

## CS 461 – ARTIFICIAL INTELLIGENCE

### HOMEWORK #1 (5% OR 10 POINTS)

Assigned: Tue 18 Feb 2020

Due: Tue 3 Mar 2020 \*\* 2 pm \*\*

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*Your group for this homework should coincide with your term project group. In any case, indicate clearly the students who are submitting this homework (i.e., write at most 5 names on the submission).*

*You must submit your entire homework (including all the original code written) to our TAs. Just a single submission per group! Our TAs will soon send you a note explaining the mechanics of submissions. They may also tell you whether there'll be a need to submit hardcopy, etc.*

*Any programming language can be used as long as you have it up and running on a portable computer. Needless to say, a group member should be prepared to give a homework demo (individually and using that portable computer) when requested to do so by our TAs.*

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First manually solve the following puzzle (**non-credit; not to be submitted**):

A group consisting of 3 cannibals and 3 missionaries seeks to cross a river. A boat is available which will hold up to 2 people. If the missionaries on either side of the river are outnumbered at any time by the cannibals on that side, even momentarily, the cannibals will do away with the unfortunate, out-numbered missionaries. What schedule of crossings can be devised to permit the entire party to cross safely? Assume that the group and the boat are on the west bank initially and that they would like to end up on the east bank eventually.

HINT: In your solution, it may be best to formulate the puzzle as state-space search. **xMyCb** is a good state representation, where  $x$  is the number of missionaries (M) on the west bank,  $y$  is the number of cannibals (C) on the west bank, and  $b$  is 1 if the boat is on the west bank (and 0, if it is on the east bank). Obviously,  $x$  and  $y$  are in the range  $[0, 4]$ . Now, answering these questions may be helpful:

- What are the initial and goal states?
- What are the operators?
- What is the branching factor?

So far, we have been preparing ourselves for the actual assignment of Homework #1, which has 2 parts (notice that the parts are independent from each other):

1. (5 points) Write a program which --- by exhaustively searching a space of possible solutions --- proves that 4 cannibals and 4 missionaries cannot be taken safely across a river with a boat holding only 2 people.
2. (5 points) Now suppose that  $M = 4$ ,  $C = 2$ ,  $B = 2$ , but that cannibals are stronger than missionaries to the extent that the missionaries are safe only when they exceed the cannibals in number (on each bank and in the boat). Again, prove that the party cannot cross safely.

Your program must use **Nondeterministic Search** (Winston, Chapter 4). You must check for repeated states. It is crucial that you explain, in the body of your program and using block comments, **how** you've implemented nondeterminism.

What should be the outputs of your homework? For both parts given above, an exhaustive list of paths which start at the initial state and can never reach the goal state would do the job. Thus, assume that you start with the initial state as the root of a tree. As you grow a tree downwards, you should never permit unsafe states (or to put it conversely, you should only allow safe states) and you should also avoid loops (repeated states). If you search the entire tree and cannot find a solution path, then you've proved (albeit computationally) that a solution does not exist.

Your program should have a simple control for 'single stepping' (tracing) in your code so that you and the TAs can inspect the intermediate stages of the problem-solving process in an incremental fashion. Needless to say, this is also useful for debugging your program during the development stage.

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#### GENERAL REMARKS (THESE ARE APPLICABLE TO ALL HOMEWORK ASSIGNMENTS)

- IF YOU ARE REQUESTED TO SUBMIT A HARDCOPY AT ANY TIME IN THIS COURSE, MAKE SURE THAT WHAT YOU SUBMIT IS CLEAN AND MACHINE-GENERATED. IF THERE IS A HANDWRITTEN ADDITION OR CORRECTION ON A PRINTOUT, YOU'LL DEFINITELY LOSE POINTS.
  - Late submissions will first have 2 points deducted categorically. Then they'll have 2 points deducted for every late day. (A new day begins at midnight.)
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