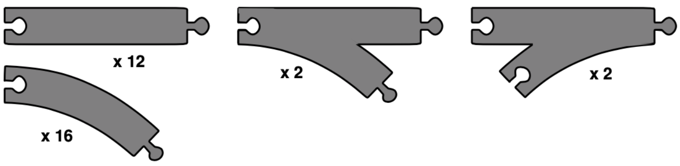
Artificial Intelligence I

Lab 3 - Winter Semester 2023 / 2024
https://moodle.haw-landshut.de/course/view.php?id=10282

1. A basic wooden railway set contains the pieces shown in the figure below. The task is to connect these pieces into a railway that has no overlapping tracks and no loose ends where a train could run off onto the floor.



(a) Suppose that the pieces fit together exactly with no slack. Give a precise formulation of the task as a search problem.

(b) Identify a suitable uninformed search algorithm for this task and explain your choice.

(c) Explain why removing any one of the "fork" pieces makes the problem unsolvable.

2. We can represent the 8-puzzle as a search problem by denoting each state by $x_{00}x_{10}x_{20}x_{01}x_{11}x_{21}x_{02}x_{12}x_{22}$ where x_{ij} is the value at column i and row j, $i, j \in \{0, 1, 2\}$, $x_{ij} \in \{0, \ldots, 8\}$. If the space is blank, the value is zero. The actions are: move blank space *up*, *down*, *left* or *right* (wherever possible). Each move has a cost of one. We will generate successors in the following order: **up, right, down, left**.

Consider the *Manhattan distance* - for every square the horizontal and vertical distances to that square's location in the goal state are added together; this value is then summed over all squares - as the heuristic function for A*-search. Note that the *Manhattan distance* of the two states

2	5	
1	4	8
7	3	6

and

1	2	3
4	5	6
7	8	

is calculated as

$$h_2(s) = 1 + 1 + 1 + 1 + 2 + 0 + 3 + 1 = 10.$$

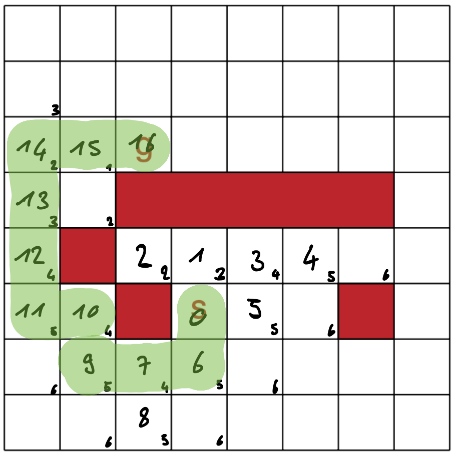
Generate the search tree of A*-search with the *Manhattan distance* heuristic

- starting from 250148736
- with goal state 123456780
- stating the values of g, h and f at each node in the tree

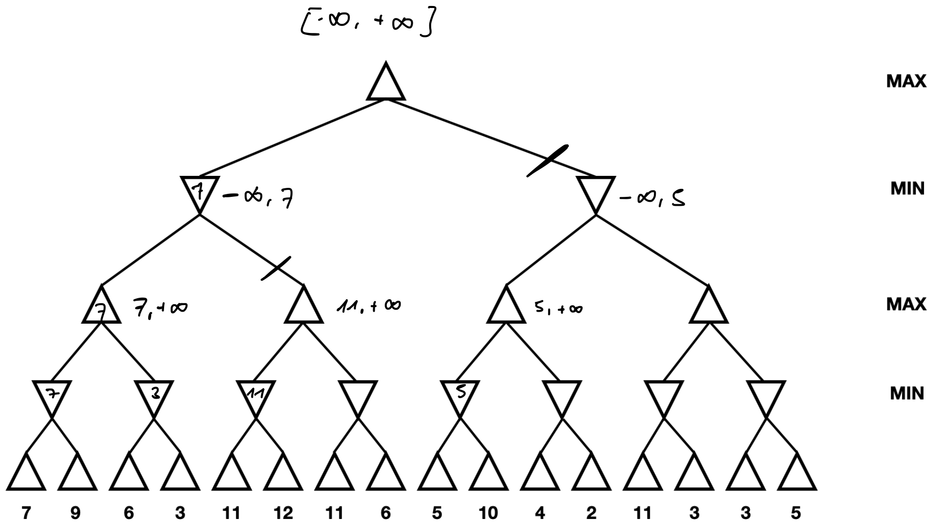
for the first five steps of the A*-algorithm. If there is a tie in the heuristic value, choose the state that comes earlier in lexicographical order. Mark the selected path in the tree.

3. Prove the following statement or give a counterexample: Uniform-cost search is a special case of A*-search.

4. On the grid below, number the nodes in order in which they are taken off the frontier for an A^*-search for the same graph. Manhattan distance should be used as the heuristic function. That is, $h(n)$ for any node n is the Manhattan distance from n to g. 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. For example, the Manhattan distance between g and s is 4. What is the path that is found by the A^*-search?



5. The search tree for a two-player game is given in the figure below with the ratings of all leaf nodes. Use *minimax search with α-β pruning* from left to right. Cross out all nodes that are not visited and give the optimal resulting rating for each inner node. Mark the chosen path.



6. Explain why the following assertion is true: For every game tree, the utility obtained by MAX using minimax decisions against a suboptimal MIN will never be lower than the utility obtained by playing against an optimal MIN.