1st Midterm Exam

Tuesday October 7
75 minutes == 75 points
Open book and notes

1. *20 points*

   Consider the following problem: you are given a path of N white and black squares. The exact configuration of white and black squares and the length of the path vary with the instance of the problem you are given to solve. An example with $N=18$ might look like this:

   You start on the left-most square and the goal is to move off the right end of the path in the least number of moves. The rules for moving are:

   1. if you are on a white square, then you can move either 1 or 2 squares to the right;

   2. if you are on a black square, then you can move either 1 or 4 squares to the right.

   Answer the following questions. Explain briefly your reasoning:

   1. Describe how you would represent the state space, including the states, successor function, and goal test.

   2. Is the search space a tree or a graph?

   3. What is the branching factor?

   4. Propose a non trivial heuristic ($h = 0$ is not allowed) for the problem and specify if it is admissible and monotonic.

2. *10 points*

   Answer the following questions briefly but precisely:

   1. Can you construct a graph in which A* will expand more nodes than Depth-First Search? If so, draw an example of such a graph and explain why A* will expand more nodes. If not, explain why such a graph is impossible.

   2. Could the same happen when comparing A* with Uniform Cost Search? Why (or why not)?

3. *10 points*

   Why is it better to design performance measures for an agent according to effects in the environment instead of behaviors of the agent?

4. *25 points*

   Answer the following questions explaining your reasoning briefly but precisely.

   1. Why any node in OPEN with $f(n) < C*$ (the cost of the optimal solution path) will eventually be selected for expansion by A*?

   2. Why does A* find an optimal solution if you remove from OPEN any node with $f(n) > C*$?

   3. Is it true that all admissible heuristics are equal, in the sense that A* will search the states in the same order no matter what the admissible heuristic is?

   4. In what sense is IDA* preferable to A*?

   5. Is Breadth-First search complete if the state space has infinite depth but a finite branching factor?

5. *10 points*

   Write a function in Lisp to split a list in two sublists, one containing all the positive elements from the list, and the other with the negative and zero elements. Elements that are not numbers should be discarded. [Hint: `(numberp x)` returns t if x is a number and false otherwise.] It should work like this:

```
(split '(8 -2 6 -1 -3)) => ((8 6) (-2 -1 -3))
(split '(2 4 3)) => ((2 4 3) nil)
(split '(2 a -3)) => ((2) (-3))
```