CMSC 421 Homework 1

Due Date: Thursday, September 15, at the start of class

1. **[15 points] Definitions of AI**

   (a) **[10 points]** Two additional dimensions for characterizing AI systems and methods are theoretical vs. practical (sometimes referred to "neat" vs. "scruffy") and "strong AI" (consciousness as an objective) vs. "weak AI" (makes no claims about whether systems are self-aware). Characterize the following definitions according to these four dimensions. Some definitions may be neutral with respect to a particular dimension, or fall in the middle of a continuum. Artificial intelligence is...

   > a collection of algorithms that are computationally tractable, adequate approximations of intractably specified problems (Partridge, 1991)
   >
   > the enterprise of constructing a physical symbol system that can reliably pass the Turing Test (Ginsberg, 1993)
   >
   > the exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense (Haugeland, 1985)
   >
   > the field of computer science that studies how machines can be made to act intelligently (Jackson, 1986)
   >
   > The automation of activites that we associate with human thinking, activities such as decision-making, problem solving, learning, . . . (Bellman, 1978)
   >
   > a field of study that encompasses computational techniques for performing tasks that apparently require intelligence when performed by humans (Tanimoto, 1990)
   >
   > a very general investigation of the nature of intelligence and the principles and mechanisms required for understanding or replicating it (Sharples et al., 1989)
   >
   > getting computers to do things that seem to be intelligent (Rowe, 1988)
   >
   > The study of computations that make it possible to perceive, reason and act (Winston, 1992)

   (b) **[5 points]** Where along these dimensions would you characterize your own interests? That is, where in this two-dimensional space do your interests lie?

2. **[15 points]**

   Choose two of the following agents, and for each, develop a PEAS description of the task environment and characterize the environment along the four dimensions given in lecture:

   (a) Microsoft Office Assistant (aka the paper clip)

   (b) PDA/Internet Travel Assistant

   (c) Search and rescue robot

   (d) Algebra tutor

(e) Robot soccer player

3. **[25 points] Search Space Formulation** The Towers of Hanoi is the following problem:

   - There are three pegs, labeled A, B, and C.
   - There are 3 disks on peg A. The top disk has a diameter of 1, the middle disk has a diameter of 2, and the bottom disk has a diameter of 3.
   - There are no disks on peg C.
   - You must move one disk at time and you can not place a larger disk on top of a smaller disk.
   - The problem is to get all of the disks on peg C.

   (a) **[10 points]** Find a representation for the states of this problem

   (b) **[10 points]** Give the initial state, goal test, successor function, and cost function.

   (c) **[5 points]** Find any solution to the problem. A solution is a sequence of operator applications.

4. **[30 points] Search Space Formulation**

   Consider the problem of a student planning an entire course of studies at UMD. The desired outcome is a schedule of courses in each semester–e.g. an assignment of classess to semesters (1st semester, 2nd semester, etc.) that satisifies the requirements of the major. Assume the following:

   - There is some set of classes C such that the student must take each of the classes in C exactly once.
   - For each class c_i, there is a (possibly empty) set $P_i \subset C$ of prerequisite classes that the student must complete before s/he takes c_i.
   - The student must take at least one and at most four classes each semester.

   (a) **[10 points]** Provide a detailed representation of your search space. Your description must be precise, i.e. you should provide an exact specification of the components of the state description (state space, initial state, operataors, goal test), of the constraints under which each operator can be applied, and of the effects of each operator on the state components.

   Make sure that your formulation of the search space has no problem with repeated states, i.e., that no node can be reached from the initial state by two different paths.

   (b) **[10 points]** Suppose the student's only aim is to complete the degree requirements in the shortest possible time, thereby hopefully minimizing the total amount of money spent on tuition. Tuition is charged per semester, not per unit, and all semesters cost the same amount. Specify a cost function for the operators in your space so that the cost of a solution will correspond exactly to the student's preferences.

(c) **[10 points]** Construct a reasonable and admissible heuristic for this search space, given your costs in b. Provide an exact description of your heuristic function and explain why it's admissible, why it's a reasonable heuristic and how you compute it efficiently given a state in your search space. (Hint: as discussed in the book, try and relax some of constraints on your operators.)

5. **[10 points] A* termination** (from *Nilsson, AI: A New Synthesis*) Algorithm A* does not terminate until a goal node is selected for expansion. However, a path to a goal node might be reached long before that node is selected for expansion. Why not terminate as soon as a goal node has been found? Illustrate your answer with an example.