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A TOURISM RECOMMENDER SYSTEM BASED ON COLLABORATION AND TEXT ANALYSIS

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This work presents a recommender system that helps travel agents in discovering options for customers, especially those who do not know where to go and what to do. The system analyzes textual messages exchanged between a travel agent and a customer through a private Web chat. Text mining techniques help discover interesting areas in the messages. After that, the system searches a database and retrieves tourist options (like cities and attractions) classified in these interesting areas. The system makes use of a tourism ontology, containing themes and a controlled vocabulary, to identify themes in the textual messages. The system acts as a decision support system, because it does not make recommendations directly to the customer.

Key words: Collaboration; Tourism; Text mining; Recommender systems; Decision support systems

Introduction

Tourism is an interesting domain for recommendation research. First, there are many options of destination and attractions for someone wishing to travel. Second, there are many different kinds of attractions, such as adventure, business, cultural/historical, and vacation. Third, all over the world are there many cities and places where these different options may become real.

With such a huge volume of options, travelers often need advice about where to go and what to see, to visit, and to do. Generally, the tourist is helped by a travel agent, a person with knowledge and capabilities to provide such advice. However, recommendations from these agents may be restricted by human factors, such as lack of memory, limited knowledge about the world, countries, or cities and their tourist options, which could result in poor capacity to match a tourist's requirements or wishes against the options stored in a database. Sometimes the final decision is much too dependent on the travel agent.

A recommender system is software to aid in the social process of indicating or receiving indication about what options are better suited in a special case for a certain individual (Resnick & Varian, 1997).

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Recommendations may be made regarding books, compact discs, music, restaurants, information, Web sites, etc.

In a tourism domain, recommendations (by humans or systems) may indicate cities to go to (destinations), places to visit, attractions to see, events to participate in, travel plans, road maps, options for hotels, air companies, etc. This is not a trivial task because many times a customer comes to the travel agency without a clear definition of his/her plan. A recommender system can assist this task by matching the customer's preferences and wishes against all available options and services and then helping the customer to decide his/her travel plan.

Recommendations can be made to the customer by software, as in a multimedia totem, an ATM device, or in a Web site, or by a human intermediary (e.g., the travel agent) who will receive information from a decision support system.

In this article, a recommender system that helps the travel agent in discovering options for the customer is presented. The system acts as a decision support system, because it does not make recommendations directly to the customer but it shows relevant tourist options to the travel agent. The system enables interactions between the travel agent and the customer through a private Web chat, where messages are exchanged online using computers connected to the Internet. The software uses text mining techniques to discover interesting areas in the messages sent (i.e., goals of the travel, kinds of attractions interesting to the customer, seasons of interest, etc.). After that, the system searches a database and retrieves tourist options (like cities and attractions) classified in these interesting areas.

This article is structured as follows. The next section presents some concepts about collaboration and recommender systems and discusses related works. In the third section, the proposed system is described in detail. The fourth section presents an example of a collaboration session using the system and discusses how the system works in this context. Finally, the last section presents concluding remarks.

Collaboration, Recommender Systems, and Related Work

According to Terveen and Hill (2001), there are four kinds of recommender systems. *Content-based systems* use only customers' preferences. Items to be recommended are chosen from those similar to the ones related to the customer (e.g., products in stock that are classified in the same section of the products bought by the customer). *Recommendation support systems* do not make automatic recommendations but help people to produce recommendations. *Social data mining systems* discover preferences by analyzing records from social activities, like messages in newsgroups, citations in scientific papers, usage logs of a system, peer-to-peer services (like exchange of music and documents), etc. *Collaborative filtering systems* do not consider the content of the items but the similarity among people and the items related to them; the goal is to find people with similar preferences and make cross-recommendations.

Recommender systems are commonly used in commerce and for merchandising, allowing companies to offer products, services, and information to help customers in their decision. Schafer et al. (2001), Srivastava et al. (2000), and Lawrence et al. (2001) discuss many applications of recommender systems to commerce and marketing in general. This kind of system is especially useful when there are many options to choose from and people that decide have little information about those options.

Specifically for the tourism domain, Ricci and Werthner (2002) presented a recommender system based on case-based reasoning. The goal of the system is to help the customer in defining a travel plan.

Recently, recommender systems are becoming an important way to support knowledge acquisition. Brusilovsky (1996) discuss applications of adaptive hypermedia systems (a kind of recommender system) in educational environments, to support students in the learning process.

Knowledge acquisition may also be accomplished when people share knowledge with each other. Knowledge sharing may occur through direct communication or indirectly when people store knowledge and others can retrieve this knowledge in a remote place or time. Information technologies have an important role in this process, especially those technologies for Computer-Supported Cooperative Work (CSCW) (Greenberg, 1999). Digital libraries, corporative portals and Intranets, Web chats, newsgroups and e-mail listings allow people to share knowledge directly or indirectly.

When people establish direct communication to exchange information and acquire knowledge, the process is termed *collaboration*. Collaboration happens when people interact, exchanging and sharing information in order to accomplish work or simply to help other people. In general, information is passed through verbal or written messages. Collaboration is one of the most important tasks for innovation and competitive advantage within *learning organizations* (Senge, 2001).

In the tourism domain, people can share knowledge about cities and attractions, so that potential travelers or tourists can discover new options. These self-experiences can be stored in a public database of tourist options.

Furthermore, collaboration can be used by the travel agent to understand the customer's wishes, preferences, requirements, and goals. Ricci and Werthner (2002) post the challenge of interacting with the customer through a dialog in order to identify the customer's interests. This conversation with the customer may be through textual messages, using technological resources (e.g., a Web chat). Once messages are exchanged, an automated system can analyze the discussion session to find subjects in the messages.

The feasibility of analyzing texts for recommendation is described in some papers. For example, Terveen and Hill (2001) discuss the PHOAKS system, which extracts addresses of Web pages from messages in the Usenet newsgroup for future recommendations. Another system (proposed by Donath et al. in Terveen & Hill, 2001) analyzes messages in the Usenet and other chats intending to later recommend group of messages according to some attributes (e.g., the presence of certain themes or discussions with greater number of participations). Komosinski et al. (2000) present a system that identifies terms in messages of a chat and gives to the participants the definition of the terms during the interaction.

Following the ideas described, this work presents a recommender system that analyzes messages exchanged in a chat between a customer and a travel agent, identifies themes or subjects in the messages, and retrieves items classified in these themes from a database. In this article, the system is adapted to a tourism domain, but its application is broader. In the next section, the system is presented in detail.

Description of the System

The goal of the system is to help travel agents in discovering tourist options for customers. The goal is achieved through recommendations of cities and their tourist attractions.

To do that, the system analyzes textual messages sent by users (a customer and a travel agent) when interacting in a private Web chat, and it identifies customer's interest areas according to a tourism ontology predefined in the system. The chat is specially constructed for this system and it is not open to nonregistered users (only two persons interacting at a time).

After that, the system looks in a database for tourist options classified in the same interest areas identified early. Figure 1 presents the general architecture of the system with the main modules and the data flow between its components.

This system belongs to all four classes of recommenders described in Terveen and Hill (2001). The system is content based because the preferences of the customer are matched against the content of items in the database. Preferences are identified in the sent messages and are defined as interesting areas. The set of possible areas is predefined in a tourism ontology (created previously). The system is a support system because it does not make recommen-

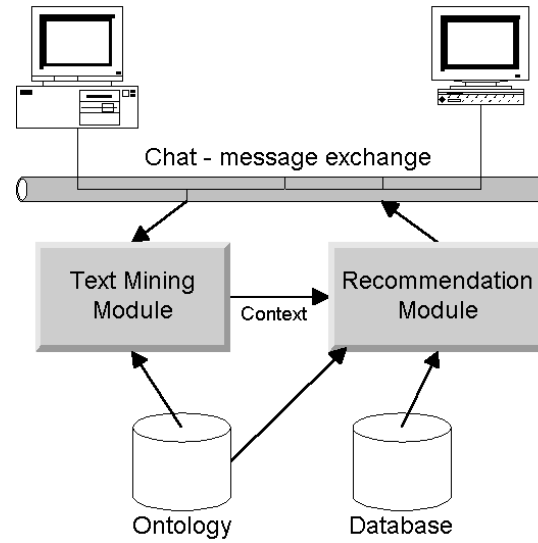

Figure 1. Architecture of the system.

dations directly to the customer, but it helps the travel agent suggesting options. It is also a social system because it analyzes messages exchanged in a Web chat. And the system uses collaborative filtering because the database is created by people (i.e., the tourist options represent self-experiences of other people).

The system described here is focused only in the problem of finding cities and attractions for the customer. This is the case when the customer arrives at the travel agency without a plan or without a destination.

The preferences or interest areas correspond to attributes of cities and attractions: for example, if the climate is hot or cold, if the attraction goal is for adventure or business or study, if the attraction is located in a beach or in mountains, etc.

Only cities and attractions stored in the database are considered for recommendation and they must be classified in areas according to the ontology. The system does not have as function to find tourism packages, to help in the travel plan, or to help in the choice of air companies, hotels, and other services.

The difference of the proposed system and those that use queries (as in a database) is that the customer does not have to know how the information is structured. In a query system, the user has to understand the structure of the database (attributes and possible values). In the proposed system, the customer does not know how the ontology is structured, and the terms defined in the ontology and the structure of the database is omitted from the participants (customer and travel agent).

In the same way, the proposed system differentiates from tourism catalogs because in the second the user has to find the options himself through a navigational process while in the first the system automatically finds the best options. Each component of the system is described in detail below.

Text Mining Module

The main resource of the system is a Text Mining module. It works as a Web *sniffer*, examining each message sent in the chat. This module is responsible for identifying themes or subjects in the messages. Themes are identified by comparing words present in the message against the rules defined in the ontology. Generic terms like prepositions (called *stopwords*) will be discarded. Each message is compared at a time and online against all themes in the ontology. The themes identified in the messages represent preferences of the customer and are forwarded to the Recommendation Module. Themes or subjects are used as attributes to select kinds of attractions and cities from the database.

The Text Mining method (a kind of classification task) was first presented in Loh et al. (2000). Instead of using Natural Language Processing (NLP) to analyze syntax and semantics, the method is based on probabilistic techniques: themes can be identified by cues. Using a *fuzzy* reasoning about the cues found in a text, it is possible to calculate the likelihood of a theme or subject being present in that text.

The algorithm is based on Rocchio's and Bayes's algorithms (Lewis, 1998; Ragas & Koster, 1998; Rocchio, 1966), because it uses a prototype-like vector to represent texts and categories and it evaluates the relationship between a text and a category using a similarity function that calculates the distance between the two vectors. The vectors representing texts and themes are composed by a list of terms with a weight associated to each term. In the case of texts, the weight represents the relative frequency of the term in the text (number of occurrences divided by the total number of terms in the text). And the weight in the theme vector represents the probability of the term being present in a text of that theme. Weights in themes are defined automatically through supervised learning processes.

The Text Mining method compares the vector representing the text of a message against vectors representing themes of the ontology. The comparison between the two vectors is done through a *fuzzy* reasoning process, following Zadeh (1973) and Nakanishi et al. (1993). In the comparison method, weights of common terms (those present in both vectors) are multiplied. The overall sum of these products, limited to 1, is the degree of relation between the text and the theme, meaning the relative probability of the theme presence in the text or that the text holds the theme with a specific degree of importance. The decision concerning if a theme is present or not depends then on the threshold used to cut off undesirable degrees.

The method is based on the relevancy index proposed in Riloff and Lehnert (1994) whose definition is "a collection of features that, together, reli-

ably predict a relevant event description." Some terms may indicate the presence of a theme with a degree of certainty. Therefore, the fuzzy reasoning process must evaluate the likelihood of a theme being present in a text, analyzing the strength of its indications. The process is like an abductive reasoning. According to Gulla et al. (1997), in a deduction, if "A→B" and "A is truth" then we can infer "B is truth." In abduction, if "A→B" and "B is truth" then "A is a probable cause for B being truth." That means if words that describe a theme appear in a text, there is a high probability of that theme being present in that text.

A Tourism Ontology

An ontology is a description of "things" that exist or can exist in a domain (Sowa, 2002). It is a formal and explicit definition of concepts (classes or categories) and their attributes and relations (Noy & McGuinness, 2002).

In the proposed system, it is necessary to have an ontology about the tourism domain. This ontology is created with a specific purpose, so it may not work in all travel agencies. It is possible for other tourism ontologies to exist (for this reason, it will be called *a* tourism ontology and not *the*).

The ontology structure is a hierarchy of themes or categories. It works like a Yahoo catalog for classifying tourism options (pairs of cities and attractions). Furthermore, for each theme, there must be a list of terms that help to identify the theme in texts. The relation between themes and terms is many-to-many (i.e., a term may be present in more than one theme and a theme may be described by many terms).

An ontology is similar to a thesaurus (in fact, a thesaurus is a kind of ontology, but this will not be discussed in this article). According to Fosket (1997), a thesaurus is a device to control terms in texts. Thesauri provide knowledge maps, representing concepts or ideas of the application domain and indicating relations among them. A thesaurus also defines terms used to describe a concept.

The internal representation of each theme is a two-dimension vector with single words and a weight associated to each word. Weights represent the importance of the word in identifying the theme in a text.

The ontology was created by humans with the help of software tools. A group of software tools, created in this research group, was used to make insertions of themes in the ontology, to add the relations between themes within the hierarchy, and to make the word list for each theme (insertion of terms and weights in the vectors). Experts defined the main themes and the relations within the hierarchy. An initial list of terms was made by experts for each theme. The TextMiningSuite software from InText Mining (www.intext.com.br) was used to help in refining the word list for each theme. Using the supervised learning strategy, experts selected relevant texts about tourism categories (themes of the ontology) and the software identified the most important terms in each context. But the final decision was made by humans. Weights were suggested by the TextMiningSuite tool according to probabilities. Experts modified the weights, reducing values of terms frequent in more than one category.

Figure 2 presents part of the tourism ontology used in the proposed system. Table 1 presents the terms used to describe each concept in this excerpt from the ontology.

Database of Tourist Attractions

To make recommendations, the system needs a database of options. These options include cities and their tourist attractions. Items in the database are not characterized by attributes. Only a summary of the option, with a few textual lines, is stored. Figure 2 shows some examples of items in the database (the database only contains tourist options of the Rio Grande do Sul state in Brazil).

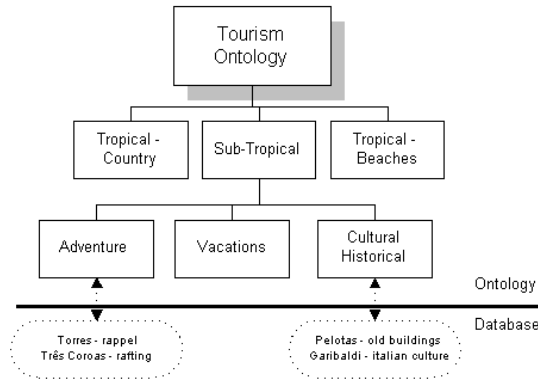

Figure 2. Excerpt from the tourism ontology and the database.

Table 1
Some Themes in the Tourism Ontology and Corresponding Terms

Themes	Terms
Subtropical	cold, mountain, snow, winter, wine, hearth
Tropical—beach	beach, forest, hot, bikini, island, summer, sea, swimming, snorkel
Adventure and sports	rappel, adrenaline, young, surf, emotion, farm, ski, diving, alone, friend, aquatic, park, windsurf, bike, racing
Vacations and relax	to rest, family, farm, relax, fishing, parties, walking, beach, gastronomic, bath, children, entertainment, park, bicycle, retired
Cultural/historical	war, museum, culture, painting, sculpture, show, concert, music, historical, monument, church, Bento Gonçalves
Group attraction	family, friends, group
Alone attraction	alone, individual
Couple attraction	couple, honeymoon, romance
Nature	canyon, waterfall, beach, sea, lake, farm, zoo
Business and study	business, trade, conference, study, language, library, university, school, college, student

The textual summary is used to classify the database items (tourism options) in themes/categories of the ontology. The same method used in the Text Mining Module is used to identify the themes related to each item. One item may be associated to many themes. The relationship between the item and a theme has a numeric degree (ranging between 0 and 1), determined by the fuzzy function explained above.

This database is created with experiences from people. A future goal is to make this database public in a Web site for other systems to use and for other people to store data about tourist options all over the world.

Recommendation Module

The recommendation module intends to simulate the role of a travel agent in offering options to the customer. This module starts when it receives a theme from the Text Mining module. Then it searches the database for items classified in the same theme. Each time the Text Mining module identifies a theme in a message, it sends this theme to the recommendation module. In the same way, search in the database is performed online (i.e., when the recommendation module receives a theme). Because a theme may have associated many options in the database, this may cause an information overload problem (many items recommended at once). The user (usually the travel agent) can configure the total number of items to be shown, limiting the final result. To improve this service, the system generates a ranking of the resulting options according to the degree of relationship between the item (a tourist option) and the theme. This degree is stored in the database when the item is inserted and classified (by the same method used in the Text Mining module).

Although the above function may limit the results shown to the user, a huge volume of options may be retrieved from the database. Another setup option exists to limit new searches to be made only in the set resulting from the last search. For example, when this option is set on, if the system identifies the theme X in the first message and the resulting set is S, the theme Y identified in the next message will cause the system to search items under the theme Y only in the set S. This narrowing function allows the user to restrict options (working as an "and" Boolean operator over the themes). The strategy is to limit the search space in the ontology, achieving nodes probable to be interest areas of the customer.

Because the discussion in the chat is synchronous, the recommender system should not interrupt the users. So indications are given in a separate frame and not inside the chat. Figure 3 shows a snapshot of the system in a real use.

Example of a Collaboration Session Using the System

This section presents an example of an application of the system. It is a chat between a customer and the travel agent. The customer gets in the system searching for travel information, but he does not know yet where he wants to go. The messages are presented and the system working is described in parentheses by an asterisk.

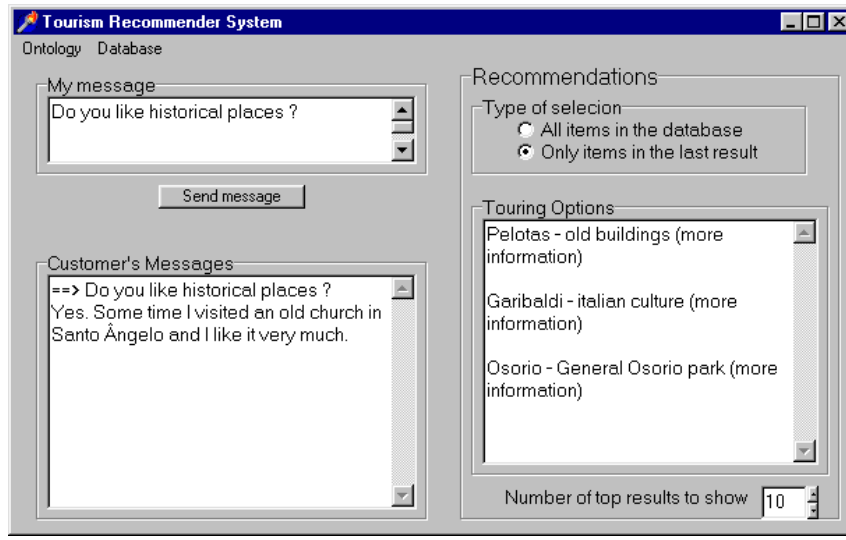

Figure 3. A snapshot of the tourism recommender system.

Customer: I want to travel next month. What do you suggest for me? (*No theme identified)

Agent: What kind of activity do you like? (*No theme identified)

Customer: I like parties. (*At this moment, the system identifies the theme "vacations and relax" and retrieves from the database some options classified in these themes)

Agent: What kind of climate do you prefer? (*No theme identified)

Customer: I prefer hot places. (*Admitting the option "only items in the last result" is checked, the system selects from the last result items classified in the theme "tropical—beach")

Agent: Do you usually travel alone or with family or friends? (*The system limits options under the themes "alone attractions" and "group attractions")

Customer: I like to travel with friends. (*The system limits options only in the "group attractions" theme)

Concluding Remarks

This work presented a recommender system to support travel agents in discovering tourist options for customers. The discovery is made analyzing messages between the customer and the agent in a private chat, using text mining methods and a tourism ontology. A prototype is being implemented in free software technologies (JavaScript, PHP, and MySQL).

The main advantage of the system is to free the agent from the burden of knowing a lot of tourist options and remembering at the exact moment when to recommend a good option to the customer. Furthermore, the customer does not have to choose attributes or requirements from a menu of options. The attribute choice limits the customer's creativity and influences his/her choice. With the proposed system, these needs and wishes will be discovered naturally during the conversation. This is especially useful for customers that do not know where they want to go and what they want to do, and this strategy does not limit options nor influence the customer.

Another advantage is that the travel agent (system user) drives the conversation and decides actually when to make the recommendation. To leave humans in command is important for filtering options and using expertise to explore and discover customers' wishes.

At the moment, the ontology is structured only for classifying options inside Rio Grande do Sul, a Brazilian state. Themes currently in the ontology represent only a part of all existing options. But it is possible to extend the ontology with other classes

of themes to support other options from different regions and countries.

Similarly, the current database only has options related to the cited region. This may be a problem because the success of recommendations is strictly dependent on quantity and quality of the available tourist options. Options have to be classified under correct themes of the ontology or risk having wrong options to recommend. Another problem is due to few options, which could cause poor recommendations independently of the recommendation method quality. Therefore, it is important to also use collaboration to populate the database. A public database, where any person may insert tourist options, is a good alternative.

In the same way, the success of recommendations also depends on the ontology used. Some problems can arise if the terms related to the themes are not suited to help in the identification of the theme in a text. Wrong terms may cause misunderstanding of themes in the messages and consequently poor recommendations. Lack of themes or terms may cause the system to lose opportunities for good recommendations. Therefore, the ontology (themes, structure, and terms) has to be created carefully by human experts with the help of automated tools. Usually, the ontology construction demands a lot of time and effort.

Regarding the text mining method, the threshold used to cut off options for recommendation has to be defined carefully. A value too small may generate a huge volume of recommendations each time, while greater values may cut off relevant options. In general, this threshold is set after training experiments. A disadvantage of the text mining method is that the context of words (near words) is lost. This may cause problems because the context may change the meaning of a word or the interpretation of a phrase (e.g., "is" and "is not").

At the moment, the customer is not identified by the system. This blocks the analysis of profiles but it enables users that are not customers of the agency to participate in the system. In a next step, profile analysis will be considered for use.

Future works include an improvement in the text mining module: a stemming algorithm is planned to filter word variations such as plurals, genre, verb conjugations (e.g., "party" and "parties" must lead to the same theme and the user can use one or the other).

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Biographical Notes

Stanley Loh is a Professor in the Catholic University of Pelotas and in the Lutheran University of Brazil. He has a Ph.D. degree in Computer Science. His interests include recommendation systems, text mining, and knowledge management.

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