Class Exercise 4

Exercise 1 : Cost Measure

Given an OR-graph G and the cost function

$$C_{P_{s-\gamma}}(n_k) = \sum_{i=k}^{m-1} \frac{c(n_i, n_{i+1})}{m-i}$$

where $P_{s-\gamma} = (n_0, n_1, \ldots, n_m)$, i.e., n_{i+1} is the successor of n_i in the solution path $P_{s-\gamma}$ and $P_{s-\gamma}$ has length m with $n_0 := s$ and $n_m := \gamma$.

Can we give a definition of $C_{P_{s-\gamma}}$ in form of a recursive cost function?

Exercise 2 : Optimistic Heuristics

Given the 8-puzzle problem. Let the true cost of each state A be the minimum number of moves necessary to reach the goal state from s. Example:

1	2	3
4		6
7	8	5

s

1	2	3
4	5	6
7	8	

γ

(a) Define $C_P(n)$ in form of a recursive cost function and define $\widehat{C}_P(n)$ based on the definition of $C_P(n)$ using some heuristic function h. What is the cost measure?

(b) The heuristic cost function h_1 estimates the cost of a state s' as the number of positions for which the content on that position in s' is not equal to the content on that position in the goal state. In the example above, $h_1(s) = 2$ (1 for the central and bottom right positions each). Is h_1 optimistic?

(c) The heuristic cost function h_2 estimates the cost of a state s' as the sum of the Manhattan (city block) distances between the position of each of the 8 tiles in s' and its position in the goal state. In the example above, $h_2(s) = 2$ (tile 5 has to be moved up by 1 and left by 1). Is h_2 optimistic?

(d) Does $h_1(s') \geq h_2(s')$ or $h_1(s') \leq h_2(s')$ hold for all possible states s'?

Exercise 3 : Evaluation Function $f = g + h$ in A*

Let n be a node in a search space graph that is explored by A* using heuristic h.

(a) When can the value of $h(n)$ change during A*-search?

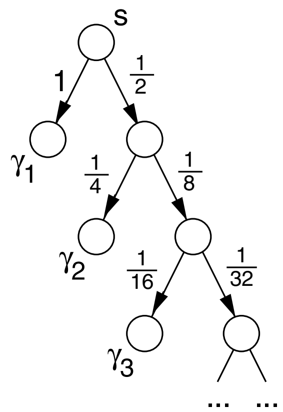
(b) When can the value of $g(n)$ change during A*-search?

Exercise 4 : Negative Cost Cycles

A negative-cost cycle is a cycle in a search space graph whose sum of edge weights is negative. Why are negative-cost cycles problematic for A* search?

Exercise 5 : Optimum Solution Paths in OR-graphs

Given the following search space graph G:



Can you determine an optimum solution graph? If no, why not?

Exercise 6 : State Space Search

You need to send out all the objects listed in the following table in postal packages.

Object	A	B	C	D	E	F	G	H	I	J
Weight (kg)	1	4	6	7	7	9	11	13	15	16

One package can weigh at most 20 kilograms. The shipping costs per package are 9,90 EUR. Your goal is to pack all items into as few packages as possible.

(a) Represent the package-packing problem as an OR graph search. What information is represented by the nodes in the graph; what operations are represented by the edges?

(b) What are goal nodes in your representation, what are the characteristics of solution paths, what are dead ends?

(c) How do you determine the costs associated with the edges in your representation?

(d) Given a solution base P, can you give a lower bound on the cost of every single solution path extending P?

