

Problem Solving and Search in Artificial Intelligence

Final Exam

25.06.2021

StudentID:

Name:

1. Consider this problem (EURO2020). In the first phase of the 2020 European Football Championship the teams are divided in groups of 4 national teams. Consider for this problem only group A. All teams of this group have to play with each other (6 matches). All matches should take place in one of 11 venues located in Europe. Each national team is located in one training location and all distances between training locations and the venues, where the matches can take place, are known. All matches M_1, \dots, M_6 (also the teams playing in each match are fixed/known) should be assigned to one of venues such that the overall travel distance of all teams in a group is smaller than 8000 km. Moreover, no team should travel more than 3000 km for all its matches in the group. Each team travels back to its training location after each match. Matches M_5 and M_6 must take place in the same time and can not be assigned to the same venue.
 - Formulate this problem as a Constraint Satisfaction Problem. Define variables, domains and formulate formally the constraints. (10p)
 - Show how you could obtain a solution to this problem by applying forward checking (few steps of the algorithm). (9p)
 - Discuss how you can solve this problem by using tabu search: (a) Propose an appropriate solution representation, (2) Define an evaluation function. (3) Define at least two possible moves, (4) How can you can use tabu list for this problem? (10p)
2. Assume a more general version of the EURO2020 problem, where n teams have to play m predetermined matches M_1, \dots, M_m (not necessarily once against each other) in k different venues where the distances between the training location of each team and the venues are all known (d_{ij} where $i \in 1, \dots, n$ and $j \in 1, \dots, k$). The overall travel distance is limited by td_{all} , the maximum for each team by td_{team} . C is the set of conflicts, where each conflict is a pair of matches that can't be assigned to the same venue.

Define and describe at least 5 features for this problem that could be used for Instance Space Analysis besides directly using n, m, k, td_{all} or td_{team} . (7p)

3. You are given a partial solution for the general EURO2020 problem of the previous question, where some matches are assigned to a venue and others aren't. Describe 3 different operators to choose and assign the next match, which can be used in a constructive selection hyper-heuristic. (7p)
4. Consider four integer decision variables x_1, x_2, x_3, x_4 with the following domains: $D(x_1) = \{1, 2\}, D(x_2) = \{1, 2\}, D(x_3) = \{1, 2, 3\}, D(x_4) = \{1, 2, 3, 4\}$.
Furthermore, consider two constraints to be defined on these variables:

- (a) $\text{alldifferent}(x_1, x_2, x_3)$
- (b) $x_2 + 3x_3 + x_4 \leq 12$

Task: Write down the domains of all variables after constraint propagation with Constraint 4a and provide an explanation by using an implication of atomic constraints for each domain change. Afterwards, perform constraint propagation with Constraint 4b on the resulting domains from the first step and again provide an explanation for each domain change plus the final variable domains. (7p)