

Introduction to Artificial Intelligence

Dr. Thomas Keller
C. Büchner, C. Grundke, A. Kauffmann

University of Zürich
Spring Semester 2022

Exercise Sheet 2

Due: March 9, 2022

Points total: 20 marks

Exercise 2.1 – Formalizing Problems

4 marks

Formalize the following problem in terms of *states*, *initial state*, *goal states*, *actions*, and *transition model*.

A farmer wants to carry a wolf, a goat and a cabbage across a river. The boat they use can carry only the farmer and either the wolf, the goat or the cabbage. If the goat and the cabbage are at the same shore without the farmer, then the goat will eat the cabbage. Furthermore if the wolf and the goat are at the same shore without the farmer, then the wolf will eat the goat. (https://en.wikipedia.org/wiki/Wolf,_goat_and_cabbage_problem)

Exercise 2.2 – Search Algorithms: Theory

5 marks

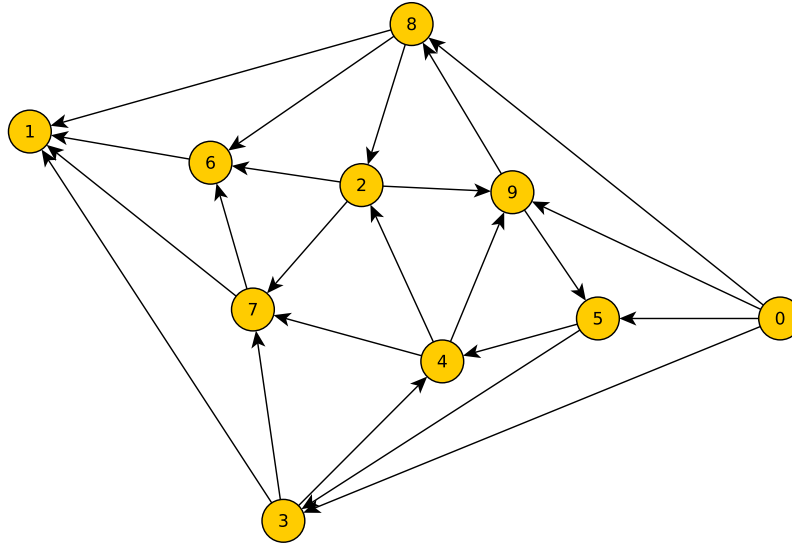
Are the following statements true or false? Justify your answer in one sentence.

- (a) A finite search problem always leads to a finite search tree. (1 mark)
- (b) Depth-first tree-like search is never useful because it is not complete. (1 mark)
- (c) Breadth-first graph search is a special case of uniform-cost search. (1 mark)
- (d) Uniform-cost search with early goal testing (instead of late goal testing) is still cost optimal. (1 mark)
- (e) Iterative deepening search is the preferred algorithm when the depth of the solution is known. (1 mark)

Exercise 2.3 – Search Algorithms: Practice

6 marks

Consider the following search problem where states are annotated with their corresponding ID. Let the initial state be state 0 and let state 7 be the only goal state.



In the following tasks, you are asked to perform two kinds of uninformed search algorithms. If a state has multiple successors, always consider the state with the lowest ID first.

Hint: Note that the graph contains cycles (e.g., 2-9-8-2). You therefore need to apply the graph variants of the algorithms.

- (a) Perform breadth-first (graph) search and draw the resulting search tree. (3 marks)
- (b) Perform depth-first (graph) search and draw the resulting search tree. (3 marks)

Exercise 2.4 – Search Algorithms: Programming

5 marks

Implement uniform-cost search in the framework provided in `sheet02-programming.zip`. It contains an implementation of search problems as well as a generic search interface and implementations of breadth-first and depth-first search. Use the template `uniform_cost_search.py` for your implementation. You can use `breadth_first_search.py` and `depth_first_search.py` as examples.

Test your implementation using the file `experiment.py`. Make sure the plans (i.e., the state sequences) found by your implementation of uniform-cost search are identical to those of breadth-first search in search problems where all actions have cost 1.

Submission rules:

- Exercise sheets must be submitted in groups of three students. Please submit a single copy of the exercises per group (only one member of the group does the submission).

- Create a single PDF file (ending `.pdf`) for all non-programming exercises. Use a file name that does not contain any spaces or special characters other than the underscore “_”. If you want to submit handwritten solutions, include their scans in the single PDF. Make sure it is in a reasonable resolution so that it is readable, but ensure at the same time that the PDF size is not astronomically large. Put the names of all group members on top of the first page. Make sure your PDF has size A4 (fits the page size if printed on A4). Submit your single PDF file to the corresponding exercise assignment in MOODLE.
- For programming exercises, only create those code text files required by the exercise. Put your names in a comment on top of each file. Make sure your code compiles and test it. Code that does not compile or which we cannot successfully execute will not be graded. Create a ZIP file (ending `.zip`, `.tar.gz`, or `.tgz`; *not* `.rar` or anything else) containing the code text file(s) (ending `.py`) and nothing else. Do not use directories within the ZIP, i.e., zip the files directly.
- Do not upload several versions to MOODLE, i.e., if you need to resubmit, use the same file name again so that the previous submission is overwritten.