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Project B22

Rolling Stock Roster Planning for Railways

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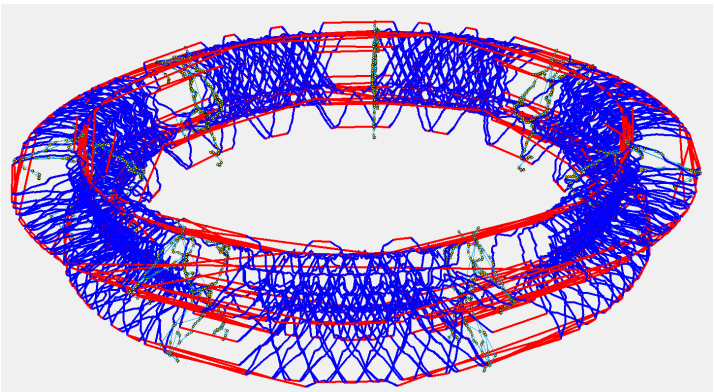
Domain of Expertise: Traffic and Transport

Rolling stock rostering is one of the basic planning problems in rail transport. It deals with the construction of rotations for individual units of rolling stock and, simultaneously, the composition of trains from these units. We focus on (long distance) passenger transport. Here, units of different types are arranged to form trains in particular sequences and orientations, and in a "regular" way.

Our approach to rolling stock rostering is based on the hypergraph assignment problem model, which serves as a universal tool to handle several types of rules. The hyperedges of the bipartite hypergraph correspond to deadhead trips. Every timetable trip is both a beginning of some deadhead trip (as a vertex in U) and an end of some deadhead trip (as a vertex in V).

ICE Vehicle Rotation Plan Visualization in TraViS



Hypergraph Assignment Problem (HAP)

Input: A bipartite hypergraph $G = (U, V, E)$ and a cost function c_E on the hyperedges.
Output: A hyperassignment in G with minimum cost w. r. t. c_E.

Integer linear programming formulation of the HAP:

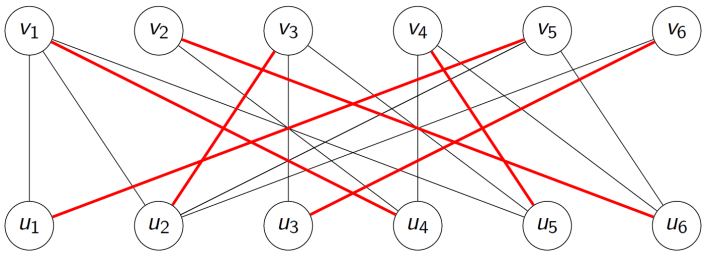
$$\min_{x \in \mathbb{R}^E} \sum_{e \in E} c_E(e) x_e$$

$$\text{s. t.} \quad \sum_{e \in \delta(v)} x_e = 1 \qquad \forall v \in U \cup V$$

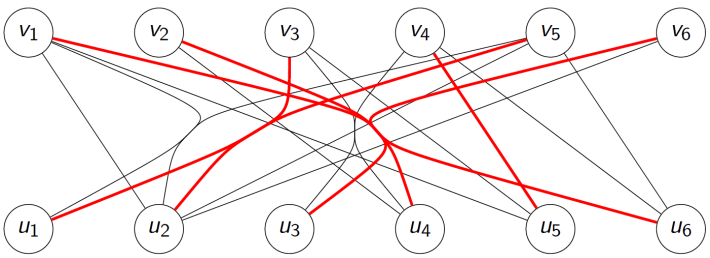
$$x \geq 0$$

$$x \in \mathbb{Z}^E$$

Hyperassignments Are Generalizations of Assignments



an assignment in a bipartite graph



a hyperassignment in a bipartite hypergraph

Approaches and Results for the HAP

- complexity (NP-hard, APX-hard)
- extended formulation, which implies all clique inequalities
- classification of facets, new facet-defining inequalities
- heuristics

Partners

DB Fernverkehr AG Frankfurt (Main) Vehicle Rotation Planning for Long Distance Passenger Railways (ZIB)