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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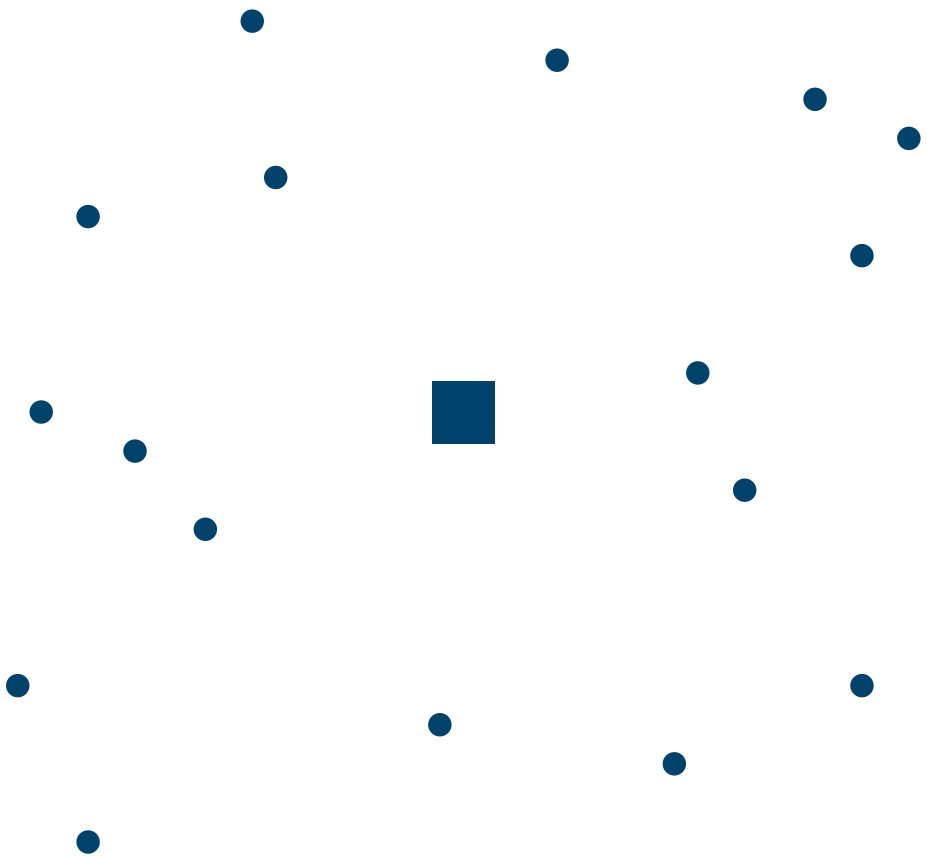
The concept of client clustering



Optimisation context

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

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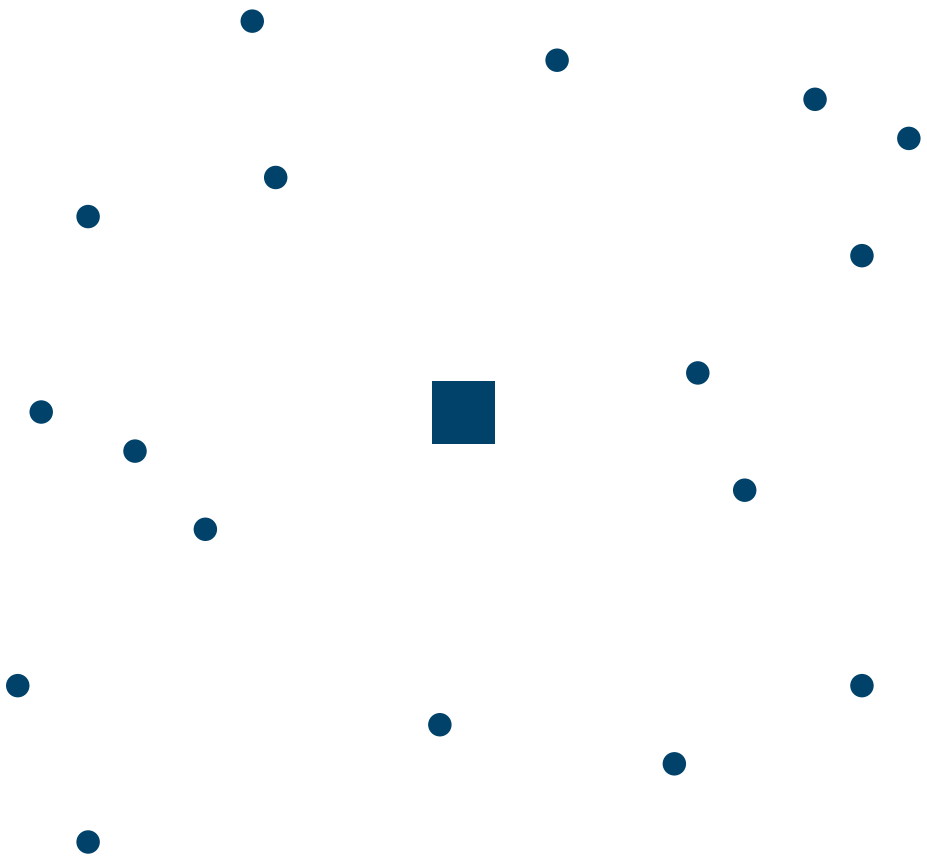

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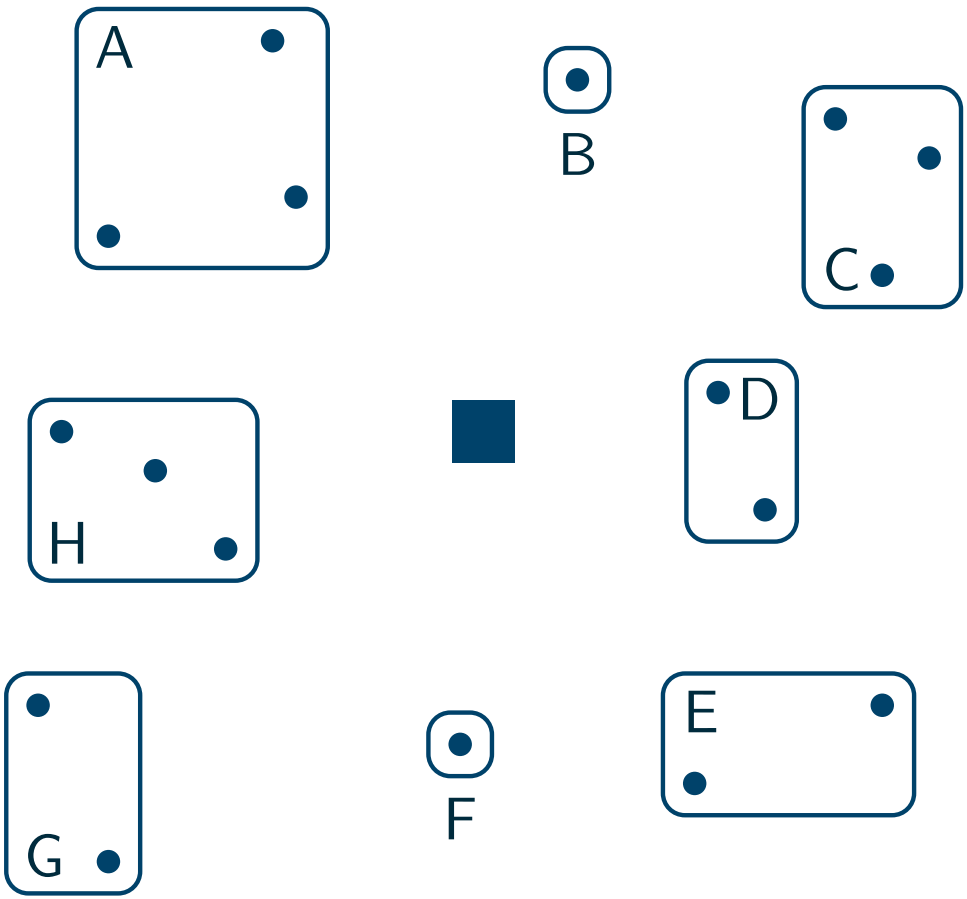
How to deal with such a nasty beast?

The concept of client clustering

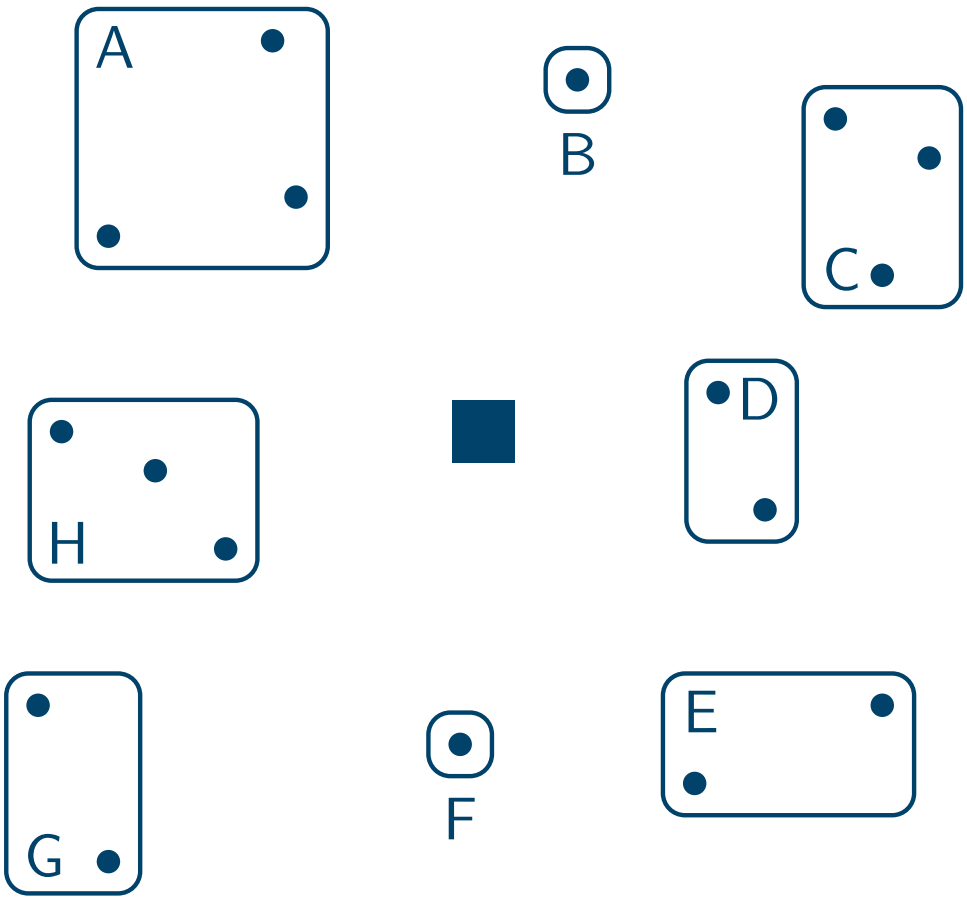


Divide distribution area in zones

- 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

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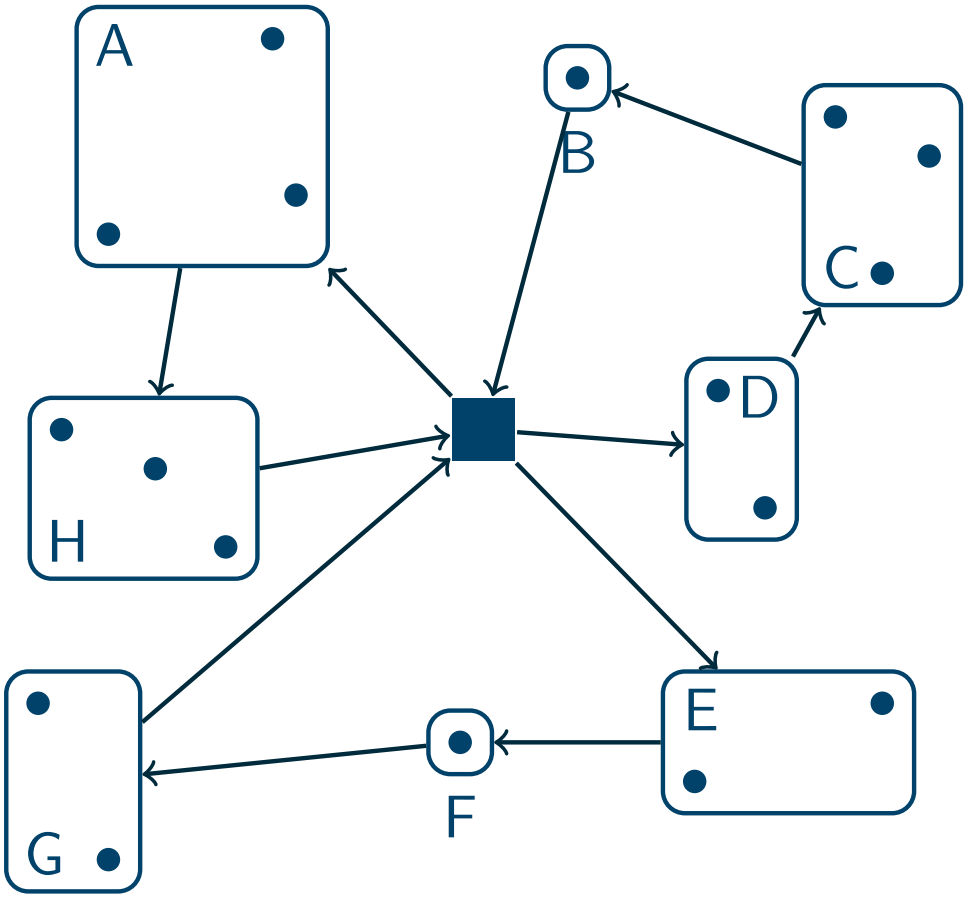

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A vehicle trip is represented by a sequence of zones

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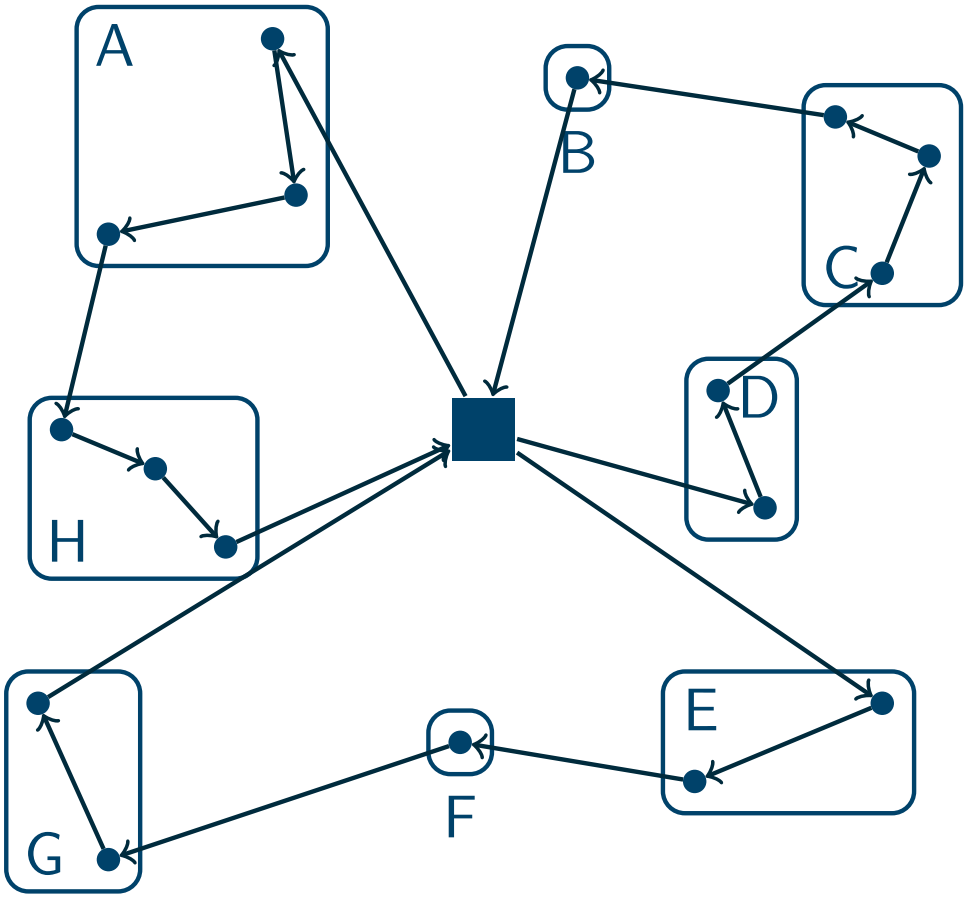

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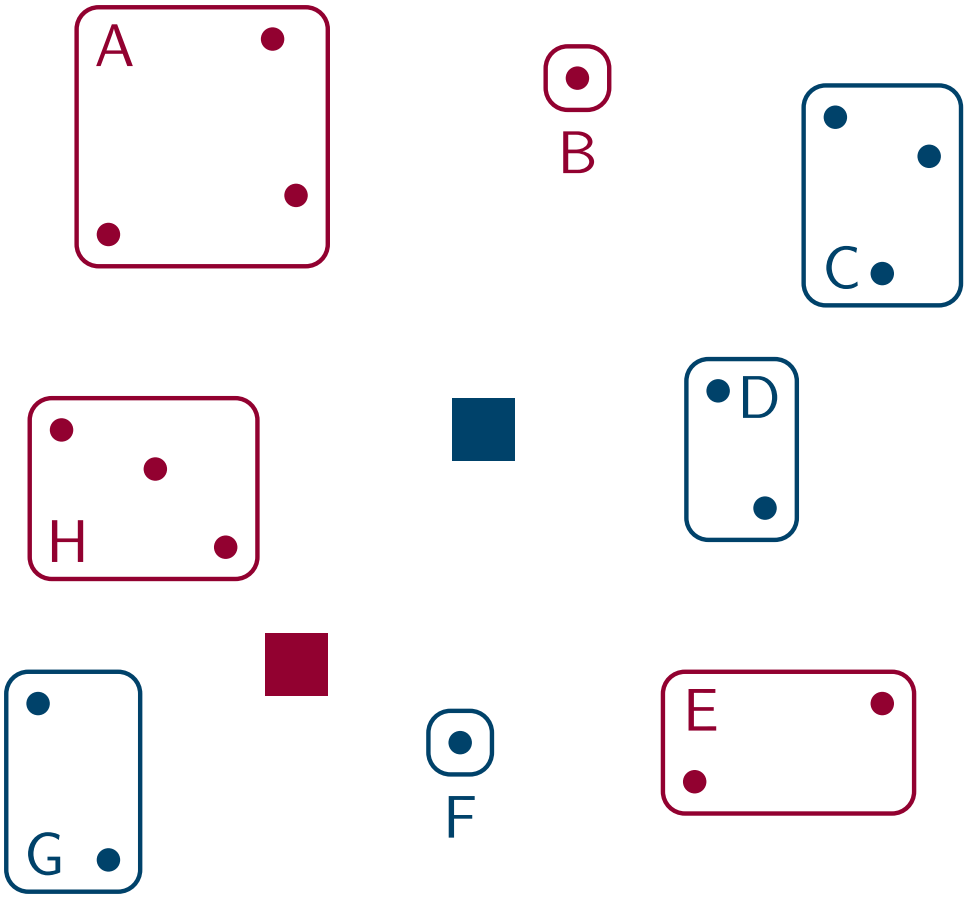
Introducing a collaborative environment



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**

Solving a collaborative routing problem

Operational plan + fair cost allocation mechanism

- **Method of aggregation** (solve problem at coalition level)
  - All resources are shared *(vehicles,warehouse capacity,. . .)*
  - All clients and their orders can be exchanged among partner

  - The size of the problem grows significantly, together with its **complexity**
  - Coalition efficiency $\stackrel{?}{=}$ Individual partner efficiency

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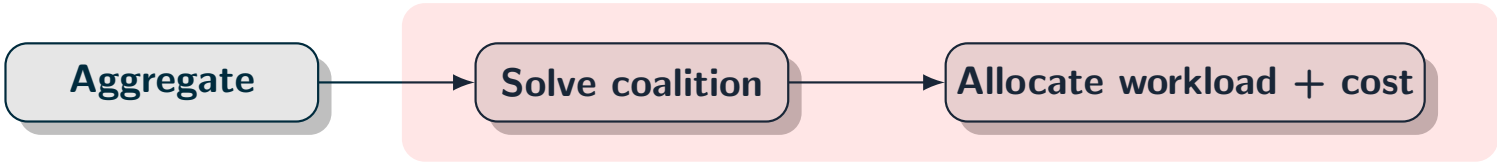

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A two-level solution approach

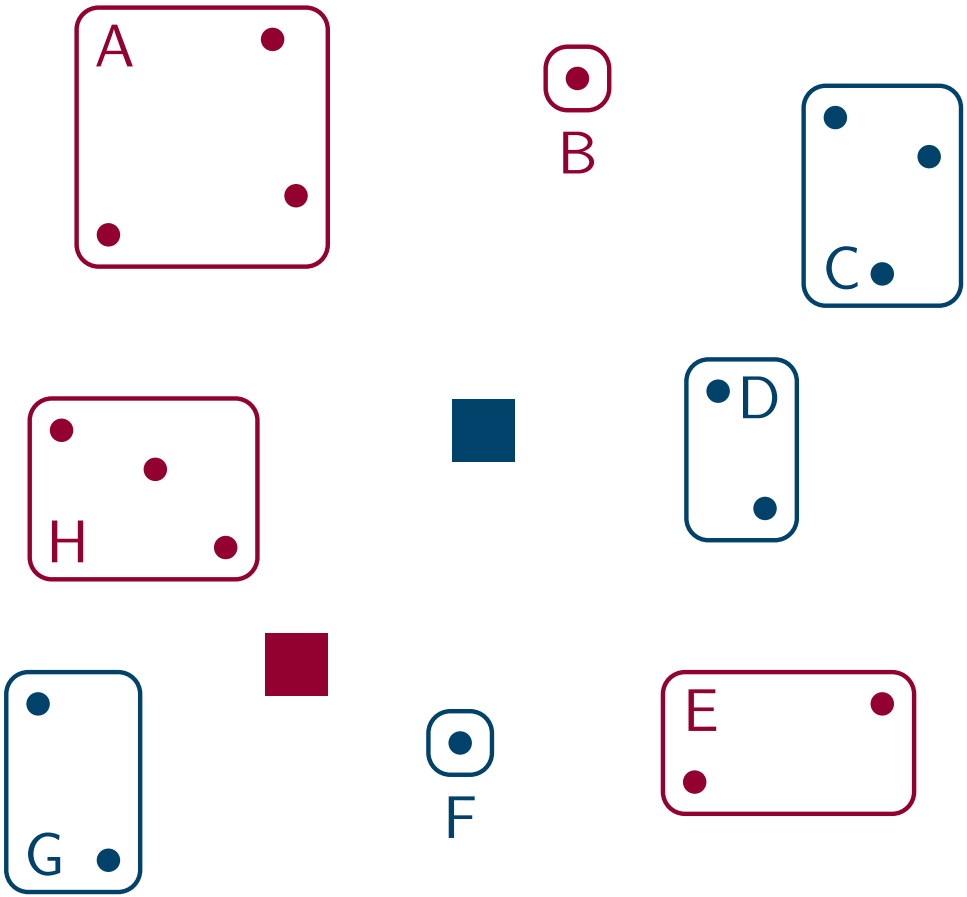
Master problem

- Coalition efficiency
- **Suggesting** *good moves*
  - Exchange/interaction between partners $\rightarrow$ **collaboration**
  - Most profitable for the coalition *(e.g. reduction of total logistic cost)*

Slave problems

- Individual partner efficiency
- Can be different for each partner
- **Evaluating** the move
  - *"At what cost will I accept the move?"*
  - *"What am I willing to pay for this move?"*

Hands-on example



- **Initial Solution:**
  Stand-alone scenario

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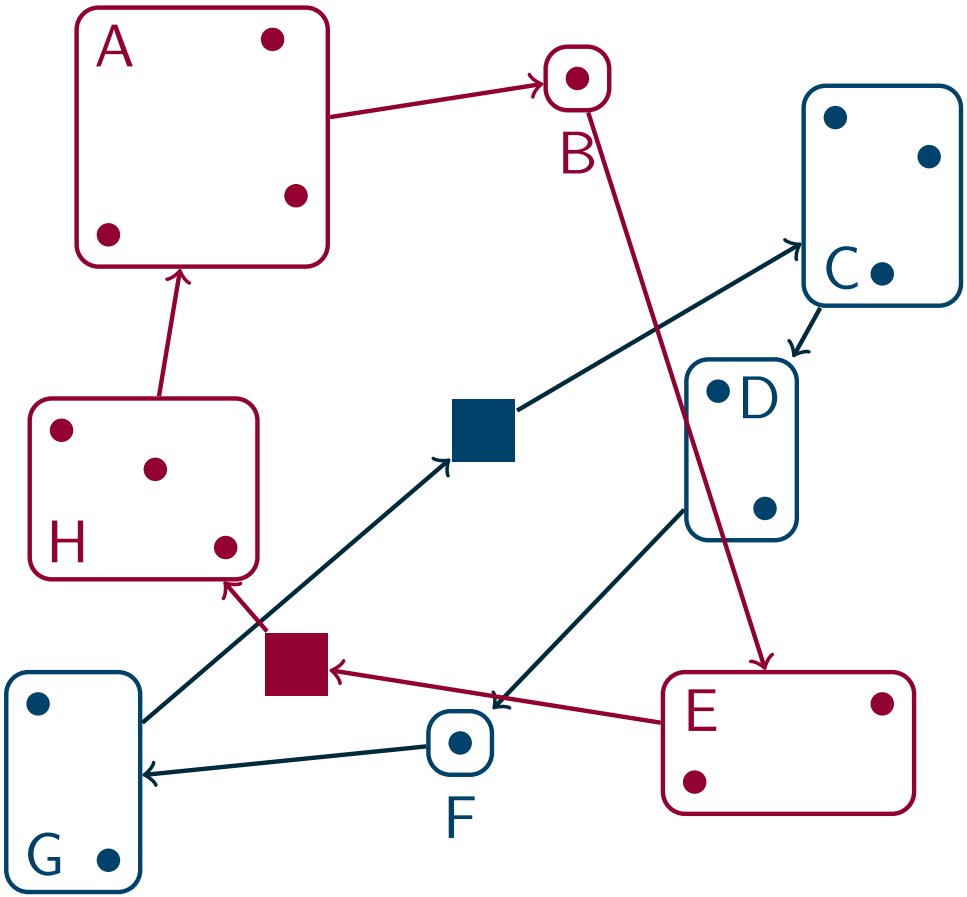

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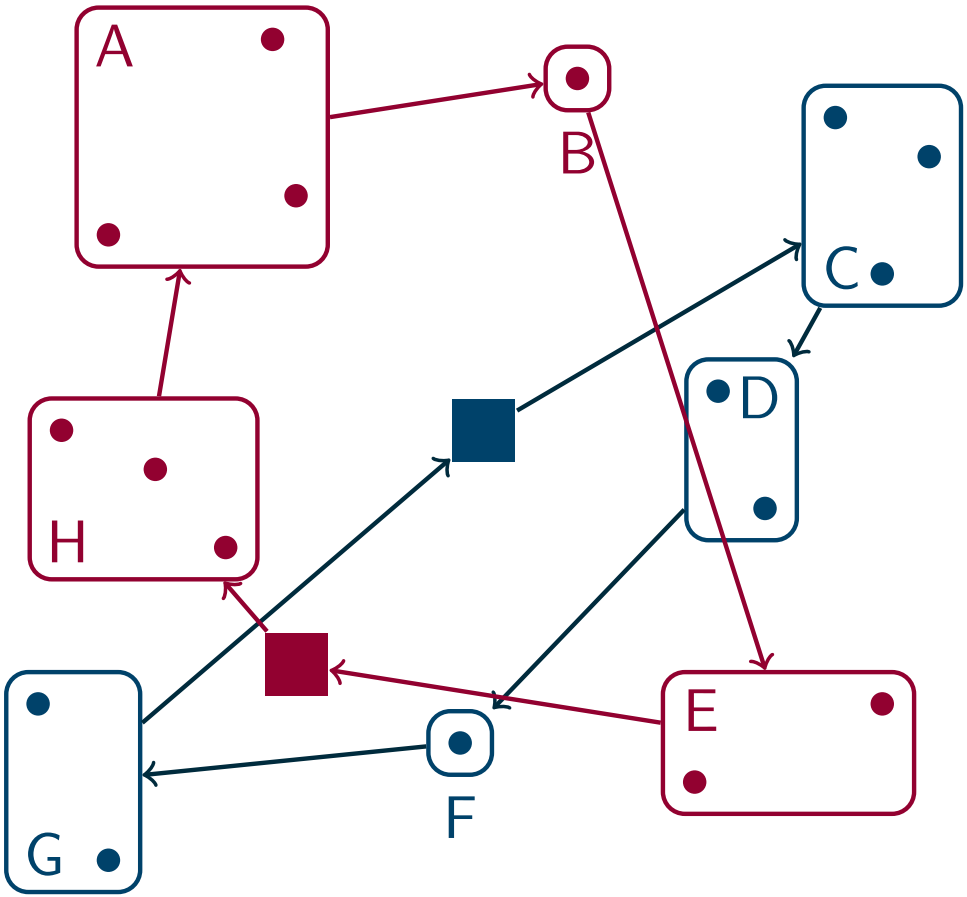

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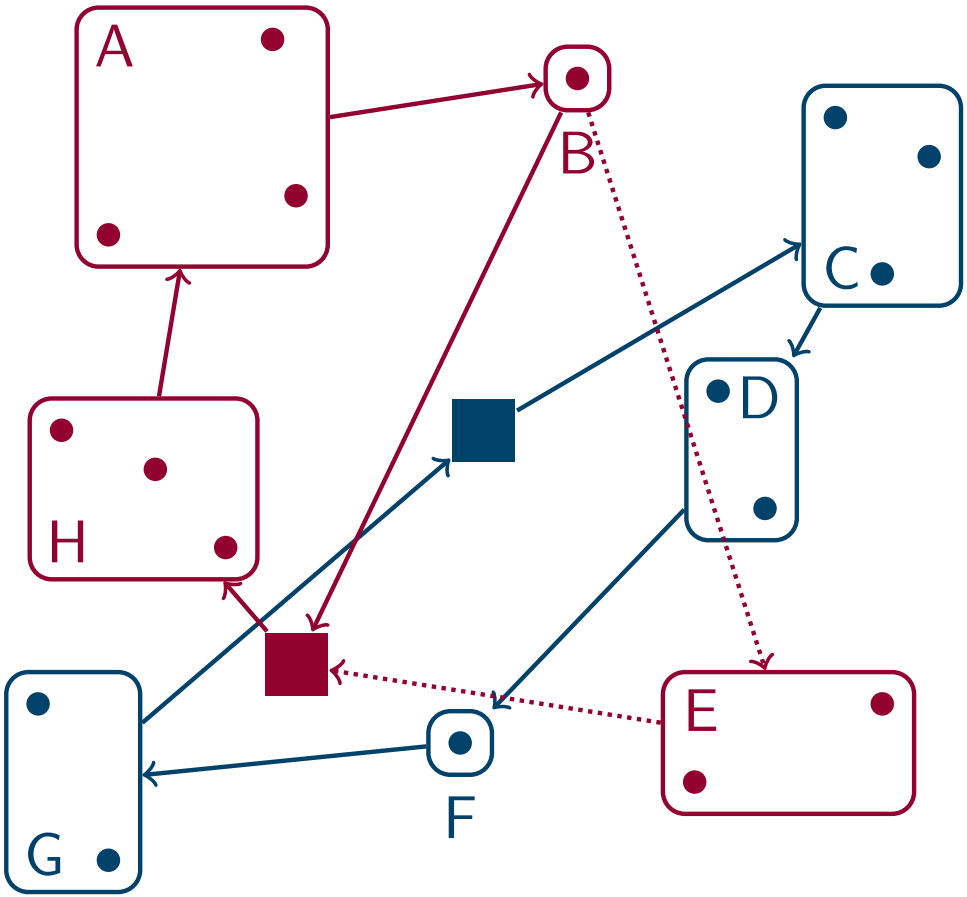

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  Red is willing to pay

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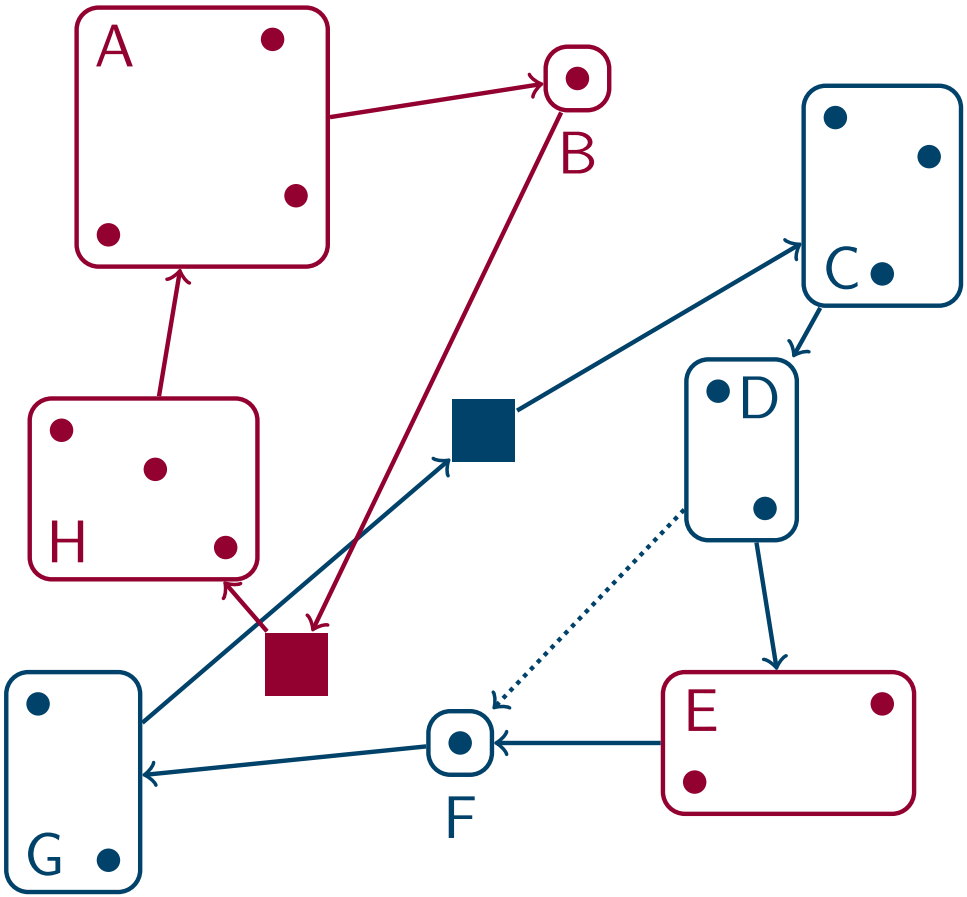

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  Red is willing to pay
  Blue wants to receive money

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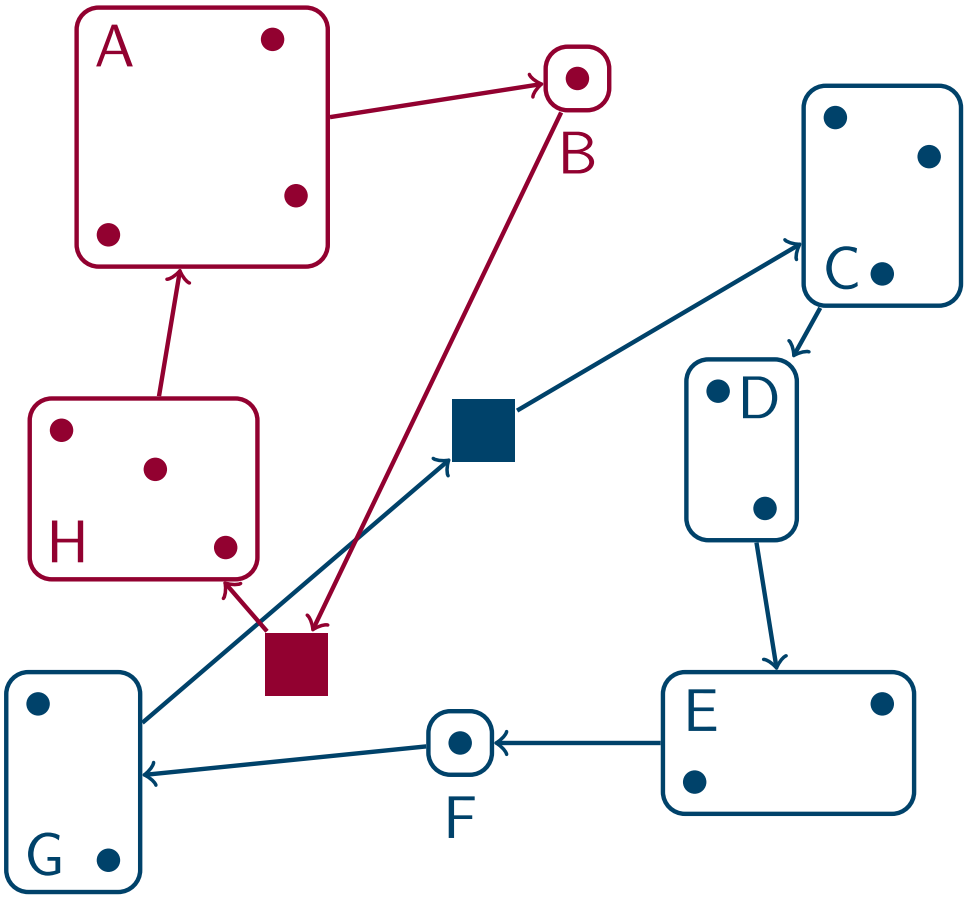
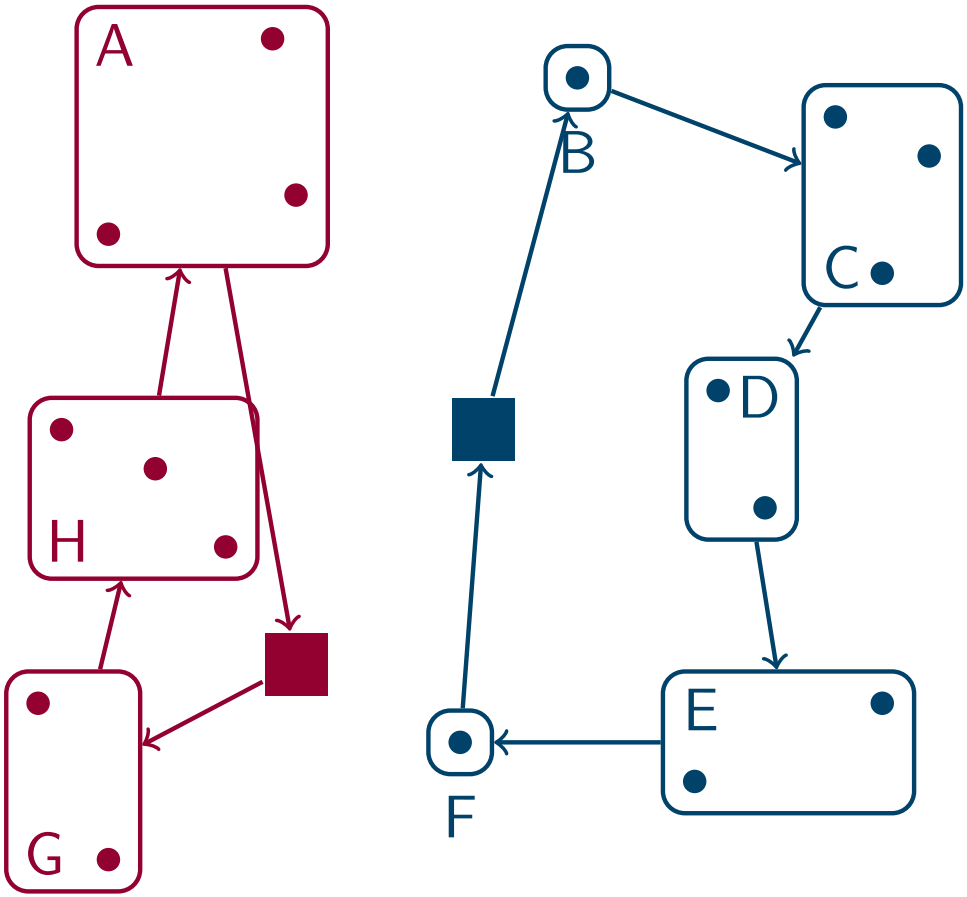


- **Initial Solution:**
  Stand-alone scenario
- **Master:**
  Cluster with highest marginal cost = E
- **Slave:**
  Red is willing to pay
  Blue wants to receive money
- **Master:**
  If match found
  - Execute move
  - Money transfer

Iterate until . . .



Remarks:

- What if no match
  - Master suggests another move
- Stopping criterion
  - No more feasible moves available

The result

- A solution approach for the Collaborative Clustered Vehicle Routing Problem

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  - **Is the solution good?**
    $\rightarrow$ At least as good as the stand-alone scenario.

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- **Coalition efficiency:**
  $\rightarrow$ **Yes!**
  Decrease in total logistic cost for the coalition, ensured by the suggestions from the Master problem.
- **Individual partner efficiency:**
  $\rightarrow$ **Yes!**
  Before executing a move, it is evaluated by the involved partners.

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- A solution approach for the Collaborative Clustered Vehicle Routing Problem
- A **cost allocation mechanism** is included implicitly in the solution procedure

- **How good (fair) is this cost allocation?**
  - No game theoretical concepts or properties can be proven
  - Based on what the individual partners **want**
  - We know that all partners **agree**

And for the future?

- Run tests and simulations for different instances and scenarios
  - Try to understand the behaviour and impact of the different building blocks in our model
- Try these ideas and framework on other routing problems that include horizontal co-operation
- Talk about these ideas, and look for feedback
- and ...


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