

OptiPark Parma Edition

Technical documentation

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Introduction

The management and optimization of urban distribution of goods is a complex task. The major problem is that most dedicated management systems do not take into account commercial traffic information in their models and this can lead to gross errors in estimating travel times on road segments, due to the lack of knowledge of possible congestions in front of delivery points by a number of concurrent delivery operations.

The recent European Project MOSCA (2001-2004): “Decision Support System For Integrated Door-To-Door Delivery: Planning and Control in Logistic Chains” aimed at improving the management of urban traffic providing assets to both commercial transport operators and to city traffic managers. The former will be able to access state-of-the-art vehicle routing algorithms which make use of privileged traffic information provided by the city administration. The latter will use the information on planned deliveries to mitigate the effects and smooth the traffic flow, reducing both the economical and the environmental impact.

In MOSCA, new prototype solutions have been developed for vehicle routing algorithms which are customised to the urban situation, where travel times on road segments are highly variable and the knowledge of this variability must be capitalised and used efficiently. The final goal is to investigate the feasibility of tools for integrated planning and control of production and transportation processes supporting sustainable development. We think that this integration and data availability brings great opportunities to make an intelligent use of the data and innovative research techniques are ready to take this chance.

OptiPark is inspired by the same design principles emerged in MOSCA. It has been developed by AntOptima, a Swiss software house with a strong focus on optimization tools and algorithms.

The idea is to provide efficient solution to the urban transport operators by sharing information about the distribution process between the different involved actors. OptiPark is a multi-user web-based application that allows both manual and automated scheduling of parking bays in the centre of the city of Parma. The Application includes a users/bays/depots administration

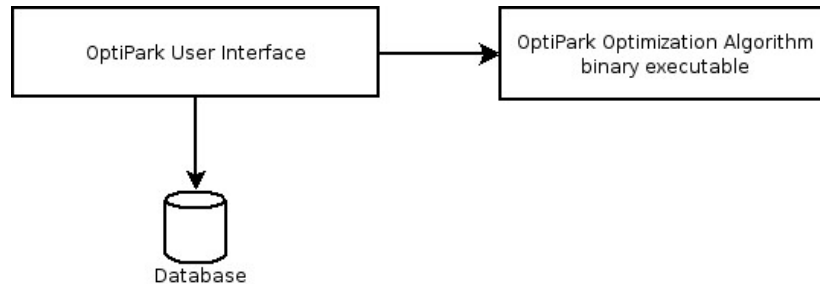
A number of dedicated parking bays are spread in the city centre in order to perform the delivery operations as close as possible to the destination points (shops, mini-markets, etc). Every day, transportation operators try to access autonomously these parking bays, but it often happens that when an operator arrives at a parking bay, he cannot use it because someone else has already taken it. In this case, either the operator stands by the bay waiting for his turn (possibly causing traffic jams) or he goes on performing other deliveries in the city (if any) before coming back and trying again to park (thus increasing the traffic flow). Actually, there is also the possibility that the operator does not wait and performs anyway the delivery (without using the dedicated bay), but this again could lead to traffic jams.

Hence, the main problem is the lack of coordination between the transportation operators when they act autonomously. OptiPark is a tool that allows managing such a coordination providing the possibility of booking the parking bay using a standard web browser. A day is divided into 48 time slots of 30 minutes each. Any transportation operator can have an overview of the occupation of the bays along the day as well as make bay reservations for his own needs.

The reservation process can be carried out either manually (simply selecting the involved parking bay and time slots by means of a couple of mouse clicks) or automatically, using the optimization tool. In case of automatic reservation, the selected time slots are interpreted as "desired time slots" for the associated parking bay and the optimization tool will compute and propose to the user a reservation plan minimizing an objective function. (See also the chapter “Optimization tool”.)

Architecture

OptiPark is composed of 3 main parts: the user interface, a database and the optimization tool. In this chapter we will discuss all of them in more detail. The following diagram shows dependencies of the different components.



As you can see the optimization tool is not dependent from the database. Data is prepared by the user interface and then fed to the tool.

The three main parts contain the seven modules described in the “Technical Specifications”. Five of them are user interface modules, one is the environment and the last one is the optimization tool.

Data structure

OptiPark uses a PostgreSQL¹ database to store schedules, depots, parking bays and users information. Illustration 1 shows the structure of this database.

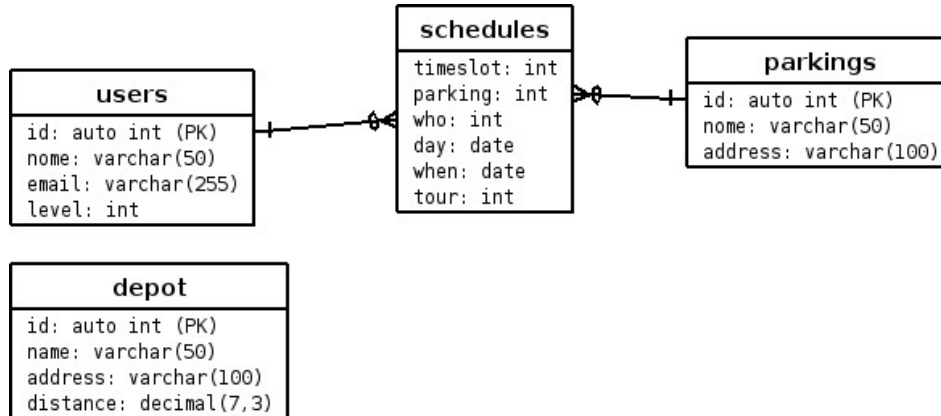


Illustration 1: Database structure

Users of the system are the transportation operators and the system administrators. The system uses the user's email as the login name. Every email address will therefore be checked for uniqueness. OptiPark has two types of user:

- simple user (LEVEL = 0)
- administrator (LEVEL = -1)

The database contains also information about the depots and the parking bays. The parking bays are all located in the centre of the city. The depots include the distance from their location to the city centre. This distance is used by the application to compute the time required to reach the bays.

¹ <http://www.postgresql.org>

Parking bays and users are connected via the schedules (reservations). Schedules include along with the user and the bays, the reserved timeslot, its day and an identifier for grouping tours. For statistical reasons the date when the reservation is submitted is also stored in this table.

Internally the users, the bays and the depots are identified by IDs. However, the operators and the administrators will never have to handle this numbers.

User interface

The user interface is a set of PHP scripts that generate Standard HTML pages hosted on an Apache web server.

The pages have been tested, with success, on all major web browsers:

- Apple Safari
- Microsoft Internet Explorer 6
- Mozilla Firefox

Security & data consistencies

Access to the system is granted only after a successful username-password authentication.

The interface was developed with security in mind. URL parameters and data are checked for SQL injections and other security attacks.

The software checks that the email of a user is in correct form (i.e. [text@text.text](#)). However, it is not required that the email address exists, that the domain is registered or that the TLD (Top Level Domain) exists.

The software checks that the reservation follows the restrictions listed below:

- a parking bay can only be occupied by one user a time
- in a tour a user can only be in one single location while on different tours the user **can** be on different bay in the same moment.

Optimization tool

The core of OptiPark's Optimization Tool is a resource allocation optimizer. The tool has to find the best position for an insertion of some reservations in the current plan according to an objective function. The new reservations are grouped together in a new tour.

The tool supports a weighted sum of the following objective functions:

- minimization of the sum of differences between the desired scheduling times and the real ones of each selected parking bay
- minimization of the total tour time
- minimization of the time window violations
- minimization of the difference between the desired start and the real start time

The start time is the arrival time in the city centre. This timeslot is obtained according to the selected departure time from a depot.

For performance reasons, the optimization tool is implemented as a native C++ standalone Windows executable and it does not access to the database. The inputs are fed to the tool by the interface according to user's needs.

The optimization tool receives as input the current plan and the user preferences. This information

are then processed by the algorithms developed by AntOptima and the optimized results are presented back to the user for acceptance.

User Interface manual

Login

As mentioned earlier, the application requires the user to authenticate to access the system. The login is done via a standard “authentication dialog”.

Once the user logged in he will be provided with a menu to choose the desired task. According to the level of the user (simple user or administrator) the amount of actions changes. The simple user's interface is a subset of the administrator's one.

Personal Data

Required user level: any

This module allows users to modify their personal profile and their password. The email, which is used as to login, can be changed as well. Since internally the application uses the user ID it is not possible to assign a reservation to someone else by changing the email.

User administration

Required user level: administrator

Through this module administrators can add, remove or modify other users. This interface can also be used to promote users to administrator level or downgrade them back to simple users.

On the main page it is possible to select different users and erase them, to add a new user or to modify a user's profile. If no password is provided, while adding a user, system will assign a random one.

WARNING: grant administrator rights only to a few trusted people. However, it is important to keep at least one administrator.

Parking bays and depots administration

Required user level: administrator

Module to edit, add and delete parking bays and depots. The module is implemented as two separated menu entries.



Illustration 2: User administration window

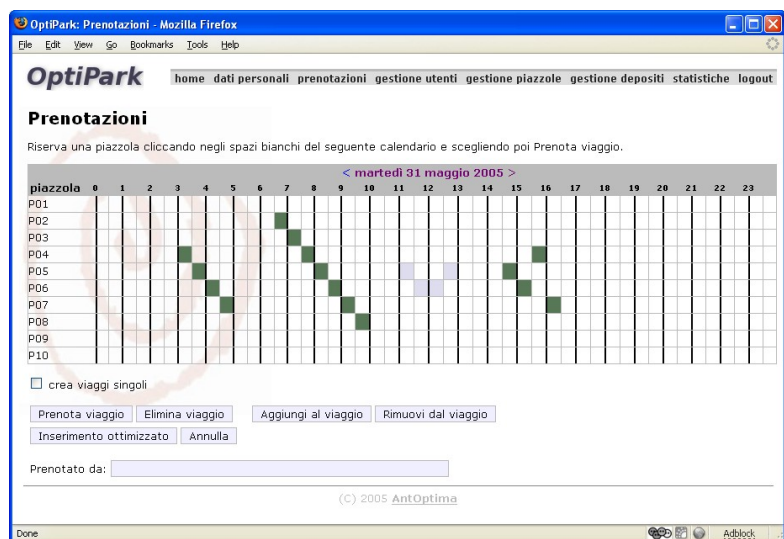


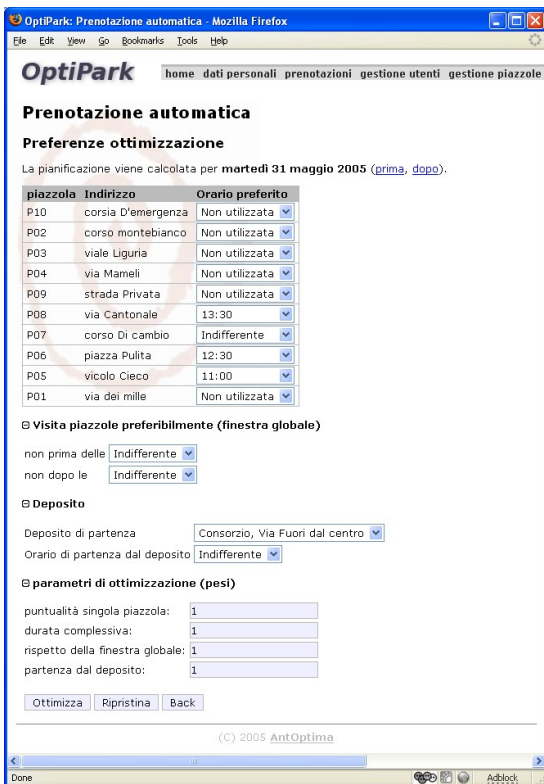
Illustration 3: The scheduling interface

Scheduling

Required user level: any

The scheduling module allows users and administrators to add, remove and modify schedules. Users have write access only on their own scheduled tasks, while administrators have full control over all the bay reservations. The interface allows to add single reservations or full “tours” of reservations. Tours represent a sequence of reservations.

This interface module, via the automated insertion button, is also the access point to the optimization tool.



The screenshot shows the 'Prenotazione automatica' section of the OptiPark website. It displays a table of parking bays with their addresses and preferred times. Below the table are various settings for optimization, including visit preferences, deposit location, and optimization weights.

piazzola	Indirizzo	Orario preferito
P10	corsia D'emergenza	Non utilizzata
P02	corso montebianco	Non utilizzata
P03	viale Liguria	Non utilizzata
P04	via Mameli	Non utilizzata
P09	strada Privata	Non utilizzata
P08	via Cantonale	13:30
P07	corso Di cambio	Indifferente
P06	piazza Pulita	12:30
P05	vicolo Cieco	11:00
P01	via dei mille	Non utilizzata

La pianificazione viene calcolata per **martedì 31 maggio 2005** ([prima](#), [dopo](#)).

Preferenze ottimizzazione

☐ **Visita piazzole preferibilmente (finestra globale)**

non prima delle: Indifferente
non dopo le: Indifferente

☐ **Deposito**

Deposito di partenza: Consorzio, Via Fuori dal centro
Orario di partenza dal deposito: Indifferente

☐ **parametri di ottimizzazione (pesi)**

puntualità singola piazzola: 1
durata complessiva: 1
rispetto della finestra globale: 1
partenza dal deposito: 1

Ottimizza Ripristina Back

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Illustration 4: The optimization inputs

information on the usage of the parking bays. It includes usage statistics based on users or bay, which are useful for monthly reports or billing purposes.

Optimization tool UI

Required user level: any

The optimizer tool's user interface allows to select all the parameters that will be passed to the optimization algorithm.

The interface is shown in Illustration 4. It includes also the weights for the objective function. However, due to their complexity, they are, by default, hidden (in the Illustration they are shown).

This module is tightly integrated with the scheduling one. The user can select some timeslots for some bays in the plan and this selection will be used in the optimizer user interface as default values.

The result of the optimization requires user confirmation before it is inserted in the plan.

Statistics

Required user level: administrator

The statistics module includes some basic statistical information on the usage of the parking bays. It includes usage statistics based on users or bay, which are useful for monthly reports or billing purposes.