Artificial Intelligence

C3 (Week – first classes in May)

Each task is worth 1 point. Tasks with an asterisk do not count toward the maximum.

1. Describe the following algorithms (can you name these algorithms?):
   (a) local beam search for $k = 1$,
   (b) local beam search with a single starting state and with no limit of stored states after a generation of a successor,
   (c) simulated annealing for $T = 0$ for the whole running time of the algorithm,
   (d) simulated annealing for $T = \infty$ for the whole running time of the algorithm,
   (e) genetic algorithm with population size 1.

   In each case, explain your answer.

2. Heuristic algorithms can be combined together in any way. Propose a smart[1] combination of the following:
   (a) evolution algorithms and hill climbing,
   (b) A^* and local beam search,
   (c) simulated annealing and evolution algorithms (conversly to what is in (a), we would like to use a general idea of simulated annealing),
   (d) taboo search with evolution algorithms.

   You may need to explain how each algorithm works.

3. Explain how *ant colony algorithms* work. How it can be applied to TSP (traveling salesman problem)?

4. Similarly to "storm problem", monograms can be also solved with contraint programming with Prolog. Describe how one can model monograms using SWI-Prolog (see Lecture W5 and W6). You may read documentation of *clpfd* module of SWI-Prolog.

5. Consider the simplified school's timetable planning (where we do not care about classrooms' availability).
   - We have a number of classes to assign.
   - Each lesson has the following parameters: a class (a group of students), a teacher.
   - Each lesson has assigned time: a number between 1 and 50 where numbers $1 \ldots 10$ correspond to time slots on Monday, $11 \ldots 20$ Tuesday, etc.
   - No class has a free period (a gap between lessons during a day).

   Express this problem as a constraint programming problem with SWI-Prolog's expressions. For defining free periods you may use additional variables.

[1] It is hard to define that requirement precisely. For the purpose of that task we assume the following: it may be worth trying to check if such a combination of algorithms work (in certain problems), *i.e.,* that it may work better than a single of the algorithms alone.

6. Express problem of class timetable planning for our Institute as a problem of constraint programming where besides requirements that define admissible[2] timetables, there is a function which evaluates the quality of an admissible timetable. So we are interested in finding such a schedule that maximizes that function. The most important part of this problem is to present such a function (so your goal is to precisely describe what makes one timetable better than the other). You need to take into account results of students' voting.

7. Select one of the following games:

   - Fox & Geese,
   - breakthrough (board game),
   - pentago,
   - "skoczki" (`https://pl.wikipedia.org/wiki/Skoczki_(gra)`).

   Propose a heuristic evaluating board position. Which parameters do you take into account?

8. The same as the previous problem but you may select a game that is not on the list.

9.

10. Answer to the following questions for Alpha-Beta-Search and MCTS algorithms:

    (a) How one can use time spent for computing the best *previous* move to compute the best *current* move (assuming that we play only one game).

    (b) How one can take advantage of concurrent code execution to increase the quality of the game?

11. (2 points $*$) Read `https://dke.maastrichtuniversity.nl/m.winands/documents/BestReplySearch.pdf` and answer to the following questions:

    (a) What is max^n algorithm?

    (b) What are *paranoid assumptions*?

    (c) What problems are related to the aforementioned algorithms?

    (d) How does Best Reply Search algorithm work, what are its strengths and weaknesses?

    (e) What is the Rolit game?

    (f) Select one of the experiments described in the article and describe its results.

    If you are going to present the solution, try to explain it the best way possible, so other students will be able to learn as much as possible from your presentation (assuming that it will take no more than 10 minutes).

    Additional question (you may skip it): how would you imagine a board-version of the Rolit game (try not to use a search engine to learn how it is sold).

[2] More or less these requirements were expressed in the previous problem.