ARTIFICAL INTELLIGENCE IN EDUCATION: CAN THE AI TEACH THEM?

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Abstract
Managerial games are an important tool in teaching strategic management. An experimental tool, enabling to play management games with artificial intelligence, was created at the Czech University of Life Sciences in Prague within the research of possibilities of how to use artificial intelligence instruments. This machine simulates the behaviour of an opponent during a specifically designed management game. To determine and optimise the specific context, it is necessary to ask and answer the following questions: how does a player play in a relatively simple market context; how many rounds does the live player need to optimise playing strategies; in what round a live player wins with certainty over the machine; how to improve the course of the game to allow a player to acquire the necessary tacit knowledge? Answers to the above questions are sought on the basis of an experiment conducted with volunteers. This work deals with the potential of e-learning systems designed on the basis of artificial intelligence instruments, their description and their possible use to obtain tacit knowledge in the area of strategic management.

Keywords
Artificial intelligence, e-learning, managerial games, neural network, strategic management, tacit knowledge

Introduction
The article at first describes the construction of an electronic educational system. Next, we define the rules and the context of the management game designed for the experiment. We describe the players and their results. To answer the questions asked, we chose qualitative research. We presented to a small group of volunteers a simple decision-making task to solve.

Last year, a team of authors: Pavlíček, Švec, and Tichá (2014) presented at the ERIE conference, possibilities for the use of management games in teaching strategic management. The presented solution has been designed as an electronic educational tool enabling students to gain experience. Experience is the knowledge of a subject or event gained through involvement in or exposure to it (Oxford English Dictionary, 1989). Linkage between experience and knowledge supports Kolb (1984:41) with his definition of learning as 'the process whereby knowledge is created through the transformation of experience'.

When we speak about knowledge, we understand the personal level of knowledge. Then we see knowledge as what person knows as well as his/her skill and ability that would determine or help him/her make decisions and take action (Gao, Li, and Nakamori, 2003). Drucker (1989: 242) defines the knowledge as information that 'changes something or somebody either by becoming grounds for action, or by making an individual or an institution capable of different and more effective action'.

Polanyi (1959) divided human knowledge into two categories: explicit knowledge (written and formalized) and tacit knowledge (the action related and unformulated). Gao, Li and Nakamori (2003: 9) expand and explain the characteristics of knowledge in Polanyi´s point of view that 'there are two different dimensions in knowledge: one relates to the scientific, logical or objective dimension; another to the subjective dimension'. In the objective dimension the knowledge is like a "thing' or 'object' that can be articulated, captured and stored. The subjective dimension of the knowledge, however, can be fully understood only by person with enough capacities. (Gao, Li, and Nakamori, 2003)

The proposed tool (Pavlíček, Švec, and Tichá, 2014) uses artificial intelligence mechanisms to support teaching of managerial decision-making through simulation using the so-called electronic agents. By the term electronic agent, we mean a machine simulating the behaviour of a real opponent, i.e. the real opponent's decision-making and strategy used in the given game. This agent is based on artificial intelligence mechanisms. I.e., it is possible to teach it based on empirically played games. By simulating real-world conditions of decision-making then the player gets practical experience in strategic decision-making.

When simulating strategic decision-making, we focus especially on the creation of knowledge as conceived by Gao, Li, and Nakamori (2003), i.e. knowledge that originates and may be understood only by a person who performs the activity and is non-transferable and cannot be obtained otherwise than by one's own experience.

During the development and testing of the electronic client, the game was played by 16 teams (98 students After having played these basic games, rules and behaviour of players were set to be controlled by artificial intelligence – electronic agents. The presence of players of two types, human and electronic agents (artificial intelligence), in a common game resulted in the following research questions being asked:

1. How does a player (only a human) play to whom a relatively simple market context is presented for decision-making?
2. How looks the player approach during game strategy settings?
3. How many rounds does a player need to optimize his/her strategy?
4. In which round, the player begins to safely win over all artificial intelligence players?

The present article answers the presented questions and tries to show the opportunities for further development of electronic educational system and its gaming agents.

Materials and Methods

Electronic Educational System

It is possible to play management games with a computer. 'Management games are used to create experiential environments within which learning and behavioural changes can occur and in which managerial behaviour can be observed. A simulated experiential environment is a simplified and contrived situation that contains enough verisimilitude, or illusion of reality, to induce real world-like responses by those participating in the exercise. Extraneous details, hazards, costs, and inconveniences must be stripped away from the simulation, thereby producing an accelerated frame of action so that they can be more efficient than their real-world operating environments.' (Keys, Wolfe, 1990:308). According to Salas, Wildman, and Piccolo (2009) simulation-based training is ideal technique for management education programs in undergraduate and graduate management programs to give students practical skills, which they need when entering the business or corporate world.

In our case, the emphasis is on a faithful simulation of real-world, yet, in the opinion of Keys and Wolf (1990), simplified business conditions. To create a software environment that meets these conditions, we chose an architecture of a solution based on the model-view-controller design pattern.
The electronic system consists of:

Controller

The controller is a control programme. Each game is defined by a particular context, rules and facts. They are stored in a special data files. The controller, based on these files, carries out calling of individual gaming agents and players. The files practically serve as a model. It says what step follows a previous one and how the controller should serve the players.

Game Strategy Settings

These are files containing the rules of the game. The sequence of game steps is set out in them, intervals of generating random values of the game (e.g. supply of material). It is possible to configure them.

Gaming Agent

Each gaming agent is an independent instance of a neuronal network with one hidden layer. This neuronal network has an input layer of 4 input neurons, 8 neurons in a hidden layer and one neuron in the output layer. The excitation function of neurons is a sigmoidal function. See Figure 2. In the displayed model, the “constructional” neuron is marked with red colour. It does not affect the computational capabilities of the agent in any way. It is a constructional residue of the used framework.

Management Game Rules

Players play a pre-specified decision-making simulation from the area of company management against three electronic gaming agents. The game has 12 rounds (each round corresponds to one calendar month); in each of the game rounds, the following four epochs take place:

1. In the first epoch, the player decides about the terms of purchase of material in the form of a demand auction where he/she competes with his/her price with other players (gaming agents).
2. In the second epoch, the player decides about the manufacture of products.
3. In the third epoch, the player decides about the terms of sale of products in the form of a supply auction wherein he/she competes with a price proposed by other players (gaming agents).
4. In the fourth epoch, the player decides on his/her costs of storing materials and products, fixed costs for factories or other costs.

At the beginning of the round, an electronic banker (artificial intelligence) displays a card with the current market conditions for the given round, i.e. with the amount of material offered for sale, its price, number of products that the market is capable of buying at a predetermined maximum price. The offered numbers are generated randomly in the displayed interval, see Tab. 1.

Material Available	Material Min. Costs	Potential Market for Finished Inventory	Max. Market for Finished Inventory	Number of Players
[1,4]	[300,800]	[4,4]	[3000,7000]	2
[1,9]	[300,800]	[4,9]	[3000,7000]	3
[1,12]	[300,800]	[4,12]	[3000,7000]	4-∞

Tab. 1: Game Card Interval Table

Each player has the opportunity to see the material, product, and financial conditions of the opponent during both rounds and the epoch. The player can watch the results of the first and second rounds. Selling auction is not public. At the end of each epoch, the banker will perform final settlement. The player who goes bankrupt during an epoch, is eliminated from the game and does not participate in the next epoch. By that, the ratio of resources on the market changes. The banker does not respond to this change and generates the playing card at the beginning of the epoch as he did for the original number of players. The player must get the dominance on the market (only financial one, not material or product one) within 12 rounds. Another objective is to force the other players to go bankrupt.

Description of the Players

7 volunteers with university education were selected to play the game. We have chosen players in a broad age range. For young players, it should not be a problem to play with a computer programme, but they have no practical experience. Older players will most likely deal with the problem of how to operate the programme but we expect them to have at least partial knowledge of the simulated situation (at least quicker orientation in the issues). We always explained the game rules to players and instructed them in how to control the programme.

3 gaming agents with an integrated optimization function always play against live players. This optimization function is partially based on the artificial intelligence technology. Auction mechanisms are operated by a neuronal network (in the current test, this means an expert algorithm based on the knowledge of game strategy and stochastic phenomena); mechanisms for deciding on the amount of production is left to the optimization algorithm of minimization of losses. The agents have an integrated offensive strategy. If there are any suitable conditions, their activity is triggered when purchasing material. This means that in case of the lack of material resources in the market and, at the same time, under the condition that an opponent (even another agent) does not have enough material, the agent intentionally buys out all material. The live player is not informed in advance about this feature. However, we think that this strategy will occur also to the players. The objective of the player is to be the market leader. This can be achieved also through forced bankruptcy of the other players

Results and Discussion

The game took place in eleven rounds with seven players. Player 1 did not play all 11 rounds but only 9.

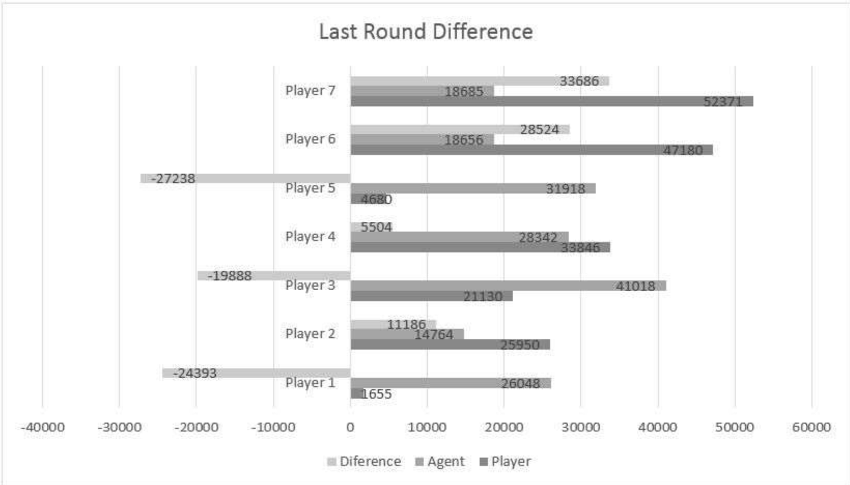

Fig. 1: Last round difference

At the end of the last round, there always remained one live player and the best agent. The graph shows the difference between the player's account and the best agent's account (player – agent). It is obvious that player 7 was the best at the end of the game, player 5 was the worst (Fig. 1).

Use of strategy in the game

As shows Trachtenberg (1991) the history of strategic thinking and strategy making comes from warfare. For our purposes – to evaluate strategic thinking and strategy making of players – we used general classification of strategies to better grasp the players' strategic behaving. The concept we used comes from Greene (2006) and his typology of warfare behaving. There are 33 general strategies which can be used in war (Greene, 2006) which are divided to five groups: 1) self-directed warfare, 2) organizational (team) warfare, 3) defensive warfare, 4) offensive warfare, and 5) unconventional (dirty) warfare. Self-directed warfare describes Greene (2006) as strategies ensuring the mind of strategist stays calm and without emotions affecting the decision. The organizational (team) warfare contains strategies about cooperation in group to ensure fast adaptation to changing conditions. The unconventional (dirty) warfare show strategies going beyond the usual rules, ethic, morality, etc. According to the game, its rules and playing conditions the only groups of strategies which can be used during the play are the defensive and offensive warfare.

Behaving in defensive manner requires to make most of firm´s resources, fight with perfect economy and to engage only in battles that are necessary (Greene, 2006). It means to know own resources and capabilities, as well as opponents resources and capabilities, and to be able to wait for the proper moment to hit in the right spot.

Behaving in offensive style depends on suddenness. The tactic is always the same – you have to strike first, hit the vulnerable spots, take over the initiative and never let it go, and create own conditions.

For the tested game, it is possible, based on observations made, to answer the selected research questions.

How looks the player approach during game strategy settings?

As we supposed the player approach for game strategy settings has two patterns.

- First pattern is based on the iterative game approach: “Play and loose” and improve the skills iteratively. (Fig 2)
- Second pattern is based on the deep study of game rules: “Play and win”. (Fig 3).

Booth patterns makes sense. But for real business we should preferred second One.

Fig. 2: Players game strategy settings

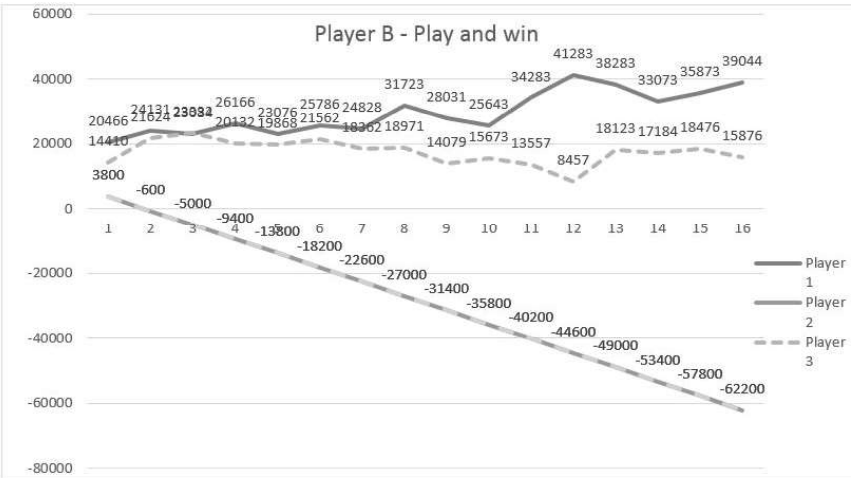

Fig. 3: Players game strategy settings

How does a player (only a human) play to whom a relatively simple management task is presented?

The players’ gaming feature has a similar course. In the early rounds, a live player plays defensively. Some players (Player 2 and Player 5) are losing in the second round compared to the previous round. Between the third and fourth rounds, the player is in a phase of stabilization of his/her decisions. At this time, a moment comes when the player decides

whether he/she will continue in his/her defensive strategy or select an offensive strategy. Some players gain (G2,3,6,7), others lose. The sixth and seventh rounds are a turning point because at that time it is almost impossible to make do with a minimalist strategy.
The reason is that, at the beginning of the game, each player receives 4 pieces of material and 2 pieces of products. Therefore, in the case of complete minimization of losses, modest financial growth can be maintained until about the sixth round. This is obviously influenced by the occurrence of resources on a playing card, which, however, is random.

How many rounds does a player need to optimize his/her playing strategy?

The player needs about 4-5 rounds to optimize his/her playing strategy. I.e. not to be in danger of getting bankrupt. (Fig 4)

In which round does the player begin to safely win over all electronic competitors?

This question is not easy to answer. Our test shows that four out of seven players gained financial dominance in the market in the seventh round. The Player (Player 7) began to financially win in the third round. The most successful player of all (player 7) gained financial dominance in the fourth round.
Player 2 and Player 4 stabilized their strategy in the seventh round. Furthermore, their financial superiority is already stable.
The sample of players is small. However, the research was taking place on a qualitative basis, i.e., we recorded also other factors that are difficult to quantify. For example, the rate of assistance during the game. All players needed some advice and partial guidance in the course of the first 3 rounds. This was probably the reason why players did not go bankrupt. The guidance provided to the players, however, partially reveals the strategy of the game which is based on minimizing the losses. Although the agents minimize their losses, the parallel algorithm of optimization of the supply is not at such a high level as in the human brain. What logically follows is also the result of the victory of the human player who is able to more quickly put into balance its expenses and income. The original superiority of robots thus logically begins to disappear in the more advanced rounds of the game.
All players mentioned how interesting the game was and proposed various options for its expansion and improvement. All of them confirmed they gained (or refreshed) new practical knowledge, i.e. experiencing a typical managerial issue in a very practical environment.

Conclusion

E-learning educational system based on artificial intelligence can be built and used in teaching. A machine built on a trivial task made it possible to practice strategic decision-making of the players. At the same time, agents' game strategy was not weak. Out of the seven players, it was practically only four players who won over the agents. This shows the great potential for using game systems designed in this way in e-learning. However, the use of neuronal networks in teaching in the similar manner is not currently mentioned. By (Baylari and Montazer, 2009) artificial neural network was used for recommending remaining states. A frequent example is the use of neural networks to recommend a trend in teaching such as prediction of enrolled courses (Kardan, Sadeghi, Ghidary, & Sani, 2013). Yet, it is not a common way to use the tools based on artificial intelligence for direct teaching, namely even despite the fact that our experiment demonstrated the possibility to involve artificial intelligence, in this case, neuronal networks, in teaching. The team is dynamically improving the artificial intelligence powered games on the

Athena application server. This is located at CULS environment. The gained data will be presented at ERIE in the next year or in the ERIE journal.

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