Week 9: Functions I

Gaddis: 6.1-4

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6.1 Modular Programming

- Modular programming: breaking a program up into smaller, manageable components (modules)
- Function: a collection of statements to perform a task, grouped into a single named unit.
- Why is modular programming important?
  - Improves maintainability/readability of programs by giving structure and organization to the code
  - Simplifies the process of writing programs: programmer can write one small function at a time

This program has one long, complex function containing all of the statements necessary to solve a problem.

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

In this program the problem has been divided into smaller problems, each of which is handled by a separate function.

```
int main()
{
   statement;
   statement;
   statement;
}
```
main function

```
void function2()
{
   statement;
   statement;
   statement;
}
```
function 2

```
void function3()
{
   statement;
   statement;
   statement;
}
```
function 3

```
void function4()
{
   statement;
   statement;
   statement;
}
```
function 4

6.2 Defining and Calling Functions

- Function definition: statements that make up a function, along with its name and return type.

```
return-type  function-name  (parameters)
{
   statements
}
```

- Function call: statement (or expression) that causes a function to execute

```
function-name (arguments)
```

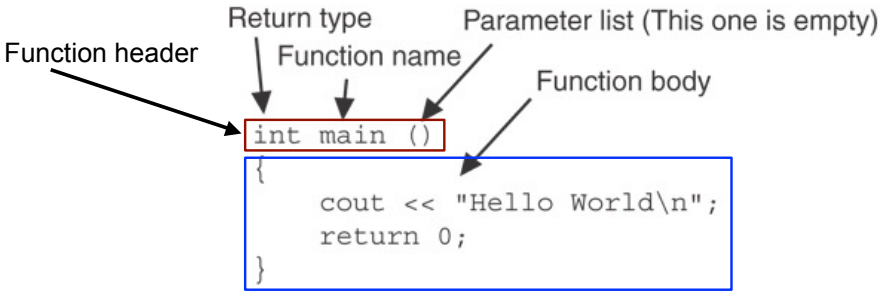
Function Definition

A Function definition includes:

- return type: data type of the value that the function returns to the part of the program that called it
- function-name: name of the function. Function names follow same rules as variables
- parameters: optional list of variable definitions. These will be assigned values from each function call.
- body: statements that perform the function's task, enclosed in { }

Function Definition

```
return-type  function-name  (parameters)
{
   statements
}
```



Function Return Type

- If a function computes and returns a value, the type of the value must be indicated

```
int getRate()
{
   …
}
```

- If a function does not return a value, its return type is void:

```
void printHeading()
{
   cout << "Monthly Sales\n";
}
```


Calling a Function

- To execute the statements in a function, you must "call" it from within another function (like main).
- To call a function, use the function name followed by a list of expressions (arguments):

```
printHeading();
```

- Whenever called, the program executes the body of the called function (it runs the statements).
- After the function terminates, execution resumes in the calling function after the function call.

Functions in a program

- Example:

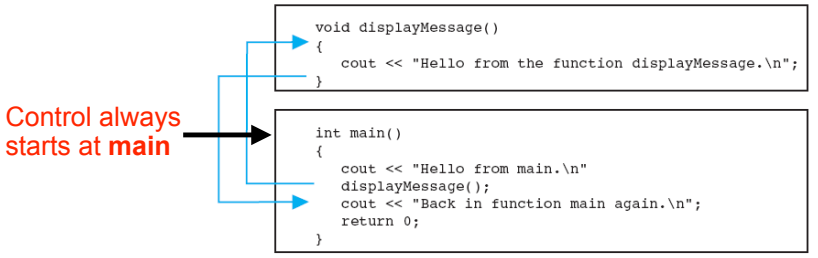
```
#include <iostream>
using namespace std;

void displayMessage()
{
   cout << “Hello from the function displayMessage.\n”;
}

int main()
{
   cout << “Hello from Main.\n”;
   displayMessage();
   cout << “Back in function Main again.\n”;
   return 0;
}
```


Functions in a program

- Output:

```
Hello from main.
Hello from the function displayMessage.
Back in function main again.
```

- Flow of Control:



Calling Functions: rules

- A program is a collection of functions, one of which must be called “main”.
- Function definitions can contain calls to other functions.
- A function must be defined before it can be called
  - In the program text, the function definition must occur before all calls to the function
  - Unless you use a “prototype”

6.3 Function Prototypes

- Compiler must know the following about a function before it sees a function call:
  - name, return type, number of parameters, and
  - data type of each parameter
- Not necessary to have the body of the function before the call.
- Sufficient to put just the function header before all functions containing calls to that function
  - Then include the complete definition later in the program.
  - The header alone is called a function prototype

Prototypes in a program

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

// function prototypes
void first();
void second();

int main() {
   cout << "I am starting in function main.\n";
   first();          // function call
   second();         // function call
   cout << "Back in function main again.\n";
   return 0;
}

// function definitions
void first() {
   cout << "I am now inside the function first.\n";
}
void second() {
   cout << "I am now inside the function second.\n";
}
```


Prototype Style Notes

- Place prototypes near the top of the program (before any other function definitions)--good style.
- With prototypes, you can place function definitions in any order in the source file
- Common style: all function prototypes at beginning, followed by definition of main, followed by other function definitions.

6.4 Sending Data into a Function

- You can pass values to a function in the function call
- This allows the function to work over different values each time it is called
- Arguments: Expressions (or values) passed to a function in the function call.
- Parameters: Variables defined in the function definition header that are assigned the values passed as arguments.

A Function with a Parameter

```
void displayValue(int num)
{
   cout << "The value is " << num << endl;
}
```

- `num` is the parameter.
- Calls to this function must have an argument (expression) that has an integer value:

```
displayValue(5);
```

Function with parameter in program

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

// Function Prototype
void displayValue(int);

int main() {
   cout << "I am passing 5 to displayValue.\n";
   displayValue(5);
   cout << "Back in function main again.\n";
   return 0;
}

// Function definition
void displayValue(int num) {
   cout << "The value is " << num << endl;
}
```

Output:

```
I am passing 5 to displayValue.
The value is 5
Back in function main again.
```


Parameter Passing Semantics

- Given this function call, with the argument of 5:

```
displayValue(5);
```

- Before the function body executes, the parameter (`num`) is initialized to the argument (`5`), like this:

```
int num = 5;
```

- Then the body of the function is executed, using num as a regular variable:

```
cout << "The value is " << num << endl;
```


Parameters in Prototypes and Function Definitions

- The prototype must include the *data type* of each parameter inside its parentheses:

```
void evenOrOdd(int);   //prototype
```

- The definition must include a *declaration* for each parameter in its parens

```
void evenOrOdd(int num)   //header
{ if (num%2==0) cout << "even";
  else cout << "odd"; }
```

- The call must include an *argument* (expression) for each parameter, inside its parentheses

```
evenOrOdd(x+10);          //call
```


Passing Multiple Arguments

When calling a function that has multiple parameters:

```
power(x+10, y);  //call
```

- the following must all match:
  - the number of arguments in the call
  - the number of data types in the prototype
  - the number of parameters in the definition
- the first argument will be used to initialize the first parameter, the second argument to initialize the second parameter, etc.
  - they are assigned in order.

Example: function calls function

```
void deeper() {
   cout << "I am now in function deeper.\n";
}

void deep() {
   cout << "Hello from the function deep.\n";
   deeper();
   cout << "Back in function deep.\n";
}

int main() {
   cout << "Hello from Main.\n";
   deep();
   cout << "Back in function Main again.\n";
   return 0;
}
```

Output:

```
Hello from Main.
Hello from the function deep.
I am now in function deeper.
Back in function deep.
Back in function Main again.
```


Example: call function more than once

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

void pluses(int count) {
   for (int i = 0; i < count; i++)
      cout << "+";
   cout << endl;
}

int main() {
   int x = 2;
   pluses(4);
   pluses(x);
   pluses(x+5);
   pluses(pow(x,3.0));
   return 0;
}
```

Output:

```
++++
++
+++++++
++++++++
```


Example: multiple parameters

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

void pluses(char ch, int count) {
   for (int i=0; i < count; i++)
      cout << ch;
   cout << endl;
}

int main() {
   int x = 2;
   char cc = '!';
   pluses('#',4);
   pluses('*',x);
   pluses(cc,x+5);
   pluses('x',pow(x,3.0));
   return 0;
}
```

Output:

```
####
**
!!!!!!!
xxxxxxxx
```