

UNIVERSITY OF TWENTE.

# A flexible iterative improvement heuristic to support creation of feasible schedules in Self-Rostering

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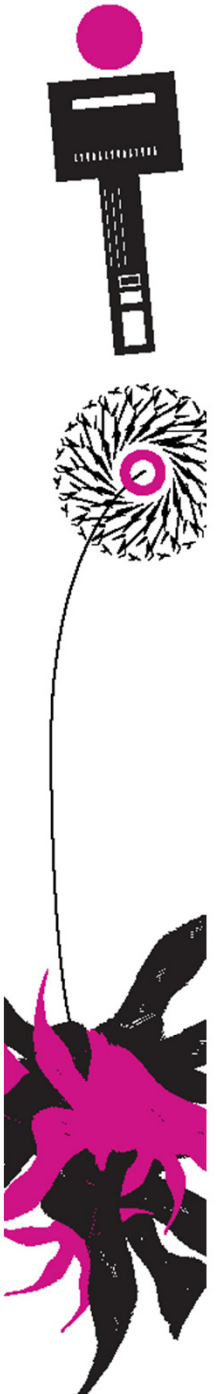
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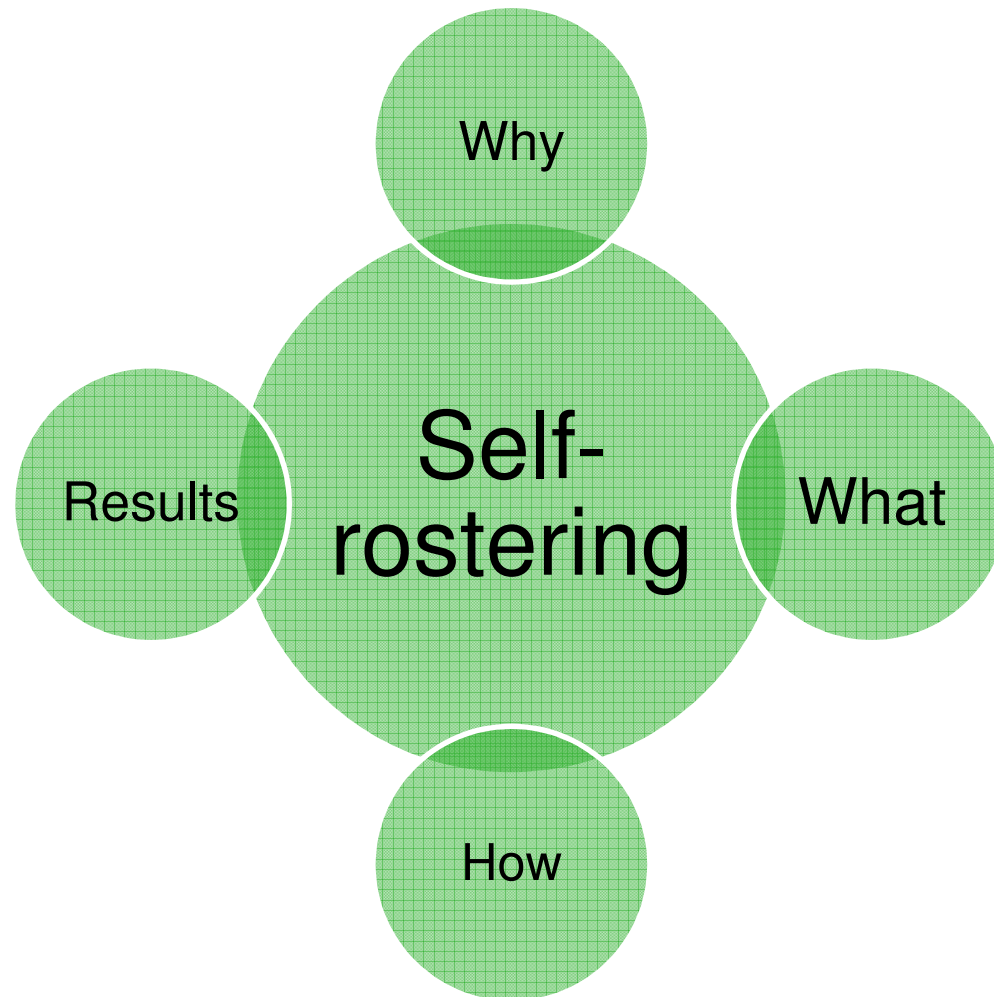


# What is Self-Rostering





## Outline

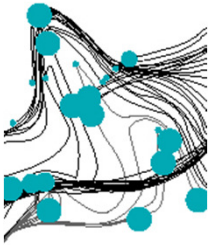




## Why Self-Rostering?

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- Employee satisfaction through better work-life balance
  - Preferences not necessarily related to specific days
  - Employee preferences might change through time
- Improved co-operation
- More commitment
- .....



## Problem description

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- Given: employees, schedules, demanded staffing levels
- Goal: minimize understaffing
- Restrictions
  - Consider labor legislation
  - Overstaffed not understaffed
  - Understaffed not overstaffed





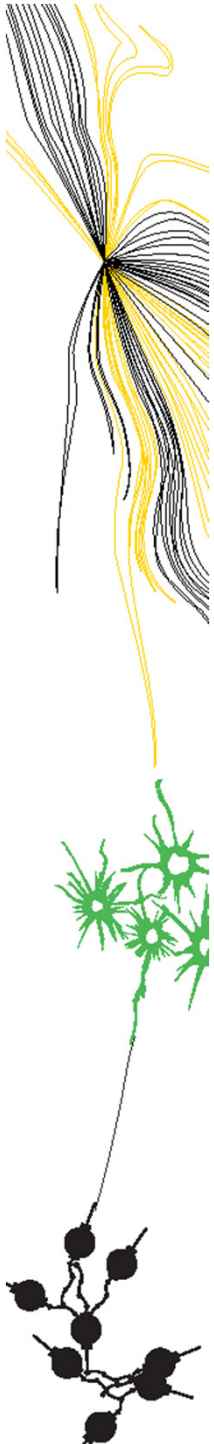
## Principal approach

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- Iterative
    - Small steps – better understanding by ‘practice’
    - Adjustments possible after each iteration
  - Apply ‘swaps’







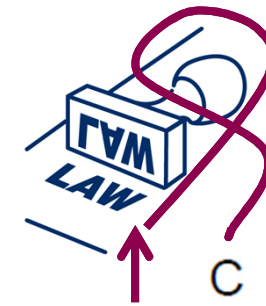
## Swaps - Example

- All shifts require 3 employees

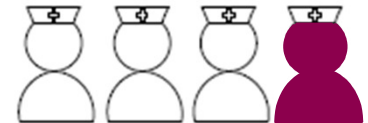
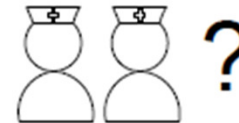
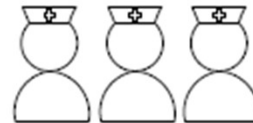
Shift

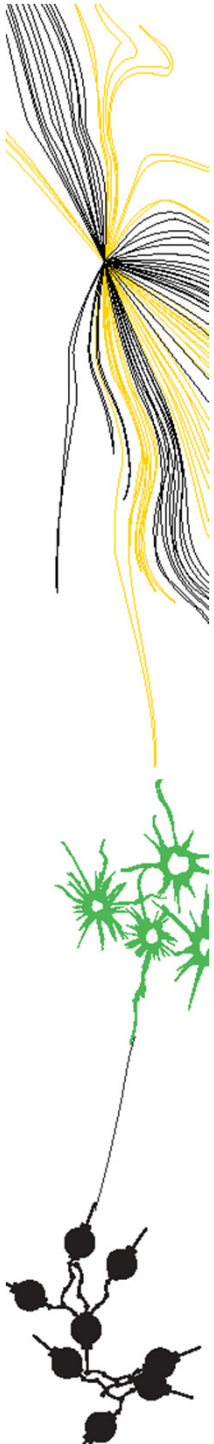
A

B



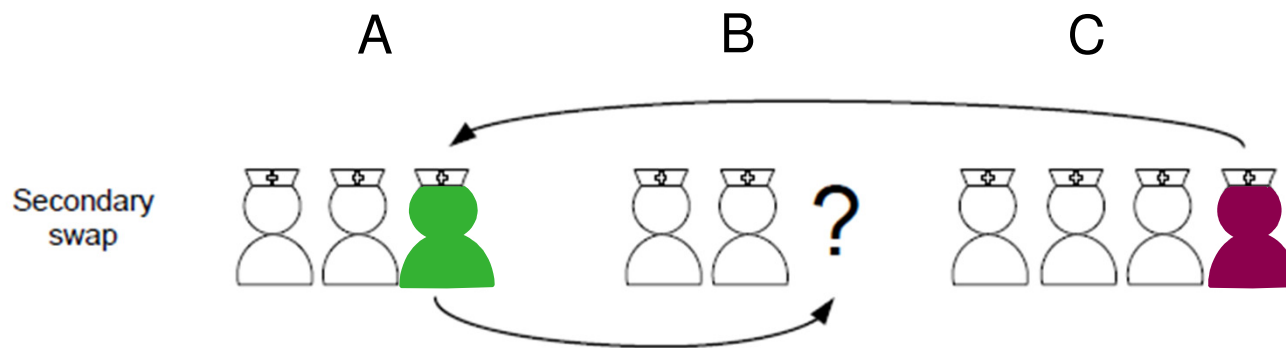
C





## Swaps

- A swap is change in schedule of 1 employee
- Overstaffed swapped with understaffed
- Not restricted to shifts on same day
  - E.g., swap shift A on day 1 to shift B on day
- Secondary swap






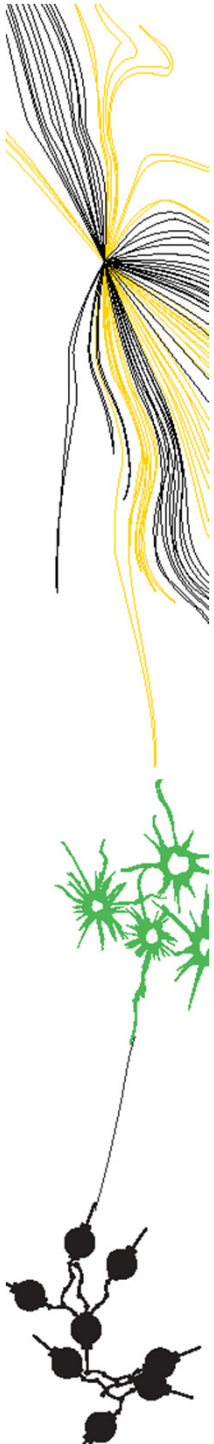


## Principal approach

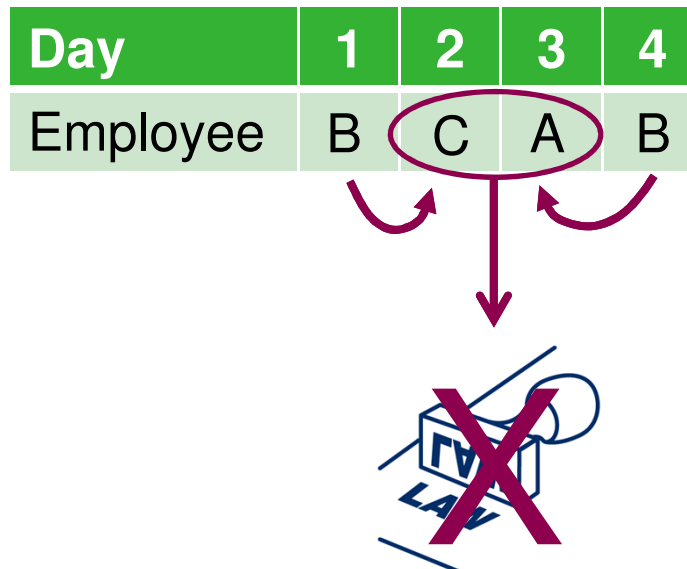
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- 
- Iterative
  - Apply swaps
    - Labor legislation isolated component
  - Max 1 swap per employee per iteration







## Swaps – max 1 swap per employee

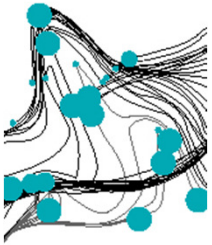




## Principal approach

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- 
- Iterative
  - Apply swaps
  - Max 1 swap per employee
  - Apply swaps to schedules of  $k$  employees with most ‘popular’ shifts
    - Overstaffed shift = popular shift
    - 1 employee: transparent vs all employees: least transparent (better resulting schedule)
- 



## Swap selection - MILP



### Minimize # overstaffed shifts

1. max 1 swap per employee
2. Overstaffed shifts  
✖️ → understaffed
3. Understaffed shifts  
✖️ → overstaffed

$$\text{Min } \sum_{k \in \text{OVER}} n_k$$

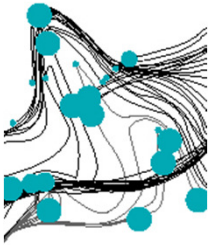
$$\sum_{j \in J_i} x_j \leq 1 \quad i \in I$$

$$x_j \in \{0,1\}$$

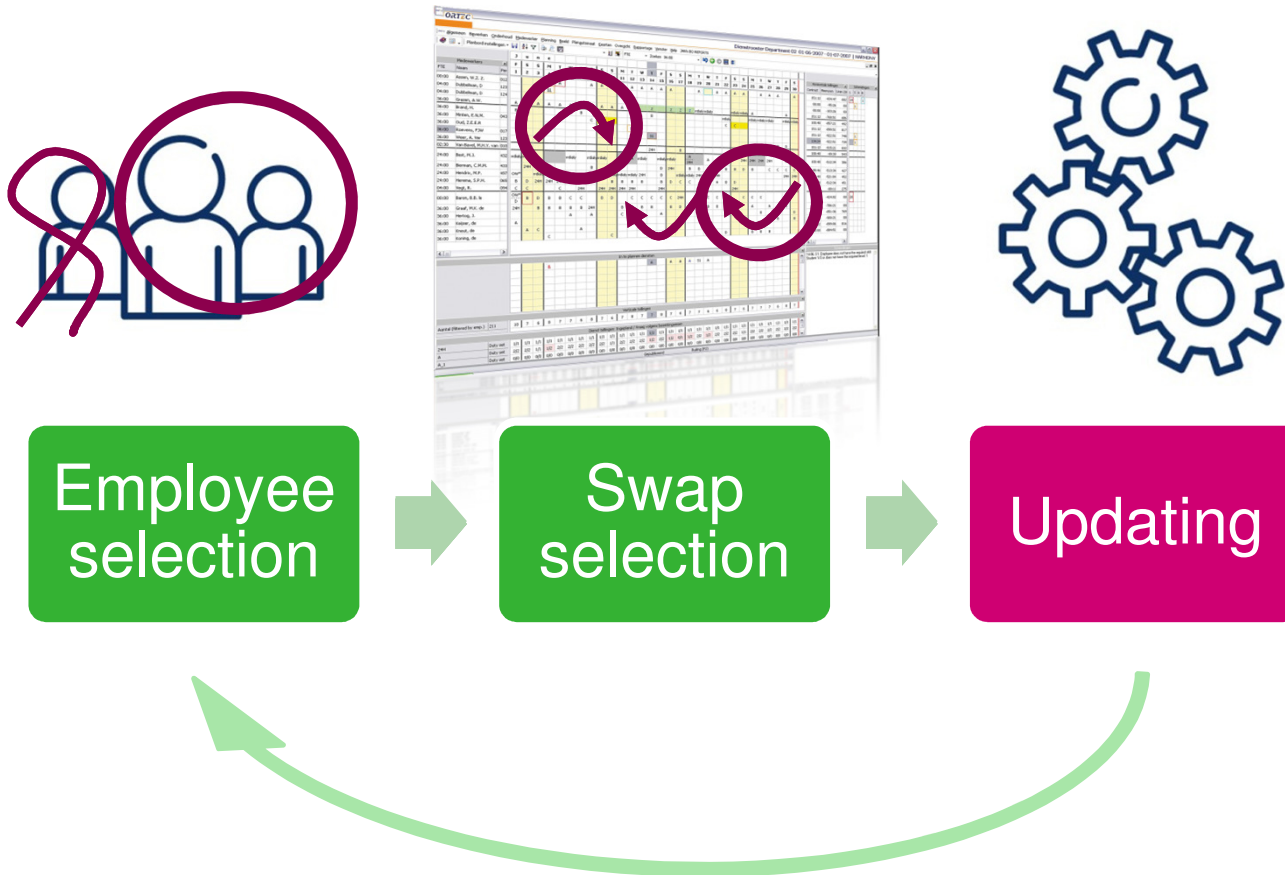
$$n_k \geq 0 \quad k \in K^O$$

$$n_k \leq 0 \quad k \in K^U$$

$$n_k = v_k + \sum_{i \in I} \left( \sum_{j \in A_i^k} x_j - \sum_{j \in U_i^k} x_j \right) \quad k \in K$$



## Iterative procedure





## Criteria case studies

- Satisfy working hours act and collective labor agreements
- Minimize total number of changes and retain at least 80% of each proposed schedule
- Wildcards
- Transparency

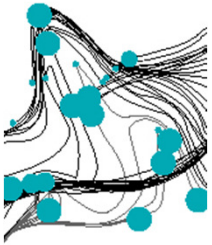


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## Results



### Input

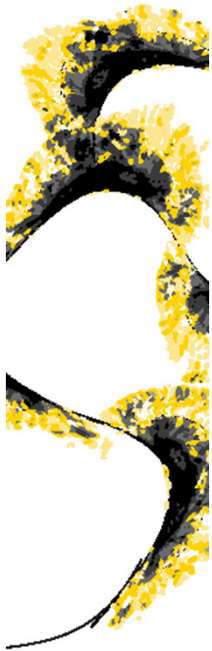
- 3 cases: 7 schedules
  - 15-80 employees
  - 16-212 shortages per month schedule
- Parameter values
  - Swap strategy
  - Remaining %
  - ...

### Output (avg)

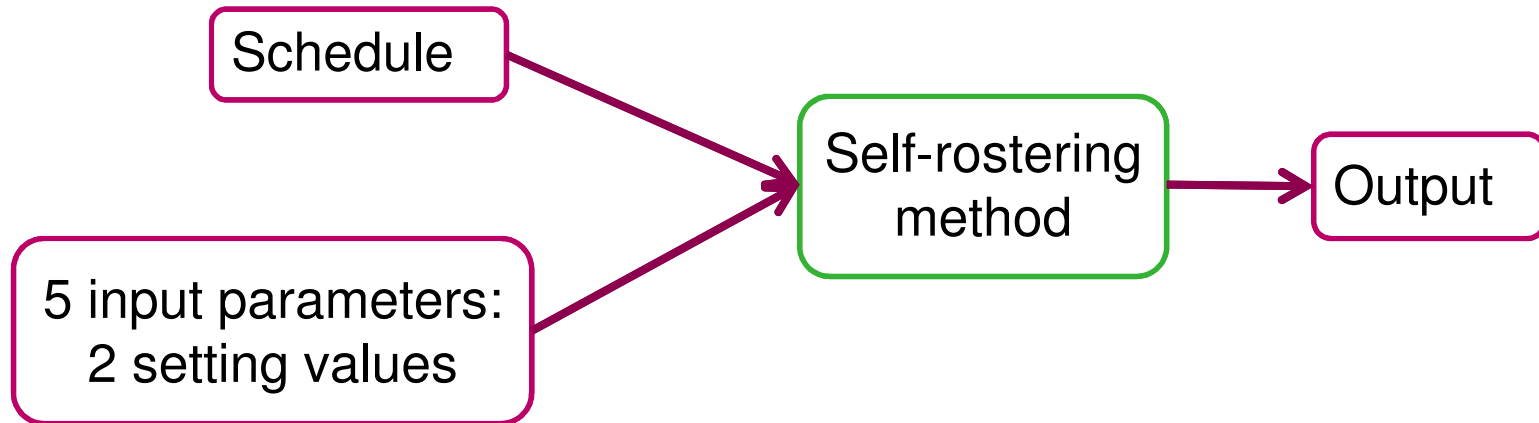
Time: **2.8 sec**

Shortages left: **0.90**

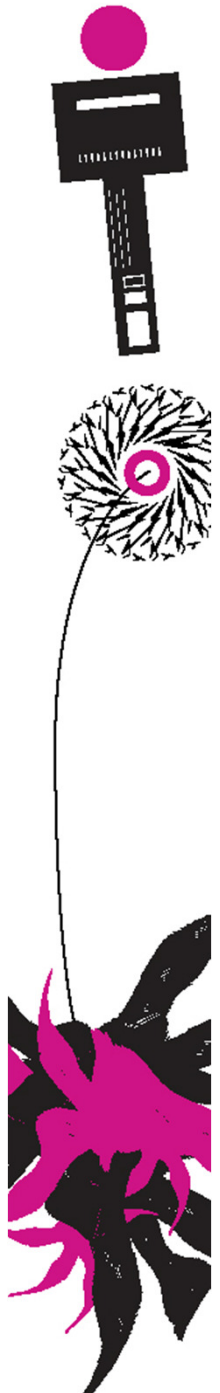
Retained schedule: **92%**



## 2<sup>k</sup> factorial design



## Results



Only  
primary  
swaps



Primary &  
secondary  
swaps

Minimum  
of 80%



Minimum  
of 70%

**Shift  
shortages  
left**



**Retained %  
of the  
preferred  
schedules**



## Summary

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- Case studies: criteria
- Flexible iterative approach
- Approach independent of Self-Rostering process
- Results
  - Short calculation times
  - Trade-off between “remaining shortages” and “remaining %”



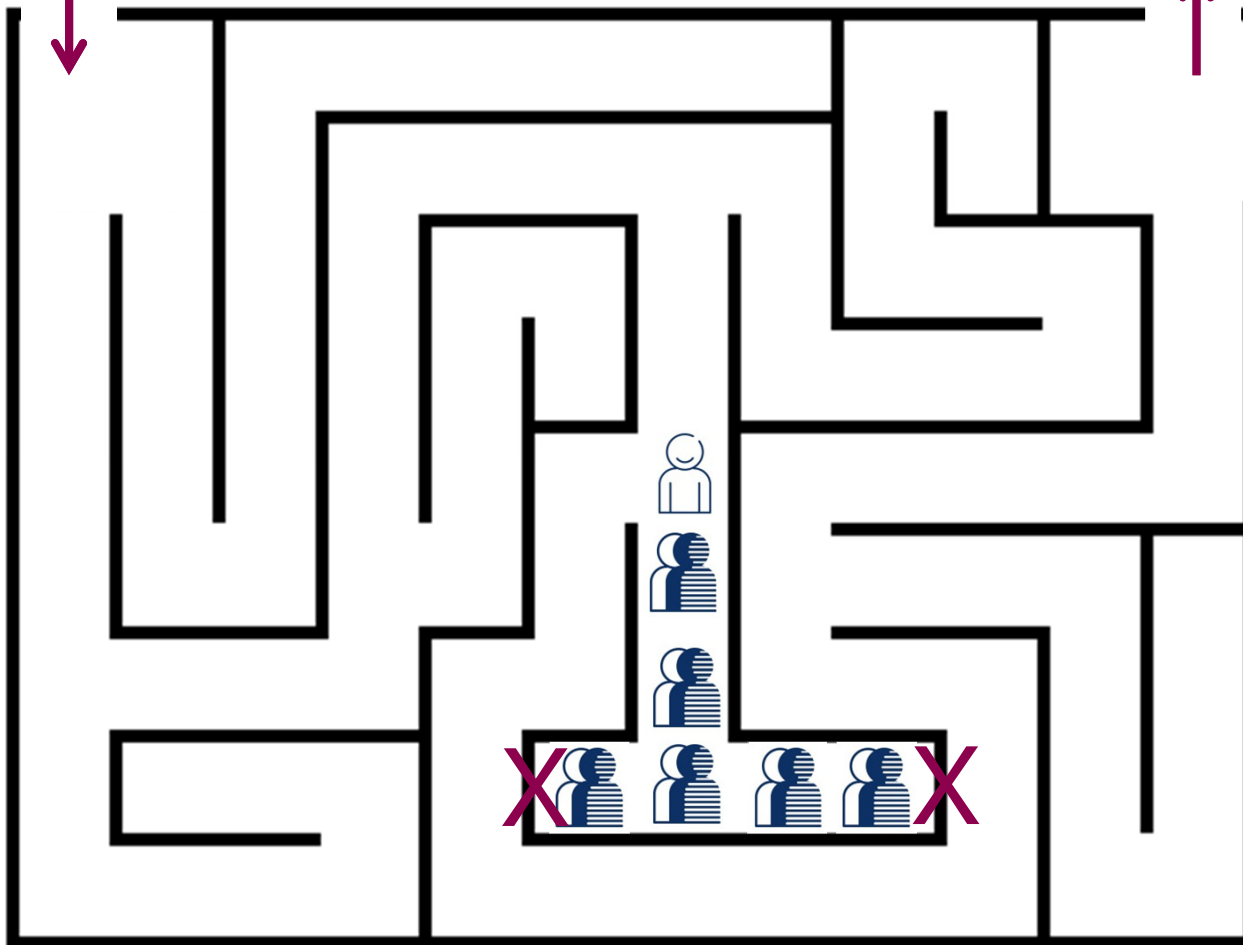
Further research

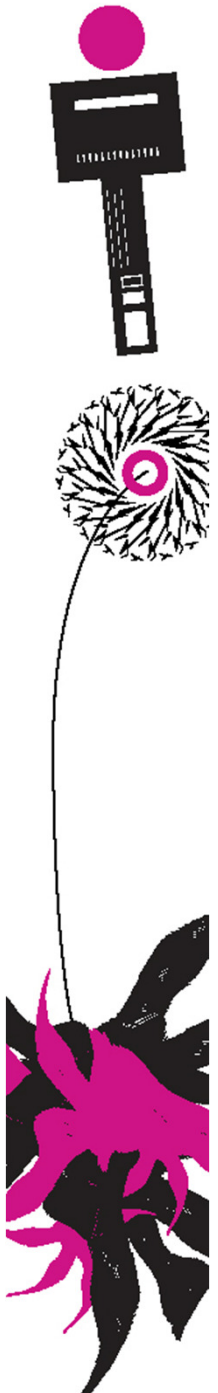
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## Questions

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### **ORchestra Bibliography**

*We kindly invite you to have a look at our online categorized bibliography for OR/MS in Health Care:*

**[www.utwente.nl/choir/en/orchestra/](http://www.utwente.nl/choir/en/orchestra/)**

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