Web Wisdom

An Essay on How Web 2.0 and Semantic Web can foster a Global Knowledge Society

Christopher Thomas*, Amit Sheth

Kno.e.sis center, Wright State University, Dayton, OH

Abstract

Admittedly this is a presumptuous title that should never be used when reporting on individual research advances. Wisdom is just not a scientific concept. In this case, though, we are reporting on recent developments on the web that lead us to believe that the web is on the way to providing a platform for not only information acquisition and business transactions, but also for large scale knowledge development and decision support. It is likely that by now every web user has participated in some sort of social function or knowledge accumulating function on the web, many times without even being aware of it, simply by searching and browsing; Other times deliberately by e.g. adding a piece of information to a Wikipedia article or by voting on a movie on IMDB.com. In this paper we will give some examples of how Web Wisdom is already emerging, some ideas of how we can create platforms that foster Web Wisdom and a critical evaluation of types of problems that can be subjected to Web Wisdom.

Key words: Human and Social Computation, Social Networking, Problem Solving

1 Introduction

Quite recently, we took our first steps on a virtual ground. We occupied phone lines to dial up to computers that allowed us access to information some universities and government organizations had to provide. Those days seem to be long gone. We do not dial into a network any longer, we are online and

* Corresponding author.

Email addresses: topher.thomas@gmail.com (Christopher Thomas), amit.sheth@wright.edu (Amit Sheth).

URLs: http://knoesis.wright.edu/students/topher/ (Christopher Thomas), http://knoesis.wright.edu/amit/ (Amit Sheth).
see it as an annoyance when we are in a spot where we cannot be. We have constant access to virtually limitless amounts of information at all times.

Probably the greatest change in the perception of the Web occurred when people started to reverse the information flow (see Fig.1)\(^1\). While the write-capability always existed, only with the advent of Web 2.0 technologies, Social Networks, Peer 2 Peer networking and other tools that facilitated participation, users started to take advantage of the read-write capabilities of the Web in a large scale.

![Fig. 1. Reversing the information flow in Web 2.0](http://www.taggly.com/tags/journal)

Tim O’Reilly, who coined the term *Web 2.0*, made an interesting observation about Web applications and knowledge accumulation:

A true Web 2.0 application is one that gets better the more people use it. Google gets smarter every time someone makes a link on the web. Google gets smarter every time someone makes a search. It gets smarter every time someone clicks on an ad. And it immediately acts on that information to improve the experience for everyone else.

It’s for this reason that I argue that the real heart of Web 2.0 is harnessing collective intelligence.\(^2\)

There is a broad consensus that the Web is moving more and more in the direction of becoming a platform for global knowledge accumulation and intelligence gathering. However, even applications such as Google are read only. Some machine takes advantage of the structure of the Web and of human interaction and reflects this insight in its search results. Some other search engines

---

1 Copied from http://www.taggly.com/tags/journal
2 From Tim O’Reilly’s Commencement Speech at SIMS
drive the interaction paradigm further by providing interaction with a human search agent, for example the ChaCha search engine. One can argue about the results of the expert searches, but it is an alternative step towards harnessing collective intelligence. In contrast to this immediate interaction between information seeker and provider, Wikipedia allows asynchronous creation and retrieval of information. Once a topic of interest is created, several users will work on it and over time and in the ideal case produce a comprehensive description of the subject. Thomas and Sheth (2007), identified patterns that identify when a Wikipedia article becomes sufficiently reliable, and additional work on measuring trust is emerging.

Recently the areas of human computation and social computation have attracted much interest. Intuitively, humans and computers excel at orthogonal tasks. While computers are efficient and effective in logical and mathematical analysis, humans are strong in conceptual tasks, tasks that require perception, intuition or creative thinking, etc. Thus it seems a logical step to share the workload. The WWW in general and the advent of social networks and the Web 2.0 paradigm in particular make it possible to analyze and harness human knowledge and human resources in an unprecedented fashion. The analysis of blogs and social networking sites has given great insight into propagation of information and the structure of social networks; sites like Wikipedia explicitly accumulate knowledge of its community members and purposeful online games such as the ESP game by von Ahn and Dabbish (2004) or Google’s image labeler give recreational incentives to participate in social processes. In a different light, the annotation of images can be seen as a computational problem that, in these cases, is solved by humans acting as computers. In the Hitchhiker’s Guide to the Galaxy, Douglas Adams describes the earth as a giant computer meant to give the ”Ultimate Answer” to life, universe and all the rest. While from some point of view this computation has probably been going on since the earth formed, the computing power has sped up significantly ever since the first cell appeared, in some sense probably comparable to Moore’s law and the development of the web has given another boost in this direction. Like never before every Internet user can participate in a global knowledge gathering process.

One unfortunate trait of the entirety of all that is known to mankind is that quite often the parts of the knowledge that matter at a given moment are not possessed by me, so I have to look for it. Web searches have proven quite helpful, but the easiest way to learn is usually being taught by someone whose knowledge we trust. What if there was a system in place that, even though not intelligent enough to answer our questions directly, knew who to ask specific questions, be this a machine, an individual or a community?

3 http://www.chacha.com/
4 http://www.wikipedia.org/
Aside from the aspect of purely putting knowledge out there for the purpose of it being absorbed and put to use by others, there is a growing tendency towards directly employing web users to solve small problems. The grid, which used to be aimed at computers solving computational problems opens up to any kind of agent that can perform any sort of task that again has a bearing on other services and users on the grid or the web. Seti@Home was a pioneer-task for the former view, Amazon.com’s Mechanical Turk is probably the largest-scale implementation of the latter.

Despite the advances in computational algorithms, Artificial Intelligence and processing speed, many problems remain unsolved and maybe computationally unsolvable. Limited by Turing-computability and complexity of both the algorithm and the necessary background knowledge, truly intelligent machines seem out of reach. The types of problems that can be mastered algorithmically are quite different from those that require extensive world-knowledge, creativity and the ability to purposefully abstract and intuit. Tasks that humans perform without even thinking about them, such as recognizing and grasping objects, planning a route through dense traffic while anticipating the behavior of others or stepping on a pile of books to change a light bulb, require very specialized algorithms that usually only perform well in the exact settings they were developed for. One of the main drawbacks of traditional Turing-computation is the lack of interaction (Wegner, 1997). Many tasks we solve require tedious computations that we like to outsource to machines that are built for these tasks and occasionally require human input to make or confirm a decision. Operating systems are a very common example of these kinds of tasks. Workflows in modern scientific experiments that involve massive computations alternating with human judgment exemplify further reaching interaction tasks. The Web 2.0 paradigm allows us to solve these kinds of tasks on a larger scale with many participants making judgments, decisions or contributing information. Google showed with its page rank algorithm (Brin and Page, 1998) one of the first large scale deployments of independent distributed decision making. Others are looking at generalizing this idea beyond ranking web pages (Rodriguez and Steinbock, 2006).

Is some information more valuable than other? Do some people make more significant contributions than others? Do some compute incorrectly? The answer to all is of course ”Yes”. The experience with Wikipedia and image labeling games has shown, though, that social processes weed out the bad seeds. Social networks deal with these phenomena by implicitly assigning trust insofar as the members of a discussion group or a smaller subcommunity have some idea of how trustworthy their friends or collaborators are.

New problems arise, when we try to find a general way of tapping this potentially vast human resource. Looking at it from a service oriented or agent centered point of view, individuals and communities on the web provide ser-
vices that can be discovered or advertised or act as agents in the realm of the web. These services can be black boxes, we might not always know whether humans, computers or both are behind the offered service. And we don’t want to know. A larger architecture that takes all possible computational resources into account wants complete transparency when it comes to choosing the appropriate service. However, the outcome matters, so we care about quality and time constraints.

Mobile-Wisdom mobile devices increasingly permeate the human landscape. The new generations of mobile devices are full fledged computers used for web browsing, email, organizing, music, etc. So far the information flow in the mobile world

Multi-level computations used to be Sensor ⇒ Effector ⇒ Sensor, could become Sensor ⇒ ((Sensor | Effector) ⇒ )* Sensor

A few years into the existence of the World Wide Web, its spiritual father Tim Berners-Lee introduced a vision of a Web not only for humans to use, but also for machines. A more meaningful, a Semantic Web (?). Many a researcher has worked hard on making this vision come to life just to be outsmarted by a bunch of folks who decided to bring more meaning to web resources without a formal underpinning. We like to follow the aforementioned thought by Hugo Liu and Patti Maes (Liu and Maes, 2007) that this is a beautiful development, because it shows that the Web has become a part of our social world and is evolving regardless of academic interference. However, we are not happy just letting things go unanalyzed and untouched. Here, we want to turn the tables a little bit to take some of the usurped area back into the hands of more rigorous semantics while taking the gold with us that was left behind in the form of tagging, collaborative ideas, Web 2.0 etc, by asking the question ”How can Semantics improve the mechanisms that are in place for collaborative strategies towards more reliable problem solving?” We have shown before, how different kinds of web-semantics can be used to describe different levels of formalization and agreement (Sheth et al., 2005). Using this insight, we want to investigate how we can describe, analyze and invoke services offered on the web in a unified way, no matter whether they are offered by individuals, communities, based on human intelligence or computational methods.

The remainder of this essay is organized as follows. In Section 2 we will give some examples of problems to which Web Wisdom can contribute. Section 3 aims at defining classes of problems that require different types of strategies to be solved, section 4 will discuss epistemological implications of Web Wisdom, section 4.2 deals with social implications. Section 7 is concerned with drawbacks and possible failures of the approach and section 8 finally concludes the essay.
2 Motivation

2.1 Problems to be solved

In the previous section we showed that there is the need and potential for collaborative problem solving. This section will identify some problem classes require different approaches and will give examples of each one.

- problems that as of now have low precision in their solution
  - web search
- problems that as of now have low precision and low recall in their solution
  - fact extraction
  - object recognition
- problems that as of now can only be solved in limited domains
  - computer vision
    - image annotation
    - object recognition
  - computer translation
- problems that could be learned, such as ANNs for robots, but where not enough training data is available
  - games that simulate the robot’s later environment, humans play the role of the robot and from success vs failure the ANN is trained
  - can be analogous worlds, a factory environment is not very exciting for a game
- problems that are intractable
  - traditional NP-hard problems
- problems where computational solutions are not feasible or insufficient
  - e.g. Encyclopedia creation and quality control
  - aesthetic quality of e.g. art/literature
- problems that are not Turing-computable

2.2 A few examples

2.2.1 Examples where the process resembles the goal

2.2.1.1 Tagging

2.2.1.2 Wikipedia The online encyclopedia Wikipedia depends on collaborative editing of content. Unfortunately, the structure of Wikipedia can only be used in a limited form for computational purposes. It is a good example for the tradeoffs between ease of participation and computational merits.
2.2.2 Examples where the process is different from the goal

2.2.2.1 ESP-Game  The image labeling game ESP (or the Google image labeler) exemplify the potential of human-computer collaboration. Humans do what they do best - identifying objects. The algorithm then analyzes the tags and decides whether information has been gained by the given tag. If specific tags are regularly used and do not provide any new information, they are set as taboo-tags to force the users to get more specific in their descriptions.

2.2.2.2 Squigl  Whereas the ESP-Game was meant to provide high-quality tags for images, Squigle is a game in which objects inside an image are clearly demarcated by drawing a line around them. The tag output from the ESP-game are presented to the players along with the image and both players draw a line around the object denoted by the tag. Bonus points are given when both players identify the same area of the image. The results are then collected and averages are computed. The output of this game can either serve search engines to give better results or as training set for object recognition algorithms.

2.2.2.3 Verbosity  This game comes

2.2.3 Examples where the solution is an analogy of the goal solution

2.2.3.1 Protein-Game

2.2.4 Platforms

2.2.4.1 Amazon’s Mechanical Turk  The Mechanical Turk differs insofar as it rather a marketplace for services.

3 Solving Difficult Problems

3.1 Defining AI-Interesting problems

Here, we are aiming at finding a unified framework for solving problems that would traditionally be interesting for the field of Artificial Intelligence. Hence, we will call them AI-interesting problems. This definition is informal and more general than that in von Ahn et al. (2004) of AI-hard problems.
Definition 1 A problem is AI-interesting if there is no algorithmic procedure that solves it efficiently, but humans can solve it with sufficient success in a reasonable amount of time or if it is as of now perceived to be more accurately solvable by humans.

The definition is intentionally kept vague, because it is not only the ”hard” problems that are generally perceived to be better solved by humans. An example is document tagging. While classifiers have a comparably high precision when assigning document classes, tagging is often intentionally biased. An Amazon page selling the new PlayStation, for instance, can easily be categorized into “pages about video game consoles”, but not as easily into the ”things my kids want that I’ll never buy, but they’ll nag their grandparents until they’ll get it anyway” category. In order to unify the view of problem solving or of services on the web, some types of problems are defined (see Figure 2).

3.2 Interaction

On an abstract level, the web is a large collection of data as well as human and computational agents, connected via static and dynamic relationships, such as hyperlinks, search engines, Web Services, etc. All these agents or services constantly perform some tasks as sensors or effectors of their virtual environment. When we use this classification to categorize activities on the web, it can be seen as a giant interactive identity machine (IIM), as defined by Wegner (1997):

Definition 2 IIMs are simple transducers that realize nonalgorithmic behav-

Fig. 2. Classes of problems and some QoS dependencies.
ior by harnessing the computing power of the environment.

3.3 Service Descriptions

We want to limit the discussion to services that can be seen as atomic, i.e. taking a set of inputs and giving back a set of outputs without requiring the invoking agent to specify other services that go along with it. The inner workings of an atomic service do not concern us here. It might well be a complex process composed of multiple services. A service can then be described as (use and cite Kats’ work here)

4 Problem Solving in a Social World

Having identified some types of problems that could benefit from large-scale problem solving, this chapter discusses epistemological implications of Web Wisdom. The obvious questions being about truth, verifiability, reliability and trust. The previous chapter showed ways to formalize these parameters, here, we are discussing reasons why this might just work. The times in which lone thinkers mused over problems in complete isolation are over. The underlying assumption here is thus that knowledge discovery and aggregation is (almost) always a social activity. This starts with language acquisition, which not only gives us the means to communicate, but arguably puts us already in an epis-
temic context Lakoff and Johnson (1980). It continues during education and socialization and does not end when we get out of school, job training or university. We gain knowledge through our peers (friends, teachers, society) and for our peers.

4.1 Individuals and Crowds

Goldman (1999) identifies four stages of social distribution of knowledge:

(1) Discovery
(2) Production and transmission of messages
(3) Message reception
(4) Message acceptance

These four stages are still all focused on individual choices, but are quite helpful, since the individual is at the first and last stage of knowledge accumulation. Stage 1 describes the individual discovery of information, regardless of how this information was produced. Stage 2 describes the transformation of
the information to knowledge and what the individual decides to do with it. The individual can decide not to communicate the information at all, in which case the path of the particular item of information ends there. If the person wants to communicate she can decide to exaggerate or falsify the information. The message receiver plays another crucial role.

![Goldman’s levels of communication](image)

**Fig. 3. Goldman’s levels of communication.**

4.2 About the Wisdom of Crowds

While Goldman (1999) analyzes the individual choices in knowledge gathering and communication this knowledge, Surowiecki (2005) in ”The Wisdom of Crowds”, identifies complementary social knowledge aggregation techniques that promise to be successful. It is possible to substitute a community for an individual in Goldman’s four stages, making justified communication more likely.

First, Surowiecki identifies three categories of problems:

1. Cognition Problems: questions with one answer or questions with a preferred answer
2. Coordination Problems that require coordination of actions between members of a community.
3. Cooperation Problems involve the challenge of getting members of a group involved in tasks or duties that seem contrary to their members’ self-interest, such as paying taxes.

Several field experiments have shown large groups succeeding in cognition problems. Surowiecki gives a few compelling examples.

- **Estimating the number of Jelly Beans in a jar.** Here, the average
estimate always got very close to the actual number, with only few individual estimates being better and these were not repeatedly the same individuals, but most likely lucky shots

- **Betting on election outcomes.** Here, Surowiecki cites the Iowa Electronic Markets (IEM) that allow stock-market style purchases of election options, where the price for an option reflect the current standing of the candidate. Even though disproportionately many Iowans participate and the number of participants is comparably small, it tends to produce better estimates than other polling data.

The first one seems quite straightforward. When the group is large enough, the individual estimation errors cancel each other out, leaving a small margin of error. If the better guesses were not just coincidental, the ”estimation experts” would have been able to repeat them. The second one is trickier, because also in polls large, representative groups are asked for an independent opinion. The difference between the polls and the betting is that participants think about how the others might act, without knowing how they will actually act. So it seems that simply taking ”the others” into consideration, improves our estimation capabilities. This is an example of people solving an extremely complex problem with many variables in an intuitive way. The argument being that intuition, normalized over large crowds, will yield good results. This is a field where machines lack capabilities. When the number of variables gets too large, computation takes a long time; when the available data is too sparse, prediction becomes unreliable.

According to Surowiecki, the requirements for good precision in answering questions, making predictions or making decisions are

- Diversity of Opinion
- Independence
- Decentralization
- Mechanisms for aggregation of the individual results

On the web, the first three are, for the most part, given by definition. However, the last point, while theoretically independent of the others, can in practice impede them, because a tighter community will likely have aggregation mechanisms more easily in place than a more loosely coupled community. In some instances, tight communities can easily sabotage the outcome of a distributed decision making process, by infusing it with pre-decided answers. A previous version of the Google page rank algorithm was particularly susceptible to this kind of misinformation-attack. So-called link-farms took advantage of the fact that Google indexes not only on the words on the pages themselves, but also on the words used in the *href* tag that links to the page. These so-called Google-
bombs\textsuperscript{5} would force Google to return e.g. the Biography page of President George W. Bush as first result of the search miserable failure or the website of his 2004 contestant John Kerry for the search term waffles. Undoubtedly, these kinds of attacks are a problem for large scale distributed problem solving, especially when the results are not evaluated but immediately serve as the input to another, independent and potentially mechanic, problem solving or decision process.

The ESP game or Google’s image labeler are examples of cognition problems that have preferred answers, but where the preference is not easily gradable. Success is measured by 2 participants using the same term to describe an image at the same time. A drawback of this method is that it leads to correct, but more generic answers. It seems that users will first enter more specific descriptions of the image, but then, when the time runs out and no consensus is reached, use more general tags, such as ”Man”, ”Woman”, ”Car”, ”Tree”, etc. Here, the kind of competition used is counterproductive to annotation-depth.

In general, it seems that crowds are quite good at solving problems that can be answered in a single sentence, an estimate or a thumbs up. How many pickles are in this jar? Which horse is going to win the race? Should I buy this company’s stock? Should the gladiator live? One cannot say that these are simple questions, but the answer is always simple and even though many factors weigh into the decision for a particular answer, there seems to be an immediate relationship between subject and object of the question.

The more difficult problem is how to map this to more complex problems that require a chain of associations that defy immediate intuition. Often, these are the ”how” and ”why” questions as supposed to the ”is it the case that”, ”how many” or ”should I” etc. questions. ”How does smoking cause cancer? “, ”what causes stem cells to differentiate at some point?” generally questions whose answers need high scrutiny and scientific exactness that random crowds cannot answer. Some of these problems might be decomposable into simple subproblems of the ”is it the case that”-kind. Also, questions can be truthfully answered with varying degrees of depth. Common sense versus the scientific method - it turns out/may turn out that both have their place.

4.3 Truth, Verifiability and Trust

Surowiecki (2005) makes a compelling case for the problem solving capabilities of anonymous masses. In the end, however, it is not enough to know that some social entity is capable of solving problems, we need to know whether there is

\textsuperscript{5} URL: en.wikipedia.org/wiki/Google_bomb
a good chance that it will solve the problem and that the solution is correct, at least to the best of the participants’ knowledge. From an epistemological point of view, it will always be easier to agree on a justified, conventional or prevalent statement than on an ad-hoc invented lie. This will hold the more, the larger the body of participants gets and so it is likely that the answer received from a crowd is at least not a maliciously invented lie. Along these lines Alvin Goldman (Goldman, 1999) asserts in "Knowledge in a Social World" that there is a "propensity towards truth." According to Goldman, it is in general more likely to get a correct answer than a false one.

5 Recruiting Problem Solvers

With all kinds of problems waiting to be solved, who is going to solve them, should I trust the problem solver and why should someone solve a problem for me in the first place? As for the person of the problem solver, it can potentially be any one or thing on the web. The more focused my search radius is, though, the more knowledge I will have about the solver and hence the more trust. Of course the equation is not quite that simple, but it is a start. In general, we can say that the golden rule, for numerous reasons, also applies in the context of problem solving on the web. Having stated this belief in the kindness of strangers, discretion is of course the better part of valor. That is why most problem solving tasks apply some sort of verification of the solutions. In a social setting, this is usually done by checking for agreement between agents. In the ESP game (von Ahn and Dabbish, 2004), image labels are only trusted when both randomly chosen players have entered them in the same round. This makes for a high precision with the price of a low recall. More generally, Game Theory knows quite a few mechanisms that can raise the likelihood of a stable outcome. Combined with the propensity towards truth and the wisdom of crowds, we are set.

Why would someone want to help me? There are numerous reasons why someone should or should not solve a stranger’s problem. Since there are no immediate repercussions for not helping out, the negative version of the golden rule does not apply.

Interestingly, as so often on the web, it was the adult entertainment industry that first made large scale use of human computation. When email providers installed CAPTCHAs to prevent bots from automatically creating thousands of spam email addresses, adult web-site providers went ahead and copied the CAPTCHA they encountered on the email provider’s site to the users’ sessions, asking them to solve the problem and as a reward see more free pictures. In the case of image labeling applications, online games became quite famous. the ESP game and Google’s image labeler draw players because they are well
developed and fun to play.

Another approach is taken by Amazon.com with its *Mechanical Turk* project. Users are paid small amounts of money to solve problems on the web. Amazon.com termed this "Artificial Artificial Intelligence". This is essentially the same route that advertisement firms are taking by giving redeemable points for taking online surveys and doing product tests.

Looking at these approaches, the good old *bread and circuses* saying comes to mind. We are happy to be exploited when in the end we can fulfill our desires for food and entertainment.

The above exemplify low commitment types of problems. The user’s involvement ends with the end of the session. In other cases, users make much stronger commitments. Contributors to Wikipedia or to Sourceforge devote substantial amounts of their time to improving articles and algorithms without reimbursement. For these kinds of problem solving communities the *bread and circuses* metaphor does not seem to apply. Maybe we can take advantage of more sophisticated analyzes of human motivation.

The Psychologist Abraham Maslow proposed in his influential paper "A Theory of Human Motivation" (Maslow, 1943) a hierarchy of needs humans aim at satisfying (see Figure 4). This hierarchy shows a level of basic physiological needs that must be satisfied first. The higher up in the hierarchy a need is the more abstractly it will be satisfied. It must be said here, that Maslow’s hierarchy is not undisputed, especially when it comes to the ordering of the needs in the hierarchy or to whether there is an order at all. This aside, for our purposes the last three levels in the hierarchy are of importance and an order is secondary.

![Fig. 4. The Maslow hierarchy of needs.](image)

Further criticisms include that it is not a fundamental human hierarchy of
needs, but geared towards a western, especially US American culture. It pre-
supposes a mostly selfish human psyche that acts altruistically only in order
to fulfill individual needs.

We can take this position as a worst case scenario by asking what does an
”invitation” to help out on a web-scale problem has to look like in order for the
selfish user to participate? In the case of high-commitment tasks, however, the
link seems vague. The Wikipedia community is to a large extent anonymous
or at least very low profile. It seems that contributing to Wikipedia is nothing
one could brag about or be highly regarded for by one’s peers. It is not the
individual contributor, but the communal outcome that matters.

Overall, to explain the motivation for participating on the web, moralistic
approaches seem to fail. Karma, the golden rule, ”what goes around, comes
around”, etc. usually involve negative assumptions, trying to have the protag-
onist imagine what happens if a bad deed is done.

Another approach to the explanation of why people act altruistically is given in
the field of Self Determination Theory (SDT). See here e.g. (Ryan and Deci,
2000). SDT looks at human actions from a less subconscious and selfishly
need-driven point of view, but rather at the degree to which people endorse
their actions at the highest level of reflection and engage in the actions with
a full sense of choice. This field has not been extensively analyzed. However,
Ludford et al. (2004) did research on factors of online participation.

At a first glimpse it seems that many factors play a role in whether a task or a
community are deemed worth participating in. This can range from aesthetic
appeal of the site to interest in the problem to the draw by members of other
networks who are already participating. Probably what draws most people
to Myspace.com is that many people are using Myspace.com. Its features
are not outstanding, its user-friendliness leaves a lot to be desired, there are
few options for privacy settings, etc. Wikipedia, as mentioned above, offers
very few rewards other than seeing a communal effort being accomplished. So
maybe on the web, with its dynamic structure, with the possibility to join and
leave communities, where interaction is location independent and hence can
draw very diverse communities from all over the world, and with its ”free of
charge” philosophy, there is some sense of ”the greater good”.

Recapitulating this chapter, we can assume that people are willing to engage in
problem solving activities provided that the incentive is, analogous to Freudian
categories, either fun, monetary benefit, or the prospect of contributing to
something sensible.
The previous chapters have outlined what kinds of web-solvable problems there are, how to formalize them, how to solve them, why we can trust the solution and why our questions may be answered in the first place. This chapter will attempt to put these capabilities and insights in the context of the Semantic Web.

The Semantic Web, as envisioned by ? is a vast collection of formalized knowledge and agents that are capable of understanding these formalizations and acting upon them. The formalized knowledge is available in form of so-called Ontologies that use logic or graph-based formalisms on top of unambiguous pointers to web resources in order to represent knowledge in a computer accessible manner. The semantic web paradigm is in some sense perpendicular to that of the Web 2.0 termed collections of human-generated networks and tags that are ambiguous, arbitrary and chaotic. These tags and connections are created on-the-fly, reflecting the taggers associations. Ontologies, by definition, contain true or at least highly justified knowledge, need to be logically consistent for agents to derive sound conclusions. Some drawbacks of this rigor have been addressed in Thomas and Sheth (2006) and Sheth et al. (2005); however, in order to have a completely reliable chain of inferences, this rigor is of great value. For this reason, Ontologies need to be created with immense scrutiny (Sahoo et al., 2006), (Thomas et al., 2006). While it is theoretically possible to have this kind of scrutiny reflected on domain-specific, expert-curated database-driven websites, such as Gene and Protein databases, the kind of grassroots semantics of the Web 2.0 takes its steam from the fact that it is easy, quick and still extremely useful. These paradigms are not easy to combine. One is dedicated for machine consumption, the other for humans. Even in the Semantic Web camp, the opinions diverge. While Jim Hendler coined the phrase ”A little semantics goes a long way”, Chris Welty asserts ”A little semantics is killing the Semantic Web.” The paradoxical situation is that both are exactly right. Web 2.0 has shown that a little semantics goes for the time being further than a lot of it. However, it has very little to do with the Semantic Web.

The question remains, then, how can these two paradigms that seem so close intuitively, yet so far ideologically and technically, be combined to achieve the kind of man-machine-hybrid computing power that the web has the potential of providing? First of all, who said that there cannot be anything between these two paradigms? We can take ”a little semantics” and gradually improve it. We can relate tags to concepts in ontologies. We can take informal assertions and convert them into formal ones. How can this be achieved? It is a problem on the web, so let the web solve it. Many communities might have a strong interest in simply tagging resources. Let them tag! Others need rigorous formal
representations and they will develop them out of their needs. Given these semantic bottom and top layers, other communities will have an incentive to relate them. In addition to manual creation of references to formal concepts, computational algorithms can find commonalities between similar pages and similar tags. It has been shown that free tagging converges to a stable semantic state where most taggers use few terms for the same resource and few taggers use diverging terms that form a long tail of tags (Halpin et al., 2007). The development of Web 2.0 parallel to the Semantic Web but with more speed and larger acceptance makes apparent the futility of pushing web users in some direction. Any attempt to marry Web 2.0 and Semantic Web must respect that lesson learnt. The Semantic Web must provide platforms that facilitate the use of semantics, that hide the formalisms from those who do not want and do not need to see them, that connect the things that are interesting to everyone to those that are interesting only to Semantic Web visionaries.

Web 2.0 is not a technological revolution. It marks a stage in a normal progression of the Web. Communication between client and server has always been possible and it has been used. Larger bandwidths and larger acceptance of the Internet by more and more users make it the ideal playground for social networking sites and collaboration between users. Hence Web 2.0 has to and is able to accommodate all the imperfections of the Web. The smorgasbord of conflicting opinions, inconsistencies even on single pages, different data formats etc. This is achieved by ignorance and apathy. The web simply does not care about these problems. So it goes on in its evolution and allows better and better searches and categorization, delivery and communication; but it cannot give us the kinds of decision making tools and question answering systems we are ultimately looking for.

Let us not kid ourselves. The reason why the Semantic Web as an overarching structure is failing is because it cannot deal with these inconsistencies. Humans use the Web, humans can deal with and consistently create ambiguous statements that would drive every automatic reasoner mad. The beauty of the Web lies in this ability to cope with all these logical fallacies. Ambiguities are signs of beauty. The human Web is the Poetry and Prose that is challenged by the flawlessness of the Semantic Web with its resemblance to the language of a Government bill. For the most part we think that bills are necessary and that there is a reason why these bills are cumbersome. We usually let those who have dedicated their lives to understanding government speech deal with them. However, we do engage in politics on many different levels. Through direct involvement in meetings, petitions, voting, consumer behavior, etc. These examples were ordered by a diminishing degree of personal involvement. This analogy can also hold for the web. Intelligent applications can analyze our behavior and learn from it.
7 Some Criticisms

One may wonder whether the kind of Web Wisdom that is promoted in this paper would, instead of Wisdom, foster nothing but great mediocrity. Millions of flies come to mind, mob rule, etc. A positive response to this criticism could be that, following Surowiecki, crowds are also good at handling cooperation problems. This could mean that a large enough crowd will outsource problems that need expert solutions even if it involves certain sacrifices, such as monetary loss, loss of recognition, etc. Furthermore, different forms of organizations can coexist on the Web. For many areas of the web infrastructure, a total knowledge democracy might not be feasible or not even desirable. The hubs and authorities paradigm (Kleinberg and Raghavan, 2005) can be seen as a web metaphor for a meritocratic form of organization. Different from a form of government, web users can change their trusted authorities at any point in time. Because of this freedom of choice, web authorities will be inclined to find the kind of organization that best benefits their peers.

Another point of criticism is ethical. If the participation in online tasks and communities is not based on selfish reasons, taking personal advantage without giving back would constitute exploitation, hence, soliciting services free of charge from volunteers should also be for the greater good.

8 Conclusion

This paper outlined a vision of a unified view of problem solving on the web. It encompasses traditional Web Services executed by computers as well as an semiformal view of human based services. The infrastructure is already in place and is even used extensively. Counting on the continuation of the current trend, Semantic Web research will have a hard time keeping up with all the ”little grassroots semantics” that are produced at a phenomenal pace. However, if it manages to give these efforts a formal underpinning without being a disturbing factor in this rather chaotic growth, it can greatly help to unify the informal approaches and thus create an environment where knowledge can prosper and problems can be solved on a larger scale.

Our future investigations will take closer looks at the human and social components of this unified framework. Using the metrics outlined, we are going to evaluate services provided by individuals and social networks with respect to their reliability, costs and accuracy. We hope that we can empirically narrow the expected parameters that different types of problem classes have in order to get a better understanding of the feasibility of invoking or requesting corresponding human or social network based services.
References


Thomas, C., Sheth, A., 2006. On the expressiveness of the languages for the semantic web - making a case for a little more.


