PUBLIC TRANSPORT TRAVEL PLANNING APPLICATION

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Abstract: Here it is presented an application that plans out travel on public transports and that chooses the best ones, according to preference criteria provided by the user. These criteria are: the time spent on the travel, the price of the tickets and the quality of the transports. The application combines different means of transport. Algorithms and heuristics were developed to draw up transport plans and to choose the best ones. The best plans are determined using the multi-attributes decision techniques.
The application uses a database that was developed in a Relational Database Management System. To draw the database at the conceptual and the applicational level, it was used one of the models based on the object, the Entity-Relationship Model.

1. INTRODUCTION

This paper presents an application that draws up transport plans using public transports and shows the best plans, according to preference criteria provided by the user. The application combines different means of transport and can be used at transport terminals (airports, bus and railway stations), at travel agencies or at information posts.

For people today, time is an indispensable resource that justifies the planning of some activities, such as travels. Travelling is still a necessity, although the sprouting of information technologies has decreased this necessity. On the other hand, an improvement in the public transports and in the transport infrastructures has been acknowledged in the latest years, leading to a growth in the use of public transports. These are some of the reasons that justify the development of an application of this kind.

In order to draw up transport plans, the user has to give information about departure and arrival places. Date and time after which the user intends to leave or date and time, before which the user wants to arrive, are data that also have to be indicated. The user must also specify his/her preference criteria in the choosing of the best plans. The user's choice reflects the importance given to the cost of the travel, the travel spending time, and the quality of the transports.

The first approach to the question in study was to represent the knowledge acquired about the public transports, using one of the methods that better represents the problem. In this case, it would not be necessary to represent the knowledge but only the information. However, this is necessary in order to develop a Knowledge-based System (usually called Expert System), for further investigation.

A database was developed in a Relational Database Management System (RDBMS). Algorithms and heuristics were developed to draw up transport plans and to determine the best ones. The best plans are determined

according to preference criteria provided by the user, using the multi-attributes decision techniques.

In analysis were the public transports, their characteristics, the type of services they provide and the payment conditions. The public transports were grouped in three sets: interurban transports, urban transports and taxis.

Urban transports are those that circulate at the urban areas and that have specific types of tickets, such as pre paid, season, return and single tickets. The interurban transports perform middle and long duration routes and although they operate with pre paid tickets, the price of the tickets depends, on which class the user wishes to travel on (1^{st} class or 2^{nd} class). Finally, the taxis, a different type of public transport with a specific kind of payment, offer different conditions from those allowed by the other means of transport. This fact justified a specific analysis.

This paper is set up as follows: In Section 2 it is indicated the knowledge representation method used and the reasons of its choice. The definition and implementation of the database are presented in Section 3. Section 4 presents some of the algorithms and heuristics used to draw up the plans and the techniques used to determine the best plans. An example of transport plans determined by the application is shown in Section 5. Section 6 concludes with the indication of some improvements to the application.

2. PUBLIC TRANSPORTS KNOWLEDGE REPRESENTATION

After analysing the universe of the public transports, it was searched among the possible knowledge representation methods, such as semantic nets, production rules, frames, scripts and others, for the one that better represented the universe in study. The method chosen was the frames, basically because this is able to represent this knowledge in a natural way and because of its inheritance mechanism (Minsky, 1975; Reichgelt, 1991).

These are the names of some of the frames that were defined: Transport, Urban, Interurban, Taxi, Operator, Taxi-Operator, Stop, Ticket, Ticket-office, Discount, Class-Type and Locality (Correia, 1996).

3. DATABASE DEFINITION AND IMPLEMENTATION

To draw the database, one began by using one of the logic models based on the object that allow the description of data at the conceptual and the applicational level, that provide the possibility of a flexible structuration and allow data restrictions in an explicit way. Among the many possible models, the Entity-Relationship model, also called E-R model was used (Chen, 1976; Carapuça, 1993; Date, 1995).

Because the Microsoft Access 97 was the Database Management System used and because it is a Relational System, it was necessary to convert the E-R diagrams into relations (Carriço, 1996).

During the conversion made basically in function of the types of relationships and of obligation of the entities in the relationships, it is necessary to guarantee that redundancy is not introduced in the database, that the constraints of integrity of entities and referential integrity are kept and that a minimum number of relations is achieved.

Finally, it was also verified, if the relations were normalised until the Fifth Normal Form, to eliminate existing redundancies in order to avoid problems with insertion and elimination of data and updating.

Figure 1 presents the relations diagram for interurban transports, using the notation by Hawryszkiewycz (Hawryszkiewycz, 1990).

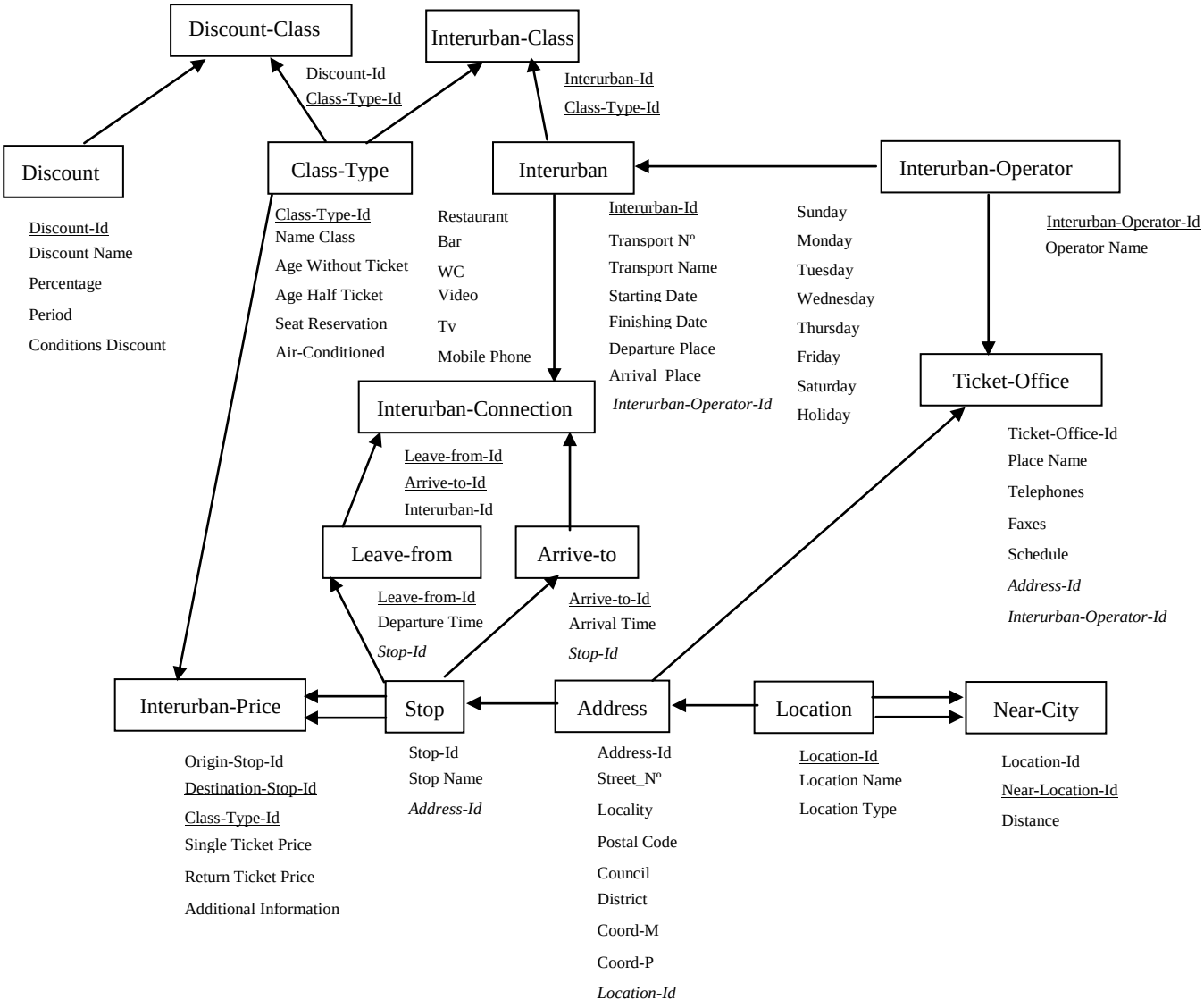

Figure 1. Relations diagram for interurban transports

In figure 1 the rectangles represent the relations. Next to the relations appear their attributes, where the primary key is underlined and the foreign key is in italic. The arrows indicate that the value of the primary key of the relation where the arrow begins has to exist in that relation before being used as a foreign key in the other relation where the arrow ends.

Information about the interurban transports that travel from the Algarve (region) to Lisbon (city) and vice-versa (train, express bus and plane), about some urban transports (bus) and about taxis is stored in the database.

Figure 2 corresponds to one of the forms that allows the database administrator to input information into the database.

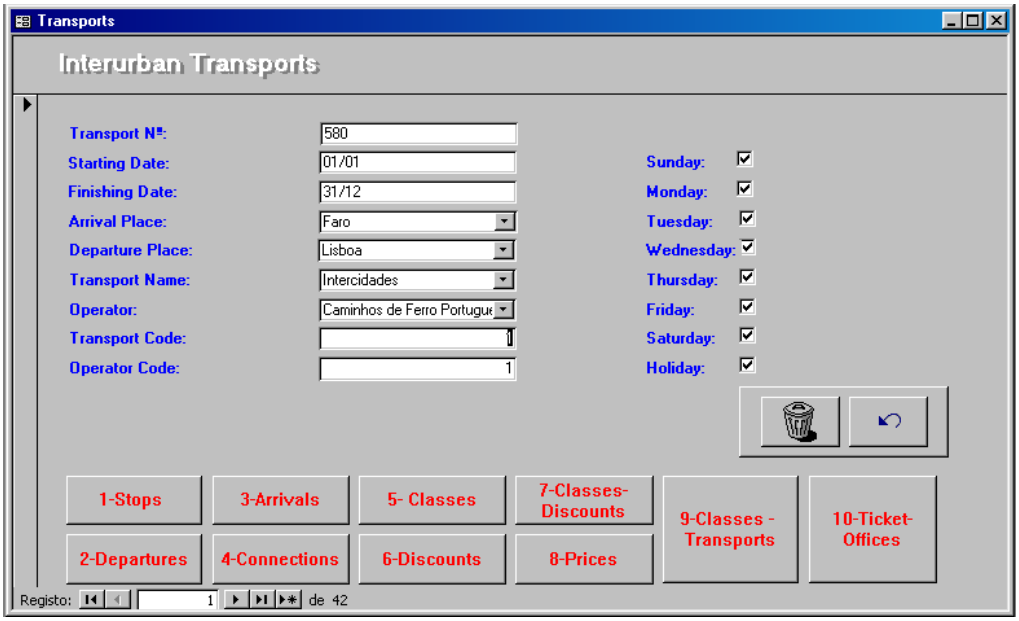

Figure 2. Form that allows the database administrator to input information into the database

4. ALGORITHMS, HEURISTICS AND BEST TRANSPORT PLANS

To determine the best transport plans that allow going from a departure place (Origin) to an arrival place (Destination), the following algorithms were developed:

- Determine the possible transport plans to go from Origin to Destination using all types of transports, except taxis;
- Determine taxi transport plans;
- Put the three best plans in preferential order.

The algorithms were developed in Microsoft Access using the Microsoft Access Basic language.

In setting up the transport plans, four types of plans were considered: plans of direct transports, plans with alternative origins to the Origin, plans with alternative destinations to the Destination, and plans with alternative origins and destinations to the Origin and Destination, respectively.

It was also considered some heuristics, such as:

- Plans not direct can be better than direct ones;
- The minimum time considered to commuting transports to depend of the type of transport and of the distance between the stopping places;
- In the search of the localities next to Origin or to Destination, to give preference to the cities, because the existence of more and better transports is more probable there.

One of the algorithms used in the determination of the transport plans is as follows:

```
/*  Algorithm DeterminePlans
 */
To verify if Origin and Destination exist in the
database (Algorithm  VerifyOriginDestinationExist)
Relating to the date specified by the user, to verify
the day of the week and if it is a holiday. (Algorithm
DetermineDateandHour)

/* Determines plans using interurban and urban
transports
 */
```

/* Corresponds to Situation 1
*/
To determine the direct interurban transports to go from Origin to Destination
To remove from the plans obtained, those not available in function of the operating period, of the week day and whether it is or not a holiday (Algorithm RemoveFunctionPDH)
If not all the transports were removed
    To verify which of them can be used in function of the hour specified by the user (Algorithm RemoveUserHour)

/* Corresponds to Situation 2,3,4
*/
To each one of the situations (2,3,4) (Heuristic H1)
    To determine other connections according to the situation (Algorithm SearchOtherMainConnections)
    To determine the interurban transports and/or urban transports for the connections obtained before (Algorithm SearchInterurbanandUrbans-234)

/* Completes plans with taxi connections
*/
For each of the main transports obtained
    To determine the transport plans using taxis (Algorithm DetermineTaxis)
/* Chooses the best plans
*/
To choose the best plans in function of the criteria indicated by the user (Algorithm ChooseBest)

/* End algorithm DeterminePlans
*/

To determine the best transport plans, the multi-attributes decision techniques were used, which allowed resolving alternative selection problems in a finite number, in function of determinate criteria. The method used was the Weighted Average Method (Ackoff, 1962).

5. EXAMPLE

Figure 3 corresponds to one of the plans obtained by the application, considering that the user intends to travel from Faro to Lisbon, leaving on the 27th of March 1999, from 7:00 AM on and considering that the travel time has to be minimum.

From this form, it is possible to get information about the ticket-offices, the different prices and types of tickets available (1st class or 2nd class) and in case of taxis or other types of connecting transports, information about them. The user has to press the correspondent key to get the best transport plans.

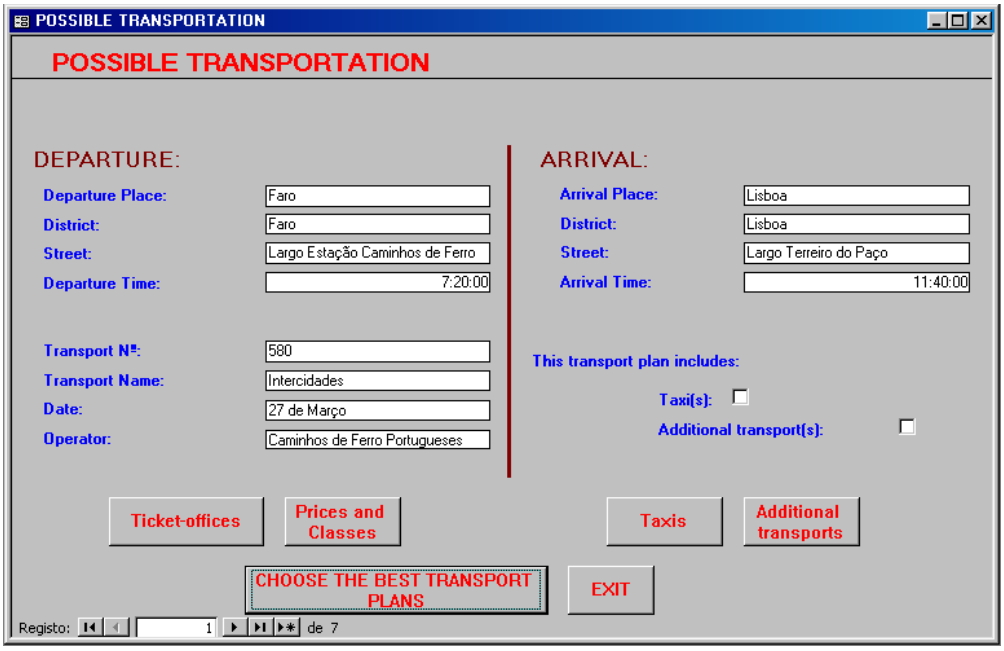

Figure 3 - Form with information about the possible transport plans

6. CONCLUSIONS

It was developed an application that draws up travel plans using public transports and that, in function of the preference criteria provided by the user, determines the best ones. The application combines different means of transport.

However, it is possible to introduce the following improvements:

1. To introduce learning mechanisms that give the application the ability to use acquired knowledge in already determined transport plans, in the planning of new ones;
2. To use the scheduling techniques and the constraints-satisfaction to choose the routes;
3. To make the minimum time considered to commuting transports depend on the time of the year in which the user intends to travel and on buying or not in anticipation, the necessary tickets;
4. To provide additional information, like maps with the route that the user has to travel over, places that the user can visit while he is waiting for the next transport, etc.;
5. To develop a more friendly interface;
6. To prepare the application to be available in the Internet.

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