A Proposal for Semantic Recommender for Outdoor Audio Tour Guides

Alexey Koren
Excursia Inc.
24103 Woodway Road
Beachwood, OH 44122, USA
alexey.koren@gmail.com

Natalia Stash
Eindhoven University of Technology
Postbus 513
5600 MB Eindhoven, The Netherlands
n.v.stash@tue.nl

Alexander Andreev
Excursia Inc.
24103 Woodway Road
Beachwood, OH 44122, USA
sasha@excursia.us

ABSTRACT

Location-based services are widely spread both as entertainment and business applications. The focus of this work is on one particular area – tourist-oriented information services. Multilingual and easy-to-access information is always in a big demand. Our project is supposed to move tourist information services to a higher level by introducing personalization and smart recommendation capabilities. The target of this work is an implementation of a personalized outdoor audio guide for tourists with dynamic context-based recommendations based on a semantic information model. Architecture will be based on the research conducted in the scope of the proposed project and the experience in developing mobile guides for outdoor and indoor environments gained within the Excursia Audio Guide and CHIP (Cultural Heritage Information Personalization) projects respectively.

Categories and Subject Descriptors

H.4 [**Information Systems Applications**]: Miscellaneous

General Terms

Algorithms, Design, Human Factors

Keywords

Outdoor audio tour guide, user model, semantic recommender

1. INTRODUCTION

The availability of mobile technologies these days makes adaptive mobile guides in various domains including tourism a popular research area. A GPS-enabled audio city guide that can adapt the tour and the story based on user location and preferences can be seen as an alternative to a live individual tour guide. A review of a number of existing adaptive mobile city guides can be found in [3].

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The adaptive mobile guide proposed in this paper will provide dynamic context-based recommendations based on a semantic information model. The project is a cooperation between the authors of Excursia Audio Guide and CHIP projects discussed in the following subsections. In section 2 the functionality of the proposed semantic recommender for outdoor audio tour guides is described. Section 3 concludes the paper.

1.1 Excursia Audio Guide Project

Excursia is a tourist-oriented customizable location-based audio guide. Excursia focuses on providing experience of independent city exploring instead of following a strictly defined route made for average tourist without any customization.

After setting up initial preferences in Excursia audio guide the tourist does not need to interact with the device anymore during the walking tour. When the visitor approaches a point of interest (POI) the audio guide automatically starts telling a story about it based on the current visitor's geographical location. With the help of such an audio guide the person can spend more time looking at the POI while listening to a story about it rather than standing next to the POI and reading the story from a book.

The story can be tailored to each individual visitor. Not only can the POIs be selected based on the visitor's preferences, also the story about the same POI can be adapted to specific visitor's interests.

The first version of platform is already available, consisting of tour creation desktop software (figure 1) and a mobile audio guide application (figure 2), both written in Java. Service is already under close beta testing in Saint-Petersburg, Russia and Helsinki, Finland. Several new locations are under development.

1.2 CHIP Project

CHIP[1] focuses on techniques for providing personalized access to the museum collection both online and inside the museum [9, 8, 5]. Based on the semantically enriched collection data (stored in RDF) of the Rijksmuseum in Amsterdam it provides the museum visitors with three web-based tools (written in Java) briefly outlined below.

In the *virtual environment* the users would typically use:

- **Art Recommender** that helps the user to discover her/his art interests in the Rijksmuseum collection, in a simple,

[1] `http://www.chip-project.org`

Figure 2: Mobile audio guide application.

Figure 3: CHIP Mobile Museum Guide.

unobtrusive and engaging way by providing semantic recommendations of artworks and art-related topics.

- **Tour Wizard** allows the user to visualize her/his personalized tours through the museum – automatically generated for the user by the system or manually created by the user – in different ways e.g. on the Rijksmuseum map, historical timeline, Google maps, etc..

The **Mobile Museum Guide** tool was developed to help the user navigate through the *physical museum* by following her/his tours presented on a mobile device. The user can also view from a desktop or laptop how the tour will look like on a mobile device since the Mobile Museum Guide provides an iPhone simulation for the graphical user interface (figure 3).

User's ratings of artworks/art topics, information about tours and viewing artworks while following the tour are stored centrally in the *user model* which is available for reading and updating to all three tools. Since it is a web-based tool, the idea behind the Mobile Museum Guide is that it can use a wireless connection inside the museum. In this way the user can access the tours that were prepared in advance before visiting the museum. While following the tour inside the museum the user can give ratings to artworks/art topics which may result in the adaptation of the tour on the fly based on changing user interests.

In [8] we showed how the Mobile Museum Guide can be extended to consider boundaries and constraints (i.e walls, doors, stairs) of the physical indoor space and as a result provide personalized tours tailored not only to current user interests but user position inside the museum as well. The guide will minimize the walking route through the museum from the current user position while maximizing the number of artworks that the user might find interesting on this route.

1.3 Aim of collaboration

This is an enriching collaboration for project participants from both sides as it combines the ideas for indoor and outdoor personalization. Different mechanisms are being used for user positioning for providing recommendations in these environments. GPS or cellular triangulation can be used outdoors. The Excursia outdoor audio guide is GPS-enabled; however, these mechanisms do not work indoors. Radio Frequency IDentification (RFID), Wireless Fidelity (Wi–Fi), Bluetooth, Ultra Wide Band (UWB) and Infrared can be used indoors. CHIP provides a small test setup that uses Wi–Fi.

It would be interesting to investigate how we could make both systems work together and reuse each other's information, e.g. how information gathered about the user when (s)he was following a city tour can be used for recommending a visit to a particular museum and providing recommendations inside the museum and vice versa - how the user's (dis)likings inside the museum can affect her/his city tour.

In this work we only focus on the functionality of an outdoor audio guide. As the basis for the proposed project we take the current implementation of the audio guide developed within the Excursia project. In this version of the guide the tour is created based on initially set user's preferences such as *Architecture*, *Museums*, etc.. The guide is therefore *customizable*, or *adaptable*. In order to make it *adaptive*, in the proposed project we plan to build a semantic recommender engine system that can offer many routes for a user based on her/his past experience and strict or fuzzy dependencies amongst interest topics. With this aim we look at some CHIP ideas for providing personalized museum tours, such as the use of semantically enriched data, mapping the data to common vocabularies, user model description, dynamic tour adaptation and in the following section discuss how they can be applied for outdoor tours as well.

2. SEMANTIC RECOMMENDER

In this section we discuss how some of the CHIP ideas for providing personalized museum tours can be applied for the implementation of the semantic recommender for outdoor audio tour guides.

2.1 Recommendations based on user model information from standard vocabularies

In CHIP prototype the user can rate artworks and art topics of the Rijksmuseum collection. This data (artworks/art topics IDs and their rating values) is stored in the user model and can be used for generating recommendations and personalized tours.

When art topics are mapped to standard vocabularies and different museums know they are talking about the same art topic, this can help them exchange information, and use information about the previous user visits to other museums (physically attending the museum or browsing through the museum website) to provide a route through another museum. Within CHIP, whenever a match could be found,

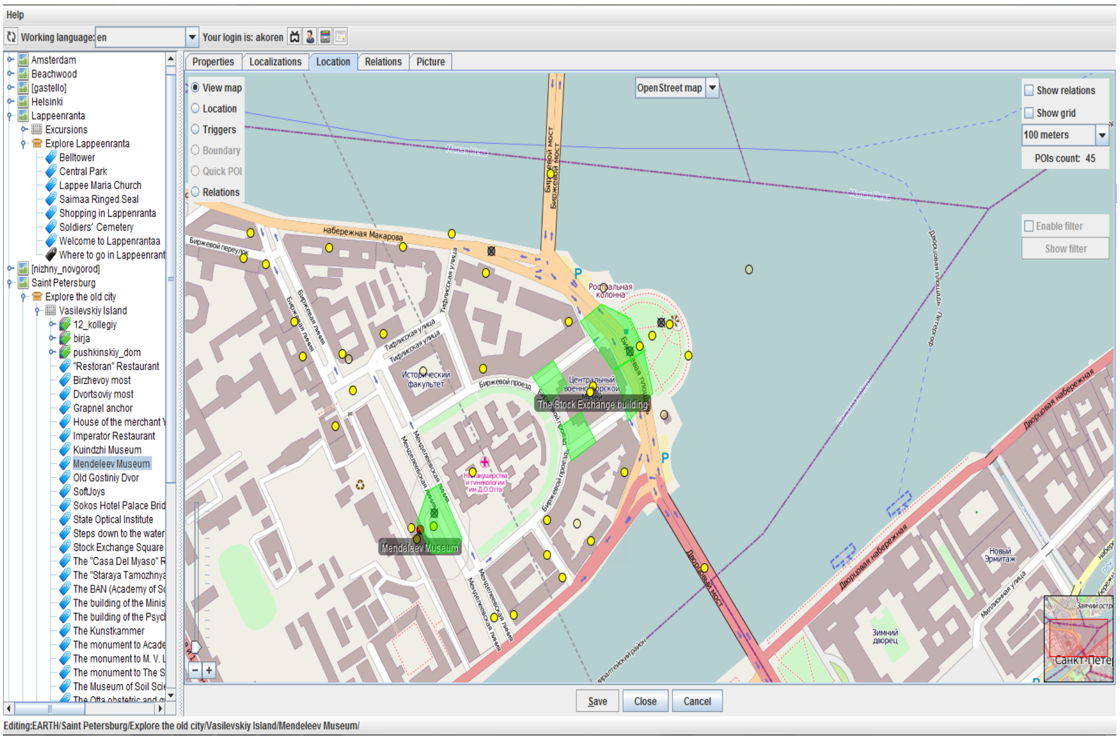

Figure 1: Tour creation desktop software.

Rijksmuseum art topics were mapped to the concepts from Getty[2] ULAN, AAT and TGN vocabularies and Iconclass[3].

To apply this idea for outdoor tours we need a semantically described data about each city mapped to common vocabularies. Based on what the user liked in previous cities recommendations could be given for what (s)he might find interesting in other cities. For example, if the user model stores information about the fact that the user likes *Baroque style* (*ID: 300021147* from *Art and Architecture Thesauri*[4]), buildings in Baroque (or related styles) in different cities can be recommended to the user.

One of the most interesting points of the proposed research is dynamic building of a user model. The aim is an interpretation of the user's actions as signals revealing her/his interests. Basically the user may always choose some areas of interests explicitly, but users do not like to interact with the mobile device a lot so it is practically impossible to make him or her analyze and check/uncheck 50 or more options in good verbose taxonomy of possible excursion topics. Moreover, sometimes user may not know whether he or she likes some category or not before visiting some related POIs. In given circumstances we should expect requests from user like "more places like this one" or "something similar or related to places I have visited in Paris last week" rather than complete and perfectly correct profile built by user.

Gathering implicit feedback is really hard when we are talking about outdoor systems. Does the user like this square or (s)he is here just for a while because (s)he is lost? What exactly does the user like about this bridge? Is it the bridge itself, sea view or tent with souvenirs? A lot of similar questions should be answered during a collection of user data and structuring feedback model.

[2] `http://www.getty.edu/research/tools/vocabularies/index.html`
[3] `http://www.iconclass.nl/`
[4] `http://www.getty.edu/research/tools/vocabularies/aat/index.html`

2.2 Recommendations based on semantically described information model

The main driving force behind the CHIP prototype is the semantic description of the Rijksmuseum collection in order for museum visitors to discover interesting relationships between the objects in the collection, such as artworks in the same or related style (*impressionism* and *post-impressionism*), on the same or related topic (*mythology* and *gods*), relationships between artists (*teacher of*, *student of*), etc.. These semantic relationships have been added based on information from Getty ULAN, AAT and TGN vocabularies and Iconclass. [9] describes the algorithm applied in CHIP for generating recommendations based on the semantically described collection data.

A semantic information model and algorithms are supposed to solve the problems highlighted in the previous section. Lots of information may be extracted from plain text describing POI to an easy-to-analyze form of RDF triples. Or information may be added implicitly by the user or content creator with semantic tagging. Verbose tourism ontology with sufficient amount of gathered data allow us to model user interests efficiently and utilize reasoning techniques to build new recommendations from relations amongst topics.

An ontology-based model gives a method of tracking a person's interests and recommending informational objects depending on her/his interests. It only takes into account interest in a particular topic and probably its ancestors, ignoring possible semantic relations to topics situated in distant parts of a tree. These relations may be hidden and not yet added to the system knowledge base.

For discovering such relations we are planning to use association rules analysis methods like market basket analysis. Thanks to hierarchical structure of ontology we are also able to use generalized association rules [6], also tracking the objects' places in the hierarchy in addition to direct associations. We are planning to start with testing A priori [1], FPG [2] and quantitative association rules [7].

Resulting ontology is supposed to be a set of existing tourism, art and heritage ontologies carefully mapped to each other when needed (survey on tourism ontologies was done in [4]) and ontologies describing the recommender and information model which are more likely to be built by us in the scope of this project.

2.3 Dynamic tour adaptation

Before starting the museum tour on a Mobile Museum Guide, the user can specify tour constraints, such as the length of the tour in terms of the maximum number of artworks included in a tour or in terms of the maximum time to spend in the museum. As was previously discussed in the introduction, when following the tour it can be adapted on the fly (re-routed from the current user position) based on current user preferences, her/his location inside the museum and spatial constraints of the museum. The system will minimize the walking route while maximizing the number of artworks that the user might find interesting on this route.

Similar ideas are applicable to outdoor guides. Following types of recommendations are suggested to be included in the prototype:

1. **Hard-coded recommendations** – links between objects or categories that were set once by content creator or were generated by semantic reasoning software.
2. **Dynamically built recommendations** – links that are generated at the time of the recommendation request. They take into account: location, already visited places, time, date, day of week, weather and other forms of context. Prototype architecture should be flexible and support of potentially any kind of context to be used in calculations.
3. **Tour creation**. In this case the user may request a tailored tour which should be built once based on the user's interests model based on implicit input and information gathered from service usage history. Other types of input are expected to be the walking time estimation and suggested area of walk. Output is a route including main POIs in given area for given user. Route may be a linked story or just summary of main POIs. In any case, it should meet location criteria such as maximum distance between two consequent POIs in an excursion and route geometry constraints (e.g. absence of cycles and minimal number of edges intersections).

3. CONCLUSIONS

The aim of the proposed project is to build a semantic recommender for outdoor guides which utilizes knowledge about a particular user, statistics and current context (e.g. location, visited places, time, date, day of week, weather, etc.) for dynamic creation of personalized routes through the most interesting points in an area.

Prototypes of server and client platforms are implemented in Java. Test content coverage is ready for Saint-Petersburg and Helsinki. The basic product is in a closed beta stage.

Hard-coded recommendations are already available. In every area (city), the user may choose preferred topics from a list. Based on this selection, location and links amongst POIs defined by content creator, this software can give personal recommendations on where to go next. Still all these recommendations are static. A user model and semantic technologies are not yet involved. So more advanced recommender features are under development.

The roadmap includes development of dynamic semantic recommender, proposal of metrics for algorithms estimation and tests on focus group.

The major research challenge is a feedback (both implicit and explicit) gathering model and its evaluation. While we can adapt approaches from web browsing and some other fields, data from real world may be fuzzier and has specific structure, patterns and hidden dependencies. Carefully gathered data from widely used location-based application with adapted and evaluated algorithms should be solid contribution to emerging area of context-aware location-based personalized services.

4. ACKNOWLEDGMENTS

The ideas for the proposed project are based on the experience gained within the Excursia and CHIP projects.

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