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► **To cite this version:**

Stefano A. Cerri, Hugh C. Davis, Thanassis Tiropanis, Mark Weal, Su White. Web Science. Encyclopedia of the Sciences of Learning, Part 23, Springer, pp.3447-3450, 2012, 10.1007/978-1-4419-1428-6_63 . lirmm-00670646

HAL Id: lirmm-00670646

<https://hal-lirmm.ccsd.cnrs.fr/lirmm-00670646>

Submitted on 16 Feb 2012

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Metadata of the chapter that will be visualized online

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2 Web Science

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11 Synonyms

12 Science for the Internet; Science for the Web

13 Definition

14 The Web is the largest human information construct in
15 history and it is transforming society (O'Hara and Hall
16 2008). Understanding what the Web is, engineering its
17 future, and ensuring its social benefit necessitate new
18 interdisciplinary approaches and research methodologies.
19 Web Science (<http://webscience.org/webscience.html>) is
20 a new interdisciplinary field that studies the Web as
21 both a piece of engineering and infrastructure (micro
22 level) and a phenomenon that impacts society and
23 human activity (macro level).

24 Web Science employs interdisciplinary research
25 approaches (Berners-Lee et al. 2006, Hendler et al. 2008).
26 Due to the size and the dynamicity of the Web, we may
27 consider it as a complex natural phenomenon that
28 deserves to be studied as such, with the help of all classical
29 means used by the natural sciences (observations, experi-
30 ments, simulations, models, abstractions, generalizations,
31 interpretations, forecasts). At the same time, the Web
32 represents also the first realistic natural laboratory for
33 controlled experiments on human behavior especially
34 when humans (and machines) perform the highest intel-
35 lectual activities of information processing; studying the
36 ways in which the Web transforms society and human
37 activity thus requires the use of interpretative approaches
38 found in social sciences. Modeling and analysis of the Web

also requires formalisms from computer science, mathe- 39
matics, and statistics. 40

Theoretical Background 41

Web Science was launched in November 2006 by scientists 42
affiliated to the Massachusetts Institute of Technology and 43
the University of Southampton in order to introduce 44
a holistic approach to researching the Web as an infra- 45
structure; and a phenomenon that affects society and 46
human activity. Other institutions soon expanded that 47
effort (Shadbolt and Berners-Lee 2008; Hendler et al. 48
2008). The scale of the impact that technical innovation 49
on the Web can have on society, e.g., the societal impact of 50
the growth of blogosphere, established the need for Web 51
Science. 52

The study of such impact on a macro level needs new 53
methods of analysis different to those that have so far been 54
employed on the micro level to study or engineer the 55
introduction of technical changes in systems, applications, 56
or protocols. Continuing innovation on the Web that 57
involves the rise of semantics (Shadbolt and Berners-Lee 58
2008) and linked data (O'Hara and Hall 2009) is expected 59
to lead to a similar impact on society rapidly expanding 60
from a micro level to a macro or global level. 61

Web Science draws from a set of complementary dis- 62
ciplines and brings together aspects of Computer Science, 63
Sociology, Psychology, Biology, and Economics (Shadbolt 64
and Berners-Lee 2008) but in terms of research activities it 65
is seen as more than the intersection of these research areas 66
and less than their union. The basic premise is that the 67
combined Web-related research efforts from these disci- 68
plines will have an effect larger than its parts: the notion of 69
emergence of constructive patterns from interconnected 70
autonomous agents, be them human or artificial. 71

The main expectations of Web Science are that it will 72
enable a more thorough study of the Web ecosystem where 73
simple rules can give rise to complex phenomena and that 74
it will address the need for a holistic approach to 75
researching the Web infrastructure integrating both social 76
and technical methodologies. It is thus expected to address 77
needs for the Web to be both engineered and understood 78
and to thereby gain an insight into what phenomena may 79

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

82 Learning About the Web

83 The question of what forms the curriculum of the subject
84 of Web Science is under active debate (<http://webscience.org/curriculum.html>). The chosen areas should contrib-
85 ute to understanding, engineering, and ensuring the social
86 benefit of the Web. In the previous section we show that
87 Web Science is an interdisciplinary subject, and research in
88 Web Science will require contributions from a wide range
89 of subjects including Mathematics, Sociology, Computer
90 Science, Law, Ecology, Artificial Intelligence, and Econom-
91 ics. This provides particular challenges for the design of
92 Web Science courses as it becomes necessary to take a truly
93 integrated interdisciplinary approach rather than teaching
94 about each of the contributory subjects in isolation.

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

- 100 1. The History of the Web. This covers the history of the
101 Internet and the work of the pre-Web hypertext
102 visionaries, as well as the Web timeline.
- 103 2. Building the Web. This covers the technologies, stan-
104 dards, and algorithms that are used to engineer the
105 Web as well as aspects of governance and community
106 inclusion in the process.
- 107 3. The Web in Society. This covers the coevolution of
108 society and the Web, and will include issues of privacy,
109 IP and copyright, and collective intelligence.
- 110 4. Deploying the Web – Operationalizing Web Science
111 for a World of International Commerce. This covers
112 the basics of information systems, online markets, and
113 E-Commerce as well as the associated technologies.
- 114 5. Analyzing the Web. The study of methodologies to
115 analyze the Web graph and data mining the informa-
116 tion it contains.
- 117 6. Understanding Web Users. The study of methodolo-
118 gies to analyze the behavior of users on the Web.

119 While these topics create a coherent curriculum that
120 addresses the objectives of Web Science, the interdisciplin-
121 ary nature of such courses presents issues both in finding
122 suitably qualified teachers and learning resources, and in
123 coping with the diversity of students when they may also
124 come from a range of disciplinary backgrounds. Conse-
125 quently many Web Science courses have tended to con-
126 centrate on building the Web and be attended by those
127 with a technical background.

Learning on the Web

128 Although not incorporated into the early visualizations of
129 Web Science, there is a strong case for learning technolo-
130 gies claiming a place in its Universe. Learning technologies
131 typically incorporate components of computer science
132 and Web engineering (the technological aspect) plus psy-
133 chology and sociology (the educational aspect). The devel-
134 opment and effective delivery of learning on the Web
135 requires both educational and technological insight. In
136 addition, such applications necessarily have to encompass
137 affordances and epistemologies derived from different
138 disciplines and fields of study in which they seek to oper-
139 ate. These demands speak for the inherent interdisciplin-
140 arity of learning technologies and make a clear argument
141 to place learning technology as an obvious member of the
142 Web Science universe very profoundly interconnected and
143 synergic with business, work, and entertainment
144 technologies.
145

Important Scientific Research and Open Questions

146 Web Science will model the Web infrastructure and its
147 architectural principles and research the relationship
148 between computer-mediated human interactions and
149 social conventions.
150

151 It is anticipated that a number of research challenges
152 will be addressed (Shadbolt and Berners-Lee 2008) includ-
153 ing the following:
154

- 155 • Innovation on Web infrastructure to foster and drive
156 social interactions by extending it with social proper-
157 ties and policies
- 158 • Analysis of the Web as an ecosystem that is related to
159 population dynamics, consumers and producers, busi-
160 ness activity, journalism, and government
- 161 • Provenance of information on the Web and challenges
162 for a Web of trust
- 163 • Legal challenges related to Intellectual Property Rights
164 on the Web
- 165 • The Web as a network of data on which information
166 can be linked, interpreted, and related to human
167 activity
- 168 • Affordances and challenges of the Web in collaborative
169 innovation and collective intelligence processes
- 170 • Affordances and challenges of the Web in addressing
171 social or cultural divides
- 172 • Architectures and pedagogy for learning on the Web

173 Web Science has an ambitious research vision in terms
174 of bringing together research methodologies from differ-
175 ent disciplines. This presents a significant challenge, as
176 research in the field needs to be evaluated rigorously on

177 the combination of research methodologies that it
178 employs and on its impact on Web Science and related
179 disciplines. In addition, training Web scientists requires
180 significant effort in terms of building Web Science curric-
181 ular, Web Science knowledge bases, and modeling and
182 analysis instruments. Addressing these challenges success-
183 fully will enable further research in the field and provide
184 new insights on the Web evolution and its impact.

185 **Cross-References**

- 186 ▶ [Advanced Learning Technologies](#)
- 187 ▶ [Information Gathering and Internet Learning](#)
- 188 ▶ [Interdisciplinary Learning](#)
- 189 ▶ [Network Communities](#)
- 190 ▶ [Online Learning](#)
- 191 ▶ [Social Networks](#)

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Uncorrected Proof