Towards a Model of Interdisciplinary Teamwork for Web Science: What can Social Theory Contribute?

Peter Kraker
Know-Center
Inffeldgasse 13, 8010 Graz
(Austria)
pkraker@know-center.at

Sebastian Dennerlein
Know-Center
Inffeldgasse 13, 8010 Graz
(Austria)
sdennerlein@know-center.at

ABSTRACT
In this position paper, we argue that the different disciplines in Web Science do not work together in an interdisciplinary way. We attribute this to a fundamental difference in approaching research between social scientists and computer scientists, which we call the patterns vs. model problem. We reason that interdisciplinary teamwork is needed to overcome the patterns vs. model problem. We then discuss two theoretical strains in social science which we see as relevant in the context of interdisciplinary teamwork. Finally, we sketch a model of interdisciplinary teamwork in Web Science based on the interplay of collaboration and cooperation.

Author Keywords
interdisciplinary teamwork, paradigms, collaboration, cooperation, patterns, models, web science

ACM Classification Keywords
J.4 [Social and Behavioral Sciences]; K.3 [Computers and Education]

1. INTRODUCTION
Each scientific discipline has its own culture. Kuhn (1962) called these cultures "paradigms" – a combination of assumptions, theories, and methods that guide research in a discipline. At times, a new set of problems arises that cannot be answered with the standard paradigm of a single discipline. Instead, these problems require knowledge from different disciplines. As a result, new formations emerge: interdisciplinary fields.

Web Science is such an interdisciplinary field. When the World Wide Web became social, studying people's online behavior became as interesting as building the infrastructure that allow for these interactions to take place [7]. In order to address the questions raised by Web Science, computers scientists need to talk to social scientists; social scientist need to talk to jurists – and sometimes they all need to talk to each other to solve a common goal.

One of the major problems of contemporary Web Science is that the different disciplines do not work together in an interdisciplinary way. Researchers often do not build on each other's strengths but they are rather suspiciously looking at each other's results. Social scientists tend to disregard computer scientists' results because they are not grounded in theory. Computer scientists tend to disregard social scientists' results because they are not based on big datasets.

When people from different scientific cultures and the corresponding paradigms get together, they surely have problems comprehending each other. They come from a different background, have a different vocabulary, and a different methodology. We, however, argue that Web Science suffers from a problem that goes beyond differences in methods or terminology and a mere new combination of existing paradigm parts. This problem deals with a fundamental difference in approaching research, and affects many other interdisciplinary fields where computer scientists and social scientists in a wider sense (sociologists, psychologists, learning scientists etc.) have to work together. We call it the models vs. patterns problem. In this paper, we discuss this fundamental problem and sketch a model grounded in social theory to overcome this problem.

2. THE PATTERNS VS. MODELS PROBLEM
To understand the way that computer scientists approach research, it is worthwhile to look at the area of knowledge discovery in databases (KDD). In 1996, Fayyad et al. defined the goal of KDD as to find new, valid, useful, and understandable patterns in data [5]. After preprocessing and data selection, the researcher performs some sort of data mining method (e.g. clustering or machine learning). The output of the data mining step are the aforementioned patterns. In a next step, the researcher evaluates the patterns and thus gains knowledge.

This process does not only describe KDD, it describes the way that a lot of computer scientists do research. Starting from a certain problem, they try to find patterns that relate to that problem in a big dataset. There is a certain caveat to the given definition of knowledge, and Fayyad and his colleagues make it very clear: „[..] knowledge in this definition

Web Science 2013 Workshop: Harnessing the Power of Social Theory for Web Science. May 1, 2013, Paris, France.

is purely user oriented and domain specific and is determined by whatever functions and thresholds the user chooses." [5] While this might be fine for practical problems, it surely isn't for scientific ones. This definition of knowledge excludes any generalization of results that goes beyond the specific situation and the specific user. To overcome this problem, computer scientists have developed good ways to identify reliable patterns that are independent of user and situation.

But a lot of these patterns are hard to interpret. Say you wanted to know which Twitter users are more likely to talk to strangers, and by various analyses you find that those are the ones that mention significantly more names of colors in their tweets. This might be a very stable pattern in the sense described before, but how do you interpret this result? This is when computer scientists turn to social scientists in order to find answers to their questions.

Social scientists, however, have a fundamentally different way of approaching a problem. Let's take the problem of which users are more likely to talk to strangers. Usually social scientists first turn to theories, in order to see which one might be applicable to the problem area. They might choose social information processing [11] that deals with how people get to know each other online. Then they come up with a general model or hypotheses based on this theory that describes the problem. Afterwards, they build an instrument to test this model, such as a survey, an interview, or an observation. In the end, they know whether the model has survived this specific test. The usual problem is that due to smaller sample sizes it is unclear to what extent the results can be generalized. That is when social scientists turn to computer scientists who can seemingly provide access to larger datasets.

But the problem is that computer scientists cannot test social scientists' models because they often do not have the data in the form that is required by these models. Social scientists on the other hand have a hard time interpreting computer scientists' patterns because they are too specific to be covered by traditional theories and models. This is what we call the patterns vs. models problem

3. INTERDISCIPLINARY TEAMWORK

We argue that it is important for Web Science to close the gap that results from the patterns vs. models problem. Otherwise, the different disciplines cannot work together as effective as they potentially could. On the more pattern-oriented side, it would be important to understand that theories are more than just castles in the sky. They can be effective guiding principles to interpret the results that are achieved. Hence theory should be baked into research to be able to understand these results. On the more theory-oriented side, researchers need to understand that data mining methods can be useful to evaluate models, but their properties need already be considered when building the models. In that way, both sides could build on each other's strengths – instead of suspiciously looking at each other's results.

Such an understanding cannot be reached, when work is simply divided between parties and then brought together in the end. In our view, Web Science requires "**interdisciplinary teamwork**" among the disciplines involved. In the following, we present two theoretical strains which we see as relevant to achieving interdisciplinary teamwork and overcoming the patterns vs. models problem. One is represented by the constructs of collaboration and cooperation presented in Dillenbourg [4] and Roschelle & Teasley [10] and the other by Bronstein's "Model for Interdisciplinary Collaboration" [2].

3.1 The Constructs of Collaboration And Cooperation

At first, it is important to understand the two concepts of collaboration and cooperation. Dillenbourg, and Roschelle & Teasley present elaborated differentiation of these two constructs of teamwork in their definitions. Dillenbourg [4] thinks of cooperation as division of work into single subtasks, which are solved individually and merged together into one final outcome in the end. Collaboration, in contrast, demands from the partners to do their work in common. Roschelle and Teasley [10] see collaboration in a similar way: according to them, collaboration is a process, in which the participants commonly acquire the relevant meanings for the problem at hand. Therefore, they fulfill the task from start to finish in a coordinated and synchronous way by negotiating and sharing meanings.

To be able to merge the fundamental differences of computer and social science approaches, it is not sufficient to assemble the different paradigm parts from both disciplines cooperatively. We argue that sole cooperation would not work for real interdisciplinary teamwork for two reasons: first, interdisciplinary approaches, such as the patterns vs. models problem, are iterative and work can't be split after a short negotiation in the beginning and simply be merged in the end. The second reason is that the common phases of the interdisciplinary efforts are more than just cooperative assemblies. They rather ask for in-depth discussions of shared meaning regarding the scientific approach itself. Therefore we define interdisciplinary teamwork in Web Science as a combination of collaboration and cooperation.

3.2 Bronstein's Model for Interdisciplinary Collaboration

While the elaborated definitions from Dillenbourg on the one hand and Roschelle & Teasley on the other hand serve as a joint fundament, we now discuss Bronstein's model for interdisciplinary collaboration [2]. The goal of Bronstein's model was to come up with a general representation of the components of optimal collaboration. The model is based on a review of the theoretical frameworks as well as the social work practice literature. Therefore, the model is grounded in theory, but it also has a strong practical side. Moreover it is independent of the domain, and has a strong focus on interdisciplinary aspects of collaboration. It can be used as a manual to provide a promising start of collaboration or to improve existing collaborative efforts independently of the underlying disciplines. Therefore, we chose this model to be able to analyze interdisciplinary teamwork in Web Science.

Bronstein's model consists of two parts (see Figure 1): the first part describes the generic components of optimum interdisciplinary collaboration; the second part places the model in context by analyzing various influences on collaboration. For our analysis, the components are much more important; we will therefore concentrate on the first part. However, the second part should be considered in more detail when further elaborating on the model sketched in this paper.

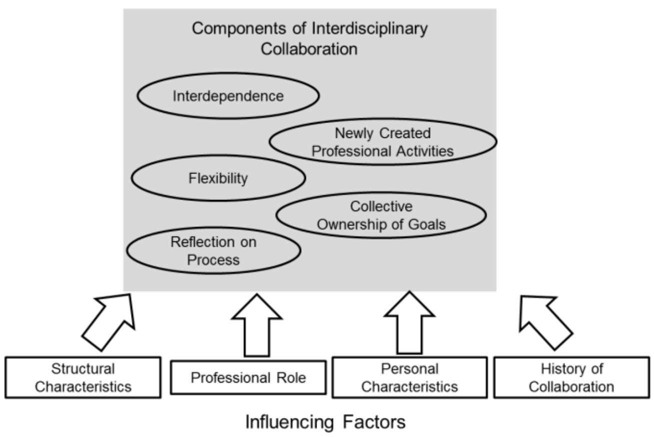

Figure 1: Bronstein's model of interdisciplinary collaboration [2]

According to Bronstein, the following components are part of optimum interdisciplinary collaboration: *interdependence, newly created professional activities, flexibility, collective ownership of goals, and reflection on process*.

Interdependence, as the first of the model's components, describes the mutual dependency of the collaborators: i.e. each collaborator is dependent on the others to achieve his or her goal. Therefore interdependence "refers to the occurrence of and reliance on interactions among professionals" [2]. The second component is represented by *newly created professional activities*, which refer to collaborative acts, programs or structures. These enable higher outcomes than individual efforts by the same persons. *Flexibility* describes the ability to accept role-blurring that is establishing productive compromises when facing disagreement and creative alternation of role according to the current (professional) need. It asks for fewer hierarchical relationships and constitutes the third component of Bronstein's model. The fourth component, *collective ownership of goals*, describes the collective responsibility alongside the whole process of joint design, definition, development and achievement of goals. The last component of the model refers to the *reflection on process*. That is, the collaborators should pay attention to the process of working together. This involves thinking and talking about their working relationship to strengthen the collaborative endeavor.

It is interesting to note that Bronstein does not differentiate between cooperation and collaboration regarding his model, besides listing other existing interpersonal processes. He cites an unclear, broader sense definition of collaboration by Bruner: "collaboration is an effective interpersonal process that facilitates the achievement of goals that cannot be reached when individual professionals act on their own" [3]. This could also be true for cooperation.

4. SKETCHING A MODEL OF INTERDISCIPLINARY TEAMWORK

We see the interplay of collaboration and cooperation as a solution to the patterns vs. models problem. In the aforementioned theories, however, this interplay is not considered. The authors rather look at them as two separated ways of working in a team. We will now illustrate, why we think that the interplay between collaboration and cooperation is so important to interdisciplinary teamwork on the basis of three components of Bronstein's model: *interdependence, newly created professional activities, and collective ownership of goals*. In accordance with Kump [9], we see these three components as central to interdisciplinary teamwork.

Concerning *interdependence*, neither cooperation nor collaboration is in itself able to fully support the demands of this component. Again, interdependence means that each of the collaborators has his or her own role and competences based on his or her discipline. He or she brings them into the team and takes partial responsibility to the achievement of the common goal. Hence each of the collaborators is positively dependent on the other's skills, when the team is assembled and the task is divided in a meaningful way. To do so, the team has to come together and collaborate at the beginning to establish a shared meaning regarding the team and its competencies, the vocabulary, the idea, the goal, the methodologies, and - above all - the overall scientific approach.

Later on, however, the team has to split up and cooperate to make use of the competencies of each member, and the strengths of each discipline, respectively. Trying to solve the whole task collaboratively and working out every single step in common would require too much time. Furthermore, it would not establish trust in the disciplinary abilities of the collaborators. This way of working wouldn't represent the idea of positive interdependence in any way. Therefore, the right timing to switch from collaboration to cooperation has to be figured out to exploit the interdependency in the best possible way.

The next step asks for assembling the partial achievements, making sense of them and planning how to further progress to reach the common goal. This action demands for a pooling/unification of the entire team, that is collaboration again. Afterwards the team needs to distribute cooperatively once more to enable the different members to engage in their subtasks. This alternation lasts iteratively until the team decides in shared collaborative session that the common goal has been reached and the work is finished.

To be able to achieve collectively owned (higher) goals, there is a need to come up *with newly created professional activities* [9]. Such activities would be a solution to the fundamental difference in approaching research as described in the patterns vs. models problem. These collaboratively created new professional activities, which could be named **collaborative paradigms**, have effects on collaboration as well as cooperation. Social researchers, for example, need to understand that computer scientists' methods can be useful to evaluate models in a collaborative step. Likewise, data mining properties need to be considered when building the models in the following cooperative step.

The *collective ownership of goals* effects cooperation as well as collaboration at the same time, because of the previously mentioned dependency of both components. That is, even when the collective goals are defined collaboratively, each discipline is represented according to its specific strengths within subgoals. These subgoals and related responsibilities will demand for cooperative engagement, even if they are interrupted by collaborative efforts until their fulfillment.

Altogether we suggest an understanding of **collaboration and cooperation as phases of the overall construct of "interdisciplinary teamwork". These phases are alternating with respect to Bronstein's components and the progress of achieving the common goal**.

5. FUTURE RESEARCH

We see this work as a first step towards a better understanding of interdisciplinary teamwork in Web Science. In a next step, it will be important to express the sketch in a formal model. Pending research questions in this respect are: What role does the second part of Bronstein's model, the influences, play in respect to collaboration and cooperation? What are the optimal durations of collaboration and cooperation phases and how do they vary over the time of the research project? What (web) tools and technologies are best suited to support the different phases?

Furthermore, we want to look at possible influences on interdisciplinary teamwork other than the models vs. patterns problem. Two important theoretical concepts that we have not discussed so far are power and hierarchy. These concepts that are explored for instance in the works of Bourdieu [1] and Foucault [6].

Finally, it will be important to test the model by evaluating it. In this step, we want to use social science methods as well as web data to show how both approaches to Web Science can be intertwined.

ACKNOWLEDGMENTS

We would like to thank two anonymous reviewers for helpful references to relevant social theories. The Know-Center is funded within the Austrian COMET program - Competence Centers for Excellent Technologies - under the auspices of the Austrian Federal Ministry of Transport, Innovation and Technology, the Austrian Federal Ministry of Economy, Family and Youth, and the State of Styria. COMET is managed by the Austrian Research Promotion Agency FFG.

REFERENCES

1. Bourdieu, P. 1988. *Homo academicus*. Suhrkamp.
2. Bronstein, L. R. (2003). A model for interdisciplinary collaboration. *Social Work*, 48(3), 297–306.
3. Bruner, C. 1991. *Thinking Collaboratively: Ten Questions and Answers To Help Policy Makers Improve Children's Services.* Education and Human Services Consortium.
4. Dillenbourg, P. 1999. What do you mean by 'collaborative learning '? *Collaborative learning: Cognitive and computational approaches*. 6(1), 1–15.
5. Fayyad, U., Piatetsky-Shapiro, G., & Smyth, P. (1996). From Data Mining to Knowledge Discovery in Databases. AI Magazine, 17(3), 37–54.
6. Foucault, M. 1980. Truth and Power. Power/Knowledge: Selected Interviews & Other Writings 1972–1977. C. Gordon, ed. Pantheon Books. 109–133.
7. Hendler, J., Shadbolt, N., Hall, W., Berners-Lee, T., & Weitzner, D. (2008). Web science: an interdisciplinary approach to understanding the Web. *Communications of the ACM*, 51(7), 60–69.
8. Kuhn, T. 1962. *The Structure of Scientific Revolutions*. University of Chicago Press.
9. Kump, B. (2011). Ich kann was, was du nicht kannst: Synergien in interdisziplinären Teams. *wissens.blitz* (48).
10. Roschelle, J. and Teasley, S. 1995. The construction of shared knowledge in paired problem solving. *Computer supported collaborative learning*. C.E. O'Malley, ed. Springer. 69–97.
11. Walther, J. B. (1992). Interpersonal Effects in Computer-Mediated Interaction: A Relational Perspective. Communication Research, 19(1), 52–90.

NOTE

This paper is based on a blog post which appeared on the blog of one of the authors: http://science20.wordpress.com/2013/03/04/the-models-vs-patterns-problem/