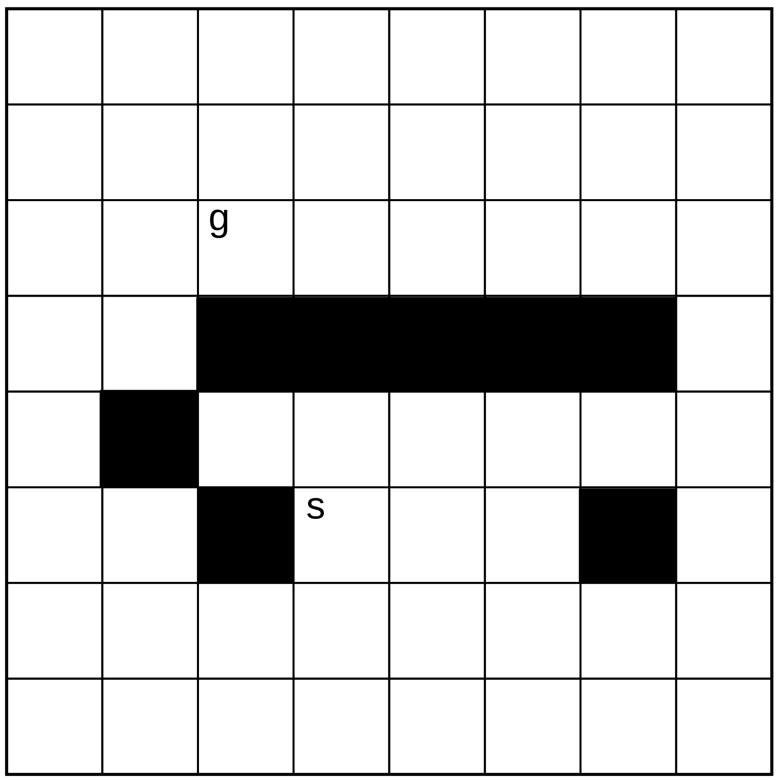
CS444 A* Exercises

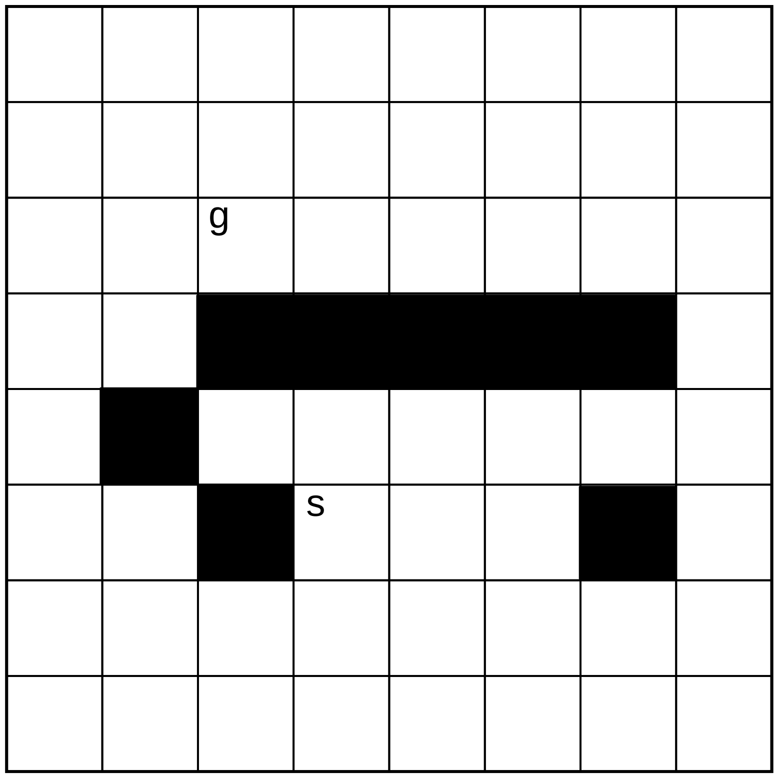
1. Consider the problem of finding a path in the grid shown in the figure below from the position s to the position g. A piece can move on the grid horizontally and vertically, one square at a time. No step may be made into a forbidden shaded area.[1]

   (a) Number the nodes expanded, in order, for a best-first search from s to g. Manhattan distance should be used as the evaluation function. The Manhattan distance between two points is the distance in the x-direction plus the distance in the y-direction. It corresponds to the distance traveled along city streets arranged in a grid. Assume multiple-path pruning. What is the first path found?

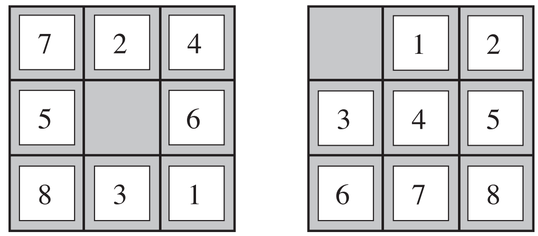


[1]This question is adapted from *Artificial Intelligence: Foundations of Computational Agents*,David Poole and Alan Mackworth, Cambridge University Press, 2010.

(b) Number the nodes in order for an A* search, with multiple-path pruning, for the same graph. What is the path found?



2. The 8-puzzle is a game of sliding tiles in which the player attempts to move the tiles into the correctly ordered sequence from an arbitrary starting position:[2]



Start State Goal State

(a) How many states does this problem have?

(b) What is the approximate branching factor for this problem?

(c) Develop an admissible heuristic function for this problem. Your heuristic should never overestimate the true solution cost. A good heuristic will have high values for states that are far from the solution, and low values for states that are near the solution.

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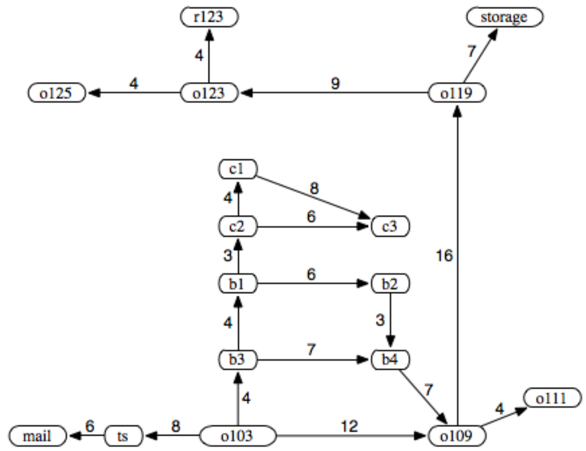
[2] *Artificial Intelligence: A Modern Approach, 3rd Edition.* Stuart Russell and Peter Norvig, Prentice Hall, 2009

3. Recall the office delivery robot problem from out textbook:



The authors provide the following heuristic function, based on straight line distances in the building:

h(mail) = 26	h(ts) = 23	h(o103) = 21
h(o109) = 24	h(o111) = 27	h(o119) = 11
h(o123) = 4	h(o125) = 6	h(r123) = 0
h(b1) = 13	h(b2) = 15	h(b3) = 17
h(b4) = 18	h(c1) = 6	h(c2) = 10
h(c3) = 12	h(storage) = 12	

Imagine we ran out of time in developing this heuristic function, and only had data for some of the rooms. We decide to use an estimate of 0 for all of the remaining rooms:

h(mail) = 26	h(ts) = 23	h(o103) = 21
h(o109) = 24	h(o111) = 27	h(o119) = 11
h(o123) = 4	h(o125) = 6	h(r123) = 0
h(b1) = 13	h(b2) = 0	h(b3) = 0
h(b4) = 0	h(c1) = 0	h(c2) = 0
h(c3) = 0	h(storage) = 0	

(a) Is this alternate heuristic admissible? Justify your answer.

(b) Is this alternate heuristic monotonic? Justify your answer.