Homework #1: Chapters 1, 2, 3

The following exercises are due at the beginning of class on February 5. Each exercise will be graded for correctness, so please start early and be sure you are confident in your answers. Also, remember that all work should be your own. Note this homework is continued on the reverse side.

1. *[15 points]* Develop a PEAS description for the following task environments. Note performance measures must be specific enough that it is clear how to measure them, and sensors and actuators should be mechanisms.

   a) A computerized psychotherapist that communicates with patients via instant messaging in an attempt to help the patient better understand his/her moods, feelings, behavior, and help the patient better respond to life's challenges.

   b) A robot that can help rescue workers locate the injured in a collapsed building.

   c) A computer program that given an image of a fingerprint can find the best match in a database of criminal fingerprints.

2. *[15 points]* For each of the agents described above, categorize it with respect to the six dimensions of task environments as described on pages 41-45 (you can omit known vs. unknown since it does not directly refer to the environment itself). Be sure that your choices accurately reflect the way you have designed your sensors and actuators in #1 above, as these will constrain what a *state* is for the environment. Give a short justification for each property.

3. *[15 points]* Consider the vacuum-cleaner world depicted in Figure 2.2 and specified on pages 35-36. Assuming that the environment is static and the agent's performance measure is **penalized** one point for **each movement**, answer the following questions:

   a) Can a simple reflex agent be perfectly rational for this environment? Explain.

   b) What about a model-based reflex agent? Explain.

   c) How do your answers to **a** and **b** change if the agent's percepts give it the clean/dirty status of *every* square in the environment at each time step?

4. *[20 points]* Consider the following situation. A 3-foot tall monkey is in a room where some bananas are suspended from the 8-foot tall ceiling. She would like to get the bananas. The room contains two stackable, movable, climbable 3-foot-high crates. Design a suitable representation for states and then give the initial state, goal test, set of actions, transition model, and cost function for this problem. Choose a formulation that is precise enough that it would be possible use a search algorithm to find a logical solution to the problem. In particular, specify the successor function by describing each action formally (i.e., precisely describe what kinds of states each action can be used in and how the state is changed when it is applied). Note, you only have to define the problem formally, you do not have to find the solution yourself.

5. *[10 points]* Suppose you are using a search algorithm to solve the 15-puzzle problem (i.e., the 4x4 version of the sliding-block puzzle described on p. 71). What are the benefits and drawbacks of using a depth first search? What are the benefits and drawbacks of using a breadth first search?

6. *[25 points]* Sudoku is a popular logic puzzle. Consider a 4x4 puzzle like the one given below. The object is to place the numbers 1-4 in the blank squares such that every row contains exactly one of each of the digits, and likewise for every column and each of the four 2x2 blocks. Assume that the only legal action is entering a number into the next *available* square (proceeding from left to right in each row, and moving from top to bottom). This number must not already appear in the same row, column or block (which would violate the puzzle's constraints). Use breadth-first search to solve this problem. Show your search tree with each node showing the current grid and labeled with the order in which it was expanded. Hint: Your tree will be deep (8 levels not including the root node) but not very wide, so please consider this when deciding how to fit your answer on one sheet of paper.

Initial State

4		1	
1			4
2		3	
3		4	