Modeling Unified Interaction for Communication Service Integration

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***Abstract*—Social network inspired communication services has made tremendous success, allowing users to communicate and share user generated contents in an efficient way. At the same time, Tele-com services are becoming more open, which makes it possible to develop improved social networking services. One of the problem that needs to be addressed for developing such services is how to fetch useful social information and make it available for the services running in the Cloud or personalized devices. This paper presents a generalized On-line interaction model that collects useful information from well known social networking services, and transforms the information into unified interaction patterns, which can be utilized for social data propagation or for discovering communication patterns. Ultimately, this allows the applications to incorporate social data for enabling smarter functions. The proposed interaction model is useful for presenting information about callers or propagating presence information to the classical address book, prioritizing information, inviting user for forming micro-communities.**

Keywords-*interaction patterns; social networks; communication services; communication pattern discovery*

I. Introduction

Today, Internet and computers has become essential part of every-day life. More and more users are using Web based social networking and communication services to interact and sharing information about their life [1] [2] and [3]. This trend leads towards the success of today's social networking services (e.g., Facebook, Twitter, LinkedIn, MySpace, and so on). For example, today Facebook has more the 500 million active users, and this number is increasing rapidly everyday.

At the same time as communication services has become an essential element of everyday life, the mobile handset industry is experiencing a paradigm shift towards open and more powerful mobile platforms [4]. These new open platforms are mainly driven by Internet companies such as Google and Apple that want to provide a rich Web experience anytime and anywhere, while reaching even more users. Ultimately, by providing a one-click-away Web experience users can better control their digital life and easier upload information at the point of inspiration, making today's Web services even stronger.

DISCLAIMER: The work has been carried out as part of an academic research project and does not necessarily represent Ericsson views and positions.

While the technological revolution toward open and powerful mobile platforms opens up for new types of pervasive services, it also opens up for the possibility to enrich classical mobile applications with social information [4] [5]. For example, classical address book in mobile phones may updated automatically with information obtained from social networks, image hosting services, Web forums, etc. Another example could be communication services that automatically determine where the users are located by analyzing status updates obtained from sensors and social networks, and then set up dynamic groups [6]. Implementation of such customized mobile applications, has been restricted for a long time by the device manufacturers and operators, but now it is possible to the developers to innovate new applications for the mobile devices.

Considering the huge amount of social data that is available on the web and the multitude of On-line communities adopted by the users, it is still a difficult task to extract useful social information and integrate it with the applications [7]. For example, some users might be using Twitter while other users might be using Orcut or Facebook, which makes it difficult to provide an unified solution that fits all users. Social data can also be differently formatted, and contain different type of information, or including conflicting information [8]. Therefore, there is a need for a software component that can automatically extract information from various social networking services and then summarize it in a machine interpretable format.

The ultimate goal of this paper is to enable communication services to be completely integrated with third party applications (i.e., mobile phone software or applications). As a step towards this goal, the paper addresses the problem of how to collect data from different communication services and get valuable information about users and platforms. Another problem addressed in the paper is how to transform the collected data into a machine interpretable format in an unified manner that can be consumed by the application developers. This problem can be described by the following scenario.

Peter has different contacts in different pervasive services. Some of them are friends, some other are colleagues, and some other may have similar interests and so on. For example, he has different friends in Facebook, Twitter, or in mobile phone's contact application. Peter uses a service to associate his social contacts. Due to tremendous information flow from all his

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pervasive services, he wants to have assistance to prioritize his contacts and filter information/content overload based on social strength and context. He expects to have a service which keep track of all his interactions and automatically prioritize contacts based on social strength. The service collects Peter's social interactions based on his preferences and contexts and infers that information for social ranking, dynamic grouping or recommending contacts.

To face the challenges expressed above, we investigated the following research questions:

- How can on-line interaction be modeled in a uniform way to enable identification of users' individual communication pattern?

The paper is organized as follow: Section 2 discusses related work, Section 3 provides an On-line interaction model, Section 4 presents an early evaluation and Section 5 provides a discussion together with future work.

II. Related Works

A. Communication Services in Context of Social Networking

In communication services, social context opens new challenges and possibilities to design mobile applications with more intelligent functioning [9]. Although, adding social context increases security and privacy risks, but it also increases social interaction and collaboration in the Web [10] [11]. Andrew T. et.al, proposed "CenceMe" system, which is able to propagate user's presence status using the mobile sensors automatically to social networks [12]. Comparing with such system, the proposed approach is managing user presence information by aggregating presence information from different social networks and exposes this information to the social graph in an unified manner. Communication in CenceMe system is single-user basis (i.e., owner of the mobile device), while communication in our system is multi-user basis as the system is being able to collect status information for the contact lists.

B. Dynamic Group Discovery

The proposed work is not focusing dynamic group discovery, yet the solution can be associated in discovering dynamic group. Dynamic group can be formed based on social data in the Web contents as well as data generated by pervasive services [13] [6] and [14]. Zin Li et al., proposed social interest discovery mechanism based on user-generated tags [14] [15]. In that approach, user tags are considered as main data for discovering groups. To simplify such approach, proposed solution provides an unified data model for representing On-line interactions associating user's current context. Therefore, by using the data model, the dynamic group discovery can be simplified in large scale. In the proposed solution, collected data is aggregated and represented as MXML based data set to which provides a machine readable view of the data set for the third party applications.

C. Social Data Collection

Social Web API's are not enough to collect social data for analysis from social networking services due to lack of standardization, data formats, and user-understandable data model and access policies. It needs some form of format to continue analysis smoothly [16]. Although, there is a proposal for open social specification but the commercial social network owner has very little adherence to that specification. To analyzing social data, there are also dependencies on social network owners [17]. Consequently, collecting social data in a simple and efficient way is a research challenge.

D. Social Data Aggregation

Use of semantic Web in social networking perspective is very promising [18] [19]. Sharing social data in the Web benefits the users for connecting, communicating and managing relationship automated and efficient ways. FOAF ontology is well-recognized to represent relationship of people in the Web [20]. But, the specification is not generalized enough for automatic mapping (from user perspective) of different kinds of Social Networks to discover relationship. In the current applications, FOAF is used to specify people relationships in terms of community. But there is need of a mapping which may map or collect social data from different social networks in semantically meaningful way. Therefore, the proposed service also contains a FOAF engine which is being able to interpret generic social data in FOAF data set and map among different social data sources.
The main contribution in this paper are (1) a generalized and simplified model for on-line interactions to generate most of the interaction using on-line communication tools, (2) possible communication patterns discovered using process mining tools, and (3) a study that evaluates social strength from multiple perspectives. Social strength is discussed in [21].

III. Modeling On-line Interaction

On-line communication is mostly driven by different form of interactions (e.g., Email, SMS, Face-booking, Twittering).These interactions are instrumented by different kind of technological support and forms actionable tools for communication. In the paper, interaction models for on-line interactions provides the way of transforming different form of interactions in a unified format. Unified form of interaction is necessary for processing and analyzing the social data. Figure 1 depicts three main stages of modeling and generating on-line interactions. Generation of on-line interaction is important to support ASG framework by providing tremendous interactions logs. Consequently, it provides a uniform way of representing on-line interactions. For the analysis of communication history for generating social strength, a uniform representation of interaction is very important, because it provides a systematic way of creating data-sets of interaction logs in a unified manner (i.e., interactions from different sources are unified in a single data-source). The first stage is an interaction life cycle where each interaction is initiated by a user of

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the communication service towards a contact or a group of contacts of the same or different services. The interaction pattern model is also designed to represent flow of activities in interactions. Format of interaction logs are discussed for capturing interactions from different sources for monitoring and analyzing communication history. Details of each of these steps are given below.

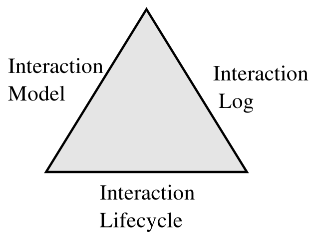

Fig. 1. On-line Interaction Building Blocks

A. Interaction Life-cycle

Figure 2 depicts the interaction life-cycle. The model simply generates one-to-one interaction, one-to-many interactions or bi-directional interactions which form conversation. To segregate conversations from interaction logs, co-relation among interactions need to be discovered. Due to simplicity, interaction is considered as a unique communication unit by ignoring conversations. This simplifies the counting of the usage of communication tools from communication history by providing a straight forward way. The interaction is initiated by the user of the service through a service client (e.g., Facebook's iPhone application). The service might be able to capture location data (with sensor's associated with application carrier) and time for instance to propagate the content (e.g., picture) via communication platform (e.g., Facebook) using a particular tool (e.g., Facebook/Photo-share). In addition, other examples are SMS, MMS, phone call, audio file sharing application, video sharing application, commenting, social tagging, tweets, or re-tweet, etc.

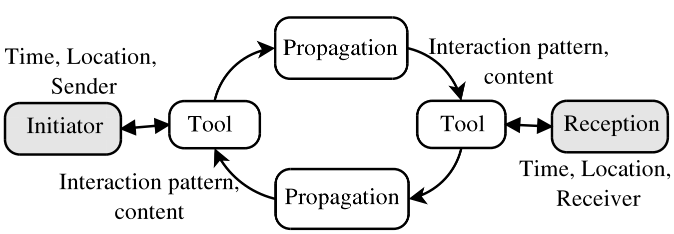

Fig. 2. On-line Interaction Life-cycle

B. Interaction Patterns

Interaction patterns provides the main steps to accomplish an interaction (e.g., initiation, tool selection, propagation, reception, etc) and may differ from platform to platform and on selection of tools. Some interactions are unidirectional which never return reply or response. On the other hand, some interactions implicitly need confirmation for inviting colleagues to participate in meeting. For example, public tweet and @receiver communication tools of Twitter application are quite different. Public tweets are initiated for a group of users while @receiver is for a particular user and it might form as a conversation at the end[22]. And eventually, it becomes more different in comparison with different tools of different communication services for instance, in Facebook and Twitter. Thus, to the aim of discovering communication patterns, we propose simplified on-line interaction patterns which comply with interaction life-cycle, vice-versa able to represent most of the communication tools by this. Figure

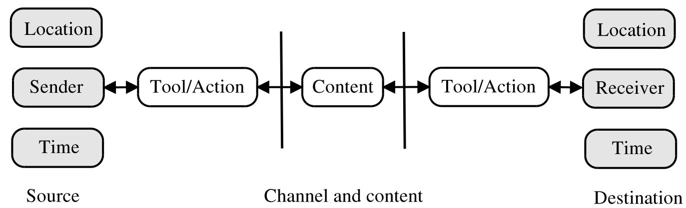

Fig. 3. Interaction pattern.

3 show communication pattern models which can be easily interpreted to form Twitter message and Facebook message. The pattern could be also used for interpreting phone calls, SMS and MMS. Interaction patterns tell the users about their communication habit. Therefore, it is important to identify communication patterns discovered from interaction logs for the recommending better communication tools and services to the specific users.

C. Interaction Log

Interaction logs contain communication history of the individuals. Table 1 shows the simple view of the interaction logs. Here we mention the basic properties/features for forming interactions. The table contains only interactions. For example, if a user replies to a corresponding message, the system considers the follow up replies as a unique interaction. Here, the sender contains information of message initiator, time and location. Action is name of the tools (SMS), platform can be Facebook or Twitter, and receiver contains the information of receiver, time and location. From Table 1, it is easier to measure frequency of interactions, platforms which helps to measure social strength.

D. Overview of the System Architecture

The proposed interaction model can be applied in the traditional aggregator services for simplifying analysis of social data. In general, aggregator services are responsible for collecting interactions from different communication services. To analyze these interactions, the aggregator services have to rely on some unified format. The proposed model is used to representation all the interactions in unified format. Figure 4 depicts overall system architecture where the proposed interaction model can be easily deployed. In the figure, different communication services are connected with the social data

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TABLE I
SAMPLE INTERACTION LOGS

Sender	Tool	Platform	Tool	Receiver
Kare:Time:Lulea	SMS	Telecom operator	Reply	Peter:Time:Stockholm
Johan:Time:Lulea	Phone call	Telecom operator	Receive	Peter:Time:Stockholm
Josef:Time:Lulea	Tweet	Twitter Web Application	Reply	Peter:Time:Sttorckholm
Juwel:Time:Stockholm	SMS	Telecom operator	Reply	Peter:Time:Stockholm

aggregator service. The aggregator service interprets all the collected interactions in the unified format. The social network miner uses the unified datasets to analyze interaction for mining communication patterns or supporting other third party services. Finally, client applications can be designed to get various services from pervasive service miner.

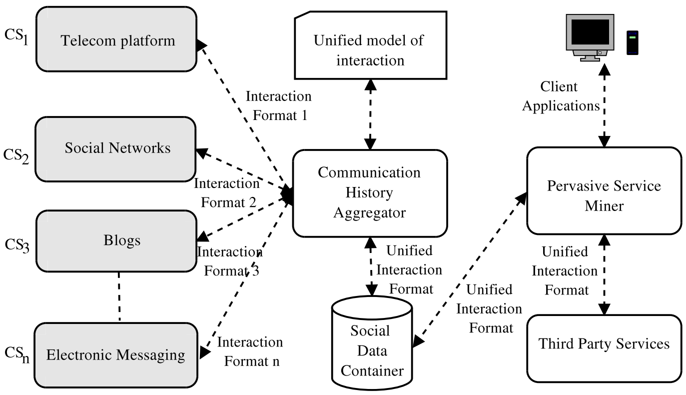


Fig. 4. System Architecture

IV. EVALUATION

A. Experimental Data Collection

An experiment was set-up to evaluate the interaction model. In the experiment, an interaction simulator is implemented to generate data-sets randomly. The simulator follows Weibull distribution to generate realistic interactions. Although there are Web-APIs (e.g., Facebook API) available for accessing real interaction data, but most of the cases, they are protected by strict privacy policy and user-specific authentication key [23]. Therefore, to run the experiment with fair amount of social data, a large number of user's interactions in different services are needed. However, these amount data could be managed by the communication services owner via publicly accessible interface. In practice, both of these options are not feasible to build the data-set considering the fact of privacy policy. Therefore, the pre-generated interaction data-set is used to run the experiment. For communication pattern mining purposes, these interactions are transformed to MXML form to make it machine readable [24]. Moreover, all these interactions are generated on the basis of proposed interaction model. Table 1, represents sample data which forms frequency log.

B. Implementation

Figure 5 depicts the ASG Powered Twitter Client for the Android Operating Systems mobile devices. The application is implemented for accessing the interaction data. The application shows how different kind of groups can be formed with social strength of relationship (high, medium or low strength), preferences and contexts. Therefore, information overload can be controlled by offering presence information in different groups based on social strength. In the current prototype, it is possible to generate dynamic group by aggregating presence information from different communication services, where the interaction model helps to represent the presence information in an unified view.

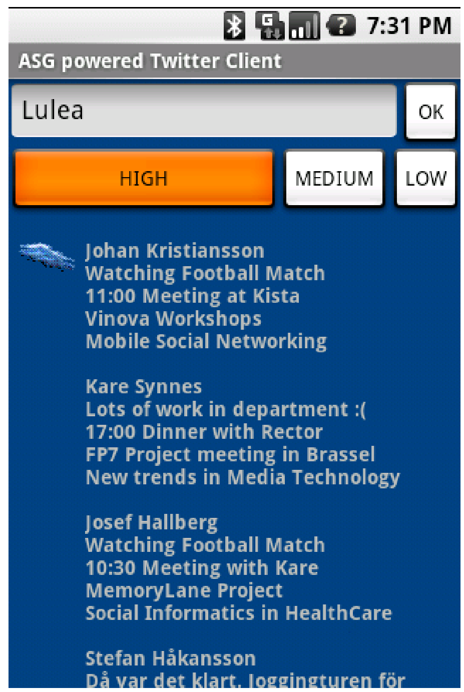


Fig. 5. Prototype of ASG Powered Twitter Client

C. Experiments using PROM process mining tool

The unified interaction model simplifies social data processing and analysis. For instance, using a process mining tool called PROM [24], the proposed model provides good result for discovering communication patterns. In PROM, each interaction in the interaction log is considered as a process instance in MXML form. The process is considered as all of the possible communication path. The experiment is run to discover communication pattern of the user from the process instance.

In PROM, MXML formed interaction logs are used to discover communication pattern. An example of MXML

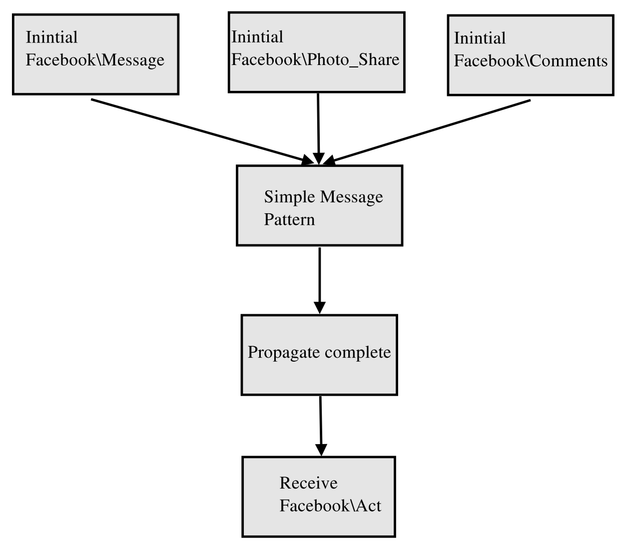
based interaction logs is illustrated in Figure 6, which contains three events. Each event represents a process instance. In the first instance, the user Juwel sent a Facebook message from the location Gotenberg at time 2009-1-1-T0:0:10 to his contact Johan. Johan received the message at location Lund in time-period 2009-1-1-30.
The process work-flow miner module of the PROM tool is used to discover user communication patterns. The tool is capable to illustrate the discovered communication patterns analyzing interaction logs. This technique helps to automatically initiate new interaction towards the user in his/her preferable communication tool discovered using PROM. Referring back to Peter scenario mentioned in Section 1, where he wants to know his communication patterns towards all his contacts, now he is able to view a set of communication patterns using his previous communication history.

```
<ProcessInstance>
  <AuditTrailEntry>
    <WorkflowModelElement>Initiate
    </WorkflowModelElement>
    <EventType >Facebook\Message
    </EventType>
    <Timestamp>1900-1-1T:0:0:10
    </Timestamp>
    <Originator>Juwel</Originator>
    <Location>Gotenberg</Location>
  </AuditTrailEntry>
  <AuditTrailEntry>
    <WorkflowModelElement>Propagate
    </WorkflowModelElement>
    <EventType >complete
    </EventType>
    <Timestamp>1900-1-1T:0:0:20
    </Timestamp>
    <Originator>Facebook</Originator>
  </AuditTrailEntry>
  <AuditTrailEntry>
    <WorkflowModelElement>Receive
    </WorkflowModelElement>
    <EventType >Facebook/ACT</EventType>
    <Timestamp>1900-1-1T:0:0:30
    </Timestamp>
    <Originator>Johan</Originator>
    <Location>Lund</Location>
  </AuditTrailEntry>
</ProcessInstance>
```

Fig. 6. Process Instances in MXML format

D. Results

One of the main contributions of this paper is to provide a new simplified approach of Web data aggregation, representation and analysis for discovering communication patterns or measuring social strength. However, collecting Web data can be easily tackled by using vendor specific Web-APIs while the real challenge still remain in merging such data for forming an aggregated social data-set, which can be used for mining and analysis purposes. To be able to accomplish this challenge, this paper contributed a generalized interaction model to capture all social data in a unified format. To test the interaction model, different type of interactions from different communication sources are interpreted in MXML format. The interaction model is able to discover user-specific communication patterns (tested in PROM tools). To reach that result, different test operations were done on different MXML files with different number of interaction instances and found that, all identical patterns are discovered. Therefore, the on-line interaction model performs significantly well in generalizing on-line interactions and discovering identical communication patterns. Figure 7 elicits a discovered communication pattern using PROM process mining tool. Here, the user uses Facebook Messaging, Photo-sharing and Photo-commenting tools for communication purposes.



(a)

Fig. 7. Discovered Interaction Patterns

V. DISCUSSION

Analysis of on-line social interaction is one of the key elements of measuring social strength [1] [2] and [8]. Therefore, a generalized model is very important to represent on-line interaction. The proposed mode is able to aggregating interactions generated by different communication and social networking services and represents those in a unified format for further analysis and data mining purposes. For instance, the model is quite effective discovering communication patterns. In the previous section, the MXML form of interactions is evaluated for discovering communication patterns. However, considering only on-line interactions limit the reliability as large portion of daily interactions (driven by face-to-face) in the physical world which are not detected by the system. Therefore, there need to be some tools to fetch physical world communication. We consider this as a challenging problem, which remain as future work. Another limitation of the work is that the experiment is run based on emulated social data with the assumption that social data are fetched from the cloud (i.e., contact lists and interaction logs). However, the proposed interaction model is able to interpret most of the interactions in the social media, for example in Facebook, Twitter and even interactions using Mobile phones.

VI. CONCLUSIONS

Due to immersive growth of Web-based communication services, there is an emergent need of integrating communication services by user-specific social data (i.e., social strength) to predict user's preferences and to filter information-overloads (i.e., micro-blogs, news feed, etc). The proposed on-line interaction model provides a simpler way of aggregating on-line interactions from large number of communication services in a unified manner. Initial prototype infers that the model is useful to work in the real-life, although there are some challenges (e.g., capturing real-world interactions, preserving user privacy) need to be addressed before the practical use of such model.

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