# WEB SCIENCE: A NEW COMPUTER-RELATED CURRICULUM

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Degree curriculums reaction to changes in society is extremely slow. This becomes ever clearer when talking about technology-based disciplines like those proposed in the *ACM computer curricula*. This paper defends that computer-related curriculums have already lived three different stages --- regarding the appearance and proliferation of digital communications and the Web. Furthermore, it seems these curriculums have become already exhausted and are facing the need of a new one. This change comes directly linked to the evolution of the Web towards the Web 2.0 and the every time deeper participation of users on it. New ways of communication, new relationships between users on the Web require new education to those involved on it. Old curriculums are not able to deal with all these new issues. A renovation is necessary. May "Web Science" be the solution?

## 1. Introduction

It was less than twenty years ago when the Computer Science and other computer-related curriculums were not talking a word about something called "the Web". That was actually normal because the Web was just born and degree curriculums usually react in a non-very-fast way to changes in needs of real world. Along these two decades, every new curriculum proposal has been adding more and more web-related subjects, either because they work with competences or skills raising from networking (e.g. subjects on the OSI communications pyramid, communications protocols, etc.) or because previous subjects took a new dimension when computers stopped being isolated to be part of a net (e.g. data bases, computer architectures, operative systems, etc.).

First computer related curriculums where proposed in the 1660s. These first curriculums of course did not say a word on "the Web" but also did not say anything about the possibility of any inter-computers communication (although there were already mainframes, protocols like ARPNET and X.25, packet switching, etc.). Years later, in 1983, a subject area called "*advanced operating systems*" designed to "*introduce to several topics of current research activity*" contained modules like "network operating systems", "distributed systems" or "security encryption". From this point, networking was getting more and more importance in computing curriculums.

## 2. Computer-related curriculums: The past and present

Analysing some curriculums proposed in the last half century by the major American organisations developing computing curriculum guidelines (ACM, AIS, AITP and IEEE-CS[1]), it is possible to see the important the influence of computers networking and the Web (later) has been.

Historically, and from the point of view of education, firstly, computers study was mainly centred on their components, the engineering behind them, their power and the algorithms they were able to run. Computers were considered only as a tool. And professionals working with computers needed this knowledge in order to get as much as possible from them. This is why one of the first ACM proposals, the ACM "Curriculum'68" [1] only proposed a Computer Science curriculum, while, at the same time, the COSINE Committee of the Commission on Engineering Education presented for Computer Science in Electrical Engineering [2] one.

A few years later, in a second stage, these computers got connected and several new issues like how to communicate them in a safe way, how to avoid information inconsistencies, etc. appeared. Computers left apart their loneliness to become part of the system, part of a net. Curriculums started to offer new subjects to include Internetworking, gateways, addressing, etc. Thus, although for many people, the birth of Internet was in 1983, in the program of Computer Science and Engineering, by the IEEE-CS [3], all these subjects were considered as "research".

A third step brought users --- not only people but also enterprises, universities, associations, etc. --- to use computers to share information, to collaborate in the Web's growth. But this did not mean an extremely active participation: somebody left information and somebody read it. The web --- and the computers forming it --- was little more than an interface for all those users accessing it. This phase is clearly related to the Web's birth (year 1992) and development. The Web brought all these people a new communication channel. This influenced in the raising of new subjects on client-server computing, network security, web programming, etc.

## 3. New Web-based curriculums: The present and future

Nowadays a fourth stage has been reached: The raise of Web 2.0 --- and the upcoming Web 3.0 --- bring users to form part of "the system", part of "the

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[1] The ACM, AIS, AITP and IEEE-CS acronyms stand for The Association for Computing Machinery, The Association for Information Systems, The Association for Information Technology Professionals and Computer Society of the Institute for Electrical and Electronic Engineers respectively.

webiety[2]. Users are not an external object anymore but they become part of the subject. And the subject is neither a computer nor a net. The subject now is the Web itself as a composition of computers, connections, and users. This makes a huge difference, and therefore should bring with it several changes. These changes should begin occurring especially in the education of those people who are going to be working *in* the Web. Old curriculums fall short to cope with this and they cannot be increased without losing strength in their focuses. They have different objectives.

| STAGE | OBJECT TO STUDY | NEW OR RENEWED SUBJECTS |
|---|---|---|
| First – "Computer" | Computer | Programming, Computer architectures, Data bases, Operative systems |
| Second – "Net" | Computers forming nets | Distributed algorithms, Nets, RPC, communication protocols, |
| Third – "The Web" | The Web and its computers | Human computer interaction, Web programming, Web security |
| Fourth – "Webiety" | Everything in and around the Web: computers, users, relationships, rights, etc. | Web analysis, Semantic web, Web based social science, Web governance |

**Table 1**. Computing curriculums stages

## 4. WSRI and the new curriculums

The Web Science Research Initiative (WSRI) was created on November 2006 by researchers from MIT and University of Southampton. In their presentation, they argued the need for a new interdisciplinary field – which would embrace mathematics, IT, psychology, economics, law, etc. – to analyse what the web is and what happens on it and around it. A field showing the vulnerabilities, the interactions that need improving, the implications that microscopic decisions have on global design, etc. A science that works on both the technical and social aspects. They also suggested that this new area be led by specialists, with the proviso that they be skilled in this wide range of subjects. This requires the appearance of teaching devoted specifically to Web Science.

One of the objectives of the WSRI, if not in the short term then in the medium term, was the joint design between the MIT and the University of Southampton of a Web Science degree. To date, this degree has not been offered perhaps because this needs both a lot of work in the curriculum design and the difficulty to change society's mind about the importance of this kind of multidisciplinary curriculums.

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[2] "Webiety" stands for Web society or the society of the Web.

## 5. Nowadays curriculums classification

Although this same exercise can be done with any specific curriculum belonging to any university, possibly, the classification of the 5 curriculums proposed by the ACM, AIS and IEEE-CS (CS, CE, SE, IT, IS) [4] can be more descriptive and interesting[3]. Given the definitions in the ACM Computing curricula, Fig. 1 shows both an approach to this classification in the proposed structure and the lack of a new curriculum covering part of the current social needs.
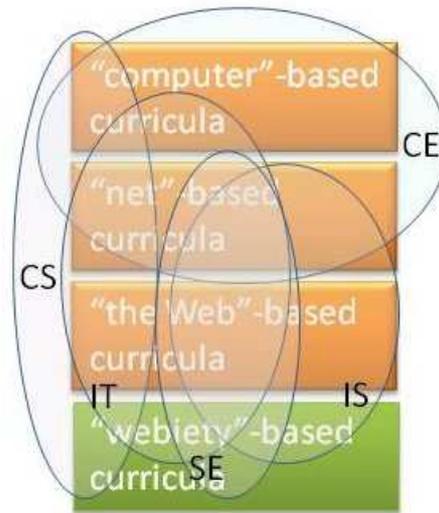


**Figure 1**. Computing related curricula approximated classification

**Computer engineering**
This is a curriculum clearly included in the first two stages. Although it combines hardware and software, does not work in the Web's level at all.

**Computer science**

Computer science curriculums deep into theoretical foundations of computers and those problems solved using intelligent systems, etc. Users are mainly not taken into account in this curriculum because they are in the 7th layer of the OSI model or even further, and CS works in lower ones.

**Information systems**

This is based on organizations and information related to these. It is perhaps the farer to the computing centred curriculums, but does not work very deeply in social aspects of computing. It is more centred on business.

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[3] We do not take into account EE due to its hardware centred basis, although this could be clearly placed in the computer-based curriculums.

### Information technology

This is the complement to the IS curriculum. While IS works around information, IT treats the technological aspects of enterprises. Thus, this is a little less web-related than IS.

### Software engineering

This is the curriculum raised around software systems and everything surrounding them (efficiency, reliability, maintenance, etc.).

## Conclusions

Current computing related curricula cope with most of the aspects around computers, nets and society. Furthermore, associations like ACM or IEEE-CS have been working deeply in the design of these curricula, defining very well frontiers and common aspects between them. But, with the appearance of the Web and its evolution, a new "component" has been added to the area: the user. This incorporation has brought several new aspects like social relationships, governance or analysis issues. That means a new professional profile, far --- and close in some terms --- to former ones is raising and the need of a new curriculum should be coming with it.

Web science might be the answer to this need: a multidisciplinary curriculum able to form professionals not only with computing skills but also with social ones. But that means to combine very different areas, like engineering, social sciences, laws, etc. Anyway, given the nature of the web itself an important feature of the new curriculum is that this must rise from the computing community, but with very open mind to achieve a symbiosis with the rest of the disciplines.

## References

[1] ACM Curriculum Committee on Computer Science. *"Curriculum 68": Recommendations for the undergraduate program in computer science.* Communications of the ACM 11, 3. 151-197. 1968
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