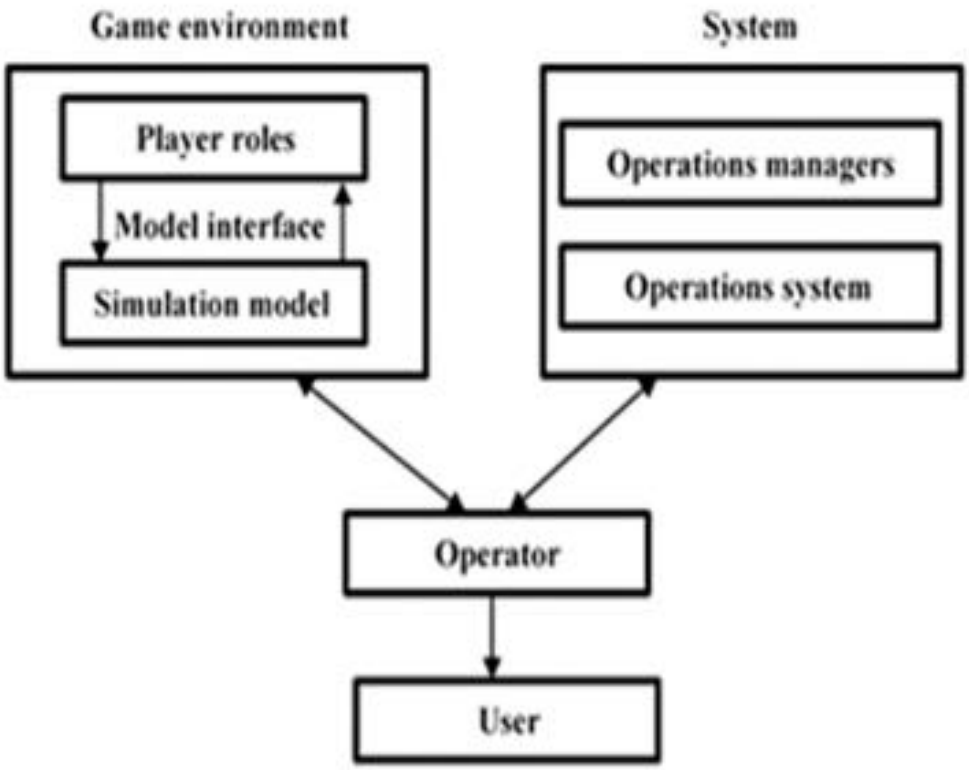

Figure 2: Serious Games Simulation

3.2 Framework and conceptual model for serious games simulator

Many researchers have acknowledged the high potential of simulated serious games in management decision-making skills. Its main explanatory power is in Active participation of learners, the possibility of experiencing the subject as a whole, having holistic view, and its ability to demonstrate the properties of the system (Durk-Jouke et al. (2012); Greenblat (1988)). Moreover Factors such as the ability to view, reproduce, economic security and availability of the system makes these games a valuable alternative for in-service training and learning (Lancaster (2014)). The simulation-based game designed as a support system Virtual decisions for managing a particular context is required. New framework with identifying, structuring and supporting the activities of conceptual model facilitates the design of serious games simulation. Similar issues are related to the design of systems for management decisions (e.g., a supply chain design company structure) and controlling and designing them (e.g., capacity planning, planning). The Nature of serious games is related to one or more major objectives. For example description is used to illustrate a subject, situation or process; delivering is used to Provide a method or technique; Implementation is used for education and training; Reflection is used for getting experience and feedback; and preparation is used to increase or direct attention to the specific situation (Durk-Jouke et al. (2012); Kasabov (1988); Lancaster (2014)). The new modeling framework is meant to support the game design process. We describe the game design process according to (Durk-Jouke et al. (2012); Greenblat (1988)). Greenblat distinguishes between five stages in game design. Stages IIII address game specification in terms of its objectives, model of a chosen referent system and its representation, while stages IV and V concern game construction and preparing for its use. Here we mainly typify stages I-III, as the framework is meant to support these modeling activities. For a more detailed discussion see Greenblat .The initial stage in the process of game design addresses the game subject matter, and characterizes players and game operators. Furthermore, it is meant to clarify the context of its use, such as, for example courses, workshops etc., as well as the resources available for game set-up and use. Stage II concerns model development. The model captures the most critical of the salient elements of a referent system, being either real or imaginary. It does so in terms of actors, system characteristics and linkages, and relevant external factors impacting the system. In stage III the designer has to determine the representational style for model elements as they have been determined in stage II. A first step involves decisions on their detail, being relevant for capturing system behavior, the time frame set for game operation, ordering of game activities, and player interaction. Next the representational form of model elements has to be determined. Greenblat distinguishes between 6 elements of form: scenario, roles, procedures and rules, external factors, visual imagery and symbols, and accounting system. The scenario is meant to inform players about the game environment and the problem they are facing. Each player is typically assigned a role, which implies goals to strive for, and resources to work with. Procedures and rules are meant to guide game operation and player activities. External factors are used to represent game elements influencing player options or outcomes of their activities. Visual imagery and symbols like markers, badges, chips etc. facilitate

players in getting around in their game environment. Accounting systems concern all quantifiable elements and their linkages. Stages IV and V address game construction and preparatory tasks for game use. Important activities are building and testing of game prototypes, and writing an operator manual (Durk-Jouke et al. (2012); Greenblat (1988)).

Stage	
Setting objectives and Parameters	•Subject matter • Purpose (i.e. learning objective) to be served • Likely players • Likely operators (i.e. game leaders) • Probable context of use • Resources (time, money, other) available for development and users
Model development	• Identify the major actors for the referent system, including their goals, activities and resources, and the interactions between them • Identify the major referent system characteristics and linkages • Indicate the type of external factors that may affect the referent system
Decisions about Representation	• Level of abstraction • Time frame • Linear, radial or interactive structure • Interaction among players • Linking model elements to game elements, i.e., scenarios, player roles, procedures and rules, external factors, visual imagery and symbols • Detailing of game elements
Construction and Modification	• Choice of materials and computer use • Prototyping • Field tests
Preparation for use by others	• Operator's manual

Figure 3: A framework and conceptual model for serious games simulator

3.3 Designing serious games simulation for portfolio selection in Tehran Stock Exchange

According to Figure 3, steps required for the design of serious games simulator securities portfolio selection has been stated:

- First stage: Subject matter: Due to increasing expansion of the stock market and the presence of all walks of people to invest in this market. Many people come

to it without proper attention and detailed market information. Many executives and investors Regardless of capital market laws and principles Participation and investment in this market. Business profits may also be accidentally increases. But, for sure, in the medium term and in most cases the Probability of the loss or the loss of capital increases or expected Success will not be achieved. Purpose: Producing a serious simulation game as a decision support system to be Applicable for different levels of user empowerment is the main goal. By using serious games simulator, Investing Without loss of invested capital and reducing the risk of investing in the stock market is easily attainable. Mastering tricks and experiences, practically, in exchange environment by simulated environment in a serious game is feasible. Facing the challenges of the stock market and real investment in a simulated virtual environment with graphics capabilities and appropriate interaction with the user can be a Perfect opportunity to gain experience or decision making. The actual planning and decision-making in the simulator to help companies, organizations and ordinary users to experience investing in the stock market by the simulator will be possible Likely players: All those who are willing to buy and sell shares Likely operators: Brokers, their branches and customers Probable context of use: Used in offices, data centers and homes Resources available to users: Time, purchase credit, corporate data

- Second stage: In this serious game simulation, the Information of the brokers branches and customers will be entered as the basic information. Each broker consists of a series of branch and each branch has a number of customers. Brokers should have updated information and deliver them to their customers as a source of information. Any kind of published information which is incomplete or incorrect will lead the wrong choice adopted by broker or client. In this simulator, the Information relating to shares of companies have been published by the stock and the same variables are used except for the economic, social and political factors. Since some of these details are implied in the information. Stock information will be different under these information.

- Third stage: User interface designed by Java, the ability to view and display the stock information of companies In the form of a windows and creating a line chart simultaneously from multiple companies creates an acceptable tool for user (Figure 4):

  When information about the details of shares is registered by broker, Clients as a main user can Enter and by observing this information they have two ways to pick stocks. The first option is selecting the Company by the user. That is the Users choose some companies to display stock price fluctuations. For the selected companies the linear graph of the stock price when the user enter them will be displayed. This selection is done according to user's interest (Figure 5).

  If the user needs to compare one or more of the company's stock price, he can Select one or more companies and choose the desired timeframe and view the Changes in stock prices in the form of a diagram and benefit the results and in the same place

Figure 4: Game Interface

does the stock selection (Figure 6):

The next section presents the proposal to the user. MATLAB software is used for it. Giving any proposal requires having the ability to predict the stock price. This prediction is done by using two algorithms Multi-Layer Neural Network (MLP) and

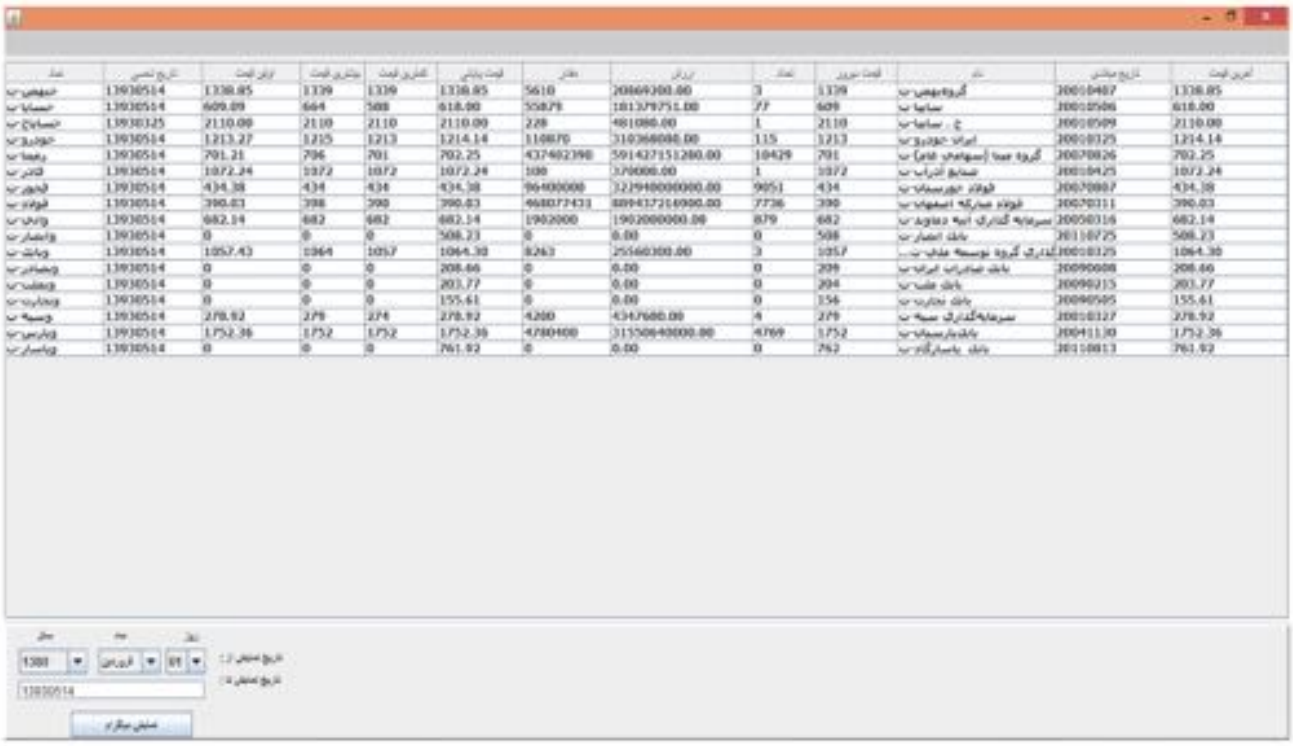

Figure 5: Result select by user

Adaptive Neuro Fuzzy Inference System (ANFIS) to see which one can forecast better. To implement the MLP The programming environment MATLAB software is used. First the use of the data must be normalized To be placed between the distance [0,1] . To normalize the data, the following formula is used:

$$X_n = (X - X_{min})/(X_{max} - X_{min})$$

The neural network used in this study is a multi-layer perceptron network (MLP) (Figure 7):

This network consists of three layers: an input layer, a hidden layer, and an output layer. Two activation functions have been used. in The first layer the Sigmoid activation function and in the second layer Linear activation function is being used. The criterion of error minimization is used for optimizing the weights. Education of the network is done by the error propagation method with the algorithm of Levenberg-Marquardt. Network architecture and neuron number of input and hidden layers are very important in predicting. Because data for latest price of

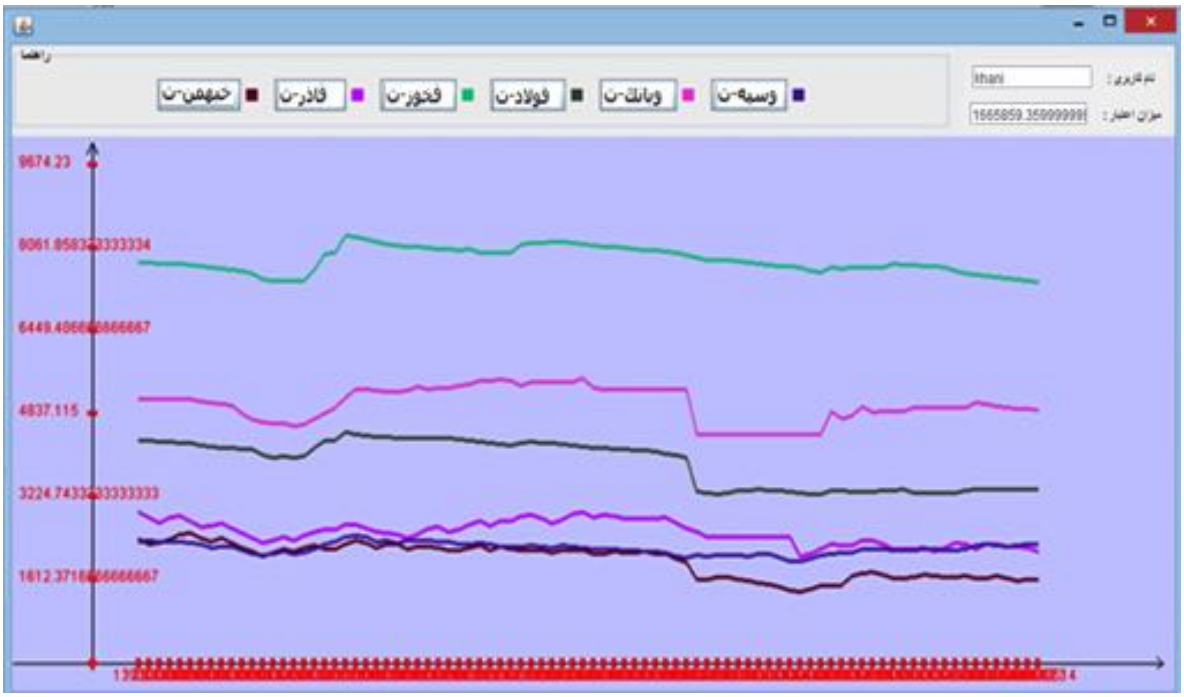

Figure 6: Diagram output

shares of stock were a long series three kinds of inputs were considered: Daily predict, weekly predict and monthly predict. For daily predict input 7 is considered that is data for seven days before. To predict the week, 5 inputs are considered that is five weeks earlier data (average per week) and to predict monthly inputs 3 are considered that is data of the last three months (average per month). As the number of neurons in the middle layer is very important in predicting outcome, many researchers find its number by testing and trial and error. In a proposed algorithm, the number of neurons in a ring is chosen to be of a 50. Each time an error occurred the current number of neurons was compared with the previous ones and finally the number of neurons was selected that had the lowest error. So the number of neurons was considered as 15. So There is a three-layer network that the input- layer neurons are different based on the prediction. neurons in the hidden layer are 15 and neuron output- layer is 1. It's a three-tier network: (1-15-7) (1-15-5) (1-15-3). Fuzzy Neural Network Coding is written in Software environment. The system consists of five layers, each layer functions are described as follows:

First layer: the membership function parameters, the fuzzy optimization operations are performed in this layer becomes our numerical variables come in the form of fuzzy Second layer: In this layer there are defined law. The input weights are determined by this law and According to adaptability of each condition, new out-

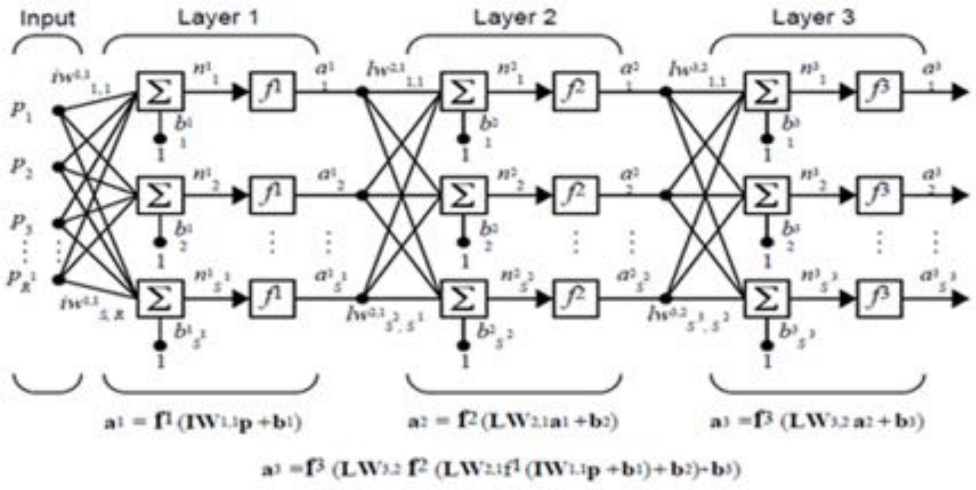

Figure 7: A Multi-Layer Perceptron Network (MLP)

put is obtained and will be sent to the next layer. The conclusion is done in this layer Therefore, this layer is the brain of the system. Third layer: in this layer, signals that are coming from the previous layer nodes are normalized Fourth layer: This layer performs the defuzzification operation Fifth layer: In this layer, all the inputs from previous layer are summed to produce the final output (Figures 8, 9).

To normalize the data, the correlation neural network is used. Gaussian membership functions are selected and for non-phase of the center-average method is used. One method of fuzzy systems is using clustering. In this research the algorithm of Fuzzy c-mean is used.

MLP and ANFIS prediction results are compared with each other. And according to them, the conclusion can be reached that Daily predictions using ANFIS error is less than other forecasts. The ANFIS algorithm to predict the stock price is more suitable for the task and evaluated. In all cases, the ability of ANFIS networks was greater and it had smaller errors in predicting stock prices, also To forecast time periods, daily, weekly and monthly were used and the result was that Daily forecasts are less in error percentage and have a very high accurate. To compare the models, root mean square error (RMSE) and mean bias error (MBE) and fraction of variance (R^2) and Mean Absolute Percentage Error (MAPE) was used as error criterion and was calculated for each model by test data.

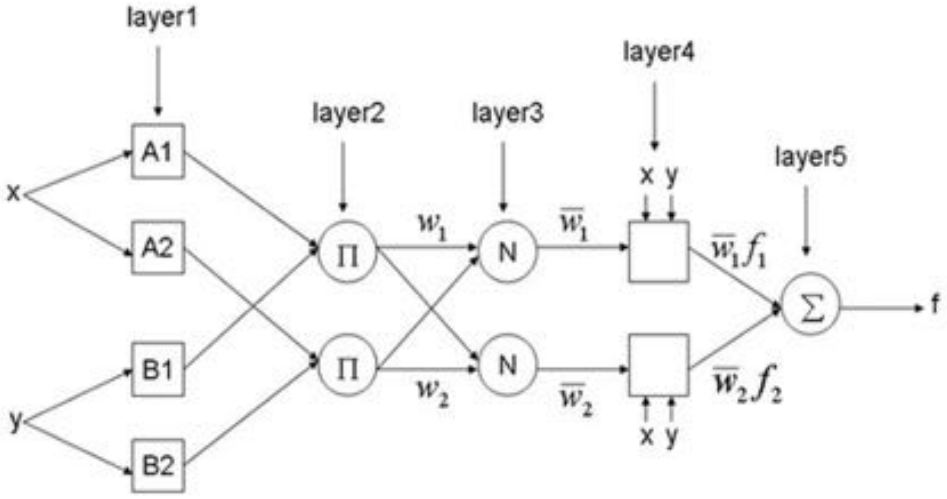

Figure 8: An Adaptive Neuro Fuzzy Inference System (ANFIS)

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2}{n}}$$

$$MBE = \frac{\sum_{i=1}^{n}(Y_i - \hat{Y}_i)}{n}$$

$$R^2 = 1 - \frac{\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2}{\sum_{i=1}^{n}(Y_i - \hat{y})^2}$$

$$MAPE = \frac{100}{n}\sum_{i=1}^{n}\left|\frac{Y_i - \hat{Y}_i}{Y_i}\right|$$

See (Azadeh et al. (2009); Kasabov (1988)). Predict for the MLP and ANFIS for some selected companies are in Figure 10:

After the stock price predicting, some priorities was predict to the user. According to user preferences in each of the role in form, the results of analysis will be provided to his in a form (Figure 11)

- Step Four: Because of the design and simulation of MATLAB, Java, My SQL is used, all of them offer in the form of an executable file and software package and Easily and requires no special hardware or equipment is available for use on

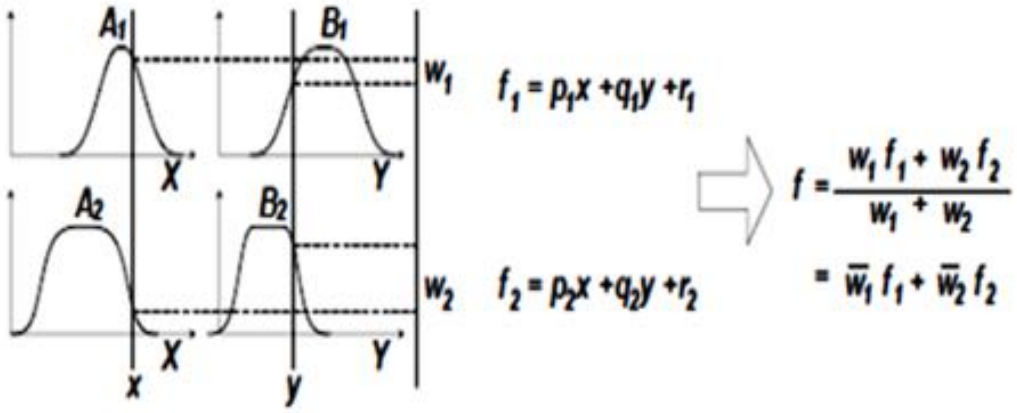

Figure 9: ANFIS relations example

computers. Game Prototype built and tested according to the actual data and information of the Stock Exchange and it has been performed.

- Step Five: In every part of the designed simulator there is User Help. In fact, the whole design can be summarized as follows:
  - The Knowledge Base Management subsystem: Using Java and MATLAB code
  - The data management subsystem: My SQL database and using primary data in Excel
  - The model management subsystem: using simulation (Serious Games Simulation)
  - User Interface: Design GUI in Java and MATLAB software.

4 Conclusion

Many executives and investors, regardless of capital market laws, invest on stocks and the profits may be happening in business but certainly in the medium term and in

MLP				ANFIC					
MAPE	MBE	R2	RMSE	MAPE	MBE	R2	RMSE		
4.5252	0.0314	0.9970	0.0415	2.2204	0.0014	0.9997	0.0217	Daily	اخابر akhaber
10.6066	0.0631	0.9780	0.1176	4.4300	0.0053	0.9975	0.0447	weekly	
36.7372	-0.269	0.8658	0.3055	9.0282	-0.016	0.9889	0.0973	Monthly	
3.9725	0.017	0.9989	0.0076	2.5656	0.0012	0.9997	0.0111	Daily	بترانس bteranc
10.5584	0.0395	0.9762	0.0722	5.2543	0.0065	0.9977	0.0317	weekly	
31.8349	0.2508	0.8278	0.3267	13.6845	-0.007	0.9797	0.1258	monthly	
3.007	0.0074	0.9986	0.0184	2.8123	0.0013	0.9996	0.0166	Daily	خبهمن khbahman
5.622	0.0583	0.9943	0.0362	5.3843	0.0067	0.9973	0.0344	weekly	
11.4626	0.0069	0.9667	0.0943	9.3035	0.0195	0.9889	0.0737	monthly	
3.5116	0.00981	0.9982	0.0172	3.4322	0.0066	0.9992	0.0165	Daily	خودرو Khodro
7.7676	0.0028	0.9933	0.0328	6.3908	0.0011	0.9964	0.0346	weekly	
15.4495	0.0216	0.9712	0.0936	10.574	0.0096	0.9800	0.0639	monthly	
3.6956	0.0021-	0.9982	0.0071	2.3949	0.0011	0.9997	0.0060	Daily	خسایا khasapa
8.4719	0.0020	0.9914	0.0137	5.5560	0.0015	0.9989	0.0121	weekly	
19.905	-0.0044	0.8848	0.0557	10.2003	0.0085	0.9925	0.0332	monthly	
3.6947	0.0055	0.9808	0.0507	3.2510	0.0047	0.9997	0.055	Daily	فاذر fazar
12.3127	0.0416	0.9714	0.1052	7.3770	0.0092	0.9848	0.0817	weekly	
19.4213	0.0631	0.9561	0.1150	15.0698	0.0498	0.9781	0.1085	monthly	

7.2342	0.0371	0.9536	0.1125	2.5052	0.0037	0.9982	0.0287	Daily	وبانک vbank
19.2572	0.1503	0.8623	0.2362	4.8259	0.0043	0.9980	0.0333	weekly	
27.2441	0.1679	0.8131	0.2451	11.0379	0.0508	0.9844	0.0833	monthly	
3.5274	0.0152	09982	0.0332	2.2340	0.0018	0.9994	0.0191	Daily	وبشهر vbshahr
10.9423	0.0654	0.9788	0.1094	5.6342	0.0159	0.9970	0.0416	weekly	
17.7472	0.1280	0.9528	0.1689	13.2398	0.0451	0.9829	0.1061	monthly	
3.1231	0.0032	0.9971	0.0233	3.0181	0.0030	0.9989	0.0225	Daily	وسایا vsaya
8.9821	-0.0151	0.9823	0.0526	6.2259	0.0148	0.9964	0.0423	weekly	
21.9126	-0.0390	0.9168	0.1207	13.7029	0.0386	0.9833	0.0796	monthly	
18.4493	0.1546	0.8923	0.2232	1.8475	0.0008	0.9997	0.0157	Daily	وغدیر vghadir
17.2960	0.0810	0.9319	0.171	4.8202	0.0102	0.9971	0.0424	weekly	
48.8710	0.3875	0.6112	0.4445	9.1310	0.0240	0.9911	0.0779	monthly	

Figure 10: Compare MLP & ANFIS

most cases, the probability of losing the capital or lack of success you expect is more. Design decision support system in the form of a serious games simulator environment is a fundamental strategy in this field. As noted, the use of serious games simulator is very pervasive in the world. Because the simulator mimics the actual data using a suitable environment for learning and gaining experience. Serious games simulator will cause to discover talents, proper training, increased confidence and user satisfaction in a virtual environment instead of the real environment. Finally it can be concluded that the use of serious games simulator training is emerging as a new approach to high performance. Many researchers have acknowledged the potential of serious games simulator in management decision-making skills. The main power of these games in the active participation of learners is the chance to experience the subject as a whole and its ability to demonstrate the convergence properties of the system. In addition, factors such as the ability to view, reproduce, economic security and availability of the system, make the games a valuable alternative for learning at work. Designing a decision support system by using serious game simulation is a fundamental strategy in this area. Since the simulation mimics reality and it implements the behavior, these simulators are designed to easily prototype to production management, operations management, marketing, and all the fields they need training and experience before they can be applied to real world. For a serious game simulation, framework and concepts should be respected to maintain efficiency while choosing the right model is very important for the design it demands interdisciplinary cooperation. This simulation modeling by using serious games helped to promote applied science among the educated class and will have the ability to use their real knowledge. With continued cooperation between social, political, cultural, science and engineering, and specialized and interdisciplinary interaction could be make a targeted and appropriate policy in regard of producing serious games simulation.

References

Abt, C. (1970). *Serious Games*. The Viking Press.

Akcetin, E. and Akcetin, N. C. (2012). Learning international trade by game in maritime business schools. *Procedia - Social and Behavioral Sciences*, 62:514–520.

Azadeh, A., Maghsoudi, A., and Sohrabkhani, S. (2009). An integrated artificial neural networks approach for predicting global radiation. *Energy Conversion and Management*, 50(6):1497–1505.

Bellotti, F., Berta, R., De Gloria, A., Lavagnino, E., Dagnino, F., Ott, M., Romero, M., Usart, M., and Mayer, I. (2012). Designing a course for stimulating entrepreneurship in higher education through serious games. *Procedia Computer Science*, 15(15):174–186.

Bhattacharyya, R., Sheikh Ahmed, H., and Samarjit, K. (2014). Fuzzy cross-entropy, mean, variance, skewness models for portfolio selection. *Journal of King Saud University Computer and Information Sciences*, 26(1):79–87.

Durk-Jouke, v. d. Z., Bart, H., and Stewart, R. (2012). Conceptual modeling for simulation-based serious gaming. *Decision Support Systems*, 54(1):33–45.

Gorman, G. D. H. and King, W. (1997). Some research perspectives on entrepreneurship education, enterprise education and education for small business management: A ten year literature review. *International Small Business Journal*, 15(3):56–77.

Greenblat, C. S. (1988). *Designing Games and Simulations: An Illustrated Handbook*. Sage Publications, London.

Gunter, G. A., Kenny, R. F., and Vick, E. H. (2006). A case for a formal design paradigm for serious games. *The Journal of the International Digital Media and Arts Association*, 3(1):93–105.

Hauge, J. B. and C.K.H. Riedel, J. (2012). Evaluation of simulation games for teaching engineering and manufacturing. *Procedia Computer Science*, 15:210–220.

Kasabov, N. K. (1988). *foundations of neural networks fuzzy systems and knowledge engineering*. Cambridge, Massachusetts: MIT Press.

Lancaster, R. J. (2014). Serious game simulation as a teaching strategy in pharmacology. clinical simulation in nursing. *Clinical Simulation in Nursing*, 10(3):129–137.

Mockus, J. and Raudys, A. (2010). On the efficient-market hypothesis and stock exchange game model. *Expert Systems with Applications*, 37(8):5673–5681.

Mortaraa, M., Catalanoa, C. E., Bellottib, F., Fiuccic, G., Houry-Panchettid, M., and Petridise, P. (2014). Learning cultural heritage by serious games. journal of cultural heritage. *Journal of Cultural Heritage*, 15(3):318–325.

Otoiu, Catalina, O. G. (2012). Testing a simulation game as a potential teaching method for a masters course in human resources management. *Procedia - Social and Behavioral Sciences*, 33(3):845–849.

Susi, T., Johannesson, M., and Backlund, P. (2007). *Serious Games - An Overview. Technical Report HS-IKI-TR-07-001 School of Humanities and Informatics*. University of Skovde, Sweden.

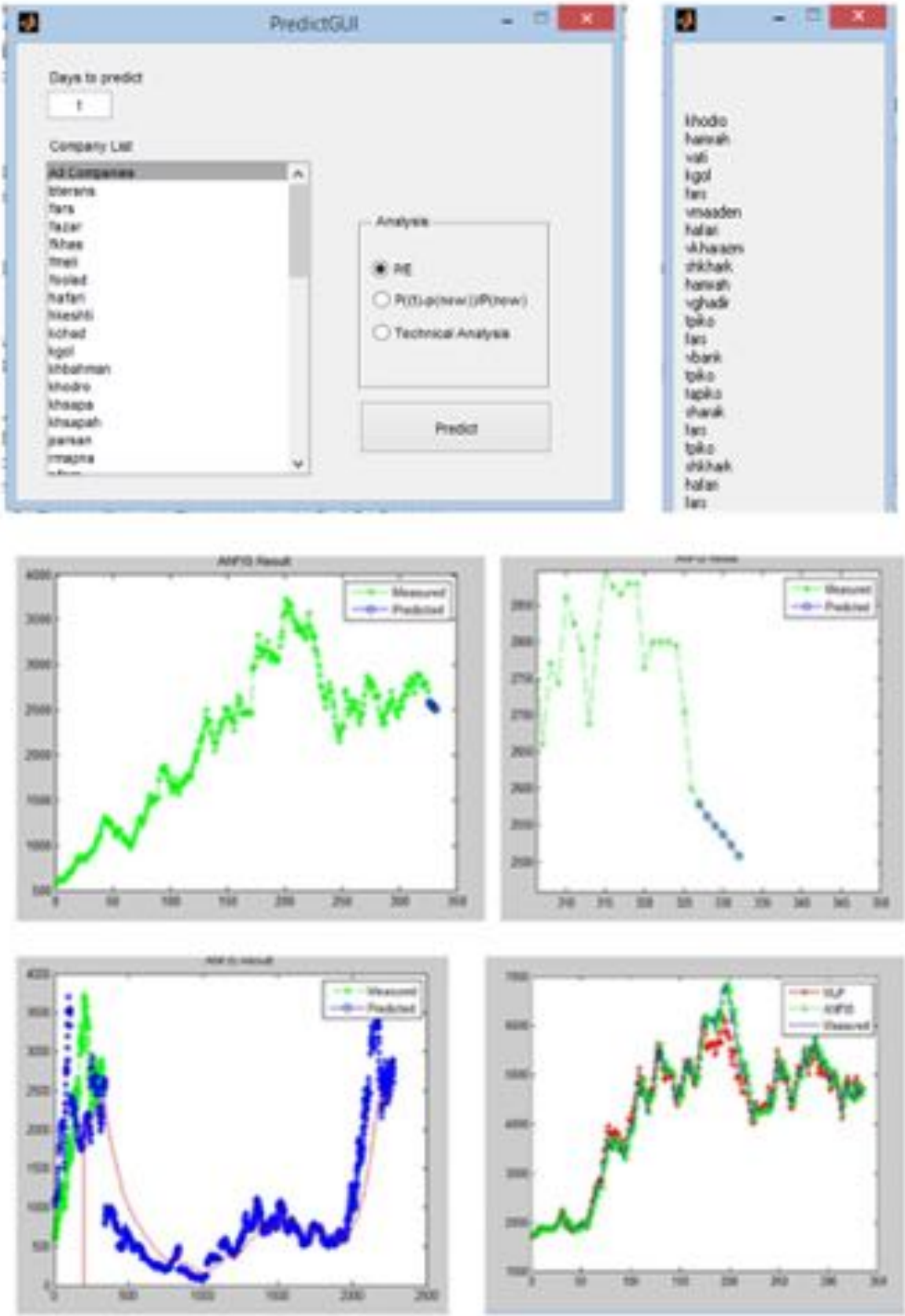

Figure 11: Prediction