Problem Solving and Search in Artificial Intelligence

Summer semester 2020
Take Home Exam, 06.07.2020

Investigate the following problems:

1. The Social Golfer Problem:
32 golfers play golf once a week, and always in groups of 4. For how many weeks can they play such that no two players play together more than once in the same group?

The problem can be generalized as a decision problem: Is it possible to schedule **n = g×p** golfers in **g** groups of **p** players for **w** weeks such that no two golfers play in the same group more than once?

(See publications for this problem in www.scholar.google or the master thesis of Markus Triska: https://www.metalevel.at/mst.pdf)

2. Logic puzzle:
(Artificial Intelligence, Russell and Norvig) Consider the following logic puzzle: In five houses, each with a different color, live 5 persons of different nationalities, each of whom prefer a different brand of cigarette, a different drink, and a different pet. Given the following facts, the question to answer is

"Where does the zebra live, and in which house do they drink water?"

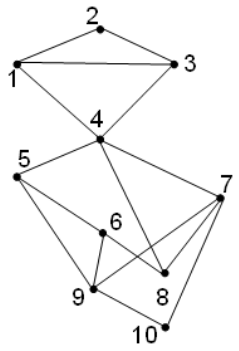
- The Englishman lives in the red house.
- The Spaniard owns the dog.
- The Norwegian lives in the first house on the left.
- Kools are smoked in the yellow house.
- The man who smokes Chesterfields lives in the house next to the man with the fox.
- The Norwegian lives next to the blue house.
- The Winston smoker owns snails.
- The Lucky Strike smoker drinks orange juice.
- The Ukrainian drinks tea.
- The Japanese smokes Parliaments.
- Kools are smoked in the house next to the house where the horse is kept.
- Coffee is drunk in the green house.
- The Green house is immediately to the right (your right) of the ivory house.
- Milk is drunk in the middle house.

3. Traveling tournament problem:
Given **n** teams with **n** even and an **n x n** symmetric distance matrix **D**, where **D(i, j)** represents the distance between the cities of team **Ti** and **Tj** , the goal in solving the traveling tournament problem is to find a valid double round robin schedule, such that the total traveling distance of all teams is minimized. A schedule is valid for the traveling tournament problem, if it satisfies the following constraints:

• Double Round-Robin constraint: Each team plays with each other team exactly two times, once in its own city and once in its opponent's city
• AtMost constraint: Each team must play no more than **U** and no less than **L** consecutive games in or away from the home city
• NoRepeat constraint: It is not allowed that two teams are playing each other in two consecutive rounds

(See publications for this problem in www.scholar.google or the master thesis of Bong Min Kim: https://www.dbai.tuwien.ac.at/staff/musliu/KimThesisFinal.pdf)

4. Tree decomposition: Investigate the generation of tree decomposition for the graph given below.



Questions:

1. Provide a CSP formulation for problems 1, 2, 3 (define variables, domains of variables, and formulate formally the constraints). (For the traveling tournament problem you should provide a CSP formulation only for a valid double round robin schedule). (10p)
2. Consider tree search for problems 1, 2, 3 and 4. Apply backtracking and forward checking (show only a part of search tree) for each problem. (10p)
3. Provide a SAT formulation for problems 1, 2 and 3 (consider only the decision variants of these problems). (10p)
4. Apply for problems 1, 3 and 4 a metaheuristic technique (only one technique should be used for each problem, but you should apply at least two techniques for these three problems). Describe these components (10p):
    a. Solution representation
    b. Initial solution, evaluation function
    c. Neighborhoods relations/moves and crossover operators (if you apply genetic algorithms)
    d. Exploration of neighborhood
    e. Acceptance of the solution for the next iteration.

5. **Theoretical questions:** during the online exam you will get 2 - 3 theoretical questions (whole material of the lecture). (10p)

Online exam:
Please submit in TUWEL (at least one day before your exam) your answers in a pdf document. Handwritten submissions are allowed.

An individual discussion (45 min – 60 min) with each student will take place in July/August/September (time slots will be provided in TUWEL).

Requirements for the online exam: Webcam, microphone, Student ID