Context Aware Recommender Systems for Tourism: A Concise Review

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***Abstract*—Nowadays, with the huge amount of data available to users, it has become difficult and tedious to choose the information that are suitable for them. Hence, the need of recommender systems has been arisen. Such architectures have been implemented in several domains and applications such as health and e-commerce. This paper focuses on the tourism field and presents an up to date survey considering the latest approaches that have been proposed to implement context-aware recommender systems for this domain.**

***Index Terms*—Recommendation, Context, Tourism**

I. Introduction

As the information has become huge and various in the worldwide web, it has become crucial to use recommender systems to help users retrieve the most appropriate data to their profiles and situations. This has been done through analyzing their profiles, previous transactions[1], preferences, opinions and interactions with other services and users [2]. There exists four types of recommender systems: content based recommenders, collaborative filtering recommenders, hybrid ones [2] and knowledge based filtering. These paradigms have various input data and apply different recommendation algorithms. This input consists of mainly the users' information (demographic), the item (service contents, description), the context (location, time, activity) and the feedback [1].

For the content-based approach, the matching implemented by the recommendation system is based on user/item profile description. However, the collaborative filtering, groups feedbacks for items from several users experiences. It analyzes similarities between items/items or users/users to induce recommendations for concerned users[3]. The user profile in this case is made of demographic and feedback information. This method has been used mostly in online shopping. For the knowledge-based filtering paradigm, a knowledge base is collected from the users requirements and items constraints and descriptions. In this case, the recommendation is performed by inference procedures[4]. When several input data are available such as feedback items details and contextual information, the hybrid approach can be used to improve the performance of the recommender system [1]. The hybrid approach combines different recommendation algorithms to improve the performance through using multiple input data like context, items characteristics and users' feedback.

Actually, at the emergence of recommender systems, they all relied on users' profiles and items descriptions to produce recommendations. However, later contributions have proposed the use of context information in order to make refined and relevant recommendations that are suitable to the target users' context (weather, location...). In this paper, we will present context aware recommendation systems that have been implemented in the tourism domain recently.

II. Background

A. Context

Throughout the literature, the context is defined as *any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application including the user and application themselves*[5]. Generally, context has four main components: identity, location, time and user activity. Contextual data can be either static assuming that the information is unchangeable over time like users' birthday or dynamic like location and time[2].

B. Context Aware Recommender Systems Paradigms

Earlier recommenders systems used users and items only to generate recommendations for target users, nevertheless, context aware recommender systems(CARS)can rely also on contextual information to make relevant recommendations. Hence, recommendations in this case are a function of users, items and context. According to [6], there exists three approaches for implementing CARS:

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• Contextual Pre-Filtering:

This approach applies context dependent criteria on the items' list before applying the recommendation model. It selects only items that are suitable to the context. Therefore, items on the new filtered list will be used to elaborate recommendations for target users. The main advantage of this technique is that any of the classical recommendation approaches can be applied on the narrowed list of items.

• Contextual Post-Filtering:

Within this approach, the filtering according to the context is done once the recommendation processing is completed. Hence, results of recommendations are refined by applying the contextual constraints in order to generate relevant results to end users.

• Contextual Modelling:

For this paradigm, the contextual filtering is integrated in the recommendation algorithm itself. It has become a phase of the recommendation process. It is included as an explicit predictor of a user's feedback about an item.

In the rest of the paper, we will be presenting the different applications of CARS in the tourism field.

C. CARS for The Field of Tourism

As explained in the 2014 report of the United Nations World tourism organization, tourism employs 1 over 11 people worldwide. However, one of the main issues in this field is how to assist target users in the planning of touristic trips to a certain place. This is because of many constraints, mainly the tremendous amount of information available in this field plus the time and financial constraints faced by users. Thus, these users might need to get the closest points of interest. Here comes the need for context aware systems for the tourism field. According to [7], the touristic CARS process contextual information that are mainly: user (tourist), item (the destination), time, location, activities on social networks and weather conditions. The contextual information used by the tourism CARS can be retrieved explicitly thanks to (feedback, ratings, social networks) or implicitly through (applications for data collection, users browsing history, agents). According to [7], the context taxonomy used in tourism consists of:

a) User(tourist): There are two types of target users: domestic and foreign; individuals or groups with social and demographic information concerning the touristic destination. This information is mainly used to model the users ratings through history and preferences. CARS use this user model to generate adequate recommendations concerning touristic destinations. This information can be collected explicitly via the ratings of users on items or through social networks; or implicitly from the users' browsing history, application-based user data collector. The user contextual information is defined by the following attributes(as shown in Fig.1):

• Type which can be either Domestic or International, and both can correspond to a Personal or Group.

• Demography that can be either Gender, Age, Job or Education.

• Motivation which can refer to Leisure, Recreation, Holiday, Visiting Family and Friends, Health/Other or Business/ Professional.

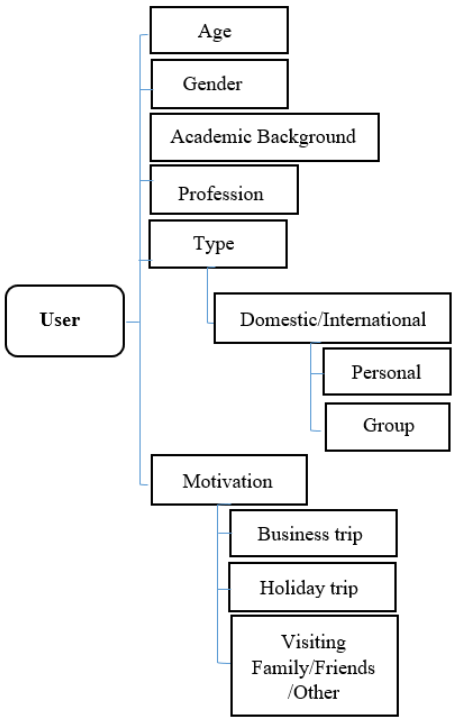

Fig. 1. User Attributes

b) Item (destination): According to [8], the item or touristic destination can be defined as *objects and tourist attraction, amenity, accessibility, supporting facilities, institutions and society, and the creative economy features supported by information related items, for instance price, hours of open or closed, promotions (discounts), services, and facilities*. This contextual information can be retrieved from data check-ins or map locations (google maps). Fig2 from [7] illustrates the attributes of the destination in a detailed manner:

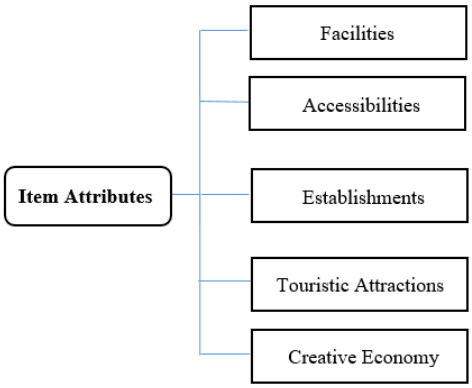

Fig. 2. Item Attributes

• Facilities includes: travel agencies, banks, hotels for accommodation, restaurants, shopping centers and hospitals.

• Accessibilites integrates : airports, transportation means, ports and routes.

• Establishments: academics, communities and media.

•Touristic attractions:nature tourism(forests,marin tourism..), human made tourism and culture tourism(culture and heritage).

• Creative economy:design, science and art.

c) Location: According to [9], and as shown in Fig.3, the contextual information of the location is broadly divided into the users' location (tourist) and items' location based on geographical, address, place, or coverage. Location can refer to the location related to contextual information on social networks like user's location, content and activity [10]. They can be obtained explicitly from check-ins (like Foursquare, Facebook) or geotagged (Flickr), or implicitly, the data can be collected from the browsing history, agent, onboard location-based services, or location application data collector, or through a sensor in the form of mobile data from GPS, telecommunications towers, Wi-Fi, or telecom operators[7].

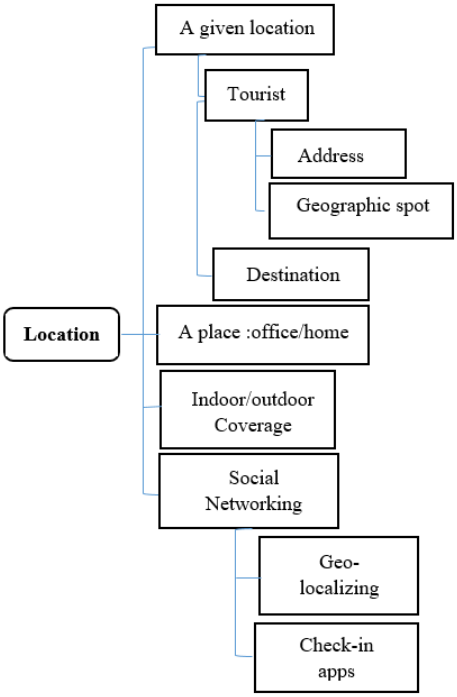

Fig. 3. Location Attributes

According to [7], the location has been assigned many attributes like:

• Specific Location of (User or Item). Each type has the value of Information (geography, address).

• Geography might have the values (Continent, Country, Province, City),or values like tourist's address, his/her place, the coverage, and social network through check-in.

d) Time: Time contextual information is defined as Time (Calendar, Day, Period, Hour). The period attributes consist of Period (Morning, Noon, Evening, Night), as well as other attributes such as calendar, day, and hour[7]. These contextual data are obtained explicitly from time-stamp (Facebook) or implicitly from browsing history or applications for data collection[7]. These attributes are well illustrated through Fig.4:

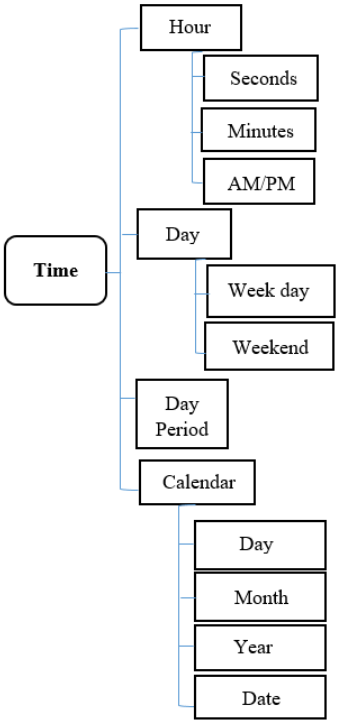

Fig. 4. Time Attributes

e) Social Networking: Social networking contextual information is defined as Social (Biography, Connecting, Texting, Sharing). Texting attributes consist of Texting (Status, Comments, Reviews, Notes), as well as other attributes such as biography, connecting, and sharing [11]. This contextual information can be obtained either explicitly from social networks or implicitly from social based services and applications specialized in the collecting of social data.[7]

f) Weather: Weather contextual information is defined by Weather (Seasons, Forecast, Conditions, and Temperatures). The seasons attribute consists of Seasons (Summer, Winter, Spring, Autumn, Rainy, Dry), as well as other attributes such as forecast, conditions, and temperatures. [7]. Such contextual information includes weather categories whether it is (sunny, cloudy and rain) and temperatures with numbers (ex: 10C). These data can be collected explicitly from weather API providers or implicitly from browsing history, applications for collecting weather data, agents[7]

III. EXAMPLES OF CARS IN TOURISM

Throughout the literature, several paradigms of CARS for tourism have been published. For instance, the recommender plateform for tourism based on vector space model using

composite social media extraction, published on 2014; the hybrid context aware system for tourist guidance based on collaborative filtering presented on 2011 and many others. In this survey, we focused on the most relevant and current paradigms that have been introduced lately. The following approaches have been chosen to be presented: CARS based on a spreading activation method in 2017; Itinerary recommender system with semantic trajectory pattern mining from geo-tagged photos in 2017 and the plan tour published in late 2016.

A. CARS based on a Spreading Activation Method

1-Relevant Concepts

• Ontology as defined in [12] *provides a means of knowledge representation; they capture a domain of interest by formally defining the relevant concepts in the domain, and the relationships between these concepts.*

• The spreading activation (SA) model *originates from psychology. In the model, a node represents a point of information with identification and attributes, and a linkage is the correlation between different realms with name, direction and weight. The retrieval starts from known or initial nodes, prior to spreading to all relevant nodes based on linkages among related nodes [13]*

2 - Presentation of the system

Most of existing recommender systems do not consider the contextual information; they use users profiles against the points of interests. The proposed recommender system has tried to overcome the following limitations of already existing systems that are [14]:

• Existing CARS did not consider using formal representation of the contextual information and user preferences.

• They did not process semantic similarities between points of interests and users preferences.

• They lacked the update mechanism that updated the user preferences according to their feedback.

• In case where preferences are assigned directly by users, nodes in the spreading process do not get additional effect and therefore confidence is not considered too for the activation value.

Because of all these limitations, the new proposed context-aware system for tourism has brought the solution that consists of the following elements:

• Building a tourism recommender platform that integrates the contextual situations in the recommendation process.

• Using an ontology based paradigm to represent points of interests, users and contextual information in a formal way in order to improve the performance of the system.

• Implementing a spreading activation method in order to facilitate the dynamic learning of users preferences and profile.

• Taking into consideration a confidence value for each activation value to assign more effect for a POI class whose preference value is assigned directly by the user.

• Updating the users profile based on their feedback through the spreading activation model.

In this paper, the contextual modeling and contextual post-filtering paradigms have been combined to consider the contextual situation in the process of producing recommendations. The discussed paradigm generates the point of interests suitable to the user in terms of preferences and location.

The algorithm implemented in this system consists of three mains phases as shown in Fig.5:

• Building the semantic network based on the domain and contextual model, through first creating a domain knowledge ontology applied to the tourism field. It represents POIs as nodes that are linked with relationships among them. Each POIs is represented by a key word. The second step is creating an ontology to model the contextual information related to tourism, like time, weather. In order to build the semantic network, the context element in the contextual model is linked to a POI in the domain knowledge ontology model through a context relation[14].

• The learning of the semantic network: the spreading activation method is used to initialise the ontologies used for recommendations and update them based on the results of the recommendation process[14].

• The recommendation phase during which the system performs the similarity check based on semantics. It produces a list of POIs that is interesting and then filters it based on the user's location. Then, it generates a more interesting list of points of interests suitable for the user's location[14]

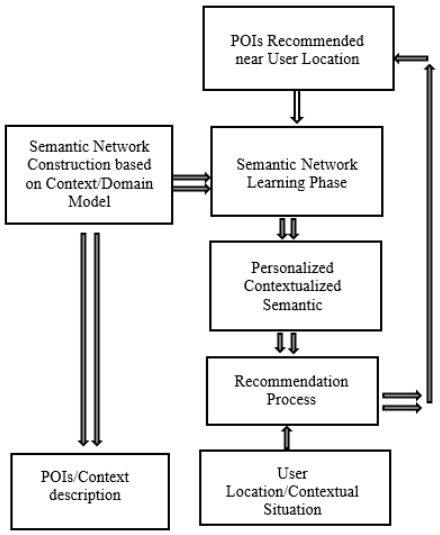

Fig. 5. CARS based on a Spreading Activation Method

3- Limitations

The proposed system lacks the following elements:

• Focusing on other aspects of the contextual information such as season, time.

• Considering the implicit side of users feedback.

• Considering more detailed levels of granularity at events' handling.

B. Semantic Itinerary Recommender System

1 - Presentation of the system

This platform is a recommender system that generates itinerary recommendations based on users previous semantic trajectories. This history is obtained from their historical photos. The system allows user to customize a set of place types and travel duration in their initial query. This system recommends semantic-level itineraries to users that show higher place type layer route suggestions compared to specific geographic-level ones[15]. For processing recommendations, this system builds on six dimensions: spatial, temporal, aspatial semantics, sequential, CF and user-provided constraints. The architecture of the semantic itinerary recommender system shown in Fig.6 consists of four main phases:

• Constructing Trajectories: this is done offline, users trajectories are built from the geo-tagged photos, previous users semantic patterns and based on contextual environment semantics.

• Building Semantic Trajectories: the raw trajectories generated in the first step are mined to become basic semantic trajectories that will later be developed by integrating contextual semantics[15].

• Semantic Trajectory Pattern Mining: this is the phase of mining trajectories patterns based on the enhanced trajectories produced in the previous step. This is done thanks to the TAS algorithm whose inputs are a set of semantic trajectories and ouput is trajectory patterns[15].

• Semantic Itinerary Recommendation: this is done at the online part, it checks users query, retrieves appropriate semantic itineraries, sorts and displays them[15].

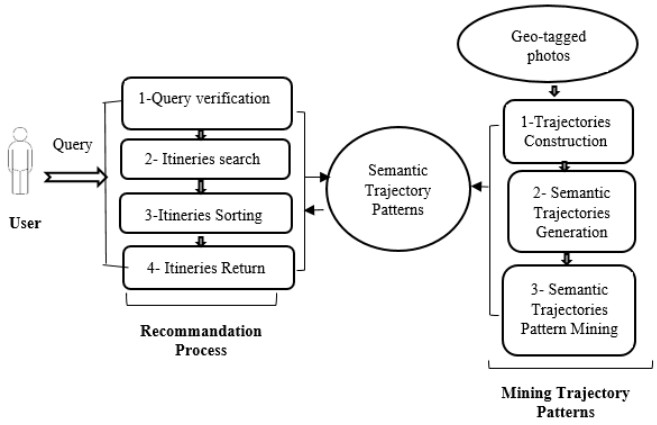

Fig. 6. Framework of Semantic Itinerary Recommender System

2- Limitations

This system has presented some limitations that can be explored in future works:

• It should explore more semantic databases to further explore semantic-level itineraries;

• It does not include the users constraints like dislikes on photos to avoid some places.

• It does not incorporate photo images to itinerary recommendations in order to reflect users preferences.

C. PlanTour

1- Presentation of the System

Travelling recommendation systems have become widely used in organizing and planning touristic trips. One of the main issues of such systems is the maintenance of the points of interests information, users ratings and connections with geographic systems. Nevertheless, lately, with social networks, target users can update their information easily. Thanks to these platforms, and through mobile applications, users can get real time information concerning guides and plans that respond to their preferences.

Plantour [16] is a new recommender system specialized in building touristic plans for users visiting a certain region. It has mainly handled the issue of the difficult start of such systems due to the lack of data at the beginning since it collects data from social networks. This platform is composed of three main services according to Fig.7

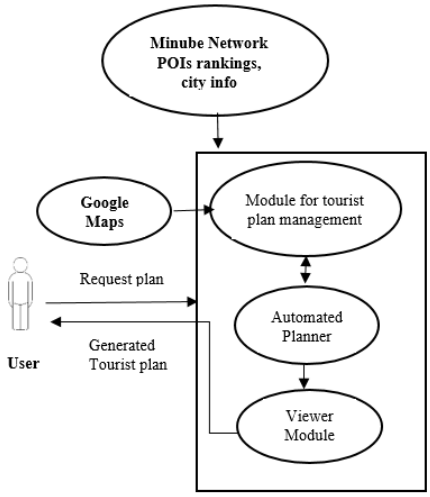

Fig. 7. Architecture of PlanTour

• The Tourist Plan Manager: this module gets the information it needs from the minube social network. Planning problems are created after the processing of these data which will be used eventually by the automated planning. They are written in the standard declarative language. Its inputs are the region the user is going to visit, and their preferences concerning the arrival time. This module is implemented using a modified version of the k-means algorithm.

• The Automated Planner: it resolves the planning tasks and takes into consideration two criteria a) maximizing the user utility of visiting places; and b) minimizing the total traveled route.

• The Viewer module: This module takes the generated plans and returns them all together in a webpage within a map. This later is provided by the Google Maps API.

Actually, the minube service is a social network specialized in traveling where end users can get ideas and inspirations

from other users experiences to choose their coming destinations. Subscribed users can share their experiences, recommendations and photos about their trips.

2 - Plantour limitations

Some of the main limitations of this solution are:

- its full dependence on the minube network.
- Having limited access to Google Maps.
- The human factor of fatigue is not considered relevant in the process.

Conclusion and Future Work

Throughout this paper, recommender systems have been defined in their broader picture along with a detailed description of their different paradigms including the content, collaborative, knowledge and hybrid paradigms. Later a focus has been done on the context aware systems in general along with definitions of their different approaches including the contextual pre-Filtering and post-filtering. Since tourism is one of the main domains where context aware systems are needed and used, a detailed overview of the contextual information needed has been performed. It has shown that these systems explore, basically, the following contextual parameters: the user, the touristic destination, the location, time, social network and the weather. Finally, a survey of the latest applications of context aware systems on tourism has been done. The first one is a context aware tourism recommender system based on a spreading activation method, which has been published in 2017, it has resolved some of crucial limitations of already existing CARS in tourism by focusing on including a formal ontology for all features(users, items..) and updating the users automatically and accordingly. Second, a recommender system for travel trajectories has been shown along with its architecture. Its main goal is to allow end users customize their queries and get the most relevant travel trajectories that satisfy their predefined needs and preferences. Finally, another system has been presented which is the Plantour platform, it is a recommender system published in late 2016, it is based on a collaborative approach and generates recommendations through consulting a common social network(minube) to get inspirations from other users and by considering the users preferences(location and time). Future works in this sense could include exploring other applications of CARS in tourism and presenting their experiments showing the usefuleness of context aware recommendations in offering precise suggestions to end users.

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