

Solving the Test Laboratory Scheduling Problem with Flexible Grouping

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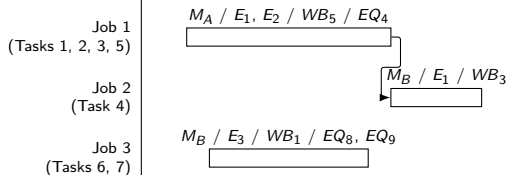
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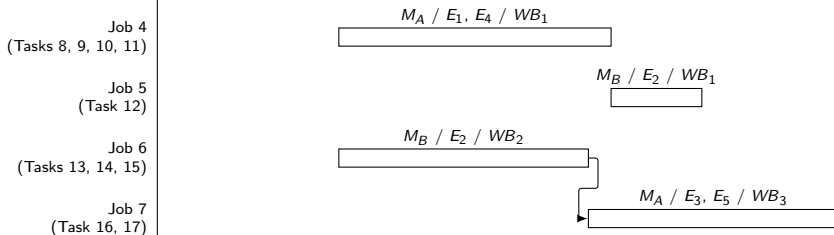
Informatics

Example schedule

Project 1

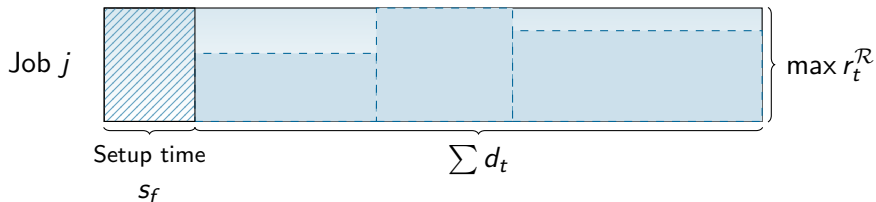


Project 2



Task grouping

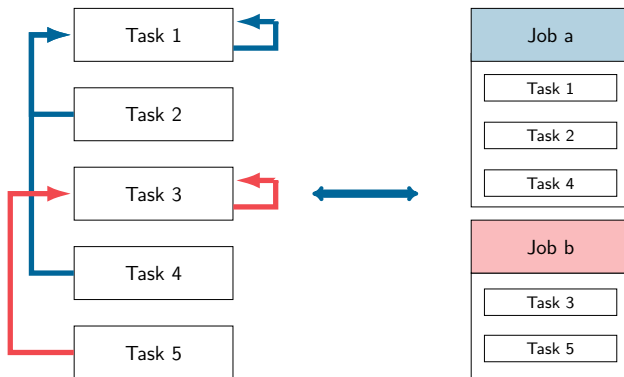
A job consists of one or several *tasks*, which define its properties:



- Available resources: $\mathcal{R}_j = \bigcap \mathcal{R}_t$
- Time window: $\alpha_j = \max \alpha_t, \omega_j = \min \omega_t$
- ...

Constraint Programming

- Major challenge: representing grouping
- Solution: Representative task for each job



Constraint Programming: Example Constraints

- Resource availability:

$$\begin{aligned} \text{assigned}[\text{repr}[t], r] = 1 &\implies r \in \mathcal{R}_t \\ &\forall t \in \text{Tasks}, r \in \text{Resources} \end{aligned}$$

- Resource requirements:

$$\sum_{r \in \text{Resources}} \text{assigned}[t, r] = \begin{cases} \max_{t' \in \text{Tasks}: \text{repr}[t'] = t} |\text{Req}_{t'}| & \text{if } \text{repr}[t] = t \\ 0 & \text{otherwise} \end{cases} \quad \forall t \in \text{Tasks}$$

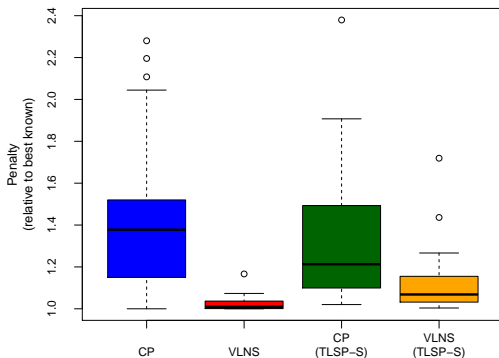
Very Large Neighborhood Search

Repeatedly generate and solve simplified CP instances:

- Only 1 project can be scheduled, the rest of the schedule is fixed
- Number increases when stuck
- Tabu list
- Some scheduling-only steps, with fixed grouping

Computational results

- 33 test instances (30 randomly generated, 3 real-world)
- Up to 1500 tasks (90 projects)
- Time limit: 2 hours
- 30 feasible solutions
- **TLSP-S**: fixed grouping given, results of Geibinger et al. (CPAIOR 2019)



- First constraint programming model for TLSP
- Mapping of tasks to each other allows handling of variable number of jobs
- Extension of VLNS for TLSP-S to work with TLSP
- Improved results despite unknown initial grouping
- New best known solutions for several large benchmark instances (including real-world data sets)
- Solution successfully deployed in test laboratory of a large company