Agents as Agents: 
A Virtual Assistant for Self-bookings in Travel

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Abstract

The cutting edge for travel industry today is turning towards electronic commerce. It is one of the industries where business is conducted successfully on the Internet already today, and where the importance of electronic commerce is likely to grow. Consumers are offered great opportunities for convenient and inexpensive travel bookings, but at the same time face certain problems and limitations in this regard. Information overload on the Internet is a fact as well as a lot of rules when making the travel arrangements, meaning that the consumer online reservation systems, where the consumer himself is responsible for planning the trip and making the arrangements, may prove to be too complicated for all but the most sophisticated users.

Since the Spring of 1998 we have been investigating the opportunities offered as well as the problems facing consumers trying to make their own travel reservations on the internet. Based on these studies we are convinced that in order for the consumer to accomplish his travel arrangements more effectively on the Internet he will need support. We have developed a software agent, FareTracer, to assist consumers who make their own travel reservations on the World Wide Web. The agent is accomplishing specialized tasks on behalf of the consumer, and acts towards reaching certain consumer specified goals with a certain amount of autonomy and flexibility. The system is implemented as a pure Java application.

Keywords: travel industry, software agents, user profile

1. Introduction

The slow growth of business-to-consumer electronic commerce has surprised many analysts whose growth predictions have been proven false, and many companies whose heavy investments in ec-applications have been hasty and unprofitable. A great exception in this regard is the travel industry, to date the largest Internet commerce category (McCartney 2000). The fact that tourism-related services have emerged as a leading product category to be promoted and distributed to consumer markets through the Internet (Palmer and McCole) is hardly surprising considering the great suitability of the tourist product for e-commerce (Bennett and Radburn 1991; Byerley and Ewers 1996; Liebmann 1997; Marcussen 1998; Buhalis and Main 1998; Anckar and Walden 2000a; McCartney 2000) and the industry’s great traditions in the IT-sector (Bloch and Segev 1996; Standing et al. 1999), with electronic markets arising already in the
mid-1970s when it became possible for travel agencies to book flights and hotel rooms online through the so-called computerized reservation systems (CRSs).

According to Champy et al. (1996), we will see a profound shift of market power from producers to consumers in the era of electronic commerce. Consumers, including potential travelers, are likely to derive many advantages from the commercial opportunities offered by the Internet, the most revolutionizing of which is the chance of price reductions as a direct result of the redistribution of profits resulting from the disintermediation effect, i.e., the bypassing of intermediaries in the distribution chain. There are, however, many hindrances to a mass-market adoption of online shopping solutions even in the highly e-suitable travel industry. Making your travel reservations on the Web may be a difficult and time-consuming task. Moreover, the travel industry is complicated, with journeys, especially complex ones, consisting of many problematic elements that an inexperienced traveler may not consider. Consequently, many industry representatives believe that an educated customer is not a threat to the future livelihood of the travel agency community (Miller 1999).

In the academic literature, agent technology has been suggested as a potential way to reduce or eliminate the most obvious impediments to consumer self-bookings in travel (Turban et al. 1999; Anckar and Walden 2000c). Today, there are many hindrances to design an optimal Web agent solution for the needs and purposes of the potential traveler. However, although agent applications are unlikely to be able to compete with the convenience offered by human agents in travel bookings, they may still offer consumers savings in time and money, and can certainly reduce their uncertainty as to whether the price of the journey is reasonable. Moreover, through Web agent technology the potential traveler has access to a much larger choice of travel service providers than through traditional or Web-based travel agencies.

This paper describes a software agent, FareTracer, that was designed to assist consumers who make their own travel arrangements on the World Wide Web. First, we give a short overview of agent technology, after which we highlight some problems associated with self-bookings, pointing out the need for agent assistance in Internet travel reservations. Next, we give an account of the Web as an arena for travel service providers in order to describe the environment in which the FareTracer operates. Chapter 5 summarizes the advantages of the agent designed, followed by a description of the structure and behavior of the FareTracer. Finally, the limitations of the agent are discussed and some concluding remarks are presented.

2. Agent Technology: An Overview

The concept of intelligent or software agents has been around in the IS world for some time indicating that the field of agents is rich and diverse. The automation of work and the automation of computer use are central to the idea of software agents. Software agents that can automatically perform certain tasks to reduce the workload on consumers will play an increasingly important role in electronic commerce, and especially in the travel industry where consumers are overloaded with information when trying to make sense of available service providers, as well as available travel arrangements, and at the same time avoiding to get lost in the cyberspace. There are
several tasks for which the agent technology is of vital importance, such as information search and providing assistance.

According to Jennings and Wooldridge (1998) most agent researchers would find themselves in broad agreement with the following key principles in the definition of software agents and agent based systems:

Software agents are computational programs or entities situated in a computing environment and assisting users with computer based tasks. They act to accomplish specialized tasks on behalf of users and act towards reaching certain user-specified or automatically generated goals with a certain degree of autonomy and flexibility (Maes 1994, Jennings et al 1995, Jennings and Wooldridge 1998). Agent-based systems refer to systems in which the key abstraction used, either in conceptualisation, design, or implementation, is that of an agent (Jennings and Wooldridge 1998).

The key attributes emphasised here are situatedness, autonomy and flexibility. Situatedness means that an agent receives sensory input from its environment and that it can perform actions which change the environment in certain ways. Autonomy means that the system is able to take initiative, to solve problems without direct intervention or constant guidance from a user or other agents, and that it has control over its own action and internal state. To be flexible means that the system is responsive, adaptive or robust, which again requires that it perceives the environment and responds in a timely fashion to changes which occur in it, and takes account of changing user needs and a changing task environment. In this way an agent system comes to know the user’s preferences better and can tailor interactions and actions to reflect them. Finally, an agent system can be made proactive. Then it not simply acts in response to the environment, but it is also able to exhibit opportunistic, goal-oriented behaviour and to take the initiative where appropriate. It does not wait to be told what to do next, rather it makes suggestions to the user (Liu 2000, Walden, Carlsson and Liu 2000, Jennings et al 1995, Jennings and Wooldridge 1995, 1998, Nwana 1996).

Agent systems maintain an ongoing interaction with the environment and can act on the environment (Hess et al 1998) Because of this, agent systems can work in both real time processing (user initiated) and in batch processing (a scheduled time or conditioned time). Agents are always "alive" and ready for action, and they do not rely on users’ explicit actions to be activated. They work in the background, serve around-the-clock, and perform automatic actions at the user-level of abstraction (Maes 1994, MacKie 1995).

With agent systems users need only specify a high-level goal instead of issuing explicit instructions, and can leave the ‘how’ and ‘when’ decisions to the agents. Agent systems make it possible for the programs to work independently of the users’ presence and instructions, and to deliver only customised user-wanted information and service (Jennings et al 1998, Maes 1994, MacKie 1995). As Negroponte (1997) claimed, the future of computing will be 100% driven by delegating to, rather than manipulating computers.

The agent approach adds diversity and competitive value to existing systems. Applications with agent functionality possess competitive advantage to those without it. They provide products that are easier to use, bypass intermediaries between
products/services and customers (users), eliminate delay in the process and free up human resources (time, cognitive efforts) for other work.

Agent wrappers can be built around legacy systems to enable them to inter-operate with other systems (Jennings et al 1998).

Agents are an alternative approach for abstraction with which to understand and manage complexity and with which to conceptualize, design and implement complex software systems. Atomic problem solving components within an agent system still have to be able to perform the necessary domain tasks, which tends to be limited by the techniques that are currently available. Tasks that are beyond the scope of automation using non-agent techniques will not necessarily be made possible simply by adapting an agent approach. It is important to exploit related technology when implementing software agents (Jennings, et al 1998)

Software agents are a technology with many unknown ramifications. When tasks are delegated to agents, users need to gain confidence in the systems that work on their behalf and this process can take time. During this period the agent systems must strike a balance between continually seeking guidance while unnecessarily distracting the user, and never seeking guidance in which it may exceed its authority (Jennings, et al 1998, Wooldridge and Jennings 1995).

3. Consumer Benefits of E-Bookings: Four Myths

The consumer benefits of e-commerce have been widely cited in the academic literature and the popular press (Hoffman et al. 1996; OECD 1999; Turban et al. 1999; Schneider & Perry 2000). Potential advantages for travelers planning and booking their journeys on the Internet include: greater convenience (from anytime, anywhere); greater amounts of multimedia destination information and real-time information on price and availability, e.g. last-minute deals; increased opportunities for comparison shopping and price comparison; and personalization benefits (more personalized relationships between suppliers and customers due to their ability to collect information on customers needs and behavioral patterns in large databases, achieving an automation of the customer profile).

Moreover, e-commerce has been suggested to give the consumer four additional benefits, namely (i) time savings as a result of the rapidity of transactions; (ii) price reductions, which may be the result of increased competition as more suppliers are able to compete in an electronically open marketplace, as a result of reduced selling prices due to a reduction in transaction costs, and manufacturers internalizing activities traditionally performed by intermediaries (Benjamin & Wigand, 1995); (iii) ease of bookings as the travel reservation-making process can potentially be automated by EC technology (Chircu & Kauffman 2000); and (iv) a wider selection of destinations and service providers. As we speak of the travel industry, these four benefits certainly deserve some special attention due to their contradictory - and partly interrelated - nature. Although these consumer benefits certainly may be derived even in the travel industry, we nevertheless present - somewhat provocatively – the suggested benefits as four myths to make our point.
3.1 Myth 1: Time Savings

According to Valle (1996), many consumers believe that they can save time and money and possibly gain additional convenience by bypassing the traditional travel agent. But although some industry representatives and authors have suggested that direct bookings are creating tremendous savings in time as travelers no longer need to spend lots of time on the telephone talking with travel agents (Resnick 1997; Miller 1999), the results of studies done by Anckar & Walden (1999; 2000) indicate that the self-booking of journeys is a highly time-consuming task - irrespective of the complexity of the journey. There are multiple reasons for the time-consuming nature of Internet bookings:

First, finding service providers (i.e. locating Web sites offering the services needed) might take time and perseverance, especially as it is often not possible to book travel directly online and certainly not possible to buy the separate parts of a trip through the same supplier (Bloch et al. 1996). Second, most travel sites do not offer any actual services (checking availability and/or making bookings) unless the user has registered for the service. These registration procedures, which normally include a long list of questions for profiling purposes, can be rather time-consuming. Third, the actual booking procedure (or availability check) usually involves a specification of many parameters in a search engine. However, if no seats are available or the price is too high, the user must normally try another search with new parameters, which can be a time-consuming task. Fourth, although the potential for making price comparisons often has been mentioned as a great consumer benefit of e-commerce, it is no doubt a time demanding task. As is pointed out by Reedy et al. (2000), comparing prices from site to site could certainly ensure the lowest expenditure for the consumer, but the cost in time and effort might not be worthwhile. Still, most travelers, exhibiting normal consumer behavior, are likely to tirelessly make price comparisons prior to making an Internet booking.

3.2. Myth 2: Price Reductions

Although the suggested consumer benefit of lower prices on electronic markets may seem intuitively realistic, it is becoming increasingly evident that getting a good travel deal on the Internet is by no means an easy task. The results of two studies done by Anckar and Walden (2000a; 2000b) indicated (i) huge variations in price in self-bookings even among highly experienced Internet users; and (ii) online bookers being unlikely to compete on price with physical travel agents. Hence, it seems to be the case that people using the Web are not always getting the best deal partly because special fares with restrictions are not always advertised online (Harris 1997), and partly because this would require some basic knowledge about the pricing principles of the travel industry and the strategies travel agents use to get a low fare (Wilson 1997).

An additional point to be made is that the effort to get a fair deal is likely to be rather time-consuming (cp. 3.1.). According to Turban et al. (1999), any experienced traveler knows that good planning and shopping around can save a considerable amount of money. However, one should remember that consumers perceive costs of search activities as resource expenditures – the time and money required to undertake
search - as well as the cognitive effort required to process the information required (Fodness and Murray 1999), meaning that the search process in itself should be taken into consideration when assessing the total costs of a journey.

Travel agencies strive to serve their customers by getting them the lowest fare available for their desired destination (Slack 1998). As most agencies offer experience, knowledge and intuition that cannot be found in an online service (Wilson 1997), even an experienced self-booker may not be able to undercut the prices offered by a human travel agent.

3.3. Myth 3: Ease of bookings

Although there certainly is a potential for automating the travel reservation-making process with EC technology, it has turned out to be a very complex software problem to give consumers an online tool to shop for and purchase travel, as well as to browse for destinations, particularly in this insanely volatile fare marketplace (Maddox 1997). Many industry representatives feel that the complexity of international flights and CRSs, with many confusing explanations of terms, will render consumer online reservation systems impractical for all but the most sophisticated users (Hart 1995). According to Chircu and Kauffman (2000), many companies using online reservation systems have documented great knowledge barriers in the case of complicated travel arrangements, as making reservations in international markets is very complicated. Hence, Turban et al. (1999) suggest that complex trips, which require specialized knowledge and arrangements, must be made by a travel agent. It should be noted, however, that research results indicate that experienced Internet users tend to fail to make even low complexity travel arrangements on the Web (Anckar and Walden 2000a and 2000b).

A journey consists of many problematic elements that an inexperienced traveler may not consider. As a result of the feeling of uncertainty associated with self-bookings, many people want to interface with human agents (Cooper and Brown 1997), patronizing travel agencies to lower the risks involved in travel and to take advantage of the convenience that an agency has traditionally provided (Valle 1996). Although online bookings have been pointed out as a highly convenient way to make travel reservations, it should nevertheless be noted that contacting a human travel agent by phone or e-mail in most cases remains the most convenient way to make one’s travel reservations.

3.4. Myth 4: A Wider Selection of Service Providers

With the boundaries of e-commerce not being defined by geography or national borders, Internet users are offered a global choice of vendors and producers. Although this certainly is a great benefit in the travel industry, which is essentially global in character, two facts, however, inhibit the potential traveler from deriving full advantages from a wide selection of tourist service providers on the Web. These limitations arise from the fact that (i) small and medium-sized tourism enterprises (SMTEs) remain under-represented in most large, established computerized reservation systems (Buhalis 1996). As the vast majority of tourism enterprises around the globe can be classified as SMTEs (Buhalis 1996 and 1999), we have a situation where most tourist service providers, due to their small size, have
insufficient resources for a Web presence, and especially for online reservation services; (ii) as a rule, online booking travel sites on the Internet offer a Web interface to the one CRS to which they subscribe. Consequently, the selection of service providers is limited to the ones that are represented in the CRS. The implication of this limitation is that the potential traveler will have to locate and browse several travel sites, all connected to competing CRSs, in order to have a large choice of service providers. Moreover, there are a great number of service providers that are not represented in the large CRSs, but nevertheless can be reached by a global tourist market through the Web sites they operate individually or as a collective effort with other service providers. In many ways, these providers using the Web as their primary tool may, in fact, represent the most attractive target for bargain seekers, as they have eliminated the intermediaries in their distribution channel.

4. Travel Industry Actors on the Web

As an arena for travel service providers, and as an environment in which the FareTracer will operate, the Web is full of nuances, offering a wide range of service providers with business models that are not always obvious to the customer.

4.1. Web-based Travel Agents

Within the academic literature, the hypothesized disintermediation effect in the travel industry, i.e. the bypassing of intermediaries as a result of e-commerce, has received much attention (Lewis and Talalayevsky 1997; Chircu and Kauffman 1999; Standing et al. 1999; Anckar and Walden 2000a). Up to this point, however, Internet self bookings have rarely been characterized by complete disintermediation, as individual travelers (the general public) do not have access directly to the large, established CRSs such as Sabre, Worldspan, Amadeus and Galileo, but have to use e-intermediaries, i.e. third-party online agencies (such as Travelocity.com or Expedia.com) as a gateway to these immense systems. In these CRSs, reservations can be made for airline flights, hotels, rental cars, etc.

The travel agencies operating on the Web are either virtual extensions of physical travel agents or virtual start-ups. The former generally accept inquiries and submit offers by e-mail, whereas the latter as a rule offer automated online booking services.

4.2. WWW-services of Individual Travel Service Providers

Airlines and hotel chains, many of which offer online booking services on their Web sites, would like to sell tickets and rooms directly to the customers via their own Web sites to eliminate commissions and maintain control over customer relationships (Hibbard 1998). However, from the customer’s point of view this is a highly time-consuming task in comparison to the one-stop-shop services offered by Web-based travel agencies. Moreover, the benefits are questionable as the airline Web sites have been criticized for not posting special deals that are not accessible through CRS-connected Web-based travel agencies (Korhonen 2000).
4.3. Web Reservation System Alliances

In response to the dramatic growth of online travel sites such as Travelocity.com and Expedia.com, airlines have recently banded together to create new reservations sites on the Web. Examples include the T2 project by 27 American air carriers (Goetzl 2000) and the venture between 11 dominant European carriers – including many fierce rivals (Middleton 2000). The aim of these high-stake efforts is to give air carriers a more direct line to the consumers, disintermediating e-intermediaries, of which some have grown to the point where their market position is getting dangerously strong (McCartney 2000). Within the hotel industry, corresponding online reservation consortia have been accessible by individual customers already for quite some time.

For consumers, such independently operated online travel consortia offers an opportunity for complete disintermediation, with no commissions being paid to middlemen. Moreover, the airlines backing the sites have announced that special deals that are not available through any travel agencies will be offered through the systems.

4.4. The Agent Environment

Travelers tend to show little or no brand loyalty (Warren and Ostergren 1990; Robinson & Kearney 1994; Baloglu et al. 1998), but instead require a travel product at the lowest price and of the highest quality - consistent with his own value judgement and preferences (Buck 1988). According to Malley (1999), the Web has unleashed a torrent of customers who are increasingly fleeting and irreverent towards brands; they do not care as much about the brand as they do about what they are getting for their money. If there is a better deal around the corner or, more aptly, on somebody else’s Web site, they go for it.

Referring to this fact, it can be assumed - as a general rule - that customers have no distinct preferences for neither the travel service provider nor the travel distributor. If we rule out frequent flyer programmes (FFPs) and other regular customer discounts, the primary priority of the potential traveler is likely to be (i) the price of the journey, and (ii) the convenience of the itinerary. The traveler will choose the journey that best satisfies his travel needs and preferences, irrespective of whether the distribution of the journey - or its components - is characterized by a complete disintermediation or not. Hence, he certainly has an interest in searching through all the options available, meaning that an agent like the FareTracer should operate within a broad environment, scanning a large number of sources within each of the actor categories presented above.

The FareTracer is an autonomous software application. The agent can monitor and react to events/changes in its environment. The environment of the agent consists of the user interface, the knowledge base, the user profiles, the Web sources it monitors, and the notion of time. The agent keeps track of time through the real-time clock of the machine where it is running. This time-sensing allows the agent to perform scheduled tasks of maintenance and data control.

The FareTracer application receives requests from the users to summarize the available travel alternatives so that the user can choose the best one. The summarized
information is based on the available information that the agent has found and the travel parameters (including the customer profile) specified by the user (cp. 6.1.). When all the alternative sources have been scanned, the agent summarizes the information and reports its findings to the user, who then picks the best alternative and books the trip, assisted by the application, electronically.

5. Advantages of Agent-Based Travel Assistance

The consumer benefits of e-commerce will for travelers planning and booking their journeys on the Internet be more realistic to achieve with the support of a software agent. The key attributes describing the agent are situatedness, autonomy and flexibility meaning that the agent approach will make the proposed myths a reality.

The consumers can save time with the support of an agent. The agent can take initiative, solve problems without direct intervention or constant guidance from the user.

The consumer can obtain better prices with the support of an agent. Different travel sites, such as Travelocity.com, and Expedia.com are normally connected to the four biggest CRSs, and hence, they do not always come up with the same fare for the same flight. Different Web sites house different search software and access different CRSs (Pachetti 2000). With the proposed agent approach the consumer can check different sources before making the final booking. It is a fact that for any particular flight, there are a multitude of ticket prices and an agent is particularly suitable to make the price comparisons for the consumer.

The ease of booking is highly dependent on the functionality of the available reservation systems. Within the knowledge base of an agent like the FareTracer it is less risky to make the bookings.

The choice of service providers becomes wider. The agent is not restricted to a certain or a few CRSs but can work through an unlimited number of service providers on the Web. Within the FareTrace application a knowledge base for small and medium-sized hospitality organizations is created.

We believe that on the average travel agencies represent the most convenient way for consumers to make their bookings. Generally, most consumers count on travel agencies to search the unduly complicated, and voluminous fares and schedules to find the lowest fare (Slack 1998). However, one should bear in mind that the travel agent cannot spend too much time per booking, which means that the terms provided by the travel agent might not be the most preferable. Another thing is that the travel agencies are not connected to several different CRSs and we would be highly surprised if they would use the service providers on the Web.

Although an increasing number of travelers are conducting preliminary research online, studies nevertheless show that they prefer to make their purchases with agents they know and trust (Miller 1999). The same point was made by Ginsburg (1995): "Why would you go through all the hassle when a competent travel agent could do it for you? A counter argument can be made by stressing factors like (i) how about-
maintaining control over your travel choices but this will be counter-balanced by the fact that travel agencies can (ii) ensure that you get the lowest possible airfare and (iii) uncover deeply discounted air and lodging deals or vacation packages. This state of affairs is recently summarized by Valle (1996):”If the services offered are not perceived to be significant or if agencies are not seen as the best means of acquiring such benefits, customers will defect”.

6. Agent Performance

6.1. Search Parameters

The key to find a journey satisfying the wants and needs of the traveler lies in the agent search parameters that are specified by the user. The tourist product is a composite product, an amalgam of what the tourist does at the destination and of all the services he uses to make it possible (Burkart and Medlik 1981). Hence, even in low-complexity bookings, a specification of a large number of parameters on core and less essential products and services may be necessary - or at least desired by the customer.

The agent search parameters can be classified according to (i) their character (journey-dependent / journey-independent) and (ii) their importance (primary importance / secondary importance). By primary importance parameters we mean customer travel demands which by necessity must be satisfied, whereas secondary importance parameters do not necessarily have to be taken into account in the itinerary, although this would be desirable from the user’s point of view. By this classification, we get 4 different parameter levels, which essentially explain the search logic of the FareTracer (see figure 1). It should, however, be noted that this parameter classification is in no way depicted in the user interface.

<table>
<thead>
<tr>
<th>PARAMETER CHARACTER</th>
<th>Primary Importance</th>
<th>Secondary Importance</th>
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<tbody>
<tr>
<td>Level 1 (necessary)</td>
<td>Level 3 (optional)</td>
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<tr>
<td>(non-static) overrides UP data</td>
<td>user profile data</td>
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<tr>
<td>Level 2 (optional)</td>
<td>Level 4 (optional)</td>
<td></td>
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<tr>
<td>user profile data</td>
<td>user profile data</td>
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**Figure 1. The Four Levels of Agent Search Parameters**

Parameters categorized as Level 1 input (non-static, or journey-dependent parameters) must by necessity be specified by the user in order for the FareTracer to perform its task. The level 1 input includes the most essential information needed by the agent, e.g. the departure and return date, point of departure, destination(s), the number and
age of travelers, etc. The level 2 input is likewise of primary importance. However, the specifications are intrinsically static, and hence included in the user profile, which is designed to make the parameter specification process faster (the user profile is explained in more detail in 4.2.3.). The level 3 and level 4 parameters are of secondary importance. The level 4 specifications are included in the customer profile, where the user has ranked these parameters as low in importance. Hence, the user defines – according to his individual preferences – the importance of a certain parameter. The parameters he has found high in importance when completing his user profile are classified as level 2 parameters.

The level 3 input, being journey-dependent, is not included in the user profile, but represent optional parameters which override the static parameters in the user profile, i.e. the basic preferences, if the user wishes to deviate from his saved profile for a certain journey.

6.2. Agent Structure and Behavior

The travel agent application consists of five building blocks (see figure 2). The different blocks are: (i) the user interface; (ii) the knowledge base; (iii) the user profiles; (iv) the data sources; and (v) the agent itself. The building blocks of the FareTracer agent are the same as they would be for any kind of information collecting agent application. The responsibilities of the different building block are described below.

Figure 2. The FareTracer building blocks and the agent environment.

6.2.1. User Interface

The user interface controller monitors the user interface and analyses all the input and output between the agent and the application user. The user can get the attention of the FareTracer with the user interface, which is the only connection between the user and the agent. When the user wants to consult the FareTracer for travel assistance, he needs to activate the user interface and give the needed information. If the agent
chooses to handle the request it will start to scan the data sources. Otherwise, if the agent is in such a state that it cannot perform any travel analyzing (in a shutdown or reset state), it will inform the user and ignore the request.

6.2.2. Knowledge Base

The knowledge base (KB) is where the agent stores its knowledge of the environment. The KB includes information about e.g. airlines, hotels and airports (figure 3). The information in the KB is entered by the travel agent (automatic retrieval) or manually by the interested parties. In chapter 3.4, we highlighted the consumer disadvantage resulting from a limited choice of interesting accommodation alternatives due to the fact that most SMHOs remain under-represented in most large CRSs and have insufficient resources for a Web presence. In order to find a remedy for this disadvantage for potential travelers and SMHOs, the FareTracer KB contains some essential data on a large number of SMHOs from all around the globe, which do not yet have a Web presence. This information is manually fed into the KB by SMHOs, that wish to be a part of the FareTracer environment. If the information in the KB is not updated within 3 months, it is automatically removed. This is to make sure that information stays correct (up-to-date). The agent is checking the Web sites that it uses on a daily basis, and if the site cannot be scanned for 3 months, the information is removed. For the manually stored information the same rules apply: the information must be controlled and updated by the responsible party within the timeframe or the information will be marked 'old'. Information that is not 'active' is not used when the FareTracer collects the different travel and accommodation alternatives.

Figure 3. The KB information content.

The information in the KB is used to compare the information in the user’s profile with the information collected from the different data sources. The agent uses the information that it finds in the KB to select trips and accommodation alternatives that best fit the specified parameters and the user profile.

6.2.3. User Profile

The user profiles consist of facts stored about the users. There is an identification process that lets the agent know who the user is. When the agent knows who the user is, it fetches the correct profile with the information about this user’s preferences. The preferences are given by the user when he/she registers with the travel agent application. The agent can handle profiles that are not complete, it skips the blanks
and uses only the given information. The user can enhance the profile and add information at any time. The profile that is stored for the user is a basic profile without any journey-specific information.

6.2.4. Information Retrieval

The last building block of the *FareTracer* consists of the data sources which the agent scans for information. This is the most challenging part. The look-and-feel of the data sources can differ quite a bit, and the services that they provide range from the company logo with static information to advanced interactive travel planners. Some of the numbers present are today’s prices with discounts, whereas some other prices are valid only under certain conditions. The agent needs to be very intelligent to be able to extract the right information from all the different types of data sources. The best way to solve this problem is to divide and conquer. The *FareTracer* has different modules for the different data sources it collects information from. This allows the agent to, through the modules, know where the important information is located in the data source, and also how it can be collected.

![Figure 4. The FareTracer Information Retrieval Process](image)

The advantage of using a one-to-one mapping of sources and modules is significant compared to the generic approach with one module for all data sources. By having specific modules for every site it is possible for each module to collect exactly the wanted information and nothing else. The module can be instructed to collect prices and other important information that is needed in the Knowledge Base. The agent can insert the information into the KB, since it understands the content of the information that it has collected. A generic module that collects information from different data sources can only, at best, guess that the data that it collected is a price for a one-way flight.

Using different modules instead of a generic one has one major drawback. The modules must be updated whenever the data source is updated. As soon as one
important part changes then there is a high possibility that the agent fails to retrieve information from that data source. This is a price that must be paid since it is the only way for the agent to really know/understand the collected information.

When the agent scans a data source, through its module, it uses the address of the site to download all the important information contained there. When the information is collected the agent parses the information and compares it with the information stored in the user profile. If the information from this data source matches the profile of the user, the downloaded information is temporarily stored, so that it can be compared to the information found on the other sites. When all the data sources have been scanned and the retrieved information has passed the first filter (the user profile), it is sorted according to the price of the journey (the default primary priority) and the preferences of the user. The 'best' alternatives are listed on top, whereas the poorest alternatives are dropped. The user can specify the amount of hits the agent should show.

8. Conclusions

The key to find a journey which satisfy the wants and needs of a traveler is the main goal when making the travel arrangements on the Web. Potential travelers are likely to derive many advantages from the commercial opportunities offered by the Internet, the most revolutionizing of which is the chance of price reductions as a direct result of the bypassing of intermediaries in the distribution chain. There are, however, many obstacles to a mass-market adoption of online shopping solutions even in the highly ec-suitable travel industry. The problem of getting lost in cyberspace, the myriad of information and inefficient browsing may be too big an obstacle for the consumer to overcome. The four myths which we have presented (i) time savings, (ii) price reduction, (iii) ease of booking, and (iv) a wider selection of service providers may be found in the travel industry, but for the myths to become value-adding reality the consumers need support.

We propose the use of an autonomous software agent, the FareTracer, which is implemented as a pure Java application. The agent can monitor and react to events/changes in its environment. This environment consists of the user interface, the knowledge base, the user profiles, the Web sources it monitors, and the notion of time. The agent keeps track of time through the real-time clock of the system where it is running. This time-sensing allows the agent to perform scheduled tasks of maintenance and data control.

The FareTracer application receives requests from the users to summarize the available travel alternatives so that the user can choose the best one. The summarized information is based on available information that the agent has found and the travel parameters (including the customer profile) specified by the user (cp. 6.1.). When all the alternative sources have been scanned, the agent summarizes the information and reports its findings to the user, who then picks the best alternative and books the trip, electronically assisted by the application.

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