Web Science

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Synonyms

Science for the Internet; Science for the Web

Definition

The Web is the largest human information construct in history and it is transforming society (O'Hara and Hall 2008). Understanding what the Web is, engineering its future, and ensuring its social benefit necessitate new interdisciplinary approaches and research methodologies. Web Science (http://webscience.org/webscience.html) is a new interdisciplinary field that studies the Web as both a piece of engineering and infrastructure (micro level) and a phenomenon that impacts society and human activity (macro level).

Web Science employs interdisciplinary research approaches (Berners-Lee et al. 2006, Hendler et al. 2008). Due to the size and the dynamicity of the Web, we may consider it as a complex natural phenomenon that deserves to be studied as such, with the help of all classical means used by the natural sciences (observations, experiments, simulations, models, abstractions, generalizations, interpretations, forecasts). At the same time, the Web represents also the first realistic natural laboratory for controlled experiments on human behavior especially when humans (and machines) perform the highest intellectual activities of information processing; studying the ways in which the Web transforms society and human activity thus requires the use of interpretative approaches found in social sciences. Modeling and analysis of the Web also requires formalisms from computer science, mathematics, and statistics.

Theoretical Background

Web Science was launched in November 2006 by scientists affiliated to the Massachusetts Institute of Technology and the University of Southampton in order to introduce a holistic approach to researching the Web as an infrastructure; and a phenomenon that affects society and human activity. Other institutions soon expanded that effort (Shadbolt and Berners-Lee 2008; Hendler et al. 2008). The scale of the impact that technical innovation on the Web can have on society, e.g., the societal impact of the growth of blogosphere, established the need for Web Science.

The study of such impact on a macro level needs new methods of analysis different to those that have so far been employed on the micro level to study or engineer the introduction of technical changes in systems, applications, or protocols. Continuing innovation on the Web that involves the rise of semantics (Shadbolt and Berners-Lee 2008) and linked data (O'Hara and Hall 2009) is expected to lead to a similar impact on society rapidly expanding from a micro level to a macro or global level.

Web Science draws from a set of complementary disciplines and brings together aspects of Computer Science, Sociology, Psychology, Biology, and Economics (Shadbolt and Berners-Lee 2008) but in terms of research activities it is seen as more than the intersection of these research areas and less than their union. The basic premise is that the combined Web-related research efforts from these disciplines will have an effect larger than its parts: the notion of emergence of constructive patterns from interconnected autonomous agents, be them human or artificial.

The main expectations of Web Science are that it will enable a more thorough study of the Web ecosystem where simple rules can give rise to complex phenomena and that it will address the need for a holistic approach to researching the Web infrastructure integrating both social and technical methodologies. It is thus expected to address needs for the Web to be both engineered and understood and to thereby gain an insight into what phenomena may

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be coming with the Web and how they may impact society and human activity (Shadbolt and Berners-Lee 2008).

Learning About the Web

The question of what forms the curriculum of the subject of Web Science is under active debate (http://webscience.org/curriculum.html). The chosen areas should contribute to understanding, engineering, and ensuring the social benefit of the Web. In the previous section we show that Web Science is an interdisciplinary subject, and research in Web Science will require contributions from a wide range of subjects including Mathematics, Sociology, Computer Science, Law, Ecology, Artificial Intelligence, and Economics. This provides particular challenges for the design of Web Science courses as it becomes necessary to take a truly integrated interdisciplinary approach rather than teaching about each of the contributory subjects in isolation.

The initial pass at the Web Science curriculum emerged after the Network for Web Science Workshop on Web Science Curriculum in September 2008 in Athens which suggested six topics:

1. The History of the Web. This covers the history of the Internet and the work of the pre-Web hypertext visionaries, as well as the Web timeline.
2. Building the Web. This covers the technologies, standards, and algorithms that are used to engineer the Web as well as aspects of governance and community inclusion in the process.
3. The Web in Society. This covers the coevolution of society and the Web, and will include issues of privacy, IP and copyright, and collective intelligence.
4. Deploying the Web – Operationalizing Web Science for a World of International Commerce. This covers the basics of information systems, online markets, and E-Commerce as well as the associated technologies.
5. Analyzing the Web. The study of methodologies to analyze the Web graph and data mining the information it contains.
6. Understanding Web Users. The study of methodologies to analyze the behavior of users on the Web.

While these topics create a coherent curriculum that addresses the objectives of Web Science, the interdisciplinary nature of such courses presents issues both in finding suitably qualified teachers and learning resources, and in coping with the diversity of students when they may also come from a range of disciplinary backgrounds. Consequently many Web Science courses have tended to concentrate on building the Web and be attended by those with a technical background.

Learning on the Web

Although not incorporated into the early visualizations of Web Science, there is a strong case for learning technologies claiming a place in its Universe. Learning technologies typically incorporate components of computer science and Web engineering (the technological aspect) plus psychology and sociology (the educational aspect). The development and effective delivery of learning on the Web requires both educational and technological insight. In addition, such applications necessarily have to encompass affordances and epistemologies derived from different disciplines and fields of study in which they seek to operate. These demands speak for the inherent interdisciplinarity of learning technologies and make a clear argument to place learning technology as an obvious member of the Web Science universe very profoundly interconnected and synergic with business, work, and entertainment technologies.

Important Scientific Research and Open Questions

Web Science will model the Web infrastructure and its architectural principles and research the relationship between computer-mediated human interactions and social conventions.

It is anticipated that a number of research challenges will be addressed (Shadbolt and Berners-Lee 2008) including the following:

- Innovation on Web infrastructure to foster and drive social interactions by extending it with social properties and policies
- Analysis of the Web as an ecosystem that is related to population dynamics, consumers and producers, business activity, journalism, and government
- Provenance of information on the Web and challenges for a Web of trust
- Legal challenges related to Intellectual Property Rights on the Web
- The Web as a network of data on which information can be linked, interpreted, and related to human activity
- Affordances and challenges of the Web in collaborative innovation and collective intelligence processes
- Affordances and challenges of the Web in addressing social or cultural divides
- Architectures and pedagogy for learning on the Web

Web Science has an ambitious research vision in terms of bringing together research methodologies from different disciplines. This presents a significant challenge, as research in the field needs to be evaluated rigorously on

the combination of research methodologies that it employs and on its impact on Web Science and related disciplines. In addition, training Web scientists requires significant effort in terms of building Web Science curricula, Web Science knowledge bases, and modeling and analysis instruments. Addressing these challenges successfully will enable further research in the field and provide new insights on the Web evolution and its impact.

Cross-References

- ► Advanced Learning Technologies
- ► Information Gathering and Internet Learning
- ► Interdisciplinary Learning
- ► Network Communities
- ► Online Learning
- ► Social Networks

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