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THE ROLE OF SEMANTIC NETWORK IN MANAGEMENT

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Purpose: The aim of this article is to present useful issues related to the role of semantic network structures used in management forms based on systemically structured data sets.
Design/methodology/approach: The methodology used is carried out by successively characterising the areas of issues included in semantic network structures.
Findings: Components, search engines, tools and platforms illustrate the results of analysing original procedures that allow a selected group of managers to take advantage of the originality of their structures.
Originality/value: The description of semantic network structures can provide management leaders with practical solutions for using professional implications, drawing on their exceptional intuition.
Keywords: Semantic network, ontology, software agents.
Category of the paper: Conceptual paper.

1. Introduction

The Semantic Web was not created from scratch, but was developed from the existing *World Wide Web* – thanks to the precise definition of the meaning of the data available on it, which allowed for closer cooperation between humans and computers. The vision of such a web was presented in the late 1990s by the creator of the *World Wide Web*, Tim Berners-Lee (Nahotko, 2003).

The main problems that the Semantic Web was supposed to solve were:

- Computers recognise the structure of hypertext pages and their typical elements – headings, links to other pages – but they cannot read the meaning of the elements they contain.
- Internet search engines do not take context into account, which means they cannot properly interpret and distinguish between homonyms and synonyms.

- In response to a search query, modern search engines return a list of web page addresses primarily based on the number of occurrences of so-called "keywords" – treated as character patterns.

The Semantic Web has become the solution to the above problems. It will allow the systematic assignment of meaning to elements of *web* pages, thanks to which the programmes that read them, called software agents, will be able to perform complex tasks assigned to them by users.

In order to implement the idea *of the Semantic Web* to exchange information and knowledge between different applications, a common terminology is needed to describe the domain in which these applications operate. Information about the relationships between them is also needed. Such a set of terms and relationships is called ontology (Węcel, 2003).

2. Components of the Semantic Web

- XML is a universal markup language designed to represent various data in a structured manner. It allows users to define and use their own tags. It does not have built-in mechanisms that enable other users to understand new tags.
- XML Schema is a language that introduces restrictions on the type and structure of data in XML documents to ensure that XML data is syntactically correct.
- RDF is a standard that allows data to be stored in the form of a directed graph. In this graph, the data is contained in the vertices, and the relationships between them and their properties are contained in the edges.
- RDF Schema introduces concepts such as classes and subclasses to graphs, allowing data with common characteristics to be grouped together. Any given piece of data can belong to multiple classes.
- OWL is a standard that allows classes to be defined based on data properties, as well as logical characteristics of relationships. OWL is therefore a standard that formally records ontologies.
- Ontologies are sets of statements recorded, for example, in RDF, defining relationships between concepts and setting rules for inference. Computers will be able to understand the semantic content of web documents by making references to the ontologies to which the concepts occurring in them refer.

Ontologies provide the terminology for such a description. It can be taken from classified domains, not necessarily dependent ones. In addition, ontologies must define logical relationships between concepts in order to ensure a deep level of analysis, as well as methods of search and intelligent inference by computer programs (Gładysz, 2017).

This leads to a comparison of a semantic network to an ontology-based knowledge management system, in which ontologies provide tools for the formal description of knowledge. Based on such a description, computer programmes can search and process data. It is thanks to ontologies that it is possible to integrate the vast amount of heterogeneous documents currently existing on the Internet.

The concept of ontology can also be viewed in the context of a model of a fragment of reality representing interesting objects and the relationships between them, as well as containing the required properties (attributes) of these objects (Perkowski, 2003).

The idea of *the Semantic Web* and the creation of *Semantic Web Services (SWS*) can be presented in three stages (Krukowski, 2005):

- Stage 1. Formulating the goal
  A user in *the Semantic Web* is represented by their software agent (e.g. a semantic search engine application), which contains, among other things, information on authorisation and security. The tasks carried out in the first stage are as follows:
  - the user enters their request (in natural language),
  - the semantic browser (using a language analyser) records this request using one or more ontologies; the request constructed in this way is called a goal; standardised ontologies are stored in a publicly accessible repository.
- Stage 2. SWS search
  Having formulating the objective, the user's programme agent connects to the intermediate layer agent and transmits the specific objective to it. Each request sent is assigned to an intermediate layer agent with access to the ontology repository, the goal repository, and the service description repository. The task of the intermediate layer agent is to search for services whose semantic description would be most compatible with the goal expressed by the user.
- Stage 3. Invoking web services
  Once the middle layer agent has constructed an execution chain from individual services, based on their semantic description, the individual services are invoked. They are represented by their agents. During the execution of the task flow chain, the middle layer agent continuously monitors its execution, communicating with individual service agents. Its responsibilities also include presenting the final results to the user.

The functioning of the Semantic Web in a simplified form has been presented in Figure 1.

Extensive research is being conducted on semantic search engines, which allow queries to be asked in natural language, and the returned results provide justifications of their application. Search engines should be equipped with additional links to pages containing more information.

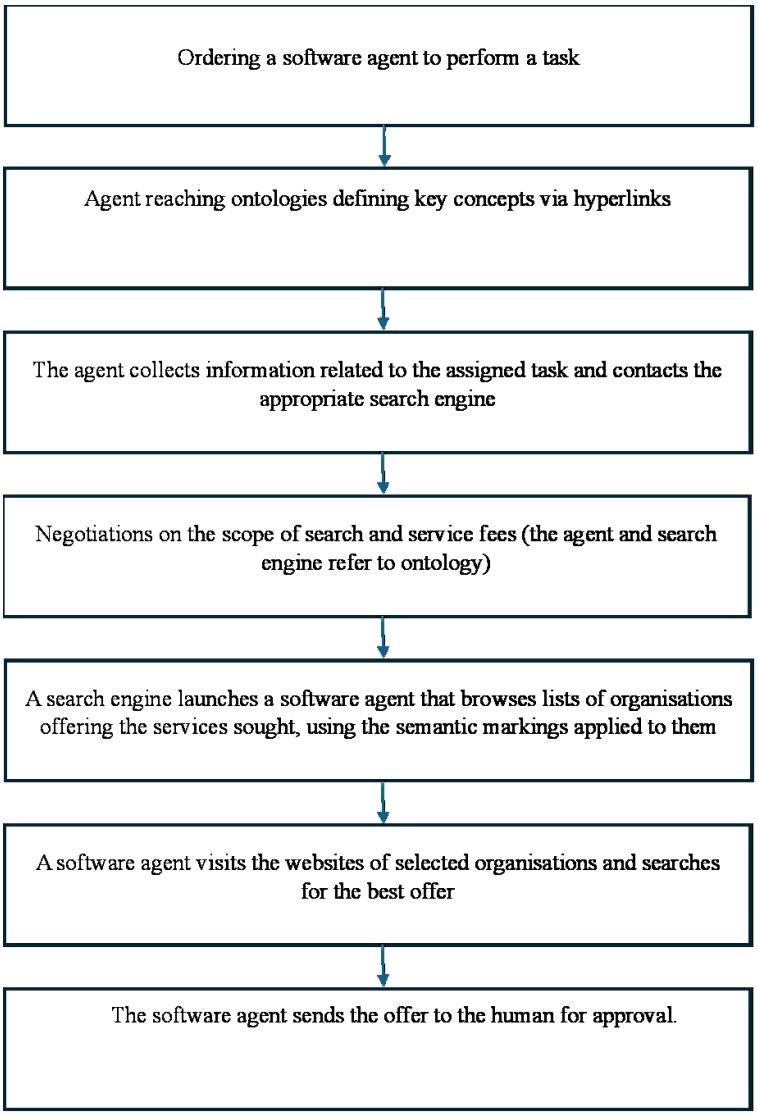

Figure 1. General structure of the Semantic Web.

Source: own work (Kiełtyka, 2020).

3. Semantic search engines

- Cuil search engine – this application features modern technology for indexing web resources and handling user queries. It provides very accurate search results. Cuil does not catalogue pages based solely on keywords taken out of key words taken from the content, but based on the connections between terms, creating natural chains of associations between them. This is a semantic approach; it does not use artificial intelligence to guess the meanings of indexed sentences. It uses a more effective algorithm that simply categorises websites more precisely (Maj, 2008).

- PowerSet (http://www.powerset.com/) – is a powerful semantic search engine owned by Microsoft. The tool allows you to define queries in natural language (English only). Answers are provided based on data from websites and the Freebase database (http://www.freebase.com/). By "understanding" the content of the query, the search engine allows you to obtain the most relevant results.
- Yahoo! SearchMonkey – displays additional links attached to the results already obtained. In addition, it is possible to create your own applications based on SearchMonkey search mechanisms.
- Rich Snippets – a tool from Google.
- Hakia (http://hakia.com/) – initially, the search engine was developed with the share of the Polish company PROKOM INVEST-MENTS S.A.

Thanks to this, the Polish language is offered. The tool is in the beta phase. Responses to queries may include specific facts, related links and photos.

An indispensable element *of the Semantic Web* is the digital signature – encrypted data blocks used by computers to verify that the downloaded information actually comes from a specific, trustworthy source. Agents should be sceptical about information found on *the Semantic Web* and verify its sources each time.

The true potential *of the Semantic Web* will be revealed when many programmes are developed that are capable of collecting information from various Internet sources, processing it, and exchanging the results with each other. Communication between humans and computers will then take on a new character, bringing it closer to the level of communication between humans (Kiełtyka, 2013).

Currently, attention should be paid to the rapidly developing area of management tools and platforms, especially when using Semantic Networks.

4. Tools and platforms used in Semantic Networks

The tools and platforms that will be briefly characterised in this section of the article assume a priori:

- fast and effective exchange of information,
- security in sending and receiving data,
- effective individual and team communication,
- integration with most commonly used tools,

Important tools and platforms used in Semantic Web concepts include:

- Chanty – a business communication tool that integrates chat, project management and collaboration functions in one place. It offers an intuitive interface, which makes communication within the organisation easy and effective (Chanty, 2024). Chanty is also a task management platform. With the ability to prioritise, set deadlines and share files, the team can work effectively on a project with all the necessary information in one place. Thanks to end-to-end encryption, even the most confidential conversations are protected from unauthorised access.
- Discord – a modern tool that facilitates teamwork and effective communication. It is a free application that enables voice and text communication, as well as real-time collaboration. It can be used on various platforms, including computers, smartphones and tablets, making it easily accessible to all team members, regardless of their location. Discord allows you to structure communication by using channels (Dobre Programy, 2024). This facilitates organised content management and access to all information within the organisation. Discord is a versatile messenger that works perfectly in a business environment. With voice and text communication, content structuring, integration with other tools, and data security, Discord becomes an invaluable aid in effective teamwork using the Synaptic Network structure.
- ClickUp – is a versatile project and task management system that integrates a range of features, enabling effective planning, monitoring, and execution of projects. It offers an intuitive interface that makes the platform easy to use, even for those unfamiliar with advanced technology.
- Fleep – an advanced communication and collaboration tool designed for organisations that want to optimise their business processes. Its main goal is to consolidate various forms of communication in one place, thus eliminating the chaos resulting from using multiple tools simultaneously. It allows you to create dedicated workspaces for teams that can be easily connected to project management programmes, calendars or documents. In an era of rapid technological development, tools such as Fleep are becoming indispensable for organisations wishing to keep pace with the competition Dobrakowski, 2024).
- Flock is an advanced business communication platform that combines chat, collaboration, project management and many other features. It is a tool that enables teams to communicate and collaborate effectively in one place (Chanty Blog, 2025). Flock offers project management features, allowing teams to effectively track progress, assign tasks, and create schedules. It is an ideal tool for organisations that want to maintain control over their project management functions without the need for separate applications.

- Glip – a modern communication and project management platform that integrates chat, collaboration, planning and organisation features in one place. It is a tool designed to facilitate teamwork, regardless of whether employees are in one office or scattered around the world. It supports real-time communication, especially when an organisation operates in an environment where the speed of response to market changes can be crucial. One of the main advantages of Glip is the ability to integrate project planning directly into the tool (Dhosting, 2023).
- Mattermost is an open platform for business communication. It is a kind of "chat for organisations", but with a much wider range of functions than popular instant messengers. It allows organisations to build their own private communication servers, giving them full control over data and security (Wysocka, 2023). Mattermost platforms enable integration with many other business tools, such as project management systems, collaboration applications and task monitoring tools. It is a powerful tool for managing communication within an organisation.
- Pumble – a communication and management tool that integrates with many features and tools (e.g. Google Drive, Dropbox, and Trello) to facilitate team collaboration. It is a so-called "combo" for project management, chat, and a place to store and share files. Using various forms of management, Pumble allows you to create projects, assign tasks, monitor progress, and supervise schedules. This allows project leaders to focus on their main goals while maintaining full control over the team's current activities (Google, 2022).
- Rocket.Chat – a flexible communication platform that facilitates organisational management and streamlines communication processes, keeping pace with technological developments and the evolution of communication tools, offering modern and effective ways of exchanging information. It is a flexible tool that can be self-hosted or used in a cloud version (Rocket Chat, 2025).

5. Summary

Work is currently underway to develop the standards needed to implement the concept of *the Semantic* Web. The aim is to enable information available on the Internet to be processed not only at the level of individual characters in a text, but also taking into account the structure of the document and the concepts contained in the text. The aim is to create and disseminate standards for describing content on the Internet in such a way that it can be processed by machines and programmes, taking into account the meaning and context of the information (Folta, Stolińska, 2012). The Semantic Web is based on ontologies (Abramowicz et al., 2010) and software agents. Ontology, as a specialised conceptual apparatus, "is intended to support

and be responsible for the efficient and unambiguous exchange of information between its users". The recipients of ontology are agents operating in information systems and within the framework of the Semantic Web concept. Managers (humans) will continue to make key decisions, but agent technologies and the IT systems built using them will represent them to a certain extent (acting in an autocratic role) and will assist them in decision-making (acting in an advisory capacity). The role of agent- technologies in building an information society defined in terms of human work should be assessed in terms of contradictions (mutual contradictions, discrepancies) rather than synergies (cooperation). The situation is different when it comes to identifying the role of agent technologies in building a digital society. A key issue for the development of agent technologies is the continuation of work related to the creation of Semantic Internet standards, and in particular the popularisation of ontology as a method of knowledge representation in an IT system (Niedbał, 2015).

Abstract

This article provides a concise overview of the key issues in semantic network structures. The descriptions focus on supporting management processes, primarily during project work. The components of a semantic network operating on a set of statements used in ontological terminology have been characterised. The operation of a semantic network is presented in three stages: goal formulation, SWS search, and web service invocation. Semantic search engines based on natural association chains are presented and described comprehensively, along with the tools and platforms used in semantic networks. Software agents, indispensable in semantic network systems, are mentioned.

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