CIS 530 Introduction to Artificial Intelligence
CIS 730 Artificial Intelligence
Fall 2013

Homework 1 of 10: Problem Set (PS1)
Warm-up: Intelligent Agents, Search

Assigned: Fri 30 Aug 2013
Due: Fri 06 Sep 2013 (before midnight)

The purpose of this assignment is to exercise your basic understanding of intelligent agents, state space search, and game theory, and to help you apply these concepts simulate the behavior of search algorithms.

This homework assignment is worth a total of 20 points (2% of the course grade).
Each problem is worth 10% for CIS 730 students and 15% for CIS 530 students.
Upload a PDF file of your solution named **`PS1.pdf`** to your K-State Online (KSOL) file dropbox.

1. **(530/730) Perception and rationality.** Continuing the class discussion from Wed 28 Aug 2013 ("Intelligent Agents" – slide 0 of Lecture 0, slide 4 of Lecture 1): What limitations of an agent's sensors (instruments for collecting perceptual information) limit its view of the world? How does this impact its rationality? Give at least two concrete examples of the effects of sensor error and limitations. You may use measurement error and data processing error as effects, but specify which type you are writing about.

2. **(530/730) Types of agents.** Consider the seven term project domains discussed in class:
   a) physics-based video game playing (AI Birds)
   b) analogical reasoning (visual analogies)
   c) question-answering system (NIST TAC QA task)
   d) probabilistic reasoning (topic modeler)
   e) recommender system (UMAP testbed)
   f) strategic/tactical single-user game playing (Angband)
   g) trading agent competition (Supply Chain Management, Lemonade Stand, or Market Design)

   Give an example of two agents for one of these domains to illustrate the distinction between a reflex agent with state and a goal-based or preference-based agent.

3. **(530/730) State space specification: Farmer, Fox, Goose, and Grain.** (Adapted from Problem 3.9a, p. 90 R&N 2e and Winston 3e.) The Farmer, Fox, Goose and Grain (FFGG) problem is usually stated as follows:

   > *A farmer comes to a river bank with a fox, a goose, and a sack of grain. He can cross over using a boat that holds himself and one of the three items at a time. If the fox is left on one bank with the goose, it will eat the goose. If the goose is left on one bank with the grain, it will eat the grain. Can the farmer get all three items and himself across without anything being eaten?*

   Formulate the problem precisely as a state space. Turn in an illustration of the state space diagram, showing which states are the initial states and which are reachable from each other.

4. **(730 only) State space search versus enumeration.** Consider the "Farmer, Fox, Goose and Grain (FFGG)" problem, also known as the "Farmer, Goose, and Bag of Beans" problem (http://en.wikipedia.org/wiki/Fox,_goose_and_bag_of_beans_puzzle) and specifically the task of finding a shortest solution to the problem. Describe, in pseudocode, a search mechanism that can find such a solution; then describe a procedure for finding **all** solutions. Is your FindAllSolutions procedure related to your FindOneSolution? Why or why not?

5. **(530/730) Understanding heuristic search.**

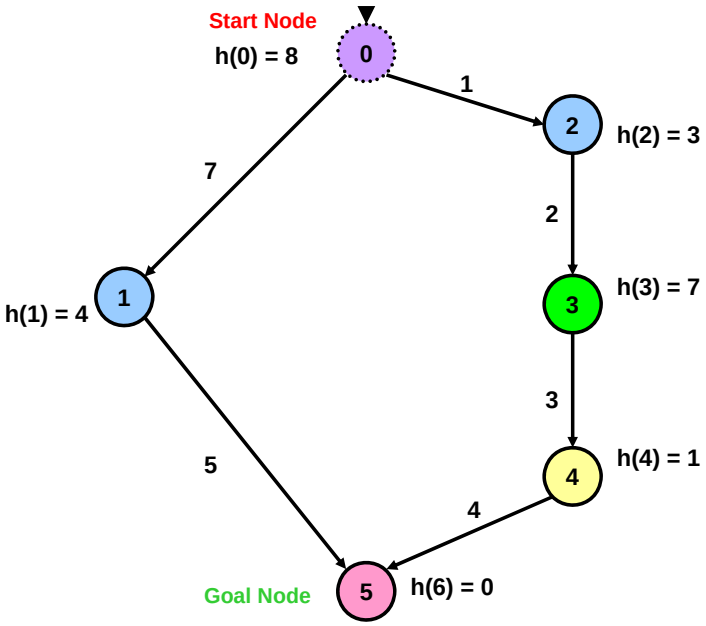
   a. Prove that local beam search with one initial state and a limit of one on the number of states retained is equivalent to hill-climbing search. What is the difference between this and only looking at a single state? *e.g.,* what is the worst-case memory cost of hill-climbing?
   b. Describe, in your own words, the relationship between uniform-cost search and breadth-first search. Give an example to illustrate the difference.

6. **(730 only) Iterative deepening in A* and in games.** What limitations does Depth-Limited Search have that IDA* overcomes? Explain in your own words why iterative deepening search is important in resource-bounded game tree search.

7. **(530/730) PEAS representations of problems.** For each of the following software agent tasks, develop a Performance measure, Environment, Actuators, Sensors (PEAS) description of the task environment:

   a. *Angry Birds* (http://en.wikipedia.org/wiki/Angry_Birds)
   b. The "Find Life on Mars" task from the AAAI 1997 Mobile Robot Competition: http://www.cc.gatech.edu/ai/robot-lab/research/aaai97/status.htm#Event%201

8. **(530/730) Heuristic Search.** Simulate the behavior of A/A* on the following graph, showing the **nodes expanded,** the **path** actually returned, and the **cost** of the path.



9. **(530/730) Comparing blind and heuristic search.** Prove each of the following statements, or give a counterexample:

    a) Breadth-first search is a special case of uniform-cost search.
    b) Depth-first search is a special case of hill-climbing tree search.
    c) Greedy search is a special case of A search.*

10. **(730 only) Local and global search.** Show how global search can overcome the following types of problems (use heuristics as in PS1-8 above).

    a) Foothill problem (local optimum) – illustrate using *graph search*
    b) Ridge problem – illustrate using *grid search*

Class participation (required).

Artificial Intelligence in Disaster Management. Watch the TEDx GenevaChange talk "All Disasters are Preventable" by Dr. Muralee Thummarukudy (given 05 Apr 2012, published 15 Apr 2012):
https://www.youtube.com/watch?v=GTm7564Vygo

Consider an agent that monitors warning signs of natural disasters and makes recommendations to assist humans in preparing for, managing, and providing relief to victims of these disasters. What might some of these disasters and their signs be? Discuss ways in which computational methods, particularly intelligent agents, can use sensors and other information gathering tools (*e.g.*, mobile device applications, web sites for reporting by aid workers and survivors). For some current examples and ideas, see the talk "Computational Disaster Management" from the 23rd International Joint Conference on Artificial Intelligence (IJCAI 2013) by Dr. Pascal Van Hentenryck of NICTA and Melbourne University.

http://ijcai.org/papers13/Papers/IJCAI13-012.pdf

Post your discussion to the message board for CIS 530 (http://bit.ly/kstate-IntroAI), along with a brief introduction stating your:

- name
- program (grad or undergrad) and major
- interests in AI – **optional** (this will be on a KSOL or Axio survey)
- special topics you would like to see covered, if any – **optional** (ditto above)