

## E-tourism recommender systems: a survey and development perspectives

O. Artemenko<sup>1</sup>, O. Kunanets<sup>2</sup>, V. Pasichnyk<sup>2</sup>

<sup>1</sup>PHEE Bukovinian University; e-mail: olga.hapon@gmail.com

<sup>2</sup>Lviv Polytechnic National University; e-mail: vpasichnyk@gmail.com

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*Abstract.* This paper describes main modern tendencies of the design and development of intelligent information technologies, implementing process of generating recommendations in tourism recommender systems. The basic trends of the e-tourism information technology tools are analyzed to show importance of creation for multitask, multykontent mobile e-tourism recommender systems with decision support functions in terms of the tourism group, which is regarded as a single collective user.

*Keywords:* recommender systems, mobile technologies, e-tourism, information technologies, trip support.

### INTRODUCTION

Modern tourists avoid intermediaries and strive to make their own decisions about their trip, choose certain alternatives perform booking and pay for their order direct. Modern tourist is urged not only by the desire to reduce costs, but also the realities of the information society in which the necessary information is worldwide available. Nowadays tourist trusts less in advertising slogans and brochures of travel agents, does not want to pay for expensive travel guides. At the planning stage of his journey tourist usually tends to make his own analysis for information on the attractiveness of alternative travel routes. In adventure are numerous information portals, online forums feedback and comments of those who have visited this trip, photos and videos submitted freely available. The main source of finding and distributing current, complete and accurate travel information is increasingly becoming a web space.

Nowadays the actual problem is not the traditional multicriterion search of relevant information, but search person oriented, personalized, adapted to the individual needs of particular “sophisticated” users need information. User’s search request for urgent information resources in extended web environment occasionally is faced with the problem of selection (filtering) of useful data in the field of many possible alternatives.

Recommender Systems – a class of information retrieval systems, designed as a set of information

resources to filter out just those instances of data that best meet the interests of a particular user. In recent times diverse e-tourism recommender systems are developing intensively [1].

### CATEGORIES OF TOURISTIC RECOMMENDER SYSTEMS

E-tourism recommender systems can be classified according to the following criteria: architecture, target audience and methods of generating recommendations [9].

Special features of architectural decisions in e-tourism recommendation systems classify them into three main groups, which in turn correspond to the historical phases of recommender systems development as software and algorithmic systems:

- off-line recommender systems;
- web-based recommender systems;
- mobile recommender systems.

Off-line recommender systems in the time dimension are the first generation of recommender systems and are characterized as single-task, with a small number of alternatives and strict selection rules. The method of generating recommendations in such systems is realized using semantic rules, frames and classical mathematical methods (such as AHP)[19]. The user of such systems must first choose priorities from a fixed list of values. This approach significantly limits user’s ability of describing their personalized preferences.

Development and active implementation in the tourism industry of modern Internet technologies, including e-commerce platforms, provided a quick spread of web-based recommender systems. Their main goal is to help users in finding the best alternative among the many web resources. The most popular function of these systems is the capability of finding optimal solutions for tasks like hotel reservation [13], booking tickets for various concerts, exhibitions, expositions, festivals, attractiveness of tourist sites to visit, etc. [23]. To create

better recommendations in recommender systems were applied data mining methods, particularly such as association rules [2], classification algorithms, clustering functions, etc. [11].

The appearance and widespread implementation of customized to the needs of the individual user (owner) gadgets with appropriate software and applications that always accompanies its owner, stores a wide range of personalized data that allows the technology to “see the world through the eyes of its owner” contributed to the appearance and development of a new class of mobile e-tourism recommendation systems [6-8]. Mobile e-tourism recommender system may be ranked as: spatial-based, context-aware and hybrid.

The main efficiency of using spatial-based recommender systems is the effective implementation of data access to GPS and geographical information systems (GIS) [4,5]. The main criteria for selecting data and generating appropriate recommendations in such systems are distance and user’s current position, according to which is estimated “accessibility” of certain alternatives for tourist or suitability to overcome a way to a certain spot. Most problems solved with the construction of optimal routes, find the nearest object and so on [21].

Context-aware e-tourism recommender systems offer their users alternatives regardless to its location. The main criteria for decision-making in such systems are individual tastes and preferences of the user. Solutions implemented through such recommender systems are mainly in the area of making optimal routes, searching for places of interest, accommodation, etc. [13,16].

The hybrid recommender systems combine the functionality of two previous classes. That means, the decision making process in this type of recommender systems is affected by both: spatial and contextual factors [1].

Due to the nature of the target audience e-tourism recommender system is either personalized or group (target group-oriented tourists).

Personalized e-tourism recommender systems received a boost to their development due to the massive introduction of smart phones and gadgets. The tourist was given a device that holds its owner’s personal data, is connected to communications networks in one way or another and always accompanies him. This enabled the collection and analysis of custom user content and therefore the development of recommendations in real time [23].

## MOBILE E-TOURISM RECOMMENDER SYSTEMS

Recommender systems as a separate class of decision support systems appeared on the information technology market with the development of Internet commerce and services provided based on Internet technologies [3]. Development of smart technologies and gadget expansion led to the appearance of a new type of recommender systems – mobile recommender systems. Mobile recommender systems are oriented to satisfy at once various user’s requests, pleasing his tastes, needs and considering current circumstances [14].

The main characteristic features of these technologies are:

- *Personalization* – gadget is usually owned by one person and this allows collecting and analyzing content and context data of this user.

- *Availability* – access to mobile networks or any Wi-Fi guarantees to the user efficiency of recommender application on his gadget. In addition, many applications are able to work in parallel in off-line mode (with fewer functions).

- *Relevance of information* – the modern mobile technologies and GPS enable “live” information broadcast.

Each stage of the recommendation performance process involves interaction of the user and the recommender system. Results should be presented or visualized in a convenient and accessible to the user form. The quality of interaction between the user and intelligent system user interface directly affects the popularity of the software on the market.

The main methods of presenting to the user the results of the recommender system’s work are:

- *Best item* – this is the easiest way to submit recommendation, offering the user only one alternative with the best fulfillment. If a user rejects this alternative (indicating the reasons for the refusal or not), he gets the next best one in the ranking of fulfillment. This method is most suitable for context-aware recommender systems.

- *A few of the best items*. The system provides for several alternatives that have the highest ratings of conformity. Sometimes the user is allowed itself to determine the number of given items and/or lower threshold cut-off alternatives based on rating performance.

- *Alternatives similar to the best item*. If there is a history of a user’s selects for a certain alternative, in future sessions recommender system may at once offer similar items (without re-evaluation of ratings). This approach is used in many content-oriented recommender systems recommendation modules of many popular online stores, entertainment portals etc.

- *All alternative items* based on probable or comprehensive rating. Recommender system gives the user the role of decision making, by visualizing all available alternatives. Each alternative is supported by comprehensive ratings on a single scale (eg, 0 to 5). This method is effective for the slot of the closed type recommender systems, where the number of alternatives is relatively small, and all the alternatives are “fixed”, in other words updating the list of alternatives is impossible (or rarely performed) and the attributes that characterize each of them are similar.

- *Comparative Review*. Recommender system may provide structured information that reflects the contrast between alternatives (usually in graphic form). The advantage of this method is that the user can see how the alternatives compare items are available if the current recommendation is not fully compliant to the user’s request [22].

Each of the given above methods of the the recommender system’s work results representation has its advantages and disadvantages and, in turn, supporters or opponents among the users. To create a suitable and multi-

task mobile e-tourism recommender system an integrated approach should be used: the possibility of presenting the results in several formats and user-friendly choice of them.

### SMART COMPONENTS OF THE E-TOURISM RECOMMENDER SYSTEMS

The problem of the first recommender systems (e-tourism as well) was the problem of extracting useful knowledge data. If information about subject domain of finding solutions (recommendations area) can be easily formalized and unified to form an array of data, the meaning of the reasons for the decisions made by the user, his wishes and a possible compromise on the decision in a knowledge space is quite problematic to formalize [15].

The functioning of the first recommender systems was based on two assumptions:

- a single user in person provides the system with necessary information with the necessary degree of confidence for developing recommendations;
- user certainly follows the recommendations, provided by the system, even if it has only partial similarity to the selecting criteria or personal preferences have changed.

User needs information support in decision-making at a time when he himself lacks information and knowledge for decision in subject area. To get knowledge of the user preferences for selection criteria in recommender systems of the previous generation user forcedly held survey [20].

The more relevant information was extracted from the questionnaire – the easier was to implement procedures to provide suitable recommendations. However, the need to formulate responses to the questionnaire numerous questions sometimes lack of “the right one” for the user among offered answers alternatives, user’s unwillingness to declare the true motives or preferences caused creation of false knowledge items in the system.

In addition, the recommender systems of the previous generation did not consider the critical circumstances a tourist faces in his travel. And these are no less important factor in decision making: a force majeure, including changing weather, unplanned expenses, catching a flu etc. can make it difficult or even impossible to follow a chosen recommendation item (the one that just a day ago seemed to be perfect choice).

Effective solution for the problem of up to date and suitable recommendations can be given by a new class of mobile e-tourism recommender systems, which contributed to the appearance of intelligent decision support technologies [17].

Modern e-tourism recommender systems widely use methods of generating recommendations to be classified as smart (intelligent). Recommender systems by applicable methods of creating solutions may be grouped into [16]:

1) Content-based recommender systems, which are used to generate recommendations analysing user-generated content, and results of user defined search priorities. The basic process of making recommendations based on users content is to combine the attributes of the target user profile, which stores its priorities and interests, with the attributes of the proposed alternatives. The result

is a rank of the alternative that reflects for the user the level of his interest to the items. Custom content is usually formed based on metadata information resources that are associated and consolidated by algorithmic tools of the gadget.

Often there is not enough information to properly determine user interest, while use of text functions creates a number of complications in the study of user’s profile through polysemic interpretation of natural language expressions. Ambiguity, synonyms and expressions of several words – all this describe the traditional problem of the keywords on which user profiles are built and conclusions are formed about user interest in certain topics.

2) Collaborative filtering recommender systems use methods of developing specific recommendations on the basis of different rating models (eg, frequency of requests) without the need for external information about alternatives or personal user data.

3) Context-Aware Recommender Systems. The described above approaches are generating recommendations focusing on assessing alternatives in terms of the preferences of individual users and do not take into account contextual information such as time, location, weather and etc. Traditionally recommender systems have to deal with two sets of data, user profiles and alternatives; while their contexts are not considered when providing recommendations.

Formally recommendation in such systems can be seen as a function of rating (R), such that compliance depends on the characteristics of the user profile (User) and alternatives specifications (Item):

$$R: User \times Item \rightarrow Rating .$$

For context-based recommender systems was proposed to improve this approach with additional environmental factors and circumstances (Context):

$$R: User \times Item \times Context \rightarrow Rating .$$

Intelligent components of such recommender systems are implemented on the ontological and knowledge basis approaches [12].

### OPTIMAL SOLUTIONS FOR GROUPS OF TOURISTS

E-tourism recommender systems are designed to offer tourists an optimal solution at various stages of their journey. Systems of this class are usually focused on solving specific problems, such as the selection of food outlets, housing, vehicles, sightseeing tours or popular tourist destinations alternatives. However, there are presented on the market recommender systems that offer wide-ranging plans for travel routes and work multitask in several focus areas [1].

Personalization is the main modern trend in information technologies market up to date. Customized for the needs of the individual user (owner) gadget with appropriate software and algorithmic applications always accompanies the owner and keeps a wide range of personalized data. That allows the gadget to “see the world through the eyes of its owner.” This trend contributes to the appearance and development of a new class of mobile recommender systems, oriented to the tourism industry (Fig.).

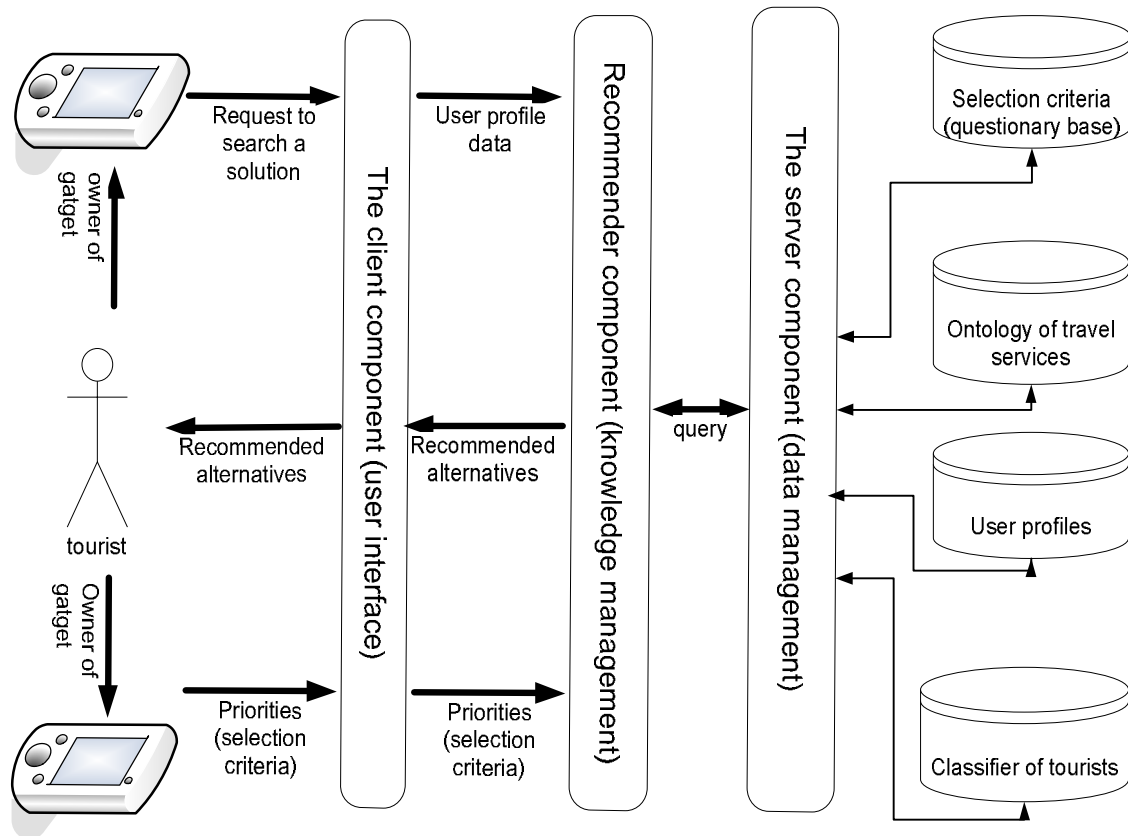


Fig. General structure of the e-tourism mobile recommender system

A wide range of original methods to generate recommendations is used in mobile e-tourism recommender systems. To provide recommendations for relatively simple tasks, such as the choice of a restaurant or hotel, usually are used collaborative filtering algorithms and/or methods for analysis of relevant user-generated personal content. The knowledge mining based and hybrid machine learning methods are used to form complex and multicriteria recommendations, including alternatives for tourist and sightseeing routes [18].

Performance of recommendations in real time, for example, to solve problems such as finding the nearest gas station, motel or parking, involves the use of contextual analysis methods and geolocation tools [5].

Finding optimal solution for group of tourists involves cutting off or neglecting of certain search criteria for some group members [10]. Among them often are people with various financial and physical abilities, diverse preferences. In other words, some of the tourists have to inferior to their personal desires or preferences in favor of the majority of members. In this case, the main function of e-tourism recommender system, along with finding options for appropriate solutions, – is to find solutions with minimal losses and concessions to certain members of the group.

#### CONCLUSIONS

Intelligent algorithmic components that enable the implementation of generating recommendations processes are an integral part of today's e-tourism recommender systems.

Further development of e-tourism recommender systems, oriented to meet the specific needs of the single tourist or group of tourists as a single team, involves the integration of information technologies, such as cloud computing and «big data», methods of data analysis platform (ontology, context analysis), mobile software and algorithmic applications. Our future research will focus on developing these information technologies innovations.

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