Exercise 1.1:
Which of the following are true and which are false? Explain your answers.

a) Depth-first search always expands at least as many nodes as A* search with an admissible heuristic.

b) \( h(n) = 0 \) is an admissible heuristic for the 8-puzzle.

c) Breadth-first search is complete even if zero step costs are allowed.

d) Assume a rook can move on a chessboard any number of squares in a straight line, vertically or horizontally, but cannot jump over other pieces. Manhattan distance is an admissible heuristic for the problem of moving the rook from square A to square B in the smallest number of moves.

Exercise 1.2:
Consider the bridge crossing problem, where 4 persons are on one side of a bridge and all of them need to end up on the other side. It is night and they have only one flashlight. Maximal 2 persons can cross the bridge at the same time and the flashlight needs to be brought back to the remaining persons. Each person walks with a different speed and when they go together they must walk at the rate of the slower man’s pace.

The goal is to find the minimal time for crossing the bridge!

<table>
<thead>
<tr>
<th>person</th>
<th>time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1 min</td>
</tr>
<tr>
<td>B</td>
<td>2 min</td>
</tr>
<tr>
<td>C</td>
<td>5 min</td>
</tr>
<tr>
<td>D</td>
<td>10 min</td>
</tr>
</tbody>
</table>

a) Which search algorithm might be suitable for the problem? Apply it to find the solution!

b) Is there a general procedure which finds an optimal solution for an arbitrary number of people and crossing times?
Exercise 1.3:
Consider a state space where the start state is number 1 and each state $k$ has two successors: numbers $2k$ and $2k + 1$.

a) Draw the portion of the state space for states 1 to 15.

b) Suppose the goal state is 11. List the order in which nodes will be visited for breadth-first search, depth-limited search with limit 3, and iterative deepening search.

c) Call the action going from $k$ to $2k$ Left, and the action going to $2k + 1$ Right. Can you find an algorithm that outputs the solution to this problem without any search at all?

Exercise 1.4:
Describe a state space in which iterative deepening search performs much worse than depth-first search (for example, $O(n^2)$ vs. $O(n)$).