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Information visualization of Twitter data for co-organizing conferences

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ABSTRACT

The aim of this research is to explore what kinds of insights information visualization of social media data can provide for co-organizing conferences. Our paper focuses on Twitter in 'during-conference' use. We present a case study based on CMAD2013 conference and on the tweet traffic during the conference day. We applied the process of data-driven visual network analysis for providing insights on Twitter use during CMAD2013 conference day. By analyzing the network of conference participants and the conference's discussion topics, we were able to identify e.g. influential conference delegates, most interesting presentations and discussions, similarities between interests of the conference participants, and several development and information needs of conference co-organization derived from the information visualizations, which have implications for the planning and co-organizing of conferences, as well as for Twitter use in communicating during conferences.

Categories and Subject Descriptors

J.4 [Social and Behavioral Sciences]: Economics.

General Terms

Management, Economics, Human Factors

Keywords

Knowledge management, knowledge transfer, microblogging, information visualization, Twitter, conference, co-organization

1. INTRODUCTION

The role of conferences and events is significant in the transfer of scientific, managerial and other types of information and knowledge. Traditionally, the role of conference participants and

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delegates has been relatively passive from the viewpoint of conference organization. However, in recent years, various co-organizational activities, as well as the inclusion of conference delegates, presenters, experts and other conference stakeholders, have become a more and more integral part of conference organization. Conference co-organization has been found to bring advantages to all stakeholders e.g. in the form of conference marketing, better understanding of participants' needs, better conference content tailoring, more efficient information sharing, and networking [e.g. 30, 28, 31].

To support the co-organization of conferences, conferences have recently adopted approaches that integrate for instance various types of social media and Web 2.0 tools. These approaches have been found quite useful from the standpoint of co-organizational activities and also the marketing of events and conferences (e.g. [1, 12]). However, such novel approaches also create large amounts of data and information which is not currently used as efficiently as possible for the benefit of conference organizers, participants and other stakeholders. Such beneficial, and yet quite problematic approaches include Facebook and Twitter, among many others. Twitter, for instance, can be used to create and enhance discussions about conference themes, as well as for various networking purposes. However, Twitter has also some restrictions as communication media which has caused that it has not been used to the full in co-organization.

The above challenges related to the large amount of generated data and the type of data produced can be impacted by many approaches, such as more traditional analytics approaches, content analysis, and as a more recent approach, which has been only little used and studied in conference co-organization and in the context of Twitter data analysis in the context of conferences, various information visualization approaches.

Information visualization exploits the human abilities for effectively processing visual images and representations in analyzing even complex problems, while it makes use of computers processing power and data organization capabilities to produce visual representations. Card et al. [9] define information visualization as "the use of computer-supported, interactive, visual representations of abstract data to amplify cognition". In recent

years, various types of information visualization approaches for social media have been created, for instance based on social network analyses methods [21, 10, 25], and the genre of information visualization develops rapidly.

Some advantages of information visualization include that a majority of the brain activity deals with processing and analyzing visual images while images are pre-attentive and processed by brain before text [8]. Empirical studies demonstrate that visual representations are superior to verbal-sequential representations in different tasks, i.e. to illustrate relations, to identify patterns, to present both an overview and details, to support problem solving and to communicate different knowledge types [see 8, 6, 18, 27].

In knowledge management, the transfer of knowledge is one of the core processes, which can be improved by using our innate abilities to process visual representations generated by information visualization [8]. Knowledge management related information visualization examines methods that can reduce the predominant problems of information users or managers, in this case people involved with the conference.

On the basis of the earlier research and the related research gaps, we devised one main research question addressing the research gaps: What type of insights can Twitter data, combined with the possibilities of information visualization, provide for the co-organization of conferences and events, while focusing the analysis especially to during-conference data?

The research subquestions are as follows:

What type of insights can Twitter data, combined with the possibilities of information visualization, provide for the co-organization of conferences about the

- conference participants and their networks (both participating on-site and/or online in a conference) for co-organizing conferences?
- discussion topics and the contents of the conference?
- lacks, development needs and information needs of conference co-organization?

The paper is organized as follows. We, first, introduce conference co-organization, social media and Twitter in co-organizing conferences, related Twitter features and restrictions and information visualization of conference data. Secondly, we present a case study of conference co-organization. Next, we present our methodology. Thereafter, we present our results and findings. Finally, we provide conclusions and areas for further research.

2. SOCIAL MEDIA AND TWITTER IN CO-ORGANIZATION OF CONFERENCES

Co-organizing conferences

Traditionally, the role of conference participants and delegates has been relatively passive. By novel ways of integrating participants in the pre-conference planning, during-conference participation and after-conference activities of e.g. sharing conference-related information, e.g. conference contents and networking can be tailored to be more useful for the participants. In addition, conference marketing can be crowdsourced to delegates and organizers alike. In recent years, conferences have adopted ways of integrating for instance social media- related approaches for the purpose of the above activities, and related research has been published on the generic topic of conference co-creational activities [e.g. 20, 15, 24, 30, 14] and related benefits. For instance Grimmes [20] sums up the various needs of conference

participants, such as tagging the conference content and talks, as well as browsing effectively the conference contents. Such activities, among many others, can be supported with various Web 2.0 and social media-based approaches.

Social media in co-organizing conferences

Beside the use of various conference management systems (CMS) that simplify the organization of events and conferences, various interactions of conference delegates take place outside the traditional CMS, and such a rich source of information for conference and event organization is increasingly social networking services and social media at large [1, 29]. Quite surprisingly, however, only 39% of event organizers use currently monitoring tools to track social media conversations and success of their organization activities [1].

Despite the already existing huge amount of interactions between conference organizers, scholars and other conference delegates via novel means of social media, the way that managerial and scientific events are organized, and the tools that support both organizers and conference participants, does not yet reflect the technological possibilities and the current use of various social media [e.g. 30, 13]. Amiando [1] have surveyed the use and user perceptions on social media in events organization. In addition, traditional CMS are designed to mainly support the organizers and reviewers of conferences, not very extensively the participants.

Conference organizers and participants are most commonly using general purpose social networking sites, especially Facebook and Twitter [13, 1] for their networking and other purposes. In scientific conferences and other purposes, social networking tools such as Mendeley, Research Gate, Academia.edu, as well as social networks tailored for scientific events, such as Lanyrd, CrowdVine, or ginkgo (combining features of both conference management systems and social media) are also used [29].

In our study, even if also other means of social media were extensively used in the co-organization of the CMAD2013 conference, such as Facebook and Google Docs, we will concentrate here on the use of Twitter for several important reasons. While Facebook was used extensively in pre-conference and post-conference networking and co-organization tasks, Twitter was the main tool used in various during-conference tasks. In addition, Twitter data, unlike the data of many other commonly used social media- related application such as Facebook and LinkedIn, is easily openly available for analysis and visualization purposes. Third, due to the restrictions and challenges of Twitter as a communication media mentioned in this study, visualization can significantly add the value of Twitter data in many respects.

Twitter in co-organizing conferences

According to Stankovic et al. [32], Twitter has lately gained significant popularity among conference and organized event participants as a means for intra-event communication. Also according to Ebner et al. [14], and Reinhardt [29], there is a growing amount of literature on the use of Twitter in scientific purposes. One area which has received both lots of recent academic interest as well as pragmatic interest in conference organizers includes its use in academic conferences.

According to Ebner et al. [14], there are several distinct ways that Twitter can be used in conferences: (a) for communication amongst participants, (b) for communication amongst organizers/presenters and audience, and (c) for reporting to non-participants about the conference.

Recent found research related to Twitter use in conferences has focused a) mainly upon simple quantitative analysis, dealing with questions such as how many tweets have been sent by how many users in a specific time frame, estimating thus the success of Twitter use [14], b) Twitter or other forms of microblogging use during a presentation to improve the situation through instant discussions by the individuals in a common class auditorium [15]. Twitter has been reported to have been used before, during and after the conference [3].

Stankovich et al. [32] propose a way of extracting valuable information from conference tweets by the concept of mapping the tweets with talks and subevents that they refer to, thus gaining additional information about users, talks, and dynamics of the event.

Chen [10] incorporated quantitative analysis, information visualization and social networking analysis techniques to study seven different academic conferences and identified major types of users and usages of Twitter during conference.

There have been also attempts to evaluate the usefulness of Twitter for reporting about academic conferences to scientific community members from outside the conference [14]. This viewpoint is, however, clearly outside the scope of this study focusing on during-conference use of Twitter.

Microblogging at conferences seems to be an additional way of discussing presented topics and exchanging additional information. It is not limited to the face-to-face audience or the location of the conference. Current literature brings forth the possibilities and benefits but also the restrictions of Twitter as an approach to support conference organization, conference-related collaboration and conference content sharing and communication. Our paper focuses on Twitter use in ‘during-conference’ use.

Twitter- type of microblogging allows virtually anyone to actively participate in conferences’ and events’ thematic debates. Current research shows that several conference speakers and attendees are using Twitter for various purposes. Communicating and sharing resources seem to be one of the most interesting and relevant ways to use Twitter- types of microblogs. Other found practices in conferences include following parallel sessions that otherwise conference delegates would not have access to.

Twitter features and restrictions

Some technical features of Twitter messaging, the messages themselves being called “tweets”, that have an impact to both the benefits and limitations of Twitter as an information sharing and communication method include first and front most the following ([see e.g. 10, 14, 32]):

- allowing registered users to share between themselves short messages of up to 140 characters (including also pictures)
- the messages can be sent to anybody registered on Twitter
- user can “follow” (select) the various streams of interesting Twitter users;

The main syntax for Twitter messaging include:

- user can search for terms or tags (marked with “#”; known as hashtags) that are used within tweets;
- user can directly address other users by a public reply (marked with “@” before the username of other users
- user can send a private message to any user (“D” or “DM” before a username);

- user can send forward interesting tweets by “retweeting” them (shown with “RT”)

The limited message size of 140 characters is often argued to be both a strength and a weakness of Twitter messaging: it can be seen as a benefit because it requires users to condense the main message to a very short space. This also makes easier the especially fast circulation and retweeting of interesting messages between a huge amount of users. Downsides include that much information can be lost e.g. if the context of messages is not mentioned or understood properly. An important generic challenge of Twitter is also that much information that is delivered through Twitter feeds in conferences, be it explicitly mentioned in tweets or implicitly otherwise present in them, remains hidden or undecipherable to common analytics approaches [32]. Information visualization is a little studied approach to support the understanding of Twitter information.

Conference data visualization and related research

According to Ware [33], information visualization aims at serving as an amplifier of the cognition of the user through expressive views, thus providing insight on phenomena represented by the data. As social media, conference management systems and business analytics software are able to provide huge amounts of data on conference delegates and publications, which could provide useful insights whether properly used, information or knowledge visualization examines methods to reduce the predominant problems of information users or managers facing the excessive amounts of data:

- “Information overload: Decision Makers cannot identify the relevant information.
- Misinterpretation: Decision makers cannot understand, evaluate and interpret the information.
- Misuse: Decision makers cannot use or misuse the information for decision making.” [8]

Interesting cases of using conference data visualization have been carried out e.g. in IRIS conference (Information Systems Research Seminar in Scandinavia), in which the evolution of conference authors’ social networks and the research topics were visualized between the time period of 1978-2006. The outputs included animations to demonstrate the evolution of IRIS co-authorship and the diffusion of terms in IRIS community. Second, the study of Huhtamäki et al. [24] provides an example of employing information visualization in conferences for a data-driven development of online conference workspaces, supporting conference delegates before, during and after the conference. They conclude on the basis of their case study that the dynamics of the conference workspace usage can be better understood by both tracking and visualization of the usage, and thus, insight can be provided e.g. on the popularity of individual views, navigation paths, as well as interestingly, also the structure and the development of the social network of the delegates.

3. CASE STUDY

The CMAD2013 (Community Manager Appreciation Day) conference held during 28 January 2013 in Finland is part of international conference series arranged globally every fourth Monday of January. CMAD conferences have been organized since 2010. The CMAD conference originated from Jeremiah Owyang’s blog [12] and was followed by a series of conferences organized at the same time in numerous cities in 2011. The first CMAD conference in Finland and Europe was organized by Tampere University of Technology in 2012. The organizing committee of the second CMAD conference (CMAD2013) in

Finland included more than 100 people, with 15 people participating in the planning meetings (virtually or face-to-face). Two of the authors were closely involved in organizing the first and the second CMAD conferences in Finland. Although Facebook was used in pre-conference and post-conference communication, the discussions during conference took place in Twitter. 155 people participated in the CMAD2013 [11] conference and 223 people in the online live stream [23] during the day. As a conference type or format, CMAD2013 could be considered as hybrid of traditional conference and unconference [19, 2, 16], having some features of unconference, such as crowdsourced planning and implementation, and some features of traditional conference, such as fixed agenda and conference services (including streaming, etc.). The goal of the CMAD2013 conference was to bring together and increase transfer of knowledge between experienced community managers of online communities and more traditional network coordinators or facilitators that are less familiar with the possibilities of Web 2.0 technologies and social media.

During the day a total of 2127 tweets were exchanged, 2115 including the cmadfi hashtag and 12 tweets where cmadfi was found in some other form.

4. RESEARCH APPROACH AND METHOD

In this study, we apply the process of data-driven visual network analytics for providing insights on how Twitter was used during CMAD2013. According to Freeman [17] visual network analysis help investigators both in finding patterns within a networked phenomenon and in communicating the results to those that are interested. For structuring the analysis process, we applied the Network Analysis and Visualization process model that Hansen et al. [22] derived by observing graduate students learning social network analysis of online communities. More specifically, the technical process we applied follows the general information visualization reference model [9]: raw data is collected, refined into data tables, transformed into visual structures from which, finally, views are created for representing the data.

In concrete terms, we implemented a tailored batch script in Python that accessed the Twitter REST API to collect all the tweets sent during January 28 that included the word cmadfi as part of their content. Twitter REST API was sufficient for collecting the tweets because it allows retrieving 1500 tweets at a time, 350 times in an hour where as more high-volume Twitter streams insist applying the Twitter Streaming API¹. MongoDB was used to manage and query the tweets. Another tailored Python batch script was developed to transform the tweet data into two networks, one representing the interconnections between people communicating over Twitter and another one representing the co-occurrence of hashtags included in the tweets. More specifically, with interconnections we refer to people mentioning each other in tweets through commenting, discussions and retweets.

The Python script uses NetworkX library to construct the network and serialize it in GEXF (Graph Exchange XML Format). For analyzing and visualizing the networks, we used Gephi, an interactive visualization and exploration platform available in open source [5]. Following the NAV model, Gephi was used to layout the networks, calculate metrics for the network nodes,

analyze networks for possible subnetworks or clusters and adjust the visual properties of the visualized network according to the analysis.

In this particular case, we decided to use the value of weighed node indegree to define node size. Indegree refers to the amount of connections pointing to a node, in this case the number of mentions that a particular user has received. The weighed value takes into account multiple incoming connections, i.e. connections in which a person has mentioned another are more important than individual mentions.

5. RESULTS AND FINDINGS

The visualization of the network of people tweeting during the CMAD2013 conference day (using cmadfi hashtag) is illustrated in Figure 1. The network of people tweeting based on the nodes indegree uncovers the most often mentioned tweeters during the day. The layout of the network is the result of a force driven layout algorithm in which nodes repel each other and the edges connecting the nodes act as springs pulling the nodes back together. As a result, nodes that are interconnected will be placed close to each other.

For the conference co-organizers familiar with the Twitter handles (usernames), that were collaboratively collected and shared using Google Docs Spreadsheet, the visualization of the network of people provides many insights. First, the network of people highlights the most influential people in the network, the larger the influence, the larger the size of the node and node label (Twitter username). Second, the interests of the people are made visible by the connections to other people, the larger the interest the larger the size of the connection (line width in Figure 1). Third, by looking at the people, and knowing which people presented in the conference (e.g. markosuomi, jpruohisto, toninummela, mikafilm, senjalarsen, and AnttiIsokangas), it is possible to deduce, at least partly, which presentations raised most discussion and were most interesting to the audience. The node color represents the clusters of nodes in the network, as according to an algorithm that analyzes the network to find groups of nodes that are particularly tightly interconnected to each other, i.e. have mentioned each other the most. In the network in Figure 1, a few clusters emerge. Many of the presenters, for instance, are included in the cluster shown in green whereas the two most active commenters, terhiaho and sveikkolainen, are the egos of their own clusters. The most important observation, however, is the tightly interconnected nature of the overall network.

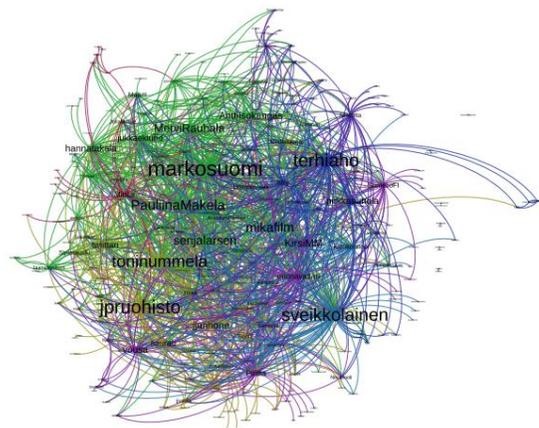


Figure 1. Force driven network of people tweeting during the CMAD2013 conference day.

¹ <https://dev.twitter.com/docs/streaming-apis>

The top 10 most influential people based on node size during the day include presenters, participants (sveikkolainen, terhiaho), co-organizers (PauliinaMakela, Piritta) and a sponsor (MerviRauhala).

The visualization of network of hashtags uncovers the different discussion themes that emerged during the conference day (Figure 2). The most used hashtag was cmadfi, chosen beforehand by the co-organizers to represent CMAD2013 conference in Finland and also communicated in the conference web pages and during the conference to the conference participants. The second most discussed topic was cmadfinimike, chosen and voiced during conference presentation [26] for discussing, which would be the appropriate translation of “community manager” in Finland. Most of the top 10 hashtags used referred to the presentations, such as sketchnotes that included visual drawings or notes of the presentations created by the participants, or more directly to the themes or concepts in the presentations, e.g. striimaus (streaming), parvi (swarm), or context of the presentation, e.g. yle (community management in Yle).

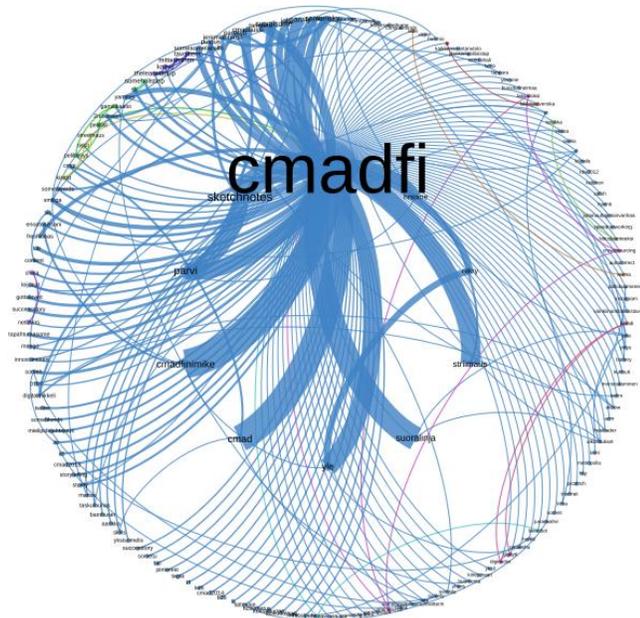


Figure 2. Dual circle of hashtags during the CMAD2013 conference day.

Dual circle does a good job in pointing out the most discussed themes during the conference day, these also providing indications of the most interesting presentations and concepts, but can also be misleading if the hashtags are not used in a consistent way. For example different hashtags were used to discuss about parvi (swarm), including parvi, parvity, and parvityo that is not easy to see from dual circle visualization of hashtags, but can be more easily seen from visualization of hashtag network that uses the force driven layout algorithm (Figure 3). We see that the dual circle layout is at its best when it is interactive allowing users to highlight interconnections by pointing individual hashtags for highlighting their direct connections.

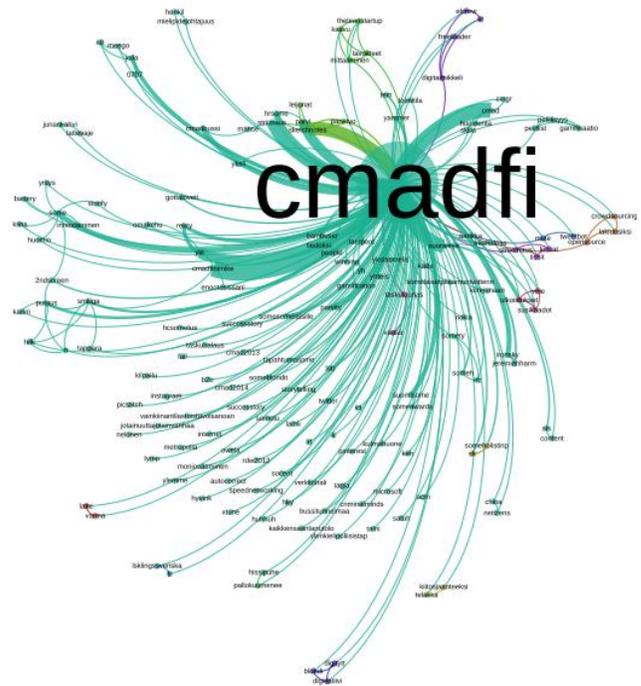


Figure 3. Force driven network of hashtags during the CMAD2013 conference day.

The force driven network of hashtags (Figure 3) uncovers several inconsistent uses of hashtags such as, gamification (including gamification, gamifikaatio, pelillist, and pelillisuus hashtags), streaming (including striimaus, streemaus hashtags) and the previously mentioned hashtags about swarms. The inconsistent use of hashtags has implications especially for conference co-organizers and presenters in planning and communicating the topics.

As in the network of people in Figure 1, node color in Figure 2 and Figure 3 shows the cluster that a particular node representing a hashtag is included in the network. In this case, with a few exceptions, there is only one group of hashtags consisting of pairs that include cmadfi together with a set of co-occurring hashtags. A few additional clusters existing but the low weight of their interconnections show that they appear only in a small number of tweets. In general, however, we encourage the investigators of this kind of hashtag visualization to pay attention to these clusters as they may indicate e.g. some emerging topics or viewpoints that should be taken into account.

The visualizations help to overcome information overload and focus on the most interesting data. For example, topical issues, such as cmadfinimike and sketchnotes can be identified from the mass of data. For instance, the cmadfinimike hashtag points out to an important debate among Finnish community management professionals of the terminology to be used, which could be further investigated by analysing the tweets (e.g. the different translations proposed for community manager) that contained the cmadfinimike hashtag. While the importance of discussion themes could be derived without visualizations, e.g. using social media analytics, the visualizations provide a way to make sense of the information more easily and also to avoid possible misinterpretation from analysing pure data (interpreting numerical data of top hashtags vs. interpreting visual data like in Figure 3).

Sketchnotes on the other hand is an interesting discussion that points out a weakness in co-organizing the conference, as it

introduces a link to sketchnotes of presentations from the conference (content outside Twitter), that is no longer available. In a sense it is lost data to the conference participants, presenters and co-organizers.

6. DISCUSSION AND CONCLUSIONS

Regarding the first research question, information visualization from Twitter data provides several insights of the networks of people participating online in the conference for co-organizing conferences.

First of all, the visualization of the network of people uncovers the influential people involved in the conference online that based on studied data represented co-organizers, presenters, sponsors or participants. The identification of the influential people have several implications for conference co-organization. The most influential presenters can indicate the most interesting conference presentations and discussion themes for the conference audience, and provide insight into planning the contents and presenters or speakers of the next conference. However, several issues affect the prestige or interest towards a person, for example the more connected the person is the more likely he or she is to receive new links (mentions, retweets) [e.g. 4]. Thus, the influentiality of a presenter would need to be further investigated.

The most influential participants are potential co-organizers and co-marketers for the future conference. Furthermore, the connections between the people can be used by the co-organizers to identify people with similar interest and for example plan sessions than interest certain groups of people. In addition, as some of the nodes are organization or other entities the co-organizers can identify potential collaborators, potential sponsors or potential organizations for target marketing. Similarly sponsors of the conference can identify potential customers and their interests or collaborators depending on their business interests. The clustering of nodes in the people network help in observing emerging discussion groups sharing an interest in a particular topic. Reasons for the emergence of such groups include e.g. spin-off discussions that a particular presentation catalyzed but did not fully cover (a possible topic for future conference rounds) or problems in accessing online content with a particular device or software. At best, such groups could be investigated in detail with the help of supporting views showing the topics or the actual contents of the particular discussion.

Regarding the second research question, the visualization of Twitter hashtag networks provides several insights of the discussion themes during the conference, as well as implications how the discussion could be better designed and facilitated. One of the findings was that the discussions tend to scatter when hashtags are created bottom-up, each person creating his or her own hashtags to describe content (e.g. concepts) of the presentations. While those hashtags that were created and communicated top-down either by conference co-organizers or presenters were more popular and seemed to last longer. To confirm that the discussions using top-down created hashtags lasted longer, would however need further analysis [cf. 7].

Regarding the third research question, an important finding from the visualization of hashtag networks was that from the collected Twitter data the content links that were created bottom-up, e.g. by the conference participants, in some cases led to broken links or discontinued services and thus missing data. Missing data in the sense that the content of the link is no longer available, and as a consequence does not accumulate to the knowledge base of past and future conferences. Also a problem with bottom-up created

links is that the conference co-organizers cannot access the statistics of the link, e.g. how many people have clicked the link. Conference co-organizers could avoid this problem by designing and promoting collaborative practices in collecting additional content related to the presentations and discussions, e.g. using shared account for creating short links (e.g. bit.ly), having an open Google Docs document or Wiki page for conference participants to post their contributions.

Overall, network visualizations are useful in revealing the overall structure of the communications that occur online during conferences. Network analysis introduces a set of methods, practices and metrics for supporting the investigation and representation of social media data. Node indegree, outdegree, betweenness and other metrics can be used to highlight nodes in different roles e.g. through node size. High indegree indicates prestige or interest towards a person (or topic), outdegree indicates activity and high betweenness shows that a person has a connecting role as a bridge between the different parts of the overall network. Indicating edge weight through its width allows observations of the key connections within the network and edge color might be used e.g. to show the different types of connections between nodes. Clustering network nodes allows further support for insight on the internal structure of the network e.g. revealing the emergent subgroups within the network.

This study leaves room for future studies in several areas. First, visualizations cover a huge amount of analysis techniques, and only a fraction has been used and investigated in this study. For instance, dynamic visualizations concerning e.g. the development of networks or discussions in the course of time were not investigated, and will be studied in future research. Second, Twitter data combined with the possibilities of visualizations offers possibilities also in the other phases of conferences, the pre-conference and post-conference phases, and should be studied separately in further studies. Third, other types of available social media data, such as Facebook or Google Docs data of conference organization, should be combined in the analyses to provide a more varied and detailed picture of the influentiality of persons, presentations and discussions in conferences, because quite naturally, not all significant discussions take place in Twitter, and some influential persons may be active elsewhere than in an individual communication channel such as Twitter.

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