

Teaching VRP in Business Schools

Helena Ramalhinho
Àlex Grasas

UPF-Barcelona GSE
Universitat Pompeu Fabra
Barcelona, Spain



1

Outline of the Presentation

- ▶ Introduction
 - Motivation
 - Objectives
- ▶ Students profile
- ▶ The teaching methodology
- ▶ The VRP webpage
- ▶ Conclusions
- ▶ Future work



2

Introduction- Motivation

- ▶ How to teach Operations Research in Business Schools?
 - Students have no background in OR...
 - Students have different motivations and interests from Engineering and Mathematics students.
 - Students will be “buyers” of OR systems and methods... in the future.
 - OR is a wonderful and fantastic tool for business decision making and analytics...

3

Introduction- Objectives

- ▶ The purpose of this work is to describe the teaching of Vehicle Routing Problems in Business Schools.
- ▶ The main objective is to call the attention of Business Schools students to the Operations Research methodology.
- ▶ Make the students interested in learning OR.
- ▶ Show the students the great potential of OR.

4

UNIVERSITAT POMPEU FABRA

The students



5

UNIVERSITAT POMPEU FABRA

The students

- ▶ No background or interest in Operations Research
 - Undergrad students
 - * Economics, Business Administration, International Business Economics
 - **Business Logistics**
 - Graduate students
 - * MBA
 - **Quantitative Methods**
 - * Master in retailing
 - * Master in International Business
 - **Logistics and Distribution Management**

6

UNIVERSITAT POMPEU FABRA

Teaching Methodology

- ▶ Ask the student to solve a real VRP problem
 - Distribution of a product to 20 stores
 - Give the students:
 - * Address of the warehouse
 - * Addresses of the stores
 - * Demand of the stores
 - * Capacity of the truck
 - * Recommendation: local example...
 - The students have 30 to 45 minutes to solve the problem... they can use any resource...

7

UNIVERSITAT POMPEU FABRA

Teaching Methodology

- ▶ Example
 - ▶ The owner of a known clothing store in Barcelona, **Julia Co.**, has shops in 20 different shopping centers in Barcelona and its surroundings. Part of the merchandise needs to be replaced every day, so several trucks deliver the goods on a daily basis.
 - ▶ The logistics planner would like to minimize the transportation cost. He has asked to his new assistant which routes the vehicles should implement in order to minimize distances, taking into account that they should always start and finish its route in the depot place and that the maximum load is 100 boxes.
 - ▶ In the following table you can see the addresses of the different shopping centers and the warehouse, as well as each demand.
 - ▶ Can you help the assistant?

8

Teaching Methodology

SHOPPING CENTER	DEMAND
Warehouse	Depot
CC Arenas de Bcn	20
Bulevard Rosa	14
CC Diagonal Mar	60
CC El Triangle	10
Maremagnum	15
CC La Maquinista	50
CC Gran Via 2	60
CC L'illa Diagonal	70
Pedralbes Centre	50
CC Splau!	30
CC Bamasud	60
CC Glòries	65
CC L'Ànec Blau	70
CC La Farga	40
La Roca Village	30
CC Parc Vallès	40
CC Heron City Bcn	65
Mataró Parc	20
CC Baricentro	35
Paddock-Bulevard	55

Teaching Methodology

► The results...

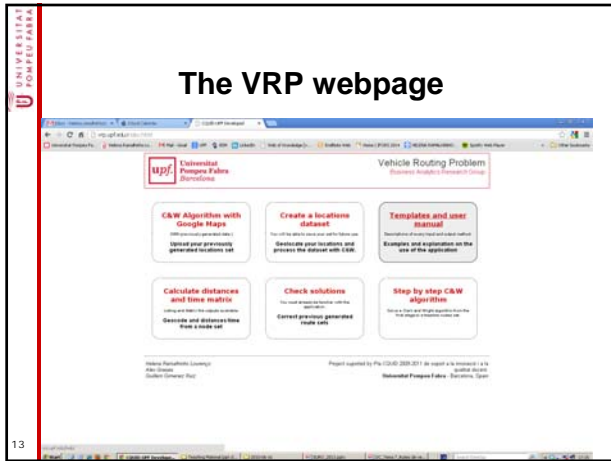
- After many questions...
- After many discussions...
- After looking in internet...

The Saving Heuristic total distance is 393

Student group	Feasibility	Total Load	Total Distance
1	Y-N	834	510
2	N	794	478
3	N	914	480
4	Y	859	437
5	Y	859	523
6	Y	859	465

- ### Teaching Methodology
- Solve the problem with the vrp.upf.edu web
 - Response of the students...
 - “And we spend so much time thinking...”
 - “I can believe it!!!”
 - “How do you do it??”
 - “Can we apply these methods to other business problems?”
 - In summary...I want to learn more about OR.

- ### Teaching Methodology
- Explain what is Operations Research
 - Explain the VRP problem
 - In some cases explain the mathematical model
 - Explain the solution approaches
 - Exact methods
 - Heuristics and metaheuristics
 - Explain the Savings Method (Clarke and Wright 1964) in detail
 - Solve some problems



The VRP webpage

- **C&W Algorithm with Google Maps**
 - Choose a .txt file from your computer
 - Read .txt file
 - Send to C&W
 - Wait for the distance matrix to be completed
 - Clarke and Wright button
 - Plot Clarke & Wright
 - Export to file

1 C&W Algorithm with Google Maps
(With previously generated data.)
Upload your previously generated locations set

The VRP webpage

- **Create a locations dataset**
 - Add each location: Name, Address, Demand
 - The demand for home is the load capacity
 - Send to C&W
 - Follow the explained in 1

2 Create a locations dataset
You will be able to save your set for future use.
Geolocate your locations and process the dataset with C&W.

The VRP webpage

- **Manual and Data sets**

3 Templates and user manual
Descriptions of every input and output method.
Examples and explanation on the use of the application

UNIVERSITAT POMPEU FABRA

The VRP webpage

► **Calculate distances and time matrix**

- Choose a .txt file from your computer
- Read .txt file
- Start distances calculation
- Save to file

4 Calculate distances and time matrix

Listing and Matrix file outputs available.

Geocode and distances/time from a node set

17

UNIVERSITAT POMPEU FABRA

The VRP webpage

► **Check solutions**

- Download the excel template file
- Complete the information required and export the file in xml
- Choose the xml file from your computer (seleccionar archivo)
- Read
- Validation

5 Check solutions

You must already be familiar with the application.

Correct previous generated route sets

18

UNIVERSITAT POMPEU FABRA

The VRP webpage

► **Step by step C&W algorithm**

- Select the number of customers (nodes)
- Write the demand of each client
- Write the cost (distance) between the depot and the client
- State the maximum load capacity
- Compute the cost (distance) matrix
- Compute the savings matrix
- Solve the problem (C&W)

6 Step by step C&W algorithm

Solve a Clark and Wright algorithm from the first stage to a feasible routes set.

19

UNIVERSITAT POMPEU FABRA

Conclusions

- We have developed an internet-based OR system to provide in depth **experimental learning** of the decisions related with the routing issues.
- The students are faced with the **difficulty** of solving a real VRP.
- The **advantages** of using OR systems are emphasized.
- The **motivation to learn OR** models and algorithms become very high.

20

Future Work

- ▶ Improve the vrp.upf.edu web:
 - Fix the bugs...
 - Wait for critics and improve!!!
 - New and more powerful algorithms
 - * **Iterated Local Search**
 - New problems as for example:
 - * OpenVRP
 - * Heterogeneous VRP
 - *

21

The team

- ▶ Thank you for your attention



The authors

The tester...



The programmer...

22