Problem Solving and Search in AI

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1 Main Algorithm

We decided to use a Greedy Randomized Adaptive Search Procedure (GRASP). For the local search, we first want to implement a *tabu search*, testing different neighborhoods (for more details, see below). In a subsequent step, depending on the results of our approach, we may think about a combination with a Variable Neighborhood Search (VNS) or a Variable Neighborhood Descent (VND).

1.1 Problem Representation

Solutions will be represented by a matrix TTP. Rows i in TTP represent the round of a game. Columns j in TTP represent the first team. The value $g_{i,j}$ of a cell represents the second team. If $g_{i,j} > 0$ then the team plays a home-game, else the team plays a out-game. Since our indices for the matrix start at 0 but we cannot represent -0 we will store the values for $g_{i,j}$ by using the transformation $(|g_{i,j}| + 1) \cdot \mathrm{sgn}(g_{i,j})$.

1.2 Construction Phase

For the construction of our initial solution, we will use a multi-phase approach similar to [RU04] where in a first step, traveling patterns with virtual teams are created and in a subsequent step, the real teams are assigned to the virtual teams.

1.3 Local Search

In our first prototype, we will implement a tabu search as local search.

2 Neighborhood

For our heuristic, we will implement and test different neighborhoods we discovered. Some of these are based on neighborhoods used in other heuristics (like [GS07, RBK08]). For our final solution, it may be that not all of these neighborhoods are used. Moreover, we would like to evaluate the usability of these different neighborhoods with respect to size, computational effort, feasibility (does it contain only valid solutions for our hard- and soft constraints), the existence of a (simple) delta function, etc.

In detail, we will consider the following neighborhoods:

swapping home/visitor swapping the home/visitor state of the two games of two teams

swapping two teams in a season (swapping teams in all games) exchanging all games of two teams

swapping rounds swapping two complete rounds

shifting rounds shifting a complete round to a different day (position)

partial swap rounds swapping the games of a team in different rounds, [GS07, HV06, CKB07] needs repair chain

partial swap games swapping the games of two team one rounds [GS07, HV06], needs repair chain

3   Problem Relaxing

In order to expand the search space, we decided to relax some problem constraints by allowing illegal solutions in combination with a penalty system. Therefore, we divide the problem constraints into *hard* and *soft* constraints. The hard constraints are that each team plays twice against each other team, once at home and once as visitor and that the result is a round-robin tour. The soft constraint deals with the home-away-patterns, as each team has limitations about the number of consequent home (or away)-games.

We will test a constant penalty as well as a dynamic penalty (called *shifting penalty*, changing the weight according to the frequencies of feasible and infeasible configurations. Depending if the previous iterations result in a (not) allowed schedule, the penalty decreases (increases). This dynamic penalty mechanism is used in several other, very successful heuristics, like those by [AMHV06] or [GS07].

References

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