Modeling the Web : Paradigm changes and strategic scenarios

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Abstract

In order to understand the Web [1], we need to adopt an approach that should be as much as possible unambiguous. We believe that Informatics is the discipline of Information[2] offering *the concepts*[3] *for modelling* Information production, transformation and consumption in complex, heterogeneous organisations consisting of autonomous communicating entities called agents. In the following we will argue that the two currently emerging paradigm shifts in Informatics: **Interaction** versus algorithms [4] ; and **Services** versus programs [5] are necessary and perhaps sufficient for understanding most of the current Web phenomena, and for forecasting future evolutions in Governance control but also in other subareas of Web Science, particularly Web Science education. At the same time, this paper shows the intentions of the Montpellier team to launch a Web Science curriculum based on these emerging paradigms for serving in the best way the trilogy of Web Science goals: understand what the Web is, engineer its future and ensure its social benefit.

What is a paradigm change?

Basically, it is a change in the foundational concepts from which we approach in general the construction of models, in particular the construction of models of complex socio-technical systems. In Science, a perfect, yet very simple example is that of the introduction of polar coordinates with respect to rectangular (Cartesian) ones in the description of the dynamics of spatio-temporal physical systems. Both coordinates may represent the same dynamics, but systems with circular (or spherical) symmetries are significantly better handled by polar coordinates. The adoption of polar coordinates has been a paradigm change that has enabled the development of classical Physics centuries ago.

What is a service?

A service is a program that can be "engaged" by another program (another service) by choosing it among available services. The consequence of this view is that services communicate in order to engage each other even when they were previously unaware of the mutual existence. The concept of *engagement* entails that of *autonomy*: therefore services (brawn) and agents (brain) meet each other [6] [7] . However, not only services do choose autonomously other services where they may delegate subtasks with respect to some goal, but services hide also the internals of their work showing only what is relevant for someone else in order to exploit them. The producer of a service may choose different fashions to accomplish his task, while the consumer of a service is unaware of the particular way the service will be delivered. Teams of autonomous collaborating agents show this important property (delegation). This induces a radical change from the classical integration to the more modern concept of *interoperability in complex socio-technical systems made of autonomous agents*.

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1 The Web Science movement (http://www.websci12.org/) has to be acknowledged to have underlined the distinction between «understanding » and « doing » by exploiting Web Technologies.
2 http://www.ed.ac.uk/schools-departments/informatics/about/vision/overview
3 http://www.info.ucl.ac.be/~pvr/book.html
4 http://www.cs.brown.edu/sites/interaction-book/
5 http://www.csc.ncsu.edu/faculty/mpsingh/books/SOC/
6 http://portal.acm.org/citation.cfm?id=1563272&CFID=8797023&CFTOKEN=51374381
7 http://libra.msra.cn/Paper/4438564

The need for interaction among agents through services entails at least three consequences:

1. the adoption of *humans in the loop* of service production (not only service consumption as the historical "users") since not every task can be "intelligently" delegated to machines (agents include software agents and humans);
2. the need for highly *context dependent semantic descriptions* of concepts, skills, goals, tasks, strategies, tactics, specifications etc in order for services and agents to understand each other in *business processes*; and
3. the management of *distributed processes and data* that concurrently operate and communicate both collaboratively and competitively in the mixed human-artificial socio-technical "organism".

Services and agents can indeed be progressively modelled assuming a *holistic view* [8] . The Web of at least 2 billion humans and 2 billion machines becomes a set of "contexts" where each human or organisation may be interested to solve a particular problem, most of the time interdisciplinary, complex, requiring multiple approaches thus help from the others.

Models of Governance

This has a very important impact on models of Governance. In fact, the classical centrally managed Organisations (including sometimes entire States) are currently facing with extreme difficulty the unforeseen consequences of currently emerging major phenomena that were previously marginal. For instance, the globalisation of economies explaining the impressive rapid growth of Countries such as China, India and Brazil frightens other Societies; the equally unforeseen explosion of socio-political "revolutions" such as the recent cases of Tunisia, Egypt, Libya and probably more in the next times is justified by the pervasive availability of immediate communication means among humans.

Models of other aspects of Web Science, education included

Interaction among autonomous artificial and human agents that cooperate and compete with each other as individuals as well as organisations shifts the main concern in modern Education, in Informatics as well as in other disciplines, from classical technical issues (algorithms, databases, programming …) to an approach that privileges models of more complex social behaviour composed by individual performance. In computing, preliminary studies [9] show the need for Informatics curricula to move progressively from traditional patterns based on Web Technologies to other approaches focussing on the analysis and synthesis of multi-centric business processes. In these scenarios, understanding the specific business requirements and context – including humans – prevails over the classical design and application of Web Technologies. Basically, the issue is to raise the conceptual level of computing education.

Looking at the possible topics (contexts) of Web Science Conferences (e.g. Koblenz, 2011; Chicago, 2012) we believe they may be individually "modelled" by means of the above mentioned paradigm shifts: (interaction among human and artificial agents and concurrent services) and the implied concepts: interoperability, business processes, autonomous agents, the pragmatics of communicating agents (speech acts and intentions), commitments, trust, negotiations, engagement, coordination, choreography, orchestration, transaction, reputation, recommendations (recommender systems), auctions, collaboration, competition, etc.

Just as one of the possible examples concerning Education and Scholarship, hereafter a statement from a Chinese student in Montpellier: "I have read an issue of the TIME magazine recently. … The result shows that the Chinese junior's ranking is very high … does

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8 http://www.booksonline.iospress.nl/Content/View.aspx?piid=1251

9 http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.152.7970

it mean that the Chinese junior education is a success? … I have spent more than 16 years in that system, I could say that the Chinese children have no interest in schools, … they hate school as much as the children in other Countries, the lessons are boring … they don't have much time to do their own stuff … " Apparently, as much as elsewhere, Chinese children learn in spite of their boring educational system … The question will be then: what "educational processes" may we envisage on the Web, including eventually schools and teachers, in order to motivate children and better their learning outcomes, often adopting a vision that people learn as a side effect of communication (informal learning)? Are those processes possibly to be abstracted and generalised for vocational, adult education as well? For group learning in developing Countries?

Wikipedia and ENCORE: why brain (domain experts) and brawn (the Web) need each other

One very interesting case study concerns "how to build and maintain a scientific encyclopaedia ". While on the one side we notice the amazing reliability of Wikipedia [10] we may ask ourselves about the need for authoring an encyclopaedia in any significant scientific domain such as the Sciences of Learning [11] or Organic Chemistry [12] [13]). In attempting an answer to this fundamental question, we exploit our previous arguments about the paradigm shift between programs and services, the first ones being chosen and (re)used *by people* and the second ones *by other programs* (by machines). As long as published "passive" information is concerned, probably a Wikipedia web site about Organic Chemistry and a literate electronic encyclopaedia produced by top scientists would look the same in a not too far future. However, if we wish the Encyclopaedia to be "smart", to anticipate questions to the human user that help finalizing his/her question, to be *proactive as a librarian*, to be able to associate scientific data more and more mimicking a skilled researcher, then *computable concepts and relations* should be available to such an encyclopaedia, in other words: ontologies (or knowledge). Whether these ontologies may be constructed top down by recursively converging collaborative interaction processes among high level scientists [14] , or bottom up by annotating facts, linking data and constructing relations, abstractions and generalisations by trial and error, is yet unknown to us. However, what seems sure is that both may contribute to the "knowledge and skills" of such a repository of human scientific wisdom, in order to make it useful and used as a prosthesis for different purposes, from student learning, to professional consulting to academic referencing.

How these concepts should be introduced

The most important concept in any Education today is *the concept of concept* as well as *the concept of relation*, differently said : how to model things with words and symbols in an unambiguous way in order to communicate that model to another agent and be understood (have an effect on the interlocutor). This is just another way to recall Austin [15] in his "How to do things with words".

The paradox is that we are all *disciplined* in explaining concepts within *our discipline*, but rather reluctant to admit other viewpoints. Interdisciplinary practices are not a starting point, rather an objective to achieve *in projects*, not in newborn hybrid disciplines.

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[10] http://en.wikipedia.org/wiki/Reliability_of_Wikipedia
[11] http://refworks.springer.com/mrw/index.php?id=2884
[12] http://www.fundp.ac.be/sciences/chimie/uco/cos/encore/presentation.html
[13] http://portal.acm.org/citation.cfm?id=1563294
[14] http://www.informaworld.com/smpp/content~db=all~content=a725750369~frm=titlelink
[15] http://en.wikipedia.org/wiki/J. L. Austin

Any attempt to give a non ambiguous model of a concept (e.g.: within an ontology) is subject to criticisms in any non closed world (by anyone adopting other viewpoints). This entails a relativistic view of competence and skills that frightens students and teachers as well. Therefore we have to consider synergies among disciplines as a necessary approach to adopt. A synergy does not mean integration, rather interoperability. Synergies entail co-adaptation, unless one accepts to be serving the other who accepts to lead, direct, guide, order.

In our Web Science endeavour, the main co-adaptation concerns *human usage* of Web technologies and their *production*. The first is usually described, classified and modelled by « social science specialists », the second one by « informaticians » (in the above outlined sense: Computer Science + Artificial Intelligence + Cognitive Science). Unfortunately, the first ones often have the tendency to freely describe observations while the second ones like either to formalize phenomena by oversimplifying their complexity (the *theoretical* approach) or to construct artefacts (the engineering, *practical* approach). Brain often does not meet brawn: it is due to the extraordinary connectivity of the Web that we dispose today of the most important natural laboratory in history of mankind perfectly suitable for studying *experimentally* human behaviour, isolated or within "immanent" societies [16]. As a consequence, the only approach in synergic projects that may link different "cultures" is the experimental one: observation, analysis, proposed synthesis (theory), forecast, revision.

All Science is either Physics or stamp collection (Rutherford); I would add: each scientific path in natural sciences goes from stamp collection to Physics. Current social scientists describe Web phenomena as biologists did for centuries when they classified animals and plants according to various, often apparent and contingent, criteria. These criteria for *analysis* and classification were often based on variables later considered non significant, due to the lack of deep insight in the origin of life. Once the DNA was discovered and measured, biologists started to build a *synthetic* discipline concerned with living organisms that adopts a few foundational concepts and rules in order to explain and predict many different natural phenomena. Biology moved progressively from "stamp collection" to "Physics".

We believe that it is now time for a synthetic reflection that identifies high level, yet unambiguous concepts to be used in the Science of the Web in order to describe, eventually simulate and measure Web phenomena. Unambiguous means suitable for a semantic description that may initially be approximate (as it is now for many of the above mentioned concepts) but has the ambition to evolve towards formalisations.
Once these well founded concepts will be generally accepted (or at least understood), synergies and experimentations will be facilitated. Obviously, research and education go hand in hand, the second capitalizes from the first and on turn generates new intellectual resources for research. Borrowing from other scientists [17]: rather than *research for development* we believe in *development through research*. We do believe that HCI, Web, Graphics and Components in Informatics are currently disjoined curricular disciplines, but their future will be their convergence thanks to the identification of unifying concepts within a Science of the Web, in order to distinguish their combinations, abstractions and generalisations according to the different scenarios of use.

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[16] http://hal-lirmm.ccsd.cnrs.fr/index.php?halsid=8b5hch4cm6fnqm0o4chq8p4l06&view_this_doc=lirmm-00522738&version=1

[17] This is the recent new strategic direction chosen by the French CIRAD (http://www.cirad.fr/); our interpretation of *development includes human learning*, in Universities and elsewhere. Therefore the lesson we draw is to use a research approach in order to learn = develop = empower.