



Bridging the gap between theory and practice

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Facts & Figures

Wide Scope

FOUNDATION

2003

NUMBER OF EMPLOYEES

50

HQ LOCATION

Lisbon, Portugal

DISTRIBUTOR LOCATIONS

Australia, Turkey, Singapore, UK, France, Cyprus, China, India

FOUNDING PARTNERS

Filipe Carvalho and Ana Sofia Pereira



Products

Meet Routyn

Routyn is a vehicle routing system that automatically plans a fleet's routes, sequencing visits to locations while saving fuel consumptions and driving costs.

What has been distinguishing *Routyn* from other similar products is its ability to solve tactical, operational and respond planning optimization problems with its unique advanced algorithms.

**WE ARE SPECIALIZED IN REDUCING
TRANSPORTATION AND LOGISTICS COSTS**

Customers

Routyn implementations

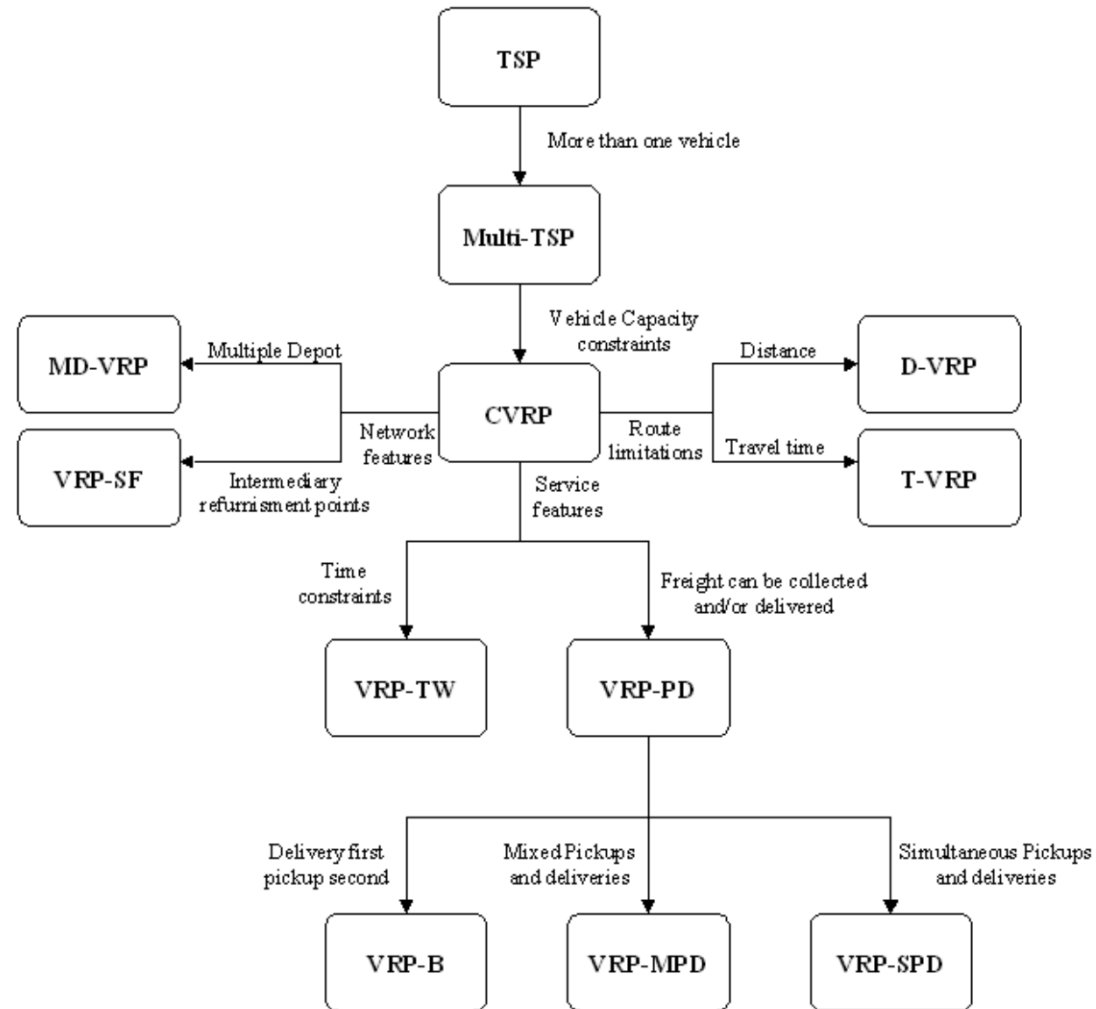


Quick Facts

- There's a 70% chance you get your food from a supermarket in Portugal replenished by trucks following routes designed by Routyn.
- And if you go to a restaurant, hotel or caffè, it goes up to 95%.

Theory

Vehicle Routing Problems



Capacitated vehicle routing problem with time windows

- 2D Matrix of travel times $t_{i,j}$
- Customers have one time window $[e_i, l_i]$
- Vehicles have a known capacity Q_k

The decision variables are specified as follows:

$$x_{ijk} = \begin{cases} 1, & \text{if arc } (i,j) \text{ is used by vehicle } k \\ 0, & \text{otherwise} \end{cases}$$

$$w_{ik} = \begin{cases} \text{service start time, if customer } i \text{ appears in the route of vehicle } k \\ 0, & \text{otherwise} \end{cases}$$

(CVRPTW):

$$\min \sum_{k \in K} \sum_{(i,j) \in A} c_{ij} x_{ijk} \quad (1)$$

Subject to:

$$\sum_{k \in K} \sum_{j \in \Delta^+(i)} x_{ijk} = 1 \quad \forall i \in V, \quad (2)$$

$$\sum_{j \in \Delta^+(0)} x_{0jk} = 1 \quad \forall k \in K, \quad (3)$$

$$\sum_{i \in \Delta^-(n+1)} x_{i,n+1,k} = 1 \quad \forall k \in K, \quad (4)$$

$$\sum_{i \in \Delta^-(j)} x_{ijk} - \sum_{i \in \Delta^+(k)} x_{jik} = 0 \quad \forall k \in K, j \in V \quad (5)$$

$$x_{ijk}(w_{ik} + s_i + t_{ij} - w_{jk}) \leq 0 \quad \forall k \in K, (i,j) \in A, \quad (6)$$

$$e_i \sum_{j \in \Delta^+(i)} x_{ijk} \leq w_{ik} \quad \forall k \in K, i \in V, \quad (7)$$

$$l_i \sum_{j \in \Delta^+(i)} x_{ijk} \geq w_{ik} \quad \forall k \in K, i \in V, \quad (8)$$

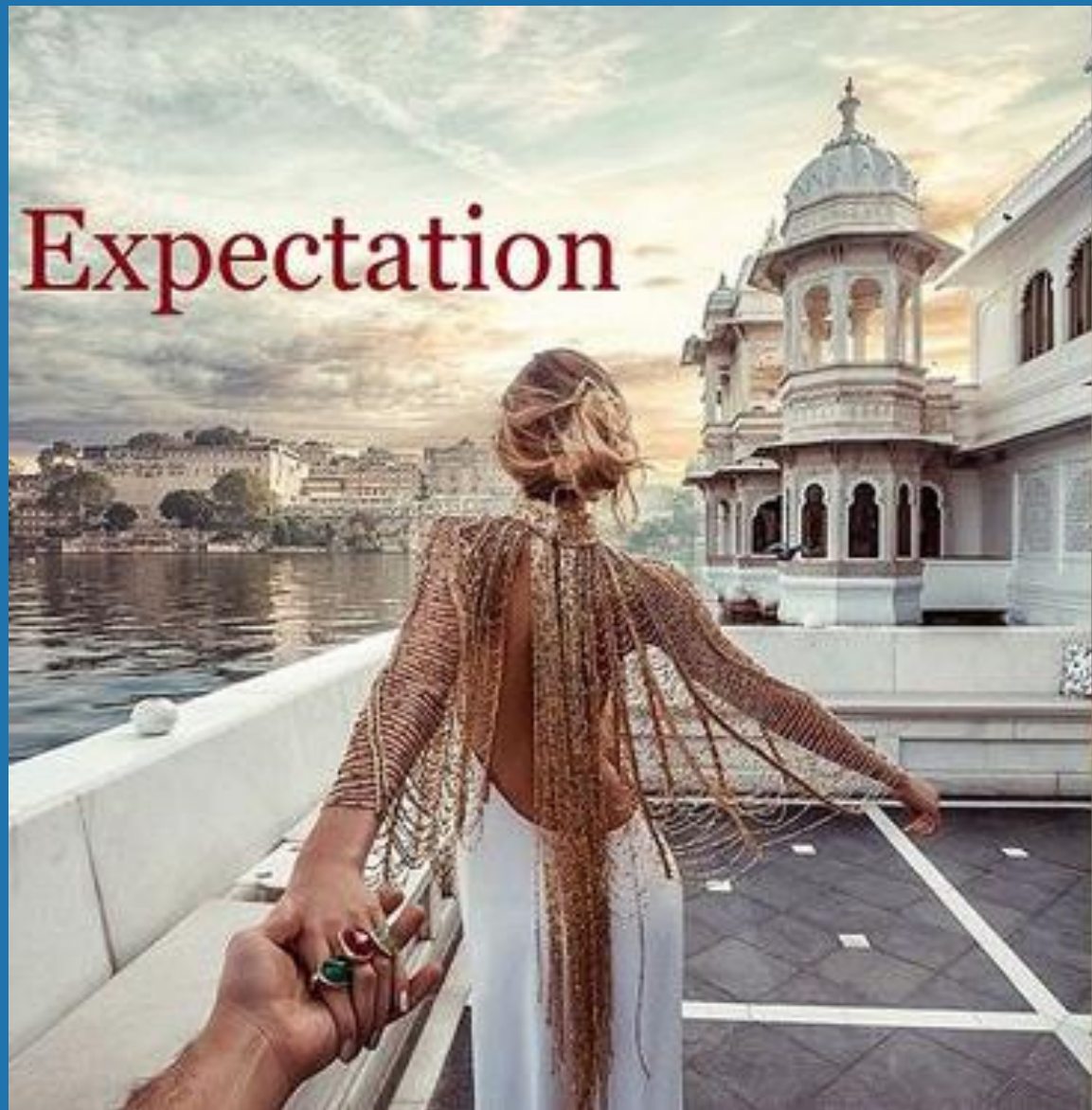
$$w_{0k} \geq E \quad \forall k \in K, \quad (9)$$

$$w_{n+1,k} \leq L \quad \forall k \in K, \quad (10)$$

$$\sum_{i \in V} q_i \sum_{j \in \Delta^+(i)} x_{ijk} \leq Q \quad \forall k \in K, \quad (11)$$

$$x_{ijk} \in \{0,1\} \quad \forall k \in K, (i,j) \in A. \quad (12)$$

Expectation



Reality



Expectation

2D Matrix of travel times $t_{i,j}$ vary with

- Origin i
- Destination j



REALITY

Travel times vary with

- Origin i
- Destination j
- Vehicle type
- Departing time of the day (15 mins slots)
- Day of week
- Holiday

Expectation

Customers have one
time window $[e_i, l_i]$

REALITY

“Deliver up to 33 pallets between 07:00 and 09:00.”

“Antecipate up to 12 pallets on the previous day between 22:00 and 23:30, as long as it’s a small truck.”

“Deliver any remaining pallets between 14:00 and 18:00.”

Expectation

- Vehicles have a known capacity Q_k



REALITY

- Trucks support up to 3 different temperature chambers: Frozen, Chilled, Ambient
- Min volume per temperature: 6 pals
- Additions of 3 pals (1 row).

Example: A 33-pals truck cannot carry 1 Frozen + 28 Ambient

Rules

Building a logistics model

Rules

All Restrictions Locations Vehicles Capacities Visit Times Geometries

115 The locations inside geometry (Geometry), must be visited (before/after) locations inside geometry (Geometry), if they are on the same trip.
Example: The locations inside geometry City Center, must be visited before locations inside geometry Suburban, if they are on the same trip. create

116 The working time of the vehicles group (Vehicles) is limited to 10% as long as there are no trips exported for execution.
Example: The working time of the vehicles group Extra is limited to 70% as long as there are no trips exported for execution. create

117 The locations group (Locations) must be visited until 10 minutes after being load on vehicles group (Vehicles).
Example: The locations group Extra must be visited until 50 minutes after being load on vehicles group Extra. create

118 The autonomy for vehicles group ElectricVehicle is 150 kms.
Example: The autonomy for vehicles group van is 150 kms. create

Import

ID	Rule	
8	The vehicle group * cannot visit more than 5 locations in the same trip.	⏻
18	The locations in geometry RemoteZone should be planned in sets of at least 5 locations.	⏻

cancel save

Infractions

Real-life touch of realism

Manage Optimization Infractions

Name:

Description:

All Restrictions | Infractions | Count | Sum | Speed Rate

5 The locations group can be visited up to min. outside the time window.
Example: The locations group After hours guard can be visited up to 60 min. outside the time window. [create](#)

6 % of the locations group may exceed its time windows.
Example: 90% of the locations group After hours guard may exceed its time windows. [create](#)

7 The total time of all visits group after the time window should not surpass min.
Example: The total time of all visits group After hours guard after the time window should not surpass 30 min. [create](#)

8 The locations group can be visited up to min. before the time window.
Example: The locations group After hours guard can be visited up to 60 min. before the time window. [create](#)

The vehicles group can work up to an additional

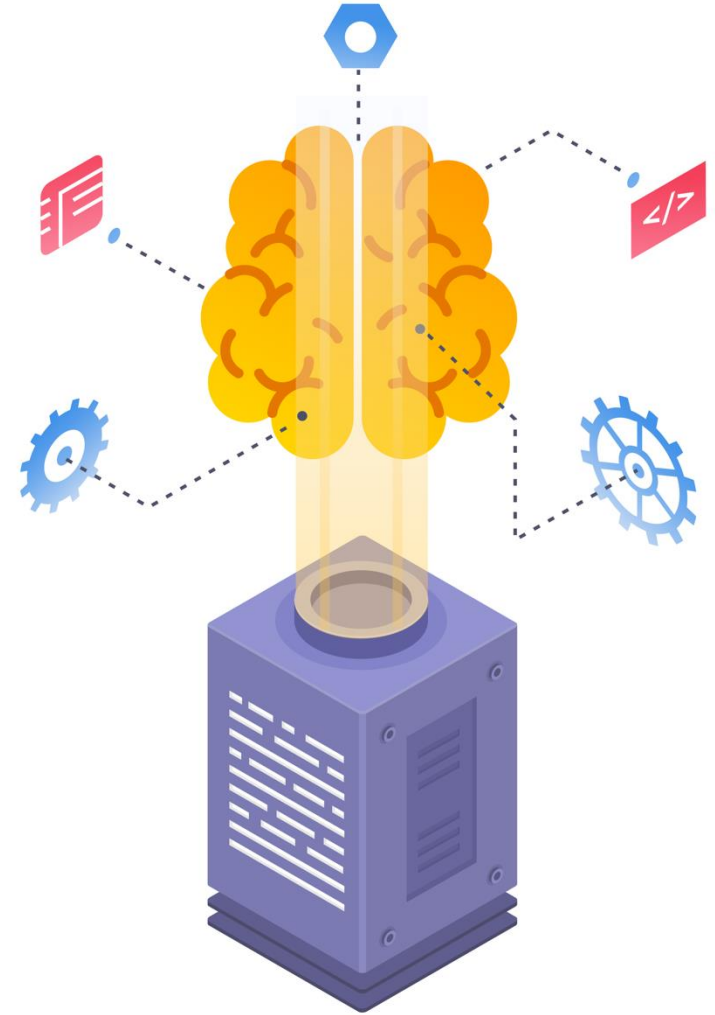
ID	Infraction	
5	The locations group Segment_B can be visited up to 15 min. outside the time window.	
5	The locations group Segment_C can be visited up to 30 min. outside the time window.	
6	10% of the locations group Segment_C may exceed its time windows.	
6	5% of the locations group Segment_B may exceed its time windows.	
14	The vehicles group Union_Driver can drive up to an additional 10 min.	
14	The vehicles group 4Hire can drive up to an additional 120 min.	
15	50% of the vehicles group 4Hire may exceed its total driving time.	

[cancel](#) [save](#)

Algorithms

Application examples

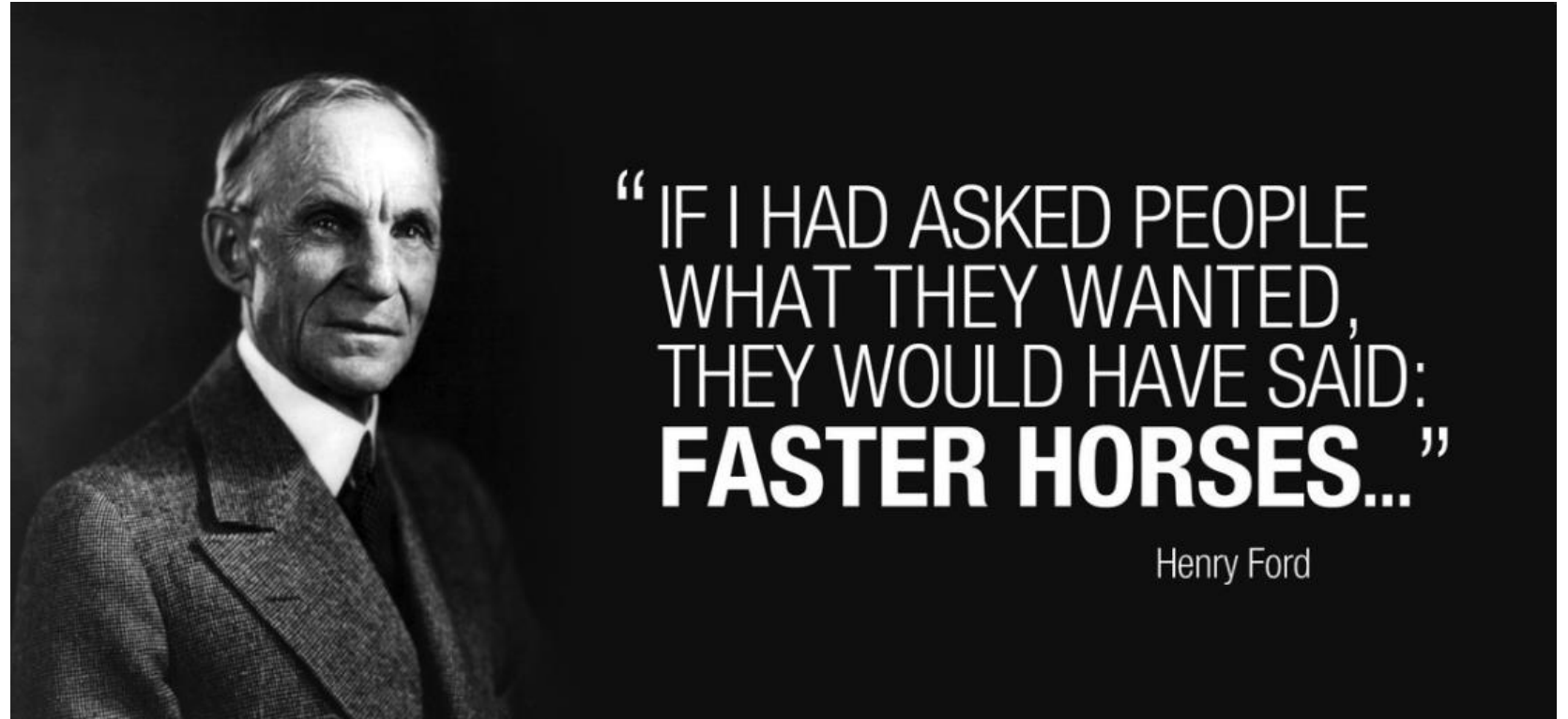
- Meta-heuristics
 - Domain-specific local search
- Mixed Integer Programming
 - Split and Merge
- Constraint programming
 - Dock Smoothing



Keys to success

Modelling, implementation and adherence

- Data quality
- Change management



Use case

ALDI testimony



Electric vehicles

Current work

- Limited number of filling stations in the warehouse for simultaneous loads
- The battery autonomy is not only measured in kms, depends if the cold engine is used or not, if the lifting platform is necessary, if the road has ups and downs, etc.
- Charging batteries for second trips considering only the required energy
- And many more constraints...



Thank you!



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