Exercise 4: The missionaries and cannibals problem

(or the sheep and wolves problem
or the carrots and rabbits problem or…)

Deadline exercise 4: Monday Dec. 10th, 08.00

Problem

3 missionaries (sheep) and 3 cannibals (wolves) stand on a riverbank. On the same riverbank a boat, that can maximally take 2 persons (minimally 1), lies. The 6 people are facing a problem: how to optimally transport (minimal number of moves) ourselves from the current riverbank (the left one) to the opposite bank of the river (the right one) in a way that guarantees that at any time the number of cannibals never outnumber the number of missionaries (they will then be eaten)?

You are given an implementation using breadth-first search that can be used to solve the problem. Try it out.

Representation

A state is represented by a list describing what side of the riverbank the boat is currently at, the number of missionaries and cannibals at the left riverbank, and the number of missionaries and cannibals at the right riverbank. The start state is thus ('left 3 3 0 0)
A node (in the BFS solution) is a list of the current state and the path (a list of states) leading to this state.

Task

1. Using some of the available procedures, implement an A*-search algorithm that finds the optimal path. The BFS solution actually does this, but will explore more nodes than necessary. You need to implement a priority queue (have a look at the queue implementation) to be used in the A*-search algorithm and decide on a heuristic for choosing the next node to visit (sit down and think about it for a while).
2. Generalize the procedure so that it can take an arbitrary number of missionaries and cannibals to be transported over the river.

You are of course allowed to change some of the implementation if you find it useful or if you find some caveat in the implementation that can be improved.