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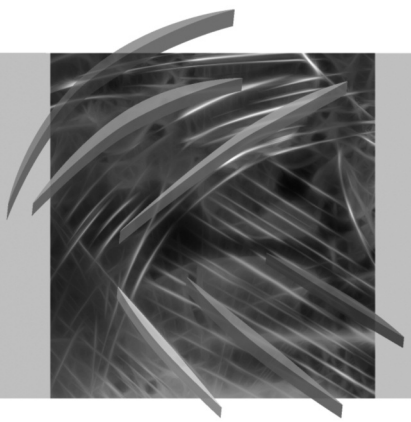

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Intelligent Technologies and Applications

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AI-SUPPORTED MANAGEMENT OF DISTRIBUTED PROCESSES: AN INVESTIGATION OF LEARNING PROCESS

Abstract: The Web capabilities and people's habits stimulate distribution of many processes in virtual environment. The e-learning is one of examples and it became a mature solution, having many participating users and organisations. However, this virtual process is harder to manage, and sometimes even to use efficiently, than the traditional learning. It has many dimensions that could be supported by Artificial Intelligence (AI). Comparing the software systems used in the-learning, e.g., LMS systems or presentation engines to the intelligent e-learning tools their differences can be easily identified, as the complexity of e-learning software and amount of data has overgrown human expectations and processing capabilities. In this paper we present how AI could be used in the e-learning and how it helps to manage this virtual distributed process.

Keywords: Artificial Intelligence, decision support, management, e-learning, distributed processes.

1. Introduction

The capabilities of IT technologies and people's habits stimulate virtualisation and distribution of processes. Their conduction in distributed environment allows organisations to achieve many advantages including increased efficiency, better quality important for organisations and more satisfying and flexible work conditions for people involved in these processes. The e-learning is an example of distributed processes and the paper will focus on it due to its multidimensional character, fast development and increasing popularity. This last feature – popularity – answers a fundamental question asked not so long ago "should we use e-learning?", while a new question arises "how can we make it better?" As the number of people using the e-learning increases, so do their expectations and the complexity of e-learning envi-

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ronments. It is harder to observe, control and to offer services meeting the users' demands. At this stage, it seems that the universal solution to these problems is to deploy Artificial Intelligence in various e-learning activities that could perform time consuming tasks, offer instant support or analyse the amount of data beyond human capabilities. The disadvantages require a constant observation and using a proper risk management, they may be significantly reduced. Hence, in our opinion the practical usage of AI in the e-learning must involve deep analysis and not only focus on purely scientific aspects. In the following sections we will analyse the applications of AI in the e-learning, starting from a general view of this process and later going through the particular stages of the e-learning.

2. E-learning as a distributed process

The development of IT Technologies caused significant economical and social changes. They also influence the educational services including universities, schools and corporate education. For the last few years, business and educational organization successfully have been using capabilities of modern IT technologies in the preparation and conduction of learning activities. The dynamic environment, frequent knowledge updates, required improvement of skills, staff mobility, open labour markets, short information life-cycle are the most important factors determining the shape of educational marked. The e-learning courses more and more often replace traditional learning. The advantages of the e-learning over traditional education include many features, e.g., availability in any place at any time or a chance to adapt learning to professional career or family life. The virtual character, where courses are separated from a physical place, causes that e-learning are examples of processes conducted in distributed environment. This also applies to all people involved in the e-learning, and service-providers (e-trainers, administrative staff) as well as learners who are members of distributed, virtual teams. A common feature of the teams cooperating in virtual organisation is their geographical distribution, constant work and being placed in different organisations [Frączkowski 2003]. The conduction of e-learning process is a complex of educational process together with business one. Due to its innovative character, limited resources and rare personal contacts it is a high-risk activity. The main risk areas for planning and conduction of the e-learning in its business profile include: communication – it eliminates non-verbal communication or marginalises it; tools for distant work – are highly sensitive to non-formalised approach to courses and errors at the stage of requirements definition; team management – includes cultural aspects, difficult work-time synchronisation; change management – unlimited e-tutors' wish list, resistance to change; quality of learning materials – unaccepted usage of resources, potential losses for organisation occurring during illegal selling of learning materials.

On the contrary, the educational side of the e-learning includes such risks for the planning and management as: communication – unspoken information, informa-

tion not provided correctly, changed information, increased time of answers; tools for distant work – excessive use of one tool causes boredom, time spent in front of computer passes very quickly, but not always effectively; team management – differences between generations, impersonating learners; change management – objections to observation of LMS users' behaviour; quality of learning materials – incorrect citations, limited search in services offering easy access, but not a high quality of information, fading analytical skills.

E-learning courses are an important component of the knowledge-based economy. Such economy is oriented on generation of innovations and their further deployment, bringing material or social benefits [Tomaszewska 2004]. It should be remembered that e-learning courses could be considered to be a form of non-material intellectual assets and the creation, management and offering of intellectual assets require proper management models and practices [Probst, Raub, Romhardt 2002]. This paper analyses the applications of Artificial Intelligence for various decisional situations in the e-learning process, considered to be an example of the distributed process.

3. Areas of AI applied in e-learning

The attention of researchers who deal with the e-learning issues is usually focused on some single aspect of this matter, for the most part on the observation of users' behaviour, on exposition of didactic material or on ensuring a proper quality level in the distance learning systems [Chen 2008; Kay, Lum 2004; Kacalak, Majewski, Zurada 2010]. However, it is necessary to remember that the organizational aspect plays a very important role in the distance learning, along with the technological and pedagogical aspects. Hence, it is suggested to analyse the e-learning as a component of the educational subprocess and the business subprocess (see Figure 1).

The adoption of the concept of the project or product life cycle enables to initiate some kind of arrangement. Every course consists of the preliminary, intermediate and final phases. On the other hand, every course is a part of the given educational offer (e.g. curriculum or studies program). The e-learning course life cycle model is, in a way, complemented by e-content life cycle model presented in [Pietruszkiewicz, Dżega 2012].

The applications of Artificial Intelligence (sometimes using Data Mining techniques) in the e-learning have a similar history to the e-learning itself. Learning Management Systems (LMS) generate vast amount of data, relating to e-learning users, their actions and behaviours and analysis of these large data sets is beyond human capabilities. The survey described in [Baker, Yacef 2009] analysed the popularity of AI & DM methods in the e-learning, focusing on the proceedings of Educational Data Mining 2008 and 2009. The results of this analysis showed the following statistics: relationship mining 9%, clustering 15%, prediction 42%, human judgment/ exploratory data analysis 12%, discovery with model 19% and others 28%. It must

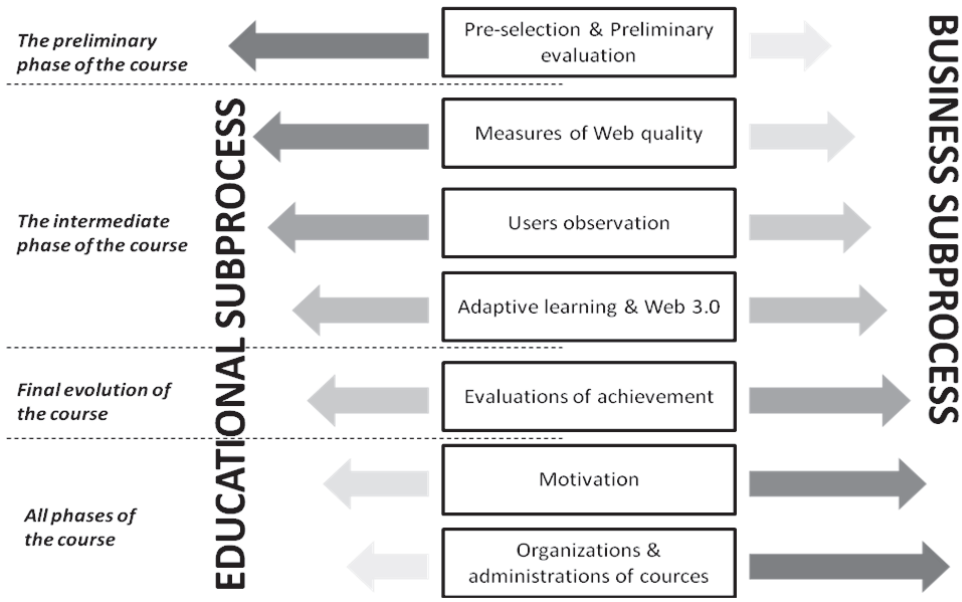

Figure 1. The main components in the e-Learning Process

be noted that the numbers do not add up to 100%, as in some papers multiple methods were used and these papers were counted into multiple categories. The largest group of AI applications in the e-learning is aimed at the observation, control and predication of users' behaviour or their performance. There are various papers presenting these aspects of AI in the e-learning, e.g. [Yu, Own, Lin 2001] analysed how the decision trees may be used by a teacher to find the relationships between students marks and their activity. The other paper [Delgado Calvo-Flores et al. 2006] deployed neural networks to predict students' marks and [Romero, Ventura 2007] describe a comparison of different classifiers used as students' grades predictors. Other research studies relate to the analysis of AI procedures in the usage of e-learning courses and supporting their improvement [Baruque et al. 2007] or to quality evaluation for e-learning courses [Balogh 2009]. Artificial Intelligence was also successfully used in the case-based reasoning application for the distance learning [Shen et al. 2003]. Among the other AI methods used in the e-learning it is worth mentioning that e.g. clustering was used to analyse the patterns of courses usage by students [Ventura, Romero, Hervás 2008] or to analyse the virtual usage steps [Mor, Minguillón 2004]. The next group of AI applications in the e-learning are the ones relating to the adaptive e-learning courses. The majority of the popular courseware systems use a static approach to the e-learning course design, while this approach has three main shortcomings [Brusilovsky, Nijhavan 2002]: modern reusability frame-

works implicitly assume that a learning object is a moveable entity; the resource repositories are being constantly updated; and "One size fits all" problem.

4. AI-supported business process

Motivation plays a vitally important role in every field. It determines a particular behaviour and actions. Researchers point out the fact that approximately 25–40% of students withdraw from e-learning courses. It is by 10–20% more than in the case of traditional courses [Frankola 2001; Lykourentzou et al. 2009]. When taking actions in order to keep clients, apart from the pedagogical aspects one should take into consideration the following data on clients: demographic features (e.g. sex, marital status, place of residence, education, professional experience); external data (e.g. the client's situation on labour market, the fact that some courses and studies are at the moment more popular, or even fashionable, than other, social mood); the client's behaviour outside the course room. Making decisions in the area of management of the learning process in e-learning is more complex than in the traditional learning. This complexity is a result, above all, of the fact that both learners and teachers operate in distributed environment. Moreover, the changes in distance learning occur quickly and equally quickly all the decisions should be made. Many educational institutions claim that as far as decision making is concerned they apply an individual approach depending on the situation [Nash 2006]. The research in the paper [Qureshi, Nawaz, Khan 2011], on the basis of the literature analysis and the results of various studies, paid special attention to the following problems with planning, initiation and development of ICTs in education: resistance of people to changes; underestimation, lack of awareness and negative attitudes towards ICTs; lack of systemic approach to implementation and lack of follow-up; high rates of system non-completion; lack of user-training; lack of administrative and technical end-user support; user dissatisfaction with new systems; and mismatches between technologies and the context, culture and work practices. All the problems mentioned above are usually tightly coupled with the cost of service of distance learning. For this reason the centres where disturbances arise must be identified, and then it is required to take some steps which would minimize their negative impact both on educational and business subprocesses. E-learning forces the institutions that deal with it to create the special units whose work is to manage the learning process in distributed environment. The correct completion of the e-learning courses depends not only on the teacher's engagement, but also on the entire e-learning development team including: project leader, instructional designer, courseware designer/author, programmer, graphics designer and audio-visual co-ordinator [Lewis, Whitlock 2003].

5. AI-supported educational process

The main idea of adaptive e-learning courses is to create an intelligent, self-adjusting mechanism which, apart from presenting the content, will also store the results of learning and analyse them to suggest relevant information and guide users through the courses over a non-linear path. The evaluation of achievement is a vitally important component both from the educational and business point of view. For learners it is a stage on which the successful completion of the course depends. For teachers, on the other hand, it is a stage where the quality of their activity and the service performed by them are assessed. Finally, for the educational institution it is a crucial moment of great responsibility for documents they issue, which certify the knowledge and skills of the learners [Mandinach 2005].

6. Technological challenges

There are also technological challenges relating to the management of the e-learning. However, they can be dealt with efficiently or significantly reduced by using proper AI methods. First of all, the e-learning process is hard to observe and the usage of traditional evaluation (questionnaires, surveys or visitations) does not fit to its main idea. It is possible to perform observations, however, LMSes are built to make management easier, but in practice the word "management" is limited to educational context, not business one. Hence, they do not provide functionality easing observations. Another issue is caused by the size of data. The amount of information available at LMSes to be collected, processed and analysed on time is far beyond human capabilities. Therefore, to be efficiently human-processed, information must be provided in a synthetic form.

The e-learning relies strongly not only on courses available via LMS, but also on various materials available on the Web. These are provided by the teachers, fellow learners or found by learners themselves. However, the full reliance on information found in the Web requires an analysis of its quality (this applies to printed materials as well, but to a lower degree) as the major problems with Web materials are their: quality (it is easy to publish web materials and it can be done by anyone); accuracy (information present in webpages might not be actual, it applies also to valid connections with other webpages); relevance (even a high quality material is useless, if it is not relevant to the demands and there is no control over content tagging or given titles). These problems create significant concerns when the Web is treated as a reliable and trusted source of information. A more detailed analysis of the issue might be found in [Kitchenham, Charters 2007].

7. Research implications and further development

We have identified main advantages and disadvantages of AI applied in the e-learning. These features relate to the three areas of the e-learning process, i.e., technological, business and pedagogical area and are presented in Table 1. It was created using the observations coming from the e-learning management practice (for over 100 courses) and the analysis of technical aspects of applied AI.

Table 1. The main advantages and disadvantages of AI-supported e-learning

Area	Advantages	Disadvantages
Technological	Autonomous mechanisms not requiring constant input. Supporting mechanisms reduce manual users' support.	More complex environment. Higher deployment costs. Higher maintenance costs.
Business	Better quality of educational product. Product tailored to one's demands. Analysis of clients' performance and behaviour.	Higher requirements for skilled staff. Heterogeneous environment to control and manage.
Pedagogical	Progress of learning adjusted to one's performance. General framework adaptable to different courses. Learner is engaged more in the process. Adaptive courses support the idea of memorisation.	Possible danger of more distant student-teacher relation. Complex environment to use. Suggestions may be unacceptable by a student. Teachers may rely too much on autonomous mechanism.

8. Conclusions

The Artificial Intelligence has many possible areas of application in the e-learning. They range from the construction of adaptive learning mechanisms, self-adjusting themselves to the students' performance, the management supporting mechanisms allowing for a better control of virtual learning environment, up to methods helping to deal with standard business problems, i.e. customers (learners) rotation. However, it is crucial to understand the both groups of effects for AI application in the e-learning. There are many advantages discussed herein, but a complex AI-supported e-learning environment causes many disadvantages and potential problems. They are caused mainly by a general phenomenon of each complex solution, i.e., a complex structure is more expensive, less fault-free or requiring higher skills, but there are additional unique risks and dangers relating to this particular domain and they must be carefully examined or observed. This analysis is an important feature missing in the most of papers which focus on the purely technical or scientific aspects of AI applied in various parts of e-learning neglecting risk sources and possible obstacles, being information very important in the practice. Summarising, in our opinion, even

if there are some issues relating to the usage of AI in the e-learning, we provided arguments when, why and how it could be used to achieve a better e-learning process – perceived as the educational as well as business one.

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WSPARCIE ZARZĄDZANIA PROCESAMI ROZPROSZONYMI SZTUCZNĄ INTELIGENCJĄ: ANALIZA PROCESU ZDALNEGO NAUCZANIA

Streszczenie: Możliwości technologii webowych oraz nawyki ludzi powodują rozproszenie wielu procesów w wirtualnym środowisku. Przykładem takiego procesu jest zdalne nauczanie, które stało się dojrzałym rozwiązaniem mającym wielu uczestników indywidualnych oraz organizacyjnych. Jednakże zarządzanie procesem wirtualnym jest trudniejsze niż tradycyjnym procesem, a czasami obserwacja ta dotyczy także samego uczestnictwa w procesie. Wiele aspektów procesów rozproszonych może zostać wspartych metodami sztucznej inteligencji. Porównując systemy oprogramowania używane w nauczaniu zdalnym, np. LMS lub systemy prezentacyjne wsparte sztuczną inteligencją, z ich pierwowzorami, z łatwością można zidentyfikować ich zalety oraz dostarczane korzyści. Rozwiązania oparte na sztucznej inteligencji są bardzo pożądane, ponieważ złożoność oprogramowania używanego w nauczaniu zdalnym oraz ilość przetwarzanych informacji przerosły oczekiwania i możliwości analityczne człowieka. W niniejszym artykule prezentujemy, w jaki sposób sztuczna inteligencja może zostać zastosowana w nauczaniu zdalnym oraz w jaki sposób może wspierać zarządzanie wirtualnymi, rozproszonymi procesami.

Słowa kluczowe: sztuczna inteligencja, wsparcie decyzji, zarządzanie, e-learning, procesy rozproszone.