COS 116
The Computational Universe
Homework 2
Due 3/8/2007

Q1) Why do supermarket chains and drugstores issue "preferred customer" cards?

Q2) Convert 45 from decimal to binary. Convert 110101 from binary to decimal.

Q3) In class we saw how to model things with directed graphs (e.g. Supreme Court decisions, the Internet). Think of two other settings where we can use graphs as a model. State clearly what the nodes and the edges represent, and indicate whether the edges are directed or not.

Q4) Below is the pseudocode for an algorithm. Argue clearly but briefly that this algorithm takes an array A and sorts it. Also, estimate its worst-case running time.

```
Input: array A of length n. Each entry is a number.

Do for i = 1 to n - 1
{

    // note in the inner loop we start at i and go down to 1
    Do for j = i to 1
    {

        if (A[j] > A[j+1])
        {
            // if two things are out of order, swap them
            tmp =A[j]
            A[j] = A[j+1]
            A[j+1] = tmp
        }

    }
}
```

Q5) Legend has it that the inventor of chess was once offered a million grains of sand by the Emperor in recognition of his brilliance. The inventor replied, "Your highness is too generous, all that I ask is that you give me as much as my invention is worth. I ask only one grain of rice for the first square on the chessboard, two for the second square, and so forth with each square receiving double the number of grains of the previous." The Emperor laughed and thought the chess inventor was being humble, so he agreed.

How many grains of rice must the Emperor pay the chess inventor? Estimate roughly how many rooms would be required to hold the rice.

Q6) [Extra Credit] For this question, you will write pseudocode for binary search. The input to the procedure is a *sorted* array of integers *A*. The variable *value* contains some number and the goal of the pseudocode is to determine if *value* is in *A*.

1. First write pseudocode for a simple algorithm that takes something like n steps (compare with all n numbers)
2. Then write the pseudocode that uses binary search and takes at most $c \log n + d$ steps where c, d are small numbers (i.e. they don't depend on n).

To simplify part 2, you may assume that n is a power of 2, that is $n = 2^k$ for some integer k. In particular, this means you may assume that $n / 2$, $n / 4$, $n / 8$, $n / 16$, etc. are all integers, as long as they are larger than 1.