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DEVELOPMENT OF THE BUSINESS INTELLIGENCE ON THE BASIS OF SEMANTIC KNOWLEDGE PROCESSING METHODS CONCEPT AND AGENT SOLUTIONS IN KNOWLEDGE-BASED ORGANIZATIONS

Introduction

The paper attempts to describe and conceptualize the impact of semantics on the growth of solutions geared to support knowledge-based organizations. The first section delineates the key issues relating to knowledge, knowledge-based organizations and knowledge management. Further, the discussion focuses on how technologies used to support organizations evolve toward semantic representation of organizational resources. Finally, the paper indicates the leverage that semantic representation methods can bring to software agent modeling as well as to the applicability of agents in such organizations. A scientific problem, considered in this study, is to analyze the current state of knowledge concerning the use of information systems and supporting their activities through the use of semantic solutions in particular metamodels of knowledge. For the purpose of this study a proposal of ontology application written in OWL was presented.

The knowledge-based organization era

In today's world, information is at the heart of the life of societies and business organizations. The overload of information being generated, processed and delivered makes it necessary to channel its flow and protect the decision maker from information noise. This is a sheer consequence of the fact that broad access to information, and efficient interaction between those who exchange it, are intrinsic to information society.

Data processing is the essence of information technology. Data has thus become a primary resource in any organization. When placed in a meaningful context, data is transformed into specific information that can be used in decision making processes. In considering a number of options within a decision making process, a decision maker should not have to rely on readily available information only. He or she must also be able to take advantage of tacit, non-codified knowledge resources.

The distinction between data, information, knowledge and wisdom is shown in Figure 1.

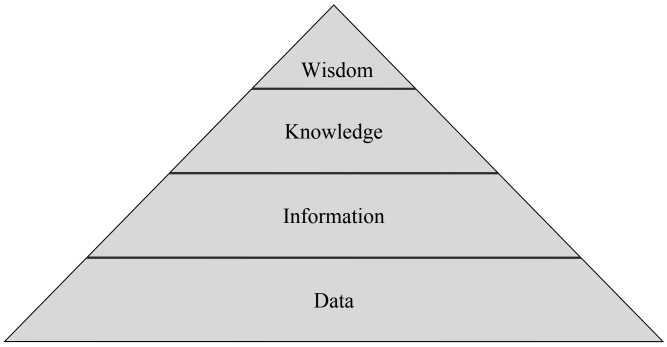

Fig. 1. Relationships between notions

Source: [GrZa09].

Upon analysis and interpretation, data becomes information as its meaning is defined by introducing a specific context for its use. Information may be in turn subject to synthesis and comprehension and hence become knowledge. Once we have knowledge and experience, we can acquire or accumulate wisdom. In the context of our further discussion, it should be mentioned that the evolution of information systems supporting organizations has reached a point where these systems are capable of creating/discovering knowledge (e.g. data mining systems), processing and delivering it (e.g. semantic portals), or even learning from it (e.g. expert systems) [Żytn13].

Organizations seem to be currently evolving toward orientation on business processes, perceived not only as sequences of actions performed by humans but also as an element of the inter- and intra-organizational cyberspace. As a result, organizations will concentrate on the e-business domain and even closer integration of business processes involving automated search of new resources, e.g. knowledge resources. The rapidly changing environment and the increasingly tough competition forces companies to seek new channels and new modes of access to these resources that will be more intuitive and more autonomous in terms of IT applications. Agent technologies seem to be able to offer such potential, lending a new, virtual dimension to collaboration [SoŻy13]. This aspect will receive special attention further in the paper.

Semantic methods of organizational knowledge representation are a solution that now largely stimulates the development of new communication channels in cyberspace. Research on knowledge codification has led to the emergence of ontologies, which make it possible to represent knowledge as formal models describing the semantics of the concepts used. Owing to their utilization, information systems no longer merely handle data, but they are equipped with a conceptual representation of the knowledge they handle. Examples of such languages include RDF, RDFS, OWL, and OWL2.

Expert systems is where the paramount importance of knowledge codification shows best. Within such systems, codified knowledge extracted from experts by knowledge engineers can be used to aid the system's inference process. A problem which arises here, however, is that of the self-containedness of knowledge within specific domains and the difficulty in combining it, e.g. blending disparate solutions into a single resource. Expert systems themselves cannot work automatically in a changing environment and take full advantage of the potential inherent in semantic representation.

Organizations' orientation on innovation stems from the fact that "[…] the dynamic changes in the global economy are forcing companies to permanently improve operating modes. The third millennium brings rapid transformations in all areas of business activity, and overturns or refutes the existing canons and principles" [GrHe08].

In management science, organizations whose corporate culture is knowledge-centered are called knowledge-based organizations. The key feature of such organizations is their preoccupation with knowledge management and accumulation of intellectual capital. Knowledge management is a central term, characteristically defined as "[…] a discipline that is focused on systematic and innovative methods, practices and tools for managing the generation, acquisition, exchange, protection, distribution, and utilization of knowledge, intellectual capital, and intangible assets" [Mont00]. A strategy followed by knowledge management systems is that of codification, which "[…] typically involves a knowledge management system founded on computer technology, the latter becoming the primary tool for the acquisition, conveyance and storage of knowledge" [Miku06].

Under such a definition, information technology should not only support an organization by providing the technical means to handle the organizational resources of codified knowledge, but it should also be designed in a way which ensures that codified knowledge is effectively utilized to support the organization's operations. Alongside business processes, organizations of this sort deal with the challenges of tacit knowledge: its codification, processing and learning. The application of software agents is increasingly visible in such organizational environments, since an organization's resources, once defined and semantically represented, can be used by inference mechanisms or adapted as representation models for the domain being supported. An example demonstrating this applicational aspect of agent technology is provided at the close of the paper.

A knowledge management system is described as a solution which is supposed to support knowledge processing. Knowledge management systems belong to a class of information systems developed to help manage knowledge in organizations [LeAl01]. Knowledge stored within such systems can comprise explicit knowledge obtained from its users as well as experience, documents, and other knowledge resources. The diversity of knowledge resources and knowledge representation methods often frustrates attempts to utilize these in deploying information technology to support decision makers: if a specific resource is, say, recorded as sound, decision support software may have difficulty retrieving it on request. If the resource, however, is described semantically, then, on the one hand, it is easier to understand its purport, and, on the other, it can be further processed by information systems.

For these reasons, information technology solutions are more and more often focused on representing the knowledge of a system's internal logic and its resources in a manner that makes it codified and shared, and hence easily stored, processed and retrieved. Notably, the semantic method of resource description employing the SWRL language can be applied to this effect [HaSt06]. Owing to it, resources defined within an information system, hitherto represented as code in a given programming language, can be represented as semantic content codified in an ontology language.

The evolution trends in business applications of information technology, including the semantic branch in particular, as well as motivations driving these trends will be illustrated by the evolution of Business Intelligence solutions.

Business Intelligence systems

Business Intelligence (BI) systems have now become the core of centralized decision support systems. The first-generation systems were described as analytical information systems and were limited to simple analysis and reporting functionalities, chiefly including spreadsheets, statistics and report generation.

However, the perceived need to support decision making processes with integrated data from throughout the organization has entailed the development of more complex and powerful systems. At the moment, Business Intelligence solutions are focused on collection, integration, storage, selection, analysis and clear presentation, and they are based on a combination of three pivotal concepts. Among the key architectural components of contemporary systems there are: data warehouses, allowing central storage of long-term data; the OLAP technology, enabling the construction of multi-dimensional structures and a rich variety of approaches to their analysis; and data mining tools responsible for the discovery of knowledge contained in data warehouses. A perfect example of software package used to implement these components in organizational settings is SAS 9.

The primary Business Intelligence layers include:

- a data integration and storage layer,
- a data analysis layer,
- a reporting layer,
- an administration layer.

The first layer handles the processes of data extraction, transformation and loading. These processes, commonly implemented in data warehouses, make it possible to integrate, unify, clean and transfer data into a warehouse. In contemporary systems, the processes can be shared by different software tools via e.g. a CWM (Common Warehouse Metamodel) [www2], although the standard involves the use of the XML language and the concepts it employs do not have semantic content.

The second layer, that of data analysis, is responsible for the selection of data for analysis as well as for conducting the analysis itself. This layer often experiences problems connected with conceptual meaning. For example, using truncated field names and concentrating on the syntactic aspect of data processing may lead to inaccuracy in interpretation. This in turn results in undesirable delays in the data analysis process. Further, the problem can only be fixed with the aid of a process analyst's expertise. Similar problems occur on the reporting layer, where required data sets have to be selected prior to report generation.

In organizational settings, support for the decision making process hinges on the findings of data analysis. Yet, analysis of the large bodies of data stored in relational databases poses challenges that stem from the system's relational model centered on electronic processing. Data model designers themselves will often employ abbreviated table names, making it unnecessarily difficult to analyze their content. Fortunately, some database engines allow the use of extended descriptions for tables and table fields, which effectively remedies the problem. However, the problem crops up again when it comes to integrating data across multiple database systems or throughout an organization. Another issue concerns databases supporting transaction systems, which are focused on processing current data as they come in. Transactional systems use data processing engines whose technical specifications are oriented on handling large numbers of simple queries but rather limited volumes of data. Problem arises when one intends to process long-term data. If this is the case, a standard transactional system data model may prove inefficient. In addition, its inadaptation to long-term data processing may cause technical problems. To this end, therefore, organizations will use data warehouses or, where support is addressed to a specific department, data marts. The use of a data warehouse implies the presence of data extraction, transformation and loading processes to take care of transferring selected datasets to the warehouse. It also involves the use of specific data models to ensure subject-orientedness. As a result, data stored in a warehouse are focused on a specific subject and thus able to better support analytical processes: when analyzing the data, decision makers find it easier to retrieve information they require.

Data warehouses introduce one more element to facilitate data analysis – metadata. In organizations, metadata have become an essential element supporting data processing and analysis. Metadata are often construed of as “data on data”. They make it possible to include a description of the resources found in a data warehouse. With analytical systems, analysts can support decision makers by providing them with data sheets or readily available data aggregates, yet to support the process of data search, retrieval and application, it is necessary to describe resources in a way that is intelligible to the decision maker. Metadata do not just describe the data as such – they constitute an inherent element describing the architecture of the Business Intelligence system as a whole, hence supporting its definition and management. Notably, however, metadata are normally utilized within a given technology solution only, and the terminology used to describe it may be baffling to non-experts.

OLAP technologies represent a leading solution supporting data analysis processes in a data warehouse environment. They account for an interactive process of data creation, management and analysis, where data are perceived as multi-dimensional tables. At present, OLAP can be seen as a separate class of support systems for data analysis as well as a part of the Business Intelligence architecture – an intermediate between data warehouses and knowledge discovery systems.

The use of OLAP technologies consists in analytical processing of multi-dimensional data. Operations that can be performed on such data include aggregation, drill-down, pivot, slicing, scoping, and filtering. These operations support the multi-dimensional data analysis process but do not enable the decision make to define meaning, since they deal with structure, not semantics, which sends us back to the issue of metadata used in data warehouses. It should be noted that data resources may have several different forms and may comprise structured, semi-structured and unstructured data [Wang10]. This distinction, however, concerns syntactic definition, not semantic description. An emerging challenge is therefore how to codify unstructured data resources – or, more precisely, the knowledge that they convey – into a form that would yield to machine processing.

The issues concerning data warehouse metadata and their structure-level processing, mentioned earlier in this paper, fuel the proliferation of new concepts, such as e.g. semantic technologies, and the emergence of a new strand in research positing the inclusion of semantic content in Business Intelligence solutions. Semantic representation of an organization's resources leads to a situation where organizational resources – rendered as tables and fields as well as in the form of text documents, e.g. e-mail messages – begin to have a semantic context and hence can be processed by artificial intelligence tools that are capable of interpreting this context.

The conception of semantic Business Intelligence systems

Semantic Business Intelligence is a relatively new concept within the Business Intelligence area. The concept opens up new application possibilities for BI systems and triggers new potential for the integration of intra-organizational knowledge, as it can be expected that the evolution of organizational knowledge processing methodology will guide researchers toward a broader use of semantics as an element of information systems. As a result, it will be feasible and reasonable to enhance such systems with software agent technology.

Novel Business Intelligence concepts are focused on the use of semantic solutions to integrate specific activity areas in an organization. An ongoing European project known as CUBIST and scheduled for the years 2010-2013 is primarily concerned with semantic technologies, business intelligence, and visual analytics. It is envisioned that the research will identify development outlooks for business intelligence and will help "[…] leverage BI to a new level of precise and user-friendly analytics of data" [www3].

It should be added that the most recent Business Intelligence concepts are often termed as BI 2.0 or BI 3.0. The former is chiefly associated with the idea of Web-based social networking and aimed at demonstrating the viability of incorporating e.g. Web-based services into Business Intelligence with a view to extending its functionality. A number of postulates have been voiced in topical literature regarding BI innovation and the drivers of its further development [Nels10].

While investigating semantic technology, one comes across accounts of research and development efforts directed at diverse applications of semantics, e.g. in analytical [EtVa12, Sell08] or reporting tools [KoSo11]. It could be argued that "Business intelligence (BI) deals with a systematic process for collecting, analyzing, and managing internal and external information and knowledge to improve an organization's decision making process" [www1]. The decision making process calls for accurate interpretations of conceptual meaning and therefore should be supported by applying semantic representation methods to organizational resources.

An example of how the new concept can be translated into business realities is the way semantics are used in some proposed solutions. The proponents of semantic Business Intelligence emphasize that it is a model "[…] in which business conceptualizations drive the localization and exploration of information. In addition to traditional drill and slice approaches, SBI users can choose among business rules and relations of business concepts to drill or slice data" [Sell08]. The SBI architecture engineered by Sell [Sell08]. The proposed solution sets out from a semantic description of data accumulated within an organization. As a next step, a mechanism supporting the data analysis process is developed. The key components of the resulting architecture include:

- **QueryManager** – the component that provides access to data by performing XML queries on heterogeneous data sources.
- **OntologyManager** – responsible for handling the ontology and collecting information required to process queries sent to the OLAP system.
- **RequestParser** – which interprets queries generated by the analytical tool and retrieves the required data from specified data sources.

Consequently, the authors arrived at a possible ontology describing the basic notions used in building the OLAP structures. Once the model defining the data storage, acquisition and aggregation mechanisms within OLAP is given a semantic representation, it becomes possible to automate the construction of multi-dimensional structures. The recent semantic BI concepts are focused on producing more accurate results for decision makers. This is achieved e.g. through user profiling, with profiles built up over time and helping determine a meaningful context for any information supplied to the user. The context in which a given resource is utilized may be derived from the semantic representation of knowledge on that resource as well as from the description of terms used. When performed in this way, analyses tend to be more efficient, too, because users are provided with just the right resources they require to complete a particular analysis. Another argument for organizations' increasing commitment to semantic technology relates to the highly desirable community approach to task performance.

Semantic description of processes in an organization makes them more susceptible to analysis and creates opportunities for improved interaction among task force members. In effect, it is much easier, for example, to identify convergent goals and tasks. The user-orientedness of semantic systems corresponds to orientation on the service user and can be seen in the functionalities they offer. In organizational settings, the use of semantics and semantic knowledge representations allows users to customize their software more closely to their needs. It also permits generation of explanations based on relations existing within the conceptual structure of a specific knowledge resource. A benefit that a shared conceptual apparatus can bring is thus improved collaboration among intra-organizational users. Software agents represent one of the solutions that can support the creation, processing and utilization of knowledge defined in an organization.

Software agent applications in knowledge-based organizations

Semantic Business Intelligence concepts, coupled with ontologies used to represent organizational knowledge, impinge on the way software agent societies are modeled in knowledge-based organizations, where explicit knowledge becomes an organizational resource and can be, as such, further processed. The progress in technologies permitting the incorporation of semantic knowledge representation into organizational support solutions makes it viable to apply software agents to address specific areas in an organization. The formerly prevalent approach assumed the use of an application programming interface (API) supplied by the software vendor; using the API, an agent would be able to manipulate the processes of data analysis or knowledge discovery.

One way of defining a software agent, encountered in many scholarly publications, is that it is "[…] a self-contained program capable of controlling its own decision making and acting, based on its perception of its environment, in pursuit of one or more objectives". Another oft quoted definition asserts that "[An] autonomous agent is a system situated within and a part of an environment that senses that environments and acts on it, over time, in pursuit of its own agenda and so as to effect what it senses in the future" [FrGr97]. It is hence regarded as a piece of software characterized by e.g. proactivity, reactivity, autonomy, mobility, reasoning, persistence, goal orientation, etc. [LuAs04]. It should be underscored, too, that solutions employing artificial intelligence can either support humans or replace them.

The existence of software agent societies makes it legitimate to talk of multi-agent systems. The greatest advantage of agent technologies is the possibility to build complex distributed systems from simple basic entities referred to as agents. Under such systems, multiple agents representing individuals and organizations can act within a common environment, each working on its task and trying to achieve its objectives.

While there is no single, generally accepted definition of a software agent, some properties can be isolated that each agent must have in order to be recognized as one, and that therefore can be seen as the constituents of "agenthood". These include [JeWo96]:

- "Autonomy: agents should be able to perform the majority of their problem solving tasks without the direct intervention of humans or other agents, and they should have a degree of control over their own actions and their own internal state".
- "Social ability: agents should be able to interact, when they deem appropriate, with other software agents and humans in order to complete their own problem solving and to help others with their activities where appropriate".
- "Responsiveness: agents should perceive their environment (which may be the physical world, a user, a collection of agents, the Internet, etc.) and respond in a timely fashion to changes which occur in it".
- "Proactiveness: agents should not simply act in response to their environment, they should be able to exhibit opportunistic, goal-directed behavior and take the initiative where appropriate".

While this list is certainly not exhaustive, the presence of these properties is indicative of solutions that deserve to be designated as agent-based or agent-oriented. An agent can assist decision makers by e.g. substituting for them in performing particularly tedious chores and routine tasks, by searching and retrieving information for them, or by exploiting its mobility to transfer knowledge between systems. Software agents can support various areas in an organization [BoBo11]:

- e-commerce,
- supply chain management,
- resource allocation,
- intelligent production,
- industrial control,
- information finding and filtering,
- collaborative work,
- mobile commerce,
- decision support,
- simulations,
- production planning and control.

When supporting specific areas and functions within an organization, agent-based solutions are mostly domain-specific and local and they do not address organizational knowledge management processes as such, nor do they assume a broader perspective on semantic and agent technologies involved.

When agent societies are to be deployed in organizations representing their knowledge in a form that can be easily processed by software agents, it is recommended to create solutions that operate in an organization's environment and support knowledge processing and programming rather than seek to immediately automate business processes. This becomes critically important when integrating information systems between organizations cooperating in an asynchronous mode and using heterogeneous technologies and standards. In such contexts, agent technologies contribute modern asynchronous communication standards, at the same time defining the logic of the underlying business processes and transcending or augmenting the existing systems integration methodology. They can, for instance, function as proactive network services set up to automate the search for new information sources.

An interface agent, whose task is to support decision makers with adequately targeted information, is one of the many kinds of agents to be found in knowledge-based organizations. Known types of interface agents include the following [Stan05]:

- Website guide – which supports navigation through Web sites;
- assistant and advisor – usually a Web site component, responsible for supplying potential clients with information about the company and its resources;
- friend – focused on interaction with the user, supports communication processes;
- contact center – receives messages from users and recommends further actions or optimum solutions to problems;
- salesman – using codified knowledge, it determines the best track for the sale of goods;
- technician – a customer-oriented entity performing the role of technical advisor and backing up the technical procedures;
- e-teacher – an agent performing the role of tutor, found e.g. in e-learning environments.

An interface agent can have a wide array of functionalities comprising [Stan11]:

- the ability to use large volumes of knowledge pertaining to a given area,
- fault tolerance,
- the ability to use symbols and abstract notions,

- the ability of adaptive and goal-oriented behavior,
- the ability to learn from its environment,
- the ability to perform real-time operations,
- the ability to communicate in real time.

If it is part of an agent society, an agent can provide even richer functionality, for example help build the customer's confidence in the company, assist with online shopping, answer frequently asked questions, collect information about the user, personalize site content, establish lasting and meaningful relationships with the customer/user and, last but not least, maximize the customer's satisfaction every time he/she contacts the company – all in an effort to win the customer's long-term loyalty. Interface agents can thus be seen as the company's electronic representatives [Stan11].

Given the recent trend for BI systems to incorporate semantic representations of domain knowledge and procedural knowledge, it should be realized that the very fact of using formal methods to represent the knowledge of a particular system can be seen as forming part of an organization's explicit knowledge. The way the system works, the logic of its functioning, and its resources of domain knowledge – all of these constitute elements of the organization's knowledge capital. Not only can software agents use such knowledge, but also the society's structure can be represented in a semantic form. These considerations are crucial to software agent modeling in knowledge-based organizations, since the organization's self-knowledge on its resources and procedures becomes part of the agents' knowledge, enabling them to process this knowledge via artificial intelligence mechanisms. On the other hand, semantic representation of their structure means that knowledge on the agents becomes an element of the system, too.

This can be illustrated with an example. Figure 2 shows the structure of semantic relations between concepts, which can be applied in modeling agent society architectures.

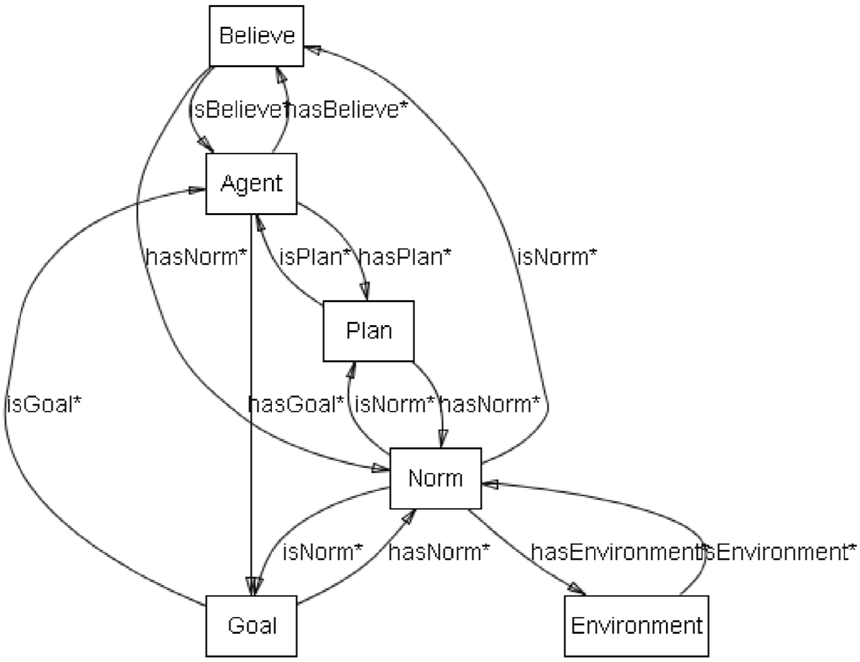

Fig. 2. Example of system architecture

Source: Own elaboration.

Within a structure described using the OWL language, an agent will have beliefs on the environment in which it is placed. It may have goals, too, which it is going to pursue, and an action plan specifying how these goals will be accomplished. Once defined, an artificial intelligence component can – based on its goals, plans and beliefs, and acting in a certain environment where it has to observe certain norms – take actions with the aim of supporting the user. All of the above must be thoroughly modeled and defined as elements of a software agent society architecture. With regard to the prior discussion of issues pertaining to the evolution of semantic Business Intelligence, it should be noted that an agent's beliefs may relate e.g. to the conceptual structure developed for the semantic BI. Figure 3 presents an OWL-based conceptual structure which has been modeled using a tool called OntoViz.

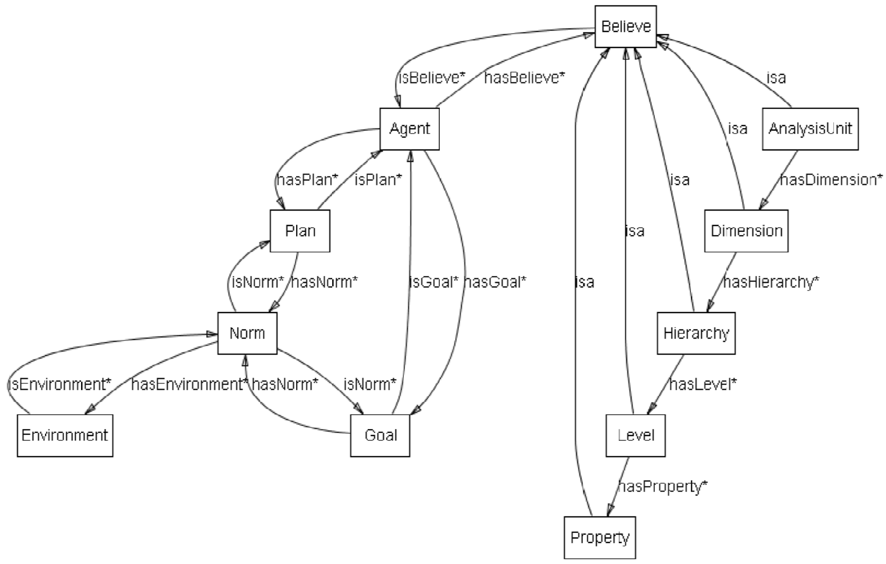

Fig. 3. Sample representation of an agent's beliefs

Source: Own elaboration.

Owing to the use of the OWL language, it is possible for an agent to represent such knowledge and to process it employing an inference mechanism, such as e.g. JENA. Sample OWL code is presented in Figure 4.

```
<owl:Class rdf:about="http://zyto.netmark.pl/enorm.owl#Hierarchy">
  <rdfs:subClassOf>
    <owl:Class rdf:about="http://zyto.netmark.pl/enorm.owl#Believe"/>
  </rdfs:subClassOf>
</owl:Class>
<owl:Class rdf:about="http://zyto.netmark.pl/enorm.owl#Level">
  <rdfs:subClassOf>
    <owl:Class rdf:about="http://zyto.netmark.pl/enorm.owl#Believe"/>
  </rdfs:subClassOf>
</owl:Class>
```

Fig. 4. Example of an agent's knowledge codified in the OWL language

Source: Own elaboration.

In consequence, in designing an agent to act within an agent society, designers can be clear about what knowledge resources it will need, which makes it easy to monitor the agent's activity or establish what knowledge it should have (based on a metamodel, e.g. an OWL-compliant one) and what knowledge it actually has when performing specific tasks (OWL instances). Nevertheless, this capability should already be born in mind at the stage of multi-agent system modeling. It is particularly important to define an overall conceptual model of the agent itself as well as of the environment in which it is situated; in fact, this modeling exercise should be seen as an essential step in the multi-agent system design process. If this is the case (see the example above), the description of the agent's architecture and its knowledge resources becomes intelligible to humans and can be readily used in codifying the solution. The resulting conceptual structure thus becomes a resource that can be processed by the agent using e.g. the SPARQL language.

One could ask how it affects the functioning of an agent society in a knowledge-based organization. If a formal language is used to describe the system's conceptual architecture, which is not common in standard IT solutions, it is possible to directly monitor agents' behavior within a multi-agent system through their conceptual description. As a result, the agents' actions cease to be clandestine, concealed within a given platform, but they are recorded in an ontology language, which makes it easy to keep track of the agents' actions as well as of the knowledge resources they use. In a knowledge-based organization which is aided by a multi-agent system alongside other computerized support tools, the way its knowledge is represented is critical; if the above guidelines are followed, the integration of software agents into the existing systems becomes much less of a problem.

Considering the prospective development of such a system, it would be an advantage if the methodology and notation to be used in programming it were linked to existing standards, such as the UML notation. It could be implemented, for example, through stereotype mechanisms. The static and dynamic structures represented by a particular language could then be easily developed using the existing programming languages. Owing to such an approach, it is easier to monitor the software agent society and its knowledge resources as well as the decisions made and the actions performed by the agents.

Conclusions

The paper has aimed to demonstrate how the evolution of the theory and practice of business informatics can contribute to increasing the resources of codified knowledge that can become part of an organization-wide knowledge management system. The evolution of computerized decision support, encompassing Business Intelligence systems, signifies further advances in support for human activity. The paper indicates that progress in these information technologies has been heavily correlated with the development of semantic methods of knowledge representation which emerged within the semantic Internet strand. This is epitomized by the semantic Business Intelligence concept, which has been discussed at length in the paper. While the originators of the concept linked it with computer support for the decision making process, it can well be, due to improved data analysis and semantic codification, utilized by software agents to automate tasks within an organization. Explicit knowledge itself can also, once codified, become part of an organization's knowledge resources.

The discussion has revealed, too, that conceptualization through a formal language affects the programming process of software agents themselves as well as of systems inhabited by them. The incorporation of semantics not only helps understand the overall architecture, but can also prove very useful in developing the actual solution: since at the codification stage the designers can reuse the concepts that were elaborated at the initial requirements definition phase, the multi-agent system development process is largely accelerated.

Acknowledgements

The issues presented constitute authors' research into the aspect of modeling software agent societies in knowledge-based organizations. The project was financed from the funds of National Science Centre 2011/03/D/HS4/00782.

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ROZWÓJ SYSTEMÓW BUSINESS INTELLIGENCE NA TLE KONCEPCJI SEMANTYCZNYCH METOD PRZETWARZANIA WIEDZY ORAZ ROZWIĄZAŃ AGENDOWYCH W ORGANIZACJACH OPARTYCH NA WIEDZY

Streszczenie

W niniejszym artykule zaprezentowano wybrane aspekty rozwoju systemów informatycznych w organizacjach opartych na wiedzy. W szczególności podjęto problematykę rozwoju systemów Business Intelligence w obszarze zastosowania systemów agentowych oraz semantycznych metod reprezentacji wiedzy.

W części pierwszej ukazano podstawowe zagadnienia dotyczące wiedzy, organizacji opartej na wiedzy oraz zarządzania wiedzą. Dalej przedstawiono rozwój systemów BI w kierunku zastosowania semantycznych metod reprezentowania ich zasobów. W ostatniej części zaprezentowano zagadnienia dotyczące wpływu omawianych teorii na modelowanie i stosowalność agentów programowych oraz zaproponowano elementy ontologii w notacji OWL opisującej powiązanie systemu agentowego z systemem BI.