

Recursion

Pasik's Three Rules

- make sure all base cases are identified and implemented properly
- make sure all recursive calls are closer to the base case
- assume all recursive calls return their respective correct results, then combine the results appropriately

```
public static long factorial (int n) {  
    long result = 1;  
    while (n > 1) result *= n--;  
    return result;  
}
```

```

public class ParameterOutOfRangeException extends Exception {
    public ParameterOutOfRangeException (String s) {
        super(s);
    }
}

...

public static long factorial (int n)
    throws ParameterOutOfRangeException {
    if (n < 0 || n > 20)
        throw new ParameterOutOfRangeException("Parameter " +
            n + " is out of range.");
    long result = 1;
    while (n > 1) result *= n--;
    return result;
}

```

```

public static long factorial (int n)
    throws ParameterOutOfRangeException {
    if (n < 0 || n > 20)
        throw new ParameterOutOfRangeException("Parameter " +
            n + " is out of range.");
    if (n == 0) return 1;
    return n * factorial(n - 1);
}

```

```

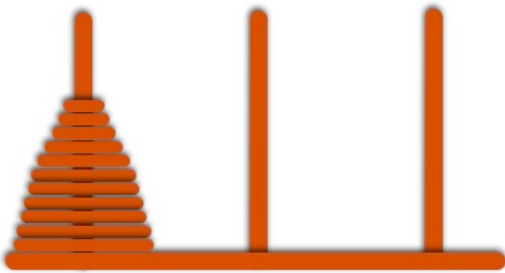
public static long factorial (int n)
    throws ParameterOutOfRangeException {
    if (n < 0 || n > 20)
        throw new ParameterOutOfRangeException("Parameter " +
            n + " is out of range.");
    return (n == 0) ? 1 : n * factorial(n - 1);
}

```

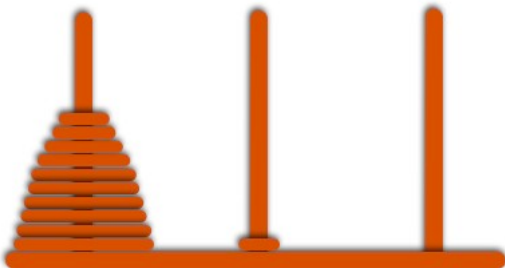
Towers of Hanoi

- monks of hanoi are presented with three poles
- pole one has 64 discs of decreasing size threaded on it
- poles two and three are empty
- their task is to move all the discs onto pole three, only moving one at a time, and never stacking a larger disc on top of a smaller one
- prophecy states that the world will come to an end when they complete their task

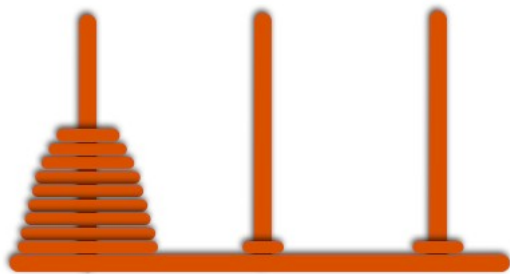
Towers of Hanoi



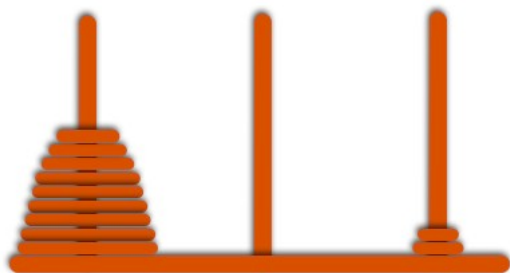
Towers of Hanoi



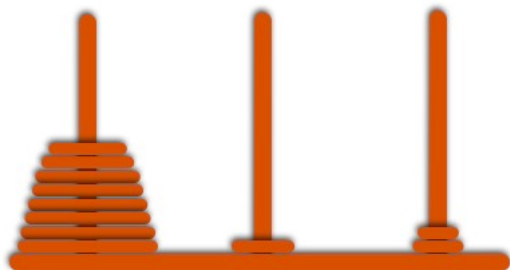
Towers of Hanoi



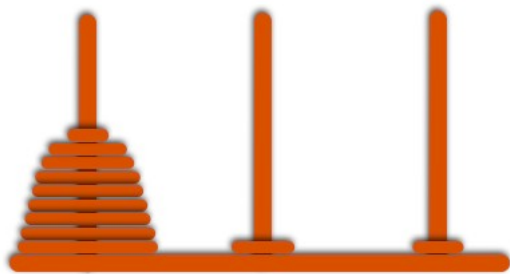
Towers of Hanoi



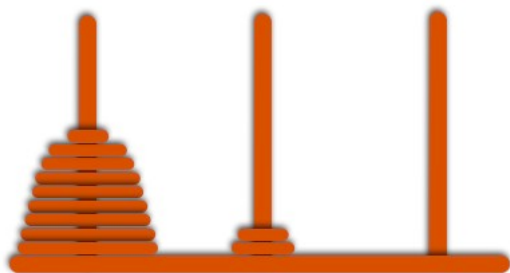
Towers of Hanoi



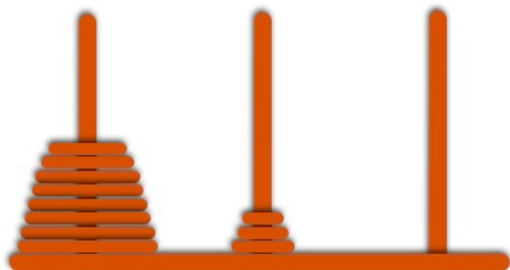
Towers of Hanoi



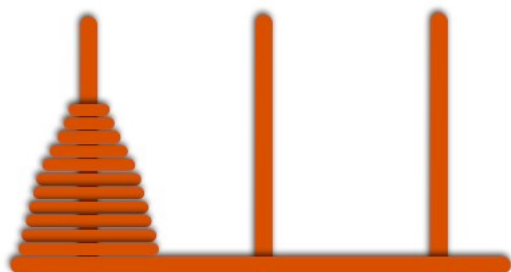
Towers of Hanoi



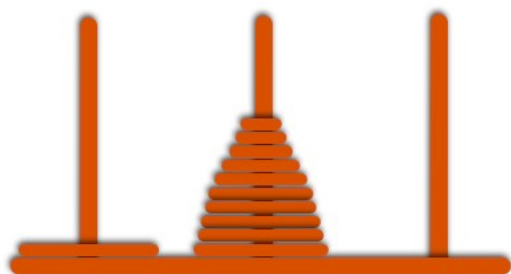
Towers of Hanoi



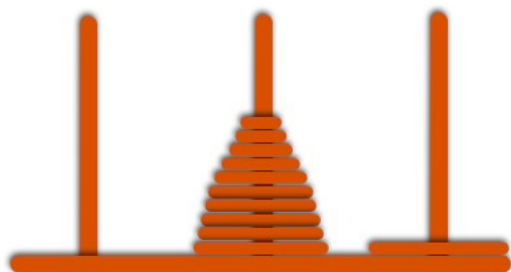
The Recursive View



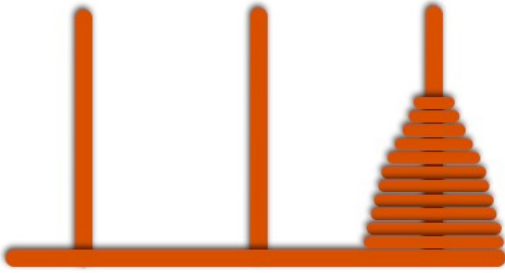
The Recursive View



The Recursive View



The Recursive View



```
public static void hanoi (int discs) {
    genHanoiInstructions(discs, "one", "three", "two");
}

private static void genHanoiInstructions
    (int discs, String from, String to, String other) {
    if (discs != 0) {
        genHanoiInstructions(discs - 1, from, other, to);
        IO.stdout.println("Move disc " + discs +
            " from pole " + from +
            " to pole " + to);
        genHanoiInstructions(discs - 1, other, to, from);
    }
}
```