Stack

Topics

1) How does the computer actually handle..
   a) Calling a function?
   b) Passing arguments?
   c) Returning a value?

Motivation

```
#include <iostream>
using namespace std;

int foo(int a, char b, float c) {
        int ans = a + b + c;
        return ans;
}

int main() {
        int x = 1;
        char y = 'A';
        x = foo(x, y, 3.14);
        return 0;
}
```

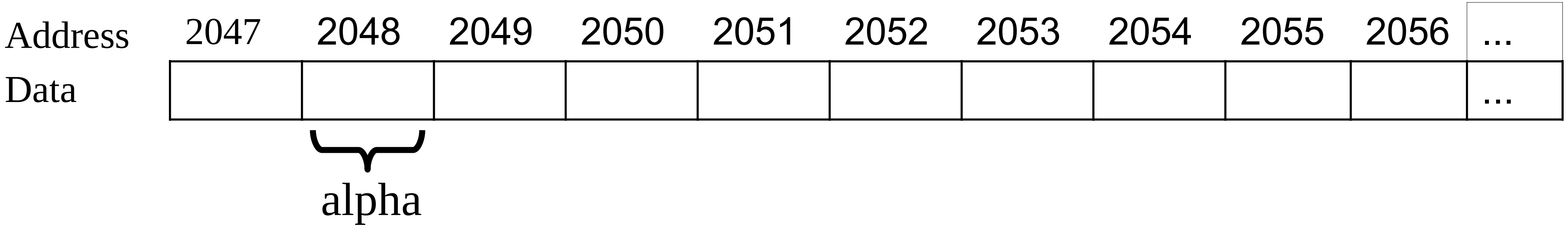
- How does this program:
  - Pass arguments to foo()?
  - Pass the return value back to main() from foo()?
  - Allocate local variables?
- Answer:..

Basics

- Computer's main memory is RAM:
  - Able to access any byte in memory..
- Each byte in memory has an address
- Each running program is given memory for:
  - Storing code (instructions)
    Code usually loaded by OS from disk.
  - Storing data (variables)
    Variables are..

Simple view of Memory

- Imagine memory as a very long row of bytes.



Address	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	...
Data											...

- Declaring a variable..
  - Simplified idea: Variables declared sequentially in memory.
  - Find size of beta:..
  - Find location of beta:..

```
int main()  {
        char alpha = 'a';           // 1 byte
        int beta = 2;               // 4 bytes
        float gamma = 3.0;      // 4 bytes
}
```

& is the..

operator

Stack Memory

- Memory can be view as a stack: Start at the..
- New variables allocated on top..
- Remove destroyed variables from top..

```
int main()  {
        char alpha = 'a';          // 1 byte
        int beta = 2;              // 4 bytes
        float gamma = 3.0;      // 4 bytes
}
```

End top of stack → 4186

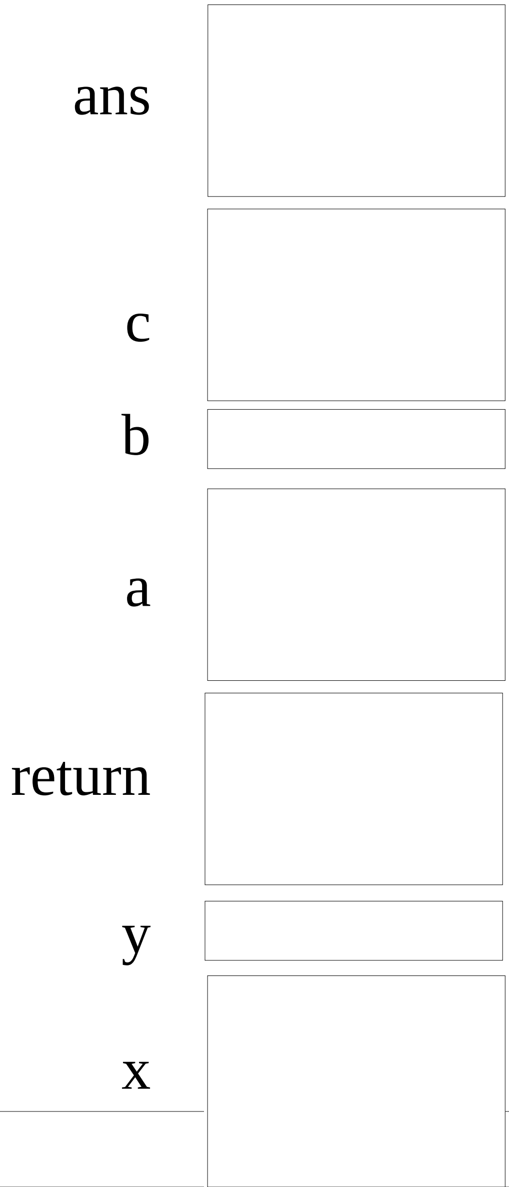
Initial top of stack → 4195

Address	Data
4185	
4186	
4187	
4188	
4189	
4190	
4191	
4192	
4193	
4194	
4195	

Function Calls

- Calling a function allocates a stack frame for the function:
  - ..
  - ..
  - ..

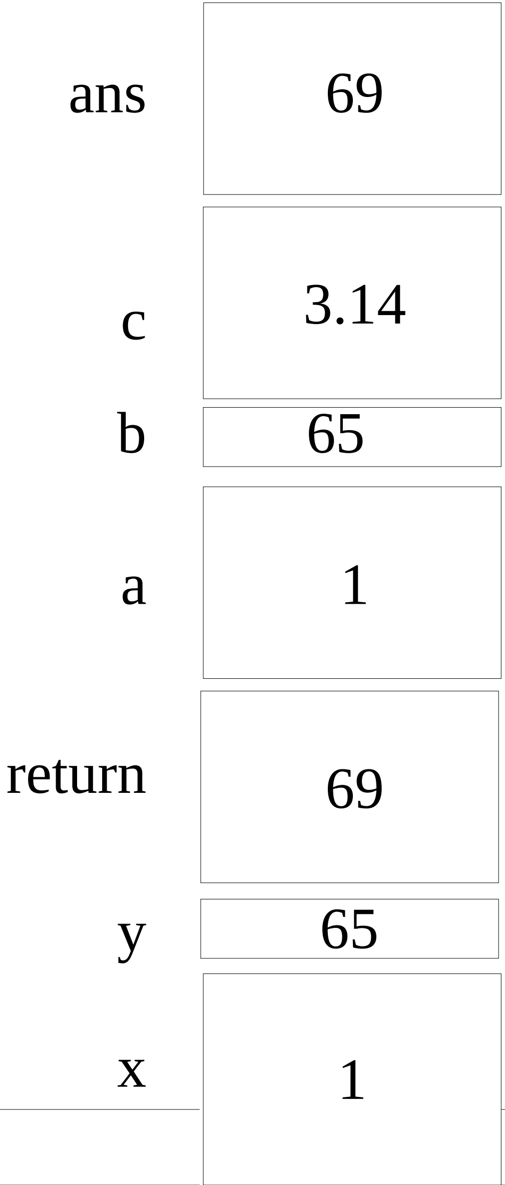
```
int foo(int a, char b, float c) {
        int ans = a + b + c;
        return ans;
}

int main() {
        int x = 1;
        char y = 'A';
        x = foo(x, y, 3.14);
        ...
```



Function Execution

- Argument values..
- Function does work.
- Return value..
- Return value handled by calling code.

```
int foo(int a, char b, float c) {
        int ans = a + b + c;
        return ans;
}
int main() {
        int x = 1;
        char y = 'A';
        x = foo(x, y, 3.14);
        ...
```

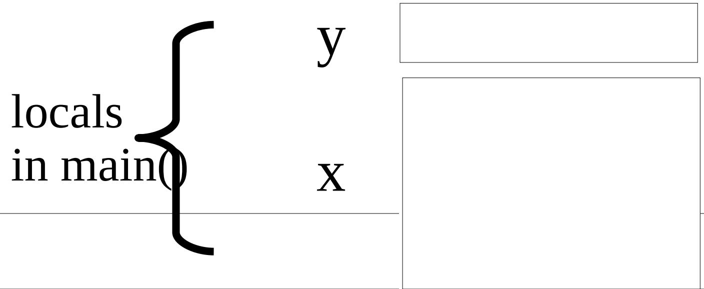


ans	69
c	3.14
b	65
a	1
return	69
y	65
x	1

Function Completion

- When foo() finishes, ..
- Memory reused by the next function call.

```
int foo(int a, char b, float c) {
      int ans = a + b + c;
      return ans;
}

int main() {
      int x = 1;
      char y = 'A';
      x = foo(x, y, 3.14);
      ...
```



Stack Growth and Reuse

- Stack grows when one function calls another
  - Once on the stack, a variable is a fixed size.
  - (Trying to grow its size would grow the whole stack!)
- If main() calls foo() (which exits) then bar(); bar()..
  - foo()'s stack frame has been popped
  - bar()'s stack frame starts at same location

Review

- What is found in a function's stack frame?

- Explain the terms push and pop

- What will happen when executing bar()?

```
int bar() {
      return bar() + 1;
}
```

Summary

- Stack used to store Stack Frames:
  - arguments, return value, and local variables.
- Entering a function pushes a stack frame, leaving pops it.
  - Stack space reused for next function call.