Exploiting Social Context Information in Context-Aware Mobile Tourism Guides

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Abstract. The social dimension of tourism is very important, because people often enjoy sightseeing in groups and involving their social network's members in some tourist activities, such as sharing photos or buying a souvenir. Thus social context information can be very relevant for context-aware mobile tourism guides, i.e. applications assisting tourists on the move, exploiting available knowledge about the situation of the tourists themselves. In this paper we share our views on the topics of formal representation, interpretation and exploitation of social context information in these applications.

Keywords: Context-Aware Mobile Tourist Guides, Context Interpretation, FOAF, Social Networks, Context-Aware Recommender Systems.

1 Introduction

Mobile tourism guides are applications designed for assisting tourists on the move during their travels, typically providing map services, giving recommendations about points of interest, helping planning personalized tours, and so on, running on mobile devices such as smartphones or PDAs. The mobile nature of these application has recently led to the proposal of a number of context-aware mobile tourism guides [1]. These guides exploit available knowledge about the situation of the user (i.e., the context) adapting their functionalities in order to better serve the user's needs, e.g. to produce more focused and useful recommendations.

Most considered context dimensions include physical location, time, mobile device capabilities, user preferences and network availability and capabilities. Social context information, i.e. the relationships existing among a group of tourists, is seldom taken into account. The social dimension of tourism, however, is very important, because people often enjoy tourist activities in groups. Moreover, some tourist activities, like sharing photos or buying a souvenir for someone, involve both people actually being at the tourist location and people not being there, but sharing a social relationship with the tourists.

Mobile applications are a very good source of social context data, coming in the form of address books, buddy lists and agendas; mobile devices such as smartphones and PDAs and their software are designed for fast and easy user interaction with these data. Moreover, location technologies increasingly available in mobile platforms and devices (e.g. GPS, GSM cell-based location, WI-Fi, Bluetooth, RFIDs) can detect the peers in the vicinity of a tourist and match/filter them on the social network data available to the mobile environment, allowing on-the-fly group recognition.

Thus for example, in one of many possible scenarios, a member of a tourist group can ask his mobile context-aware tourist guide for recommendations about nearby points of interests, telling it that the group context is to be considered. The guide initially brings together a list of the members of the group, either detecting them via location services, or by address book entry selection by the tourist. Then the guide provides a set of recommended points of interest, taking into account the group context: the recommendation could be tailored to the recognized overall group type (e.g. "family", "friends", "couple", "total strangers", etc.), and/or tailored to the (more or less) common interests of the group's members.

In another scenario, a tourist can ask his mobile tourist guide for suggestions about a gift to buy in a tourist location, selecting from a buddy list the person who will receive the gift. The guide gives then recommendations of gifts and shops where to buy them, taking into account the relationship between the tourist and the gift receiver (e.g. "girlfriend/boyfriend", "parent", "friend", etc.).

In the present paper we share our views on the topics of representing, interpreting and exploiting available social context information in context-aware mobile tourism guides.

2 FOAF for Social Context Representation

Friend Of A Friend (FOAF[1]) is a popular ontology for the representation of personal profile information and social relationships among groups of peers. Built on the Resource Description Framework (RDF[2]) Semantic Web language, FOAF gives a representation of a social relationship network as a graph structure, where people connected to each other by a given relationship are represented as graph nodes connected by edges. Personal profile information is also represented by RDF subgraphs connected to people nodes.

The main strengths of the FOAF ontology, stemming from its RDF/Semantic Web nature, are simplicity and extensibility. In fact, the basic FOAF vocabulary specification intentionally provides a limited set of properties for representing profile information and only one property (the generic property "knows") for representing social relationship information. Starting with this FOAF core vocabulary, virtually any RDF vocabulary can be embedded in FOAF extending its profile representation capabilities, while the social network representation capabilities can be extended by specializing the "knows" property with increasingly expressive social relationship subproperties. In fact, recently the FOAF community made a number of proposal for extending FOAF with specialized vocabularies (e.g. [2]) and social relationship

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[1] FOAF Vocabulary Specification, Namespace Document, 27 July 2005, http://xmlns.com/foaf/0.1/

[2] RDF Vocabulary Description Language 1.0: RDF Schema, W3C Recommendation, 10 February 2004, http://www.w3.org/TR/rdf-schema/

vocabularies (e.g. [3]). In the present paper, discussing FOAF, we will refer preferably to an extended FOAF ontology.

Given a tourist activity, its social context can be represented as a FOAF document, describing personal profiles and social relationships for the group of people involved in the activity itself. We will not address here the problem of retrieving and composing such a FOAF document (Monaghan et al. give in [4] an example of FOAF document retrieval). We simply assume that, given a tourist situation, a FOAF description of the social context of the participants is available to the mobile tourist guide application.

3 Social Context Interpretation and Exploitation

In order to obtain a level of description of the social context useful for adaptation purposes in a tourist guide, its FOAF graph representation needs to be augmented and enriched. In other words, it's necessary to move from the low-level, implicit information encoded in the graph towards higher-level, qualitative and more semantically informative social context representations (in context-awareness methodologies, this step is usually called *context interpretation*, or *context inference*).

Examples of high-level patterns typologies that can be extracted and summarized from the FOAF low-level representation are:

- A qualitative categorization of the overall social situation of a group (referred or not to a given person's point of view). For example, a tourist situation can be given the category "with family", "with friends", "with colleagues", “with total strangers”, depending on the existing social relationships within the tourist group.

- A characterization of the relationship subgroups possibly existing within the larger tourist group. For example, a tourist group can be characterized as a "group of families", a "group of couples", a "group of coworker teams", etc.

- A characterization of the "virtual" subgroups possibly existing within the larger tourist group. For example, in a group of families, the subgroups of the adults and the subgroup of the children; a subgroup sharing common cultural or gastronomical interests; etc.

- Arbitrary social patterns recognizable in the FOAF social context representation, being of some usefulness for adaptation purposes. For example, "A person living in the current tourist location, wanting to sightseeing with a group of his friends from a foreign country"; "A person looking for a gift for his best friend"; “A grandparent with her/his grandchildren”; etc.

These high-level descriptions and patterns can be obtained from the low-level FOAF representation using a wide range of inference techniques, such as:

- Rule-based inference and ontology-based inference, leveraging the formal nature of a FOAF document as a graph built on formal RDF vocabularies. For example, in [5] Luther et al. use an OWL version of FOAF and OWL-DL reasoning methods to enrich group descriptions with qualitative categorizations of the social situation. For another example, in [6] Jie et al. present a RuleML version of FOAF allowing rule-based reasoning and inference on social networks.

- Statistical reasoning, especially for identifying "virtual" subgroups existing within the tourist group. For example, in [7] Ardissono et al. use group stereotypical modeling and statistical analysis to characterize tourist subgroups. Cluster analysis methods can also prove useful when addressing the problem of (semi-)automatically find suitable subgroups.

- Graph matching algorithms, including RDF query languages, for matching specific pre-defined social network patterns in the FOAF graph. For example, the SPARQL[3] query language for RDF can be used to find pre-defined FOAF patterns.

- Data mining algorithms, enabling the automatic discovery of frequent social network patterns in the FOAF graph. These discovered patterns are not designed or pre-defined, like the majority of the patterns recognized or generated by the previously listed inference techniques. Instead, given a data set composed by a number of FOAF graphs, each representing a different social context situation, data mining analysis can identify recurrent, emerging patterns, potentially representing some important aspect of a social situation. Grimnes et al. give in [8] an example of data mining analysis on FOAF graphs. The advantage of mined patterns is that they can potentially represent novel social context features, missed by human designers. On the other hand, because they are automatically generated, there's the need of performing some kind of validation on them, either by human inspection (in a semi-automatic approach) or by fully automated validation procedures (e.g. a procedure checking whether the use of a given novel mined pattern can statistically improve the performance of a recommendation task).

Once derived, high-level social context descriptions and patterns can be made available to the mobile tourist guide application, becoming new context dimensions on which adaptation of the guide's functionalities can be performed. The formal representation of these patterns in the application could also be FOAF-based, or could be expressed in other semantic languages than RDF, like OWL or RuleML, and formalized into a different ontology than FOAF. Semantic representation of the derived social context patterns it's substantially more difficult to obtain for data-mined patterns, because they are automatically generated and often their semantics are not known in advance.

Restricting our considerations to the recommendation functionalities present in nearly all mobile tourist guides, social context dimensions can prove themselves useful in many ways, such as:

- In the case that "virtual subgroups" are recognized in a tourist group (for example common interest or similar age subgroups), the recommendation about items of interest can be customized for each subgroup, for example actually producing several distinct recommendations, each tailored to the needs of a distinct subgroup. Ardissono et al. use this approach in [7].

- More generally, if the recommendation functionality of the mobile tourist guide is based on a context-aware recommender, i.e. a recommender that makes use of context information in order to suggest items of interest, then the social context dimensions can provide a relevant input, to be exploited together with other context dimensions. For example, a context-aware recommender based on CBR (Case Based Reasoning) methods, using the similarity between contexts, could suggest to a given tourist group attractions highly rated by other tourist groups being in similar social situations.

[3] SPARQL Query Language for RDF, W3C Candidate Recommendation 6 April 2006, http://www.w3.org/TR/rdf-sparql-query/

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