

Community visualisations in Open Knowledge Space

Uncovering rabbit holes in a digital ecosystem

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Abstract—Visualisations have a long tradition in the research of social networks. The increase in the popularity of various social networking and community services in modern Web has emphasised the need for high-end visualisation targeted for the end users of the services. We see the community visualisations as means for a member of the community to uncover “rabbit holes” leading into new and unexpected information landscapes, to both discover unknown members with complementing interests and find unknown interests of already known members, and, in all, to become a working part of a community. In this paper, we lay the foundations for community visualisations related to Open Knowledge Space, a collaborative knowledge-creation platform currently developed in OPAALS, a European Network of Excellence. In addition, we discuss the connections between community visualisation, social network analysis, Semantic Web and Web 2.0 and introduce a set of community visualisation prototypes designed to support the community building and knowledge-creation processes in Open Knowledge Space.

community visualisation; digital ecosystems; social network analysis; data processing pipelines

1. INTRODUCTION

Finding relevant information and people with similar interests is a major issue in any digital community or, in general, any *digital ecosystem* (see <http://www.digital-ecosystems.org/>). The information content in a digital community is always, at least partly, informal and vague and therefore hard to manage with machines. Also finding the proper location to input new information may be challenging - not to mention becoming a working part of the community. We argue that *community visualisations* can provide a member of an ecosystem means to solve these problems.

The overall objective of *information visualisations* can be characterised as to serve as an amplifier of user's cognition by giving insight to the data visualised [1]. The *visual information seeking mantra* by Shneiderman distils the usage process of a visualisation in the following way: “overview first, zoom and filter, then details-on-demand” [2]. The mantra suggests that visualisation is a process rather than a static image.

At best, the visualisations can act as “rabbit holes” in a digital ecosystem through which users are able to find and situate themselves into new information landscapes (cf. [3]).

The rabbit hole is a metaphor inspired by Lewis Carroll that “has also come to signify any event which triggers a completely unexpected, bizarre situation or paradigm” [4]. McGonigal has introduced the metaphor in the context of game design and provokes by stating that rabbit holes create community, build a learning culture, increase sensitivity, produce vertigo and virtualise everyday life [5].

Creating a personal connection between the user of the visualisation and the visualised data can be seen as a motivation factor for using the visualisation and, more importantly, the creation and refinement of the data that is visualised. Heer even claims that when visualisation users are “successfully able to 'write themselves into the data', the hope is that they might then continue on to more fully explore their data environs” [1].

Social networking is an uprising phenomena in the state-of-the-art Web or *Web 2.0* [6]. The social network data, essentially the member profiles and the articulated relationships between the profiles, is often quite formal, thus enabling the mechanical data analysis (see [7], [8]). Once the data can be analysed, interactive visualisations providing means to navigate the social network data and gain overall insight on the community structure can be created (see [9]).

In this article, we start by describing the context we are working in, continue with an overview of our evolving theoretical framework, discuss the social networking in general and particularly in the context of Open Knowledge Space (OKS). We also introduce two early community visualisation prototypes and discuss their design and implementation. We finish the paper with a general discussion, some early conclusions and directions mapping our work in the future.

A. What is OKS?

Open Philosophies for Associative Autopoietic Digital Ecosystems (OPAALS) is a multidisciplinary Network of Excellence for developing the science and technology behind digital ecosystems (<http://opaals.org>) coordinated by London School of Economics and Political Science (see <http://www.lse.ac.uk/>). To support the multidisciplinary research work done across Europe, Africa, Asia, and South-America as well as the efficient dissemination of the research

results, the OPAALS community is designing and constructing Open Knowledge Space (OKS). The work is done in an evolutionary manner, largely by tailoring and integrating existing tools for creating, refining, and accessing the information in OKS related to the OPAALS research. Interestingly, OKS is a digital ecosystem about digital ecosystems.

While OKS can not be easily formalised, we see that it includes at least the following web-based tools: 1) *OKS wiki* offers a platform for collaborative writing. 2) *OKS blogs* are informal journals written by the members of OKS community. While not being able to edit each others' blogs, members may add comments to any blog writing. 3) *OKS members profiles*. Since OKS does not currently provide any formal tools for member profile creation, we have used the OKS wiki member pages for capturing the profile information.

B. Some concepts

Working in a multidisciplinary domain is difficult for many reasons, the lack of shared concepts is one of the main issues. In the following, some of the concepts used in this paper are introduced and discussed.

In general, social science data can be categorised as follows. *Attribute data* is related to the properties of an agent in the network including the properties, qualities and or characteristics defining the agents as individuals in a community. The connections, contacts and ties between the network agents is referred as *relational data*. Third type of data, *ideational data* does “describe the meanings, motives, definitions and typifications themselves”. [10]

In this paper, *member* is used as a synonym for agent, user, actor, and (human) entity. Connections are called *relations* or *relationships*. In 1930's, Jacob Moreno introduced a concept of *sociogram* as means to visually represent “social configurations” (see [10]). We use the concept to refer to a logical description of a social network that is processed from the raw data in order to be visualised. By *community visualisation*, we refer to visualisations of the social networks in a community.

II. BACKGROUND AND RELATED WORK

Both social network analysis (SNA) and social network visualisation have a long history in sociological research. From the originally hand-drawn images to the current interactive visualisations created with and running in computers, the social networks have been visualised in particular with diagrams, or sociograms, based on points representing social actors and lines representing the connections between actors. With the visualisations, the researchers have been able to gain and share insight on social networks. [11]

Traditionally, SNA has been applied by expert users and researchers when analysing a particular real-life social phenomena. As the popularity of social networking applications such as LinkedIn, Facebook, Orkut, and Friendster and Last.fm, Flickr, and other web communities has increased, the potential possibilities of end-user driven

visualisation of the are becoming more evident to the service developers. There are various reported attempts to apply SNA in the context of social networking for research purposes (see e.g.[7], [12]).

Exploring the social network in the state-of-the-art social networking services is, in most cases, only possible through a linear list of friends presented as a part of a member profile. This makes it difficult to grasp the overall insight of the social network (cf. [9]). To support the exploration of social network in *Friendster*, a popular social networking service, Heer and boyd designed and built a social network visualisation tool *Vizster*. *Vizster* follows the tradition of sociograms by using nodes to represent the *Friendster* members. The nodes are interlinked by the articulated friendships between members with lines representing the relationships.

The member profiles play a significant role in a social networking service. On basis of their research on *Friendster*, boyd and Heer state that people use their profiles as means of creating and interpreting the context of online performance [13]. Heer and boyd point out that in *Friendster*, the existing profiles act as norms for new members defining their profile and that users tend to refine their tastes according to the ones of their friends [9].

III. OPEN KNOWLEDGE SPACE AS A MEDIUM FOR SOCIAL NETWORKING

A. Social networking in online communities

User profiles and other common social networking features are implemented into existing Web services in a fashion sometimes resembling the enthusiasm related to the gold rush. Despite the obvious hype, the social networking feature come with distinct advantages to the members of a community.

The member profiles are the core of social networking. The profiles include attribute data of a member such as name, nickname, image, contact information, online accounts, interests and preferences. In addition to the attribute data, the members are often able to define relationships to other members of the community. The relationships are, in many services including Last.fm, *Friendster*, and Orkut, referred as “friendship” or sometimes simply “connections” like e.g. in LinkedIn.

In addition to the explicitly stated member profiles, the recorded member actions and the actual content of the service can be used to mine weak links between members. In Last.fm, for example, the music listened by a member is tracked and mined in order to find member-to-member, artist-to-artist, and member-to-artist relationships and create recommendations for the members [14]. In addition, the members are able to formally associate their published writings with artists, thus creating more annotated relations into the contents of Last.fm.

B. OKS as a social networking platform

Open Knowledge Space can be used as a social networking platform for researchers and other actors interested in the research of open digital ecosystems. The members are, already, able to define their profiles. The possibility to track

OKS users and mine the contents of OKS in order to induce new facts on users and new connections between users is appealing but needs further analysis and research. For example, on basis of the fact that user is mostly reading and editing wiki pages in two categories, **Visualisation** and **SocialNetworkAnalysis**, the members could be offered the possibility to easily define the two areas as interests into the profile (cf. [15]).

In Open Knowledge Space, currently, the member profiles are managed with *FactsAbout cards*, simple wiki pages following a specified structure. A page template is provided for the members to input their information. The OKS member profile include name, image, email, organisation, interests, the OPAALS tasks that the member is participating in, a free description, and links to homepage, blog and publications in systems external to OKS. The values are either free text or URIs pointing to wiki pages or other Web resources. Fig. 1 shows an example of a personal wiki page including the FactsAbout card.

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What's up?

1	Daturah - Warmachines	04:26pm Thu
2	Fly Pan Am - Sound-Support Surface Noise	04:26pm Thu
3	Do Make Say Think - Hurray! Hurray! Horr	04:26pm Thu
4	We vs. Death - And Knows Translats II	04:26pm Thu
5	Tracer - The Design Threat	04:00pm Thu
6	This Is Our Country - Breathing - Weathered	04:00pm Thu
7	Esmee - Histories Repeating as One Tho	03:43pm Thu
8	God Is an Astronaut - A Moment Of Stillness	03:38pm Thu
9	Ef - Final Touch - Hidden Agenda	03:27pm Thu
10	Stint - For Dinner	03:22pm Thu

TODO: latest del.icio.us links

Fall 2007: A the moment, my main activities regarding OPAALS include preparing a paper on community visualisation to the 1st OPAALS conference and the development of Actor Network, Community of Interest, and other social network visualisations for OKS

Visualisations
 The visualisations are available at the visualisation portal

Visualise Jukka :
 Community of Actors >>
 Community of Interest >>
 Actor Network >> (Instructions)
 View or modify FactsAbout
 Image

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Figure1. Example of a personal wiki page including the FactsAbout card

The FactsAbout card carrying the profile information of a OKS member is on the right side of the Fig. 1. The profile attributes are key-value pair, multiple values can be defined as needed. Music listening habits and other, more personal content, are not included in the profile data although it could be meaningful information to some of the OKS members.

C. Expressing researcher profiles in OKS

Friend of a Friend (FOAF, see [16]) is, along *RDF Site Summary* (RSS)¹, one of the first Semantic Web applications

1 Other names for RSS include Really Simple Syndication and Rich Site Summary. In this article, RSS refers to syndication in general so also Atom is logically included in the list.

gaining wider popularity – largely due to the fact that both are in the core of the Web 2.0 phenomena. In short, FOAF is a vocabulary or a simple ontology for representing profile data including personal information, contact details, online accounts, publications, and interests. In addition, since FOAF enables the expression of relationships between individuals with the **foaf:knows** property, it can be used to represent a social network as a whole.

FOAF is an application of *Resource Description Framework* (RDF), the default mechanism for publishing metadata in *Semantic Web*. Semantic Web is an initiative of *World Wide Web Consortium* (W3C) aiming for a Web of machine interpretable meanings [17]. As RDF statements form logically a graph, the analogy between sociogram and FOAF might seem quite straightforward. However, as the example visualisations will show, several data processing steps are needed to transform the initial FOAF description to the final sociogram.

IV. EARLY EXAMPLES OF COMMUNITY VISUALISATIONS

The first community visualisations prototypes of OKS are based on wiki data. The two prototypes to be introduced are *Community of Interest* and *Actor Network*, first visualising the relationships between OKS members on basis of their articulated interests and the latter presenting relationships between OKS members based on their recorded wiki editing behaviour. For now, the sociograms are created with ad hoc methods. In the future, more sophisticated SNA methods will be applied as needed (see e.g. [18], [19]). The two visualisations are introduced and discussed in the following chapters. As both of the prototypes use a tailored version of Vizster as a visualisation player, the fundamentals of Vizster are introduced first.

A. Vizster fundamentals

Vizster is designed to support the free exploration of a social network in a playful manner (see [9]). The playfulness is supported by the highly interactive interface. Originally developed to support the exploration of the data collected from a social networking service Friendster, Vizster is able to represent both the structure of the social network and the details of individual user profiles, or in SNA terms, the sociogram including both the attribute data and relationships.

The social network is visualised from an egocentric point-of-view. Heer and boyd state that instead of following the Shneiderman visualisation mantra, the design philosophy of Vizster is “start with what you know, then grow” [9]. As the connections between the members are explicitly articulated by the members themselves, the immediate friends of a member act as landmarks helping the user to navigate and situate themselves into the visualisation. Nodes representing Friendster members display the name and a representative image of the member. Once a member node is selected, the profile information is presented in the visualisation. [9]

Vizster uses a spring-embedded layout algorithm where each node repel each other and the edges act as springs. The tension of the springs is adjusted according the connectivity

between nodes: the less connected the node is, the higher tension is given to the node thus forcing loosely connected nodes to form sub-communities or *cliques*. The possibilities to interact with Vizster include extending and collapsing the nodes by double-clicking a node, highlighting the nodes representing the friends and friends-of-friends of a member by pointing a member node, panning and zooming the visualisation, and a keyword search that can be used either by entering free text or by clicking the profile details. The X-Ray mode can be used to classify the profiles according their attribute data. Finally, a community highlighting mechanism can be used for automatic determination of the community structure. [9]

During informal experiments of the visualisation, the users were found to appreciate the playful aspects of the visualisation [9], [3]. The playfulness has been noticed also during the first experiments with the OPAALS visualisations.

To support a tight integration of Vizster to various OKS tools and views, a deep linking mechanism was implemented into Vizster. As the current OKS tools are Web-based, the Vizster is delivered as a full-featured application, instead of an Applet, by using Java Web Start launch technology (see <http://java.sun.com/products/javawebstart/>). The node that is selected by default can be specified as a parameter during the launch. This enables the creation of context-sensitive hyperlinks and special kind of bookmarks able to dynamically parametrise the bookmark, *bookmarklets*, for launching the visualisation directly into a specific state with a regular Web browser, assuming Java is supported by the environment in use. The up-right part of Fig. 1 shows a set of links placed on a wiki page enabling the launch of community visualisation with a particular OKS member selected.

A drop-down menu enabling the selection of a particular OKS member present in the visualisation data was added to Vizster on basis of the preliminary experiments with the visualisation. This is possible since there are, currently, tens of members in OKS. By design, Vizster is able to handle large networks of members so new ways to select a particular member have to be considered as more OKS members appear.

B. Community of Interest

Community of Interest is an example of a sociogram that is based on inferred rather than articulated relationships between members. The relationships are formed through shared interest between members based on the profile data. The connections between actors are, for now, processed in a simplistic manner: a relationship between two members is formed if they share at least one interest. The interests are defined in the FactsAbout cards either as free text or by adding hyperlinks to wiki pages defining or containing information on the subjects that the member is interested in. Fig. 2 includes an example view of Community of Interest and Fig. 3 shows an example of the profile display. In Vizster, the two displays are placed next to each other.

vizster

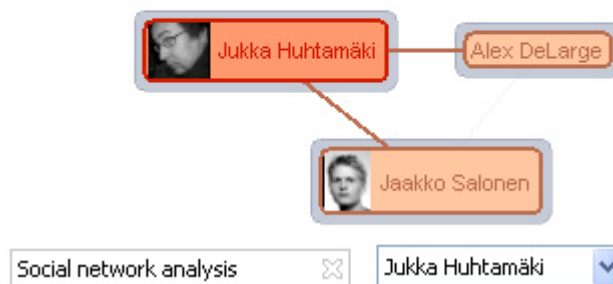


Figure2. Example view of Community of Interest in Vizster

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Figure3. Example view of the profile display in Vizster

On basis of Fig. 2, we can conclude that since all three OKS members are interconnected, they share at least one interest. The details of a profile can be used to find out the interests of each member in detail (see Fig. 3). Another approach is to use the in-built search mechanism of Vizster: in Fig. 2, the state of the visualisation shows that all three profiles include the text “Social network analysis” that a user has entered. The same text is highlighted in the profile display in Fig. 3.

A major problem with the current relationship-creation method is that it is *crisp* (as opposed to *fuzzy*): a connection between two members is established only if the two free texts or hyperlink URIs compared are equal. The means to improve the current mechanism include, among all, the following:

First, a *tagging* mechanism following the conventions of *folksonomies* might catalyse the evolution of a shared vocabulary for defining the interests. A folksonomy is a vocabulary that is not controlled by third parties, but is rather defined by the members of a community (see e.g. [20]). Tagging refers to a functionality enabling adding the individual folksonomy concepts into the contents of a Web community (cf. [21]), in this case to the profile of a member.

Second, an *interpretation ontology* specifying the

connections between individual concepts can be developed. Nykänen defines an interpretation ontology as a special case of interpretation logics that, in general, enable the shared use of incompatible logics [22]. Examples of the types of connections between concepts include is-a and synonymous relationships.

Third, a more organic integration of the visualisations and the OKS content management tools - together with defined processes, practices and guidelines - enable easier adjustment of the interest descriptions, thus promoting the use of shared concepts. The latter approach is already partly supported by a scenario description available for the users of OKS. The scenario describes a usage pattern of the visualisation in defining the interests in a uniform manner.

C. Actor Network

Actor Network is the first attempt to visualise a social network of OKS members on basis of their recorded actions instead of data explicitly created by the members. For now, the Actor Network visualisation is based purely on the editing data collected from the wiki. In the future, more OKS tools will be connected to the visualisation. Fig. 4 shows an example of Actor Network in action.

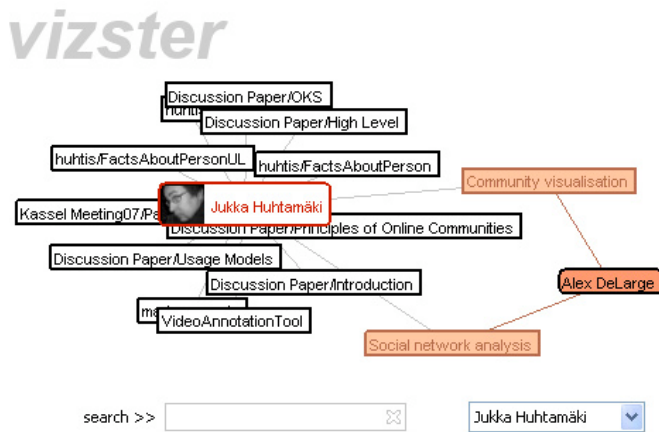


Figure4. Example view of Actor Network in Vizster

In Fig. 4, there are two member profiles present in Actor Network sociogram, namely *Jukka* and *Alex*. As seen, Alex has not yet added his picture into his FactsAbout card. From the visualisation, we can see that there are two pages, *Community visualisation* and *Social network analysis*, jointly edited by the two OKS member. In addition, Jukka has edited a few other pages. The node representing Alex is collapsed, so he might have edited some other pages as well. In the live visualisation, a profile display similar to Fig. 3 appears on the right side of the sociogram.

Unlike in the original version of Vizster where only the member profiles are present, in Actor Network also the targets of action are present as nodes in the visualisation. This makes the relational data visible and supports finding new targets of possible interest. A connection between a member and a target of action, currently a wiki page, is established if the actor has

edited the page at least once. The approach is, of course, again quite naïve but nevertheless does enable the implementation of the first prototype of the visualisation for comments and critique.

As the name of the visualisation suggest, we are aiming for visualising the OKS actors and targets-of-action in general instead of wiki pages and editors. In order to do this, we have to integrate more data sources into the visualisation data processing pipeline and, in addition, generalise the data processing methods and the visualisation player.

D. Design and implementation of the visualisations

The sociogram data for the visualisations is processed with *VizPipe*, a general framework for building *data processing pipelines* with arbitrary components, both open source or proprietary. *VizPipe* is currently being developed in the Hypermedia Laboratory of Tampere University of Technology (see [23]). Data processing pipelines are chains of parametrised data transformations refining raw data into a visualisation (see [24], [25]). Although being technically able to handle various data formats also internally, the *VizPipe* pipelines deliver data on Extensible Markup Language (XML) format in order to gain high interoperability. *VizPipe* already includes components for fetching data from different systems in various formats, data aggregators supporting both XML and RDF, transformation engines capable of mapping data between different XML vocabularies, engine for querying RDF data with SPARQL (see [26]) *et cetera*. New components are introduced to the environment as needed.

Both Community of Interest and Actor Network are based on FOAF data representing the OKS member profiles. A pipeline for creating the FOAF data is structured as follows. First, FactsAbout pages are collected from the wiki, in *DocBook XML* (<http://www.docbook.org/>) format, with a spider component utilising the export functionality of *MoinMoin* (see <http://moinmoin.wikiwikiweb.de/>), the wiki engine currently in use in OKS. Next, the individual FactsAbout pages are aggregated into a single XML document and profile data are distilled from the pages with a simple transformation. The result, a document following a general vocabulary for facts is, finally, transformed into a FOAF document. In addition, a separate pipeline collects the facial images of OKS members.

The sociogram data in Community of Interest is created from FOAF data with a SPARQL query that selects all the member-member pairs sharing at least one interest. A parallel SPARQL query picks all the member attributes needed in the visualisation. On basis of the result sets of the two queries, a general description of the Community of Interest is created. Finally, as *Vizster* uses a dialect of Graph Markup Language (GML), the sociogram data is transformed into a GML document.

For the Actor Network, the FOAF data are aggregated with the metadata collected from OKS wiki, including the page-specific editing information. The aggregated RDF data are then queried to find relations between the wiki pages and the members of OKS. The details of the pages and the members

are collected with two additional queries. The three result sets are used to, first, create a general description of the actor network and, finally, a GML representation of the sociogram.

The data processing procedures in the two pipelines show that although the raw data encoded in RDF and the resulting sociograms are both logically graphs, a lot of processing is needed to create a detailed end result. However, there are tools to visualise also the raw data that can be used to complement the visualisation in order to gain insight and make the process more transparent.

V. DISCUSSION

For now, the data analysis in the two cases presented is being performed with query and transformation languages that enable simple low-level operations on basis of the data. The mathematical methods of social network analysis, graph theory, and data mining introduce expressive means to create new information into the member profiles. As a general matrix algebra tool is already integrated into the visualisation pipeline framework, we are now planning to introduce some selected social network analysis algorithms into the pipelines, thus making the creation of the sociograms more sophisticated. Also component enabling inference based on graphs, in particular ontologies, will be integrated into the environment. Nevertheless, we see that the visualisation end-user should be given means to alter both the data and the sociogram-creation algorithm. In addition, we see that the data analysis process should be as transparent to the end-user as possible (cf. [27]).

By design, FOAF is intended to enable people publishing information for machines to process: “If people publish information in the FOAF document format, machines will be able to make use of that information.” [16]. This implies that the member profile information is explicitly defined by the people, not inferred by a machine. Despite the fact that FOAF, as RDF in general, is intended to include precise information that can be easily processed with e.g. query languages, in practice the FOAF information can be quite arbitrary.

To generalise, there are two approaches to apply FOAF in implementing social networking. The first option is to encode explicit profiles with FOAF directly and utilise high-end social network analysis and other data analysis methods in creating the sociograms. Alternatively, FOAF can be used to encode the results of data analysis based on explicit profile data and recorded user action, thus enabling a more direct creation of sociograms on basis of the FOAF description. At this point, we are leaning towards the latter approach but more work is needed before conclusions.

Currently, wiki data covers the majority of OKS data available for the visualisations. As new data sources emerge, integration work is needed to connect the data processing pipelines to the raw data. The two Semantic Web killer applications, RSS and FOAF, can be used jointly to make the interface between visualisations and OKS more generic. As both vocabularies are RDF based, they can be easily extended if new kind of data needs to be imported into the visualisations.

After the problems of technical nature with added

transparency and parametrisation of data analysis are solved, we anticipate the emergence of issues related to e.g. the publicity of the profile information and the data recording the actions of a member. The improved visualisations we and other are aiming for, capable of crafting more expressive views to the contents of a digital ecosystem, together with the expanding nature of such an ecosystem come together with a problem named as “dilemma of collapsed contexts and unknown audiences” by boyd and Heer [13]. This means, essentially, that the members of the community evaluate the context of their actions of basis of the prevailing situation and act accordingly. As the ecosystem evolves, the context potentially enlarge and converge. The in-built version control system makes the issue of context collapsing even more meaningful.

VI. CONCLUSIONS AND FUTURE DIRECTIONS

After the initial implementation and integration work, the first community visualisation are now in use in Open Knowledge Space. Vizster, the visualisation client currently used, provides the visualisation user with powerful means to navigate the pre-designed sociograms. However, since the user is not able to alter the data set, the options to manipulate the visualisations are limited. As the development of visualisation pipeline environment VizPipe proceeds, appropriate means to parametrise the data and the analysis can be offered to the user. We see that this both adds to the usefulness of the visualisation while at the same time the visualisation more transparent.

The possibility of community visualisations acting as means of pointing OKS members into rabbit holes leading to new, unexpected informations landscapes, thus supporting sharing information over disciplines, problem-solving, and innovation is a very high-level and abstract goal but, at the same time, something that the visualisations can enable at best. More work is needed before this objective can be understood and defined in a concrete level.

The idea of enabling community members to write themselves into the social network with the help of visualisations is also appealing. In order to achieve this, however, the integration of the visualisations and the content management applications has to be organic and, more importantly, the processes must be clear to the actors. In addition, the causalities between the actions of a member and the resulting visualisations have to be understandable, that is, the data processing and visualisation methods and algorithms have to be as transparent and intuitive as possible.

More work is needed before the issues related to evolving contexts and the publicity of social network data can be described in more detail.

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