


Programming Lab 6D

Towers of Hanoi

Topics: Recursion, passing parameters, function return values, nested functions, preserving and restoring registers across function calls, calling C functions from assembly.

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Lab6D-Main.c

Prerequisite Reading: Chapters 1-6

Revised: January 22, 2021

Background¹: The Tower of Hanoi is a mathematical game or puzzle invented by the French mathematician Édouard Lucas in 1883. It consists of three rods and a number of disks of different sizes, which can slide onto any rod. The puzzle starts with the disks in a neat stack in ascending order of size on one rod, the smallest at the top, thus making a conical shape. The objective of the puzzle is to move the entire stack to another rod, obeying the following simple rules:

1. Only one disk can be moved at a time.
2. Each move consists of taking the upper disk from one of the stacks and placing it on top of another stack or on an empty rod.
3. No larger disk may be placed on top of a smaller disk.

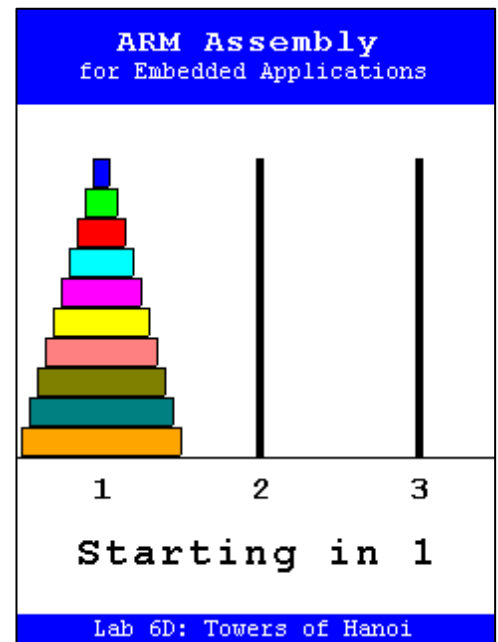
With 3 disks, the puzzle can be solved in 7 moves. The minimal number of moves required to solve a Tower of Hanoi puzzle is $2^n - 1$, where n is the number of disks.

Mythology: There is a story about an Indian temple in Kashi Vishwanath which contains a large room with three time-worn posts in it, surrounded by 64 golden disks. Brahmin priests, acting out the command of an ancient prophecy, have been moving these disks in accordance with the immutable rules of Brahma since that time. According to the legend, when the last move of the puzzle is completed, the world will end. If the legend were true, and if the priests were able to move disks at a rate of one per second, using the smallest number of moves it would take them $2^{64} - 1$ seconds or roughly 585 billion years to finish, which is about 42 times the current age of the Universe.

Assignment: The main program will compile and run without writing any assembly. However, your task is to create an equivalent replacement in assembly language for the following function found in the C main program. The original C version has been defined as “weak” so that the linker will automatically replace it in the executable image by the one you create in assembly; you do not need to remove the C version. Function `Move1Disk` is provided in the main program; do not recreate it in assembly – just call it from assembly.

```
void Hanoi(int num, int fm, int to, int aux) ;
{
    if (num > 1) Hanoi(num - 1, fm, aux, to) ;
    Move1Disk(fm, to) ;
    if (num > 1) Hanoi(num - 1, aux, to, fm) ;
}
```

Test your function using the main program. If you code works correctly, the display should look like the image on the right. The program starts automatically, but you may press the blue pushbutton at any time to single step through the solution. Hopefully it won't take you 585 billion years!



¹ Adapted from https://en.wikipedia.org/wiki/Tower_of_Hanoi