Requirements Engineering Patterns for the Modeling of Online Social Networks Features

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***Abstract*—This paper proposes requirements patterns for Online Social Networks (OSNs). Patterns are based on features observed on currently popular OSNs, and are defined as *i-star* models. Patterns are relevant for the requirements engineering of new OSNs. They can help in requirements elicitation, in order to avoid missing important OSN requirements. They can be used as basic models of OSN requirements, something that a modeler starts from, and then specializes and changes according to the specific requirements from OSN stakeholders.**

I. Introduction

Requirements Engineering (RE) involves the elicitation, modelling, and analysis of requirements for a system-to-be, in order to produce its specification. The system-to-be is subsequently engineered and deployed according to the specification.

This paper focuses on patterns of requirements for Online Social Networks (OSNs), a class of systems which has become particularly popular over the last decade. Some of its instances, such as Facebook and Linkedin count hundreds of millions of registered users, that is, users who have provided personal information in order to be able to use these systems. OSNs were defined by Boyd et al. [1] as:

> "Web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system. The nature and nomenclature of these connections may vary from site to site."

OSNs have attracted considerable attention in research. For instance, Boyd and Ellison wrote a defining essay on Social Network Sites [1]; Ellison et al. studied the use of Facebook by college students [2] . The contributions mostly focus on: the properties of graphs induced by user data, user activity, and privacy and trust issues.

As far as we know, not much attention has been invested in RE for OSNs. What should be taken into account when designing a OSN? What are the recurring features that we can find in popular OSNs? How should we model these features? Can we define requirements patterns for the design of OSNs?

In this paper, we apply the modeling language *i-star* [3] to represent patterns of OSN requirements, induced from features that we found in major OSNs.

The objectives of the paper and its corresponding contributions are, firstly, that we identify recurring features of OSNs, and secondly, that we propose requirements patterns that correspond to the features.

The rest of this paper is organized as follows. In Section II, we review the related work. In Section III, we identify the features of the OSNs. And finally, we discuss the results and conclude the paper in Section IV and Section V respectively.

II. Literature Review

Existing research has explored several aspects of OSN, ranging from their structure, to the topics of privacy and trust, including analyses of why and how people use OSNs.

Data about relationships between users give graphs, where users are typically nodes, and edges indicate relationship instances. Such graphs have received considerable attention in research. There are studies of Flickr, YouTube, LiveJournal and Orkut [4]; MySpace and Orkut [5]; Sina blogs and Xiaonei SNS, two large Chinese OSNs [6]; Flickr and Yahoo! 360 [7]; and Twitter [8]. For examples of findings, consider Xiang et al., who proposed a model for the representation and the inference of the relationship strength between members of OSN [9]; or Mislove et al. [10], who claim that graphs induced by various OSNs user relationships, despite their different purposes, share a number of similar structural features, namely: highly skewed degree distribution, a small diameter, and significant local clustering.

Various authors have studied the reasons why teenagers [11], college students [12] or young adults [13] are members of a social network. These reasons range from satisfying a "friend" and connection needs to having an additional source of information, and emerging adults use OSNs *"to connect with others, in particular those in their offline lives"* [14], [13].

978-1-4799-6327-0/14/$31.00 © 2014 IEEE

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Data forming the user profile on OSNs have also been studied, including: the role of profile components in the creation of online friendship connections [15]; how *"a social network profile's lists of interests can function as an expressive arena for taste performance"* [16]; the kinds of information Facebook users shared on their profile were identified [17]. Mislove et al. also explored the possibility to infer the attributes of some users in an OSN, given the attributes of some users in the same network. The authors discovered that members of OSN usually share the same attributes as their friends; and thus the attributes of some users can be inferred accurately given the attributes of other users belonging to the same community [18].

As mentioned earlier, the privacy and trust are important issues in the context of OSNs. Several researchers have explored these problems. For instance, the trust and privacy issues were compared between Facebook and MySpace, and the authors find out that both OSNs members share similar levels of privacy concerns, with Facebook users more trusting of the OSN and its users [19]. Guha et al. proposed NOYB (*"None Of Your Business"*), a mechanism providing *"fine-grained control over user privacy in online services while preserving much of the functionality provided by the service"* [20]. Other studies include: the study of the relationship between trust and profile similarity [21]; and the measurement and comparison of *"the privacy attitudes intentions against the privacy settings on Facebook"*, the empirical evaluation showed that every participant had at least *"one sharing violation based on their stated sharing intentions"*, that is, every participant shared something they wanted to keep private, or conversely, they wanted to share something but kept it private [22].

Several behavior-related studies were carried out: *"The Spread of Behavior in an Online Social Network Experiment"* [23]; a human behavior-oriented analysis of Club Nexus, an online community at Stanford University [24]; and the relationship between college students' use of social network (here Facebook), and their stock of social capital was explored [25].

Specific OSN were also studied in detail: MySpace [26]; Facebook [27], [28]; YouTube [29]; and Massively Multiplayer Online Games (MMOGs) [30].

Our work here shares some similarities, but still distinguishes itself from these studies. We seek to propose models of recurring requirements in OSNs, a topic which has less to do with the formal properties of graphs induced by user relationships. Also, we are interested in the reasons why people use OSNs, the activities they engage in, the user profile, and the privacy issue; but not in the sole goal of better understanding these matters. Instead we are interested in these OSN related concepts because they are useful in the RE phase. Indeed, the latter should thoroughly analyze the situation before and after the introduction of the system-to-be (here an OSN); hence the RE step should consider the reasons that motivate people to become an OSN member, it should consider their activities, the way they will present themselves, and the issues the users could meet while using the system.

III. Requirements Patterns for Online Social Networks

A. Recurring Features on Online Social Networks

In our prior work [31], we identified a set of features present in various well-known OSNs, including Facebook, Flickr, LinkedIn, MySpace, Pinterest, Twitter, Tumblr, and YouTube. We organized the features into Profile, Relationships, Content, Privacy, Goal, Recommendations, and Connection categories.

- *Profile*: The user profile is a means for the user to introduce and present herself to the other members of the network. Various types of information are necessary or can be communicated by the user on her profile:
  - Login information: email, and username
  - Identity: name, birthdate, address, profile picture
  - Occupation: school, job, etc.
  - Family
  - Beliefs: political and/or religious beliefs
  - Skills: languages, qualifications
  - Hobbies/Favorites: sports, culture, favorite movie, favorite quote, etc.
  - Else: *"About You"* space.
- *Relationship*: The relationship can be defined as the link between two users. The relationship can be *Unidirectional*, or *Bidirectional*:
  - Unidirectional: the relationship is unreciprocated. For instance, a user likes, or subscribes to a fan page; or follows another user.
  - Bidirectional: the relationship is reciprocated. A friend request is sent by a user to another user. The latter has to accept or deny the friend request. If she confirms it, then the relationship is created. Otherwise, no link exists between the two users.
- *Content*: Users can post, and share different types of content. Members of an OSN can share:
  - Text: a user can post strings of characters. It can be a status, a text, a note, a link to another webpage, quotes, etc.
  - Comment: a user can comment on his own post, or on another user's post. This post can be a photo, a status, a note, or any other kind of activity.
  - Like/Repost: a user can like or repost his own posts or another user's. This post can be a photo, a status, a note, or any other kind of activity.
  - Tag: a user can tag his own post or another user's. The tag can concern users on photos, videos, status. Or the tag can be used to document, and be able to identify a media.
  - Media: a user can post, comment, like a photo or video.
  - Message: a user can send a message to another user.
  - Groups: a user can create and join a group.
- *Privacy*: Users can decide what they want to share with the other users, with their friends, and what they want to keep private. Three degrees of privacy exist:

TABLE I
FEATURES OF ONLINE SOCIAL NETWORKS

Category	Features
Profile	Login, Identity, Occupation, Family, Beliefs, Skills, Hobbies, Else
Relationships	Unidirectional, Bidirectional
Content	Text, Comment, Like/Repost Tag, Media, Message, Groups
Privacy	Private, Semi-Public, Public
Goal	Network-Oriented, Knowledge-Sharing
Recommendations	Users, Public Figure, Content
Connection	Sign In, Share

  - Private: if a content or information is private, then only the given user has access to it
  - Semi-public: the user decides to share content and/or information with particular groups, or particular categories of users. This group can consist of his friends, friends of friends, groups of friends, etc.
  - Public: anyone has access to the posts shared by the user. It can be every member of the OSN, or even anyone visiting the OSN.
- *Goal*: Even if every social network is different, we can still classify them in one of two types of OSN: network-oriented OSN, and knowledge-sharing OSN [32]. The former type puts the emphasis on the relationships between users; while the latter focuses more on the content sharing [32].
- *Recommendation*: Based on the information shared by the users, as well as on the information inferred from it; OSN can provide recommendations to its members. These recommendations can be about:
  - Users: a user is recommended a list of people he may know.
  - Business/Public Figure: a user is recommended a list of businesses or celebrities he may like.
  - Content: a user is recommended photos, videos, social network groups he may like.
- *Connection to Other OSN*: A connection can be established between various social networks. The link between two different sites can exist for two distinct reasons:
  - Sign In: a user can sign in to a social network, using his account of another social network.
  - Share Content: a user can post simultaneously on various social networks.

This set of features is summarized in Table I

B. Modeling Patterns

1) Why i-star?: We chose to use *i-star* because this RE language allows the representation of stakeholders as actors and the dependencies between them and the OSN.

OSNs involve several actors: the user of an OSN, a friend of the user, a public figure she likes, the public, and the OSN. We are interested in modeling these actors and how they depend on each other to achieve goals, perform tasks, and to provide resources.

For our purpose here, we will not represent the Strategic Dependency (SD) model because we are interested in more details. Indeed, we identified generic OSN features, which are implementations that satisfy requirements; and now we want to model these requirements. The SR models proved more appropriate.

2) Requirements Patterns: We will start with the Profile features category. The user depends on the OSN to present herself to the other users of the social network. The OSN has thus the task to present the user, and will perform this task by achieving the goal Display the user profile (task-decomposition link). To achieve that goal, the OSN has to perform the following tasks: display the user identity, display her occupation, her family members, her skills, her hobbies, her beliefs, and her short presentation. This is represented by means-ends links. Also, to achieve its goal, the OSN depends on the user to provide a login and a password; as well as to share some personal information (represented by resource dependencies).

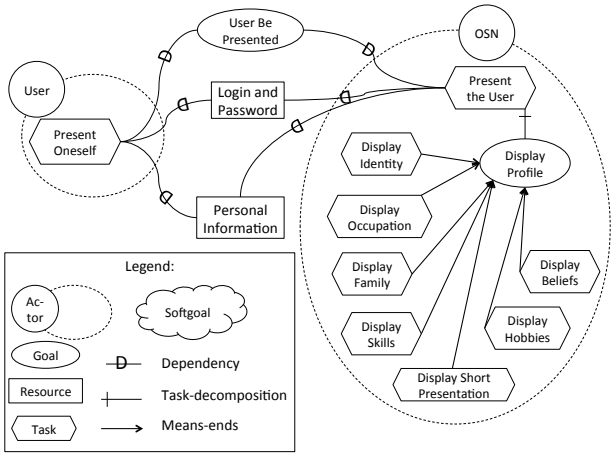

Fig. 1. Strategic Rationale Model for the Profile Features Category

We will now turn to the Relationships features category. The user depends on the OSN to link her with other users, and in doing so, satisfying a friend need (modeled as softgoal). The OSN has thus an internal task "Link Users". The latter is decomposed into two goals: Users be linked unidirectionally, and Users be linked Bidirectionally. For the former, the OSN has to link the user to a public figure page. The site depends thus on the given public figure to have an OSN account (resource dependency). For the latter, the OSN sends and receives a response to a friend request. The website depends on the user's friend to respond to the request. Also, the OSN depends on the user to provide the name of the public figure

or the friend she wants to be linked with.

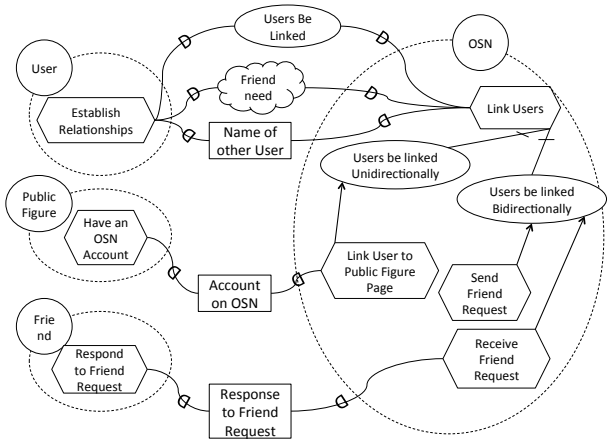

Fig. 2. Strategic Rationale Model for the Relationships Features Category

The Content features category SR Model is similar to the Profile's. The user depends on the OSN to share content with the other users of the social network, and to serve as an additional information source. The OSN has thus the task and corresponding goal of displaying the user content. To achieve that goal, the OSN has to perform the following tasks: display the user text, display her likes and reposts, her comments, her tags, her photos and videos, her messages, and the groups she created and/or joined. This is represented by means-ends links. Also, to achieve its goal, the OSN depends on the user to provide some content to share (represented by a resource dependency).

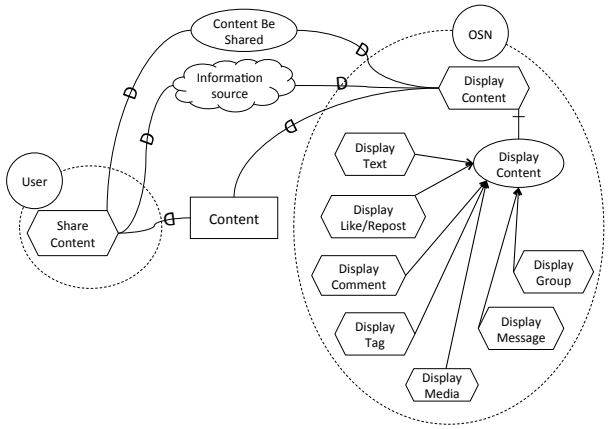

Fig. 3. Strategic Rationale Model for the Content Features Category

As far as the Privacy features category is concerned, four actors are taken into account, that is the User, the OSN, the Public, and the Friend. The user depends on the OSN to manage her privacy settings, and to provide her with a feeling of control over her data (modeled as a softgoal). This internal task is decomposed in three goals: "Set post to Private", "Set Post to Semi-Public", and "Set Post to Public". Those are achieved by the following tasks: Keep post private, display post to (a group of) friends, and display post to public , respectively (modeled as means-ends links). To perform the necessary tasks, the OSN depends on the user to provide the desired privacy level. Also, the public depends on the OSN to display public posts; and friends depend on the OSN to display semi-public posts.

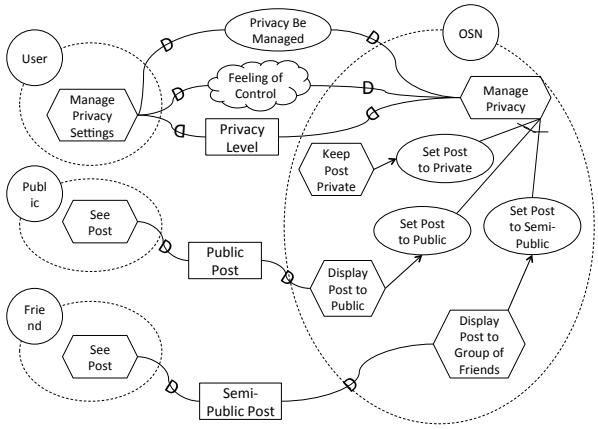

Fig. 4. Strategic Rationale Model for the Privacy Features Category

We will now turn to the Recommendation features category. The user depends on the OSN to get recommendations, and thus to enhance her experience. The OSN will perform this task by achieving the following goals: give user recommendations, give content recommendations, and give public figure recommendations. The OSN depends on the user to be active (modeled as resource dependency).

Finally, as far as the Connection features category is concerned, the user depends on the OSN to connect her various OSN accounts, and to enhance her experience. The OSN will perform this task by achieving the following goals: connect OSNs to sign in, and connect OSN to share post. The OSN depends on the user to have different OSN accounts (modeled as resource dependency).

IV. Discussion

The aim of this study was to propose a set of modeling patterns for each OSN features category. Indeed, requirements engineering is a crucial step in the design of any information system; and the RE phase for the development of OSNs has not been explored yet. Also, modeling patterns could have significant practical implications for the design of new OSNs.

We selected *i-star* for the modeling of the OSN requirements. From Fig. 1 to 6 in Section III, we can observe that this

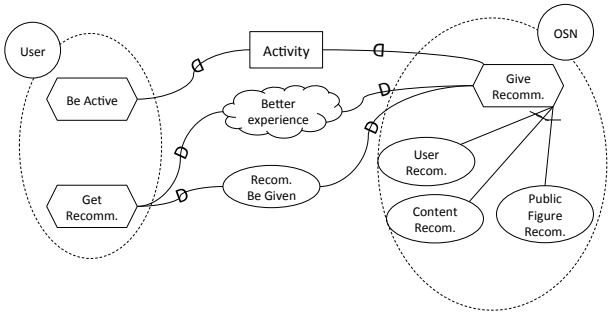

Fig. 5. Strategic Rationale Model for the Recommendation Features Category

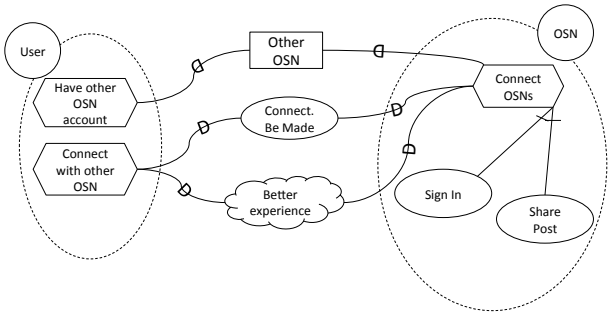

Fig. 6. Strategic Rationale Model for the Connection Features Category

RE language is appropriate for the modeling of OSN requirements. Indeed, we could represent each individual feature, by representing the internal goals and tasks of each stakeholder; as well as the relationships (dependencies) between them.

As a general rule, patterns offer some uniformity; and the development of new OSNs could be simplified and improved for designers. Specifically, the proposed modeling patterns can have those practical implications for the design of future OSNs. They can be used in the RE step of an OSN in order to, for instance, stimulate ideas during elicitation; to better understand, and explicitly state the elements that should be taken into account in RE for OSNs; to try to avoid the the pitfall of implicit requirements; to serve as a starting point for a requirements model of an OSN; to help check completeness of a requirements model for OSN; etc. The proposed patterns are generic enough so that they can be adapted to a particular environment. Yet, we believe we were also complete and managed to represent each feature in each category.

In order to evaluate and validate these modeling patterns, these should be used for the design of both types of OSNs (knowledge-sharing OSNs, and network-oriented OSNs); as well as for OSNs serving various purposes (for instance, a OSN for professional use; a dating service OSN, etc.). The results should then yield information regarding the strengths, the weaknesses, and the limitations of these proposed patterns.

V. Conclusion

Patterns are an important tool in the design of new information systems. If practitioners can use patterns on a systematic basis, the process of software development could be facilitated.

In this paper we proposed a set of modeling patterns for each feature of each category of OSN features. Firstly, in a previous work, we identified a set of features characterizing OSNs. These features are organized by category: Profile, Relationships, Content, Privacy, Recommendations, and Connection. These features are implementations satisfying the OSN requirements. Secondly, we modeled the features using *i-star*, an existing RE language. The resulting patterns are represented in Fig. 1 to 6 in Section III.

Finally, we discussed the results in Section IV.

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