Pointers
Chapter 10

Pointers

- Pointers are one of the most powerful features of C++
- Pointers give programmers more control over the computer's memory
- A pointer is the memory address of a variable
- A pointer is one of the most difficult and important concepts in C/C++

Variable Addresses

- A variable's address is the address of the first byte allocated to that variable
- Why the first byte?
- How can we find out the size of data types on a machine?

2.1 Pointer Declarations (10.2)

- The memory address of a variable can be stored in another variable called a pointer
- Pointers are declared using the **`*`** operator
- The following declares a pointer to an integer
  - **`int *pLength;`**
- In the following statement, **`length`** is an integer and **`pLength`** is a pointer to an integer
  - **`int *pLength, length;`**

2.2 Pointer Declarations (10.2)

- How would you create two pointers to doubles?
- Note:
  - Using our coding standards, we will use the convention that all pointer variables start with a small p (eg. pCount, pX)

2.3 Address Operator (10.1)

- How do we assign to a pointer the address of a variable?
- Use the address operator (**`&`**)
- **`&`** returns the memory address of it's operand
- Example:
  - **`pLength = &length;`**
- Where have we used **`&`** before?

2.4 Address Operator

- Operand of the address operator must be an *lvalue*
- An *lvalue* is something to which a value can be assigned
- Address operator cannot be applied to constants
  - `int *pX;`
  - `int const NUM = 98;`
  - `pX = &NUM;  // ERROR`
  - `pX = &8;  // ERROR`

2.5 Pointer Operations (10.2)

```
int x, *pX;
x = 8;   // set x to a value of 8
pX = &x; // set the pointer variable to point
         // to the address of x

cout << "x is: " << x << endl;
cout << "Size of x is: " << sizeof(x) << endl;
cout << "Address of x is: " << pX << endl;
cout << "Address of x is: " << &x << endl;
```


2.6 Indirection Operator

- How can we use the pointer variable to modify the value in the variable?
  - i.e. how to use **pX** to change the value of **x**
- *Answer:* use the indirection operator (*****)
- The ***** operator dereferences the pointer
  - You are actually working with whatever the pointer is pointing to
- Using the example on the previous slide
  - `cout << "pX is pointing to: " << *pX << endl;`

2.7 Indirection Operator

- Using `*` as we did in the previous example is called dereferencing the pointer
- Using our example, how can we dereference `pX` so that it changes the value of `x` from 8 to 10?
- How can we change the value of `x` to a value entered by the user using the indirection operator?

2.8 Common Pointer Mistakes

- What is wrong with the following?

```
int x, *pX;
x = 8;

*pX = 2;
pX = 9;
*x = 4;
```


2.9 Pointers and Functions (10.7)

- What are the two ways of passing arguments into functions?
- Write two functions `square1` and `square2` that will calculate the square of an integer.
  - `square1` should accept the argument passed by value,
  - `square2` should accept the argument passed by reference.

Pointers and Functions (10.7)

- There is a third way of passing arguments into functions
- It's called
  - passing by reference without using reference arguments
  - Or passing by reference using pointers
- The address of the argument is passed instead of the argument itself

2.10 Passing by reference (10.7)

```
void square3(int *pNum)
{
  *pNum *= *pNum;
}
```

- What would a function call to the above function look like?

2.11 Function Call (10.7)

```
int val = 5;
square3(&val);
cout << val << endl;
```

Summary

- Today I introduced
  - The concept of pointer variables
  - The address operator
  - The indirection operator
- We have covered:
  - Sections 10.1, 10.2, and 10.7
- You should read ahead:
  - Sections 10.3, 10.4, 10.5, and 10.6