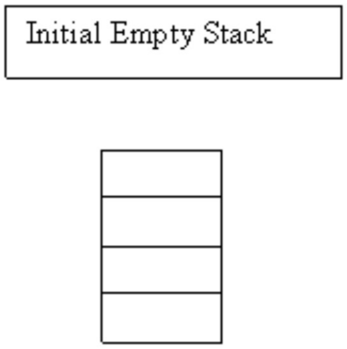
Recursion

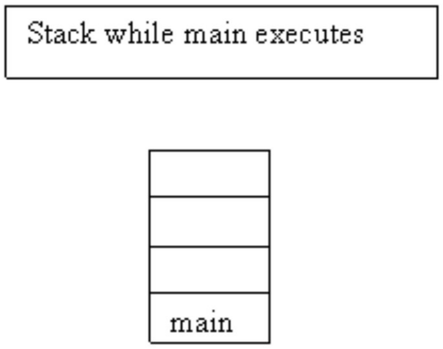
When I first encountered recursion I thought: “This is simple, a function that calls itself.” Naturally, I was soon confused and wondering what hit me - I had a new appreciation of the difficulties inherent in recursive processes.

Over the years I mastered recursion and then had to teach it. I did not realize at first that I had a mental image that the students did not have. That image, which TOTALLY explains recursion, is the function as it resides on the program stack.

Let me explain the program stack and then show how that applies to recursion...

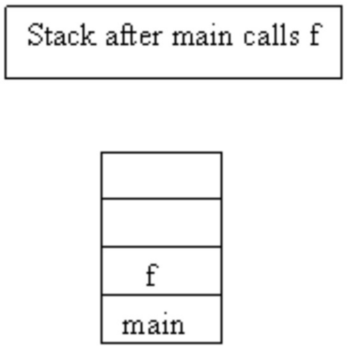
Every executable’s main is loaded into a program stack at the beginning of execution. It remains there until it completes, at which time it is popped off of the stack.

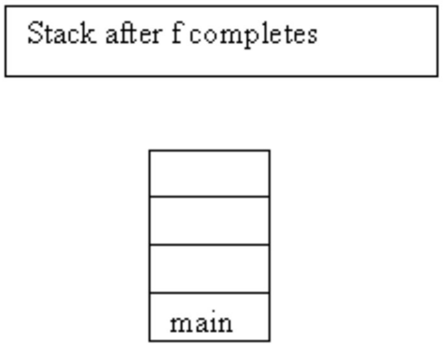




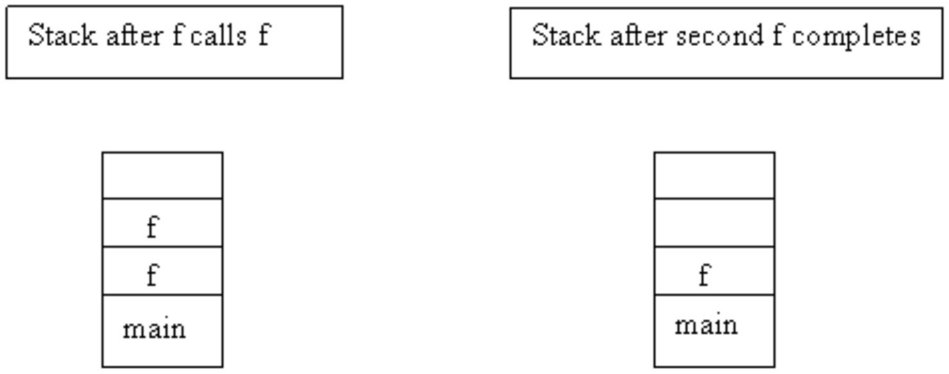
I will not go into all the details of what is in the stack as this will just cloud the discussion.

If main calls a function, that function is loaded onto the top of the stack and remains there until it is complete at which point it is popped off of the stack.





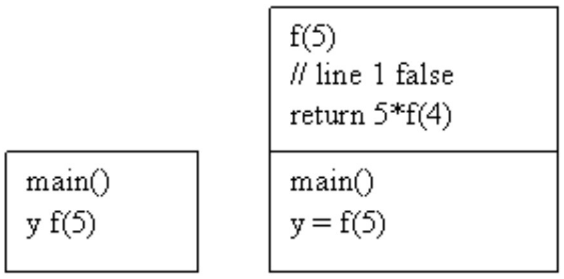
Now, a recursive function calls itself. That means another instance of the function will be placed on the stack and will remain there until the function completes.



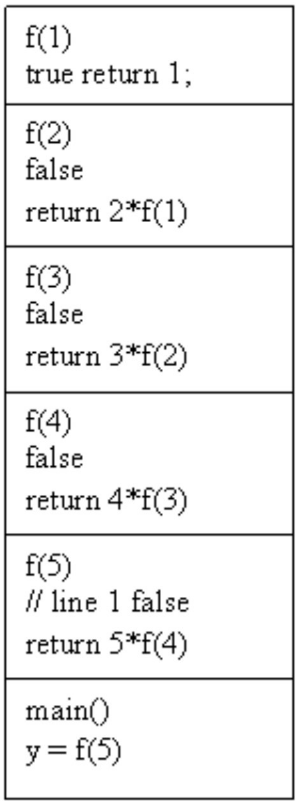
You need to look at a recursive function in terms of the program stack. Lets use factorial as an example. 5 factorial is 5x4x3x2x1 = 120 and this can be implemented recursively.

```
int f(int x){

   if(x == 1) return 1;// line 1

   return f(x-1)*x;    // line 2

}

void main(){

   int y = f(5);// main call

   // y should get 120

}
```

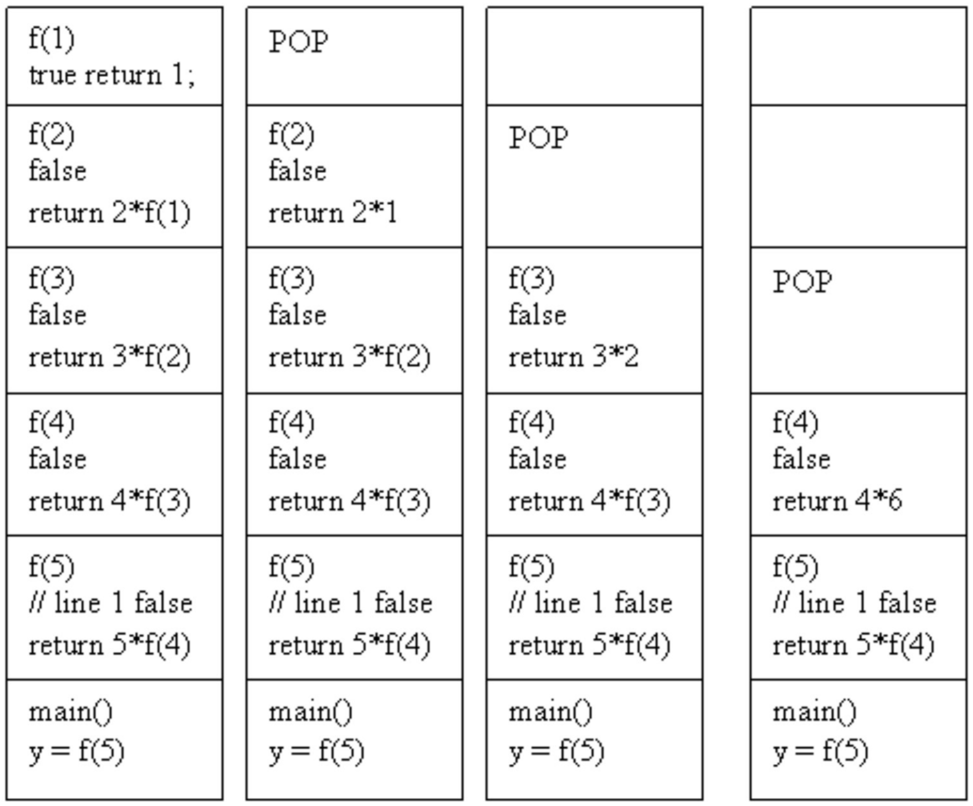
So lets watch the stack and see what happens.

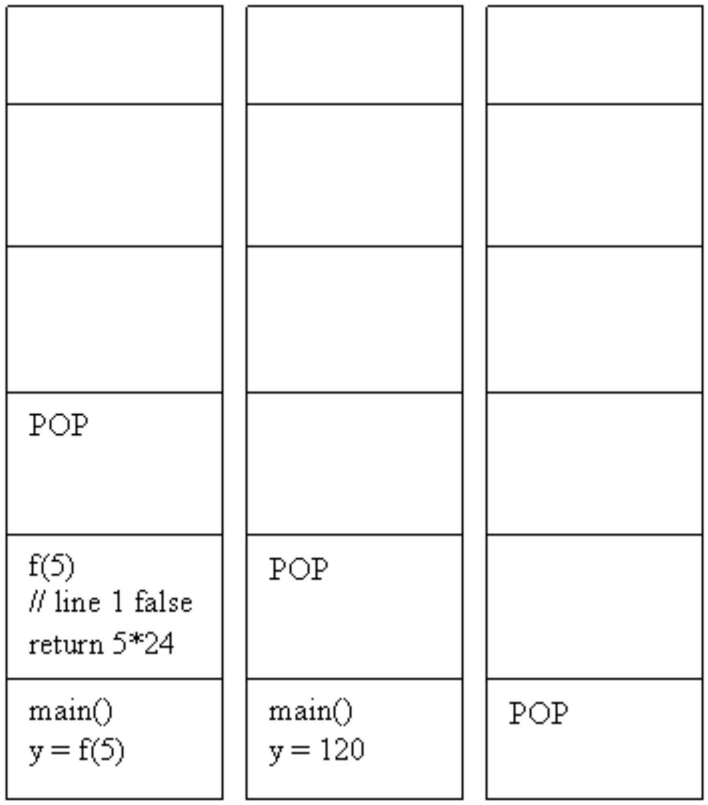


main calls the function f with a value of 5, so on the stack we get f(5). Line 1 is false so we go to line 2 which calls f(4), etc. Note that f(4) must complete before f(5) can complete. f(5) will complete by returning 5*f(4). The stack will look like:



So at this point none of the functions have yet returned! The first to return will be f(1) which will return 1. Then f(2) will return 2. Then f(3) will return 6. As in:





You can think of even the most complex recursive functions in terms of the program stack and you will then totally understand exactly what is going on in your program.

Admittedly, The more complex the function the more book keeping you will have to do.