CptS 440/540 – Artificial Intelligence
Fall 2020

Exam I

October 1, 2020, 9:10am-10:25am, Pacific time

Instructions (read carefully):

1. This exam has 7 questions and 7 pages.
2. You must submit a single PDF file with your responses to the exam questions on Blackboard Learn by 10:25am pacific time on October 1, 2020.
3. If your submission is late, as determined by the Blackboard Learn timestamp on your submission, then you will be deducted 1 point for each minute your exam is late. The exam is worth 60 points and is designed to be completed in 1 hour (if you studied). This leaves 15 minutes to access the exam and upload your response; please plan accordingly.
4. The exam is open book and open notes, and you may use a calculator. You may not receive any assistance during the exam from other people or the Internet. Evidence of assistance will result in a zero on the exam. If you have questions during the exam, you may email me at holder@wsu.edu. I will be monitoring my email during the exam and will respond as soon as possible.
5. Your exam response can be created with an editor on your computer and/or scans or pictures of a written response. Make sure all responses are clearly legible and that the exam question number is clearly indicated. Again, your exam response must be a single PDF file.

1. Clearly print your full name and your WSU ID number.

2. Take a picture of yourself holding your WSU ID card, but hold your card **upside-down**. Your full face and your card's name, photo, and ID number should be clearly visible in the picture. Include the picture in your PDF response. *Your exam will not be graded without this picture included*.

3. (12 points) Short answer questions.

   a. (2 points) Indicate which game below applies to you based on the last digit of your WSU ID #?

      If the last digit of your WSU ID # is **even** (0,2,4,6 or 8), then your game is:

      8-puzzle

      If the last digit of your WSU ID # is **odd** (1,3,5,7 or 9), then your game is:

      Wumpus World

   b. (6 points) For each task property below, indicate one of the two options that applies to your game from part (a).

      i. Fully-observable vs. Partially-observable

      ii. Single-agent vs. Multi-agent

      iii. Deterministic vs. Stochastic

      iv. Episodic vs. Sequential

      v. Static vs. Dynamic

      vi. Discrete vs. Continuous

   c. (2 points) What is the branching factor for the search problem corresponding to your game from part (a)?

   d. (2 points) Describe an admissible heuristic for the search problem corresponding to your game from part (a)?

4. (8 points) More short answer questions.

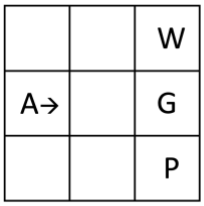
   a. (2 points) What does it mean for a search algorithm to be complete?

   b. (2 points) Describe a search algorithm, and any necessary constraints, such that the search algorithm is both complete and optimal.

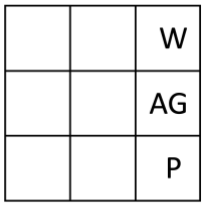
   c. (2 points) What is the time complexity of breadth-first search for a search problem with branching factor *b* and optimal solution depth *d*?

   d. (2 points) Of the four approaches to AI discussed in class, which approach is the one we are pursuing in this course?

5. (10 points) Consider the following initial and goal states for a 3x3 Wumpus World search problem. The initial state has the agent in (1,2) facing Right, and the goal state is that the agent is in (3,2), co-located with the gold, regardless of orientation. The available actions are GoForward (GF), TurnLeft (TL), and TurnRight (TR), and should be considered in this order.



Initial State

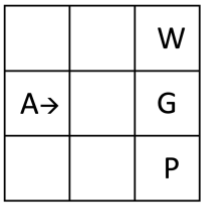


Goal State

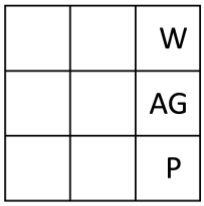
a. (8 points) Draw the search tree showing all nodes generated by the Breadth-First Search algorithm, as described in the lecture notes, to solve this problem. Each node should be drawn as a 3x3 grid like the above initial and goal states.

b. (2 points) How many total nodes are generated using Iterative-Deepening Search to solve this problem?

6. (15 points) Consider the same 3x3 Wumpus World search problem described in question 6. The same initial and goal states are copied below.



Initial State

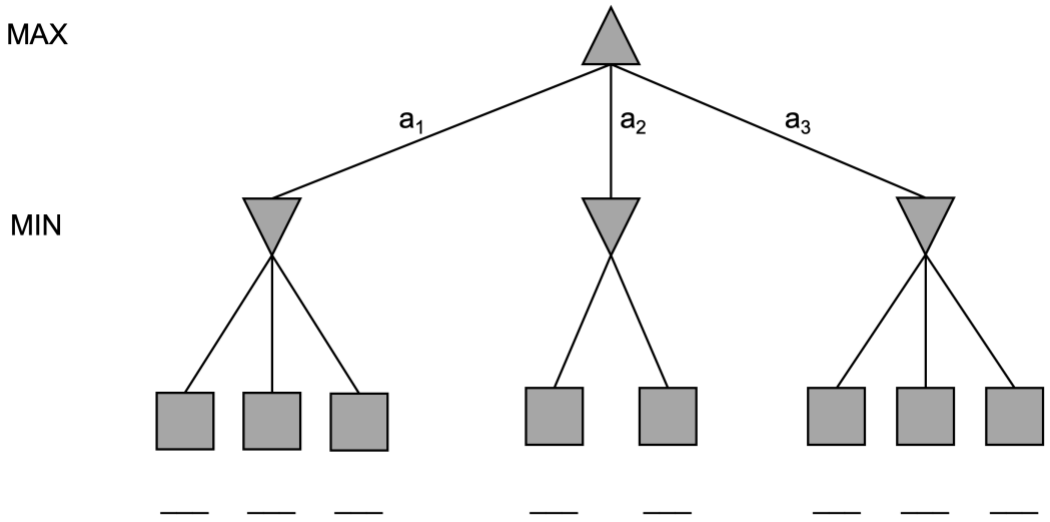


Goal State

Draw the search tree generated by the A* search algorithm, as described in the lecture notes, to solve this problem using the city-block distance for the heuristic *h*. The city-block distance for a Wumpus World state is the city-block distance between the agent's current location and the agent's goal location. Next to every node, show the values of *f*, *g* and *h*. Each node should be drawn as a 3x3 grid like the above initial and goal states.

7. (15 points) Game tree search.

   a. (6 points) In the 8 blanks provided below the terminal nodes, enter the last 8 digits of your WSU ID # in **increasing order** from left to right. Perform Minimax-Search on the resulting game tree below. Put the value next to each node. Indicate which action MAX should take: a_1, a_2 or a_3.



   b. (9 points) In the 8 blanks provided below the terminal nodes, enter the last 8 digits of your WSU ID # in **decreasing order** from left to right. Perform Alpha-Beta-Search on the resulting game tree below. Put an "X" over each node that is pruned, i.e., not evaluated (including all nodes in a pruned subtree). Put the final value next to all other nodes. Indicate which action MAX should take: a_1, a_2 or a_3.