Evolution of the Web and its Uses in Healthcare

HASSAN A. AZIZ, AISHA MADANI

LEARNING OBJECTIVES

1. Define the term "world wide web".
2. Identify and describe the roles of the pioneers responsible for the development of the world wide web.
3. Describe the evolution of the generations of the web.
4. Compare and contrast the four generations of the web.
5. Discuss the current and potential applications of the web in healthcare.

ABBREVIATIONS: UDI - Universal Document Identifier, HTML - Hypertext Markup Language, HTTP - Hypertext Transfer Protocol, URI - Universal Resource Identifier, GWT - Google Web Toolkit, RSS - Really Simple Syndication, W3C - World Wide Web consortium, EHR - Electronic Health Record , HIS - Hospital Information System , LIS - Laboratory Information System, PACS - Picture Archive and Communication System

INDEX TERMS: Internet; Social Media; Computer Communication Networks; Public Health Informatics; Web 3.0; Web 4.0

Hassan A. Aziz, PhD, MLS(ASCP)^cm, College of Arts and Sciences, Qatar University, Doha – Qatar

Aisha Madani, Weill Cornell Medical College – Qatar, Doha – Qatar

Address for Correspondence: Hassan A. Aziz, PhD, MLS(ASCP)^cm, Associate Dean for Academic Affairs, Director and Associate Professor of Biomedical Science, College of Arts and Sciences, Qatar University, P.O. Box: 2713, Doha – Qatar, 00974-4403-4783, Hassan.Aziz@ qu.edu.qa

INTRODUCTION

Before the Internet, people obtained health information from consulting a healthcare provider, books, magazines and newspapers or simply by asking family and friends. Nowadays, the internet has become a major source of information for those who have access to it. Large numbers of patients rely on the internet as a source for their queries regarding medical information including diagnosis, control, treatment and prognosis of either their own health or relatives and loved ones.

The world wide web is not identical to the internet but it is the most prominent part of it. The "web" is defined as a techno-social system that allows individuals to interact on technological networks, thus improving individual's cognition, communication and cooperation.[1] The revolutionary idea of the web was introduced by Tim Burners Lee. The web and its related technologies have progressed tremendously in the past two decades. Four generations have risen since the launch of the web. The web of cognition was known as "Web 1.0", which was considered as the first generation and a read-only format of the web. Although revolutionary, it provided limited user interaction especially for commercial businesses to share information with customers. It was basically used to search for information and read it. Second came "Web 2.0" with the ability to read and write. It allowed managing significant crowds with common interests in social interactions as defined by Dale Dougherty in 2004. The semantic web, "Web 3.0", provided machine-readable content on the web. It is made up of two main platforms, the semantic technologies and social computing environment. These two platforms provided two important tasks. The semantic technologies characterized open standards that could be applied on the top of the web. The social computing environment allows human machine cooperation arranging a large number of the social web communities. The symbiotic web, "Web 4.0", is on the horizon. It will be a web of intelligent interaction in which human mind and machines can interact in

symbiosis. The differences between all the four generations of web are numerous as well as their utilization and application in different areas especially in healthcare.

The Informational Web 1.0

Developed in 1991, Web 1.0 refers to the first version of the read-only web. It was known as the "informational mono-directional web". Web 1.0 was a source of information generated by a limited number of authors for a large number of users so it operated mainly like a library of reference books.[8]

Tim Burners Lee was successful in creating a common information space to enable the communication between people by sharing information. The idea came into fruition through Lee's creation of a global hypertext space in which any network could access information by a single Universal Document Identifier (UDI). The technologies of the informational web included: Hypertext Markup Language (HTML), HyperText Transfer Protocol (HTTP) and Universal Resource Identifier (URI) that were updated infrequently. Web 1.0 didn't disappear, yet it was covered with the social form of Web 2.0.1

The Social Web 2.0

The social web, "Web 2.0", emerged by Dale Dougherty and was promoted by Tim O'Reilly in a conference at a brainstorming session between O'Reilly and MediaLive International in the year 2004.[2] Users in Web 2.0 were actively communicating, collaborating with each other and building connections across the web. All of these features made the new web an outstanding tool to support collaboration. Also, the exponential growth from Web 1.0 to Web 2.0 emerged in a way that the content could be easily generated, published by users and facilitated new online activities, which were not achievable with the previous Web 1.0 model.[6] The most important feature of Web 2.0 was that it encouraged human approach and supported group interaction on the web. It had been claimed that Web 2.0 could be people-centric making it suitable for healthcare applications.[12] Google Web Toolkit (GWT), blogs, really simple syndication (RSS), Flex, tags, mash-ups, and wikis were examples of the main technologies and services of Web 2.0.1. These applications enabled end-users to build and share their own media with little technical knowledge.[7]

The Semantic Web 3.0

The third generation of web emerged in 2006 and it was termed the semantic web as suggested by John Markoff of the New York Times. It is the current evolving version of the web, where the software agents use "meta-data" to read, compare and integrate information to develop them into intelligent responses to the operators.[8] The developed applications of Web 3.0 enabled users to perform several tasks, such as collecting information from different sources and searching relevant information to effectively meet the needs of the users.[7] Also, it improved data management, supported globalization and collaboration in the social web and increased the accessibility of mobile Internet. In addition, it included sophisticated properties, which were important machine facilitated tools in understanding of information such as, natural language, micro format, machine learning and data mining.

The World Wide Web consortium (W3C) pursued developing, improving and standardizing the system, languages and publications through this generation in an attempt to make the web readable by machines and not only by human. Many established corporations are taking the lead into Web 3.0 technologies. For examples, Ontoprise, a German company, focused on ontology related tools while another European enterprise called Mondeca focused on information integration. Larger corporations such as Microsoft, IBM and Oracle are getting into this area as well.[7]

Differences between Web 1.0, 2.0 and 3.0

Table 1 summarizes the detailed differences between the three web generations.[9] The key differences between them are:
- Web 1.0: read only web that focused on content creativity of producer
- Web 2.0: focused on content creativity of users and producers
- Web 3.0: linked data sets are the main focus.

The Dream of Web 4.0

The revolution of Web 1.0 through Web 3.0 generated the dream of having an interaction of a symbiotic web between users and machines in terms of the Ultra-Intelligent Electronic Agent, Web 4.0 (also called as

Table 1. Detailed summary of the differences among the web generations

Web 1.0	Web 2.0	Web 3.0
1991	2004	2006
Informational Web	Social Web	Semantic Web
Tim Berners Lee	Tim O 'Reilly	Tim Berners Lee
Read Only	Read and Write	Read, Write & Execute
Distribution	Communication	Engagement
Connect Information	Connect People	Connect Knowledge
Text and graphic based flash	2D portals, Wikis, videos, personal publishing	3D portals, avatar representation, integrated game, education and business
Content published by providers to consumers	Content published by people or companies and other people can consume and publish content to other people, such as YouTube, flicker.	Applications built by people or companies so that others can interact with it and l-publish services, such as Facebook, Google maps.
Search engines retrieve macro contents very fast but many times results are inaccurate or more than users need.	Search engines retrieve tags with micro contents. The tagging is manual and covers small percent of the WWW. It tags everything: pictures, links, events, news, blogs, audio, etc.	Search engines retrieve micro content texts and tag automatically so it translates billions of Web 1.0 macro contents into micro contents, resulting in more precise search.
The content was static, one way publishing without any real interaction between readers or publishers.	It is a two-way communication through social networking.	It is undefined and delivers to you a Personalized web experience.
The web in the beginning when it was first developing web 1.0	Sophisticated user interaction with web pages.	More interactive with users, leading to a kind of artificial intelligence.
Personal web sites	Blogs	Semantic blogs such as Semi Blog and Haystack
Content Management system	Wikis, Wikipedia	Semantic Wikis: Semantic Media-Wiki

WebOS). Possibly it will be tremendous and powerful interfaces that are mind controlled using Web 4.0, where the machines would be smarter in building more commanding interfaces in reading, writing, execution and concurrency. This generation of the web will be as a middleware that will function like an operating system. Moreover, it will infer a massive web of intelligent interactions that will be similar to the human brain. There is no exact definition for this generation, yet the great developments of the web so far will assure more technologies and application to be added using artificial intelligence.[1] The first Web 4.0 consumer electronics was created by Rafi and Olivier. For instance, visiting a popular website, i.e. amazon.com, more than once, the Web will recognize you and provide you with related advices. It is therefore the goal of this web generation to migrate the online functionality into the physical world.[13]

Applications in Healthcare

Web 2.0 applications have been widely used by many online health related professionals and healthcare organizations because it provides a powerful way of sharing information and ease in collaboration.[14] A broad range of technologies is introduced into healthcare through Web 2.0 such as "personal health application" and "personally controlled health record".[15]

If the technologies of Web 2.0 are applied into a healthcare system, five key themes will emerge: social networking, participation, apo-mediation, collaboration and openness. These themes enable healthcare transaction and treatment to be clear with the potential to improve patient safety and effectiveness of medical care. Web 2.0 plays a role in the management and support of patients in the main three aspects of healthcare; prevention, diagnosis and treatment. In this context, many applications are available to monitor patient's health problems. These applications can support healthcare professionals and patients.[6] Additional applications can be explored in the areas of research and training for medical professionals.

There are several examples of the adaptation of Web 2.0 tools in healthcare:
- ➢ HealthMap
  - ▪ The application aggregates information to examine outbreaks of different conditions using RSS feeds, which are combined with Google Earth.[4]
- ➢ SecondLife
  - ▪ Virtual patients can visit a health information island to receive real information from real physicians about health and medical conditions.4
- ➢ Flu Wiki
  - ▪ Local public health officials can monitor spread of influenza infections and prepare for epidemic and outbreak.[6]

The current access to the unorganized information in Web 2.0 shifts the online habits of physicians to build better way for information retrieval.[17,18] Web 3.0 generation enables computers to talk to each other and to perform the necessary required tasks. Web 3.0 applications utilize metadata, which means data about data, transforming into a huge database and later organizing it into more meaningful information.[19]

Web 3.0 will be an important challenge for the doctors in healthcare organizations, since greater personalization and the treatment of patient's health problems is relying on the usage of the latest technologies. The benefit of using this system and making the search for health information available to patients will result in reducing the cost of medical treatment. As an example, the epidemiological datasets integrated with the three-dimensional use of Google Earth can provide a warning system for natural disasters and new disease.[3] Additional examples of the adaptation of Web 3.0 tools in healthcare and medicine are PubMed and the Cochrane Library. They are both trusted databases in biomedical fields. Another example is Wikiproteins. It uses semantic technologies and is unique in importing mined data from several trusted databases such as PubMed and the National Library of Medicine. It combines the genetic information and scientific literature. [20]

An application of Web 4.0 has been launched recently called "WebView". This application provides a fast review of patient's reports and images from operating systems such as (Windows, Mac and tablets) and any HTML5 web browser such as (Chrome, Safari). It could be integrated with the Electronic Health Record (EHR), Hospital Information System (HIS), Laboratory Information System (LIS) and voice recognition software. This application provides a sophisticated clinical images management, well designed reporting system for cardiology, obstetrics, gynecology and radiology. The reporting system in this application has a powerful Picture Archive and Communication System (PACS) imaging archive and tremendous imaging review workstations, a built in clinical database, and comprehensive analysis and reporting.[10]

CONCLUSION

The collaborative tools and social networking of the web are taking the lead now in bringing patients together to discuss their health related problems. The revolution of web generations from Web 1.0 to 4.0 affects the technology enterprise as well as the healthcare sector in adopting the latest technologies that best serve the patients and physicians. Several applications of Web 2.0, 3.0 and recently Web 4.0 are

becoming widely available to increase workflow efficiency and to move toward patient centered information resulting in overall improvement in healthcare.

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