Conceptual Model for a Hotel Seeking Agent

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ABSTRACT: Planning a holiday via the Internet can be a daunting process. Decision making is based on finding the right information in short time among an overwhelming amount of data sources.
There are various attempts to support the web based search for an appropriate hotel such as feedback questionnaires, personalized user interfaces and monitoring the behavior of the site's visitors. In many cases the tourist does not find the spatial information he would need according to his specific preferences. To address this problem a tourist would need tools to retrieve the spatial information according to his current priorities. The relevant information is determined as data elements describing facts corresponding to the tourist's preferences. Identifying these information elements is a step towards an efficient spatial information retrieval and its communication to the user.
The present paper analyzes the decision process of a Hotel Seeking Agent. Our hypothesis is that user preferences have to be considered in the data retrieval process. The work was motivated by classical dialog based booking process between human operators, carried out on the telephone. We introduce the conceptual model of a user interface, which considers the agents preferences and describes the overall decision making process. An outlook to future research topics is given.

1. Introduction

Internet portals offer various possibilities for tourists to plan all types of vacations. However, the handling of such systems can be frustrating because sometimes it is impossible to find the relevant information for a particular spatial decision, although it would be available. Hence decision making supported by an information system is based on finding the right information among an overwhelming amount of data sources. Another crucial point is that the information retrieval process has to be accomplished within a limited time period. A tourist does not want to spend more time than absolutely necessary to find a suitable hotel.

The outcome of traditional tourist information system on the web would present the user with a result regardless of his preferences. Every hotel has certain attributes. A possibility to choose among them is to select them at the user interface where the order of the attributes is fixed. In the example below the user interface includes an uncountable amount of attributes (see figure 1).

The approach can not be successful for two reasons. First empirical studies show that human users seem to be able to cope with 7+/- 2 elements at the same time and that they can capture around 3-4 elements at a quick glance (Miller 1994). The amount of the displayed attributes has to be reduced in comparison to traditional systems. This can be achieved by defining suitable ontologies for the involved objects and processes.

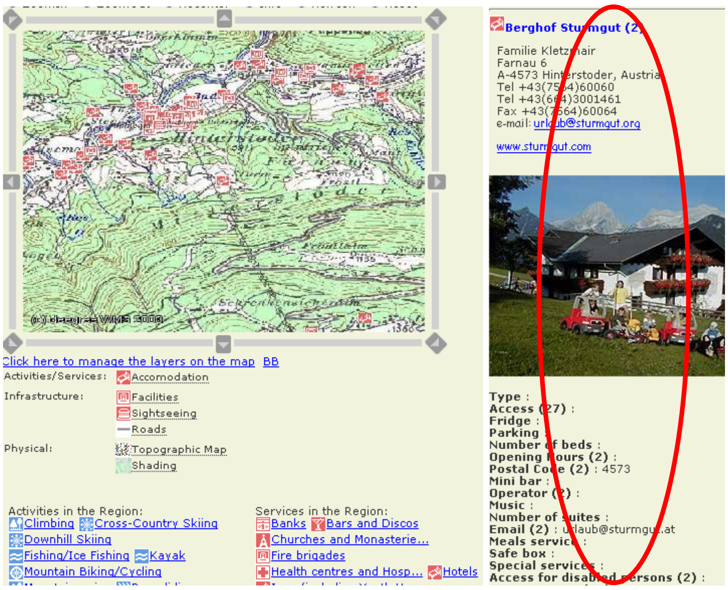

Figure 1: The user is overwhelmed by the number of attributes

Second users have preferences that should be considered when retrieving data from the information system. A way to consider the user's preferences is to let the user decide upon the ranking of the attributes of the involved objects.

The focus of this paper is on the latter aspect. We analyze the decision process that brings up information based on user preferences. Our research hypothesis is that user preferences ought to be considered in an efficient data retrieval process. Efficiency is measured as the time needed to retrieve the relevant information out of the system. In a conceptual model we suggest to introduce a total order into the query attributes via a direct manipulation interface (Shneiderman 1998).

An example for a user scenario can be described as following. A user might know exactly that he needs to go to Hinterstoder in Upper Austria at a certain date. He can specify that on the web site. Thus he needs an accommodation at a specific location at a specific date. These are musts or so-called hard criteria. Other aspects might be convenient but are not at all obligatory such as a 4-star category or higher and a personal sauna.

Currently in many cases the user could end up with no results, because there is no accommodation available that fulfills all the criteria. The tourist then would have to start the search again even though there might be a hotel in Hinterstoder available that fulfills the hard criteria.

We want to stress that when searching a web interface the user should have several possibilities to set his preferences.

- Reconsider his settings
- Set his preferences
- Soften up search strategy

If the priority of finding a hotel in Hinterstoder is higher than the priority of carrying out a certain activity, then this should be considered in the data retrieval process. In any case the web portal should at least display the available hotel in Hinterstoder.

The remainder of the paper is organized as follows. Section 2 introduces findings in spatial decision making and tourist information systems. Section 3 presents a conceptual model of a hotel seeking agent. Section 4 discusses a prototypic implementation and results achieved so far. The concluding fifth section gives an outlook to future research.

2. Spatial Decision Making and the Web

A decision problem is defined by the available alternatives (Edwards 1954). Decision making processes can be structured in many different ways resulting in a variety of decision making modles. To name only a few, we mention riskless and risky decision making processes (Tversky and Kahneman 1981). Rational decision making process and decision making with bounded rationality are further examples (Edwards 1954).

Personalized user interfaces are supporting the user in retrieving decision relevant information on the Internet (Staab, Werthner et al. 2002). However the revision of the user preferences can be a tedious process. Developing a shared knowledge base of the system and its user through a direct feedback approach is one way to agree upon a common understanding of vague spatial concepts (Cai, Wang et al. 2003). User interface agents are also an attempt to facilitate the use of an information system. The user interface agents operate parallel to the user and try to retrieve information by applying certain strategies (D'Aloisi and Giannini 1995; Li, Zhou et al. 2002).

Though there have been recently a number of approaches that try to consider the user’s needs in web-GIS (Raubal, Rinner, Hochmair) they require a lot of user input and some knowledge about algorithms used to retrieve data from a system. A dialog based approach seems promising. The user answers a series of questions comparable to a telephone booking. However it has to be restricted to a limited number of questions. Users have to be very acquainted with a website (like Amazon) to be willing to spend more time on feedback.

Comprehensive Data Models are needed that improve the decision process (Frank and Achatschitz 2004). We need to build ontologies for hotels, sport activities, tourist attractions, and many more objects that can be implemented in a tourist information system.

3. Conceptual Model of a Hotel Seeking Agent

The presented model is a dialogue based model in extension to the work of (Linden, Hanks et al. 1997). Linden et al. concentrated on booking a flight. The user could ask the system for available flights. We will take over some of the findings to apply it to the case of searching for a suitable hotel. The desired hotel has to have certain attributes, some are obligatory (place, price, …) some are mandatory (sauna, pool, breakfast,…). For the tourist and his decision which hotel to book only hotels where the attributes correspond to the user’s preferences are relevant. Through directly manipulating the interface the user can specify these preferences, by putting the hotel attributes into a preferred order. Changing the preferences will result in a revision of the relevant information. By direct manipulation we mean an interface that immediately reacts to the user’s settings and manipulations in the interface.

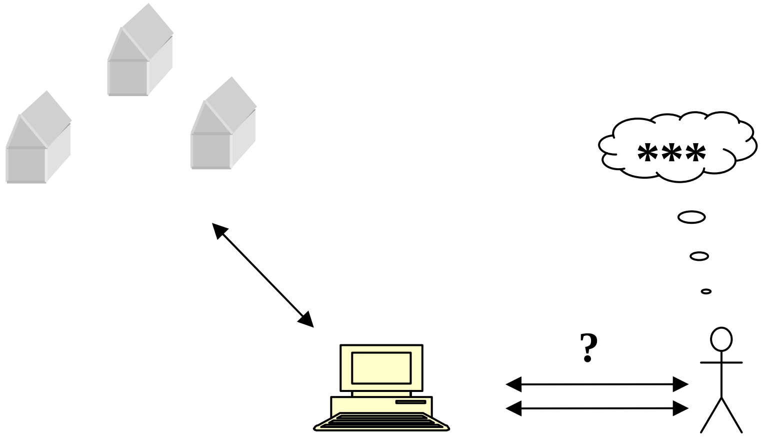

Figure 2: The users' preferences have to be included into the system. The double arrows indicate the feedback loops.

We apply an agent based approach to simulate the query process. An agent can be defined as "Anything that can be viewed as perceiving its environment through sensors and acting upon the environment through effectors" (Russell and Norvig 1995). The present model contains three actors: hotels, a user-interface, and a hotel seeking agent (see figure 2).

Hotels are objects with attributes that are stored in the database of the information system. The user interface stands at the same time for the information system (Frank 1993).

The agent can observe and manipulate the user-interface. The user interface has been realized as a finite state machine, a manipulation will lead it from one state into another. Several assumptions have been made:

- We restrict our model to a site selection problem. We want to find a hotel at a specific location. The agent knows where he wants to go and can state his preferences in a total order.
- Attributes are organized in some kind of structure. The elements in this structure can be assigned a preference. The data structure forms a partial order. Finding a more efficient structure is topic of future research.
- An agent can change his mind. He can change obligatory to mandatory constraints and vice versa. The agent can also change his preferences. Therefore feedback loops are forseen in the model.

The underlying assumption is that the user knows his preferences and chooses the alternative that best fits his preferences. The user as well as the information system are involved in this interaction process, the following elements have been identified in the decision process:

1. The user has to state his preferences by setting the priorities in the interface.
2. The information system has to produce candidate solutions by searching the web/data base with some search engine and appropriate search terms.
3. The user has to exclude those that do not fulfill obligatory criteria.
4. The user has to select the alternative that fits his preferences best.

4. Computational Model

For the realization of this computational model we chose an executable functional language. Haskell is widely accepted for rapid prototyping in scientific communities (Bird 1998). We built a functional model of the decision making process showing that the concept is feasible. We identified smaller elements of the decision process. The specifications are executable. In functional programming languages every statement is treated as a function, i.e.,

```
fun:: a -> b -> c ≙ f(a,b) = c
```

The notation given above will be used throughout the following paragraphs. The simplicity of the system was at the core of the conceptual model; therefore we kept the possiblity of interaction small. All the user can do is, defining a total order of his preferences. For each preference he has to state a value range, i.e., the price of the hotel the user is seeking shall not exceed one hundred euros. As this criterion is not as important to the user as having a personal sauna, it will be ranked lower. Thus he implicitly states that he is willing to pay more if a personal sauna is available in the hotel.

The attributes as well as the preference values have to be standardized in order to be comparable, according for example to the rank order rule (Raubal and Rinner 2004). The ordering then determines the weighting of the preferences. In the present work we apply the weights according to the position in a preference list.

$$w_i = \frac{i}{\sum_{i=1}^{n} i} \quad n \ldots \text{Number of preferences}$$

We introduce data types as simple as possible. Preferences, weights of the hotel attributes, and scores of the utilities, are represented as floating numbers. The hotel is an object with the usual attributes such as name, category (string), price (float)…

```
type Pref = Float
type Weight = Float
type Score = Float
Data Hotel = Hotel Name Category Price Location …
```

These types will be used in the subsequent functions that formalize the overall decision process. We represent these functions by their signatures. The agent uses them when manipulating the user interface. "[]" indicate lists of objects. In a first step the user states his preferences in a total order. This allows the calculation of weighted preferences.

```
statePref::[Pref]->[(Pref,Weight)]
```

Optionally the user can set hard criteria. These will reduce the available data sets significantly, by excluding all hotels that do not fulfill these criteria.

```
setObligatory:: [Hotel]->[(Pref,Float)]->[Bool]->[Hotel]
```

The following step creates candidate solutions. We are not interested in the result but in the overall process. We refer to work carried out for finding the optimal path for cyclists (Hochmair and Rinner 2005) and also on web focused publications like (Raubal and Rinner 2004). It is important to use standardized values of the attributes for evaluating the candidates.

```
createCandidates::[(Pref,Weight)]->[Hotel]->[(Hotel,Score)]
```

In any case the result will be ranked as a list of information elements, based on a utility score.

```
utility::Hotel->[(Pref,Weight)]->Score
```

The resulting list will be sorted and displayed to the user.

```
sortByUtilityScore::[(Hotel,Score)]->[(Hotel,Score)]
```

The user has two options: If he likes a hotel and its displayed attributes he can continue and select it. Otherwise he can criticize the information system by redefining his preferences. In the present model this is done by reordering the preferences, and optionally by resetting some of the obligatory criteria. In this feedback loop the function *createCandidates* will be called again until the user decides to select one of the displayed alternatives. This phase is critical because too many loops could cause the user to give up the search. The selection of one candidate among the displayed solutions is the final step of the decision process.

```
selectCandidate::[(Hotel,Float)]->(Hotel,Float)
```

The identified elements can be connected to a single function that represents the decision making process of a hotel seeking agent on a web enabled GIS site.

```
dP::(Hotel,Float)
dP = (selectCandidate . sortByUtilityScore) (createCandidates
(statePref preflist ) hotellist)
```

The decision process *dP* needs as inputs a list of hotels with their attributes (*hotellist)* and the users preferences given with standardized values (*preflist*). Optionally the hotel list can be pre-processed by excluding all hotels that do not fulfill obligatory criteria. The values of the attributes and preferences are standardized in order to be comparable.

5. Conclusion

We presented a conceptual model for a hotel seeking agent. The decision making process has been decomposed into the elementary units. A functional model has been implemented. While previous research focused on creating candidate solutions (Raubal and Rinner 2004; Hochmair and Rinner 2005) we focused on the overall process.

We hypothesize for future work that the selection strategy has more influence on the usability of a portal than the utility score evaluation. We will identify user groups based on their selection strategies. The agents we envision will implement emotions, like choosing a hotel to which they connect a former experience. Multiagent systems that consider hotel recommendations between agents are another goal of future research.

An extension of the model in several directions seems possible. The results motivate especially the investigation of the new paradigm of data retrieval that is based on the user desires rather than on the available data sources.

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