



University of Antwerp
Operations Research Group

ANT/OR

Horizontal co-operation in a clustered distribution environment

exchanging zones for increased efficiency

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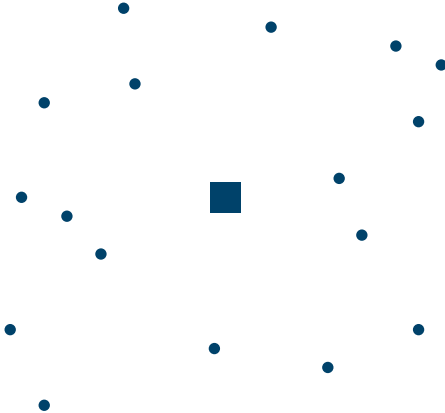
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The concept of **client clustering**

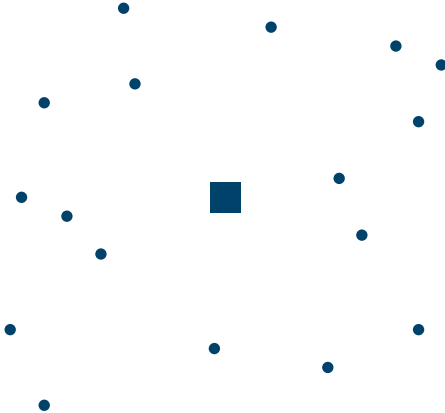


Optimisation context

- ▶ Large-scale VRP
- ▶ Short-term planning
- ▶ Dynamic



The concept of client clustering



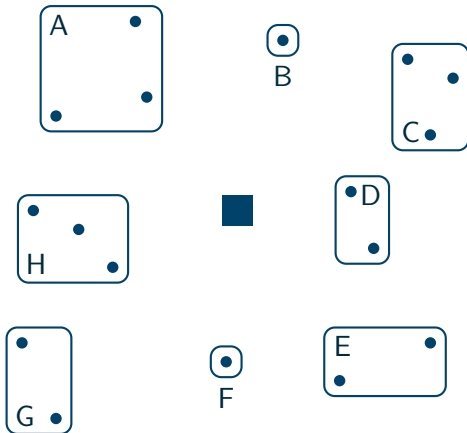
Optimisation context

- ▶ Large-scale VRP
- ▶ Short-term planning
- ▶ Dynamic

How to deal with such a nasty beast?



The concept of **client clustering**



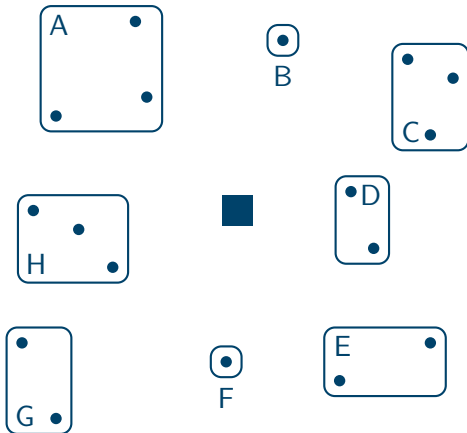
Divide distribution area in **zones**

- ▶ One vehicle serves multiple zones
- ▶ *Sorting* is decoupled from *routing*
- ▶ Reduction of problem complexity

Janssens et al. (2015)



The clustered vehicle routing problem

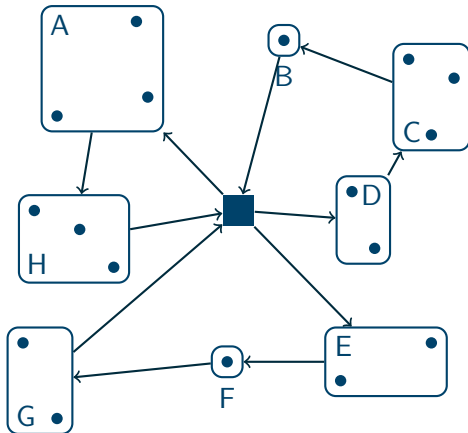


Strong cluster constraints

- ▶ Serve all clients with a given fleet of vehicles
- ▶ Visit clients of each zone sequentially in the same path



The clustered vehicle routing problem



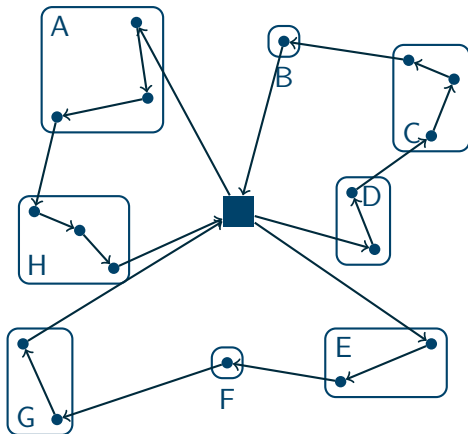
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A vehicle trip is represented by a sequence of zones



The clustered vehicle routing problem



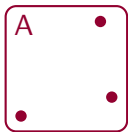
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Introducing a collaborative environment

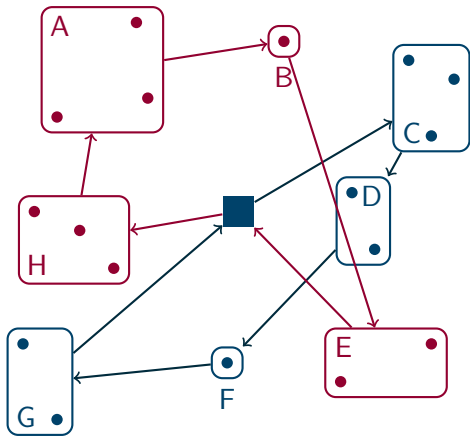


In a world with multiple courier companies. . .

- ▶ ... setting up a horizontal collaboration might be beneficial
- ▶ A single courier company then becomes a **partner** in the **coalition**



Introducing a collaborative environment

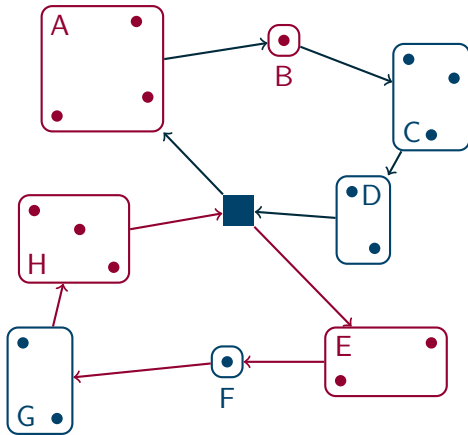


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Introducing a collaborative environment

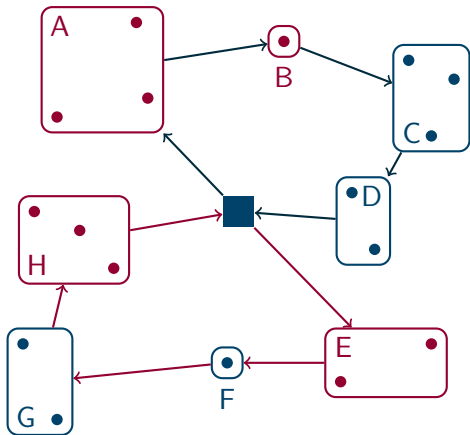


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Introducing a collaborative environment



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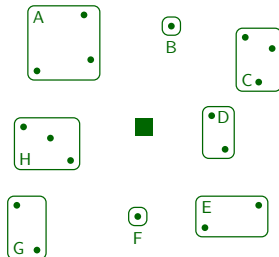
But how to tackle this collaborative routing problem?



Solving a collaborative routing problem

► Method of aggregation

- Redefinition of the problem at the **coalition level**
- Solve the (non-collaborative) problem for the coalition as a whole
- For the group, the obtained solution is optimal

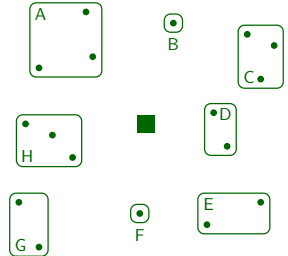




Solving a collaborative routing problem

► Method of aggregation

- Redefinition of the problem at the **coalition level**
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- For the group, the obtained solution is optimal



But...

- the multi-partner problem characteristics are ignored.
- the workload and costs should be allocated back to the individual partners.
- how to define what is best for the coalition (objective function)?
- is what is best for the coalition also the best for all partners?



Coalition efficiency vs. Partner efficiency

- ▶ **Coalition efficiency (objective of the coalition)**
 - ▶ What is the most desired outcome for the coalition as a whole
 - ▶ One (set of) objective(s) that all partners agree on

Minimise the total logistic cost

Coalition efficiency vs. Partner efficiency

- ▶ **Coalition efficiency (objective of the coalition)**

- ▶ What is the most desired outcome for the coalition as a whole
- ▶ One (set of) objective(s) that all partners agree on

Minimise the total logistic cost

- ▶ **Partner efficiency (objective of an individual partner)**

- ▶ Which outcome is preferred by each of the individual partners
- ▶ One (set of) objective(s) per partner
- ▶ Possibly conflicting interests

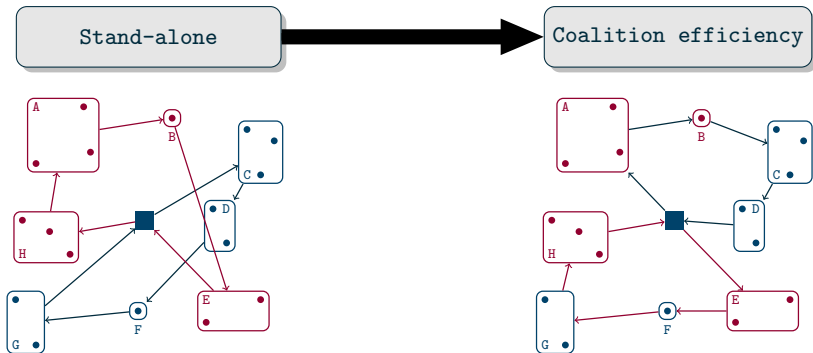
$\forall p$, minimise the cost to be paid by partner p

→ Increasing *complexity*

→ To obtain the cost, a *cost allocation method* is to be integrated in the optimisation procedure



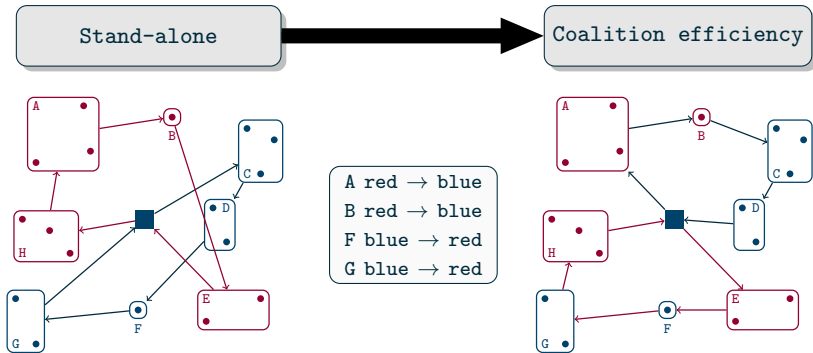
A guided solution approach



- ▶ **Coalition efficiency** should be the underlying goal for the group (the preferred direction to go to)
- ▶ Identify all **exchange moves** that should be executed to go from the current (stand-alone) scenario to full coalition efficiency



A guided solution approach



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A **guided** solution approach

A red → blue

B red → blue

F blue → red

G blue → red

- ▶ List of **promising moves**
 - ▶ Reduction of the solution space
 - ▶ Focus attention on *promising* region
 - ▶ Optimisation in driven by **coalition efficiency**

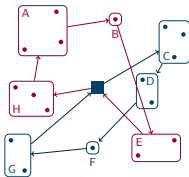
Determine the subset(s) of promising moves so that the obtained solutions are **partner efficient**

When executing all moves, the best solution for the coalition is obtained.



Solution approach

A red → blue
B red → blue
F blue → red
G blue → red



► Enumeration of all move subsets

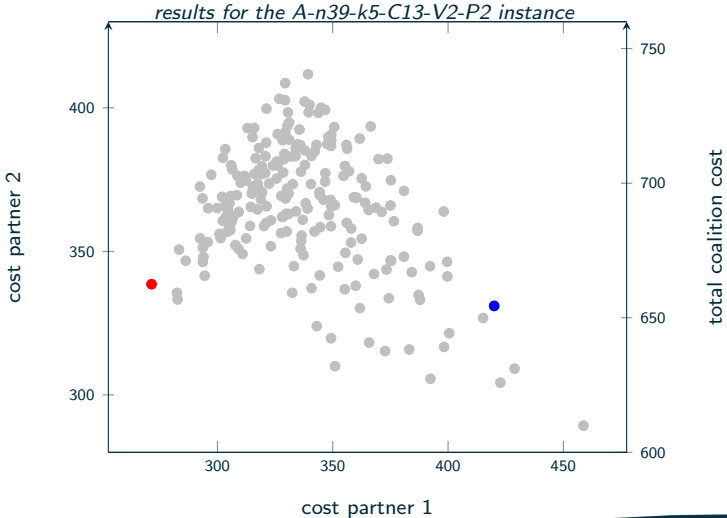
- All possible combinations of moves are evaluated
- For every move subset, the CluVRP should be solved for every partner
- Number of possible subsets = 2^m

► Heuristic exploration of the solution space

- Local search based exploration of move subset candidates
- Focus on large subsets → coalition efficiency

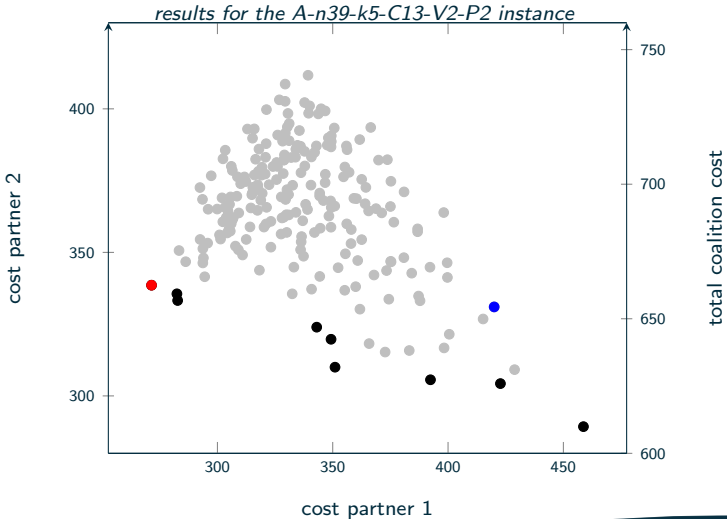


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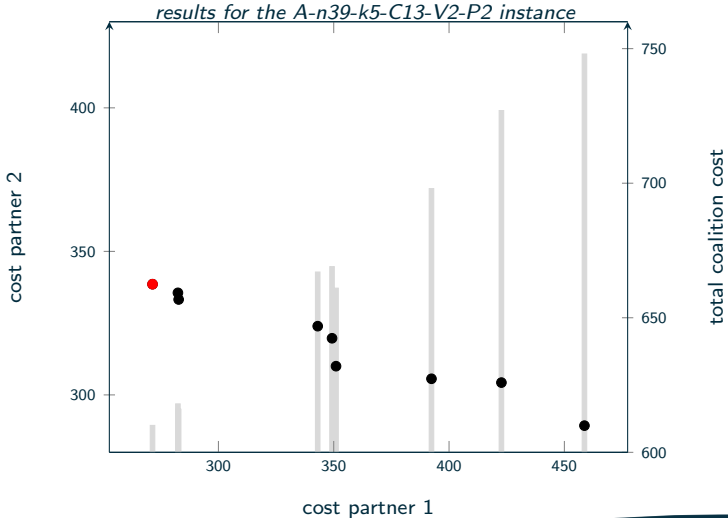


A guided solution approach





A guided solution approach





The results

- ▶ **Acknowledge that there is a difference between coalition efficiency and partner efficiency**
 - ▶ What is best for the group, is not always best for the individual partners
- ▶ **When collaboration is involved, the total coalition cost should be divided among the collaborating partners**
 - ▶ Results will depend on the chosen **cost allocation mechanism**
 - ▶ Allocating the cost of a complete solution, or e.g. per trip makes a difference
- ▶ **The framework is applied for solving the ColCluVRP, but can be used for any other routing problem**



What will the future bring?

- ▶ Develop a nice (guided) heuristic exploration of the solution
 - ▶ Run simulations on larger instances
 - ▶ Try to understand the behaviour and impact of the different building blocks in our model
- ▶ Further extend these ideas and framework on other routing problems that include horizontal co-operation
- ▶ Talk about these ideas and look for feedback



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