CSC 211: Object Oriented Programming

Scope, Parameter passing, Call stack

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Scope of Variables, Passing Parameters

Scope (where is a variable visible?)

- **Local** variables
  - local to a function, cannot be used outside the function
- **Global** variables
  - available to all functions in the same program
  - declared outside any function
  - not recommended, make programs difficult to maintain
- **Global** constants
  - same as global variables, but require the `const` type qualifier

A Global Named Constant (*part 1 of 2*)

```
//Computes the area of a circle and the volume of a sphere.
//Uses the same radius for both calculations.
#include <iostream>
#include <cmath>
using namespace std;

const double PI = 3.14159;

double area(double radius);
//Returns the area of a circle with the specified radius.

double volume(double radius);
//Returns the volume of a sphere with the specified radius.

int main()
{
    double radius_of_both, area_of_circle, volume_of_sphere;

    cout << "Enter a radius to use for both a circle\n"
         << "and a sphere (in inches): ";
    cin >> radius_of_both;

    area_of_circle = area(radius_of_both);
    volume_of_sphere = volume(radius_of_both);

    cout << "Radius = " << radius_of_both << " inches\n"
         << "Area of circle = " << area_of_circle
         << " square inches\n"
         << "Volume of sphere = " << volume_of_sphere
         << " cubic inches\n";

    return 0;
}
```

A Global Named Constant (*part 2 of 2*)

```
double area(double radius)
{
    return (PI * pow(radius, 2));
}

double volume(double radius)
{
    return ((4.0/3.0) * PI * pow(radius, 3));
}
```

Sample Dialogue

```
Enter a radius to use for both a circle
and a sphere (in inches): 2
Radius = 2 inches
Area of circle = 12.5664 square inches
Volume of sphere = 33.5103 cubic inches
```

from: Problem Solving with C++, 10th Edition, Walter Savitch

Block Scope Revisited

```
1   #include <iostream>
2   using namespace std;
3
4   const double GLOBAL_CONST = 1.0;
5
6   int function1 (int param);
7
8   int main()
9   {
10      int x;
11      double d = GLOBAL_CONST;
12
13      for (int i = 0; i < 10; i++)
14      {
15          x = function1(i);
16      }
17      return 0;
18  }
19
20  int function1 (int param)
21  {
22      double y = GLOBAL_CONST;
23      ...
24      return 0;
25  }
```

Local and Global scope are examples of Block scope. A variable can be directly accessed only within its scope.

*Block scope: Variable **i** has scope from lines 13-16*

*Local scope to **main:** Variable **x** has scope from lines 10-18 and variable **d** has scope from lines 11-18*

*Global scope: The constant **GLOBAL_CONST** has scope from lines 4-25 and the function **function1** has scope from lines 6-25*

*Local scope to **function1:** Variable **param** has scope from lines 20-25 and variable **y** has scope from lines 22-25*

from: Problem Solving with C++, 10th Edition, Walter Savitch

Passing parameters (pass by value)

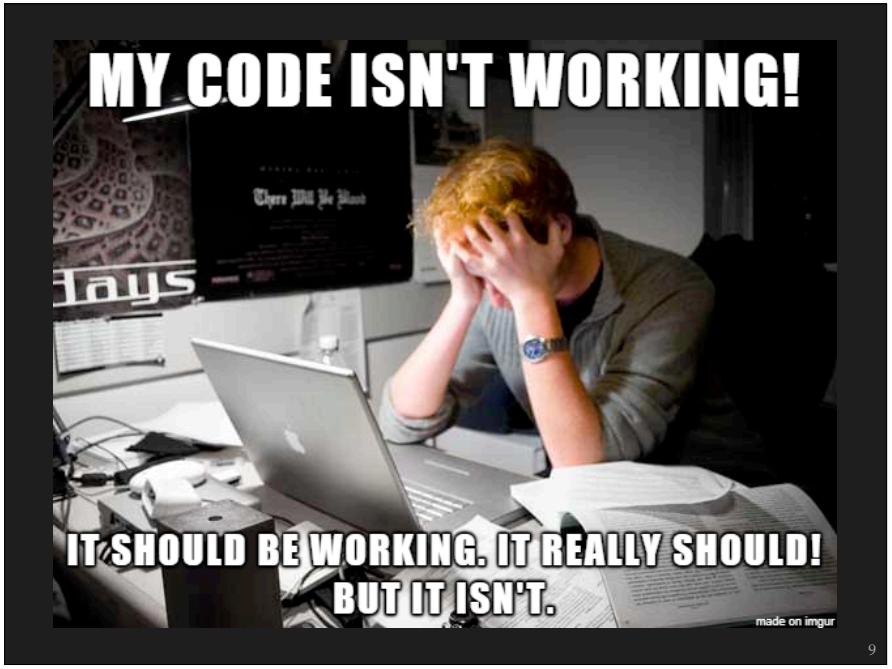
- Parameters are actually **local variables** to the function
- The **pass by value** mechanism (default method)
  - parameters are initialized to the values of the arguments in the function call
  - when invoking a function call, **arguments are copied into the parameters** of a function

Lets try a swap function …

```
void swap (int x, int y) {
    int temp;

    temp = x;
    x = y;
    y = temp;

    return;
}
```


What is the output?

```
#include <iostream>

void swap (int x, int y);

int main () {
    int x = 100;
    int y = 200;

    std::cout << "Value of x :" << x << '\n';
    std::cout << "Value of y :" << y << '\n';

    swap(x, y);

    std::cout << "Value of x :" << x << '\n';
    std::cout << "Value of y :" << y << '\n';

    return 0;
}
```



An **Integrated Development Environment** (IDE) usually provides a built-in **debugger**

References

- A **reference** is an alias for another variable
  - just another name for the same memory location

```
int main() {
    int val1 = 1, val2 = 5;
    int &ref = val1;

    val1 += 1;
    ref += 1;
    ref = val2;
    ref *= 2;

    return 0;
}
```

&

Pass by reference

- You can pass arguments to functions **by reference**
- Modifying the reference parameter modifies the actual argument!

```
void swap (int& x, int& y) {
    int temp;

    temp = x;
    x = y;
    y = temp;

    return;
}
```

What is the output

```
#include <iostream>

void mystery(int& b, int c, int& a) {
    a ++;
    b --;
    c += a;
}

int main() {
    int a = 5;
    int b = 10;
    int c = 15;

    mystery(c, a, b);
    std::cout << a << ' ' << b << ' ' << c << '\n';

    return 0;
}
```

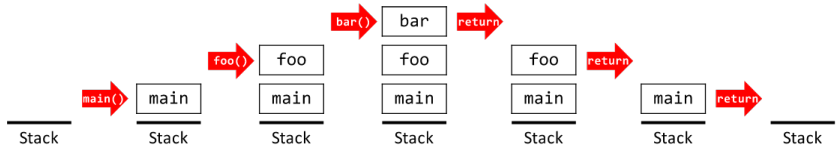

The call stack

Function calls and the call stack

- Variables are stored at different locations in memory
- In practice, it is well more structured …
  - **stack-based memory management** is used by many language implementations
- Program execution needs a **call stack** to deal with functions
  - a **stack frame** stores data for a function call, essentially local variables

Stack frames

```
void bar() {
}

void foo() {
    bar();
}

int main() {
    foo();
}
```



https://eecs280staff.github.io/notes/02_ProceduralAbstraction_Testing.html

Stack frames (detailed view)

```
#include <iostream>

int plus_one(int x) {
    return x + 1;
}

int plus_two(int x) {
    return plus_one(x + 1);
}

int main() {
    int result = 0;
    result = plus_one(0);
    result = plus_two(result);
    std::cout << result;
}
```

https://eecs280staff.github.io/notes/02_ProceduralAbstraction_Testing.html

Additional remarks on functions

Preconditions and Postconditions

from: Problem Solving with C++, 10th Edition, Walter Savitch

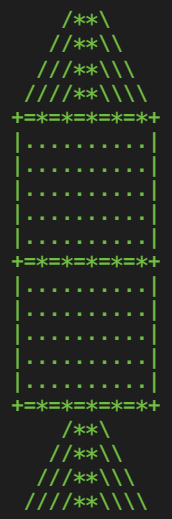
Testing and Debugging

- Each function must be tested as a separate an independent unit
- Once properly tested, the function then can be used in the program

Functions must be tested in environments where every other function has already been fully tested and debugged

Example - Ascii Art

Decomposition - dealing with complexity



Handling multiple scales