University of Paderborn
Planning and Heuristic Search
WS 2021/22
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Class Exercise #1

Exercise 1 : Concepts

For the following problems answer these questions:

(i) What is the problem setting (initial state)?

(ii) What is the type of the problem task (optimization or constraint satisfaction)?

(iii) What does a solution look like, a search algorithm should return?

(iv) Describe an algorithmic approach to find a solution.

(v) What domain information can be used to increase search efficiency?

(Use mathematical notation if possible.)

Problems:

(a) Generalization of the 8-Puzzle problem to rectangular boards.

(b) Generalization of the 8-Queens problem to quadratic boards with forbidden fields.

Exercise 2 : Modeling

In the water-jug puzzle, we are given a 3-liter jug, named *Three*, and a 4-liter jug, named *Four*. Initially, *Three* and *Four* are empty. Either jug can be filled with water from a tap, T, and we can discard water from either jug down a drain, D. Water may be poured from one jug into the other. There is no additional measuring device. We want to find a set of operations that will leave precisely two liters of water in *Four*.

Don't worry! Here's a solution:

(a) fill *Three* from the tap,

(b) pour *Three* into *Four*,

(c) fill *Three* from the tap,

(d) pour as much from *Three* into *Four* as will fill it,

(e) discard *Four*,

(f) pour *Three* into *Four*.

(a) Set up a state-space search formulation of the water-jug puzzle:

  (a1) Give the initial iconic state description as a data structure.

  (a2) Give a goal condition on states as some test on data structures.

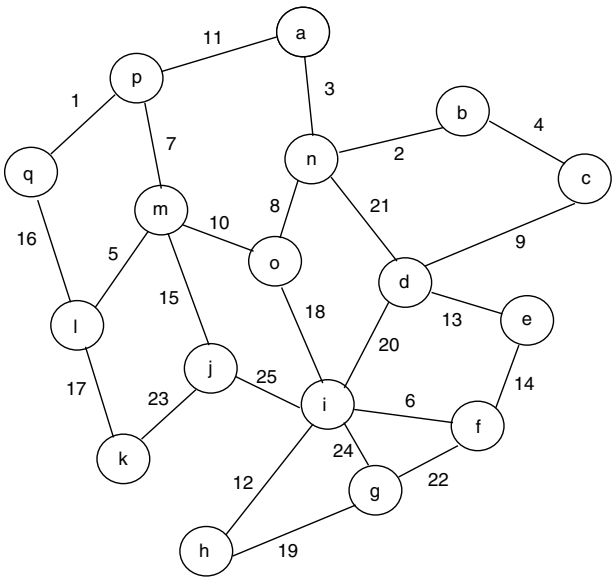
  (a3) Name the operators on states and give precise descriptions of what each operator does to a state description.

(b) Draw a graph of all of the distinct state-space nodes that are within three moves of the start node, label each node by its state description, and show at least one path to each node in the graph — labeling each arc by the name of the appropriate operator. In addition to these nodes, show also all of the nodes and arcs (properly labeled) on a path to the solution.

[Nilsson 1998]

Exercise 3 : Uninformed search in a graph

Given is the following undirected state space graph with start node a and no goal nodes. In which order are the nodes expanded during search? On node expansion, nodes are inserted in ascending order. Note that the edge weights are ignored by depth-first search and breadth-first search.



How can we describe the processing of search algorithms? How can we guarantee termination? Are the results correct? How can we increase efficiency?

(a) Use depth-first search. Also list the DFS-depth of each node.

(b) Use breadth-first search. Also list the depth of each node.

(c) Use uniform cost search. Also list the cost of the backpointer path for each node.