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CREATION OF SOFTWARE AGENTS' SOCIETY FROM THE PERSPECTIVE OF IMPLEMENTATION COMPANIES. THE ADVANTAGES OF THEIR USE, THE PROBLEMS OF CONSTRUCTION AND UNIQUE FEATURES*

Abstract: The variety of solutions supporting operations of a knowledge-based organization tends to conduct research in the area of the applicability of software agents. Software agents allow, thanks to the defined mechanisms of representation of knowledge, the promotion of knowledge between employees of the organization and help to support business activities such as customer service and promoting the brand. In this article we will present a list of issues concerning interviews conducted with companies involved in the design and implementation of such solutions.

Keywords: software agent societies, knowledge management, software agent.

1. Introduction

Due to the characteristics of agents, i.e. autonomy, ability to recognize the context, pro activity and reactivity, and the ability to communicate and interact, agents are mainly used in tasks that require distributed processing and exchange of information. The most frequently mentioned examples of agent-based approaches may include supporting the circulation of electronic documents, distributed problem solving, e-business and the use of agents on the Internet. However, they are not sufficient, as shown by the current study conducted by the authors, regarding the application of software agents in knowledge-based organizations [Sołtysik-Piorunkiewicz, Żytniewski 2013].

As indicated by L. Dignum and V. Abecker [Van Elst, Dignum, Abecker 2004], from the point of view of the organization, there is an inherent dichotomy between the goals of the business processes and the objectives of knowledge management processes – employees always try primarily to achieve business goals because they are to be held accountable for their execution. Taking care of organizational knowledge, or adding to the common pool of knowledge, its organization or even browsing, is perceived as a goal of much less importance then the effective performance of business-related tasks. Therefore, for the effective implementation of knowledge management it is necessary to emphasize its importance for achieving the business objectives of the organization.

Knowledge management addresses issues that change over time – all the elements of an organization affecting the knowledge management system are subject to change [Van Elst, Dignum, Abecker 2004]. Therefore it is difficult to design and implement a system that is at the same time generic, equally useful for all departments and members of the organization and will be evolving without losing its usefulness. Another disadvantage is the fact that a very rare knowledge management system is being implemented at one time across the whole organization – in the majority of cases an incremental approach is used when the system is at first implemented within a single department and then made available to the others.

The development of information management systems stimulates the search for new forms of supporting business processes. In addition to the systems aimed at processing and distribution of data and information, organizations are increasingly looking for solutions that support the processing of the knowledge held by their staff and its environment.

Recent research in this area indicates that such solutions should be built in the current concept of WEB 3.0, based on methods of semantic knowledge representation [Żytniewski 2013] and support the various stages of the business process. Knowledge driven multi-agent systems are one of the current trends in the development of software agent technologies [Ivanovic, Budimac 2012].

One aspect of the research conducted by the authors was to demonstrate the approach of Polish companies regarding the construction of such solutions. For this purpose, a series of interviews with organizations based on the knowledge, dealing with programming agents during performing their everyday operations, was conducted. This study consists of a diagnosis of the key areas of application software agents in knowledge-based organizations. So far, we have conducted structured interviews with five of the larger manufacturers of this kind of solutions in Poland. Some companies did not agree to an interview.

Interviews with representatives of these organizations were supposed to help in answering the following questions: "What key functionality the agent software has and how is it unique? What benefits can organizations acquire after implementing agent software? What problems can be seen in knowledge modeling software agents distribution?

In the first part of the article, the basic typologies of agent systems will be shown. The second part will present the partial results of research on the issue of modeling agent solutions in the context of companies implementing such software in organizations that observe the need for computer support for the process of identification, codification, distribution and dissemination of knowledge in the area of business process execution.

2. Basic typologies of agent systems

It is difficult to discern a consensus about definitions and a similar position among researchers and authors of various works. In terms of the life cycle of knowledge management systems, the approach presented here refers to the stage of dissemination and promotion of intra-organizational knowledge. One of the most interesting classifications of agent systems applications is shown by Paprzycki in his work [Paprzycki 2009]. Referring to the use of software agents, he proposes the division of a sphere of existing applications of agents into three classes.

The first group includes the use of agents playing the role of components of distributed systems. The second group of agents mentioned in this scheme is used as a tool for modeling complex systems. The third group are agents used to manage and personalize information supporting the user by means of, for example, animated characters.

This type of agent-based solutions can be divided into the following groups [Kuligowska 2007]. Purchase agents (shopping agents) represent particular interests of customers by searching for the best offer for the customer and facilitating the process of making a purchase in the online store. Selling agents represent the interests of the sellers and are used to streamline the sales process. Marketing agents gather, through dialogue or searching the web, all available customer information and analyze it using statistical and econometric methods to optimize and allow preparing marketing campaigns targeting specific customers. Virtual assistants support the user in the search for a specific item, or while visiting a particular site. Agents have mechanisms which help them in searching for information/messages useful for the customer. Assistants support the promotion of new products as well. Software agents should support natural language processing and generate explanations for customers [Zimmerman et al. 2007]. Typically, they are built on the basis of aiml language, i.e. [Too Chuan Tan, Inamura 2012].

Specified typologies related to the perception of agents in the context of the solutions that are part of information systems, can be extended on the basis of the research on agent-based support for knowledge-based organizations and are the easiest type of solutions in the context of building software agents society [Żytniewski 2010].

As pointed out, an interesting and increasingly widespread use of software agents is supporting activities related to the overall communication with the customer. Software agents, in the form of virtual advisors, appear on the websites of companies,

taking on the role of a seller who is able to enter into dialogue with the customer, assess and identify customer needs and propose the solution in the form of a particular product. Of course, the virtual advisor is also able to properly advertise the product. Similarly, though in a slightly different fragment of marketing communications, are agents providing after-sales service work. Their job is to answer customer questions related either to the product or service and receiving complaints and/or propose a solution to the problem. As a result these solutions are used not only to provide knowledge regarding business processes during their execution, but they can help users who are looking for answers to questions that go beyond the core business of the organization. Thus, in terms of the construction of modern knowledge management systems, software agents can be a coherent part of such systems, supporting the different stages of its life cycle and actively supporting the knowledge-based organizations.

The issues related to the software agents usage indicate that modeling software agents society is not a trivial task and requires reference not only to the knowledge about the architecture of information systems, but also to the model of knowledge for such a system. This knowledge model will not only serve as a knowledge structure for an agent, but will provide links to the knowledge embedded into other information systems of an organization, which is of great importance especially in the context of building a heterogeneous software agents community [Żytniewski 2010].

3. The benefits of using the software agents in an organization

The advancement in the concept of software agents community and the variety of approaches to its architecture and methods of construction, meant that the research has been focused on providing the theoretical framework for building the multi-agent solutions that offer support for the organizations, in particular knowledge-based organizations. Such agent communities support the processing and distribution of information and knowledge using the mechanisms of semantic knowledge representation and operate in the context of ubiquitous communication. Four of the indicated assumptions limited our research to the application of agent-based solutions in supporting the human – computer interaction and in the context of their possible use as part of knowledge management systems.

Organizations using software agents take advantage of a wide variety of benefits, among which the most frequently mentioned is an improvement for internal and external communication channels. The main functionality of virtual advisors is to provide the end customer with instant access to information without having to call the hotline or search for a specific web page. This is undoubtedly an improvement of the process of communication and provides new channels of communication for external users. The virtual advisor also facilitates the usage of internal applications for employees. It provides a kind of help desk, which is the first line of support, and eliminates the need for traditional help files. An employee who is not proficient in

terms of the usage of the software may simply ask a question related to the functionality of the software, and the agent gives him or her the expected answer. Given this, it surely improves internal communication and speeds up access to information and knowledge for internal stakeholders. The use of software agents in a call center to answer the most common customers' questions brings measurable benefits for the organization by reducing the cost of its service and by increasing customer satisfaction.

The use of agents typically requires clarification and formalization of the knowledge processing or even the introduction of knowledge management, given the fact that the virtual advisor requires actual knowledge. The most obvious seems to be looking for improvement in the distribution of knowledge, e.g. the provision of information and the customer service process, especially in those organizations where the existing procedures are the most formal and well documented.

Agent interface representing an intelligent search mechanism streamlines the process of handling an applicant in the office, which, due to its use, becomes more efficient and faster. Similarly, the software agent can support internal users which execute formal, well-defined and well-described processes by reducing the time and improving access to information necessary for the resolution of the problems. Thus, consulting the agent will optimize the business processes.

Organizations recognize another opportunity to improve business processes in running training courses via the Internet supported by the software agent, which makes it possible to carry out an individual training program, depending on the needs and expectations of the participants. Despite the fact that the lecture is run by a machine the participant may, in the course of his or her studies, receive help in the form of answers to his or her questions. According to a representative of one of the companies participating in the survey, this is a significant improvement in the business process. Software agents are also reported to bring benefits in cases of supporting the process of taking orders in an online shop. The survey results include a description of sales service process improvement in which information software agents are used to replace the traditional communication channels like inquiries, e-mail, or instant messaging like Skype or MSN Messenger, in situations where it is necessary to identify and/or specify the technical parameters of equipment sold or to clarify some definitions. The customer can get the answer on-line from the agent. In addition to the obvious benefits of cost savings and speeding up the process, companies indicated the higher attractiveness of this form of assistance.

4. Problems encountered in the modelling of knowledge for the agent solution

As indicated by the respondents, the process of the preparation of agent-based solutions forces the company to develop and implement the knowledge model agent system. As indicated by the surveyed companies, this process is most necessary to

develop a knowledge model of agent system, which is further supplemented by knowledge acquired by them in the course of the current activities of the organization.

The surveyed companies indicated that often the organizations which have implemented agent systems have no processes developed related to knowledge management, the emergence of a virtual advisor, which requires the provision of current knowledge is mobilizing the company to refine or create a model of knowledge. Of course it is necessary to create such a model of knowledge and then maintain and continuously modify it. In fact, such a model or even a place, where this knowledge is stored, does not exist in most organizations. In such a situation the implementation and maintenance of a virtual advisor can be problematic.

Even in organizations managed by knowledge, maintaining and updating knowledge of the agent requires the creation of a suitable model of knowledge which the virtual advisor could easily use. During the implementation, such a model of knowledge is created or integrated with an agent. One way to get a good model of knowledge is also to provide the user with a tool that will allow him/her to independently model and acquire the possessed knowledge. Among the most frequent issues encountered in the stage of modeling the knowledge for the agent solutions, bringing knowledge to a basic amount of information is indicated. This is due to the fact that, for the use of agent system, it is necessary to systematize and categorize knowledge which is usually defined as a paper copy or the tacit knowledge of employees. As indicated by the testing companies, problems often arise from the very large language ambiguity, and therefore it is difficult to unambiguously and relevantly interpret the information. Then a consultation with employees of the company is necessary which will allow the knowledge engineer to clarify and codify the knowledge contained in the agent system.

5. Unique functionalities distinguishing software agent solutions implemented in an organisation

The research conducted on a group of suppliers of IT solutions offering agent-based solutions focused on solutions designed to assist the processing and distribution of knowledge in organizations and outside them. The research has found that the companies analysed specialise in most cases in building agent-based solutions which can be classified in the group of virtual agents. They were characterised by having a codified knowledge base, an element of agent visualisation and the use of audiovisual mechanisms to support contact with the user.

Each of these solutions, depending on the preferences and experience of the teams responsible for creating them, had various specific features. Despite the established specificity of this type of solutions, user expectations, and consequently the proposals of designers, make that practically each of the systems offered on the Polish market has unique features distinguishing it from the competition. This allows the potential user to choose a solution with specificity that suits the business processes

performed in his/her organization so that the improvement of their performance can be even more effective. The authors of such solutions indicated various main factors in their work on designing and building virtual assistants that must be taken into consideration during building such solutions.

The first factor is preparing a knowledge base in the context of answers to general questions, not connected with the agent's area of detailed knowledge. The solution that is created should not focus only on answering questions that have been entered into the knowledge base so that the virtual assistant could talk on a specific subject, answering the questions that have been defined earlier in the knowledge base. The authors' intention is to create a "general knowledge base" enabling "conversation" on general topics, i.e. about e.g. weather, current affairs or the "interests" of the virtual assistant. This is especially helpful in stressful situations, e.g. during a job interview with a recruitment agent. The authors of the solution claim that, thanks to designing a very extensive knowledge base from the beginning, their virtual assistants are perceived as more "human", which makes the base the best compared with the competition and results in winning the biggest number of customers who appreciated the idea.

Another element that must be taken into consideration is conversation thread, i.e. concentration on the essence of the "conversation" and ability to go back and pick up the thread where it was left off. In the case of a temporary change of the subject, when the interlocutor pays a compliment or strays away from the main thread of the conversation, the solution proposed will respond to such a compliment or attempt to stray away from the subject, but it will try to return to the same place in the conversation. Other agents, although they will also respond to a compliment or accosting, will not return to the same place in the conversation or continue it from that place.

No matter how long the interlocutor strays away from the subject, the agent will try to return to the place where he/she abandoned the main thread of the conversation, attempting all the time to direct the conversation to the same topic that has been discussed and which it is designed to talk about (e.g. marketing, recruitment, consulting) and returning to exactly the same place. It will remember what was talked about and will try to continue the conversation. According to the authors, it is the agent's knowledge base and appropriate mechanism of operation that are the essential elements impacting its functionality, its visual aspect is less important here.

In the context of application of a software agent, it is important to link it with an organization's information systems, in particular to provide it with up-to-date information and knowledge to communicate to its interlocutors. The agent-based solution is tightly integrated with the e-services platform offered by the authors and a catalogue of public services. This means that it not only searches for information in the database or used knowledge bases, but also has access to shared data sets in an integration platform which is offered to customers, which allows it to better and more quickly search for information, solutions and services that are provided by the e-services platform.

According to those surveyed, another aspect that is of key importance in building software agents is the analysis of natural language for recognizing the interpretations of users' utterances combined with human speech recognition and biometrical methods which, on the one hand, makes the solution more user-friendly and effective, and on the other hand, significantly extends the spectrum of its possible applications and makes it more universal. All the utterances entered by the user are analysed and appropriately interpreted and matched with an answer. Naturally, this requires a very extensive base that enables an accurate representation of the sense of an utterance. The authors attempt to go a step further and equip their solution with human speech analysis and simulation. The aim is to make the simulation resemble as closely as possible natural human speech and use the form of communication that is most familiar to a human being – conversation. The systems are able to recognise simple expressions or commands arising from the context of the conversation held and to give a proper, synthetic answer or provide hints where the information being searched for could be found.

Among the solutions analysed, we also found ones that have been created to meet very specific needs of customers. They are characterised by a very narrow specialisation and are dedicated to successfully solve a specific problem. For example, an agent supporting "automatic handling of people calling a call-centre" is concentrated on speech recognition and communication using a synthesiser. The task of such an agent is to effectively verify the caller. The virtual agent, based on the data possessed, e.g. checking personal information of the caller or the analysis of the answers to three simple questions which are usually asked by a human being – a consultant. It is also possible to use the module of voice biometrics. After completing a correct verification, the agent may alternatively provide other functionalities depending on the needs of individual customers. Bad quality telephone links, especially band distortions, may be a certain obstacle, but it is possible to adjust the equipment so that the effects are satisfactory. Such a solution has a broad range of potential users, from customers of banks, insurance companies or public service offices to participants of a recruitment process in any company. It is the only solution to use with a bigger number of agents at the same time. However, despite the concentration on the same subject, it is difficult to consider this case as cooperation of software agent communities. It is possible though to analyse individually operating software agents.

6. Conclusions

The conducted partial studies indicate that such solutions are now heavily used by organizations and require further consideration in terms of the methodology of agent construction solutions. The studies have shown that companies implementing such solutions do not sufficiently take a methodical approach to the problem of the design and deployment of agents. This is due to the fact that the construction of such

solutions requires, on the one hand, to address the issues of software development methods, and on the other theories of knowledge engineering that are required in the context of modelling the knowledge base of agents.

The solutions offered by the developers of agent systems can be qualified to the so-called group of intelligent user interfaces, including, among others, solutions such as natural language processing, adaptive interfaces, cooperative problem solving by the user and the computer, use of visualizations, the use of artificial intelligence for better explanation, and all sorts of variations other than the classic forms of interaction with the user (e.g. control by words and gestures).

A well-designed interface provides the ability to personalize the system, providing adaptive means of communication and actions to the individual needs of each user. At the same time their work environment allows for the automatic identification of the characteristics of a particular user by using a set of tags, transmitters, devices, or other attributes, such as individual biometric features, ranging from the traditional fingerprint scan by facial recognition, to the user's eye tracking systems, and even mood diagnosis by measuring the level of skin conductance, heart rate and temperature [IBM Blue Eye Project...]. The solutions can also use all the technologies that support intelligent speech recognition, learning pointing, viewing and navigating systems able to recognize touch and gestures. Such an enhanced system will be able to identify a specific user or a specific stimulus from another system and respond accordingly by running the appropriate operating profile for the authenticated user. The usability of systems also increases the "ability" of the interface to interact with the user. Intelligent interactive user interfaces, while using the services of a "virtual advisor" for example, in public offices, banks, medical clinics, social security facilities, or any other similar institutions, are a particularly valuable support for the elderly and disabled, who, in relation to their state, have specific difficulties with the use of traditional equipment [Sołtysik, Kostrubała 2013].

References

Computer Science Department, Oklahoma State University, Tulsa, OK 74106 USA.

IBM Blue Eye Project – Emotional Mouse, http://www.almaden.ibm.com/cs/BlueEyes/index.html, http://www.sciforums.com/Blue-Eye-Project-Emotional-Mouse-t-4956.html.

Ivanovic M., Budimac Z., *Software Agents: State-of-the-Art and Possible Applications International Conference on Computer Systems and Technologies - CompSysTech'2012*, 12, pp.11-22.

Kuligowska K., *Zastosowanie inteligentnych agentów w aplikacjach handlu elektronicznego: wirtualni asystenci*, Ekonomia, Warszawa 2007, pp. 99-112.

Paprzycki M., *Agenci programowi jako metodologia tworzenia oprogramowania*, 2009, http://www.e--informatyka.pl/wiki/Agenci_programowi_jako_metodologia_tworzenia_oprogramowania [accessed: 20.05.2013].

Sołtysik A., Kostrubała S., *Projektowanie i budowa inteligentnych interfejsów użytkownika*, [in:] *Decision Support Systems Conference SWO'2013*, eds. T. Porębska-Miąc, H. Sroka, University of Economics in Katowice, Katowice 2013 (positively reviewed article).

Sołtysik-Piorunkiewicz A., Żytniewski M., *Software Agent Societies for Process Management in Knowledge-Based Organization*, European Conference on Knowledge Management − ECKM 2013, 2013 (positively reviewed article).

Too Chuan Tan J., Inamura T., *Extending Chatterbot System into Multimodal Interaction Framework with Embodied Contextual Understanding*, [in:] *HRI '12: Proceedings of the Seventh Annual ACM/IEEE International Conference On Human-Robot Interaction*, 2012, pp. 251-252.

Van Elst L., Dignum V., Abecker A., *Towards agent-mediated knowledge management*, [in:] *Agent--Mediated Knowledge Management*, eds. L. Van Elst, V. Dignum, A. Abecker, Springer Verlag, 2004.

Zimmerman J., Forluzzi J., Mancuso V., Kwak S., *How interface agents affect interaction between humans and computers*, [in:] *DPPI '07 Proceedings of the 2007 Conference on Designing Pleasurable Products and Interfaces,* 2007, pp. 209-221.

Żytniewski M., *Development of the conception of software agent societies*, Conference Materials "European Space of Electronic Communication", Copenhagen 2013.

Żytniewski M., *Ontologies in multiagent systems*, [in:] *Decision Support Systems Conference SWO'2010*, eds. T. Porębska-Miąc, aH. Sroka, University of Economics in Katowice, Katowice 2010.

TWORZENIE SPOŁECZNOŚCI AGENTÓW PROGRAMOWYCH Z PERSPEKTYWY WYBRANYCH FIRM WDROŻENIOWYCH. ZALETY ICH ZASTOSOWANIA, PROBLEMY BUDOWY ORAZ UNIKALNE CECHY

Streszczenie: Różnorodność rozwiązań informatycznych wspierających działanie organizacji opartych na wiedzy skłania do podejmowania badań stosowalności w tym obszarze agentów programowych. Agenty programowe, dzięki zdefiniowanym mechanizmom reprezentacji wiedzy, pozwalają na propagowanie wiedzy między pracownikami danej organizacji, wspomagają także działania biznesowe, wspierając np. obsługę klienta, promowanie marki. W niniejszym artykule ukazano zagadnienia dotyczące przeprowadzanych wywiadów z firmami zajmującymi się wdrażaniem i projektowaniem takich rozwiązań.

Słowa kluczowe: agent programowy, społeczności agentów programowych, zarządzanie wiedzą.