COMP 472/6721 **Assignment 2** **Fall 2012**

Due date: Wednesday Oct. 10, 2012
Late submission: none accepted
Teams: You can do the project individually or in teams of 2.
Teams must submit only 1 copy of the assignment.
Purpose: The purpose of this assignment is to make you practice state space search, heuristic development, and search for game playing.

Question 1 (25pts): The fox, the goose and the bag of beans

Once upon a time a farmer went to market and purchased a fox, a goose, and a bag of beans. On his way home, the farmer came to the bank of a river and rented a boat. But in crossing the river by boat, the farmer could carry only himself and a single one of his purchases - the fox, the goose, or the bag of the beans.

If left alone, the fox would eat the goose, and the goose would eat the beans.
The farmer's challenge was to carry himself and his purchases to the far bank of the river, leaving each purchase intact.

Represent this problem as a search problem. Choose a representation for the problem's states and:

A. Write down the initial state

B. Write down the goal state

C. Write down all illegal states

D. Write down the possible actions

E. Draw the state space for this problem.

F. Find a series of moves to solve this problem.

Question 2 (25pts): The sliding-tile puzzle

Consider the following sliding-tile puzzle. The puzzle consists of three black tiles, three white tiles, and an empty space as shown below.

The puzzle has two kinds of legal moves:

1- A tile may move into an adjacent location if it is empty. This has a cost of 1.
2. A tile can jump over one or two other tiles into the empty position. This has a cost equal to 1 plus the number of tiles jumped over.

The goal is to have all the white tiles to the left of all the black tiles regardless of the position of the empty space.

A. Does this state space contain loops? Show an example.

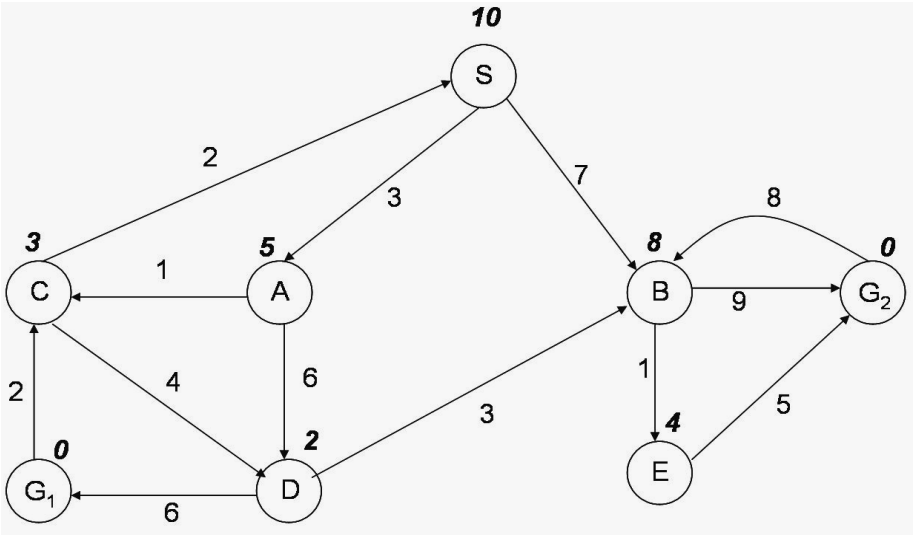
B. Propose a heuristic for solving this problem that is admissible. Show the evaluation and illustrate your heuristic on the following states:

```
h(bbbewww) = ? and why?      // this is the state shown above
h(bebwwbw) = ? and why?
h(bebwbww) = ? and why?
h(ewwwbbb) = ? and why?
h(wwwebbb) = ? and why?
```

C. Draw the initial state of the search space and its successor states (so only the root and one level down). For each node, indicate its heuristic value (using the heuristic of part B) above), and mark each edge with its cost.

Question 3 (25pts): Search Algorithms

Consider the following state space:



where:

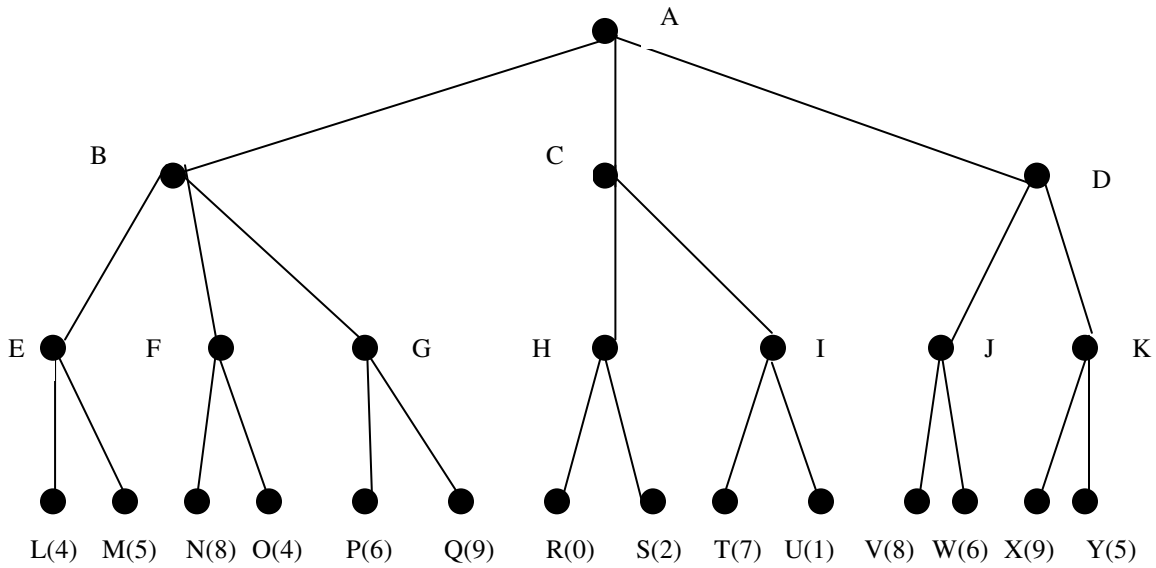
- S is the initial state and G_1 and G_2 are two possible goal states.
- The possible actions between states are indicated by arrows.
- The number labelling each arc is the actual cost of the action. For example, the cost of going from S to A is 3.
- The number in bold italic near each state is the value of the heuristic function *h* at that state. For example, the value of *h* at state C is 3.

Give the sequence of nodes visited in order to find a solution to this problem when using the following search strategies:

A- Breadth first search
B- Depth first search
C- Hill climbing
D- Best-first search
E- Algorithm A

Question 4 (25pts): Minimax & Alpha-beta

Consider the game tree below. Each node is labelled with a letter, and the evaluation function for each leaf is indicated in parentheses. Assume that the "max" player goes first.



A- Compute the minimax game value of nodes A, B, C, and D using the minimax algorithm. Show all values that are brought up to the internal nodes. What move should MAX do?

B- Cross out the branches of all the nodes that are <u>not</u> visited by alpha-beta pruning. Show all your work.

C- Draw a new game tree by re-ordering the children of each internal node (B to M), such that the new game tree is equivalent to the tree above, but alpha-beta pruning will prune as many nodes as possible.

Submission:

The assignment can be handed-in on paper or electronically by midnight on the due date.

1. Make sure that you have signed the expectation of originality form (available on the Web page; or at: http://www.encs.concordia.ca/documents/expectations.pdf) and given it to me.

2. In addition, write one of the following statements on your assignment:
   - For individual work: *"I certify that this submission is my original work and meets the Faculty's Expectations of Originality***",** with your signature, I.D. #, and the date.
   - For group work***:*** *"We certify that this submission is the original work of members of the group and meets the Faculty's Expectations of Originality"*, with the signatures and I.D. #s of all the team members and the date.

3. If you hand in your assignment on Paper:
   - Staple your hand-written answers together and give it in class.
   - If you cannot give the assignment in class:
     - Go to the Department of Computer Science and Software Engineering (EV3. 139)
     - Ask the receptionist to stamp the date and time on your assignment.
     - Put the assignment in my mailbox (Kosseim) in room EV 3.251.

4. If you hand in your assignment Electronically:
   - Create one zip file, containing all files for your assignment.

   - Name your zip file this way:
     - For individual work: name the zip file: *a2_studentID*, where *studentID* is your ID number.
     - For group work***:*** name the zip file: *a2_studentID1_studentID2*, where *studentID1* and *studentID2* are the ID numbers of each student.

   - Upload your zip file at: https://fis.encs.concordia.ca/eas/

Note: If you hand in both an electronic copy and a paper copy, then **both** must be on time.