Homework 1

Due on **02/14/2021**

1. For each of the following activities, give a PEAS description of the task environment and characterize it in terms of the properties listed in Section
   a. Playing soccer
   b. Knitting a sweater
   c. Bidding on an item at an auction

2. To what extent are the following computer systems instances of artificial intelligence:
   • Supermarket bar code scanners.
   • Web search engines.
   • Voice-activated telephone menus.
   • Spelling and grammar correction features in word processing programs.
   • Internet routing algorithms that respond dynamically to the state of the network.

3. Examine the AI literature to discover whether the following tasks can currently be solved by computers:
   a. Playing a decent game of table tennis (Ping-Pong).
   b. Driving in the center of Cairo, Egypt.
   c. Driving in Victorville, California.
   d. Buying a week's worth of groceries at the market.
   e. Buying a week's worth of groceries on the Web.
   f. Playing a decent game of bridge at a competitive level.
   g. Discovering and proving new mathematical theorems.
   h. Writing an intentionally funny story.
   i. Giving competent legal advice in a specialized area of law.
   j. Translating spoken English into spoken Swedish in real time.
   k. Performing a complex surgical operation.
   For the currently infeasible tasks, try to find out what the difficulties are and predict when, if ever, they will be overcome.

4. The missionaries and cannibals' problem is usually stated as follows. Three missionaries and three cannibals are on one side of a river, along with a boat that can hold one or two people. Find a way to get everyone to the other side without ever leaving a group of missionaries in one place outnumbered by the cannibals in that place.
   a. Formulate the problem precisely, making only those distinctions necessary to ensure a valid solution. Draw a diagram of the complete state space.
   b. Implement and solve the problem optimally using an appropriate search algorithm. Is it a good idea to check for repeated states?
   c. Why do you think people have a hard time solving this puzzle, given that the state space is so simple?

5. 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)=0h(n)=0 is an admissible heuristic for the 8-puzzle.
   c. A* is of no use in robotics because percepts, states, and actions are continuous.
   d. Breadth-first search is complete even if zero step costs are allowed.
   e. Assume that a rook can move on a chessboard any number of squares in a straight 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.

6. Prove each of the following statements or give a counterexample:
   1. Breadth-first search is a special case of uniform-cost search.
   2. Depth-first search is a special case of best-first tree search.
   3. Uniform-cost search is a special case of A search.

7. Consider a best-first search algorithm in which the evaluation function is f(n)=(2−w)g(n)+wh(n). For what values of w is this complete? For what values is it optimal, assuming that h is admissible? What kind of search does this perform for w=0, w=1, and w=2?

8. Invent a heuristic function for the 8-puzzle that sometimes overestimates, and show how it can lead to a suboptimal solution on a particular problem. (You can use a computer to help if you want.) Prove that if h never overestimates by more than c, A∗ using h returns a solution whose cost exceeds that of the optimal solution by no more than c.

9. What is the size of the state space in the blocks-world example given below?