Lab Class S:VI

By February 4th, 2015 solutions for the following exercises have to be submitted: 1, 2, 3, 5, 7,

Exercise 1 : Heuristics

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?

(c) When can the value of $g(n)$ change during A*-search with admissible h?

(d) When can the value of $g(n)$ change during A*-search with monotone h?

Exercise 2 : Admissibility

In the lecture, we have proven that the algorithm A* is admissible when using an admissible heuristic. Does this also apply to the algorithm Z?

Justify your answer.

Exercise 3 : Monotonicity

Consider the search problem of finding the shortest sequence of knight moves between two given squares on a chessboard, as discussed in the lecture. Let h be a heuristic that estimates the number of moves remaining for a given board square represented by node n.

$$h(n) = \frac{d_M(n, \gamma)}{3}$$

where $d_M(n_1, n_2)$ is the Manhattan distance between the board squares corresponding to nodes n_1 and n_2.

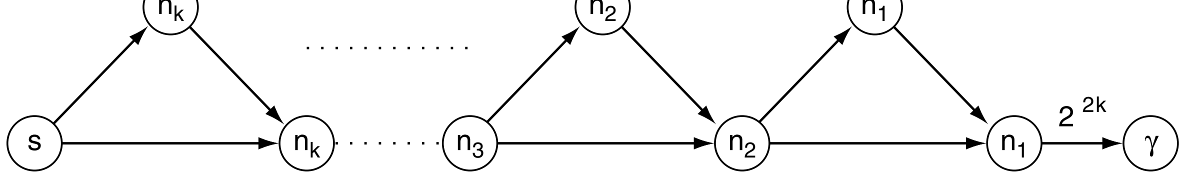
(a) Define the term “monotonicity” in the context of heuristic cost estimation functions.

(b) Show that h is both admissible and monotone.

(c) For the same search problem, find a heuristic that is admissible, but not monotone.

Exercise 4 : Reopening

Consider the following search space graph:



Add edge cost values and h-values for the nodes, such that the number of reopenings done by algorithm A* is exponential in k.

Exercise 5 : Relaxed Models

Consider the general approach to weighted node evaluation, where $f_w(n) = (1 - w) \cdot g(n) + w \cdot h(n)$. Under which conditions does it make sense to use a weighting where w is close to 1, disregarding the current path cost g?

Exercise 6 : Relaxed Models

The algorithm A^*_ε uses two heuristic functions h and h_F. What is the advantage of using $h \neq h_F$?

Exercise 7 : Implementing DWA* Search

Consider the 8-puzzle problem. Your task is to reach the goal state γ with as few moves as possible.

6	4	7
8	5	
3	2	1

s

1	2	3
4	5	6
7	8	

γ

(a) Consider the case that γ would not be reachable from a start state. Would DWA* expand the same number of nodes as A* until it fails?

(b) Consider the case $N = 1$, $\epsilon \approx 1$ and $h \approx h^*$. Would you expect that DWA* performs more, less, or the same amount of node expansions as A*?

(c) Consider the case $N \to \infty$, $\epsilon \approx 1$ and $h \approx h^*$. Would you expect that DWA* performs more, less, or the same amount of node expansions as A*?

(d) Implement a DWA* search for the 8-Puzzle problem using h_2, the sum of the Manhattan distances from each of the 8 tiles to its position in the goal state. What changes do you need to make to your A* implementation? You can also use the A* example implementation from the lecture's web page as a base.

(e) Run your implementation with $N \in \{5, 10, 15, \ldots, 50\}$ and $\epsilon \in \{\frac{1}{8}, \frac{1}{4}, \frac{1}{2}, 1, 2\}$. Use s as the start and γ as the goal state. Show the number of node expansions performed by DWA* for each of the 50 pairs of N and ϵ. You can use a table or graphs.

(f) For the same parameters as above, show the number of moves of the solution found by DWA*, $g(\gamma)$, for each pair of N and ϵ.

(g) For what parameter setting does DWA* terminate with an optimal solution with the smallest amount of node expansions? How many node expansions are these?

(h) For what parameter setting does DWA* terminate with a solution with the smallest amount of node expansions? How many node expansions are these?