Using Common Sense in Providing Personalized Recommendations in the Tourism Domain

B. De Carolis, I. Mazzotta, N. Novielli and V. Silvestri
Intelligent Interfaces Research Group
Dipartimento di Informatica, University of Bari
Via Orabona, 4 – 70125 Bari - Italy

{decarolis,mazzotta,novielli,silvestri}@di.uniba.it

ABSTRACT

Most of mobile tourism recommender systems take into account mainly the users preferences and location when providing personalized suggestions about what to see in the area (either reactively or proactively). MyMap is a mobile recommender system able to provide personalized presentation of objects of interest in the Tourism Domain that exploits two main knowledge sources: the user profile, that is formalized in order to express situational statements and the current context. In our evaluation experiments we discovered that MyMap suggestions missed of common sense knowledge. For instance: if it is raining recommendations about open-air places should be avoided even if the user strongly prefers these kind of places and has not expressed any preference about alternatives. In this paper, we will illustrate how this functionality has been added to the system and we present the first results of the application of common sense knowledge to the recommendation engine of MyMap.

Keywords

Mobile systems, personalization, common sense.

1. INTRODUCTION

In mobile recommendation systems contextual features are used for better adapting and filtering information by exploiting available knowledge about the situation of the user to produce more focused and useful recommendations [2,10].

A very important application domain for mobile recommender systems is represented by Tourism [4]. Many of the systems developed in this domain employ context features such as the user physical location, time, device capabilities and user preferences for personalizing items to recommend [1,6,12,13,18,20].

MyMap is a mobile system that provides personalized recommendations of places of interests and delivers targeted information to tourists both proactively and on-request according to the *situational interests* of the user. MyMap [9] provides personalized suggestions and comparative descriptions about what to see, starting from domain knowledge and using a ***Mobile User Profiles*** (MUP) for managing situational user preferences, a media-independent content planner and a context-sensitive surface generator.

Besides the user's situation, that can be in part explicitly input by the user at the beginning of the session and partially inferred by the system (i.e. reason of travel is usually inserted by the user while the season is derived by the system looking at the date), MyMap uses some contextual parameters that allow personalizing recommendations dynamically, as relevant features may change during interaction. In particular, context features are related to the user (i.e.: location, activity, emotional state, etc.) and to the environment in which the user is moving (spatial information, date and time, weather conditions, noise and light level, temperature, availability of resources, etc.).

In this paper we present how the context-awareness of MyMap has been improved by taking into account these factors and the possible problems that may arise from the incompleteness of the representation of situational interests. In fact, in one of the experiments that we conducted for evaluating the system, we noticed that MyMap suggestions missed of what may be called *common sense* and of information related to exceptional situations that could make useless the suggestion and thus decreasing users' trust towards the system.

This was due to the fact that MyMap, when suggesting items, maps the situation, the situational preferences of the users and the metadata descriptions associated to places of interest present in the map. In fact, if in the user profile there isn't a complete description of the situation, in terms of contextual factors to be taken into account, some recommendations could result inappropriate. For instance: if in the user profile there is an evidence (acquired implicitly or explicitly) that user prefers to eat outside in the summer, the system will recommend to the user places having in their description the possibility to eat outside in the summer. However, since in the profile it is not explicitly formalized "when it is not raining", the system will recommend open-air places also in this situation. Another case in which the system would not provide proper recommendations regards the fact that a place, that is usually open, is temporary closed or not accessible for extraordinary reasons (i.e. a church that is usually open is temporary inaccessible because of private ceremony).

According to these findings we could consider two approaches for addressing this issue:

1) Giving to the MUP Manager module, when profiling the user, the capability of adding to each inference on user preferences the necessary common sense knowledge: this solution works well in situation regarding weather conditions but it seems not appropriate for dealing with exceptional events or for temporal reasoning.

2) Providing MyMap with common sense knowledge that allows implementing a context-aware capability that does not depend

only on the situation related to preferences as in the previous prototype of the system.

At this stage of the project, we decided to adopt this second approach. Therefore we defined a set of common sense rules that allows to the system, according to the type of object of interest or to some of its properties, to check some contextual factors (i.e. by invoking an internal or external services) relevant for triggering common sense rules and to apply the most appropriate filtering strategy. Moreover, being MyMap a system that uses Natural Language Generation (NLG) techniques for generating explanations, when a common sense rule is applied then an explanation about why certain places were temporary unavailable or not recommended, although they match user preferences, could be provided.

The paper is structured as follows: after a brief explanation of MyMap system that is important to understand how the recommendation process has been implemented, we focus on the description of how common sense rules have been used for providing personalized and context-aware recommendations of places of interest. Conclusions and future work directions are discussed in the last Section.

2. OVERVIEW OF MYMAP

MyMap, as other mobile systems in the domain of tourism, is based on the idea of using a map for outlining information about places of interests in a particular town. The user at the beginning of the consultation may describe her situation by answering to simple questions concerning the "reason of travel", "preferred activities in certain time slices", etc. Some other parameters about the situation are derived, for instance the current season may be derived from the date.

During its use, MyMap may provide suggestions and information about places either proactively, in presence of interesting objects, events, and so on, and according to context parameters such as the user position and time and to the described situation or on-request. When explicitly requesting information, the user may ask for a specific category of places and may provide further details on her situation. In both cases, in order to generate descriptions and provide targeted information about places of interest, the map has been annotated so as to define a correspondence between its graphical objects and metadata to be used by the system for generating the recommendation.

To build these metadata we asked to human experts in the tourism domain to annotate the objects in the map by inserting all the relevant features that they reputed useful for selecting items and generating descriptions. For this reasons we use a graphical tool (Inote [14]) that provides a way of annotating images in a user-friendly way.

Then, in the recommendation process applied in MyMap, the objects of interest are described as follows: a *map region* has some "General Properties" that identify it: the name of the town, the described area, its coordinates, and so on. In this region it is possible to identify some areas of interest denoted as *overlays*. The main information content of each overlay then consists in a list of *details* that correspond to the category of places of interest (eating places, art, nature, and so on). Each place of interest is described by a set of *attributes*. Each attribute is denoted as "annotation" whose value is described by the "text" tag. When an attribute has an associated description, the value of the "text" tag

is set to *reference*, in this way it is possible to generate a link to its description.

In Table 1 an example of annotation describing a restaurant named *Citta' Vecchia* is reported. This is a typical restaurant with the possibility of eating outside only, having a nice view on the historical center, accessible by wheelchairs and so on.

Table 1. A fragment of metadata describing a restaurant.

```
<overlay><title>bari-zone1</title>
<detail><title>eating</title>
    <annotation><title>eating_type</title>
    <text>restaurant</text> </annotation>
    <annotation><title>name</title>
    <text>Città Vecchia</text> </annotation>
    <annotation><title>coordinates</title>
    <text>41°06'14.800"N 16°45'57.013"E</text>
    </annotation>
    <annotation><title>food-type</title>
    <text>typical</text> </annotation>
    <annotation><title>view</title>
    <text>historical center</text></annotation>
    <annotation><title>table</title>
    <text>open-air</text></annotation>
    <annotation><title>timetable</title>
    <text>12.00-22.00</text></annotation>
    <annotation><title>closed</title>
    <text>Monday</text></annotation>
    <annotation><title>wheelchair accessibility</title>
    <text>yes </text></annotation>
        …
</detail>…
</overlay>
```

MyMap decides which information to provide and how to present it (see [6] for more details), starting from an XML representation of domain knowledge. To this aim the system uses two components: the **Mobile User Profile** (MUP) Manager and the **Information Selection and Presentation** module. These components, given a metadata representation of a map, cooperate in establishing which information to present and how to structure the presentation according to the "user in context" features.

The MUP Manager uses profiles formalized according to the *UbisWorld* language [21] that allows expressing context-dependent interests and preferences (i.e. "I like eating local food when I'm abroad" or "I like eating outside in the summer").

These statements represent knowledge about users' situational preferences that could be inferred by a personal agent [8] that logs situational data by observing the user and/or extracts these data from the cloud and mines this log in order to extract situational knowledge [5].

Table 2 represents a simple fragment of the MUP of a tourist named Dora who in the summer prefers to eat outside.

Table 2. A fragment of MUP.

```
<Statement id="16">
<content> <subject><UbisWorld:Dora /></subject>
<predicate><UserOL:eating</predicate>
<predicate-range><UserOL: restaurant,fast-food,pizzeria/>
</predicate-range><object>restaurant</object>
<predicate><UserOL:table/></predicate>
<predicate-range><UserOL:open-air,inside…./>
</predicate-range><object>open-air</object>
</content>
<restriction><season>summer</season></restriction>
<meta>
<owner><UbisWorld:Dora /></owner>
<privacy><UbisWorld:friends /></privacy>
<purpose><UbisWorld:commercial /></purpose>
<retention><UbisWorld:short /></retention>
<viewer><UbisWorld:MyMap /></viewer>
<explanation confidence="0,75"  creator="Dora" evidence="
Interface input "method="acquire_pref" />
</meta>
</Statement>
```

In the syntax of situational statements, the tag *restriction* can be used to express constraints on the situation.

For example:

```
<restriction><location>abroad</location></restriction>,
<restriction><season>summer</season></restriction>,
<restriction><weather>raining</weather></restriction>
```

indicate constraints to be taken into account when evaluating the statement on the location, season and weather condition respectively.

The Information Selection and Presentation task generates the description of the selected items, after an explicit user request or proactively in presence of interesting objects, by executing the following steps:

- Selection of relevant content to be presented: this is done by matching user preferences, situation and context features with the metadata describing the region of the map where the user is located. Then, given the description of the situation S of a user u as a set of features ($S(u)=[sf_1,…,sf_n]$), according to the dynamic context features represented by the time t, user's position p and weather condition w, the system selects a set of relevant situational statements in the *MUP* of the user u and regarding *all* categories of objects of interest in MyMap ($SSt(u)= Select(MUP(u),S(u),t ,p ,w ,all)$).

  The resulting statements are then grouped according to their categories. For each situational statement in a category c_j the list of attributes against which perform the matching of the attributes a_i of items of interest is extracted and the list of preferred items i_k is produced by ordering them according to the number of matched user interests and to their confidence value. This rank is calculated according as follows: for each matching attribute ma of objects present in the area a: $rank(i_k)=\Sigma \; confidence \; (ma(i_k,a))/nr(ma)$.

  Items whose value is above a certain threshold (0.5) are presented to the user on the map to be used for generating both individual and comparative descriptions. If none of them goes above the threshold, then the system presents all items and indicates to the user that none of them is close to her preferences or interests.

  Information about the matched user preferences is exploited to generate an explanation about why the items were recommended. In case the user explicitly asks for recommendations about a category cj, MyMap applies the same procedure by specifying it in the selection query: $SSt(u)=Select(MUP(u),S(u),h,p, j))$.

- Selection of the presentation plan that best suits the user *request*. In MyMap, using a simple NLG approach, we use plans formalized in DPML [5] corresponding to the following communicative goals:

  Describe(single_object), as a consequence of the user click on the map spot,

  DescribeArea(list_of_objects), allows describing objects of interest belonging to different categories

  Compare(list_of_objects) allows describing by comparison a set of objects of interest of the same type.

- Instantiation of the generic plan with selected data.

- Visualization of the results as a web page (Figure 1) structured as follow:

a) on the **left side** the **map** of the town area where the user is located and the graphical indications about places of interest are displayed; b) on the **right side** a list of recommended places, grouped by category, is provided; c) if more than one object of the same category are present in the list, the *Compare* **link** is displayed and the user may ask for a comparative description by clicking on it; d) on the bottom part, when the user selects a single place or asks for a comparison, the correspondent message is displayed.

Figure 1. An example of interaction.

The user may always ask for the visualization of all the items present on the map without any personalization and may deactivate the comparison functionality in her setting page.

MyMap may use its own map or GoogleMap. In this last case, in order to keep the architecture unvaried, we created a matching between our markup and the tagging formalism used by GoogleMap, by exploiting the GPS coordinates.

3. USING COMMON SENSE

Let's consider the following scenario:

Dora is in Bari the first time. When she is abroad she prefers to taste local food in typical restaurants possibly eating outside since it is summer. She arrives downtown and it is lunch time, unlikely it starts raining! Using her personal device she asks for suggestions about where to eat.

In such a scenario, according to situational statements describing her eating preferences, MyMap would select typical restaurants close to where she is in which it is possible to eat outside discarding those that do not offer this facility. In this case, the situation of the user can be expressed as $S(Dora)=[season="summer" location="abroad"]$ and the set of relevant statements for the *eating* category will be selected as $SSt(Dora)=Select(MUP(Dora), S(Dora), 13.00,coord, raining, eating)$.

From this list, all attributes with their confidence against which matching all relevant items will be extracted ([(eating_type=restaurant,.75), (food_type=typical,1),(table=open-air,.75)]).

Then, according to these preferences, all places (<details>) of category "eating" being "restaurant" matching these attributes and with coordinates that show that the place is relatively close to the user position (within 500 mt) will be selected. Starting from this list, their rank will be calculated: for instance for the item i described in Table 1: $rank(i)=(0,75+1+0,75)/3=0,83$, and therefore that restaurant will be recommended.

Let's suppose that Dora choose it and, once there, she discovers that she can only eat outside. Of course, Dora would be disappointed and maybe she would say to MyMap: "Hey, don't you know that is raining! Why did you suggest me this restaurant?"

Similar situations might arise for instance if the system would suggest visiting an open-air museum when it is raining or a

monument when it is closed.

As explained in the Introduction we decided to handle this kind of situations by extending MyMap with common sense rules that are used to ulterior filtering the recommended set before suggesting places of interest.

In Table 3 examples of common sense rules used in MyMap are presented.

The first column describes which attribute is evaluated for applying the rule (it can be the name of the preference, attribute or its value), the second column indicates to which category of items the rule can be applied, the third one denotes which context provision service has to be used for checking the context features described in the fourth column. The fifth column indicates which revision strategy has to be used and, the last column specify which communicative strategy to apply to communicate with the user.

Preference	Category	Checking Action	Context Condition	Revision Strategy	Explanation
Open Air	All	meteo(local)	Raining	Same category: -Keep matching other preferences -Not recommendable Open Air -Check explicit preferences	Indicate on the map differently Explain why
Open Air	All	meteo(local)	Sunny Temperature >30° Humidity= high Wind=low 10.30<Time< 17.30	Same category: - Keep matching other preferences -Not recommendable Open Air -Check explicit preferences	Indicate on the map differently Explain why
…	…	…	…	…	
-	Monument /Event	Check_if_op en (local)	-	Same category: Exclude that item	Indicate on the map differently Explain why

Table 3. Examples of common sense rules

Then, in the previously described scenario since the restaurant has only open-air tables, if the local meteo service says that it is raining then this place will be indicate as not recommendable.

However, in writing this rules and in describing which was the most appropriate system behaviour in each situation we evaluated different solutions. The most critical decision concerned the visualization of not recommendable or not accessible items and, consequently the provision of an explanation regarding why those items were not recommendable in that context.

For instance, let's suppose that the user is interested in Romanic churches and that the system excludes the *Basilica di San Nicola* (that is one of the most shining examples of Apulia Romanic architecture) since that day there is a private ceremony and the church is closed. The user sees it and wonders why MyMap has not recommended to visit it since Romanic is her preferred style.

We think that this is a problem that could be approached in several ways. For this reason we are testing different visualization strategies of not recommendable and temporary not available items. We are considering the following options:

Items excluded since they are temporary unavailable or labelled as not recommendable by the application of common sense rules are:

a) **not visualized** on the map as those that do not match situational preferences of the user;

b) indicated with a **different icon** (Figure 2 shows an example in which we used the yellow triangle) on which the user may click to get explanation about why that item is not recommendable or not available and then, she may decide what to do;

c) indicated with the same icon but **different colours** to indicate if an item is recommended (green), not recommendable (yellow) or not temporary available (red).

At present we leave to the user the possibility to set the preferred option in the configuration phase of the system.

From the result collected so far, we noticed that most of users decide to set the system according to the second option. However we are designing an evaluation study on the field with the intent to test empirically which is the best approach so as to avoid usability problems due to the application of a wrong strategy.
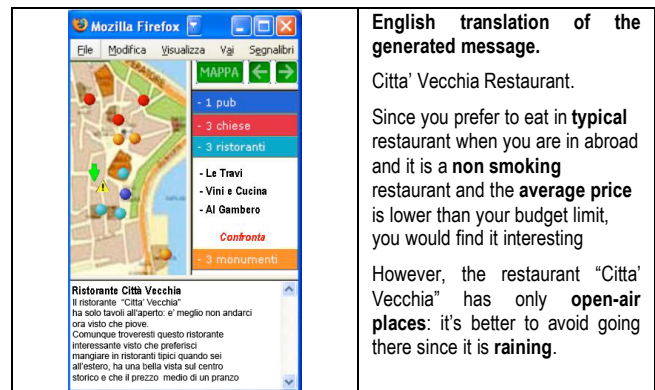

Figure 2. An example of generated recommendation.

4. CONCLUSIONS AND FUTURE WORK

In this paper, we described how common sense knowledge can be used to improve the context-awareness of a mobile system that provides recommendations in the tourism domain.

Adding common sense knowledge in a system like MyMap may result useful especially in situations in which the knowledge about the user situation is incomplete and therefore the filtering strategy would return inappropriate results.

However, there three major problems that we wish to address in our future work. The first one regards visualization strategy: when a common sense rule is applied and items that normally would have been taken into account are discarded because of contextual features, is it better to show or not the *not recommendable* or *temporary unavailable* items?

Another problem concerns the heterogeneity and incompleteness of data in the user profile and in the annotation of places of interest so as to reason appropriately on the situation. A possible solution to overcome this problem can be the use of an ontology based approach [7] and mediation techniques [3].

Our research group faced this problem in another project [16] and we plan to integrate this component in MyMap in order to add semantics to the system [8]. Ontologies are generally used to provide a uniform conceptualization of terms and, concerning

recommender system, they can be applied in the description of user profiles, of the domain and of the context. In this way they enable semantic matching of objects, context and profiles, instead of a simple keyword-based matching.

The third problem concerns the amount of necessary common sense knowledge. In wide domains such as the tourism one it is difficult to foreseen all the possible contextual situations that might arise and moreover some rules may be in conflict with each other. These are typical problems of rule-based systems, however we plan to deal with this problem by adding a learning capability to the system in which we plan to exploit the potentiality of the conversational approach for both gathering knowledge about the situational preferences and new rules.

At present the acquisition of situational preferences of the user is handled either explicitly, through user input, or implicitly by the Personal User Modelling Agent (PUMA, [8]) that infers them from existing knowledge and translates them into situational statements.

Given the expertise of our research group in dialog modeling [11,15], we plan to use natural language dialogs for acquiring information about the user incrementally during the interaction [19, 22] and to gather information in case of conflicting or ambiguous rules.

The conversational approach aims at overcoming the problem of acquisition of data relevant for personalization without boring the user and thus making the interaction more efficient and natural. In our opinion, achieving this goal means engaging the user and motivate her at providing information about self useful for achieving adaptation and therefore for providing more focused and appropriate recommendations.

5. ACKNOWLEDGMENTS

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