CS 271 - Introduction to Artificial Intelligence **Fall 2016**

HomeWork 1

Name: *Liangjian Chen*
ID: *#52006933* *October 12, 2016*

Problem 1 (a) i. The struct is defined as follow

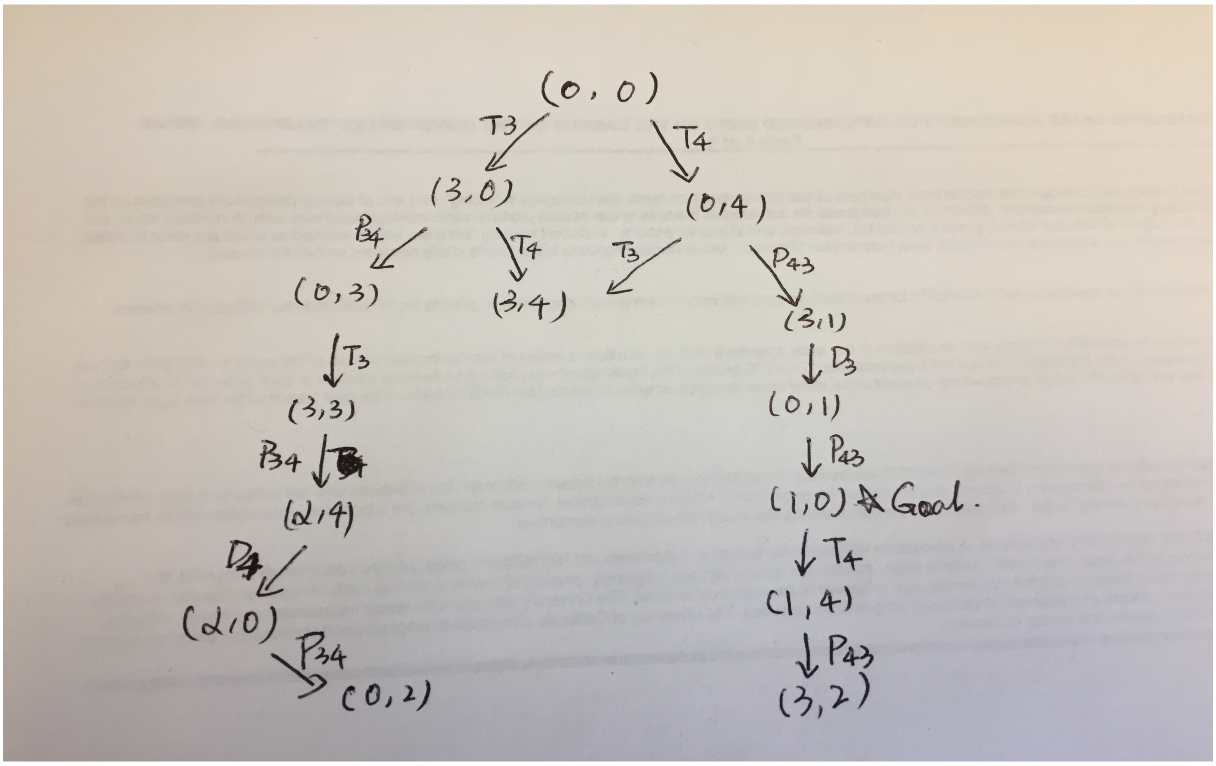
Struct *State* **contains**
| int $Four$, $Three$;
end

ii. Define a pair of number (a,b) represent $Three$ is a and $Four$ is b. There is 14 different states in whole state space. They are:
(0,0),(3,0),(0,4),(0,3),(3,4),(3,1),(3,3)
(0,1),(1,0),(1,4),(3,2),(2,4),(2,0),(0,2)

iii. goal state is all the state that Three = 1. So goal test is checking whether Three is one.

iv. (1) operation T-3, $Three \leftarrow 3$
(2) operation T-4, $Four \leftarrow 4$
(3) operation D-3, $Three \leftarrow 0$
(4) operation D-4, $Four \leftarrow 0$
(5) operation P-34(poure Three to Four)
if $4 - Four \leq Three$ then $Three \leftarrow Three + Four - 4, Four \leftarrow 4$.
else $Four \leftarrow Four + Three, Three \leftarrow 0$
(6) operation P-43(poure Four to Three)
if $3 - Three \leq Four$ then $Four \leftarrow Three + Four - 3, Three \leftarrow 3$.
else $Three \leftarrow Three + Four, Four \leftarrow 0$

(b) The graph is shown below.



Problem 2 (a) The struct is defined as follow

Struct *State* **contains**
  int M, C;
  char boat.
end

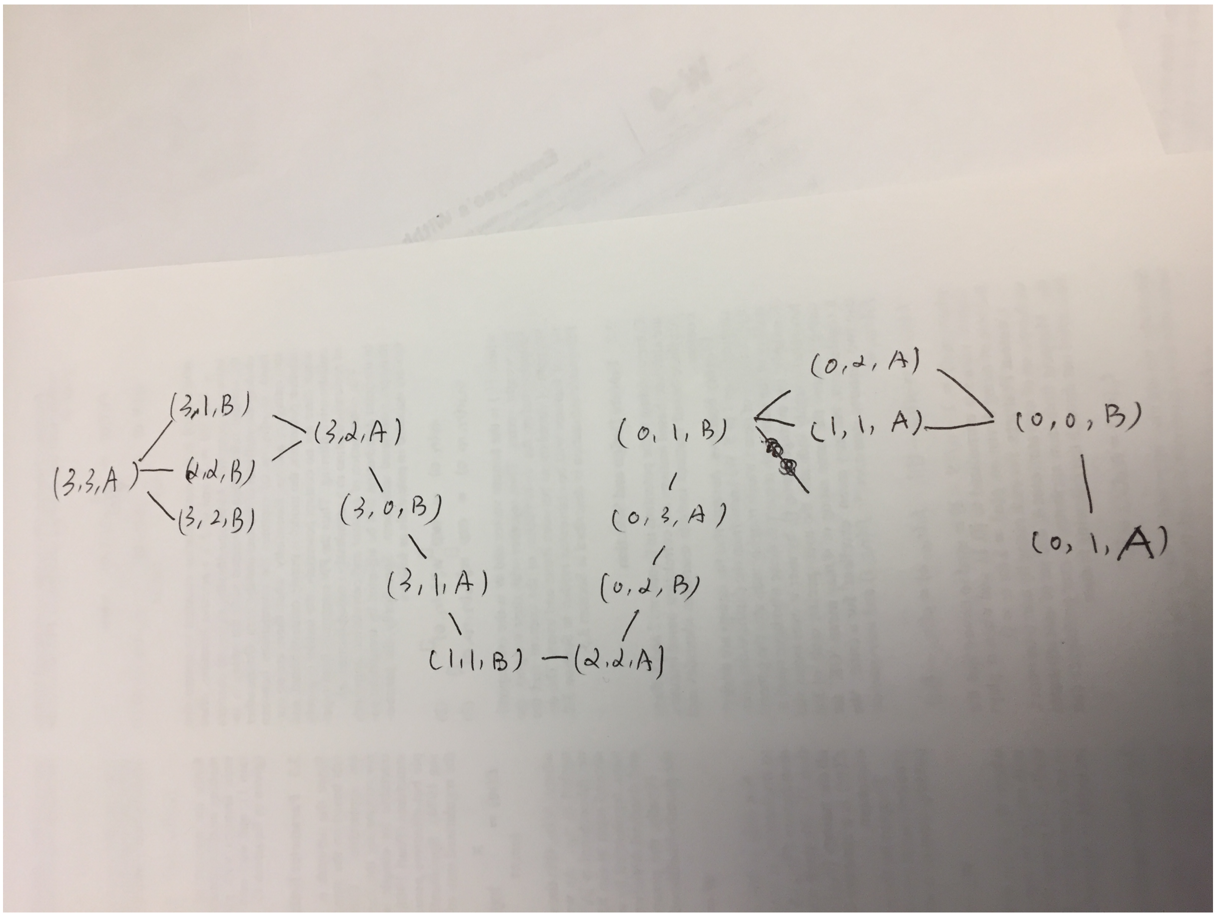
Here, M represent Missionary, C represent Cannibal.
Let define the original side is side A, other side is side B. This State is how many Missionary and Cannibal on side A and where is the ship. In this state space, there are $3 * 3 * 2 = 18$ different state (including some illegal states).
For short,Assume (x,y,z) means state(M,C,boat).

So, initial state is (3,3,A), and goal state is (0,0,B);

(b) Since there is 5 different choices, ship one or two people to another side.

if $boat == A$ **then**
  if $M \geq 1$ ***and*** $(M == 1$ ***or*** $M - 1 \geq C)$ **then**
    Go State(M - 1,C,"B");
  end
  if $M \geq 2$ ***and*** $(M == 2$ ***or*** $M - 2 \geq C)$ **then**
    Go State(M-2,C,"B");
  end
  if $C \geq 1$ ***and*** $(3 - M \geq 3 - C + 1$ ***or*** $M == 3)$ **then**
    Go State(M,C-1,"B");
  end
  if $C \geq 2$ ***and*** $(3 - M \geq 5 - C$ ***or*** $M == 3)$ **then**
    Go State(M,C-2,"B");
  end
  if $M \geq 1$ ***and*** $C \geq 1$ **then**
    Go State(M-1,C-1,"B");
  end
else
  if $3 - M \geq 1$ ***and*** $(3 - M == 1$ ***or*** $3 - M - 1 \geq C)$ **then**
    Go State(M + 1,C,"A");
  end
  if $3 - M \geq 2$ ***and*** $(3 - M == 2$ ***or*** $3 - M - 2 \geq C)$ **then**
    Go State(M + 2,C,"A");
  end
  if $3 - C \geq 1$ ***and*** $(M \geq C + 1$ ***or*** $M == 0)$ **then**
    Go State(M,C + 1, "A");
  end
  if $3 - C \geq 2$ ***and*** $(M \geq C + 2$ ***or*** $M == 0)$ **then**
    Go State(M,C + 2, "A");
  end
  if $3 - M \geq 1$ ***and*** $3 - C \geq 1$ **then**
    Go State(M + 1,C + 1,"A");
  end
end

(c) The graph is shown below.



(d) Starting from the initial state, use the action set describe above, to find every possible next state. For every state which we have not visited yet, search it recursively until we find a goal state or there is no more available next state.

Problem 3 (a) $S \to A \to B \to C \to F \to D \to E \to L \to M \to H \to I \to J \to K \to G$

(b) $S \to A \to D \to E \to J \to G$

(c) $S \to$
$S \to A \to B \to C \to$
$S \to A \to D \to E \to B \to F \to C \to H \to I \to$
$S \to A \to D \to E \to J \to K \to L \to B \to F \to M \to C \to H \to I \to$
$S \to A \to D \to E \to J \to G$

Problem 4 (a)

$$\text{Max} = \sum_{i=0}^{g} b^i = \frac{b^{g+1}-1}{b-1} = O(b^g)$$

$$\text{Min} = 1 + \sum_{i=0}^{g-1} b^i = 1 + \frac{b^g - 1}{b-1} = O(b^{g-1})$$

(b)

$$\text{Min} = g + 1 = O(g)$$

$$\text{Max} = \sum_{i=0}^{d} b^i - \sum_{i=0}^{d-g} b^i + 1 = \frac{b^{d+1}-1}{b-1} - \frac{b^{d-g+1}-1}{b-1} + 1 = O(b^d)$$

(c)

$$\text{Min} = g + 1 + \sum_{j=0}^{g-1}\sum_{i=0}^{j} b^i = \frac{b^{g+1}-b}{(b-1)^2} - \frac{g}{b-1} + g + 1 = O(b^{g-1})$$

$$\text{Max} = \sum_{j=0}^{g}\sum_{i=0}^{j} b^i = \frac{b^{g+2}-b}{(b-1)^2} - \frac{g+1}{b-1} = O(b^g)$$

Problem 5 For a graph $G(E,V)$,the number of comparison is equal to the number of edge $|E|$. Because degree is b and depth is d, $|E|= \frac{b|V|}{2}$. Then larger the number of node is, larger the number comparison is. And know that there are at most $1 + \sum_{i=0}^{d-1} b(b-1)^i = O(b^d)$ nodes. Thus, the number of comparison is $O(b^d)$.

Extra credit:

Assume $f(b,d)$ is the maximum possible number of node in the graph.
In this case, the number of comparison is $\sum_{i=0}^{f(b,d)} i = O(f(b,d)^2) = O(b^{2d})$