

Teaching VRP in Business Schools

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Outline of the Presentation

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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...

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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.

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The students




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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**


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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...

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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?

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Teaching Methodology

SHOPPING CENTER		DEMAND
Warehouse	Avinguda Parc Logistic, 2-10, Barcelona.	Depot
CC Arenas de Bcn	Gran Via de les Corts Catalanes, 373, Barcelona.	20
Bulevard Rosa	Passeig de Gràcia, 53, Barcelona.	14
CC Diagonal Mar	Avinguda Diagonal, 3, Barcelona.	60
CC El Triangle	Plaça de Catalunya, 4, Barcelona.	10
Maremagnum	Moll d'Espanya, 5, Barcelona.	15
CC La Maquinista	Carrer Potosí, 2, Barcelona.	50
CC Gran Via 2	Avinguda de la Granvia de l'Hospitalet, L'hospitalet.	60
CC L'illa Diagonal	Avinguda Diagonal, 557, Barcelona.	70
Pedralbes Centre	Avinguda Diagonal, 609, Barcelona.	50
CC Splau!	Avinguda del Baix Llobregat, Cornellà.	30
CC Barnasud	Carrer Progrés, 69, Gavà.	60
CC Glòries	Avinguda Diagonal, 208, Barcelona.	65
CC L'Ànc Blau	Avinguda del Canal Olímpic, 24, Castelldefels.	70
CC La Farga	Avinguda Josep Tarradellas i Joan, 0, L'hospitalet.	40
La Roca Village	La Roca Village, Sant Agnès de Malanyes.	30
CC Parc Vallès	Avinguda Tèxtil, Terrassa.	40
CC Heron City Bcn	Passeig Andreu Nin, Barcelona.	65
Mataró Parc	Carrer Estrasburgo, 5, Mataró.	20
CC Baricentro	Ctra. N-150 Km. 6,7, Barberà del Vallès.	35
Paddock-Bulevard	Avinguda de Francesc Macià, 46, Barcelona.	55

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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


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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.

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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

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The VRP webpage

upf. Universitat Pompeu Fabra Barcelona

Vehicle Routing Problem
Business Analytics Research Group

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

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

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

Calculate distances and time matrix
Listing and Matrix file outputs available.
Geocode and distances/time from a node set

Check solutions
You must already be familiar with the application.
Correct previous generated route sets

Step by step C&W algorithm
Solve a Clarke and Wright algorithm from the first stage to a feasible route set.

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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

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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.

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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

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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

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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

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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.


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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.

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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
 - *


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The team

- Thank you for your attention

The authors



The tester...





The programmer...

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