
**CSCE 2211 Fall 2023 Applied Data Structures
Assignment #1**

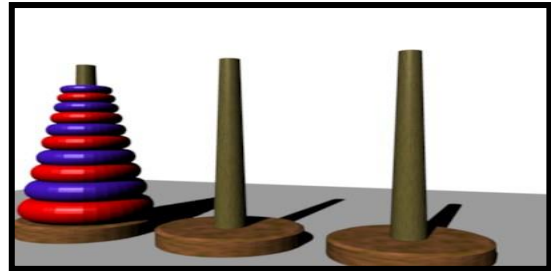
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Date: Thu Sept 7, Due: Thu Sept 14, 2023

Implement the following programs using the Stack ADT:

Problem 1: The Towers of Hanoi

In the Towers of Hanoi game, there are 3 pegs (A, B, C) and N disks with varying sizes that can be stacked on a peg. The objective is to move all the disks from peg (A) to peg (C), probably by using the auxiliary peg (B). At any moment, no larger disk can be placed on top of a smaller one. For example:



- To move one disk from A to C:
Move disk1 from A to C
- To move two disks (top is 1, bottom is 2):
Move 1 from A to B
Move 2 from A to C
Move 1 from B to C
- To move N disks from A to C and we already know how to move N-1 disks from any one peg to another:
 1. Move the top N-1 disks by a series of legal moves from A to B using C. That leaves the largest disk (Disk N) in peg A.
 2. Move Disk N from A to C directly
 3. Move the N-1 disks on peg B by a series of legal moves from B to C using A

Algorithm

This is a recursive problem that can be solved by the following recursive algorithm:

```
Towers (N, Source , Target , Aux)
{
    if (N == 1) move disk 1 from Source to Target directly
    else
    {
        Call Towers to move N-1 disks from Source to Aux via Target
        Move disk N from Source to Target directly
        Call Towers to move N-1 disks from Aux to Target via Source
    }
}
```

An animation of the game is available at:

<http://mathworld.wolfram.com/TowerofHanoi.html>

Since any single disk move is always from or to the top of the peg, it is natural to represent the pegs with their disk contents as stacks of disks.

Required Implementations:

1. Implement an array-based stack template class *Stackt*.
2. Develop a program using the algorithm given above to simulate the Towers of Hanoi game. Number the disks 1,2,3,...,N in ascending order of their size. Using the *Stackt* class, assign a *stack* to each peg to represent its disk content at any moment. Display the stacks to see each move until all disks have been moved from peg A to peg C. For a given N, display the number of moves needed.

The End of the Universe

According to legend, there is a set of 64 gold disks on 3 diamond needles, called the Tower of Brahma. Legend reports that the Universe will end when the task is completed. (Edouard Lucas, *R'ecr'ations Math'ematiques*, Vol. 3, pp 55–59, Gauthier-Villars, Paris, 1893.)

When will the Universe end if one move takes one second?

1,462,581,131,979
year