6.7 The `return` statement

- Used to stop the execution of a void function
- Can be placed anywhere in the function body
  - the function immediately transfers control back to the statement that called it.
- Statements that follow the return statement will not be executed
- In a void function with no return statement, the compiler adds a return statement before the last `}

6.8 Returning a value from a function

- You can use the return statement in a non-void function to send a value back to the function call:
  ```
  return expr;
  ```
- The value of the `expr` will be sent back.
- The data type of `expr` must be placed in the function header:

  ```
  int doubleIt(int x) {
      return x*2;
  }
  ```
  
  Return type:
  ```
  Value being returned
  ```
Calling a function that returns a value

- If the function returns void, the function call is a statement:
  \[
  \text{pluses}(4);
  \]
- If the function returns a value, the function call is an expression:
  \[
  \text{int } y = \text{doubleIt}(4);
  \]
- The value of the function call (underlined) is the value of the expr returned from the function, and you should do something with it.

```
pluses(4);
```

```
int y = doubleIt(4);
```

Data transfer

- The function call from main: \( \text{sum(value1, value2)} \) passes the values stored in \( \text{value1} \) and \( \text{value2} \) (20 and 40) to the function, assigning them to \( x \) and \( y \).
- The result, \( x+y \) (60), is returned to the call and stored in \( \text{total} \).

```
total = sum(value1, value2);
```

```
total = sum(20, 40);
```

```
total = sum(value1, value2);
```

```
int sum(int x, int y) {
    return x + y;
}
```

```
int main() {
    int value1;
    int value2;
    int total;
    cout << "Enter 2 numbers: " << endl;
    cin >> value1 >> value2;
    total = sum(value1, value2);
    cout << "The sum is " << total << endl;
}
```

```
Enter 2 numbers: 20 40
The sum is 60
```

Retuning the sum of two ints

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

int sum(int, int);

int main() {
    int value1;
    int value2;
    int total;
    cout << "Enter 2 numbers: " << endl;
    cin >> value1 >> value2;
    total = sum(value1, value2);
    cout << "The sum is " << total << endl;
}

int sum(int x, int y) {
    return x + y;
}
```

```
Enter 2 numbers: 20 40
The sum is 60
```

Function call expression

- When a function call calls a function that returns a value, it is an expression.
- The function call can occur in any context where an expression is allowed:
  - assign to variable (or array element)
  - output via cout
  - use in a more complicated expression
  - pass as an argument to another function
- The value of the function call is determined by the value of the expression returned from the function.
6.9 Returning a boolean value

```cpp
bool isValid(int number) {
    bool status;
    if (number >= 1 && number <= 100)
        status = true;
    else
        status = false;
    return status;
}
```

• the above function is equivalent to this one:

```cpp
bool isValid(int number) {
    return (number >= 1 && number <= 100);
}
```

6.5 Passing Data by Value (review)

• **Pass by value**: when an argument is passed to a function, its value is copied into the parameter.

• Parameter passing is implemented using variable initialization (behind the scenes):

```cpp
    int param = argument;
```

• Changes to the parameter in the function definition cannot affect the value of the argument in the call

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

void changeMe(int);

int main() {
    int number = 12;
    cout << "number is " << number << endl;
    changeMe(number);
    cout << "Back in main, number is " << number << endl;
    return 0;
}

void changeMe(int myValue) {
    myValue = 200;
    cout << "myValue is " << myValue << endl;
}
```

Example: Pass by Value

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

void changeMe(int);

int main() {
    int number = 12;
    cout << "number is " << number << endl;
    changeMe(number);
    cout << "Back in main, number is " << number << endl;
    return 0;
}

void changeMe(int myValue) {
    myValue = 200;
    cout << "myValue is " << myValue << endl;
}
```

// changeMe failed!
Pass by Value notes

When the argument is a variable (as in f(x)):
• The parameter is initialized to a *copy* of the argument’s value.
• Even if the body of the function changes the parameter, the argument in the function call is unchanged.
• The parameter and the argument are stored in separate variables, separate locations in memory.

Example: Pass by Reference

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

void changeMe(int &);

int main() {
    int number = 12;
    cout << "number is " << number << endl;
    changeMe(number);
    cout << "Back in main, number is " << number << endl;
    return 0;
}

void changeMe(int &myValue) {
    myValue = 200;
    cout << "myValue is " << myValue << endl;
}
```

Output:
```
number is 12
myValue is 200
Back in main, number is 200
```

Using Pass by Reference for input

```cpp
void getRadius(double &rad) {
    cout << "Enter the radius of the circle: ";
    cin >> rad;
}

int main() {
    const double PI = 3.14159;
    double radius;
    double area;
    cout << fixed << setprecision(2);
    getRadius(radius);
    area = PI * square(radius);
    cout << "The area is " << area << endl;
    return 0;
}
```

Example: Pass by Reference

```cpp
double square(double number) {
    return number * number;
}
```

6.13 Passing Data by Reference

• **Pass by reference**: when an argument is passed to a function, the function has direct access to the original argument.
• Pass by reference in C++ is implemented using a reference parameter, which has an ampersand (&) in front of it:
  ```cpp
  void changeMe(int &myValue);
  ```
• A reference parameter acts as an *alias* to its argument.
• Changes to the parameter in the function **DO** affect the value of the argument.

Example: Pass by Reference

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

void changeMe(int &);

int main() {
    double square(double number) {
        return number * number;
    }
    void getRadius(double &rad) {
        cout << "Enter the radius of the circle: ";
        cin >> rad;
    }
    int main() {
        const double PI = 3.14159;
        double radius;
        double area;
        cout << fixed << setprecision(2);
        getRadius(radius);
        area = PI * square(radius);
        cout << "The area is " << area << endl;
        return 0;
    }
```

During the function execution, rad is an alias to radius in the main program.
Pass by Reference notes

- Changes made to a reference parameter are actually made to its argument
- The & must be in the function header AND the function prototype.
- The argument passed to a reference parameter must be a variable – it cannot be a constant or contain an operator (like +)
- Use when appropriate – don’t use when:
  ‣ the argument should not be changed by function (!)
  ‣ the function returns only 1 value: use return stmt!

6.10 Local and Global Variables

- Variables defined inside a function are local to that function.
  ‣ They are hidden from the statements in other functions, which cannot access them.
- Because the variables defined in a function are hidden, other functions may have separate, distinct variables with the same name.
  ‣ This is not bad style. These are easy to keep straight
- Parameters are also local to the function in which they are defined.

Local variables are hidden from other functions

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

void anotherFunction();

int main() {
    int num = 1;
    cout << "In main, num is " << num << endl;
    anotherFunction();
    cout << "Back in main, num is " << num << endl;
    return 0;
}

void anotherFunction() {
    int num = 20;
    cout << "In anotherFunction, num is " << num << endl;
}
```

Output:

```
In main, num is 1
In anotherFunction, num is 20
Back in main, num is 1
```

Local Variable Lifetime

- A function’s local variables and parameters exist only while the function is executing.
- When the function begins, its parameters and local variables (as their definitions are encountered) are created in memory, and when the function ends, the parameters and local variables are destroyed.
- This means that any value stored in a local variable is lost between calls to the function in which the variable is declared.
Global Variables

- A global variable is any variable defined outside all the functions in a program.
- The scope of a global variable is the portion of the program starting from the variable definition to the end of the file.
- This means that a global variable can be accessed by all functions that are defined after the global variable is defined.

Global Variables: example

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

void anotherFunction();
int num = 2;

int main() {
    cout << "In main, num is " << num << endl;
    anotherFunction();
    cout << "Back in main, num is " << num << endl;
    return 0;
}

void anotherFunction() {
    cout << "In anotherFunction, num is " << num << endl;
    num = 50;
    cout << "But now it is changed to " << num << endl;
}
```

Output:

```
In main, num is 2
In anotherFunction, num is 2
But now it is changed to 50
Back in main, num is 50
```

Global Variables/Constants

Do not use global variables!!! Because:

- They make programs difficult to debug.
  - If the wrong value is stored in a global var, you must scan the entire program to see where the variable is changed.
- Functions that access globals are not self-contained.
  - cannot easily reuse the function in another program.
  - cannot understand the function without understanding how the global is used everywhere.

It is ok (and good) to use global constants because their values do not change.

Global Constants: example

```cpp
const double PI = 3.14159;

double getArea(double number) {
    return PI * number * number;
}

double getPerimeter(double number) {
    return PI * 2 * number;
}

int main() {
    double radius;
    cout << fixed << setprecision(2);
    cout << "Enter the radius of the circle: ";
    cin >> radius;
    cout << "The area is " << getArea(radius) << endl;
    cout << "The perimeter is " << getPerimeter(radius) << endl;
}
```

Output:

```
Enter the radius of the circle: 2.2
The area is 15.21
The perimeter is 13.82
```