Problem Solving and Search in AI
Tutorial 1 (on May 5th)

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SS 2015

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 an chessboard any number of squares in a straigth 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!

person	time
A	1 min
B	2 min
C	5 min
D	10 min

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. $O(n)$).