More!: Mobile Interaction with Linked Data

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Abstract. Science2.0 can radically change how researchers connect and collaborate. In this paper, we focus on researchers who attend academic events, such as workshops or conferences. We have developed a mobile social discovery tool, called More!, that presents academic and Web2.0 information sources and enables researchers to explore information about speakers and their work. More! also supports follow-up of future work. The application is powered by information sources that expose Linked Data through a RESTful API. More! has been extensively evaluated, showing promising results.

Keywords: Social discovery, Science2.0, Research2.0, Web2.0, mobile applications, mobile devices, Linked Data

1 Introduction

Science2.0 is the result of applying Web2.0 tools and approaches to regular research processes in order to increase participation and collaboration [1]. Our Science2.0 work focuses on openness and sharing, mashing up data and services, and using Web2.0 tools for communication. Although efforts to encourage research collaboration are quite dispersed and many challenges remain, first experiences suggest that Science2.0 is considerably more productive than the traditional way of doing research [2]. One of the key goals behind the Science2.0 concept is to support the connection of researchers in order to nurture fruitful cooperation. To this end, research support systems are beginning to apply social networking approaches [2][3] by supporting discovery, connection, sharing and discussion among researchers.

In this paper, we focus on the scenario where researchers are presenting their work while attendees in a conference or seminar may be interested to find more information about the topic and the speaker. The attendee may want to (i) find information about previous and current work of the presenter, (ii) stay up to date on new work from the presenter and (iii) share the work of the speaker with colleagues, for instance the members of a research group, who may or may not be attending the same event. In more conventional settings, the attendee may use a search engine, talk with the presenter afterwards, consult the proceedings, etc. Our paper describes how the use of mobile technology can improve this process.

Generally speaking, our work deals with awareness for researchers of relevant Web2.0 information sources and communication channels, such as social networks,

micro-blogs, blogs, etc. “More!” is our mobile application that groups relevant information about a speaker and presents it in a way that can be easily exposed and integrated in the normal workflow of an academic event. This work is becoming more relevant as, over the last years, Web2.0 tools are being increasingly used to support every phase of the research lifecycle [4][5]. Furthermore, our tool is both relevant for junior researchers (who may not recognize the person on stage or the name in the conference schedule), and for established researchers who move into a new domain [6][7].

The structure of this paper is as follows: in section 2, we present related tools and approaches to support face-to-face event enhancements, enriched profiles, and social discovery. Section 3 describes the inspiration and design of More!. Section 4 explains the back-end infrastructure that supports the application. We conducted a user evaluation to gather feedback regarding the usability and functionality of the tool. The results of this evaluation are presented and discussed in section 5. Finally, we conclude and present challenges for further work in section 6.

2 Related Work

The main objective of More! is to deliver instant information from different sources to a researcher attending a face-to-face event, such as a conference, a seminar or a workshop. While there are related tools that focus on enhancing research events, or providing rich user profiles or social discovery capabilities, none of them cover the full scope of our application. Our work focuses on all three areas in order to enable social discovery through rich user profiles at scientific events.

Face-to-Face Event Enhancements. There has been some work on enhancing the experience of researchers attending face-to-face events. Conference planning and navigation tools like the IBM Event Maps [8] or the Conference Navigator [9] focus on helping conference attendees to browse and organize their conference schedule. Moreover, the Conference Navigator supports community-based personalization and recommendations [9]. Like these desktop tools, mobile applications like Conference Guide [10], Conference Compass [11] and CHI 2011 Mobile Application [12] give attendees of the event the possibility to explore and manipulate their personal conference schedule on-site.

These applications provide an overview of a specific conference based on a pre-defined schedule and help the user to plan their attendance at such events beforehand. In contrast, our application focuses on helping users to get more information about the speaker and the presentation topic while at the event, through links to academic and Web2.0 information sources. Thus, we focus more on discovery and exploration than on planning or navigation. In addition, More! addresses research activities beyond the presentation at hand, such as becoming aware of additional or later work of the presenter, or informing colleagues about it, etc.

Enriched Profiles. Tools like Gist [13] and Rapportive [14] provide enriched contact profiles on mobile and desktop clients. The idea behind these tools is to make

available, when needed, extra information about a person through a mobile application or a browser extension, so that it can be integrated in for instance web based email applications. It is important to mention that enriched profiles provide information about people that the user already knows or had contact with before, but they do not provide information about a person that is not part of the current social network of users. In contrast, More! offers this information to researchers who are interested in the work, ideas or resources of a person that they possibly do not know yet.

Social Discovery. Location-aware devices are used to connect geographically close people. Mobile applications like Shhmooze [15], Banjo [16] and Sonar [17] focus on helping users to discover interesting people based on proximity, social network links and profiles. While these applications could be used at a specific research event, they are not tied to the purpose of the event. More! aims to be nicely integrated in the workflow of a face-to-face research event, providing extra information about the current speaker.

JumpScan is an application that mimics the functionality of More!, but that does not focus on the Science2.0 context [18]. The main difference with our application is that JumpScan does not support sharing of profiles and does not include any academic information sources - two characteristics that are crucial in the context of More!. However, we expect that the findings from our evaluations and experience will also be valid, and probably useful, for JumpScan.

3 The Application: More!

In order to create not only a useful, but also a usable application, we developed More! following a rapid prototyping approach [19] with frequent user feedback cycles. The application is inspired by the mobile music discovery service Shazam [20], which enables users to identify a song by recording a small fragment of the music. Through a fingerprinting technique, the song is identified and different kinds of information about it are retrieved; such as artist, title, album, and a YouTube and iTunes link. Shazam enables the user to share their discovery with other users through various channels, such as Twitter, Facebook and e-mail.

In the context of a research event, we want to make the discovery and sharing process as smooth as Shazam does for music. The core elements we target with our application are: (i) a fingerprint that enables a frictionless exploration process, (ii) automatic linking to different information sources, and (iii) the ability to share the discovery. These core elements found in the music discovery application guide our design. A more detailed explanation of the design process is presented in [21].

In the current prototype, we use Quick Response (QR) codes as the fingerprint to identify researchers. These are matrix barcodes that can encode any kind of data, such as numeric, alphanumeric and binary characters [22]. Currently, there are several mobile applications available that resolve these codes and return the encoded value to the application to take further action. For our fingerprinting purposes, we encode the URL of the researcher's More! page.

The user interface of our application includes four clusters of information: general, academic, social network identities, and communication & sharing (see Figure 1). These clusters expose the following information:

- general information: full name, photo, e-mail and affiliation;
- academic information: paper and slides being presented, and publications list;
- social networks identities from Twitter, SlideShare, blog, Delicious, LinkedIn, and Facebook.

With these information sources, the attendee can explore the research paper and slides of the current presentation, and the publications list of the speaker. Moreover, participants can 'identify' and 'follow' the speaker on some of the mainstream Web2.0 social tools. As a result, the attendee will get access to previous, current and future work of the speaker.

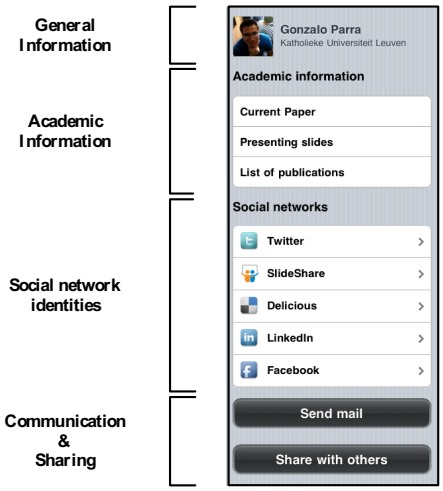

Fig. 1. The More! application.

More! enables the attendee to establish direct contact with the researcher via e-mail or social networks. Moreover, the tool allows sharing the discovery with other possibly interested researchers that attendees have more direct relations with (for instance members of their research group).

The workflow of the application in a conference scenario is as follows:

1. The speaker or conference organizer exposes a QR code (resolvable to an URL link) to the audience. We have experimented with different means to do so, for instance by exposing the code on the presentation slides, participant tags and including it in the event schedule.
2. Conference participants capture and decode the QR code, using any code reader application available on their handheld device (such as ScanLife [23]). After decoding, they are automatically redirected to the More! web application. As an alternative, the attendee can also use a URL and a regular web browser to load the application directly.
3. More! presents the data on the client tool.

4 Back-end Service: Research.fm

The More! application depends on the availability of information about the research and Web2.0 presence of the speaker. This section presents our work on how to model, obtain, store, manage and share these data.

4.1 Model

We follow a domain driven design methodology [24] where a single model, the Semantic Web for Research Communities ontology (SWRC) [25] is used to enable manipulation and linking of resources. In order to capture all relevant data, we extended SWRC with the FOAF [26], SIOC [27] and vCard [28] ontologies.

The SWRC model has a representation of the most relevant research entities, such as Person, Publication, Organization, and their relationships. The main concepts we use from the ontology are presented in Figure 2. The Publication entity has one or more authors, with zero or more online accounts; and these are affiliated to an organization.

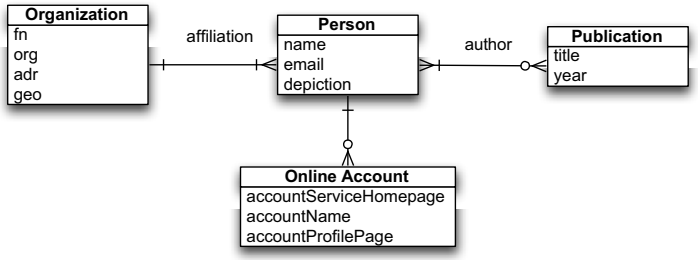

Fig. 2. Main Concepts of the SWRC Ontology.

The FOAF and SIOC ontologies have been used to extend the description of the Person entity in order to be able to capture online accounts. For example, by making use of the foaf:OnlineAccount class together with the foaf:hasOnlineAccount property, we can model the different web identities (Online Account) of a swrc:Person, including its homepage and profile page of the user. Furthermore, the vCard ontology is used to extend the Organization entity, for example, for giving a better structure to addresses.

4.2 API

Our goal is to enable open access to large amounts of structured data on research, with our current focus on publications and authors. These data can power a variety of tools that can help researchers to better understand their community [7]. We want to reduce access barriers, provide multiple communication options and expose data for easy integration [29]. For these reasons, we deployed a back-end infrastructure that stores the information about researchers and exposes it via a RESTful API that we

refer to as "Research.fm", in order to connect and leverage the Linked Open Data technology [30]. This infrastructure is ongoing work in the context of the European FP7 STELLAR Network-of-excellence that aims to provide access to social network presence and publication data of researchers in a standardized way [29] [31].

The Research.fm API implements the Cool URI [32] principle to provide readable, unambiguous, and persistent URIs for resources. The SWRC domain model entities are the core elements exposed by the different methods of the API. This API allows access to these data for a variety of Science2.0 applications. Besides for More!, the API is also used by other research exploration applications like Muse [33] and Science Table [34].

4.3 Architecture

The architecture that supports the data sharing approach is presented in Figure 3. Different sources, like publication archives, institutions, and social media repositories (eg. user directories, such as Soharc [35]), feed a central repository that exposes the previously described model through the Research.fm API. These information sources expose their data through the Really Simple Syndication (RSS) format and/or the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) [36], which allows automating the process. Both approaches expose XML representations of SWRC and FOAF ontologies to the central repository.

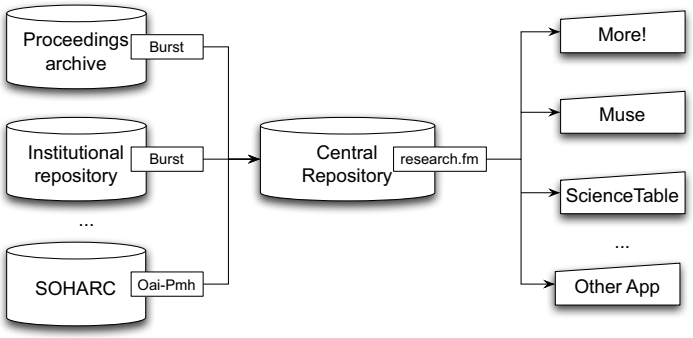

Fig. 3. Back-end architecture.

The central repository implementation is based on technology that we developed to store and manage learning objects and their metadata [37]. This flexible technology allows the consumption and management of different metadata schemas. The key feature of this technology is the ability to consume, store and expose any kind of XML document, which allowed us to easily develop the Research.fm API on top of it. Our repository technology has been evaluated on common software quality attributes, such as performance, reliability, interoperability, configurability and scalability [37].

The development of the back-end is ongoing work [29][31] that focuses on the adoption of a domain driven development methodology.

5 Evaluation

More! aims to increase awareness about different information sources, in order to help researchers to be more knowledgeable about related work. In order to assess the acceptance of the tool in real-life situations (i.e. at research events), we designed an evaluation in two steps.

Initially, we carried out two studies where the usability and functionality of the tool were tested in different contexts: a fictional scenario and a small real-life scenario. This approach provided us with feedback regarding the satisfaction level of the users and highlighted problems with the implementation. We used real data in order to reduce the artificial nature of the tests and increase the validity of the results from these initial evaluations [38]. The participants clearly agreed that More! is simple and easy to use but noted some concerns regarding the functionality, specifically related to the possibility of following the speaker's presentation via More!. Based on this feedback, the final version did not include extra functionality but re-arranged the presentation of the information for a final evaluation. This initial evaluation step is extensively described and discussed in [21].

In a second step, the application was tested in a research event, where researchers provided valuable feedback on the usability, functionality, and usefulness of the tool. This evaluation allowed us to obtain better insight in social interactions between researchers and how More! can enhance these. For this purpose, the tool was presented and promoted to all attendees of the EC-TEL 2010 conference [39] via mail, Twitter and during the opening session. From the previous evaluations, we observed that users had difficulties capturing QR codes during a presentation. In order to address this issue, the participants received QR codes for the different presentations on a leaflet added to the program of the conference. We also included a short explanation of what these codes were and how to use them. The participants were able to scan the QR code of a particular presentation and obtain the More! page of the presenter. Finally, evaluation data was gathered using 2 methods: a survey and usage tracking of the tool from all attendees.

For the survey, 10 users (8 male, 2 female) participated in the evaluation. The participants were between 28 and 50 years old, with the majority (n = 8) being less than 32 years old. All the participants were familiar with the Web2.0 concept, had prior knowledge of social tools and were active users of such tools for research purposes. 7 participants were researchers and 3 identified themselves as students. All the participants had a smartphone, powered by either Apple's iOS (n = 7) or Google's Android (n = 3) operating systems. The evaluations were focused on three dimensions: ease of use, satisfaction, and usefulness. In order to increase the accuracy and reliability of the questionnaire results compared to our previous evaluations, we used a seven-point Likert rating scale [40] and we added some extra questions to have more detailed feedback in the different evaluated dimensions. The questionnaires evaluated the usability of the application and were based on the USE questionnaire [41], where numerical values represent the agreement to a statement ranging from 1 to 7, with 7 being the highest agreement value. The results from the evaluation show us that the participants agree that More! is easy to use (M = 5,7 and SD = 1,06) and were convinced about its usefulness (M = 5,5 and SD = 1,43). Regarding the ease of use, the participants were a bit disappointed with a non flexible application that required

some effort to be used successfully every time. We observed that these results were due to the problems experienced by the usage of QR codes. Also, it is important to mention that the participants found the tool as not being able to make them more productive.

In the questionnaire, participants had the opportunity to list the most positive and negative aspects of the tool. On the one hand, they were enthusiastic about the idea of combining information in one place and expressed the fact that the tool was easy to use. More! allowed the users to have a single point of access for different information sources, which provide the participants with a deeper view of the academic background of the presenter. On the other hand, the most important identified drawback of the application is the use of QR codes. Participants did not have any QR capturing and decoding application on their smartphone and expressed difficulties with finding and downloading one. Also, they were struggling with the quality of the printed codes, which made this a frustrating process. This means that the current workflow of the tool does not succeed in providing the frictionless experience to obtain the required data. This can also be observed from the results of the satisfaction dimension from the questionnaire, where participants express a bit less satisfaction with the tool (M = 5,2 and SD = 1,48), compared to the other dimensions – see Figure 4. While our sample size is too small to be conclusive, it is important to mention that our previous evaluation results [21] are consistent with these conclusions. In the previous evaluations a five-point Likert scale was used. In order to analyze and compare them, we used an equivalence of the Likert rating scales as presented in previous work [42]. Figure 4 summarizes and compares the results of the questionnaire with the initial studies. From the figure, we can observe that the trend among the different dimensions is descending when the context of the evaluation gets more realistic. Unexpectedly, the tool is not as easy and useful as we thought, and does not completely satisfy the users.

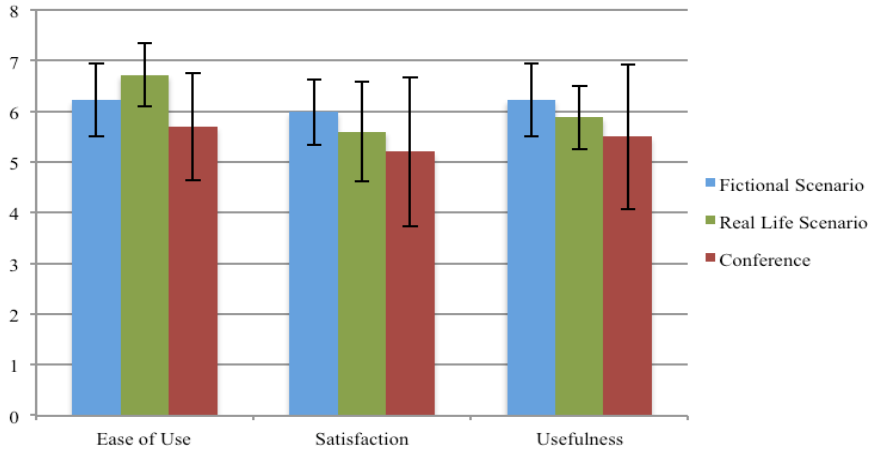

Fig. 4. Comparison of the different evaluations.

As stated before, the usage of the tool was tracked during the conference days. Figure 5 presents an overview of the visits and the devices that were used to access More!. There were a total 105 visits to the More! web application during the 4 days of the conference; which had around 250 participants in total. Out of the 105 visits, 62 were unique visitors over the 4 days, representing only 24.8% of the participants. In total, there were 260 page views with an average of 02:49 minutes per visit. Participants used More! less than two times and accessed around 4 pages during the conference. Furthermore, we were able to obtain an overview of the devices used to access the More! application. From the total number of visits, 63% of the visits came from personal computers and the rest from mobile devices. Unexpectedly, the application usage was significantly below than desired and its implementation for mobile devices was probably not necessary in these settings.

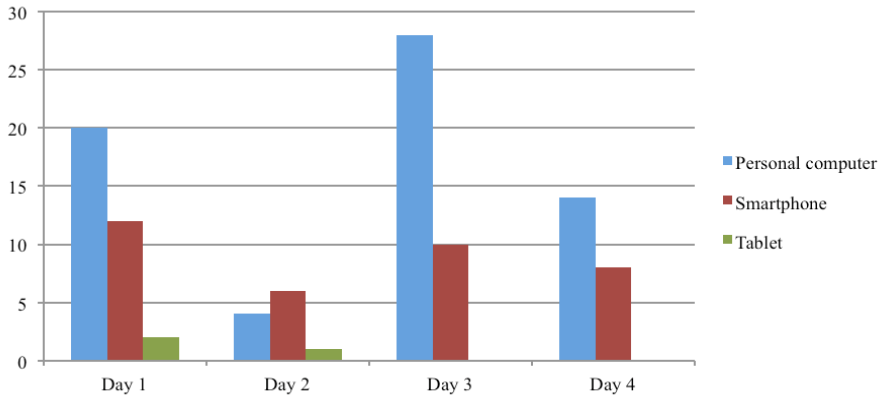

Fig. 5. Visits per device during the days of the conference.

6 Conclusion

In this paper, we have presented More!, a mobile web application that aims to increase awareness among researchers. Our application enables the enrichment of a face-to-face presentation with information that the Web2.0 environment provides. A back-end infrastructure was leveraged to support our mobile web tool. Our evaluation in different scenarios demonstrates that More! is simple, easy to use, and useful in a face-to-face scenario; but not widely accepted. The web application approach allowed participants to use different kind of devices to enjoy the benefits of the tool.

On the other hand, while the tool itself provides the expected functionality for the researchers, the initial fingerprint with QR codes is not an ideal solution and reduced the satisfaction level. Future work could include the test and comparison of different fingerprinting techniques to replace the QR codes, such as: shortened URLs, face recognition or location based services.

A deeper study of this type of discovery applications is needed, in order to better understand how awareness about ongoing relevant work, or even collaboration

between researchers, can be improved. Moreover, there is a need to collect and connect the type of information that More! relies on. Research.fm aims to be the shared archive of data; consumed by More! and possibly other tools [29] [31].

Finally, we are working on a suite of Science2.0 tools for a wide range of devices (from handhelds, over laptops and desktops, to tabletops). Future work will further analyze these tools in a broader context. Indeed, it is important to understand more deeply the context in which applications like More! can bootstrap connections among researchers. Thus, we need to identify in more detail the specific requirements of researchers and the extent to which the research context influences "sensemaking" tasks [43] in the Science2.0 community.

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