Software Simulations Usage in Business Decision Making Education

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Case study

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Abstract: Because of great importance in improving business decision making teaching process in educational institutions, a large number of software simulators are developed. Based on that information, it was necessary to present simulations as one of the most modern educational solutions, with possibilities of their usage. The basic features of a software system developed to support the teaching of business decision making and machine learning algorithms used in this field at the the Singidunum University Faculty of Business Valjevo, have been presented in the paper.

Keywords: software business simulations, business decision making, machine learning

Introduction

Nowadays, modern management is unimaginable without business decision making process. Information technology usage is considered as a mandatory tool for that purposes. As interest in this field rapidly grows, more attention has been devoted to its usage in educational purpose. Techniques for effortless learning are being developed and software systems are one of them. Usage of this kind of software in education is covered in detail in this paper - to be precise, software business simulations are the main focus in the research. Usage of these educational tools is popular because it enables users to maintain active approach to learning process from controlled and safe environment.

Software simulations make possible usage of real world situations with strictly defined roles for each user in data-rich environment which helps out business decision making process. In this manner, it is possible to get practical insight in modern company's ways of functioning.

Because of mentioned advantages in software simulations usage, business decision algorithm simulation system (original abbr. SAPO) has been developed at the Singidunum University Faculty of Business Valjevo. This software has been presented in this paper. The SAPO system is designed to generate student interest in business decision-making and allow them to further improve their knowledge of this subject matter.

The paper is organized as follows: Information technology and modern business decision making, Software business simulations in business decision making, Description of the software simulator developed at the Faculty of business Valjevo and Conclusion.

Information Technology And Modern Business Decision Making

Decision making is a part of everyday life. Some decisions have exceptionally big importance (e.g. important business decisions), while others are quite simple, for example, what to eat for dinner. Rational

thinking says that we should devote more time to important decisions, but that is not always the case because decision making is not a rational process by default. There is no way to avoid feeling of regret after making wrong decisions – that is something that each one of us felt at some point. Experienced decision-makers take advantage from wrong decisions - they learn from them.

Many human and every engineering activities have direct or indirect economic goals. Those goals are associated with decision making processes. Because of that, these processes are studied at many universities and big companies. [1]

Information technology role in modern business decision making

It is hard to make good decisions without good data which is necessary in every phase and for every activity in business decision making. If data is processed manually, process would last too long but, mostly, data is necessary in very short terms. Because of that, information technology is gaining importance as an important tool in decision making.

Modern management relies on technology usage. Great amount of data is collected from business transactions. In order to adapt those data for decision making process, data mining techniques are used. These techniques are based on a computer oriented searching and analyzing data in order to find usable patterns. These patterns present new knowledge which improves marketing and sales activities, customer relationship management and decision making. As follows, it is possible to get strategically important data about customers and their interests. For the searching purposes, machine learning algorithms are used.

Companies go even further in collecting customer data so, for example, when purchasing something, information about product that customer ordered is saved, together with order size, purchasing period, customer's interests etc. Online transactions can give even more information about customer and his personal habits during online shopping. Series of purchase, financial history and other personal data are a few mouse clicks away. First step in data mining process is to collect this kind of customer data, whether their source is internet transaction, purchase in the store, or other sources of information about the customer.

Software Business Simulations In Business Decision Making

Business software simulations history

Business simulations usage has been constantly growing, since the mid 1950s. Today, this teaching method has reached a high usage level at many universities. Although there are records of fighting games in China, 3,000 BC, first modern business simulation was presented in 1955. That was *Monopologs* simulation exercise, developed by the Rand corporation. It was focused on U.S. Air Force logistics support system. User's task was to manage the supply chain, and it was similar by structure to what modern solutions in this field offer. [2]

The rapid increase of business simulations happened between 1958 and 1961. It is estimated that over 100 simulations were developed untill 1961. They were used by more than 30,000 executives from different companies. The number of simulations has increased to about 200 until the 1969. The continuing increase in that time pointed to the growing popularity of this area. [3]

Development of the simulation field in education leads to a higher demand for more complex solutions. As a result, there are numerous models for different areas today and increasing number of educational institutions which are trying to provide practical approach to learning in this way.

Software simulations usability

Simulation is defined as an interactive abstraction of real life, or like any attempt to emulate an environment or system. [4] Practically, simulations present exercises within certain knowledge, skills and strategies that must be applied in order to fulfill certain tasks. They present open-ended games within which users are going through a particular situation using

a number of variables. It is necessary that every user takes a certain role, examines certain states, threats and problems and makes decisions based on that. It is also possible to notice effects of every decision that is made. The simulation can be carried out in various directions, depending on the user's decisions.

Simulations are especially useful in explaining complex business situations that can occur, because they are *active* educational tool. They present controlled environment with no forfeiture risk. Thanks to that, students can understand relationships between their decisions and effect on functional areas within the company.

Important characteristics of visual simulations are: [5]

- implementation of an adequate model of real-world situations which participant is faced with;
- defined roles for each participant, with identified responsibilities and limitations;
- data-driven environment that enables users to perform the range of strategies, from very broad to very sophisticated defining of business decisions;
- statement of changes as consequences of actions that participants undertook.

With the appropriate use, simulations present extraordinary tool for e-learning, which forms the basis of modern education. In this way, it is possible to stimulate students to be more actively involved, with the abillity to learn from personal experience. Essentially, they have the possibility to explore real situations that they can expect in the workplace. During the work in simulated environment, teacher is having an exact insight in all activities. This allows him to assist participants as they encounter a problem.

Visual software simulations importance in business decision making

There is an ancient Chinese proverb that says: "Tell me and I will forget, show me and I may remember, involve me and I will understand". This claim is especialy true in the field such as decision making. Participants could understand how certain business decision making algorithm works if they read from the book, or see the algorithm on the board. But if they have the possibilty to try it out, then they can understand much easier and faster.

There are numerous benefits of using visual software simulations in education: [6]

- an interesting way of learning because students can gather and examine data while working with the simulation;
- speeding up the learning process by actively engaging participants;
- combine knowledge from different fields;
- strongly motivating participants towards active learning instead of passive listening;
- interactive character of simulation that enables participants to inspect results of their decisions.

Today, simulations have very important role in education. One of the leading educational and scientific computing societies, ACM, recommends the usage of an appropriate software in laboratory exercises, especially in computer engineering field, as a very important way of allowing students to follow, explore and handle characteristics and behaviours of devices, systems and processes. The use of applications and simulations is recommended in modeling and analyzing real systems which are not practical for the physical implementation. [7] Suitable area for this application is also decision making, so that all of the allegations related to the computer engineering and simulations usage can be applied in this case.

Description of the Software Simulator Developed at the Faculty of Business Valjevo

The SAPO software system uses broad-based algorithms which are expected to best assist students in their studies. The selection of the algorithms takes into account the recommendations of the IEEE International Conference on Data Mining held in 2006 [8]. Based on the recommendations, the following algorithms are chosen: decision trees (ID3), clustering (k-means), Naive Bayes and perceptron.

The system is divided into four logical units. The task of each module is to simulate a specific algo-

rithm, and the first step requires the user to select the desired one. Following selection, the appropriate working area is displayed along with the required toolbars. There are options which allow the user to gradually move through the algorithm - One step forward, One step backward, Go to the beginning and Go to the end.

The screen of the decision tree module is comprised of three blocks: a table containing attribute names and input data, messages about the execution of the algorithm, and a graphical display of the decision tree. Algorithm ID3 [9] is used to generate the decision three (Fig. 1). After the input dataset is entered, the values are stored in the corresponding table and options for moving through the algorithm become enabled. When the algorithm is started, the decision tree is displayed in a separate frame, while a message about each step appears in the frame on the right side.

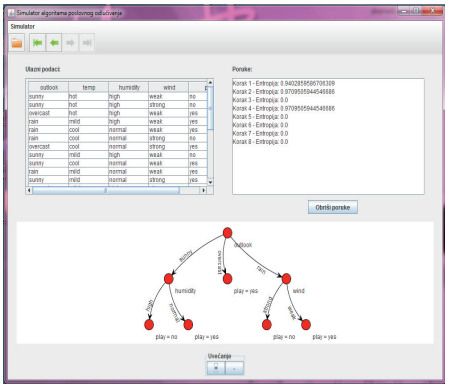

Fig. 1. Decision tree module layout

The name of the attribute is displayed next to each node, while the values of the attribute are shown next to the branches originating at that node. The tree leaves contain the decisions made by the decision tree. After a right click on any of the nodes, the context menu will display the information gain of each child node, showing how the algorithm has split the input dataset. It is possible to enlarge or reduce the tree, and to move it within the frame.

Similar to the decision tree simulation, the screen of the clustering module is comprised of three parts. The first part is used to manipulate the display of points and the history of centroid movement, the second writes messages, and the third draws points as well as clusters with corresponding centroids.

The k-means [10] algorithm is used in this simulator (Fig. 3). Before the algorithm is started, certain parameters need to be adjusted, such as: the initial number of points, the number of clusters, the dispersion of points and the display of history. Sliders are used to limit user input, as they are convenient for easier definition of the values which the user may input. It is important to note that the number of clusters may not be greater than the number of points. If such parameter selection is attempted, a warning message will be displayed. If the history display option is selected, the current centroid and all previous positions connected by lines will be displayed to show the trajectory generated by the centroid.

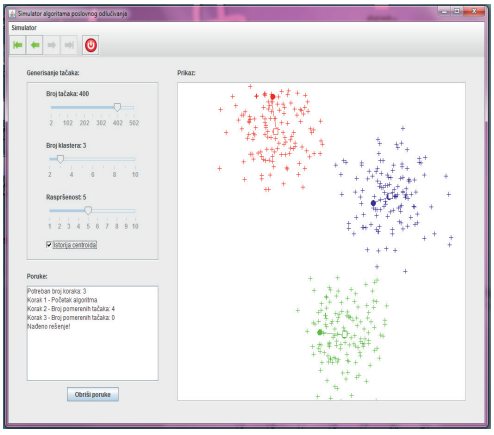

Fig. 3. Clustering module layout

A random function is used to generate random points, but with a fixed seed. This ensures that the same selected numbers of points and clusters, and dispersions, always yield identical positions of the points.

At the very beginning, upon initiation of the algorithm, the number of steps needed to arrive at the solution will be displayed. Then, the number of points that have moved in each pass is displayed and the points represented by different colors, depending on the cluster to which they belong.

The Naive Bayes [11] module is comprised of several principal parts: frames with input and test data, messages frame and graphical output of the algorithm (Fig. 4). To start this simulation, it is necessary to enter input data into the input data table. The table containing test data will include existing values of attributes in dropdown menus. The user can

select attributes from each of these menus and the algorithm will use them to compute probabilities. If any attribute is changed, the user needs to click on the Refresh test example button to remove the previous test example from the view and display a new example.

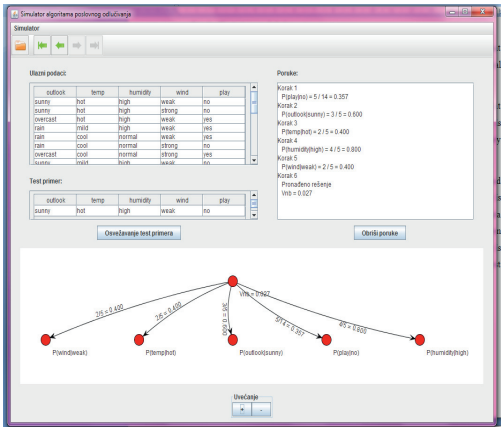

Fig. 4. Naive Bayes module layout

After selecting the desired test example, the algorithm can be started. At each step of the algorithm, the graphical display frame draws the nodes which represent conditional probabilities.

Each leaf shows which conditional probability it represents, while the branch that connects it to the root shows the value of that conditional probability as the number of the corresponding examples divided by the total number of examples. The destination probability is in the tree root, denoted by VNB. While the algorithm is running, the input data table highlights the rows being computed in each steps. Each step is explained in detail in the messages frame.

The screen of the perceptron [12] module is comprised of an input parameter adjustment screen, an input data table, a messages screen, and a graphical display of the perceptron (Fig. 5). The parameters frame allows the initial values of the weights (w1 and w2), the learning rate, the perceptron threshold and the maximum number of iterations of the program to be set. The input table uses a binary function to simulate basic Boolean operations. There are two inputs and one output. The value of the output may be varied by means of a dropdown menu; the allowed values are 0 and 1.

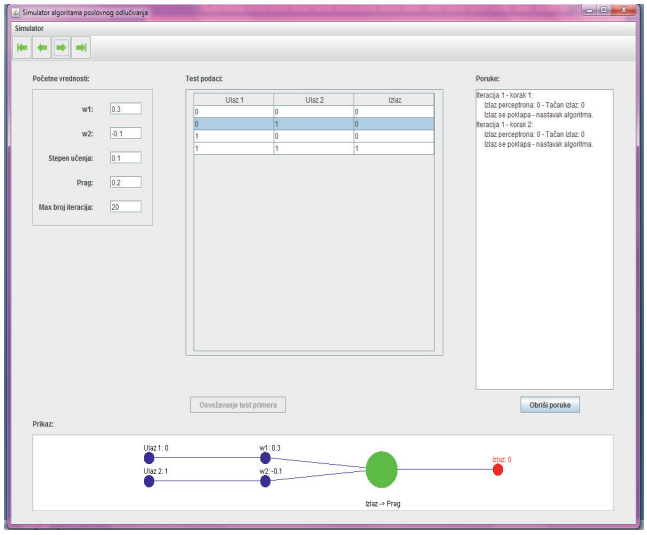

Fig. 5: Perceptron module layout.

The algorithm processes the input data table row by row, and conveys the values to the perceptron. The row currently processed is highlighted. The perceptron receives the values and computes the output. The input values, the weights, the sum of the input values and weights, the threshold and the output are displayed. For better organization and ease of understanding, the various parts of the figure are shown in different colors.

At each step, a textual output from the program is displayed in the messages frame, including the current iteration, the step in that iteration, and indication whether the perceptron output matches the desired output. If there is no match, explanation is provided about how weight changes are computed and what their values are.

Conclusion

In this paper, an attempt is made to better understanding of visual software simulations in business decision making. Nowadays, business decision making is a subject matter at numerous universities. Also, modern business organizations would not be possible without it.

Visual software solutions attain education quallity and better understanding of topics, and they are consequently an option for understanding of this field.

Because of that, as a solution for beter understanding of this field, software simulations are used. They make possible further improvement of education quality and understanding of discussed topics. It is possible to learn from personal experience while working in safe environment.

Since 1950s, software simulations have gained high popularity and they are extensively used in education today. Many universities use these solutions for practical training. Thus, possibility is made for students to try out situations that they can get into after finding a job. This possibility is very important for company, considering that making wrong decisions can cause serious consequences.

As an example of simulations usage, a software system developed at the Singidunum University Faculty of business Valjevo has been presented. The SAPO system allows its users to see how business decision-making and artificial intelligence algorithms are used. It allows for the input dataset to be assigned, the selected algorithm to be applied to this dataset, and then the execution to be monitored step by step. During the simulation, in order to better understand how it works, detailed information is displayed about the current stage of the algorithm. SAPO system can be used as a tool to accelerate learning and test assimilated knowledge.

Authorship statement

Author(s) confirms that the above named article is an original work, did not previously published or is currently under consideration for any other publication.

Conflicts of interest

We declare that we have no conflicts of interest.

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