An Ontology-Based Interaction Concept
for Social-Aware Applications

Alexandra Funke, Sören Brunk, Romina Kühn, and Thomas Schlegel

TU Dresden – Junior Professorship in Software Engineering of Ubiquitous Systems,
Dresden, Germany
`{alexandra.funke,soeren.brunk,romina.kuehn,`
`thomas.schlegel}@tu-dresden.de`

Abstract. With the usage of mobile devices becoming more and more ubiquitous, access to social networks such as Facebook and Twitter from those devices is increasing at a fast rate. Many different social networking applications for mobile devices exist but most of them only enable access to one social network. As users are often registered in multiple social networks, they have to use different applications for mobile access. Furthermore, most applications do not consider the users' social context to aid them with their intentions. This paper presents our idea to model the user's social context and intentions in social networks within an ontology. Based on this ontology we describe an interaction concept that allows publishing information in different social networks in a flexible way. We implemented a prototype to show how our findings can be presented. To conclude, we highlight some possibilities for the future of ontology-based social-aware applications.

Keywords: interaction, ontology, semantic modeling, social-aware, social media.

1   Introduction

The number of people using social networks is still rising at a fast pace. Furthermore many people are using several different social networking services simultaneously due to various reasons. One of the reasons is the different focus and functionality offered by various social networks. Some are specialized in offering functionality, such as storage and sharing of photos, videos or other media while others emphasize the aspect of networking and communication.

Another reason is that often different contacts are members of different social networks. In order to reach or follow them all, accounts in multiple social networks are necessary. However, having accounts in multiple social networks raises new issues. Each social network offers its own interface to access it. Thus users have to log on to several websites or use several applications. A lot of functionality is also redundant or overlaps so that people have to decide to use just one social network for a specific intention or to repeat things to reach everyone. Besides being tedious work, duplicating postings may lead to redundant information overflow for people participating in multiple social networks.

A fast increase of people with mobile devices [1] is pushing the success of social networks even more. Increasingly, people are using those devices to access social networks from everywhere. Besides mobility, there are other advantages as well in using mobile devices for social networking. For example, most devices have an integrated camera allowing sharing of photos or videos immediately. Furthermore, sensors such as GPS can be used to easily share location information. However, there are also challenges, mostly related to hardware restrictions such as small displays and keyboards that make the use of mobile devices more difficult. Besides having mobile websites, many social network providers offer native applications for the most popular mobile platforms. Those applications are also restricted to their own social network. In order to use the functionality of multiple social networks, users have to install and use one application for each network they want to use. Reading and sharing content within multiple social networks is even more difficult on mobile devices due to the mentioned hardware restrictions. Currently, just a few mobile applications allow using the functionality of multiple social networks from one interface. Existing ones are mainly restricted to show a combined social stream. Another interesting aspect that is missing in most social networking applications is that they do not take advantage of the social context to aid users in reaching their goals. The social context consists of the user's contacts, relationships, preferences and memberships in social networks. In addition, the user's intentions influence the usage of the social network. On the one hand, they are part of the social context and represent the reasons to share any kind of information. On the other hand, they focus on aspects such as who wants the user to be contacted or which kind of information is intended for whom.

To illustrate our approach, this paper is structured as follows: in Section 1 we introduce some related work that deals with ontologies for applications in the field of social media. Some applications available for different mobile operating systems are considered and compared in Section 2. These applications integrate a variety of social networks and social media to support the use of many different networks. A definition for "social-awareness" is given in Section 3. This section also presents our ontology, the interaction concept for social-aware applications and the prototype implementation. The paper concludes with a summary and discussion of our concept and future work.

2   Related Work

"An ontology is a specification of a conceptualization." [2] It offers a flexible way to model the knowledge of a domain.

Currently, there is a lack of research in the area of ontology-based approaches for meta-social networks or the modeling of user goals for social media. A meta-social network is an application or a network that enables the user to send messages and status updates in many different social networks at the same time. Different aspects are included in this field. On the one hand, the development of ontologies for context-aware systems plays an important role. On the other hand, approaches that focus on

the user needs and different kinds of social network services and their integration in a meta-social network are essential requirements for our interaction concept.

Context is defined as all information about the interaction between user and application. [3] Neto et al. [4] have developed a context model that is based on a domain-independent ontology that providing classes, properties and relations. Lower ontologies can import them easily for specific domains. Tietze and Schlegel [5] describe a possibility to use social networks and meta-social networks in the domain of public transportation. Starting with a classification of social network services and the specification of functionalities, meta-social networks are presented. In their work, an example is given describing how the passengers of public transportation could inform others about things like delays or cancellations using a meta-social network application. We use some of their specific aspects but apply them to our more general approach by integrating their model of social network capabilities into our ontology.

2.1   Mobile Applications for Social Media

There is a small number of mobile applications supporting the use of multiple social networks at the same time. The iOS application Sociable[1] integrates four social networks: Facebook, Twitter, LinkedIn and Tumblr. It enables the user to send status updates to all selected networks at the same time. An update can contain text, images or the user's location. It is not possible to read data from the social networks, such as streams, messages, or profiles. Furthermore, there is no option to specify the recipients of the message or to send the contents based on the goals of the user.

Seesmic[2] is another app, which is designed for social information exchange. It is available for different operating systems. Seesmic integrates Facebook and Twitter. Users can browse through their streams, friend lists or profile pages. Text, images or locations can be sent to both networks at the same time. It is possible to select a single contact or all contacts as recipients of a message. Seesmic only enables to specify a single recipient of a message by going to a friend's profile and posting a message on his or her stream. A further disadvantage is that the application does not save any settings of previous interactions.

The applications shown above, Sociable and Seesmic, do not support functionalities such as selecting specific persons or groups as recipients for a message. Neither can updates be sent via additional communication channels such as e-mail. Only contacts from the social networks can receive messages. It is not possible to select other people from the contacts list of the smartphone. Users of multiple networks cannot specify one particular network as preference for different types of content (e.g. to share images) using the apps mentioned above. Another important point is that for every new message, users have to explicitly define the settings for sending, as there is no way to save the settings and reuse them later. Based on those facts, we have developed a concept that considers these aspects and tries to integrate them in a user-friendly way. The focus of our work lies on the members of social networks and their needs, the so-called users' intentions.

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[1] http://andysmart.org/work/sociable/
[2] https://seesmic.com/

2.2 Semantic Modeling for Social Media

FOAF (Friend of a Friend)[3] is one of the first semantic models to grasp social interconnections between people. Persons, their activities and relationships to other people or objects are modeled in this ontology. Moreover, FOAF can also describe documents and organizations. This data is implemented machine-readable in RDF (Resource Description Framework) [6] and OWL (Web Ontology Language). [7] FOAF profiles can be used to find out, for example, who knows whom and if two persons have the same friends. To model these relationships, every profile gets a unique identifier. The base information of people are name, e-mail address and photos. Furthermore, blog, interests and publications can be specified. The focus of our work lies on the goals and intentions of the users, which cannot be modeled with FOAF. Nevertheless, FOAF can be used as a basis for our developed ontology.

3 Social-Aware Applications

Users' contacts, relationships, preferences and memberships in different networks are social information of the user and part of the user context. Therefore, we call it the social context of the user. An application that is sensitive to this data is social-aware. This means that such an app collects social information and responds through adapting the visualization or interaction. Similar to context-sensitive applications that are aware of the location or environment of the user, such an application is aware of the user's social context. If the application knows the contacts of the user and the frequency of communication with them, it can predict a possible target audience and appropriate functionalities for sharing content with users. Furthermore, information, such as the classification of contacts in social groups (e.g. mother and father are part of the family group), and the location in combination with friends (e.g. university and fellow students) can also play a major role in social-aware applications. Boldrini at al. [8] state that social-aware applications can learn automatically, collect social information and use it to predict future movements of the user. They developed a content sharing service that tracks the social context and relationships to optimize the distribution of data to interested users. In our work, the focus lies on the social contacts within social networks and the distribution of personal data over various communities and functionalities.

3.1 An Ontology for Social-Aware Applications

With an ontology it is possible to represent arbitrary concepts and their relations within a formal model. OWL ontologies are described in terms of classes of individuals as well as the properties of those individuals. Properties can connect different individuals or they can relate data attributes to an individual. Relations are described in a formal way with strictly defined semantics. In doing so, it is possible to apply inference rules to infer implicit facts from existing ones.

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[3] http://www.foaf-project.org/

Our main motivation for using an ontology is the possibility to model the social context of the user in a flexible way and independently from one concrete technology or social network. This is a key factor in order to integrate the functionality of multiple social networks and to actually use the social context to aid users. Another advantage is the possibility to integrate and reuse other existing ontologies. In our work, we include several other ontologies describing related concepts, such as FOAF, to model relations among people.
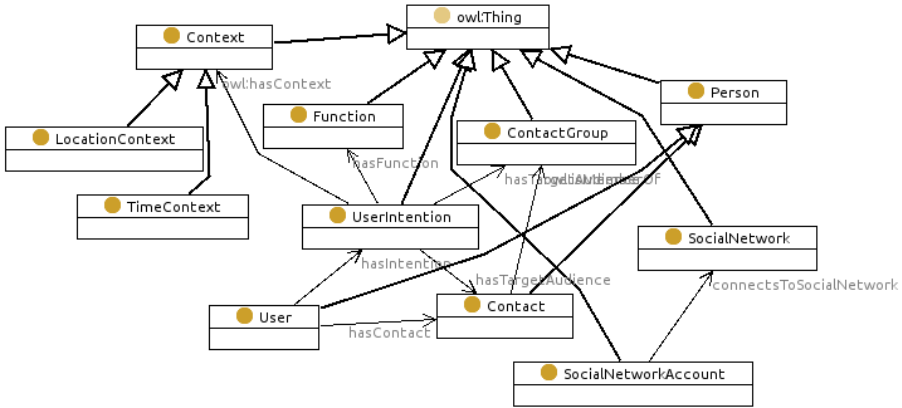

Fig. 1. Simplified view of the main concepts within our ontology

In the following paragraphs, we describe some of the main concepts of our ontology. Figure 1 gives an overview of these concepts.

The use of a social network is always related to some intentions of its users. For example, they might want to check if there are any status updates of their friends or upload a photo for their family. Based on those intentions, they interact with the user interface of their social network to achieve their goal. Their intentions are translated into some actions within the available functionality. Our main focus is to grasp what users intend to do within their social networks. This information is modeled within the *UserIntention* class. The purpose of this class is to describe a user's intentions and actions in social networks in an abstract and social-network independent way. Intentions are described in a formal way as precise as possible. This enables us to map an intention to possibly multiple specific networks, the concrete functionality within those networks as well as to recipients and groups of recipients in different networks.

An example showing some individuals of our ontology as well as their relations is shown in Figure 2.

An intention contains the desired functionality of a social network, such as posting a message or uploading a photo. Desired functionality is modeled in the *Function* class. Combining other actions into new ones can compose more complex actions. This gives us the flexibility necessary to support things like uploading a photo and posting it together with a text message. An intention also has some options, usually
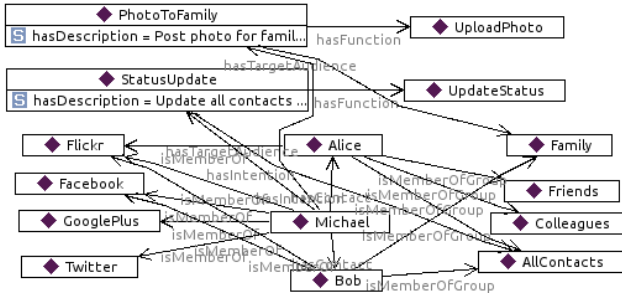
Fig. 2. An example part of ontology instances describing intentions

dependent on the function. For example, an option would be whether the current location should be shared together with a message and the importance of that message. In order to match the desired functionality to the features supported by social networks, we require a compatible model of the network capabilities. For that, we include an existing ontology describing the capabilities of different social networks. [5] Modeling the capabilities enables us to do things such as automatically selecting an appropriate social network for certain input and functionality requirements. Another part of the intention is the target audience serving as list of recipients. This functionality is important to allow users to select who can see their content and many social networks support it. A target audience can be linked to an intention. It is modeled independently of concrete social networks but can be mapped to concrete contacts as described below. A special target audience can also be the public, which is mapped to the corresponding settings in concrete social networks as well. Some social networks or publication channels such as blogs do not allow content to be published to a restricted set of recipients. This can be modeled within our ontology to avoid publishing content meant only for a private audience. An intention can also contain a human readable description allowing easier reuse.

The User class covers information regarding data of individual users and the social networks they use. It includes the users' accounts in social networks as well as their preferences. Preferred social networks in general or for specific functions can be described here. For example, users might prefer a specialized social network such as Flickr as their primary network for uploading photos. This information can be used to post photos to Flickr and automatically create links to it in other social networks.

As social networks are primarily about communication, a user's contacts or friends are one of the core concepts within our ontology. The *Contact* class and the properties connected to it describe a user's contacts and the relation with them. As contacts often have accounts in multiple social networks, it is important to have a mapping of those accounts to one identity. The *Contact* class has a property that maps accounts in different social networks to one person instance. This mapping could be done automatically, e.g., based on the contact's name or e-mail address. The user could also manually choose which contact in different social networks is the same person. The *ContactGroup* class allows for a flexible creation of groups. Similar to contacts, it allows a mapping to groups of a social network or to contacts directly if groups are not supported. For example, a *ContactGroup* "Family" can be mapped to the

corresponding groups in different social networks and could include a family member who has only an e-mail address. Preferences of contacts, e.g., regarding a preferred social network, can be modeled within our ontology as well. Together with the users' preferences and the mapping of contacts to their accounts in different social networks, it can be used to avoid posting the same information multiple times to the same people in multiple social networks but instead make sure that it reaches each contact just once through their preferred channel. The *Contact* and *ContactGroup* classes enable a straightforward mapping of their instances to an address book structure for integration into existing applications.

3.2   An Ontology-Based Interaction Concept

As shown above, an ontology can serve as a flexible model to represent a user's social and physical context and to integrate multiple social networks. However, an ontology on its own does not make a social-aware application as it is merely a way to create a model of the users' intentions and their context. We need to take advantage of this model to help users communicate in an efficient and user friendly way. Therefore, we have developed an interaction concept that uses our ontology to aid the users in their utilization of social communication.

Similar to the ontology, our interaction concept is built around the user's intention. As shown in the previous section, intentions in the ontology are modeled in an abstract way and are independent of a specific network. We can use this fact to move from a social network centric view to a task or intention based view. Our concept includes an integrated view on the social networks used by one person also known as a meta-social network. While most meta-social networks or applications focus on having an integrated stream of content from multiple social networks, they are rather limited when it comes to the creation and distribution of content over multiple social media channels as shown in 2.1. Our goal is to decouple the creation and sharing of content in social networks from one single provider and to help users to express their intentions to the system by using the social context.

A typical interaction flow within our concept would look like this: The first interaction step is always to choose the desired functionality and to select or create the content to be shared. This can be done in two ways. The first way is to select the functionality first and then the content. For example, users might choose to update their status and then provide text using an input field. The second way to choose desired functionality is to determine it automatically based on the type of provided content. For example, it is possible to take a photo and immediately share it through the application. The next step is to select options such as showing the current location with a message. These options mostly depend on the chosen functionality and content type. After that, the target audience can be selected. The selection allows choosing from any combination of contacts and groups as stored in the ontology. As described in the previous chapter, the identities of the same person in different social networks are all connected to one contact, which allows us to select a contact only once, independent of their social network accounts/identities. The same is true for groups as they are mapped to each social network as well. Special groups, such as "public", can

be chosen, too. The selection can be done using the local address book if it can be synchronized with the ontology.

A selection of social networks is done automatically based on the chosen functionality, the target audience and preference settings. Obviously, only networks supporting the desired functionality can be used. Based on the target audience, only networks that have at least one recipient are chosen. This selection is further refined if one person has an account in multiple networks. To avoid duplicates for the recipient, only one channel is chosen per contact if possible. This is in turn based on the contact's preferred network or, if that information is not available, based on the user's preferences. As an optional step, the user can then refine that selection manually. If the content cannot be delivered to all recipients of the target audience due to a deselection, a warning will show up. As the last step, sharing of content can be triggered and it will be distributed through the selected channels.

The intention will be saved automatically for possible reuse later to increase efficiency. Together with the intention, context information is available, such as the current location. Optionally, users can assign a description to the stored intention if they intend to use it again with new content. A simple approach would be to show a list of most recent intentions as suggestion to the user, or the most frequently used. However, it is also possible to utilize the social context contained in the intentions in a more sophisticated way. That is, for example, the information which contacts or groups have been used how often recently, which networks were used, what functionality and so on. This information can be used not only to suggest a previously used intention but may also help to create a new intention by suggesting likely values based on history. For example, by recommending most recent contacts or often used functionality. Furthermore, social context can be combined with the current selection when creating an intention. After a user chose to share a photo, the target audience used most frequently will be suggested together with photo sharing.

Using the social context could help making the interaction of users with their social networks more efficient and user friendly. However, for user acceptance, it is important not to decide too many things automatically but leave control with users. For many interaction steps, we therefore compute the most likely values based on ontology, history and context and show them as an unobtrusive suggestion leaving the choice to the user whether to accept or to ignore the recommendation.

3.3   Implementation

In order to evaluate our concept, we have created a prototype implementation for mobile devices using the Android platform. The application enables the user to send status updates and messages or to share pictures in the social network Facebook, the micro blogging service Twitter and the photo hosting service Flickr using a single common interface. Thus, users can type a text, choose a picture from the gallery of their smartphone and send this to certain people. As recipients, single persons can be selected as well as groups of persons, e.g. the group "Family". A special feature of this app is that contacts may not only be chosen from the social networks but also

from the address book of the mobile device. After all parameters are set the message is sent as specified.

Flickr operates as primary network for sharing photos. Thus, if this network is selected, the picture will be uploaded to that platform and the posts for Facebook and Twitter only contain a link to this page. Otherwise, the images are uploaded directly to the target platform of the posting. When the user sets all preferences and sends a status update, the settings are saved as an intention. Furthermore, the application can be started via the intent to share photos. The user only has to choose a picture in the gallery, select "Share" and our meta-social network application. This integrates a task based approach with the platform. Some of the functionality presented in our theoretical concept cannot be implemented because of restrictions of the social networks' APIs. For example, it is not possible to send direct messages via the Facebook API. According to Facebook, this restriction is necessary in order to avoid spam. The procedure for sending a message is simple. The application starts and the user can type in a text. Afterwards, users may select the group via the group button and shares the picture through the preferred streams, e.g., upload the picture in a Flickr album and send a link to the members of the group "Family" via Facebook, Twitter and maybe via e-mail. For users, it is possible to personalize the message and the recipients of the information when using our application. Furthermore, they can choose people from the contacts list, not only from the communities. One of the most important facts is that the intentions are saved and can be reused for later messages.

4   Conclusions and Future Work

In this paper we have shown how social context and intentions of users in social networks can be modeled within an ontology. Based on that, we described an interaction concept and showed how it can be implemented in a prototypical application. As a preliminary work, we presented several applications that are currently available for smartphones and showed the limitations of those apps. Furthermore, we discussed related work that deals with ontologies for context sensitive applications, the modeling of user intentions and the development of meta-social networks.

We have shown some advantages of using an ontology to model the social context such as flexibility and the possibility to integrate existing models. The functionalities, contacts and settings were described in an abstract way to capture the social context independently of concrete social networks and technologies. Thus, the ontology provides easy modeling and mapping of users and functionalities from different social networks. The user-centered interaction concept based on this utilizes the social context in order to help users to connect to each other and share information in a fast and simple way. Users can not only share content with all their contacts easily, they can also save intentions through their social context for later reuse. The implemented prototype puts one possibility of our interaction concept into practice. It integrates different networks with different functionalities in a single application using a common interface.

Future work could contain the implementation of not only social context but also other context information to enhance functionality. For example, the user intentions suggested could be based on temporal or physical context in addition to social context and including the location context could support suggesting intentions based on this information. An intention that was created at a certain location can be recommended for reuse. In general, context ontologies can be used for that purpose. In some social networks, it is possible to tag different people on photos. If an application enables this feature, it can suggest the tagged people as recipients of the corresponding photo. Furthermore people who are closely related to them may be suggested. It is also conceivable that the ontology tracks content that is shared via different social networks. Hence, comments which were written as reply to this message could be associated with each other.

Therefore, we think our approach explores interesting aspects of social-aware applications and leads to intriguing questions for further research in the fields of ontology-based interaction concepts and of social-aware applications for ubiquitous social media.

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