# Web Science and Human-Computer Interaction

## Forming a Mutually Supportive Relationship

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HCI and Web Science are interdisciplinary fields concerned with the intersection of people and technology. So how do they relate? What defines these fields, how do they overlap, and do they tread on each other's toes? More pertinently, what strengths do they share? How might they benefit each other?

Defining the precise boundaries of interdisciplinary fields is an impossible task. The Web Science community is youthful, still consolidating its identity, and at times prone to questioning its own definition. By contrast, HCI is an established field, but like all active research fields, it is constantly evolving.

### Introducing Web Science

First formally proposed in 2006, Web Science examines the Web as an unfolding process. It has various definitions, from "the science of decentralized information systems" to "the study of social machines" (see sidebar). Web Science studies the impact of the Web upon society and vice versa, focusing on Web-enabled social practices.

Web Science is motivated by the complexity of the relationship between society and the Web. The Web is much more than the sum of its parts, and Web Science helps us understand the complex multiplicity of sociotechnical interactions—both micro and macro—enabled by the Web and the millions who contribute to it. That understanding helps us make informed decisions, whether we're discussing government policy, infrastructures, and standards, or trying to understand the ways in which online social networks fail to support the richness and dynamism of human relations.

We can gain some initial insight into the scope of Web Science by examining the "Web Science butterfly" (Figure 1), a diagram used to illustrate its relevant disciplines when Web Science was first proposed [1]. Figure 2 is a "heat map" of the butterfly [2], created by analyzing papers from the Web Science conferences from 2009 to 2011 for topics that were clearly related to certain disciplines. As can be seen, some disciplines such as AI and sociology were strongly represented, while others were not.

Human-computer interaction (HCI), as readers of this magazine well know, is the study of the issues that arise when people encounter computer-based technology, and how this understanding can aid in the design of better technology. Like Web Science, HCI is radically interdisciplinary; indeed, the second author's HCI textbook describes the "ideal" designer as having expertise including: psychology, cognitive science, ergonomics, sociology, computer science, engineering, business, graphic design, and technical writing.

Many of these areas are found in the Web Science butterfly, notably computer science and psychology, which have traditionally been at the heart of HCI. However, some are missing. Based on this list and the kinds of topics found in HCI conferences and journals, Figure 3 adds some areas to the Web Science butterfly. Some of these added areas are relatively minor within HCI, and so Figure 4 shows a heat map of the principle and secondary areas (based on subjec-

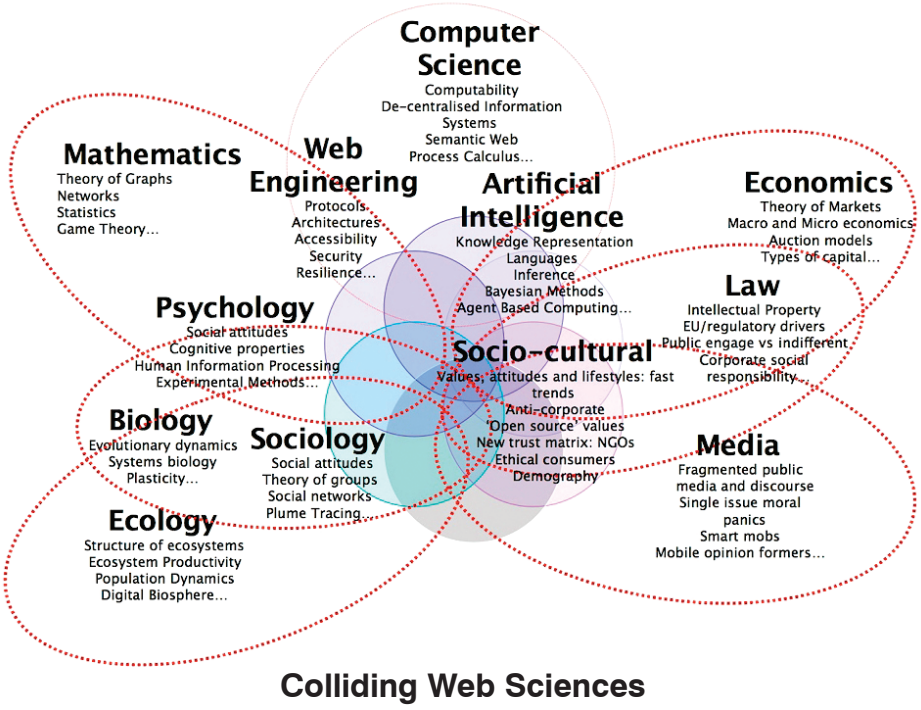
tive analysis by the second author). Note that philosophy is arguably part of Web Science and merely happens to be absent from the Web Science butterfly [1].

### HCI and Web Science: Subject Matter

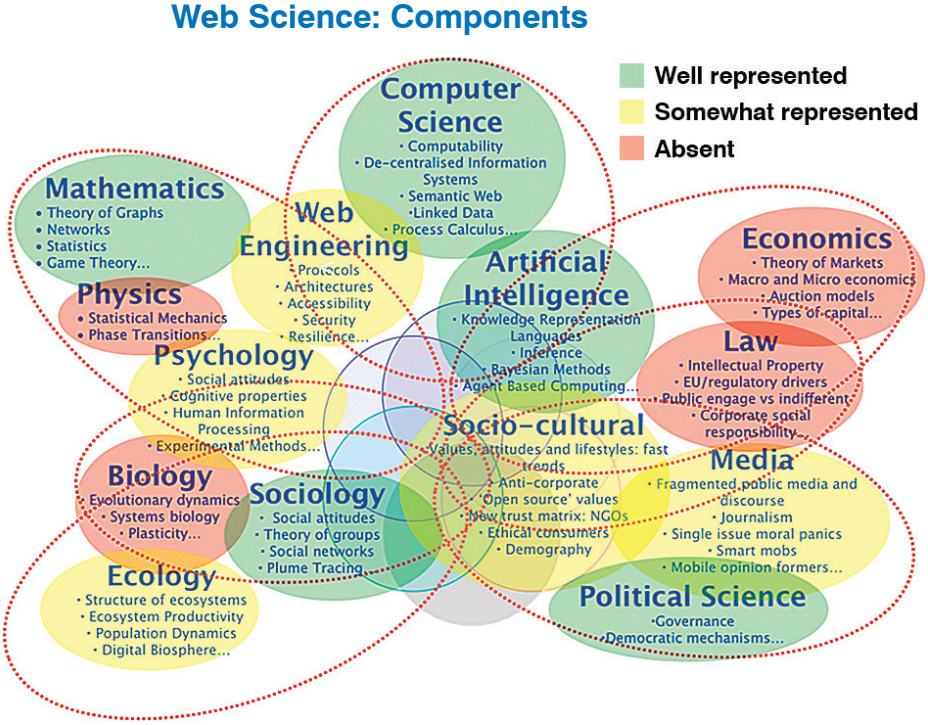
HCI and Web Science clearly share similar application areas and often ask similar questions. Ben Shneiderman recently wrote, "HCI designs now influence commercial success, reform education, change family life, and affect the political stability of nations" [3].

Arguably, Web Science studies this breadth of HCI's impact, but of course it is more complicated than this. Web scientists build and evaluate tools, while HCI researchers study the broader societal implications and interactions resulting from their systems. Indeed, these are perhaps the contexts in which collaboration between the fields would be most fruitful: Tools from HCI can be useful to Web scientists, and vice versa. For example, Web Science techniques can help HCI practitioners understand how certain interactions propagate online, while HCI user experience tools could help Web scientists to understand people's experiences of the mobile Web.

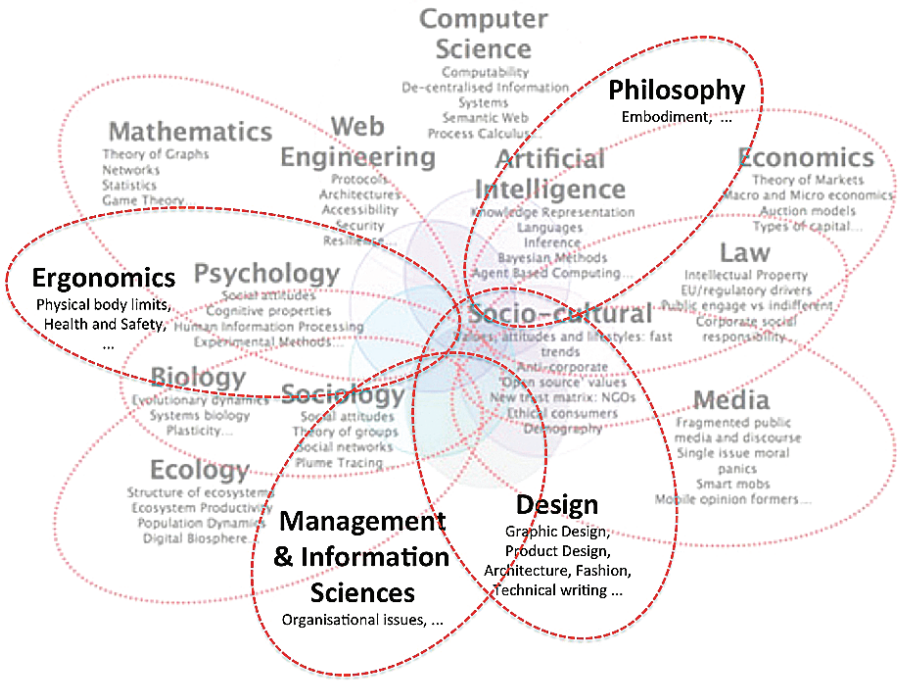
The fields share broader parallels. The cover story of the July + August 2011 issue of *interactions* describes a refocusing within HCI from interface evaluation through system design and into "general sense-making of our world": "This panoply of ideas, critiques, art, designs, and reflections at times

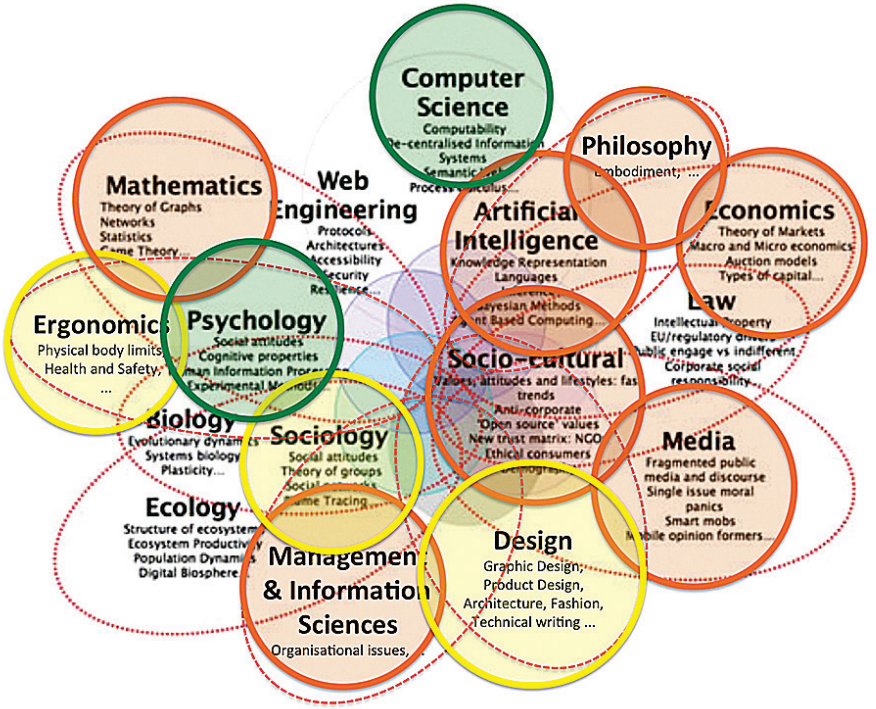



Colliding Web Sciences




▸ Figure 1 (top). The original Web Science butterfly [1]. Figure 2 (bottom). Web Science heat map, showing discipline presence [1]. (Adapted from Shadbolt by Hooper, Marie, Kalampokis.)




sits uneasily with a more scientific research agenda. There is something about the kinds of questions being raised that makes us realize this mixing of scientific knowledge, on the one hand, and design expertise, on the other, can create uneasy bedfellows" [4].

Both Web Science and HCI are areas where the concept of tension arising from multiple domains is not unfamiliar.

Finally, we should not forget that Web Science is about affecting as well as understanding that interaction between the Web and society. This is another area in which HCI expertise could be relevant: Socially aware work in HCI has considered technology for emotional well-being, community engagement, and inclusion. Such work can inform Web Science.

**HCI and Web Science: Scope**

Though HCI and Web Science are clearly related, there are overlaps and differences in emphasis between the two. Some HCI areas are not included in Web Science, such as anything to do with individual interfaces that are not Web interfaces, from word processors to SatNavs. Indeed, many networked interfaces, collaborative and individual, are not really part of the wider Web even if they often now use Web protocols. HCI also deals with details of interactions, for example, the time it takes to hit a button on screen, which would seem out of place in a Web Science venue, even if the interface under consideration were on the Web. Similarly, some areas of Web Science are outside or at the edge of the remit of HCI. For example, past Web Science papers

▸ Figure 3 (top). The HCI + Web Science butterfly. Figure 4 (bottom). The HCI heat map.

have covered topics including (in the context of the Web) politics, philosophy, law, and economics, while a significant portion of papers at the Web Science'11 conference drew on network science and network analysis techniques.

There are clear overlaps: Recent examples include work on culturally adaptive interfaces and social network churn. Looking back before Web Science, or even the Web itself, Jonathan Grudin's classic analysis of groupware, "Why CSCW Applications Fail," [5] includes issues of critical mass and what would now be called network effects, which would not look out of place in a Web Science setting; indeed, it is not surprising that Grudin's work was the inspiration for the second author's later analysis in the 1990s of the potential for CSCW applications on the Web [6].

Shneiderman recently discussed the role of modern-day HCI, proposing the dual concepts of *macro-HCI* and *micro-HCI:* "Micro-HCI researchers and developers design and build innovative interfaces and deliver validated guidelines for use ... dealing with well-stated requirements, clear benchmark tasks, established measures of human performance, and effective predictive models, such as Fitts' Law.

"Macro-HCI researchers and developers design and build interfaces in expanding areas, such as affective experience, aesthetics, motivation, social participation, trust, empathy, responsibility, and privacy. ... Macro-HCI researchers have to face the challenge of more open tasks, unanticipated user goals, new measures of system efficacy, and even conflicts among users in large communities" [3].

Micro-HCI challenges involve accommodating a wide range of users (novice/expert, young/old, literate/illiterate, abled/disabled) and accounting for gender, personality, culture, ethnicity, and motivation. Macro-HCI challenges involve commerce, law, health and wellness, education, creative arts, community relationships, politics, policy negotiation, conflict resolution, international development, and peace studies.

We can see strong overlaps between HCI and Web Science, particularly in usability, cultural awareness, the evaluation of Web-based systems, interfaces for Web/mobile/ubiquitous computing, and macro-HCI: affective experience, aesthetics, motivation, social participation, trust, empathy, responsibility, and privacy.

Parts of micro-HCI clearly fall outside the remit of Web Science, although the design and evaluation of Web and mobile devices do not. However, macro-HCI sounds very close to Web Science: Web scientists do at times design and build interfaces, and the application domains and challenges of macro-HCI could appear in a description of Web Science.

This initially sounds as though the critical difference is the scale of human phenomena studied. If we expand the simplistic technological distinction between Web technology and computer technology, we can see Web Science and HCI occupying overlapping but distinct positions, where the overlap includes much (but not all) of macro-HCI (see Figure 5).

The term *lumpen* in the scale axis in Figure 5 (and Figure 6) reflects the way in which some parts of Web Science deal with people in terms of their statistical qualities or aggregate behaviors. In HCI sometimes the individual can get lost behind *average* behaviors, but the focus tends to be more on the individual or social group.

*Both Web Science and HCI are areas where the concept of tension arising from multiple domains is not unfamiliar.*

**HCI and Web Science: Methodology**

Micro-HCI tends to favor more quantitative methods (measurements, log analysis, task timings, codified subjective ratings), whether these are laboratory experiments or studies "in the wild." In contrast, macro-HCI is more likely to adopt qualitative studies, with interpretative forms of analysis.

Though the heat maps for both Web Science and HCI (Figure 2, Figure 4) include strong contributions from sociology, in the case of Web Science, this includes more quantitative and theoretical areas (such as social network analysis), whereas in HCI it is more observational techniques that have been adopted, notably ethnography, with its roots in anthropology. Methodologically, Web Science may have more in common with micro-HCI than macro-HCI (Figure 6); indeed, the term *social machine* would be anathema to many on the more qualitative side of HCI. This is further emphasized by comparing the heat maps: In Web Science the more positivist domains of

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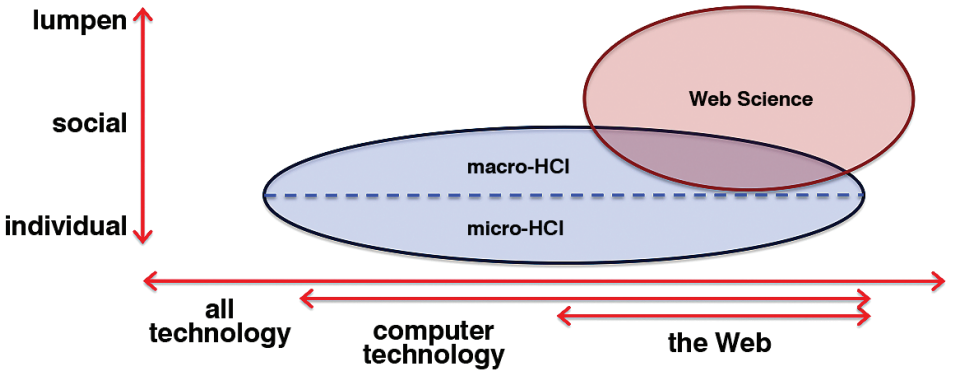
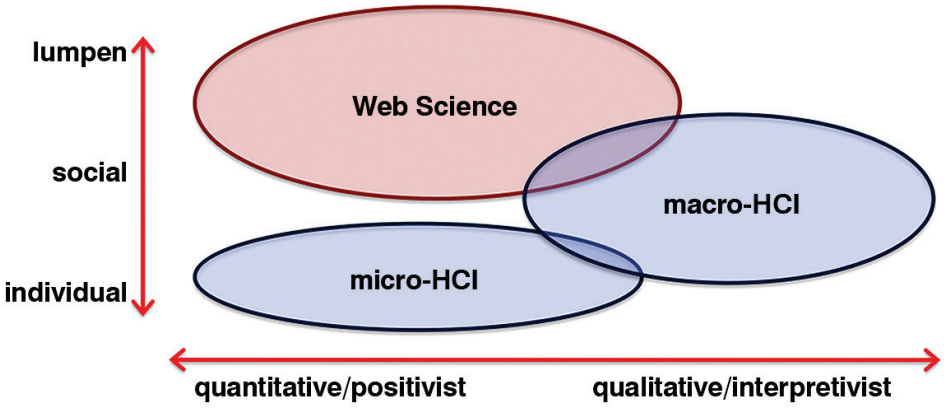
For more information see: http://alandix.com/academic/papers/WebSciHCI-2013


► Figure 5. Scope of HCI and Web Science—scale of human phenomena versus kind of technology.




► Figure 6. Scope of HCI and Web Science—human scale versus methodological stance.

mathematics and AI are prominent; in HCI these are weaker but found more in micro-HCI.

Of course, aggregate behavior arises from multiple individual choices, which suggests potential for complementary connections between the methodologically similar micro-HCI and quantitative Web Science. We can conceive a situation wherein Web Science makes sense of the overall impact of individual choices and HCI addresses why these occur, and, if appropriate, how they may be influenced by suitable design.

### Lessons for HCI from Web Science

In our first paper examining the intersection between these topics, we offered lessons to the Web Science community from HCI [7]. These concerned the division between interpretivist and positivist approaches, methods and methodology, evaluation, and design focus and methods. Here, we offer the flip side of that coin: lessons for HCI from Web Science.

*Interdisciplinary research arising from cross-disciplinary supervision.* Current best practice for doctoral Web Science students involves allocating each student supervisors from different disciplines. This is an exemplary approach toward encouraging interdisciplinary research, and it is notable that these students have been producing high-quality work. It is not only the students, exposed early on in their research to multiple epistemologies and methods, who benefit: Supervisors have observed that they themselves have learned a great deal. Education feeds into research and vice versa: Establishing best practice in doctoral-level education in this way is of benefit in many directions. It is interesting that

in the U.K., digital economy Ph.D. students typically have a pattern of supervisors similar to that of disciplines such as computer science, management, and design.

*(Sometimes) single-track events.* Although the volume of work in both HCI and Web Science means that it is impractical for every conference, retreat, or meet-up to run as a single-track event, the Web Science community strongly benefits from having some events in single-track format—most notably, the Web Science conference series, the cornerstone of the community. This is arguably more important for Web Science—a young community that is to some extent still consolidating and building its self-image—than for HCI, an established field. Nonetheless, we have previously observed [8] that although some of the strongest work in HCI results from holding onto both interpretivist and positivist approaches, there remain some researchers, sadly not inconsiderable, on either side of this divide who do not respect the complementary approaches.

*Integration with industry.* Web Science is an interdisciplinary field, an academic conference series, and is deeply coupled with industry. Google transforms the way we use the Web; Twitter and Facebook have transformed online social networks; without Amazon, eBay, Etsy, and more, online commerce would be unrecognizable. In sum, industry is key to Web Science. In the same way, industry is key to HCI. HCI researchers do not conduct their research in a vacuum, despite the low number of practitioners attending conferences such as CHI.

Web scientists have recognized this issue. Problems certainly exist (much information relevant to Web Science is locked in proprietary silos, with industrial partners understandably unwilling to share that data for fear of repercussions due to de-anonymization), but there is a notable effort within the Web Science community to engage with industry. For example, ACM WebSci'12 included keynotes from industry leaders and two industrial panels.

It is partly a sign of the maturity of HCI that there are now dedicated practitioner conferences such as UXPA and IxDA, although this now means that industrial attendees at general HCI events are most often from research labs, not frontline usability. There is some movement within HCI toward reaching back into industry, notably the formation of the SIGCHI Research-Practice Interaction community and recent reflections in *interactions* on the role of UX designers and researchers within industry [9]. Is it time to reinvigorate these links more broadly?

## Conclusion

We have explored the parallels between HCI and Web Science, defining the two fields' relationship in terms of subject matter, scope, and methodology. We have highlighted shared goals and challenges, as well as areas that the communities do not have in common, and we have offered three lessons from the Web Science community that may be helpful to HCI researchers and practitioners.

Many of the current positive elements of Web Science were present in the early days of HCI. Is it just that as disciplines mature, the early sense of intimacy and wide connections gives way to more focused areas? Looking from HCI into Web Science, are we like a parent admiring the exuberance of youth, but then saying, "Ah, but one day you'll grow up." ... Or do we have something to re-learn from that vigor?

## Acknowledgment

*Thanks to Ben Shneiderman for his helpful comments on an earlier version of this article.*

### ENDNOTES:

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**DOI:** 10.1145/2451856.2451868