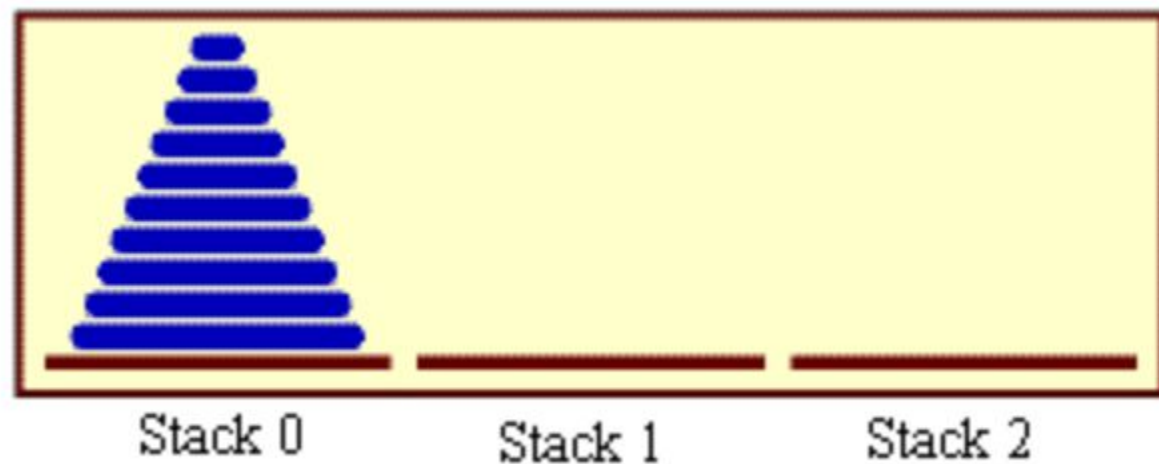


# Recitation 05

The Towers of Hanoi

# The Towers of Hanoi

- This problem is easy to solve with recursion and difficult to solve without it
- Involves a stack of various-sized disks, piled up on a base in order of decreasing size
- The object is to move the stack from one base to another
  - Only one disk can be moved at a time
  - No disk can ever be placed on top of a smaller disk
- There is a third base that can be used as a “spare”



# Lore

On the first day of creation, a group of monks in an isolated tower near Hanoi were given a stack of 64 disks and were assigned the task of moving one disk every day, according to the rules of the problem. On the day that they complete their task of moving all the disks from one stack to another, the universe will come to an end. Don't worry the number of steps required to solve the problem for  $N$  disks is  $2^N - 1$ . It would take the monks 50,000,000,000,000 years!

# Problem

- We want to move ten disks from Stack 0 to Stack 1 (subject to the rules given above)
- Stack 2 can be used as a spare
- Can we reduce this to a smaller problems of the same type?
  - Possibly generalizing the problem a bit to make this possible?

- Let's consider the size of the problem to be the number of disks to be moved.
- If there are  $N$  disks in Stack 0, we eventually need to move the bottom disk from Stack 0 to Stack 1
- Before we can do that, the first  $N-1$  disk must be on Stack 2
  - According to the rules of
- Once we've moved the  $N$ -th disk to Stack 1, we must move the other  $N-1$  disk from stack 2 to Stack 1 to complete the solution
- **Moving  $N-1$  disks is the same type of problem as moving  $N$  disks, except that is a smaller problem (This is our recursive approach!)**

- The problem needs to be generalized a bit to accommodate which stack is being used as the spare (i.e. after we have moved the N-th disk from Stack 0 to Stack 1, we need to move N-1 disks from Stack 2 to Stack 1, using Stack 0 as the spare, etc).

```
public static void towersOfHanoi(int disks, int from, int to, int spare) {  
    //base case(s)  
  
    // recursive case  
}
```

# References

[Javanotes 8.1.3, Section 9.1 -- Recursion](#)