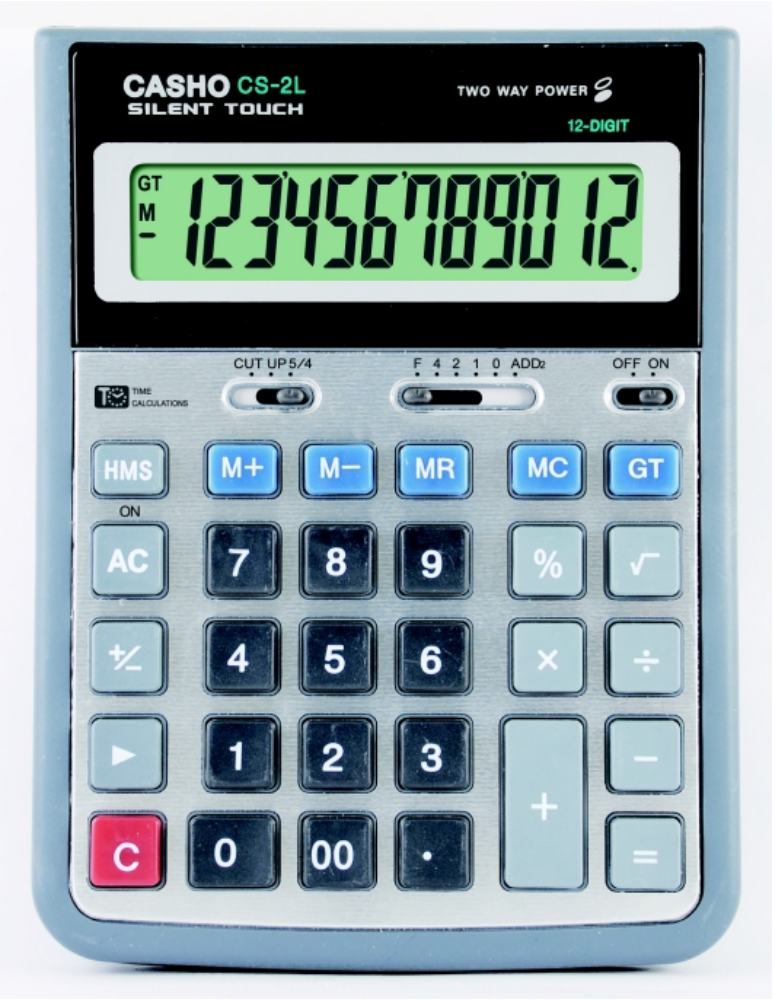
Class 3

What is a function?

- Functions are like the buttons on a calculator.
- What are some of the functions of a calculator?
- The actual code that the function executes is in its own separate spot—then, you call it by name (kind of like a button!) in your program when you want to use it.




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

//function declaration (prototype)
void printHello();

int main(int argc, const char * argv[])
{
     //function call
    printHello();

    return 0;
}

//function definition
void printHello(){ //←function header
    //function body
    cout << "Hi there Nina!";
    return;
}
```

```
Hi there Nina!
```

- This small program demonstrates a simple function called printHello().
- Good function are simple, concise and have clear names.
- When the function is called in main, the program jumps to the code within the function body below and runs it.
- Once the function is done running, the program jumps back to main and continues.

Functions are a form of *abstraction.*

Abstraction means that you don't need to understand how everything works "under the hood" in order to interact with a system.

```
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int main(int argc, const char * argv[])
{
    //function call
    printHello();

    return 0;
}

//function definition
void printHello(){ //←function header
    //function body
    cout << "Hi there Nina!";
    return;
}
```

```
Hi there Nina!
```

Building a function:

1. Declare your function outside of any other functions or brackets using a prototype*.
   *It's actually optional, but definitely recommended.
   - Syntax:
     returnType functionName(parameters);

2. Define your function.
   - What does your function do?

   Syntax:

returnTypefunctionName(parameterType parameterName){
        Block of code to execute.
        return;
    }

1. Where do you want to use your function?
   - I want this greeting to print when I run my program, so I call printHello() in main.

- When do you think functions will be useful to you?
- Can you think of any functions you might want to write?
- What is the simplest way you can think of to describe what functions do?

Why should I use functions? Are they versatile?

Functions are amazing!

1. They boil down complex instructions into one function call, like a button.

    - This is great when you need to do one task many times.

1. You can feed them data to work with by using parameters and arguments.

    - You have seen this with length(string), which counts the number of characters in the string you specify between the parenthesis.

1. They can spit data back out at you by using return statements.

    - length(string) returns the number of characters in a string.

Parameters

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

//function declaration (prototype)
void printName(string);

int main(int argc, const char * argv[])
{
    string nameInput;

    cout << "Enter your name:\n";
    cin >> nameInput;

    //function call
    printName(nameInput);

    return 0;
}

//function definition
void printName(string n){ //function header
    //function body
    cout << "Hi there " + n + "!\n";
    return;
}
```

- Functions are able to use values from the outside by defining *parameters (highlighted)*.
- Parameters live in the parenthesis following a function's name.
- You pass *arguments* to functions according to the parameter's data type.
- The function makes a copy of the value you pass to it in order to use it.

```
Enter your name:
Emmett
Hi there Emmett!
```

Parameters

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

//function declaration (prototype)
void printName(string);

int main(int argc, const char * argv[])
{
    string nameInput;

    cout << "Enter your name:\n";
    cin >> nameInput;

    //function call
    printName(nameInput);

    return 0;
}

//function definition
void printName(string n){ //function header
    //function body
    cout << "Hi there " + n + "!\n";
    return;
}
```

- printName() has a string parameter.
- printName() accepts nameInput because it is a string, which matches the parameter type.
- nameInput is an *argument passed by value* into printName() as n.
- To pass by value means that nameInput was copied and assigned to n.

```
Enter your name:
Emmett
Hi there Emmett!
```

Newspaper content is passed to a printer, just like a function parameter!

So...what happens to all of those parameter variables that were passed by value?

I hope you didn't get too attached to that string n we passed to printName(), because...

What lives in a function, dies in a function.

Don't worry—those variables aren't just lying all over the place.

When a function ends, all of the variables declared within it are cleared from memory.

Return Values

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

//function declaration (prototype)
int playerStrength(int);

int main(int argc, const char * argv[])
{
    int age;

    cout << "How old are you?\n";
    cin >> age;

    cout << "\nWow, you can carry\n";
    //function call
    cout << playerStrength(age) << " items!\n";

    return 0;
}

//function definition
int playerStrength(int n){
    n *= 5;
    return n; //return value
}
```

- The *return* statement allows a function to send data back when it is called.
- You need to specify your return type before the function name in both the prototype and function header.
- Of course, the actual return value's data type must also match.
- playerStrength() returns an int value.
- It takes the player's age input, multiplies it by 5 and returns the new value.

```
How old are you?
69
Wow, you can carry
345 items!
```

Return Values

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

//function declaration (prototype)
void printHello();

int main(int argc, const char * argv[])
{
     //function call
    printHello();

    return 0;
}

//function definition
void printHello(){ //←function header
    //function body
    cout << "Hi there Nina!";
    return;
}
```

```
Hi there Nina!
```

Two important notes about return values:

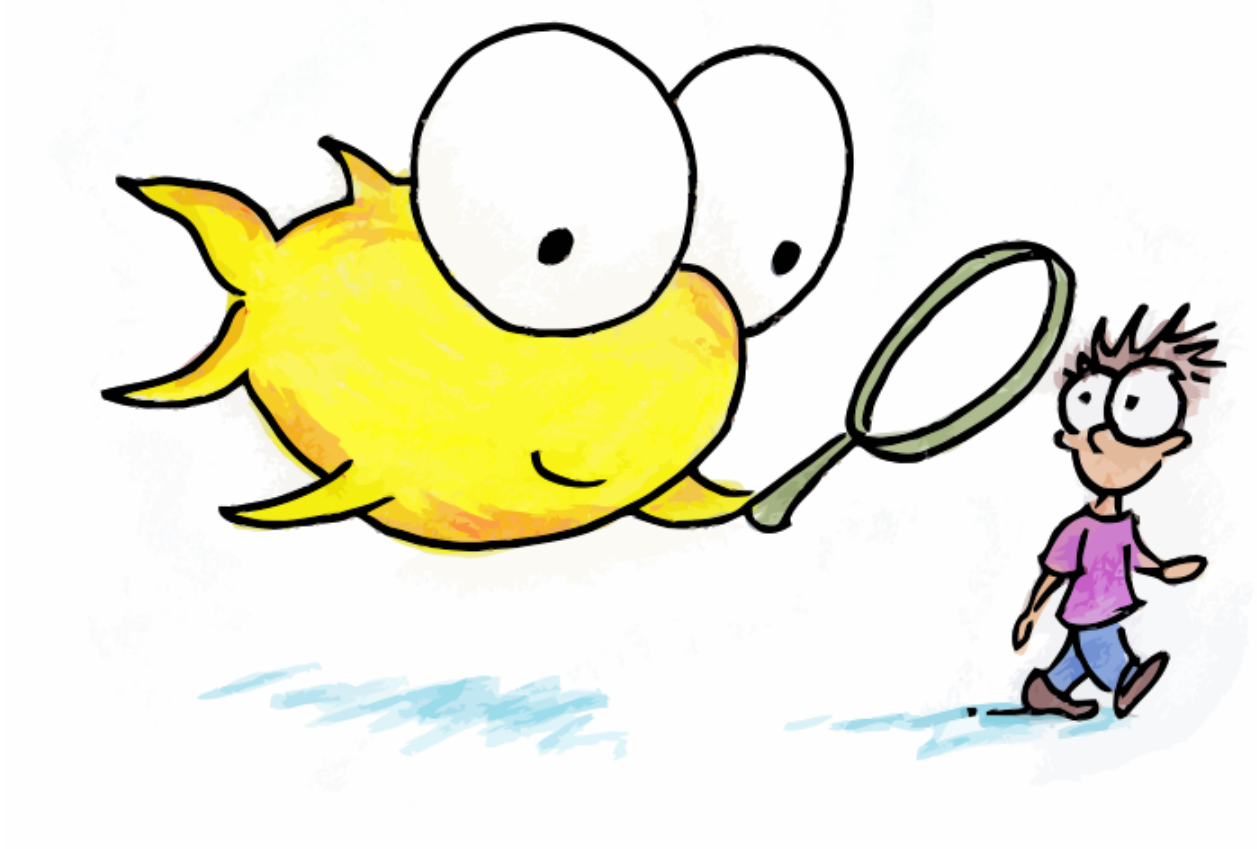
1. The return statement is a stop sign for the function.
2. You don't have to return any data, but you do need to have a return statement.
3. To stop a function without a return type, you just use:
   return;
4. This is the old printHello() example, which is a function that returns "void," aka, no values.

Does anyone want to write a function that will add two numbers together and return the sum?

1. Prompt user to enter one number.
2. Prompt user to enter a second number.
3. Output the sum of the two numbers by passing those two values into a function.

Hint: The return type will be an int!

So what's all this fuss about parameters and return values—why can't my program just see ALL of my code?



Well... do you remember abstraction? You don't need to know what makes a laptop tick, because you can interact with it via UI, a keyboard, a screen, etc.

"Abstraction saves you from worrying about the details, while encapsulation hides the details from you" (p160).

- *Encapsulation* dictates that data is only visible within the *scope* (aka any set of curly brackets) that it lives in.
- Think about encapsulation in terms of bundling—each object is a separate bundle of instructions that are wrapped up and hidden from the user.
- Functions need return values and parameters so that the user can interact with a program without having to worry about each line of code required to execute a task.


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

void my_scope();

// visible everywhere
string glob = "I'm everywhere";

int main(){
    string greeting = "I live in main";
    cout << greeting << endl;
    cout << glob << endl;

    my_scope();

    return 0;
}

void my_scope(){
    // same name, different variable
    string greeting = "I live in my_scope";
    cout << greeting << endl;
    cout << glob << endl;
}
```

```
I live in main
I'm everywhere
I live in my_scope
I'm everywhere
```

Scopes

- Scopes control visibility within your program—they're the locked doors through which only parameters, return values and *global variables* can move.
- Local Variables: Defined within a scope and only visible to that scope.
- Global Variables: Defined outside of all scopes, and thus visible to all scopes.
- Scopes can also be nested: if a function asks for a variable and it can't be found within the functions scope, that function will travel up through its parent scopes until it finds the variable.

You might be wondering,
what about those functions that seem to take multiple types?

Like to_string()?

to_string() takes ints, floats and even doubles!

But how...

You can by overloading functions!

You overload a function by:

- Defining and declaring multiple functions of the same name.
- The catch is that each time, you use a different set of parameters.
- When you call the function, your program checks the arguments passed in against the sets of parameters in order to determine which function to use. This is what makes overloading functions possible.

Overloading Functions

```
int score(int);
int score(int, int);

int main()
{
    score(3);
    score(3,5);

    return 0;
}

int score(int n){
    cout << "int function\n";
    return 0;
}

int score(int f, int i){
    cout << "int function, 2 parameters\n";
    return 0;
}
```

```
int function
int function, 2 parameters
```

- score() is defined and declared twice, but with different different parameters.
- Note that return value can be the same, or different.
- Only the parameters need to be different.

It sounds like functions can do it all, right? But at what cost?

You might not be thinking much about memory yet, but once you start making functions that transform 3D objects, you'll be cutting every corner to make your program runs as fast as possible.

Inlining Functions

- When you call an inlined function, it doesn't actually do the normal function call.
- The program makes a copy of the function in place of the call instead of jumping to the original function body.
- They're most useful for reducing overhead when calling tiny functions, such as functions that return a value using only a few lines of code.

```
int main()
{
    Hello();
    return 0;
}

inline void Hello(){
    cout << "Hello!\n";
    return;
}
```

```
Hello!
```

What if I want to make a function that can change a variable outside of its scope?


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

void multiplyReference(int&);

int main()
{
    //define and declare the variable j
    //and the reference i to the variable j
    int j = 1;
    int& i = j;

    //print what i references (j)
    //pass that reference into the function
    //and print the output (what i references
                                    times 10)
    cout << i << "\n";
    multiplyReference(i);
    cout << i << "\n";

    return 0;
}

void multiplyReference(int& i){
    i *= 10;
}
```

```
1
10
```

References

- A reference basically acts as a nickname for another variable.
- In this program, i is a reference to j. Anything done to i also happens to j.
- In other words, both a reference and its assigned variable access the same spot in memory.
- A reference does not actually hold any value, it can only refer to another variable.


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

void multiplyReference(int&);

int main()
{
    //define and declare the variable j
    //and the reference i to the variable j
    int j = 1;
    int& i = j;

    //print what i references (j)
    //pass that reference into the function
    //and print the output (what i references
                                    times 10)
    cout << i << "\n";
    multiplyReference(i);
    cout << i << "\n";

    return 0;
}

void multiplyReference(int& i){
    i *= 10;
}
```

References

- You CANNOT assign literal values to references. A reference can only be instantiated to an existing variable.
- When declaring, you must assign a variable immediately or it won't compile.
- Reference syntax:

typeName& variableName =variable

- Pass by Reference: Using a reference to change a value from within a function.

```
1
10
```


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

int multiplyReference(const int&);

int main()
{
    //define and declare the variable j
    //and the const reference i to the variable j
    int j = 1;
    const int& i = j;

    //print what i references (j)
    //pass that reference into the function
    //and print the output (what i references
                                    times 10)
    cout << i << endl;
    cout << multiplyReference(i) << endl;

    return 0;
}

int multiplyReference(const int& i){
    return i * 10;
}
```

Const References

- Sometimes, you want to pass by reference to avoid making copies of huge objects, but you don't want the object to be altered.
- Remember constants? You can use a const reference.
- When you pass a const reference to a function, that reference is protected and unalterable.

```
1
10
```

Side Note: main(int argc, char *argv[])....??

- *main* looks like a function, but what are these two parameters? In other words, who's calling *main*?
- The parameterss hold data that can be passed in at the start of execution (when you hit Run in Xcode)

- argc: argument count
- argv: argument values
- Most commonly used when running code outside of Xcode (by using... the terminal D:)
- Example of providing arguments to main() via terminal:
- You can specify these arguments ("command line arguments") in an Xcode menu

```
./a.out coding_is_fun //you type this into terminal

Then, this stuff happens under the hood:
argc = 2 // counts # of strings in argv array
{"./a.out", "coding_is_fun"} //contents of argv
```

Homework

- Write a small two-player text game where the first player enters a list of 5 things or people they love most, and the second player tries to guess what those things are.

- Function 1: Greets the players and prints a description of how to play.

- Function 2: Prompts user input for 5 different things or people, then receives that input and saves it in an array (or vector, if you want the player to choose how many things they enter). *try figuring out how to hide the player's input in your console, or just print a bunch of spaces to hide it! ☺

- Function 3: Prompt player to guess! Pass that array or vector as a reference to a function that will check through the list for matches each time the second player guesses.

This is a basic outline of an exercise in functions and references, but feel free to be as creative with the gameplay as you want!