CIS 32 Spring 2009, Homework 3

1. This is known as the *dogs & sheep* problem:

   > "A farmer has three dogs and 3 sheep that he wants to get across a river. He has a boat, which in addition to him, will hold one or two animals, but no more. He can never leave more dogs than sheep either in the boat or on either side of the river."

   (a) You can represent the state of this problem by writing:

   $$(s, d, k)$$

   to indicate that there are s sheep, d dogs, and k boats on the original side of the river.

   (b) Using this representation, apply breadth first search to the problem and draw out the resulting search tree until you find a goal (with this representation the goal is $(0, 0, 0)$.

   (c) What is the optimal solution to this problem?

   (10 points)

2. In chess, the average branching factor is 35.

   (a) What will the average size of an agenda be for a breadth first search in chess at depth 10?

   (b) Generalise your result from the first part to give an expression which gives the average size of an agenda in breadth first search in a problem with branching factor b at depth d.

   (c) What will the average size of an agenda be for a depth first search in chess at depth 10?

   (d) Generalise your result from the last part to give an expression which gives the average size of an agenda in depth first search in a problem with branching factor b at depth d.

   (10 points)

3. The *Towers of Hanoi* problem:

   > "In a Tibetan monastry, there are 3 columns and 64 golden rings. The rings are of different sizes and rest over the columns. At the beginning of time, all the rings rested on the leftmost column, and since then, the monks have been moving the rings 1-by-1 between columns. The monks must obey two rules:
   >
   > (a) They may only move one ring at a time between columns.
   >
   > (b) No ring may rest upon a smaller ring."

   The 64 ring Hanoi problem is hard (and very very slow to solve). We will consider a small version of the problem using 3 rings (see Figure 1).

   Write down the search tree for the 3-ring problem using:

   (a) depth limited search to depth 3;

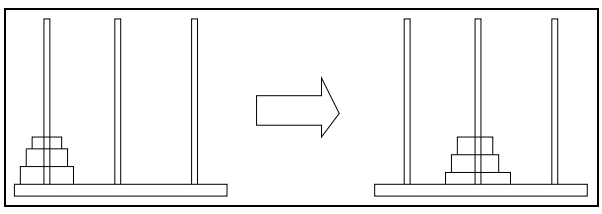

Figure 1: The 3 Ring Towers of Hanoi Problem

(b) iterative deepening to depth 4;

Next, formulate a path cost function and an admissible heuristic for the problem, and solve it using:

(c) uniform cost search;

(d) greedy search;

(e) A* search.

(20 points)

4. Consider the game tree in Figure 2 (overleaf). Nodes represent states of a game. The numbers in the nodes are the names of the nodes. Numbers next to the nodes, if any, are the values of the nodes, reflecting the values of the corresponding states of the game.

   (a) Apply minimax search to the game tree to compute the values of the triangular nodes.

   (b) Which nodes should be pruned using the alpha/beta technique. Your answer should explain why each node that you list should be pruned.

   (10 points)

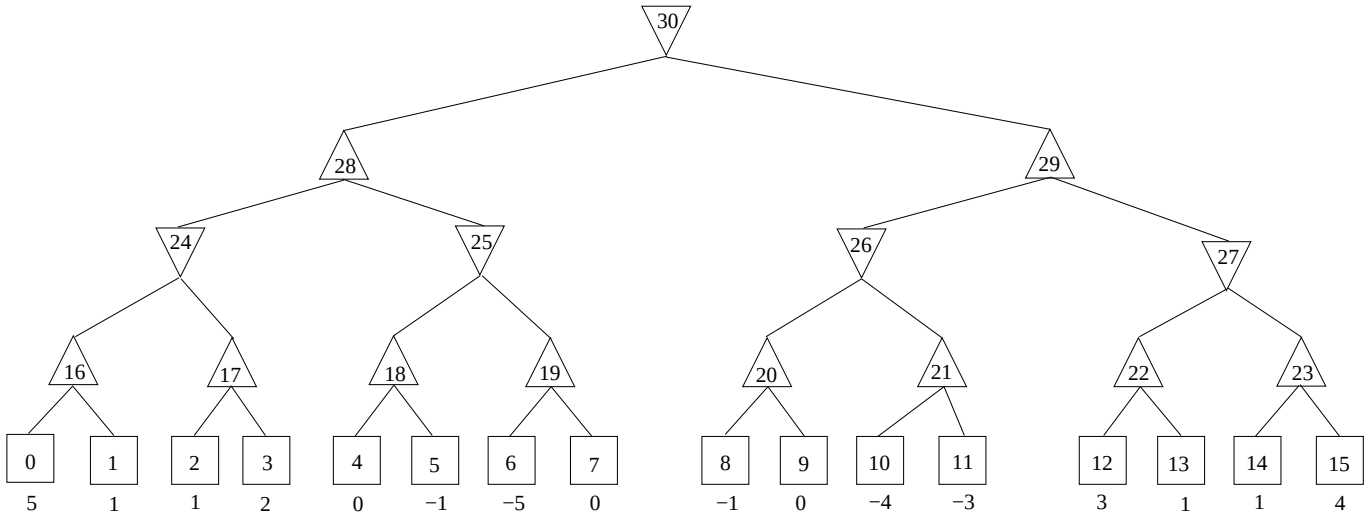

Figure 2: The game tree for Question 4.