CIS681 – Homework 1 – Graph Search
****SOLUTIONS****

Due: Tuesday March 11, 2006 – 25 points

1. (15 points)

   To put the problem in state space representation, one must describe what a legal state looks like, then identify the start state, a goal predicate, and set of operators.

   State Representation A state will be represented as a six-tuple of the following form:

   state = `(ML, CL, BoatLeft, MR, CR, BoatRight)`

   Where:

   `ML` is the number of missionaries on the left side of the river
   `CL` is the number of cannibals on the left side of the river
   `BoatLeft` is the number of boats on the left side of the river
   `MR` is the number of missionaries on the right side of the river
   `CR` is the number of cannibals on the right side of the river
   `BoatRight` is the number of boats on the right side of the river

   and where
   `ML + MR = 3`
   `CL + CR = 3`
   `BoatLeft + BoatRight = 1`
   `ML = 0 OR ML >= CL`
   `MR = 0 OR MR >= CR`

   Initial State = `(3, 3, 1, 0, 0, 0)`
   Goal State = `(0, 0, X, 3, 3, Y)` where `X + Y = 1`.
   Operators :

   (a) Move 1 Missionary Right
   `Precondition: (ML, CL, 1, MR, CR, 0) where ML > CL`
   `New State: (ML-1, CL, 0, MR+1, CR, 1)`
   (b) Move 2 Missionaries Right
   `Precondition: (ML, CL, 1, MR, CR, 0)`
   `where ML > 1 and ((ML-2 = 0) OR (ML-1 > CL))`
   `New State: (ML-2, CL, 0, MR+2, CR, 1)`

(c) Move 1 Missionary and 1 Cannibal Right

`Precondition: (ML, CL, 1, MR, CR, 0) where ML > 0 and CL > 0`
`New State: (ML-1, CL-1, 0, MR+1, CR+1, 1)`

(d) Move 1 Cannibal Right

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Precondition: (ML, CL, 1, MR, CR, 0)
       where (CL > 0) and ((MR = 0) OR (MR > CR))
New State: (ML, CL-1, 0, MR, CR+1, 1)
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(e) Move 2 Cannibals Right

`Precondition: (ML, CL, 1, MR, CR, 0) where (MR = 0) OR (MR > CR > 1)`
`New State: (ML, CL-2, 0, MR, CR+2, 1)`

(f) You would have 5 more moves that are the mirror image of the above allowing 1 or 2 Missionaries, 1 or 2 Cannibals, and 1 Canibal and 1 Missionary moving Left.

Heuristic Function = `NumbMissLeft + NumbCannLeft`

This function would get smaller as you get closer to a goal node of having everyone on the right hand side of the river.

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Initial State:

(3,3,1,0,0,0) Heuristic Value: 6

Expl = initial state

Successors of Initial State:
(2,2,0,1,1,1) Heuristic Value: 4
(3,2,0,0,1,1) Heuristic Value: 5
(3,1,0,0,2,1) Heuristic Value: 4

OPEN LIST:
(2,2,0,1,1,1) Heuristic Value: 4
(3,2,0,0,1,1) Heuristic Value: 5
(3,1,0,0,2,1) Heuristic Value: 4

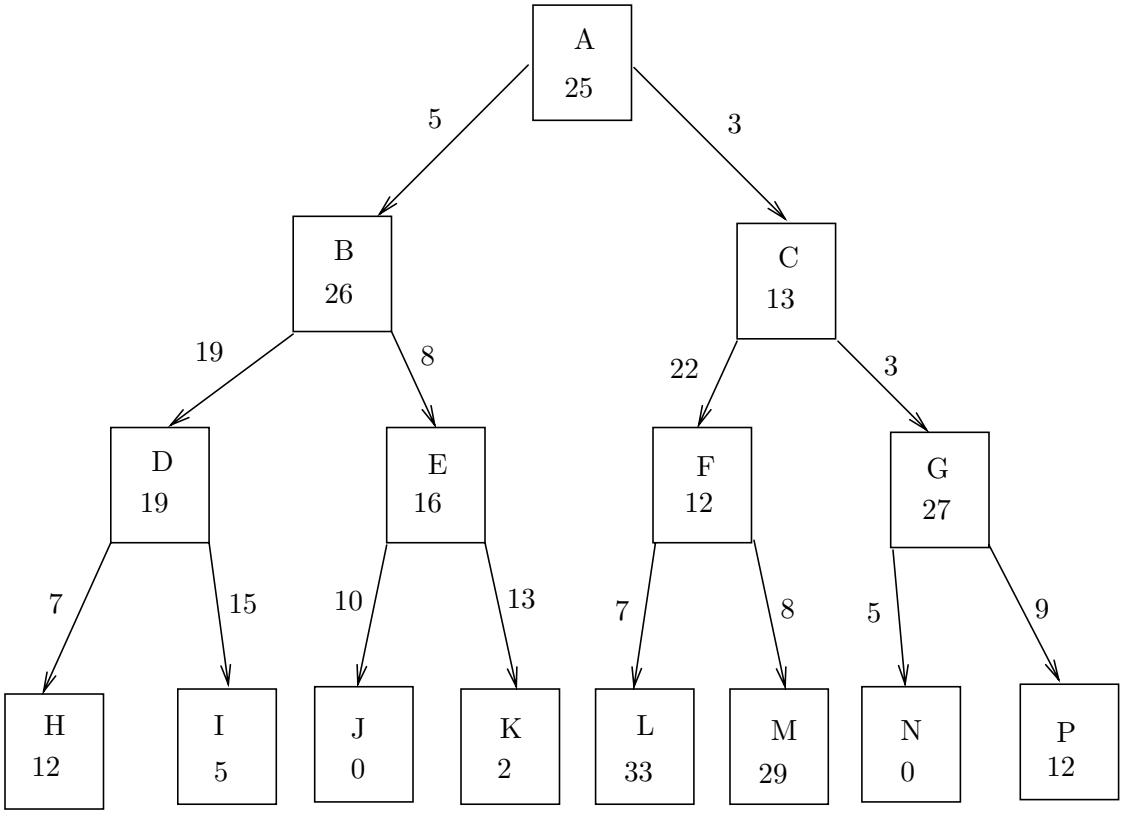

Expl = (2,2,0,1,1,1) Heuristic Value: 4

Successors of Expl:
(3,3,1,0,0,0) Heuristic Value: 6
(3,2,1,0,1,0) Heuristic Value: 5
```

```
OPEN LIST
(3,2,0,0,1,1) Heuristic Value: 5
(3,1,0,0,2,1) Heuristic Value: 4
(3,3,1,0,0,0) Heuristic Value: 6
(3,2,1,0,1,0) Heuristic Value: 5

Expl = (3,1,0,0,2,1) Heuristic Value: 4
```

2. (10 points)



Each node in the tree is represented by a box indicating the node name and the estimated cost of the path from that state to a goal node (an estimated cost of 0 indicates a goal state so nodes J and N are both goal states). The actual cost of going from one node to another is indicated by a number associated with each arc. Indicate the order in which the nodes in the tree would be searched in going from node A to a goal state for the following kinds of search.

(a) depth-first search (3 points):
`A B D H I E J`

(b) best-first (or greedy) search (3 points)
`A C F B E J`

(c) algorithm-A search (4 points)
`A C B E J`