

## CIS 716 Homework 2

### 1. The *Towers of Hanoi* problem:

In a Tibetan monastery, 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.

(quite what monks in Tibet have to do with Hanoi is not explained)

The 64 ring Hanoi problem is hard (and takes a very long time to solve).

But consider a small version of the problem using 3 rings (see Figure 1), draw out the full search space down to depth 4, and find one solution (which may require you to look more than 4 levels into the search tree).

(20 points)

### 2. Consider the Towers of Hanoi problem again. Write down the search tree for the 3-ring problem using:

- (a) depth limited search to depth 3;
- (b) iterative deepening to depth 4;
- (c) bidirectional search

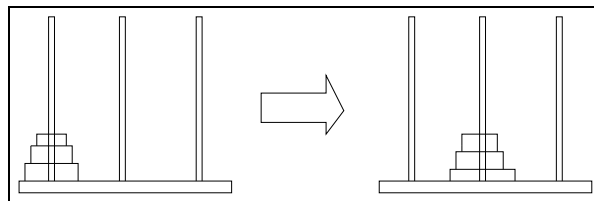


Figure 1: The 3 Ring Towers of Hanoi Problem

(50 points)

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

- What will the average size of an agenda be for a breadth first search in chess at depth 10?
- 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  $d$ .
- Repeat the first part of this question for depth first search.
- Repeat the second part of this question for depth first search.

(30 points)