

Web 3.0 in Decision Support Systems

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Abstract

This study presents the relationship between current technologies- Web 1.0, 2.0 and third generation of the web which is Web 3.0. Web 3.0 is the last evolution of web that requires Web 2.0 technologies, semantic web and artificial intelligence. The Web 3.0 technology is a system that includes Web 2.0 technologies (that provides rich content and interaction between users), semantic web technologies (which try to understand and interpret of the data) and basic artificial intelligence (which provides ability of thinking to the machines like a human being). Web 3.0 technologies are expected to be implemented in education, search engines and decision making processes in the near future. Machines can contact both with people or machines in Web 3.0. Web 3.0 in Decision Support Systems that is new developing web technologies help the decision maker for decision making process.

Keywords: Decision support systems, Web technology, Web 3.0.

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ABSTRACT

This study presents the relationship between current technologies- Web 1.0, 2.0 and third generation of the web which is Web 3.0. Web 3.0 is the last evolution of web that requires Web 2.0 technologies, semantic web and artificial intelligence. The Web 3.0 technology is a system that includes Web 2.0 technologies (that provides rich content and interaction between users), semantic web technologies (which try to understand and interpret of the data) and basic artificial intelligence (which provides ability of thinking to the machines like a human being). Web 3.0 technologies are expected to be implemented in education, search engines and decision making processes in the near future. Machines can contact both with people or machines in Web 3.0. Web 3.0 in Decision Support Systems that is new developing web technologies help the decision maker for decision making process.

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INTRODUCTION

New web technologies are required for meeting the increasing human needs. Web is used not only for human needs, but also for communication between people or machines. The main properties of current web technologies are integrated, user oriented and providing rich content. However, rapidly changing human needs and technologies are caused by faster, more interactive and intelligent web technologies. Decision Support System (DSS) is a computer based application that helps people to make decisions for business and/or organizational activities. DSS facilitates decisions of service and production systems like health, industry and education. Dynamic structures and characteristics of the systems make hard to take decisions. Decisions are also needed in web technology; thus, web technologies use decision support systems. It is designed to help the decision maker for decision making process. DSS makes it easy for the web users to search and find by using these types of technologies.

Nowadays, people mostly use e-commerce sites for all their needs. Thus, web technologies are used online shopping due to meeting people needs. However, new web technology must be faster and more intelligent because existing web technologies offers results and alternatives in millisecond. Intelligent systems facilitate decision making process more sensible. These systems are defined as “An intelligent system is a machine with an embedded, Internet-connected computer that has the capacity to gather and analyze data and communicate with other systems” (Wigmore, 2013). Basic elements of intelligent web applications are content, algorithm and reference (which is called triangle of intelligence) (Marmanis and Babenco, 2009). Content is the raw data that is collected behavior of all users. Reference (knowledge) is obtained by interpretations of the raw data. Thinking ability of the web is given by an algorithm.

Web technology has three evolutions. The first phase of web technology provides information published on the website to only be read. WEB 2.0 has interaction between web designers and users that both web developer and user contribute sharing or adding extra information. The third evolution of web, Web 3.0 technology, requires Web 2.0 technologies, semantic web and artificial intelligence. Web 3.0 in decision support systems is presented and foreseen in some Web 3.0 application areas given in this study.

The rest of the chapter is organized as follows: previous several studies about decision support systems and web technology are given at background. In the next section, properties of DSS and WEB technology are defined. Web 3.0 (semantic web, web 2.0 and artificial intelligence) is given in the following section. Then, several future research applications are presented. Conclusion is given in the last part.

BACKGROUND

Although the literature on Web 1.0 and 2.0 is extensive, the studies on Web 3.0 are quite fewer. Arnot and Pervan (2005) have investigated 1020 DSS articles from 1990 to 2003. Some classification standards are “personal decision support systems, group support systems, negotiation support systems, intelligent decision support systems, knowledge management based DSS, executive information data warehousing and systems/business intelligence” according to Arnot and Pervan (2005).

Pattal et al. (2009) focus on relationship between Web 2.0, Web 3.0 and the Semantic Web. They also consider rising security concerns about rapid and sequential Web developments. The distinctions between Web 1.0, 2.0 and 3.0 applications can be summarized. The characteristics of the web generations are introduced and compared by Aghaei et al. (2012).

Semantic web is improved for being understandable, interpretable and usable by the software through smart agents according to Demirli and Kutuk (2010). Social networks and other Web 2.0 applications have been examined from a legal perspective. Probable social and economic changes are assessed considering new development of internet by Koc (2013).

Web 2.0 and 3.0 technologies are mentioned based on teaching and learning experiences for distance education system by Kimbrell (2013). Murugesan (2010) presents basic features and characteristics of Web 2.0, 3.0 and X.0. Also the meaning of Web X.0 and differences of between web technologies is given in detail.

WEB TECHNOLOGIES IN DECISION SUPPORT SYSTEMS

Decision Support System is a computer-based system that helps users that helps decision making process of problem solving and the identification of users' data and model (Ngai et al. 2014). Web 3.0 is the third phase evolution of World Wide Web, focuses on understanding of the information that establishes logical connection between the whole web networks (Maxwell, 2010). According to these two definitions, Web 3.0 in decision support systems (WEB3-DSS) is defined as smarter and more intelligent decision support systems in web technologies. WEB3-DSS helps the web users during decision making process. In this part of the study, definition and properties of DSS will initially be identified. Web 3.0 technology is given in detail according to Web 2.0, semantic web and artificial intelligence.

Decision Support Systems

DSS facilitates decision making process for organizations. Decision making is very hard in today's growing service and production systems. Many factors such as competition and dynamic structures must be considered during the decision making process. Decision makers will apply decision support system taking into consideration of these factors by using integrated computer-based information systems. The general characteristic properties of decision support systems are described (Holsapple and Sena, 2003) as follows:

- DSS includes that “how to accomplish various tasks” and “which conclusions are acceptable for different situations”.
- It has the ability to acquire and maintain descriptive knowledge.
- It can present knowledge in various customized ways and standardized reports.
- Choosing beneficial information from subsets of stored data. Moreover, at the problem recognition and/or solution process can present or derive new information.
- A flexible choice which enables direct *interaction* between decision maker and users is possible
- It provides *coordination* between participant decision makers.

Decision support systems can be differently classified according to their properties. One of these classifications is categorical classification based on user's level. According to categorical classification DSS is divided into three groups: passive, active and collaborative. Passive DSS only facilitates the decision making process but it does not produce a solution or suggestion unlike Active DSS. Collaborative DSS proposes many suggestions that are changed and formed according to wishes and needs of user. Developing web technologies require Collaborative DSS.

A typical decision support system consists of three subsystems which are data, model and dialog management. Data management stores and manages the information Model management subsystems not only help creating model but also provide sustainability of the model. Dialog management plays the role of interface in DSS in which decision makers interact with DSS and various analysis are implemented.

Web 2.0

Web 2.0 is the second generation of the web technologies. Web 2.0 focuses on user-based technology. This term is firstly used by O'Reilly in conference of the internet communication in 2004 (O'Reilly, 2005). Web 2.0 technology has been developed due to the lack and insufficiency of the Web 1.0. Although static HTML pages are used at Web 1.0, dynamic web pages are required at the second phase evolution of the World Wide Web. Especially, visual and technological progress is provided by means of WEB 2.0 technologies (Aksu et al. 2011). Collaboration and sharing of the information is possible between users and developers on the Web 2.0.

Some applications of Web 2.0 are as follows (Haughn, 2015):

- Wikis: It is defined as contribution, collaboration and edition of the web pages.
- Mash-up: It is a complementary element for web pages and applications.

- Social networking: This provides connection between users.
- User generated content: Available information over the web can be read, interpreted, commented by users.
- Unified communications: individual user can control the integration of multiple forms of call and multimedia functions.
- Social curation: one or more themes and topics are arranged by collaborative sharing of content.

Semantic Web

Nacer and Aissani (2014) describe semantic web as an extension of the current web in which knowledge is given in a well-defined meaning by using ontologies. Some basic components of Semantic web are such as Resource Description Framework, Simple Knowledge Organization Systems, Web Ontology Language and Rule Interchange Format (Borsje et al. 2006).

Semantic structures are able to implement many business work areas. More recent work on application of semantic web technologies are logistics, tourism, collaborative work, finance, telecommunication, bioinformatics, business intelligence, geographic intelligent systems (Grimm and Abecker, 2007). To give an example of semantic web system, when “driver” is written into search engine, the first related word will be “car”. Semantic web technology will establish a relationship between driver and car. Semantic structure can also understand and interpret sentences. “*True Knowledge*” search engine is an example of the semantic web technology (Dataversity, 2011). Especially, when “sentences” are written on the search engine, Semantic web ensures a logical and reasonable relationship. Moreover, it offers alternative and associated results according to requested sentence.

Semantic technology helps the decision maker by means of interpretation of the data. After the interpretation of the data, it provides associated/related results. *Recommendation systems* also have same goals. In recent years, there has been an increasing amount of literature on recommendation systems. Predicting users’ responses is main purpose for a recommender system. Though semantic web searches the relationships, recommender systems offer alternative solutions according to user behaviors. Thus, the relationship between semantic web and recommender systems is important. Most current web sites have recommender systems. Recommender system helps users on the decision making. For instance, if a person wants to choose movies from the internet, he/she will watch trailers first. However, every month or even every week a new release movies are seen. If he/she wants to watch an action movie, system might recommend some movie trailers according to the former users’ options using data mining techniques. These kinds of systems consider previous information of the users and guide them in the next stages.

WEB 3.0

Web 3.0 integrates data, knowledge and applications on the web using collaborative platform that makes the web meaningful (machine-centric) unlike Web 1.0 connecting information (info-centric), and Web 2.0 connecting people (people-centric) (Murugesan, 2010). The Web 3.0 technology is a system that includes Web 2.0 technologies (that provides rich content and interaction between users), semantic web technologies (which tries to understand and interpret of the knowledge) and basic artificial intelligence

(which provides ability of thinking to the machines like a human being). According to the definition of the Web 3.0, WEB3-DSS is a system that can manage the decision making process using developed web technologies.

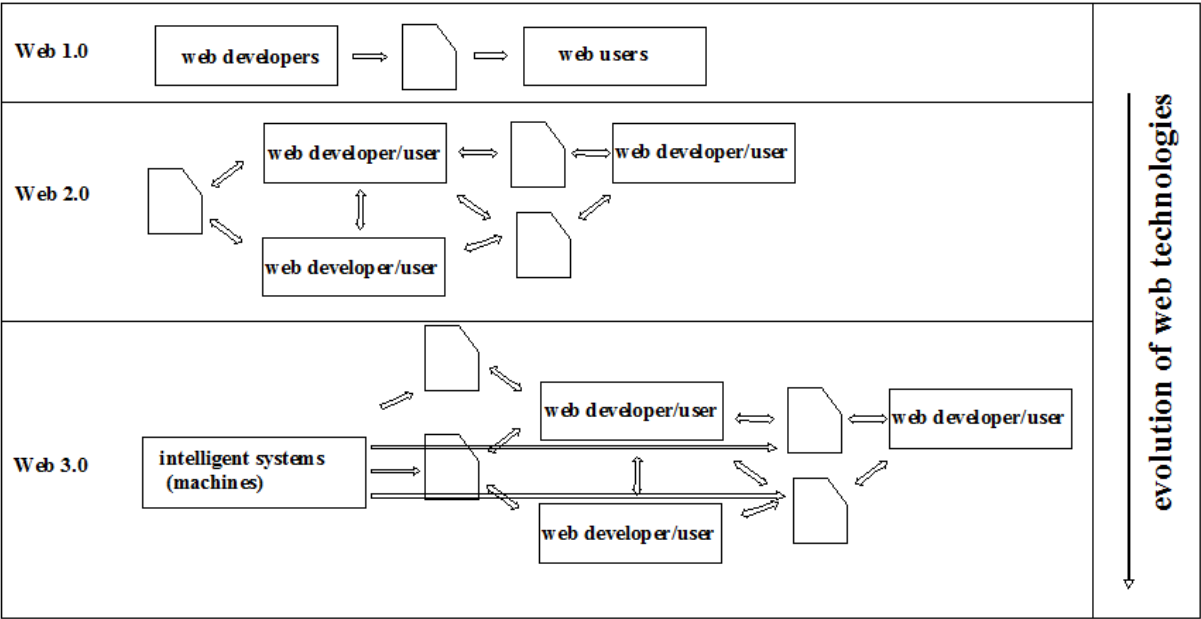


Figure 1. Evolution of the web technologies (from web1.0 to web 3.0) (Martin, 2007)

Figure 1 demonstrates development of web technology from Web 1.0 to Web 3.0. The direction of the arrows shows interaction between users and developers. Web developers (producer) create a new web page and web users (consumers) can only browse it. The first phase of web technology provides information published on the website to be only read and searched for internet users. Well-known examples of Web 1.0 are like online dictionaries, personal web sites, university web sites, and blogs. Second phase is WEB 2.0 which has interaction between web designers and users. Web developers present information by means of websites and moreover, web users can contribute the content. Each user is also a producer (because of the interaction between designers and users). They will share their comments and add extra information. Classic examples of Web 2.0 are social networks (such as Facebook, Twitter and Instagram) and online examination. Web 2.0 is introduced in later sections in detail. Web user can share pictures on Facebook, Twitter or Instagram and other users can write comments or like the pictures. In recent years, web has some changed because intelligent systems are used for the management of web that is called WEB 3.0. In addition to Web 2.0, Web 3.0 needs intelligent systems for understanding and interpretation of the information on the web page. Semantic web is needed for this smart structure. Some authors claim that Web 3.0 and semantic web are same due to common intelligent structure. However, they are not the same but not completely different.

Table 1. Properties of web technologies (Aksu et al, 2011)

WEB		
Web 1.0	Web 2.0	Web 3.0
1990-2000	2000-2010	2010-2020

Properties	online	global, any time accessible, interactive	user-oriented	user content, user interaction, user platform	faster	unlimited information and access, parallelism
	publishable	rich content, current, customizable	rich content	Multi-media, labeled, free content	interactive	multi-dimensional, transparency of the device and space
	user	online transactions, searchable	integrated	web standards, browser standards, service standards	smart	semantic, artificial intelligence
	innovative	original	innovative	original	innovative	original

Some properties of Web 1.0, 2.0 and 3.0 are indicated in Table 1 in detail. These three types of web technologies have different properties besides common properties like being innovative. Table 1 demonstrates that Web 1.0 is online and publishable. This technology submits rich and customizable content however only presents readable or searchable information. Web 2.0 has common properties with Web 1.0. Moreover, one of the most important extra features is being user-oriented (that refers to taken into account users). Web 3.0 has not only Web 2.0 properties but also has features like being high speed, interactive and intelligence. Interactive means multi-dimensional web and transparency of the device for web technologies. Machines can contact with people and other machines like people. Connection between devices is possible with intelligent structures. Thus, semantic web structure and artificial intelligence are specific features of Web 3.0 technology.

Distinctions between Web 1.0, 2.0 and 3.0 applications are shown in Table 2. According to the Pattal et al. (2009), application of Web 3.0 are quite fewer. For instance, online games are an example for Web 2.0 while PC games are Web 1.0. However, online 3D-games are an example of Web 3.0. While Web 1.0 and 2.0 have some application examples of video based systems (home video and YouTube), Web 3.0 does not have any examples yet.

Table 2. Distinctions between web applications Pattal et al. (2009)

Web 1.0	Web 2.0	Web 3.0
FrontPage	MySpace	SIOC-project.org
Encarta	Wikipedia	Dbpedia
Streetmap/MapQuest	Google earth	3-D Street View
PC games	Online games	Online 3D-games
Home video	YouTube	Yet to come
Mp3.com	iTunes	Yet to come
Microsoft Office	Google Docs	Yet to come

Semantic web obtains an understanding of knowledge. Furthermore, artificial intelligence techniques also allow thinking ability of the internet. Integration of the Semantic web and basic artificial intelligence create the WEB 3.0. A simple example can help to understand of the integration process: some keywords are used while searching of the information on the internet. Search engine offers some alternative solutions according to the words that passed (labeled) on the internet before. The meaning of

the sentence or word can be understood through web 3.0 technology instead of giving alternative pages related to the keywords.

Operating principle of the Web 3.0

Web 3.0 has common operating principles with semantic web. Firstly, a new system is developed with the desired characteristics using an intelligent system. The collection of the necessary data (users' behaviors) is the next stage for the sustainability of the system. Stored users' behaviors help the intelligent systems at the decision making process. Since, learning ability of the system depends on the performance of the intelligent system. Selecting the most appropriate intelligent system is based on previous experiences of the web designer and the performance of the intelligent system depends on the ability of the designer as well.

Basic properties of the Web 3.0

Web 3.0 consists of three main components which are semantic web, web 2.0 technologies and basic artificial intelligence (Murugesan, 2010). Figure 2 demonstrates the components of the newly developed web technology. In spite of the widespread use of WEB 2.0, web developers foresee raise of the semantic web technologies. However, semantic web requires more intelligent systems like basic artificial intelligence techniques (AI). AI has some components such as learning, reasoning, problem solving, perception and language understanding (Copeland, 2000). People prefer faster and smart technologies like this new technology which is called the Web 3.0 to meet and satisfy the needs of people.

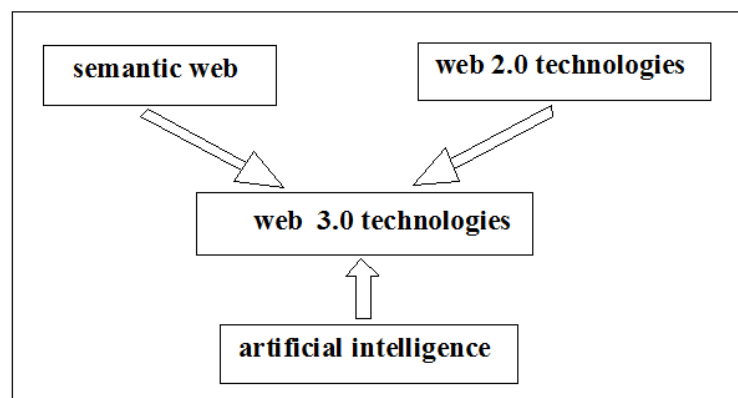


Figure 2. Components of Web 3.0

Users may share their comments and can add extra information for contribution. Collaboration between users and designers is very important at Web 2.0 (Social networking sites can be given the most familiar example). If these types of technology combine semantic infrastructure to basic artificial intelligence, information and people centric web technologies will be converted to machine-centric. This offers faster and more intelligent web technology.

FUTURE RESEARCH DIRECTIONS

Considerably more work needs to be done to determine application areas of new web technologies. However, Web 3.0 technologies are expected to be implemented in education, search engines and decision making processes.

In education, web technologies will be used especially in distance education. Educators present a lecture and evaluate student assignments and exams by means of distance education system. Students select their lessons and lecturers at the beginning of the semester, they can ask questions during or after the lesson. Considering the situations of educators and students, some changes can be more effective and beneficial for education system by using developing new web technologies. Considering the student questions, exams and assignments can be prepared by intelligent systems in which machines (Web 3.0 technology) maybe used at the preparation of the questions instead of the people (lecturers).

If a student who wants to choose a university writes “university rankings” into Google search engine, 148 million results are obtained at 0.38 seconds. Looking at millions of web pages is not possible and sensible for selection of the proper university. The student's goal is to select the most appropriate university considering university rankings. Search engine in Web 3.0 will present universities as a group according to the students’ interests and wishes for their decision.

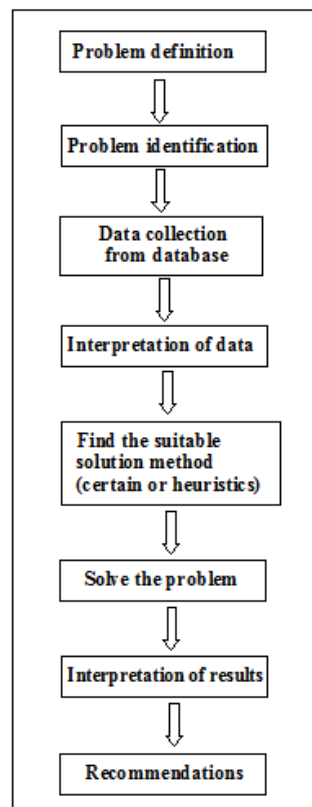


Figure 3. Web 3.0 in DSS

Basic steps of decision-making process are shown in Figure 3. These steps are managed by decision makers from start to finish. Instead of the decision makers, web technologies should facilitate decision making process. Thus, DSS will be the most important application area for Web 3.0. Problem is defined by the responsible person at the decision-making process. In the following stage, Web 3.0 technology will be used at all remaining steps in the near future. Web 3.0 starts with problem identification for DSS and problem types should be identified using Web 3.0 such as vehicle routing, scheduling or assembly line balancing problem. At the third and fourth stages of the decision making process, the necessary data must be collected from the database. However, people centric systems are very slow in collecting data.

Instead of the human, new web technology will collect, interpret and evaluate data for systems. Selection of the convenient solution method is one of the most important stages. In this fifth stage, Web 3.0 will help the selection of the solution methods and decision problem will be solved with exact algorithm such as branch-bound/branch-cut algorithm or heuristics methods such as genetic algorithm, particle swarm optimization or ant colony optimization. Solution methods will also be integrated with new web technologies. Thus, there is no need of people in order to run optimization programs. Not only running model but also interpretation of the results will be done by Web 3.0 technology that will present faster and more accurate results. At the final part of the decision making process, Web 3.0 will present efficient and effective feedback to decision makers.

CONCLUSION

In this paper, Web 3.0 technology in decision support systems is presented and some foreseen Web 3.0 application areas are given. Web technologies start with connection of information and continue with connection of people. But new web can understand, interpret and manage the information with the integration of whole technologies that establishes logical connection between networks. New Web 3.0 technology requires Web 2.0 technologies, semantic web and artificial intelligence. Third evolution of web will be faster, more interactive and intelligent than current technologies. Web 3.0 technologies are expected to be implemented in education, search engines and decision making processes. Especially, new developing web technologies help the decision maker for decision making process.

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