Einführung in Künstliche Intelligenz SS 2019, 2.0 VU, 184.735

Exercise Sheet 1 – Agents and Search

For the discussion part of this exercise, mark your solved exercises in **TUWEL** until Sunday, June 09, 23:55 CET. The registration for a solution discussion ends on Friday, June 14, 23:55 CET. Be sure that you tick only those exercises that you can solve and explain!

In the discussion, students will be asked questions about their solutions of examples they checked. The discussion will be evaluated with 0-15 points, which are weighted with the fraction of checked examples and rounded to the next integer. There is *no minimum number of points* needed for a positive grade (i.e., you do not need to participate for a positive grade, but you can get at most 85% without doing exercises).
Note, however, that *your registration is binding*. Thus, *if* you register for a solution discussion, then it is *mandatory* to show up. Not coming to the discussion after registration will lead to a reduction of examination attempts from 4 to 2.
Please ask questions in the **TISS** Forum or visit our tutors during the tutor hours (see **TUWEL**).

Exercise 1.1: Describe the application types (PEAS) and the task environments of each of the following intelligent agents. Be sure to explain your reasoning and assumptions.

(1) Playing an online multiplayer game,

(2) Playing a game of Minesweeper,

(3) Robot vacuum cleaner.

Exercise 1.2: Let $f(n) = c \cdot g(n) + d \cdot h(n)$ be an evaluation function, where c and d are constants.

(1) Define c, d, $h(\cdot)$, $g(\cdot)$ such that A* with this evaluation function acts as a breadth-first search.

(2) Define c, d, $h(\cdot)$, $g(\cdot)$ such that A* with this evaluation function acts as a depth-first search.

(3) Define c, d, $h(\cdot)$, $g(\cdot)$ such that A* with this evaluation function acts as a uniform cost search.

You may assume that nodes contain all the information that we discussed in the lecture.

Exercise 1.3: Assume h_a, h_b, h_c are admissible heuristics. Which of the following heuristics are admissible?

(a) $h_1(n) = |h_a(n) - h_b(n)|$,

(b) $h_2(n) = 2h_a(n) - (h_b(n) + h_c(n))$,

(c) $h_3(n) = \min\{h_a(n) \cdot h_b(n),\ h_c(n)\}$.

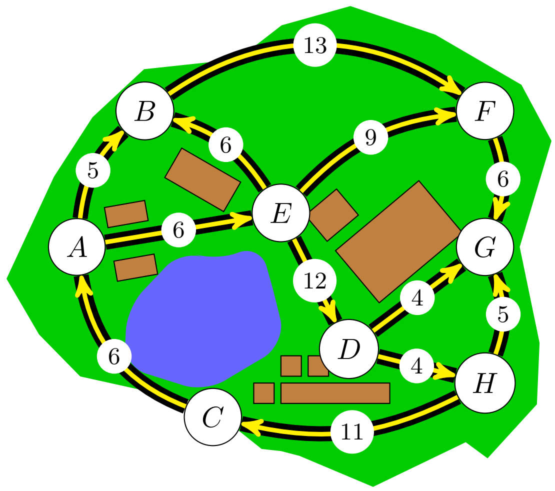
Exercise 1.4: Prove that if the heuristics $h_1, \ldots, h_k$ are all monotone (consistent), then

$$h(n) = \max\{h_1(n), \ldots, h_k(n)\}$$

is admissible. Is h also consistent?

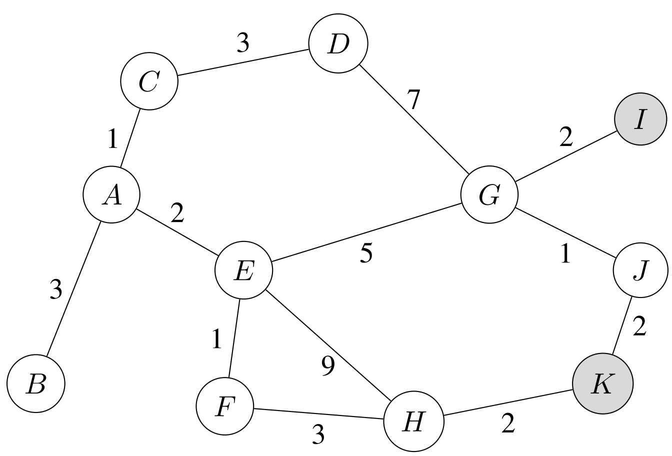
Exercise 1.5: Driving from your home at node A to university at node G, you usually take the shortest path $A \to E \to D \to G$. Due to recently started construction work, however, the segment $E \to D$ would take you a bit longer than usual to cross.

Use the A* algorithm using the given heuristic function h on the city graph below in order to see if there is a shorter path from A to G. In which order are the nodes expanded? Show the contents of the priority queue at each iteration. If multiple nodes have the same priority, expand the one that comes first alphabetically.



$$h(A) = 12,\ h(B) = 11,\ h(C) = 10,\ h(D) = 3,\ h(E) = 6,\ h(F) = 6,\ h(G) = 0,\ h(H) = 4$$

Exercise 1.6: Consider the following graph (the gray nodes are goal nodes):



Use the listed search strategies on the given graph to look for a goal node, starting from the node A (depth 0). In case you can expand several nodes and the search strategy does not specify the order, choose the nodes in alphabetic order. Where applicable, specify the contents of the *frontier* and the *explored set* for each step or the contents of the call stack for recursive approaches.

- Breadth-first search with goal test at generation time,
- Uniform cost search,
- Depth-first search with goal test at expansion time, iterative,

- Depth-limited search (use a limit of 2),
- Iterative deepening search.

Exercise 1.7: Consider again the 8-Puzzle discussed in the lecture. Consider the discussed heuristics

- $h_1(n)$: number of misplaced tiles,
- $h_2(n)$: Manhattan distance.

Show whether the two suggested heuristics are admissible and/or consistent (monotonic).

Exercise 1.8: Decide and explain which of the following statements are true and which are false? Back up your answers with proofs or counterexamples.

(1) Breadth-first search always expands at least as many nodes as an A* search with an admissible heuristic.

(2) The A* algorithm yields an optimal path in a graph search if the used heuristic is admissible.

(3) Every admissible heuristic is also consistent.