Functions and the stack

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Overview

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Anatomy of a program in memory

Code / Static Data	Where the code to be executed and other static data (think global variables, things explicitly tagged with the static keyword, etc.) are stored; lifetime of static data objects: throughout program execution
Heap / Free Store	The dynamic memory area, where dynamic objects created are stored; lifetime of heap objects: until explicitly deleted or when the program terminates
	In classical architectures, the stack and heap grow towards one another
Stack	Stores local variables, manages function calls; extensively involved in performing computations; lifetime of 'automatic' objects: persistent until the end of the block that declared them

*** Note: This is a simplified model*

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  - Any necessary house-keeping information (such as return location)
  - The actual arguments passed to the function
  - The local variables defined in that function
- When the function returns to its callee, its `activation record` is `popped` (removed) from the stack

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- This is why local variables are known as `automatic variables`: their memory is managed automatically by the function call mechanism

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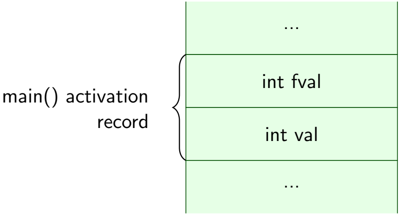
Simplified example

- When you run your program, an `activation record` for `main` is pushed for the stack

```
int main()
{
    cout << "Number:  ";
    int val;
    cin >> val;
    int fval = fact(val);

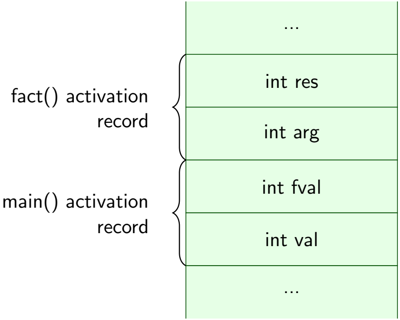
    return 0;
}
```



Simplified example

- When our factorial function `fact` (`int fact(int val)`) is called, an activation record for it is pushed (added) to the stack

```
int fact(int val)
{
    int res = 1;
    while(val > 1) {
        res *= val;
        val -= 1;
    }
    return res;
}
```



Simplified example

- When our factorial function (`int fact(int val)`) has finished executing, its activation record is popped (removed) from the stack

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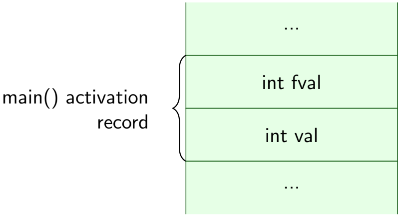
{
    cout << "Number:  ";
    int val;
    cin >> val;
    int fval = fact(val);

    return 0;
}
```



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- The code defining each function (including main) is stored in the `code/static` region of your program's address space
- Calling a respective function retrieves the instructions from this region of memory for execution
- Meanwhile, the stack will maintain the following in its activation record:
  - Any necessary house-keeping information (such as return location)
  - Any arguments passed to the function
  - Any local variables variables that are declared in the function body

Overview

References

- Lippman, B., Lajoie, Josee, & Moo, B. E. (2016). *C++ primer* (5th ed.). Addison-Wesley.
- Stroustrup, B. (2014). *Programming: principles and practice using C++* (2nd ed.). Addison-Wesley.