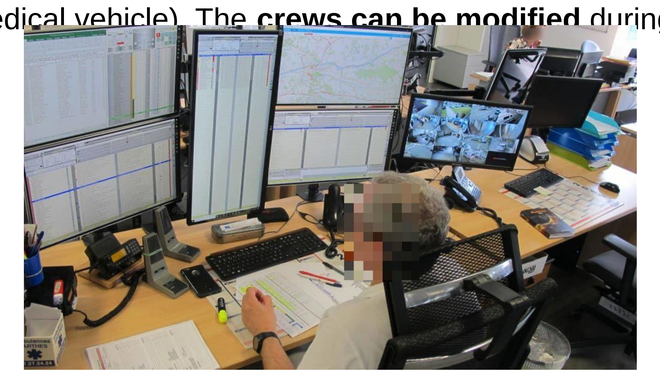
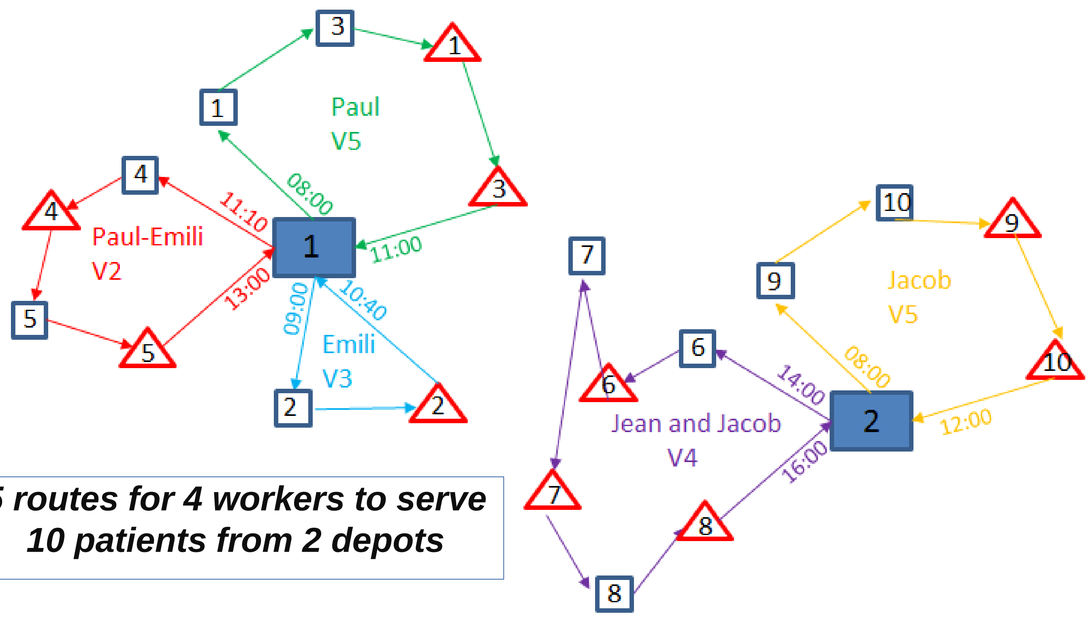
Proactive and reactive planning for medical transportation

Context and problem description

- Decisions:
  - To assign the drivers and assistants to some vehicles (ambulance, taxi, light medical vehicle). The **crews can be modified** during the day
  - To **reject** some requests
  - To **dispatch** the medical transportation requests to the vehicles
  - To decide on the **operating time** of the workers
- Constraints:
  - To serve the maximal number of requests
  - To satisfy the time constraints for the requests
  - The skills of the crew have to match with the request requirements
  - Legal working rules on **breaks** and lunch breaks have to be satisfied



A regulation center



5 routes for 4 workers to serve 10 patients from 2 depots

Data characteristics

- From 100 to **2,000 requests** per day
- From 30% to 70% of the requests are known the day before
- From 20 to **300 drivers** and vehicles
  - Up to ten attributes for workers (spoken languages, diploma, experience, taxi licence, …)
  - Different initial working periods
- From 10 to **250 vehicles** based in 5 to **60 depots**
- 3 types of vehicles with different costs:
  - Ambulances (2 workers)
  - Taxi
  - Light Medical Vehicle

Solution framework

- A first **proactive plan** is built the day before
  - It defines the beginning of the working period of some workers
  - It fixes some service times in the planning
  - Two approaches are applied to build the proactive plan:
    - The final objectives minimization
    - To balance the workloads
    - To unbalance the workloads, i.e., to keep some drivers available
- During the day **the plan is dynamically updated**
  - **Deep modifications** are allowed: If the move to the patient did not start, the current assignment can be modified
  - The **flexibility** on the service times and the limits of the working periods are used to insert new requests
- A large neighborhood search combined with a local search is able to find good solutions to the static and the dynamic problems

The Lomaco Online solution

Numerical results

- On the static problem
  - Our heuristic outperforms the manual approach:
    - From 1 to 6.5 uncovered requests
    - The global evaluation of the solutions is improved by a factor 2
  - Our heuristic improves the best known solutions for some special cases with multiple trips and some variants of the dial-a-ride problem
  - The average number of trips per worker is 1.3 and 5.0 on some large instances.
- On the dynamic problem
  - Our approach outperforms two manual strategies in 93% of the simulated cases
  - Using the proactive plan to initiate the dynamic process, improves the final solution from 3% to 14% depending on the context

Contact : *garaix@emse.fr*

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MINES Saint-Étienne

Une école de l'IMT

Authors

Mohammed Skiredj
Thierry Garaix
Xiaolan Xie

Partners

LIMOS

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ANRT ASSOCIATION NATIONALE RECHERCHE TECHNOLOGIE