CSEP 573 Introduction to Artificial Intelligence Winter 2011
Assignment 1
Due: Wednesday January 19, 6:30PM

Q 1: [10 points] Explore any one application domain of AI and write a brief report (about 500 words) on the current state of the art in that domains. Mention your sources of information and cite the source especially if you are using someone else's language verbatim. [extra credit: explore another application domain]

[answer]

Q 2: [5 points] You have two jugs of water with capacities 4 and 13 liters. You also have an infinite supply of water. Can you use the two jugs to get exactly 2 liters of water? Cast this as a search problem: what's your state space, action space, goal condition, and costs of actions? What is a solution to the problem?

[answer]

Q 3: [15 points] Negative Costs in Search: Problem 3.8 from AIMA 3rd Edition

[answer]

Q 4: [10 points] Prove that a consistent heuristic is always admissible.

[answer]

Q 5: [10 points] Prove that A* with an admissible but inconsistent heuristic may not find an optimal solution when running search using GRAPH-SEARCH function (see Figure 3.7 of AIMA 3rd edition).

[answer]

Q 6: [50 points] Programming Assignment. You need to use A* to solve the flashlight problem. The problem is stated as follows: there are n people {0,1,...,n-1}. They all need to cross the bridge but they have just one flashlight. A maximum of two people may cross at a time. It is nighttime, so someone must carry the single flashlight during each crossing. They all have different speeds such that the time taken to cross the bridge for person i is given by $T(i)$ minutes. You may assume without loss of generality that for $i<j$, $T(i) <= T(j)$. The speed of two people crossing the bridge is determined by the slower of the two. You need to find the shortest amount of time in which all the people can cross the bridge.

As an example suppose there are 4 person and time taken ($T(i)$) are 1,2,5 and 10 for i=0,1,2,3 respectively. A solution to the problem is:

- 0 and 3 go across 10 minutes
- 0 goes back with light 1 minute
- 0 and 2 go across 5 minutes
- 0 goes back with light 1 minute
- 0 and 1 go across 2 minutes
- Total 19 minutes

Note: this is not the optimal solution for this problem. The optimal is 17 minutes.

Q 6-1: Give a brief writeup on how you modeled the problem as a search problem.

[answer]

Q 6-2: Design and describe 3 or more heuristic functions for this problem. At least one heuristic function needs to be consistent, since we wish to find the optimal solution.

[answer]

Q 6-3: Generate random problems with increasing n and test A* with different heuristics on those problems. Plot the time taken in solving the problems as a function of problem size. Also plot the number of nodes expanded as a function of the problem size. Make observations about the efficiency of search with respect to the quality of the heuristic function. (If you have inconsistent/inadmissible heuristics in your mix, also plot the solution quality versus the optimal). Are there any problems which can be solved by one heuristic but can't by others? [To make your life simple, you may give a total time bound or a memory bound.]

[answer]

Description of the Programming Project

We are using the code libaries from Java implementation of the code in the Russel and Norvig book. http://code.google.com/p/aima-java/ You should download the code provided there so that you can examine all the programs. However, to use the libaries for this assignment you only need the aima-core.jar file. This is included in the assignment1 directory contained in assignment1.zip

The first thing to do is to set your Java CLASSPATH variable to include that jar file and also the current directory. Once that is done, you should be able to compile the .java files in the "map" subdirectory, and run MapAStarTest.

```
cd map
javac *.java
java MapAStarTest
```

These files implement and run an AStar Search for traveling between cities in Romania, as shown in figure 3.24 on page 96 of the text.

For your programming assignment, you will be writing analogous code for the Flashlight problem. Template files can be found in the assignment1/a1submit directory. For a brief discussion of what you need to do, look at the "Notes on Search" section of http://aima-java.googlecode.com/svn/trunk/aima-core/README.txt

Input format: Your FlashlightAStarTest program should take command line arguments that consist of the number of people, followed by the times of each in increasing order. For example:

```
java FlashlightAStarTest 4 1 2 5 10
```

Output format: The program should produce output in the format of: Total time; Total # of nodes expanded; and the id's of people crossing and returning, ending with a -1. These should all be on one line, with a single newline. For example:

```
19; 200; 0+3, 0, 0+2, 0, 0+1, -1
```

Grading for the Programming Project

◦[15 points] accurate coding as verified by testing your turned in code on some test
  cases. The tests will use scripts, so exact naming conventions are important.
◦[15 points] The set of heuristic functions you consider. (Just put your best in your
  code file)
◦[20 points] Your evaluation/explanation of your results.
◦[Extra credit] if you include other algorithms in your experimental evaluation and
  analysis (examples include dfs, bfs, uniform cost search, greedy best first, etc)
◦[Extra credit] if your heuristic function is creative.
◦[Extra credit] if your code can solve problems that others' cannot.

What to Turn In

Use the Class Dropbox (link is coming) to turn in a single file: "a1submit.zip". This
should contain the a1submit directory with a single .pdf file called
assignment1Report.pdf and all of your java code for the Flashlight search project.

Do not include any .class or .jar files. The .pdf file should include a writeup for all the
questions that require one. Basically, for any place above that includes an "[answer]"
marker you should have something written.