The financial support by the Austrian Federal Ministry for Digital and Economic Affairs, the National Foundation for Research, Technology and Development and the Christian Doppler Research Association is gratefully acknowledged.

Contact: lkletzan@dbai.tuwien.ac.at

Problem Definition

- Input: Predetermined bus tours
- Input: Distance matrix

- Shift overview:
  - start work
  - Driving time $D_i$
  - passive ride
  - end work
  - rest
  - Working time $W_i$

Constraints

- **Total Time**
  - $T_i \leq T_{\text{max}} = 14$ hours

- **Driving Time**
  - $D_i \leq D_{\text{max}} = 9$ hours

- **Break**
  - $\geq 3$ hours: shift split

Solution

- **Goal**: Assign drivers to all bus legs satisfying all constraints
- **Objective function**:
  \[ \sum \left( 2 \cdot W_i + T_i \right) + 30 \cdot \text{change}_i + 180 \cdot \text{split}_i \]

- **Contributions**:
  - Analysis of problem characteristics
  - New benchmark data set
  - Solution method based on construction heuristic and Simulated Annealing
  - Evaluation of employee satisfaction criteria

Instances

- **Typical demand distribution**:
- **Many options to distribute split breaks due to idle times in vehicle tours**

Benchmark Instances

- New instance generator
- Publicly available instance set
- 50 instances
- 10 different sizes: 10 tours (about 70 legs) to 100 tours (almost 1000 legs)

Evaluation

- **Importance of Employee Satisfaction**
  - Only optimizing working time objective has huge cost on other objectives:

Results on Benchmark Instances

- **4% improvement to human expert solutions for very large instance with 2700 bus legs**
- **Improving 4 out of 10 instances on problem from Brasil**
- **4 out of 5 best results for size 10 are optimal**
- **Gap of 3-5% to optimum for medium size instances**