

# REJA: A GEOREFERENCED HYBRID RECOMMENDER SYSTEM FOR RESTAURANTS

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## Abstract

*Recommender systems have become a key tool in marketing processes in e-commerce, because they provide an added value to Web-based applications in order to keep customers. In the tourist sector, the use of tourist Web based sites has got a great success due to the fact that the easy integration of tourist business processes in Web based tools. In this contribution, we introduce a hybrid recommender system for restaurants, collaborative and knowledge-based, that is able to provide recommendations in any required situation by the users/customers; besides it provides information referred by Google Maps, regarding the recommendations. Such a system has been developed for our province, Jaén (Spain), but it can be easily extended for any other geographic area.*

## 1. Introduction

Due to the huge amount of information in the Web and in its services, such as sale or marketing processes, recently there have been developed different tools in order to provide users an easy, quick and suitable access to the information they require from the Web. Recommender systems have arisen in this field because the aim of such systems is to customize the information that receives the users according to their preferences, necessities or tastes. Due to their success there exists a wide range of applications for recommender systems [1 2], mainly for leisure e-commerce.

In the literature, we can find different recommender systems such as: collaborative systems [3-5], content-based systems [6, 7], demographic systems [7], knowledge-based systems [6, 8], utility-based systems and hybrid systems [9].

Collaborative recommender systems [2, 10] have been the most successful and spread recommender systems due to their simplicity and good results. However, such systems present an important drawback of the cold-start [11] that means, when a *new user* is

registered in the system, it cannot provide her good recommendations because of the lack of data necessary for its recommendation computation process.

In order to mitigate this drawback, a common solution is hybridizing different models of recommendation, such that they complement each other to overcome their own drawbacks.

In this contribution, we propose a commuted hybrid recommender system, called REJA (REstaurants of JAén), that hybridize a collaborative and a knowledge-based system and it is applied to restaurant recommendations. This system has been developed and applied to restaurants of the province of Jaén but it might be easily extended to any other area. The main advantage of this proposal is the use of incomplete preference relations in the knowledge-based system [12, 13] in order to overcome the cold-start problem of the collaborative one. Additionally, this recommender system provides information referred by Google Maps regarding the provided recommendations.

The paper is structured as follows: Section 2 makes a brief revision about the recommendation models that includes *REJA*, Section 3 introduces our proposal of a hybrid recommender system for restaurants, Section 4 presents the geographic referred module of *REJA* and finally the contribution is concluded in Section 5.

## 2. Recommender Systems

We propose a commuted hybrid recommender system that hybridizes a collaborative and a knowledge-based model. Due to that, we first briefly review a general collaborative model and our proposal for the knowledge-based system.

### 2.1 Collaborative Recommender Systems

Collaborative recommender systems work by collecting human judgments (ratings) for items in a given domain and grouping people who share the same needs, preferences, etc. [3, 5, 7, 14].

Table 1: Dataset used by a Collaborative Recommender System

	<i>Le meniuer</i>	<i>La Brasserie</i>	<i>Pizzeria Ita</i>	<i>Trattoria Spgg</i>	<i>Restaurant Z</i>
Alex	9	1	9	?	10
Ricardo	4		3	10	4
...	...	...	...	...	...
Pedro	6	3	?	6	7

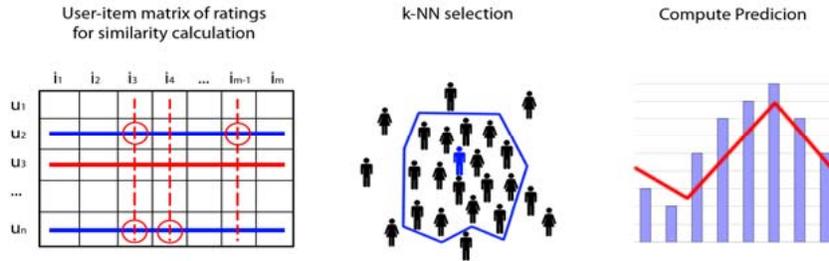


Figure 1: Tasks concerning Neighborhood-user-based methods

Customers of collaborative recommender systems share with each other their judgments and opinions about items they have already experienced, such that, the system can support them in order to make right and better decisions about the items available in the system. The collaborative systems provide useful customized recommendations for interesting items by using algorithms which try to predict user's satisfaction regarding an unrated item based on users with similar profiles to the target user.

The data used by collaborative systems consist of *items*, *users* and *ratings* provided by the users regarding the items. Therefore, the search space is a matrix of users and items where each cell represents a rating given by an user with respect to an item (see Table 1).

These systems carry out three general tasks to elaborate the recommendations demanded by users [5] (see Fig. 1):

- Analyzing and selecting data sets
- Grouping users
- Generating predictions

The system computes predictions of those items not rated yet by the target user, by a weighting aggregation of the similar users' ratings.

## 2.2 Knowledge-Based Recommender Systems

As it was aforementioned collaborative systems present the *cold start* problem [11]. In order to overcome this drawback, we propose to hybridize the

collaborative system with a knowledge-based one, such that the latter can compute recommendations for new users without the ratings required by the former.

Knowledge-based systems compute their recommendations by using the available knowledge with respect to matching degree between item features and user necessities. Usually, this knowledge is gathered from explicit information provided by the user and hence a user profile that represents her needs is built. There exist different methods to exploit such a knowledge [9], being the most common one the case based reasoning [15].

Due to the fact that the requirements to explicitly provide information are unlikely welcome by the users because it is a tedious and time consuming task, we have developed a knowledge-based model [12, 13] that just demand a minimum amount of information in order to build a sufficient user profile to compute suitable recommendations for the user. Such a model is based on the use of incomplete preference relations and it follows the following recommendations scheme (see Fig. 2):

- 1) A database with items to recommend is built.
- 2) To build a user's profile:
  - a) To gather user's preference information:
    - i) An incomplete preference relation about user's preferences is gathered.
    - ii) A filling algorithm for incomplete preference relations is applied [12, 13].
  - b) To build a user's profile:
    - i) From the preference relations are built partial user's profiles from different items and features.

- ii) Partial profiles are aggregated in order to obtain a user profile that will be used to compute recommendations.
- 3) Product Filtering: by using the user's profile the items in database are filtered according to user's needs.
- 4) Recommendations: the items closer to user's needs obtained in the filter phase are recommended.

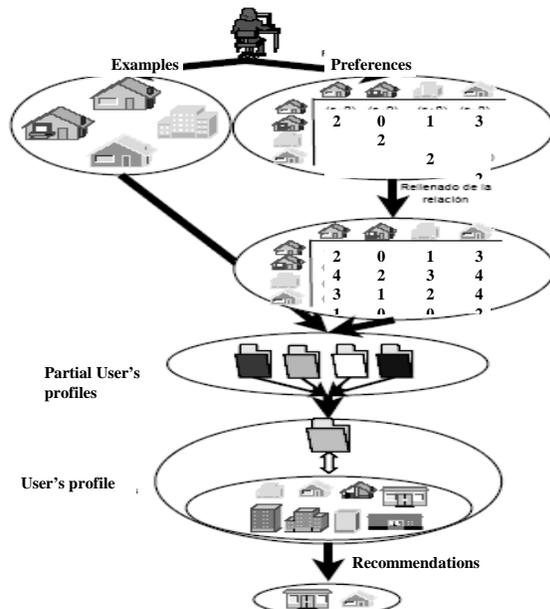


Figure 2. Knowledge Based Recommender System

### 3. REJA: A Restaurant Recommender System

This section introduces the recommender system for restaurants of Jaén, called *REJA*, whose URL is: <http://trantor.ujen.es/~mafer/joomla/index.php?lang=en>. This system implements a hybrid system by commutation with the recommendation models presented in Section 2. This hybridization makes of *REJA* a system that takes the advantages of each model in order to overcome their own drawbacks.

The main aim of *REJA* is to provide successful recommendations to users about the existing restaurants. Following, we are going to present the working of each one of the different recommendation models provided by *REJA*.

#### 3.1 REJA: Collaborative System

The collaborative system used by *REJA* has been implemented by using the collaborative filtering engine *CoFE* (<http://eecs.oregonstate.edu/iis/CoFE/>) that uses a database with all the restaurants in the province of Jaén and the users registered in the system.

In order to obtain a recommendation of the collaborative system, the user must be registered then she should login and provide enough ratings about the restaurants known by her (this system requires at least 20 ratings).

The system obtains explicit information from the user who may rate the restaurants in which she has already been or known. This information is used to build and modify the user's profile and to compute suitable recommendations for her. From the users' profiles this system computes the similarity among the users and builds neighbourhoods of users with similar profiles. The system uses the neighbourhoods and the profile of the target user to provide her ten restaurants that have not been rated yet by her, but have got good ratings by other users of his neighbourhood.

Such as it was aforementioned in Section 2, the collaborative model suffers the *cold start* problem that affects new users. In *REJA* we have overcome this problem by means of hybridizing with the knowledge-based systems presented in Section 2.2 and whose way of working is presented in the section below.

#### 3.2 REJA: Knowledge based System

The aim of this model is to provide recommendations to the users when the collaborative system does not have enough information about them. To do so, *REJA* needs a minimum amount of information about user's needs that is gathered as an incomplete preference relation (user's knowledge) and knowledge that the system has about the restaurants in the database (catalogue Knowledge). The knowledge-based system computes the recommendations by means of a case based reasoning method [15]. This model implements the phases introduced in Section 2.2 as:

- 1) User's profile:
  - a) *To gather user's preference information:* The system gathers the user's preferences and needs by means of an incomplete preference relation to minimize this process, as follows:
    - i) The logged user chooses one example (restaurant) similar to her needs.
    - ii) The system provides three well known restaurants, usually chains or franchises, and then requires from the user three ratings comparing her example to the three restaurants provided.
  - b) *To build a user's profile:* With these three pieces of data, the system fills up the incomplete preference relation [12, 13] and computes the user's profile that will be used to obtain the recommendations.
- 2) Product Filtering: the system filters the restaurants according to the user's profile in order to take into

account only those restaurants that fulfil user's needs. In our case the filter uses as filtering attributes the type of food, the price, and so on.

- 3) Recommendations: from those restaurants that fulfil more or less the user's needs, *REJA* recommends those that better satisfy these requirements. To do so, the system rank the set of restaurants obtained in the previous phase according to the quality of service and provides the top ten to the user.

#### 4. *REJA*: Geographic Information

Currently, Geographic Information Systems (GIS) [16] are really appreciated by users, because they provide graphic information avoiding textual data overloading. Thus, users can do or check any geographical query obtaining graphical information easy and quick to understand. Therefore, we have developed and integrated a geographic module in *REJA* that provides information referred by Google Maps regarding the recommended items (restaurants). The aim of the information service referred by Google Maps is provide users information such as:

- a) Restaurant Location on a virtual map.
- b) Search the shortest path from user's home to the recommended restaurant.
- c) Hot tourist points (museums, parking places, hospitals, cash machines, etc).
- d) Calculate the route between two points chosen by the user on the map.

#### 5. Concluding Remarks

This contribution has introduced a recommender system for restaurants, called *REJA*. Such a system is composed by a collaborative and a knowledge-based model in order to avoid the *cold start* problem of the former model by means of a knowledge-based process that uses fuzzy linguistic incomplete preference relations. Besides, *REJA* introduces a new facility for its users that consists in a geographic information module that provides geographic information referred by Google Maps about the recommended restaurants. This system has been developed with information related to the province of Jaén in Spain, but it is easy to extend to any other geographic area.

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