Knowledge Federation as a Principle of Social Organization of Knowledge Creation and Sharing

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Abstract. We introduce *knowledge federation* as a principle of social organization of knowledge creation and sharing that is conducive to improving our collective intelligence (ability to understand and handle complex issues). We point at the advantages of *knowledge federation* and propose a strategy to realize it in practice.

Keywords: knowledge federation, knowledge organization, collective intelligence, socio-semantic web.

Dedication. We dedicate this article to Doug Engelbart in recognition for his guiding insights and inspiration.

1 Introduction

Doxa is the term used by sociologist Pierre Bourdieu for a peculiarity of our perception, due to which our existing social order appears to us as equally immutable as the natural one. Unlike *orthodoxy* which, while allowing for only one 'right' order of things to exist, acknowledges the existence of other 'deviant' possibilities, *doxa* denies even the possibility of other options. We begin this article with this word, because *doxa* highlights a blind spot in our perception of social reality behind which, we submit, extraordinarily large possibilities for creative contribution are hidden. *Doxa* is a reason why we try to solve our problems by thinking as we did when we created them. And why we create new technology to support the patterns of usage that developed based on the old technology. While the examples are as ubiquitous as the computer desktop and email, we here focus on a much larger example – knowledge creation and sharing as a whole.

The following two vignettes will help us introduce our theme.

1.1 Fragmentation of Sociology

After the Second World War sociology grew dramatically, and by the 1980s the number of sociologists and sociology publications increased more than five-fold. At the same time, sociology divided itself into a number of regional and methodological sub-specialties, which were rapidly losing contact with one another.

The disadvantages of this style of organization were easily recognized, and in the 1989 a conference was organized by two leading researchers, European Pierre Bourdieu and American James Coleman, to explore the possibility of bridging the dividing lines and putting sociology back together. In the epilog to the book that resulted from this conference, Bourdieu argued that "the progress of scientific reason in sociology hinges crucially on a transformation of the *social organization of scientific production and communication*." [1]

Bourdieu's argumentation is insightful and worth quoting:

> "Max Weber (1978) reminds us that, in the art of warfare, the greatest progress originated not in technical inventions but in transformations of the social organization of the warriors, as for instance in the case of the invention of the Macedonian phalanx. One may, along the same line, ask whether a transformation of the social organization of scientific production and circulation and, in particular, of the forms of communication and exchange through which logical and empirical control is carried out would not be capable of contributing to the progress of scientific reason in sociology—and to do so more powerfully than the refinement of new technologies of measurement or the endless warnings and 'presuppositional' discussions of epistemologists and methodologists. I have in mind here a scientific *politique*—that is, policy and politics—whose goal would be to foster scientific communication and debate across the many divisions associated with rational traditions and with the fragmentation of social science into empirical subspecialties, theoretical paradigms, and methodological schools." [1]

The same reasoning may be taken a step further. While Bourdieu's focus was on the progress of scientific reason *in sociology*, the disadvantages of the fragmented organization of sociology become more accented when we consider them in the context of the knowledge production *in the society*. A consequence of the fragmentation of sociology is that our society no longer has *the sociology* to inform it about its problems.

The Club of Rome was organized to supplement this vitally important role.

1.2 Institution of the Club of Rome

The Club of Rome is an international think tank, instituted in 1968 by business leader and humanist Aurelio Peccei and scientist Alex King, with the mission to develop reliable insights about the risks and prospects of our global society in rapid change. While the awareness of the global risks is now common, this was not the case in 1972 when the Club voiced its alarm [2]. From their rich history, we shall highlight only an insight that was made already on their initial meeting in Rome, by Erich

Jantsch in his keynote speech, where he argued that the global social system is lacking feedback (mission-critical knowledge), and therefore also control (sustainability).

The organization and the activity of the Club of Rome contrasted sharply with the organization and the manner of development of academic sociology. The Club insisted that it was impossible to understand or solve any of the characteristic global problems by focusing on the problem, and that we needed to focus on what they called the *world problematique*, the condition that encompasses them all. To that end a trans-disciplinary organization was needed, and the Club of Rome organized itself accordingly, to include as much as possible all disciplinary and regional points of view.

It may be interesting to observe that since its inception, the Club of Rome struggled with the prevailing mind set in the academia. Summarizing the experiences of the constitutional meeting in Rome, Peccei wrote:

> "We discussed how the problematique should be approached in the context of the world system and wanted to share our views with a number of scientists, economists and sociologists. [...] The rationale behind this initiative was that, if some ten or so Europeans of different origins and disciplines can be made to agree on no matter what among themselves, then even the devil can be reconciled with holy water. [...] For instance, a controversy arose over the difference between the word 'system' in English and the French cognate 'système', spawning a whole hour of sophisticated debate [...] After 2 days it proved virtually impossible to have the conferees agree among themselves, not even on mere prolegomena." [3]

1.3 Preeminence of Social Organization

We may now paraphrase Bourdieu by saying that "Progress hinges crucially on a transformation of the social organization of knowledge production and communication." We have omitted the qualification "of scientific reason in sociology" because (1) the described fragmentation of sociology is an instance of a general trend and (2) a different organization of knowledge work and even motivation for knowledge work are needed to secure progress, as the second vignette illustrated.

When Bourdieu voiced his appeal, there was no Web, no Wikis and no Topic Maps. With the book and the classroom as media, perhaps a radically different social organization was not yet possible. Now the technology allows us to implement just about any form of social organization we may be able to imagine.

1.4 D'Après Bourdieu Project

The question remains '*What can we do* to facilitate the development of a remedial social organization of knowledge creation and sharing in practice?'

As our knowledge federation research community is convening for the first time, and is about to define its problem space and its manner of working, we propose to adopt the above question as our main focus of interest. We propose to organize the work in our community as a cooperative strategy game, where our shared goal will be

to discover 'moves' that can further the above cause. We call this line of work D'Après Bourdieu (According to Bourdieu) Project, to remind us that, according to Bourdieu, it is likely to lead to greatest progress.

Notice that the task of developing a better social organization has a self-referential, Catch 22-like structure: The effects of whatever we might do or say might end up being confined to our community. The reason is that there is little or no communication between the communities – the very problem we have undertaken to solve.

We propose to handle this difficulty by creating a small instance of a remedial social organization involving researchers from a variety of communities, who will make the task of implementing a remedial social organization their shared goal. Or in other words, we propose to use 'bootstrapping,' a general strategy developed by Douglas Engelbart [4].

We submit that this strategy – evolving an instance of a better social organization of knowledge production and sharing – will profile us with respect to other similarly motivated communities and efforts, such as the Global Sensemaking and the Semantic Web. It will also allow us to synergize with their work, and to augment their prospects of success.

1.5 Organization of this Article

The remainder of this article is organized as follows. In the second section, we define and motivate *knowledge federation* and our proposed strategy. One of the key advantages of taking the systemic approach by placing the social organization and the development of an instance of the whole system into the center is that this approach allows us to see what building blocks may be needed, and to use this to orient research. In the remaining three sections we describe three such building blocks: the Domain Map Object, the Value Matrix Object and the Knowledge Federation Methodology. In the concluding section we generalize our discussion and point at the proposed research agenda as a way to develop a methodology for 'programming the Web.'

2 Why *Knowledge Federation*

We explain *knowledge federation* by comparing it with two familiar principles of organization – conventional authoring of documents, and Wikipedia-style *knowledge unification*. We then discuss the advantages of our proposed strategy.

2.1 What is 'Knowledge Federation'

The conventional practice – authoring documents, without any systemic effort to organize the documents and the knowledge they contain into a coherent system, has the disadvantage of leaving the following Herculean tasks to the reader:

- Identifying and assembling the knowledge resources that are required for making a qualified judgment about a subject.
- Reconciling the divided or even incompatible opinions in order to arrive at an informed conclusion.
- Keeping the knowledge up to date and securing that it reflects the state of the art.

As the number of authored documents increases, these tasks tend to become impossible. To cope, the knowledge workers specialize and divide their domains, which leads to the problem described in Introduction.

An alternative is Wikipedia-style *knowledge unification*. In the Wikipedia, there is only one article associated with any subject. That article represents (an approximation of) the consensus position of the global community about its subject and reflects the current state of knowledge.

This principle of organization, however, also has disadvantages:

- The simple social process by which the consensus is reached (overwriting) obviously leaves room for improvement.
- It is difficult to secure that the authors receive credit for their work.
- It is difficult to show conflicting or contradictory points of view when those exist and need to exist.

Recognizing these limitations, Wikipedia disallows the publication of the results that have not already been published via conventional channels. But this means that the Wikipedia-style organization is suitable only for an encyclopedia, and not as an alternative to the conventional practice in the sciences and the media.

We define *knowledge federation* as the principle of organization that combines the advantages of the above two approaches and avoids their disadvantages (we italicize a concept when we attribute to it a *local* meaning, i.e. the one defined in this article). If we liken the conventional authored documents to independent states, and Wikipedia-style *knowledge unification* to everyone being coalesced into a single state, then *knowledge federation* may be likened to political federation, which aims to reconcile the demands for autonomy of the local units with the interests of the larger whole they compose together.

We let *knowledge federation* point at the broad spectrum of social organizations that are possible between the conventional document authoring and the Wikipedia-style *knowledge unification* as simple extreme points.

Knowledge federation is both a social organization of knowledge production, and an organization of knowledge resources. Used as a verb, it denotes the corresponding activities.

2.2 Advantages of the Proposed Strategy

Since in the academia we are accustomed to considering an analytical result (observing how the world is) as a contribution, and everything else as a means to that end, or else as a distraction, the wisdom of focusing our attention at the practical development of *knowledge federation* may be questioned. We offer the following arguments to support this orientation:

- **Global brain argument**. Think of the totality of the people (researchers, journalists…) and social processes that create knowledge as the global brain, whose vitally important role is to provide our 'social organism' awareness and guidance. As we have seen, the fragmented organization does not yield a sort of global brain we can rely on. If now the global organism appears to be acting unintelligently or even self destructively, should we not begin the remedial action by examining what is likely to be the root cause of this problem? Should we not give the task of inter-connecting our global brain, and organizing it intelligently, a highest priority on our sustainability agenda? We propose our strategy as a way to bootstrap the self-organization of the global brain.
- **Technology adoption argument**. The existing social organization of knowledge production and sharing (book and article document formats, peer reviews, journals, promotion criteria…) is a complex system that has evolved during several millennia, based on the book and the lecture hall as media. To highlight its complexity, imagine it as a transportation system, and imagine a different social organization, the one that would be capable of truly taking advantage of the possibilities that the technology now has to offer (multimedia, Semantic Web, wikis…) as an entirely different, non-polluting transportation system that would offer the combined advantages of the automobile and the public transportation. Then our current way of deploying the technology would resemble bringing to the market various building blocks of this new transportation system (engines, transmissions, steering…), produced by different companies, who never secured that their products fit together into a meaningful whole, and who don't even know what the whole thing is supposed to look like. Our proposed strategy would be like creating a prototype instance of the whole transportation system. By doing that we enable large-scale adoption of the existing technology, and facilitate the creation of the components that are still missing.
- **Efficiency argument**. To see the possibility of orders-of-magnitude improvement in efficiency and effectiveness, imagine a *federated* university course, where the learning resources are co-created by international contributors and offered to learners worldwide. Instead of having to create an entire textbook or lecture slides, an instructor is able to focus on a single lecture or part of a lecture, and also join forces with creative video artists, animators and communicators, who are themselves members of the *federation*. The learning resources are created and kept up to date by the people who have the best knowledge of the material. The learners too participate in the creation, evaluation and 'digestion' of the knowledge resources, and in that way complete a well-functioning knowledge ecosystem.
- **Contribution to knowledge argument**. Normally, any of us is capable of contributing only one (fictitious) person-lifetime amount of knowledge. But if we manage to improve the over-all system of knowledge production, and thereby augment everyone's ability to contribute and acquire knowledge by, say, only 1%, this would have an effect comparable to millions of personal

contributions. And as we have seen, a much larger, *qualitative* improvement may be possible.

The main insight from the punctuated equilibrium theory of evolution may be used to complete this argument, by explaining why our proposed strategy (producing a small functioning instance of *knowledge federation* within our own community) is a natural way to approach the above goal (of affecting the global system): While affecting the large system directly may be difficult or impossible, evolving a new species in a fragment of the population, 'isolated at the periphery of the ancestral range' is the way in which evolution *can* make a 'jump.' And that is exactly what we are proposing.

3 Domain Map Object

We make initial progress towards a *knowledge federation* system design by identifying its three large building blocks. We begin with the *domain map object*.

3.1 Geographical Maps, Topic Maps and *Domain Maps*

The main purpose of the Domain Map Object is, intuitively, to provide a 'map' for placing and locating knowledge resources.

A reader familiar with Topic Maps will need no introduction to the usefulness of such maps. Like a topic map, the Domain Map will allow for a subject-centric organization of knowledge resources, where each subject points at all the resources that are *about* that subject. To properly make an article or any other knowledge resource known and accessible, its author will not only publish it, but also 'place it on the map.'

A significant difference between a topic map and a *domain map* is that the former is a topical index into a domain, while the latter *represents* a domain. In this regard a *domain map* is more similar to a geographical map. A *domain map* should not only map the existing knowledge, but also orient research, by showing the areas where knowledge is still lacking.

To that end, the Domain Map Object will provide functions for co-creating abstract views of a domain.

Multiple views of a domain will be provided (analogous to geophysical, political, climatological and other maps in geography).

The representation of *domain maps* invites creative use of visual techniques.

3.2 Exports and Imports

In addition to serving as a map of a domain, the Domain Map Object will also serve for communication between domains.

To that end, the Domain Map Object will have provisions for importing knowledge from other domains, and for exporting knowledge to other domains.

4 Value Matrix Object

Even when all the resources are placed on the *domain map,* the problem of the cognitive overload will not be solved, because there will still be millions of resources associated with many of the subjects. A purpose of the Value Matrix Object is to provide additional information about the knowledge resources that will enable us to prioritize the ones that are most suitable for a given query.

Another purpose of the Value Matrix Object is to make it possible to evaluate the contributions of the authors.

4.1 Accumulating Value Information for a Resource

The Value Matrix Object is an object associated with a knowledge resource, whose purpose is to accumulate the information about the value of the resource, throughout the lifetime of the resource [5].

A *value matrix* may be envisioned as a matrix whose rows are criteria (relevance, quality, reliability, level of expertise needed for understanding etc.) and whose columns are distinct ways of making valuations (expert judgment, popular vote, number of accesses etc.).

A challenge to which the Value Matrix Object aims to provide an answer is to maintain a record of *all* the data that may later be useful for estimating the priority of a resource with respect to a particular query.

Here are some use cases:

- The user may want to access only the ground-breaking results in an area.
- The user may look for a most authoritative survey for general audience.
- The user may trust a specific researcher as an expert with profound understanding of an area and ask for only those resources to which that chosen researcher has given the highest recommendation.

4.2 Evaluating an Author's Contributions to Knowledge

The habitual practice, to evaluate the academic contributions by the publication record alone, tends to discourage the authors from spending time on knowledge organization, and encourage them to produce large volumes. Hence the conventional evaluations support the practices that lead to cognitive overload. Our challenge is to do the opposite.

A *value matrix* will allow for evaluating the author's contributions by multiple criteria such as:

- Publishing one or several articles that are considered as outstanding by some of the leading experts in a field.
- Contributig to the organization and systematization of knowledge.
- Contributing to the dissemination of knowledge from one's own to other domains.

A promotion committee in a particular department may take any subset of these and other criteria into account.

This function may make the Value Matrix Object a key component of a healthy knowledge ecology.

5 *Methodology*

As we have pointed out in Introduction, *knowledge federation* may need to involve not only new technical solutions and new patterns of organization, but also new practices, methods and even goals and values. A purpose of the *methodology* is to foster such developments.

A *methodology* is a written convention, subject to mutual agreement, specifying the fundamental assumptions and methods based on which knowledge can be created and communicated. Being a written convention, the *methodology* provides a rational basis for departing from habitual ways. By making a convention, we create a rational, tradition-independent foundation for knowledge creation.

The traditions and communities of interest can then use this foundation to combine and exchange their knowledge.

In what follows we identify several ways in which a *methodology* may benefit *knowledge federation*. We base our discussion on the Polyscopic Modeling *methodology* prototype (*polyscopy*) [6,7,8].

5.1 Specifying the Goals and the Criteria

The pursuit of knowledge has, of course, an intrinsic value that is beyond pragmatic concerns. In our contemporary condition, however, certain new kinds of knowledge may need to be created with high priority, because the systemic sustainability may require that, or for other reasons. A purpose of the *methodology* is to express this need explicitly, and thereby initiate the development of suitable practice.

The Polyscopic Modeling *methodology* defines the *gestalt* as an interpretation of a situation that points at an appropriate action. An example is 'the house is on fire.' Polyscopic Modeling identifies having a correct *gestalt* as a distinguishing characteristic of 'being informed.'

One may be absorbed in an observation of distant stars through a telescope and ignore that his house is on fire. While science gives us certain preoccupations and ways of looking at things, acquiring correct *gestalts* requires that we remain open to new ways of looking and use and develop new ways of making sense. In *polyscopy* this is made explicit by a criterion called *perspective,* which specifies that information must illuminate a subject or issue from all relevant sides and angles, so that everything that can contribute to sound judgment is exposed.

It is easy to see how this empowers *knowledge federation*.

5.2 Specifying the Assumptions

The conventional practice is to create knowledge by augmenting the reality picture shared by a community (a discipline or a tradition), by using the language or the

terminology shared by the community. The Biblical myth of the Tower of Babel illustrates the difficulty of putting the divergent worldviews and vocabularies together.

Polyscopy handles this difficulty by postulating that information reflects not reality but experience, and by allowing for concept definition by *postulation* (explicitly written convention subject to agreement).

To see why this is helpful, consider the question that tends to divide the traditions – the nature and the existence of God. *Polyscopy* would ignore the metaphysical differences as 'modeling artifacts' and would focus on experience, aiming to identify the pertinent experiences that are similar across traditions. It would define the concept 'God' in a way that makes it possible to answer the most relevant questions.

By explicitly stating the fundamental assumptions, a *methodology* can provide a shared, tradition-independent ground for *federating* knowledge, without hidden assumptions, and without giving an unfair advantage to any of the traditions.

5.3 Specifying the Methods

A *methodology* can specify the methods by which heterogeneous pieces can be combined together.

Polyscopy provides three such methods. They are called *information holons*. An *information holon* is both a whole 'piece of information' and a piece in a larger whole.

In a *federated* organization, the books and articles may no longer be suitable basic units of information. *Information holons* are a candidate alternative.

6 Concluding remarks

The Wikipedia and more generally the Web 2.0 approach have been criticized as "disintermediating the expert." This presents a challenge to the academia, because much of the academic tradition has to do with expertise (acquiring expertise, being certified as an expert, having the prerogatives to do independent research, be qualified to teach on a certain level etc.). In this context, our *knowledge federation* proposal may be considered as an academic response to some of the existing trends in Web development.

The current practice is that the changes of the way knowledge is created and accessed globally are made by a handful of computer programmers, simply by creating a piece of software and making it available on the Web.

We submit that this key social function needs to become a subject of concerted *academic* attention. And since the task of developing functional ways of creating and using knowledge requires a lot more than a single type of expertise (technological, sociological, cognitive, legal…), this task needs to be handled by a *federation* of experts.

In the recently published Handbook of Research on Socio-Technical Design and Social Networking Systems, Thomas Erickson writes the following:

> "But socio-technical design is not just about designing things, it is about designing things that participate in complex systems that have both social and technical aspects. Furthermore, these systems and the activities they support are distributed across time and space [and are] in constant flux. [...] this complexity raises a number of general questions that socio-technical systems designers will need to address. First of all, how do we represent such systems? How do we cast a complex system into a material form in such a way that we can reflect on it? [...] how do we carry out reflective conversations with them? How will we go about ensuring that we ask the right questions, from the right perspectives, in the right contexts? Perhaps, taking a cue from participatory design (e.g., Greenbaum and Kyng, 1991), we will need to greatly expand the range of participants involved in the reflective processes, which in turn may require developing new sorts of design artifacts to aid in participatory reflection.[...] how do we ensure that eventually we converge? Or do we? Perhaps the notion that the end result of a design process is a stable product is old-fashioned. Perhaps we're headed towards a future of 'permanent beta,' in which things are designed so that their design may continue during use, where the leading edge of design resides not with the producers but with the users. [...] However things turn out, it seems clear that socio-technical design will require new methods, new tools, new participants, and new practices." [9]

We submit that *knowledge federation* is a form of organization suitable for socio-technical design, and propose the project outlined in this article as a way to develop the required methodology.

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