Decision making system for finacial time series

Jan Budík; Jiří Kříž
Brno University of Technology
Faculty of Business and Management, Department of Informatics
Kolejní 4, 612 00 Brno, Czech Republic
www.fbm.vutbr.cz

Abstract: *The article deals with the issue of statistical analysis, simulation and time series prediction. In this case, the input data is represented by a record of the development of financial instruments that appear to have stochastic properties. The MATLAB programming environment is used to create an application for the purpose of automation of data evaluation. Having produced data outputs, the application generates rules for the support of financial decision-making processes. A case study is presented, as well. The objective is to demonstrate the use of modern methods of economic decision making in real stock market environment.*

Key Words: Decision making system, decision making process, data mining system, data mining process, MATLAB

1. Introduction

Predictions and analyses of time series created by non-exact systems like markets are among the most complicated, least reliable and least stable ones. The problems related to the stability of the created models originate from a variety of immeasurable inputs that affect the system (markets) as well as from ever-changing conditions. In principle, prices are largely affected by the current mood and emotions of brokers. Each and every broker is under influence of many factors, which means that any detailed description and list of rules according to which prices change is technically impossible. If we want to predict market developments with some success, we do not need to analyze behaviour patterns. It is enough to carry out statistical analyses and to predict developments only from partial data (1).

These days, advanced computers are often used to predict these systems. This technology facilitates automation of computing processes. Its outputs are represented by strong statistical data that support the decision-making process under said unstable conditions. Among these modern methods is, for example, the use of neural networks, fuzzy logic, genetic algorithms or algorithmic programming. In real life it is much more common to see combinations of the aforementioned methods, as these methods can support one another in terms of decision making; quite often these hybrid methods help achieve better and more stable results (2).

These days automatic trading systems are more and more common at electronic markets; these systems operate with input and output data based on pre-defined algorithms. This fact represents a whole new dimension of speculations and requires that one be prepared sufficiently in terms of their business style. The approach that is described in this article describes a combination of the automatic trading system with the use of previous experience and the expert's ability to make sound financial decisions. The computer programme makes 80 percent of all decisions, whereas the remaining 20 percent are represented by interventions by the expert who needs to decide on inadequacy of the generated order (1).

2. Market movement theory

The created application statistically proves prior knowledge demonstrated by a stock market expert and seeks its optimal parameters. The main idea is based on searching for sufficiently significant price oscillations within day trading processes, and it is irrelevant whether they are increases or decreases. The potential for sufficient price changes is an important property. The input series is represented by a change in the price of the financial instrument in question, with the time-slot pattern being one minute. This series offers optimum time slots for electronic market entry, the risk level value and the potential profit value are optimised. The determined time periods, risk values and potential profit values are evaluated by the expert and supported by fundamental facts such as market opening times, fundamental reporting, market closing times, etc. The application output confirms the piece of information that financial markets do not generate prices at random, as there exists a certain order within the system, in spite of a number of immeasurable inputs.

3. Data mining process

3.1 Description of system for data mining and decision making

The application created for the purpose of decision making facilitation consists of two basic partial processes – cf. Fig. 1. The first part (Data mining system) is intended for statistical analysis and determination of correlations within the input database of price changes. The second part (Decision making system) operates with prior knowledge that is transferred from the first part and the purpose of which is to establish direct connection with the electronic stock exchange and to enter input and output orders. In the course of both partial processes the expert's experience and market sentiment in terms of financial decision making are made use of.

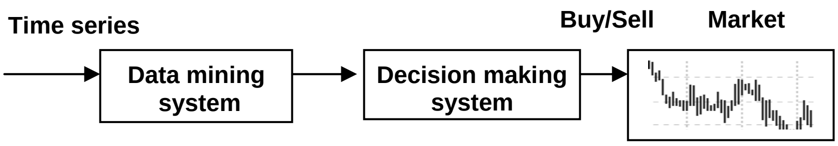

Fig. 1: Data mining and decision making system

3.2 General diagram of the relevant information mining process

The successful retrieval process with respect to relevant information within the input data is shown below (Fig. 2).

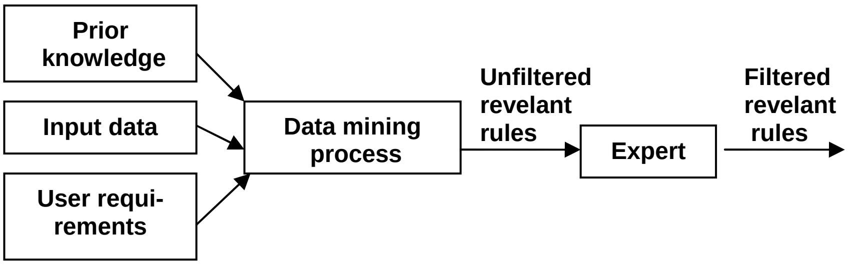

Fig. 2: Data mining system

Description of individual process stages:

Prior knowledge: input into the process of relevant information mining from data that represents prior knowledge based on the market movement theory based on price change moments within daytrading.

Input data: record of development of the price of a selected financial instrument, with the time-slot pattern being 1 minute.

User requirements: detailed information provided by the user, specifying desired time intervals, the use of static or dynamic outputs, etc.

Data mining process: application created in the MATLAB environment the purpose of which is to find relevant rules that shall pass through the first rough filter. Data mining part output is the data input for the expert.

Unfiltered relevant rules: data mining process output representing successful rules that passed through the first filter, as well as input for the expert.

Expert: an individual who is an expert in financial decision-making processes, who will ensure the final filter of rules based on their experience and market sentiment.

Filtered relevant rules: list of rules that successfully passed through the first mechanical filter as well as the second filter of the expert. They represent the input data for the next system that processes stock market orders.

3.3 General diagram of the decision-making process

Fig. 3 is a graphic representation of application of determined filtered rules within the real stock market environment.

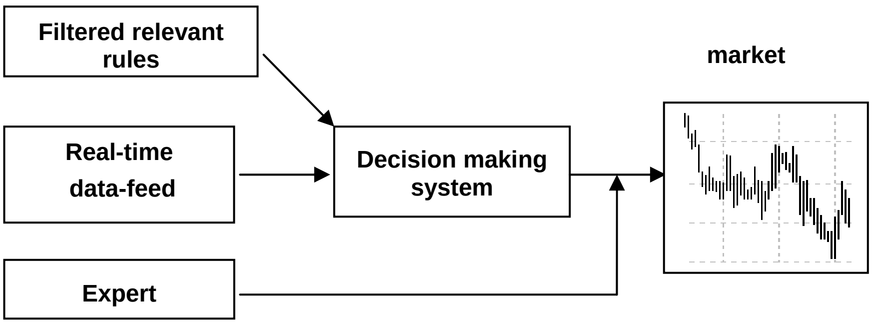

Fig. 3: Decision making system

Filtered relevant rules: rules generated based on the process depicted by Fig. 2.

Real time data-feed: real data provided by the provider of access to the electronic market, being the second input into the decision-making system, with the time-slot pattern being one minute.

Expert: individual, specialist in financial decision-making processes who intervenes in the process of trading position management based on their experience and market sentiment and reacts to error situations in real time.

Decision-making system: application created in the MATLAB environment with direct access to stock market, which makes decisions based on a pre-defined algorithm and enters orders within the electronic market.

Market: electronic stock market environment where input and output orders are entered.

3.4 Principle of mining information from data

Once the time periods are found during which regular and sufficiently big price changes occur as a part of day trading, an algorithm is found with respect to the measurement of the maximum change – MAX. In the process of maximum change measurement it is essential to define reference points 1 and 2. The first reference point indicates the commencement of measurement of the change, whereas the second reference point indicates the price value, upon the achievement of which the maximum change measurement process ends. Fig. 4 represents change measurement for a decrease in prices. Change measurement in case of an increase in prices is analogical, with points 1 and 2 being reversed.

Fig. 4 : Maximum change measurement in case of a decrease in prices

Price values 1 and 2 are generated over a certain period of time and they are maximum and minimum values over a certain monitored time period. Maximum change measurement is carried out throughout the entire historical database of input prices, resulting in the creation of a matrix of maximum changes (cf. Fig. 5).

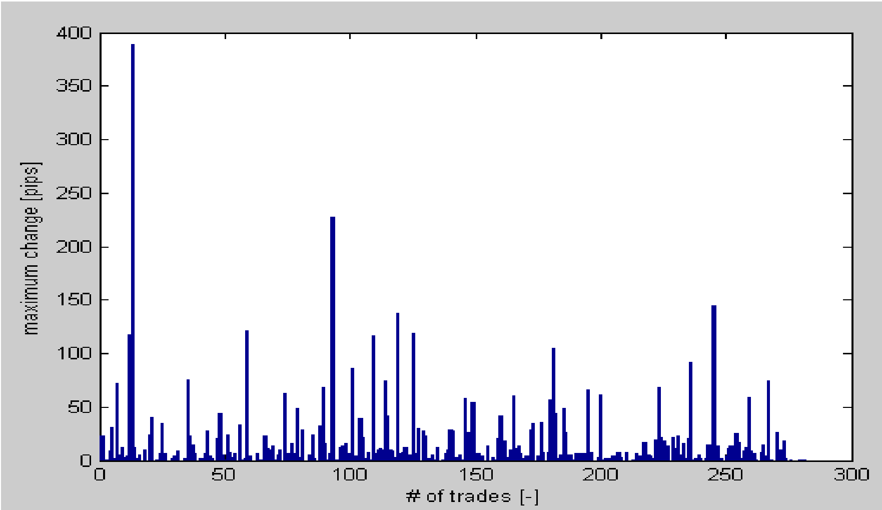

Fig. 5: Graphic representation of matrix of maximum changes

The matrix of maximum changes is further transformed into the final matrix of overall profits. The most suitable point 2 is sought for the purpose of conclusion of maximum change measurement. Individual results of profit matrices for individual settings of point 2 are displayed in the 3-D chart in Fig. 6. Different settings of point 2 are represented by the axis labelled Stop Loss.

4. Case study

The case study seeks to find optimum location settings for stop close orders for pre-defined time segments. The chart in Fig. 6 represents the optimum setting of Profit Target and Stop Loss values, when point 1 and point 2, for the measurement of maximum change (cf. Fig. 4), are sought for the time segment of 1:50 AM – 1:55 AM with respect to the USD/JPY cross rate in the second half of the year 2009.

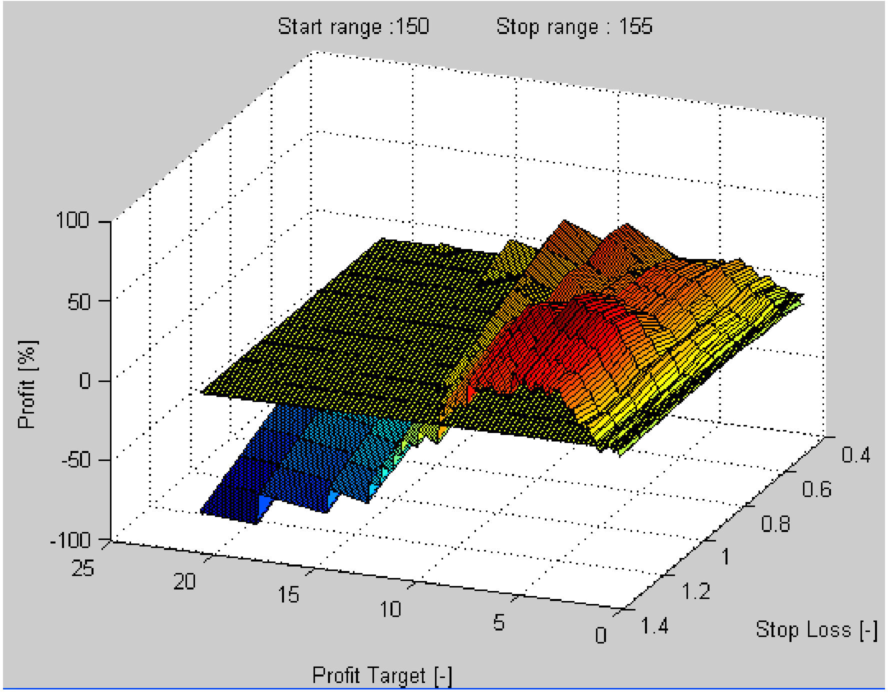

Fig. 6: 3-D representation of measured values for the time period of 1:50 AM – 1:55 AM for the USD/JPY cross rate

The expert will use the 3-D chart to read the optimum setting of or risk level (Stop Loss) and potential profit (Profit Target). Entry orders are entered at 1:55 AM, which is prior to Tokyo Stock Market opening, which fact can be interpreted as a strong fundament for confirmation of relevance of input rules.

Fig. 7 represents the same analysis as that on Fig. 6, with the difference being that point 1 and 2 for the purpose of maximum change measurement are moved to 1:55 AM – 2:00 AM. The chart proves that the second case study will show better stability and it will be more convenient to seek rules in this chart, as a higher number of combinations of parameters referred to as Profit Target and Stop Loss show higher-than-zero Profit values, i.e. they generate profit. This study confirms the fundamental rule of market opening where substantial changes in one direction occur.

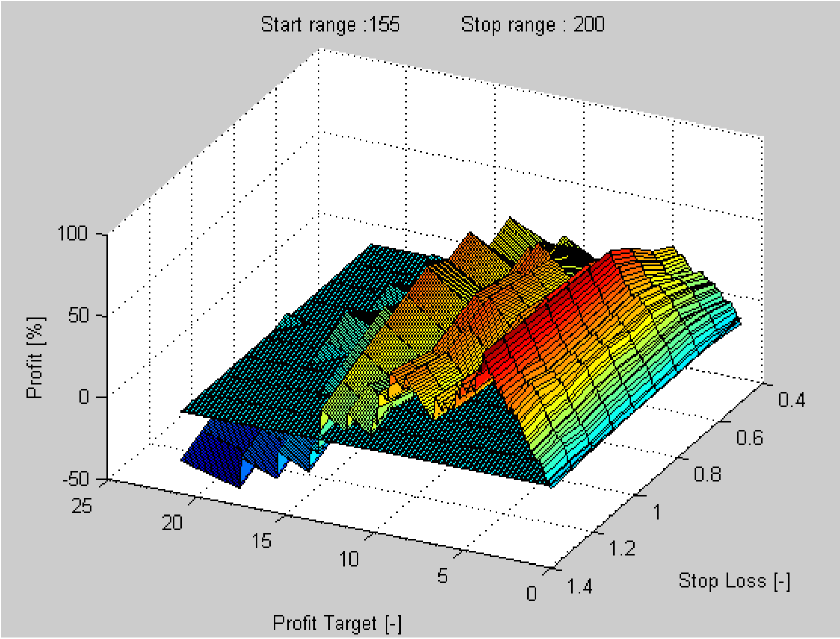

Fig. 7: 3-D representation of measured values for the time period of 1:55 AM – 2:00 AM for the USD/JPY cross rate

5. Conclusion

Application of modern methods of data processing appears to be a strong instrument of statistical analysis and economic system simulation. The article deals with the use of the concept of data mining for the creation of application to generate rules of financial decision-making within the environment of electronic stock markets. Part of the process is also the utilisation of experience and abilities to make sound financial decisions and the utilisation of the expert's qualities in achieving higher stability and profit. The expert's participation is desirable both in terms of the data mining part (where the expert's role is that of a final filter of determined rules) and in terms of the part of the process during which orders are placed within an electronic market. Upon order placement the expert's participation ratio is approximately 20 percent, whereas the remaining 80 percent are represented by a pre-defined algorithm as programmed.

The case study takes into consideration the fundament of Tokyo Stock Exchange opening (at 2:00 AM) which is confirmed using the aforementioned algorithms. Optimal parameters with respect to risk and potential profit are found. The results prove the fact, *inter alia*, that even economic systems that appear to have stochastic properties at first are a system of their own.

Bibliography

[1] DOSTÁL, P. *Pokročilé metody analýz a modelování v podnikatelství a veřejné správě, (The Advanced Methods of Analyses and Simulation in Business and Public Service – in Czech)*, CERM, Brno, 2008, 432 pgs, ISBN 978-80-7204-605-8.

[2] HONZÍK, P. *Strojové učení.* Brno: Brno University of Technology, Faculty of Electrical Engineering and Communication, 2006, 85 pgs

[3] KANTARDZIC, M., *Data Mining: Concepts, Models, Methods, and Algorithms*, Wiley-IEEE Press, 2002. 360 pgs, ISBN 978-0-471-22852-3

[4] RUEY, S., *Analysis of Financial Time Series,* Wiley-Interscience, 2001. 472 pgs, ISBN 978-0471415442

[5] KITAGAWA, G., *Introducing to Time Series Modeling*, Chapman & Hall, 2010. 296 pgs, ISBN 9781584889212