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
The concept of client clustering

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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
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

A vehicle trip is represented by a sequence of zones
The clustered vehicle routing problem

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A vehicle trip is represented by a sequence of zones.
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 partners

The size of the problem grows significantly, together with its complexity

- Coalition efficiency $\frac{?}{?}$ Individual partner efficiency
Solving a collaborative routing problem

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- **Method of aggregation** (solve problem at coalition level)
  - All resources are shared (*vehicles, warehouse capacity, ...*)
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- The size of the problem grows significantly, together with its **complexity**
- Coalition efficiency \( \equiv \) Individual partner efficiency
A two-level solution approach

Master problem
- Coalition efficiency
- **Suggesting** good moves
  - Exchange/interaction between partners
  - 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?"
**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

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Hands-on example

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Master:
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**Hands-on example**

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  Stand-alone scenario

- **Master:**
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- **Slave:**
  Red is willing to pay

▶ Initial Solution: Stand-alone scenario

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Hands-on example

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- **Master:**
  If match found
  - Execute move
  - Money transfer
Iterate until ...
A solution approach for the Collaborative Clustered Vehicle Routing Problem
A solution approach for the **Collaborative Clustered Vehicle Routing Problem**

- **Is the solution good?**
  - At least as good as the stand-alone scenario.
A solution approach for the Collaborative Clustered Vehicle Routing Problem

- Is the solution good?
  - At least as good as the stand-alone scenario.

- **Coalition efficiency:**
  - Yes!
  Decrease in total logistic cost for the coalition, ensured by the suggestions from the Master problem.

- **Individual partner efficiency:**
  - Yes!
  Before executing a move, it is evaluated by the involved partners.
A solution approach for the Collaborative Clustered Vehicle Routing Problem

A cost allocation mechanism is included implicitly in the solution procedure
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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