Challenges for Mobile Social Networking Applications

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Abstract. This paper presents work in progress regarding utilization of social network information for mobile applications. Primarily a number of challenges are identified, such as how to mine data from multiple social networks, how to integrate and consolidate social networks, and how to manage semantic information for mobile applications. The challenges are discussed from a semantic Web perspective using a driving scenario as motivation.

The main objective is to enable mobile applications to benefit from semantic information obtained from Web services, mobile devices, or the surrounding environment. The goal is therefore to create a framework that enables integration of semantic information (location, activity, interests, etc) with social network data (from Twitter, FaceBook, LinkedIn, etc) to facilitate intelligent yet easy to use communication tools for individual persons as well as groups of persons. An ultimate goal is to make complex communication simple through utilization of semantic information and social network data for pervasive services in mobile devices.

Keywords: Mobile Social Networking, SOA.

1 Introduction

Social networks have had an almost viral growth of users during the last years, where services such as FaceBook, Twitter, LinkedIn and Delicious enable users to share personal information with family members, friends and colleagues as well as loose acquaintances and the public in general. The personal information most commonly consists of text notes/messages, photos and videos, but the personal information can also consist of social data such as contacts or list of friends. At the same time a rapid growth of mobile computing has been made possible through advanced mobile terminals connected through wireless/GSM/3G networks, which has enabled users to be ubiquitously connected and thus be 'always on'.

This rapid development in mobile computing has made social networks almost ubiquitous, where access to them can be done through a multitude of devices such as

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a PC or a mobile phone as well as through public information displays or pervasive devices. While it is possible to access social networking services from almost anywhere, few services can today take full advantage of the mobility of the users.

Semantic information about users' location, context (such as what terminal they use) and situation (such as the current activity) can be used to filter information from social networks to support novel mobile applications. An example of such an application is to dynamically create and maintain groups (dynamic groups) based on semantic information such as using NFC-enabled mobile terminals to initiate creation of a new group or to add a member to an existing group [9]. It is also possible to automatically infer semantic information about a user into social networks (such as automated Twitter notes or LinkedIn updates).

The goal of the work is to engineer novel mobile applications through dynamic utilization of the social data available in social networks. For example, data mined from FaceBook, Twitter, LinkedIn and/or Delicious and fused can be utilized in a mobile application that presents real-time information of friends, family members and colleagues etc as a semantic contact lists or a group member list [1, 2, and 3].

This paper identifies a list of challenges for creating a platform for mobile social networking, using a top-down approach from both. The rest of the paper is structured as follows: Section 2 presents related work, Section 3 presents a motivating scenario, Section 4 introduces an architectural overview, Section 5 describes services for mobile applications, Section 6 presents challenges in mobile social networking, and finally Section 7 provides a discussion and future work.

2 Related Work

Tim-Berners Lee already in 1995 defined the Web as a collective intelligence. The viral growth of social networks today can be explained through both societal developments and technological advancements that together have enabled new types of applications where users today co-create content. 'The cloud' is the current paradigm of computing, building on this notion of co-creating both content and services [4]. Thus, Lee's vision of a collective intelligence is becoming true.

This is in particular true for social networking applications, as users feed the services with personal information and also contribute to the development of services (based on open software initiatives). Example services are:

- Wikipedia[1] harnesses collective intelligence to co-create content.
- Flickr[2] provides users with free photo sharing.
- YouTube[3] has as a service for video sharing reinvented the Web.
- Delicious[4] is an application to store, organize and share Web.
- Digg[5] enables users to share their opinion on digital contents (e.g. news, pictures, and videos) and be able to see the rank of that content.

[1] http://en.wikipedia.org/
[2] http://www.flickr.com/
[3] http://www.youtube.com/
[4] http://www.delicious.com/
[5] http://www.digg.com/

- LinkedIn[6] builds social networks by linking people together.
- Blogs[7] are social spaces where the users may read, write or even comment on their thoughts over the Internet to share opinions and raise open discussions.

The decentralized design techniques where end users participates in creating content provides a basic model for designing social networking applications. Creating, sharing, tagging and commenting on content while building social networks (communities) are hence central, as social needs are one reason for the viral growth of these services. However, mobile devices are now taking this even further by enabling users to be 'always on' which has many implications.

It has been shown that social context is important for designing and developing context-aware mobile applications [16], while also increasing the risk of privacy and integrity violation. In general mobile social networking applications allow users to have more social interactions and collaborations using the Web in more efficient and interesting manner [17]. For instance, the "CenceMe" system is able to collect users' present status or context information using mobile sensors and can export users' present status automatically to social networks [1]. Push-and-pull types of mobile applications are important in the context of mobile social networks [16, 1]. Pull applications may collect real-time information (e.g., micro-blogs. Status, etc) from different social networks using social API's and push applications may publish status based on sensor generated context to different mobile networks.

A dynamic group is a concept of creating and managing groups based on social data as well as semantic information [9, 15, and 3]. Related to this is a social interest discovery mechanism based on user-generated tags for discovering groups [3].

However, current API's are not enough to collect social data from social networking sites due to lack of standardization of data formats and model as well as access policies [18]. There are initiatives on open social interfaces but they have proven not to be usable in practice [19], mainly because of dependencies on social network owners (e.g. for analyzing social data) [2].

3 Motivating Scenario

Alice is a business executive at a call centre who has a large network of family members, friends and colleagues. She is very busy at work and her social life has regrettably been suffering over the last years. However, lately she has started to manage her social networks using a semantic contact application in her mobile device. It helps her by presenting status updates from the persons she is interested in (by filtering and merging information from FaceBook, Twitter, LinkedIn, etc). She also receives the latest news or interesting blogs of her friends though the application, which keeps her updated. She feels socially connected – even if busy!

Moreover, Alice uses the application for creating dynamic group that gives her a fast and easy way to communicate. This morning she plans for a lunch with her friends so she uses the application to see who are nearby and have time to chat. Four of her friends are online at the same location, so she invokes the communication tool and they decide to meet for lunch downtown.

[6] http://www.linkedin.com/
[7] http://www.blogger.com/home

Alice checks her calendar and todo-list, decides to take a walk downtown since the weather is lovely, and then uses the application to notify her friends that she is 'talking a walk downtown'. Her friends can then see her new status by using a similar application or by using the underlying services like Twitter or FaceBook.

A traditional contact application in a mobile phone contains contact information that most often is user-generated. However, Apple's iPhone and Google's Android platforms allow contact information to be imported from other applications. The semantic contact application described in the scenario above can automatically fetch, filter and fuse data from different data sources (social networks, news, blogs, calendars, etc), which simplifies social interaction by providing contact information updated in real-time. This means a possible shift from communication by email, phone or GSM text messages to rich communication using additional media while being able to communicate with a group as easily as an individual. Fig. 1 below depicts an Android prototype which presents a semantic contact application where information from different sources is fused and presented as semantic information about each contact in the list.

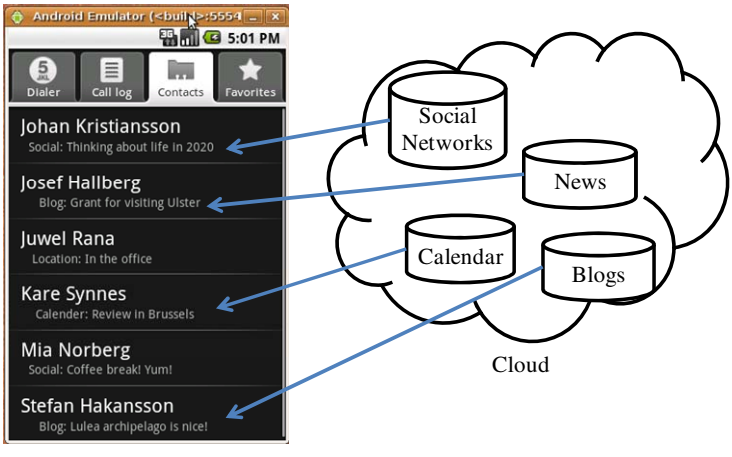

Fig. 1. Semantic Contact Application

4 Engineering a Platform for Mobile Social Networking

We investigate the feasibility of a platform for mobile social networking applications based on a Service Oriented Architecture (SOA) [6, 13]. The architecture has three main parts: the mobile client, the backend services, and the service integrator. The service integrator integrates mobile clients (e.g. mobile device software) and backend services (e.g. social data collector services or location tracking services) by providing a standard interface. In this paper we emphasize on identifying the challenges for developing a SOA-based platform for mobile social networking.

There are mainly two reasons why a SOA-based architecture is preferred for mobile social networking. The first reason is that it provides a more open and decentralized platform to adapt and integrate backend services into. The second is that the large

number of social networking users and heterogeneity in applications demand sustainability, easy deployment and management as well as high integration of social applications. These criteria can be met by utilizing a SOA-based architecture.

In Fig. 2 below we can see a three layer view of the platform architecture. This view describes some of the necessary components for the platform, and is relevant in order to understand the core architecture. In the first layer we can see how the backend services collect Web data, such as social data, from different sources of the Web (e.g. Facebook, Twitter, etc.). This can be done by using social API's[8], which in turn establish connections between social networks and data collector services.

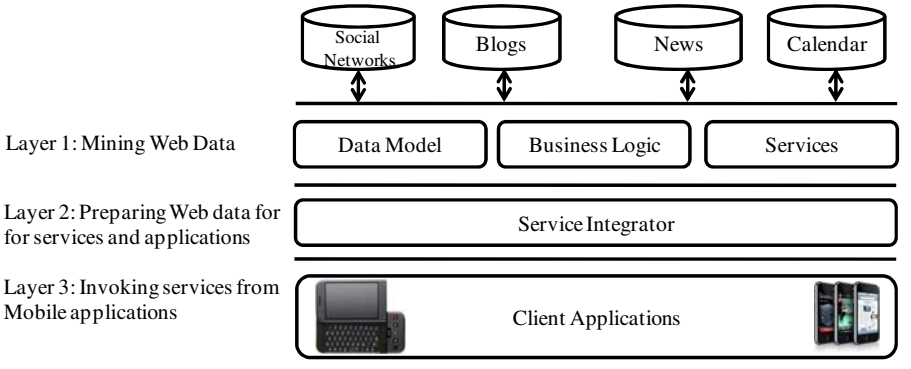

Fig. 2. Three layer view of the envision platform architecture

The service integrator is in layer 2. The role of the service integrator is to ensure interoperability of mobile clients and services. It supports interoperability by utilizing the standard specification for accessing social data [12]. Layer 3 shows how mobile clients, such as iPhone and Google Android applications, access services (e.g. social data collector services, profile builder services, etc.). Some services are associated with the mobile device software. For example, a semantic dialer application looks for unknown caller information in the social data collector service. This application also synchronizes the contact list (name, phone number, email address, status, etc) with the data from social networks via the social data collector service.

Aggregation of social data is one of the challenges in social data management. However, services which are based on reasoning techniques (e.g. profile builder services, dynamic group creator services) need a clean and complete social data set. These services provide operation for searching friends, discovering dynamic groups and so on [10]. For that purpose, the ontology based data model can be used [7, 10]. However, there are some problems in merging data, as shown in Fig. 3. By merging multi-source social data we also increase the privacy implications. A platform for aggregating and merging multi-source social data may provide a foundation for different types of services for building not only smart and flexible mobile applications but also applications such as a semantic browser. It enables mobile device software to integrate with social networks.

[8] http://www.programmableWeb.com/apis/directory/1?apicat=Social

5 Services for Enhancing Capacity of Mobile Applications

The semantic contact application discussed in Section 2 uses different backend services. These services enrich the capacity of mobile clients by providing real-time context-aware and social data. Therefore, the services need to use the semantic Web to ensure integrity and applicability of the data [20]. There are some problems that need to be addressed to ensure reliability of these services. One is identifying individuals from different social networks and aggregating social data for the purpose of being used in mobile applications. For example, Alice has a friend named Bob who has accounts in Facebook, Twitter and Blogger and he is using different email addresses. If Alice knows all of Bob's email addresses it is possible for her to access Bob's information from the different sources. If Alice enters the email addresses in the semantic contact application she is using the application will be able to fetch Bob's status, his blog entries, and the news he has shown interest in. For this process to work seamlessly and automatically there is a need for a number of backend services which are described below.

Profile Builder Service: The profile builder services fetch data from different public and private data sources of the Web and build consistent profile leveraging semantic Web technology. The data sources use different data formats and access policies, so it is difficult to provide a consistent data model for capturing data and building a profile on an individual basis. Fig. 3 below provides the RDF-based extended FOAF documents where data is collected from several data sources. The data refers to Bob, but the data identification keys are different. For example, in A^1 the data source is Facebook and the data owner identification key is bob@gmail.com while in A^2 the data

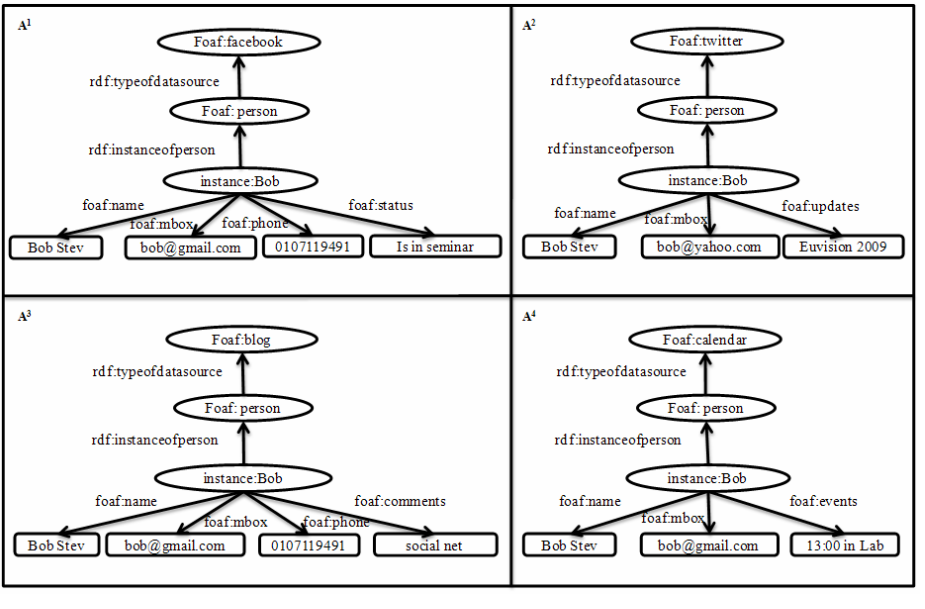

Fig. 3. Conflicts in data owner identifier

source is Twitter and the data owner identification key is bob@yahoo.com. Even if the data owner is Bob in both cases it appears as if the data owners are different because of the owner identification key.

Location Tracking Service: Location tracking services provides location information of the mobile user. Preserving privacy is one the main problem for developing such services.

Dynamic Group Creator Service: The Dynamic Group service contains all updated information of the user's contact lists and individuals. It enhances the capacity of the mobile application to perform standard query operation and build dynamic groups on the fly. This service utilizes the data collected by the data collector service and provides high value services.

Social Data Collector Service: The Social Data collector aggregates social data from different social networks.

6 Challenges

This Section describes challenges related to building a mobile social networking platform.

Interaction Design: As mentioned in the paper, semantic information obtained from the Web can be used to improve existing mobile applications, for example implementing a semantic contact application. One challenge is to investigate how to best utilize semantic information so that the application becomes easier to use, given the limited attention span of the human mind. As it also may be difficult or even impossible to develop a system with 100 percent accuracy, it is necessary to modify the application, in particular the user interface, to better deal with inaccurate or conflicting semantic information. For example, one option could be to implement a recommendation system where the user always has the final word. Another option could be to adapt the user interface (e.g. re-arrange or sort visible artifacts) to minimize user interaction. An option is also to weigh redundant information to achieve better accuracy. Optimally the user may not notice that the system sometimes fails as the application just become a bit less informative or more difficult to use in that particular case.

New Communication Services: Semantic information can be used to implement new types of communication services. For example, implementing a new Web service that forms dynamic groups of people based on location and user interest. One important research challenge is to explore how these new services should be designed and evaluate possible user benefits. This includes developing new Web frameworks and middleware as well as new user interfaces. One could for example imagine a dynamic group being visualized as third dimensional graph where the user can easily browse and navigate the currently discovered dynamic groups.

Unified Communication: When developing a new communication service it is important to get as many users as possible. When more and more communication services are deployed as Web services, it becomes possible to create mashups or aggregated Web services. As users being part of a dynamic group could be using

different communication services (e.g. Twitter and Facebook) the system should automatically dispatch messages between different social networks. A challenge is therefore to make an integrated effort of consolidating social networks, or even create a virtual social network service. Although similar services (e.g. OpenSocial [19]) already exist, more advanced orchestration and Web frameworks should be developed to more easily utilize new Web APIs.

Data Mining: Data mining algorithms must be utilized in order to generate semantic information. By extracting information from social networks it is possible to automatically discover information about users. For example, automatically find phone numbers, user names and relationship between users. The information can be obtained from a wide variety of sources, including news feeds, images, videos, and text obtained from classical Web pages. However, as users may have different account or profile names, it can be difficult to map information to a one particular user. Similarly, using non unique data fields to map data can easily result in inaccurate data sets. For example, using a personal name to map data obtained from a Web page to Twitter account can easily result in inaccuracy as personal names are typically not unique.

Another problem is that the vast majority of the data on Web is not available to a crawler or even a browser, but is hidden in forms, data bases, and interactive interfaces. While many Web services now provide public APIs which makes it easier to access hidden data, they usually require some form of authentication in order to be used. This means that the data mining software must maintain credentials to different Web sites while at the same time not jeopardize the security of the users.

In addition to accessing data on the Web, data mining software should also be able to access data stored on mobile devices. For example, accessing data stored in contact list, call history, message history, and browser history etc. The call list is particularly interested as it in principle is a social network, many times reflecting the user's closest social contact or real friends [5]. One option to access local data on mobile phones it let the mobile device be accessible from the Internet (e.g. via a local Web server) so that a crawler can access the data. Another option is to let a software running on the mobile device publish relevant information to an external Web service. In both cases, it is important not to compromise the user's privacy while also preserving the battery life time of the mobile device.

Yet another enhancement could be to let the mobile devices interact with the surrounding environment. For example, detecting social interaction patterns by getting information from sensors (RFID, NFS, Bluetooth, barcodes etc.) deployed in buildings or other mobile devices. This information should be aggregated and processed with other information obtained from the Web in order to draw as good as possible.

Semantic Web and Reasoning: Once data has been fetched from the Web, it needs to be combined and refined into useful semantic information. Depending on the data received from the data mining component, the reasoning module analyses the data, draw conclusions, and store the refined data in a suitable ontology. One important research challenge is to develop suitable ontologies and rules to fuse the data into fields that fits the used ontology. Machine learning algorithms such as clustering algorithms and statistical models can be used to find useful patterns, but it could also be useful to analyze the data offline to manually find patterns, for example matching data to social sciences theories. Defining useful rules and applying machine learning

algorithms to efficiently utilize vast data set containing information from the Web and sensors to improve personal communication is still a challenging research problem.

Privacy: As mentioned before, semantic information about a user must be treated carefully. The challenge is to support privacy and integrity in a simple yet powerful way. A common solution is to let the users be in control and provides some easy way for the users to share information. Typically, users will only share information if the gain is greater than possibly privacy implications. For example, people upload videos and images to YouTube and Flickr because they want other people to be able to easily access the data, or to improve their own social status. These aspects must be considered when developing new services.

7 Discussion and Future Work

This paper draws a skeleton for a mobile social networking architecture while presenting major challenges for implementing a mobile social networking platform, which in turn raises a number of research questions worthy to discuss and to study more closely in the future.

There are always inherent problems with gathering information from numerous sources, such as different social networks. Traceability of information is a logical problem about how, when and from where a particular social network is collecting social data. How can this information be trusted? How can the source of the information be relayed to the user without adding interaction overhead and confuse a user? Is it possible to fuse the information in a heterogeneous and meaningful way?

Social networks can simplify communication, not only because social networks are able to aggregate social data over the Internet, but also because of the potential influence social data can have on different applications (e.g., mobile applications or desktop applications). However, simplification often means automation and making the services more pervasive. In this lies a basic question, is it possible to find a good balance between proactivity (where the system acts in behalf of the user) and pervasiveness (where the system avoids prompting the user for a response)? Is it possible to reduce the cognitive load communication tools have on users, especially when it comes to being 'always online' and having a limited attention span?

Privacy and integrity safeguards are important, as automation of revealing personal information increases the risks of misuse of the information simply because more information will be available. It may prove vital to design the architecture from a simple yet powerful framework for privacy and integrity – otherwise users may choose not to trust the new services and thus not use them. Would dynamic groups be such a methodology for providing control of personal information? Can information be presented in less detail without loss of perceived use and without sacrificing the desired functionality of the services?

Naturally standards for social data are bound to be defined, such as OpenSocial, which are necessary in order for integration of social networks with mobile applications. Naturally also service providers will strive for the opposite in order to leverage their own services. The question here is whether it is possible to fuse information from the social networks existing today and how is that fused information perceived from perspectives of correctness, completeness and non-ambiguity? What information

is possible to derive from the different social networks, as their API-based access policies are both limited and their APIs in some cases also are deprecated with no or little notification to developers?

Also, data formats and orchestration policies are not yet standardized, which means possible limitation in an open platform for social network integration with the mobile applications. Would OpenSocial currently suffice and how could it be developed to suit the needs of mobile applications? Is an extended API necessary and what parameters are of importance (flexibility, heterogeneity, etc)?

Most social networks are accesses through a Web-browser today, using Web2.0 and SOA as an enabling technologies. A mobile device has obvious limitations for presentation of graphical content, but instead are almost always carried with the user and is thus 'always on'. Would it be possible to mitigate the gap using semantic Web technology and pervasive methods based on semantic information? Less is more, as the saying, but what is lost due to the selection of information to present to the user?

Lastly, communication should be simple and intuitive. Most users use a minimum of the functionality of the mobile devices they use for communication. Can simplicity be achieved through a flexible way of creating, maintaining and using a social network for communication (e.g. utilizing dynamic groups)?

8 Conclusion

This paper presents challenges for utilizing social network information to enhance mobile applications. The three most challenging issues may be how to integrate and consolidate social networks, how to mitigate the gap between the traditional and the mobile Web through use of semantic Web technology, and how to manage semantic information for mobile applications. The challenges were discussed from a semantic Web and SOA perspective together with a driving scenario as motivation.

The main conclusion is that a mobile social networking framework would enable integration of general semantic information (location, activity, interests, etc) with social network data (from Twitter, FaceBook, LinkedIn, etc) to facilitate intelligent yet easy to use communication tools for individual persons as well as groups of persons. A goal is to make complex communication simple through utilization of pervasive technologies and semantic information from social networks. Mobile social networking would ultimately connect a person's virtual and physical world, thus enabling a wide range of novel applications that benefit from semantic information in general and social network data in particular.

References

1. Miluzzo, E., Lane, N.D., Fodor, K., Peterson, R., Lu, H., Musolesi, M., Eisenman, S.B., Zheng, X., Campbell, A.T.: Sensing meets mobile social networks: the design, implementation and evaluation of the CenceMe application. In: 6th ACM Conference on Embedded Network Sensor Systems, Raleigh, NC (2008)
2. Huberman, B.A., Romero, D.M., Wu, F.: Social networks that matter: Twitter under the microscope. In: CoRR abs/0812.1045 (2008)

3. Li, X., Guo, L., Zhao, Y.E.: Tag-based social interest discovery. In: 17th international Conference on World Wide Web, Beijing (2008)
4. Lytras, M., Damiani, E., Pablos, P.: Web 2.0: the Business Model. Springer Publishing Company, Incorporated (2008)
5. Ankolekar, A., Luon, Y., Szabo, G., Huberman, B.: Friendlee: A Mobile Application for Your Social Life. In: MobileHCI, Bonn (2009)
6. Michlmayr, A., Leitner, P., Rosenberg, F., Dustdar, S.: Publish/subscribe in the VRESCo SOA runtime. In: Second international Conference on Distributed Event-Based Systems, Rome (2008)
7. Veijalainen, J.: Developing Mobile Ontologies; Who, Why, Where, and How? In: 8th international conference on Mobile Data Management, Mannheim, pp. 398–401 (2007)
8. Web Services Description Language (WSDL) 1.1, http://www.w3.org/TR/wsdl
9. Hallberg, J., Norberg, M.B., Kristiansson, J., Synnes, K., Nugent, C.: Creating dynamic groups using context-awareness. In: 6th international Conference on Mobile and Ubiquitous Multimedia, Oulu, Finland (2007)
10. Christopoulou, E., Goumopoulos, C., Kameas, A.: An ontology-based context management and reasoning process for UbiComp applications. In: Joint Conference on Smart Objects and Ambient intelligence: innovative Context-Aware Services: Usages and Technologies (2005)
11. Ding, L., Zhou, L., Finin, T., Joshi, A.: How the Semantic Web is Being Used: An Analysis of FOAF Documents. In: 38th Annual Hawaii international Conference on System Sciences, vol. 04 (2005)
12. Mello, A., Rein, L.: Using Standards to Normalize Domain Specific Metadata. In: W3C Workshop on the Future of Social Networking, Barcelona (2009)
13. Borcea, C., Gupta, A., Kalra, A., Jones, Q., Iftode, L.: The MobiSoC middleware for mobile social computing: challenges, design, and early experiences. In: 1st international Conference on Mobile Wireless Middleware, Operating Systems, and Applications, Innsbruck, Austria (2008)
14. Kolan, P., Dantu, R.: Socio-technical defense against voice spamming. ACM Trans. Auton. Adapt. Syst. 2 (2007)
15. Seo, J., Croft, W.B.: Blog site search using resource selection. In: 17th ACM Conference on information and Knowledge Management, Napa Valley, California (2008)
16. Häkkilä, J., Mäntyjärvi, J.: Developing design guidelines for context-aware mobile applications. In: 3rd international Conference on Mobile Technology, Applications &Amp; Systems Bangkok (2006)
17. Zigkolis, C., Kompatsiaris, Y., Vakali, A.: Information analysis in mobile social networks for added-value services. In: The W3C Workshop on the Future of Social Networking, Barcelona (2009)
18. http://www.programmableWeb.com/apis/directory/1?apicat=Social (May 2009)
19. http://www.opensocial.org/page/opensocial-foundation-faq (May 2009)
20. Mika, P.: Social Networks and the Semantic Web (Semantic Web and Beyond). Springer, New York (2007)