Real-life case studies on transport and workforce optimization

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Case study I

- A locally operating company producing and transporting meals and food products
- Modeled as pickup and delivery problem with time windows
  - Maximum route duration for part of orders
  - Backhauling
  - Split delivery
  - Tight time windows
  - Homogeneous fleet
  - Volume based capacity constraint
  - Working time regulations
  - Only one loading platform per pickup location
  - Short distances
  - About 5 main pickup locations and >200 delivery locations

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Estimated savings

	Current practice		Optimized solution	
Weekday	**Vehicles**	**Time (h)**	**Vehicles**	**Time (h)**
Monday	11	61	8	37,33
Tuesday	11	54,5	6	32,38
Wednesday	11	54,5	6	32,38
Thursday	11	61	8	37,33
Friday	11	54,5	6	32,38
Saturday	4	20	4	12,76
Sunday	4	20	4	12,76
Total	**63**	**325,5**	**42**	**197,32**
Savings			**33%**	**39%**

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Practical problems

- Modeling the problem
    - Route duration vs. time windows
- Parking cost
- Service time adjustment
- Travel time adjustment
- Drivers' breaks
- Volume usage of each order vs. vehicle capacity
- Missing data

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Case study 2

- School transportation
- Standard issues:
  - Time windows
  - Capacity
  - Max travel time...
- And
  - Optimal pickup location
  - Optimal delivery location
  - Big problem, over 150 routes each day

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Results

- Savings depend on the desired travel time

- 9.2% less routes

- 25.7% savings in kilometers

- By allowing 10 minutes more time in vehicle
  - Additional 10% reduction in routes possible

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Practical issues

- Vehicle slack time
  - Now set to 20%
- Bypassing school before planned drop off
- Gap:
  - Combining bus schedules

Case study 3

- Combined hub location and vehicle routing
- A set of potential terminal locations given
- Vehicle routes optimized for each combination
- Considers terminal chains
- Multi-driver teams
- Applied to nationwide transportation

Latest developments

- Stochastic problems
- Delivery volume optimization
- Trailer management
- Optimal delivery timings
- Periodic problems
- Speed ups
- Combining workforce optimization

Workforce management

- Creates rosters and schedules tasks for each shift with desired accuracy, considering:
    - Regulations and recommendations
    - Worker differences
    - Multiple objectives
    - Optimal shift start times
    - Circulation schemes
    - Different task types
    - Impact of timing
    - Any planning period length
    - Exceptions
    - Optimal break timing
    - Required workforce,...

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Performance

- Linear scaling wrt. planning period length and number of tasks

- CPU time e.g. for one month and about 40 employees, 1 second

- Has been tested with 50 000 employees and one year period

- Applications in transportation and retail stores

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Algorithmic approach

- Based on finding positions where improvement possible

- VNS scheme over multiple local search heuristics

- Roster and shift planning separated

- Special purpose methods

- Example: One-by-one segment re-insertion

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Parallel computing

- Standard multi-core approach

- Common time-matrix

- Solution divided to partial solutions

- Share the best found solution

- Current implementation does not suit well for GPU computing

- Future plan: new data structures & point-based approach

Parallel workforce optimization

- Based on splitting the problem or running multiple scenarios simultaneously

- Alternatively: move evaluation can be split or the different algorithms

- Future work: how to apply GPU & speedups

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