# CHAPTER 9
# CLASSES

**CMPS 148**

# Lab #5

- Write a program that allows the user to type **any** amount of input numbers (-1 to stop):
  - Print out the sorted result
- Start by creating a **dynamic array** of size 5.
- Whenever the user enters too many numbers, grow the size of the array by 2
  - For example, when the 6th number is entered:
    - Create a new dynamic array of size 10
    - Transfer the existing 5 numbers
    - **Delete** the old array, change the pointer.
    - Add the 6th number

# Today's Topics

- Introduction to C++ Objects
  - Creating a data type of our own
  - Using properties and functions
  - Pre-Defined classes

# Objects and Variables

- We have seen a number of different data types
  - int, double, float, char, bool

- In a way, they represent *abstract* ideas of "things"
  - Integers -> 01011001
  - 'A' -> 110100
  - True -> 1

# Objects and Variables

- Data Types can be ***instantiated*** as variables - or ***instances.***
  - int x, y; // x and y are *instances*
- You can have many instances of the same data-type
  - Each instance (or variable) has its own memory
  - Each instance conforms to the same "rules" as all other instances of the common data type
- Built-in data-types are also called **primitives**

# Objects and Variables

- Often, we deal with programs that have *higher level* concepts involved.
  - We write programs that deal with:
    - Students and grades
    - Circles and rectangles (area, volume, etc.)
    - Bank loans and interest calculations
    - Etc.
- As our programs get larger, it is useful to model these ideas *directly* in C++
  - We will consider these ideas **objects**.

# Objects

- Objects can be composed of two types of things:
  - State (Properties)
  - Behaviors (Actions)
- For example, we can consider a circle
  - Property: radius
  - Action: calculate area
- Or a loan…
  - Property: Principle, Interest Rate
  - Action: calculate monthly payment, print balance, etc.

# Object-Oriented Programming

- OOP is the predominant style of modern programming
  - C++ was one of the first languages to stress this
  - C#, Java are other common OOP languages
  - Many languages have been given support:
    - JavaScript, PHP, Ruby, Groovy

# Classes

- A *class* is a user-defined *data-type*.
  - A class's instances are called **objects**

> **Object** is to *class* as
> **variable** is to *data type*

  - Lets create a Circle class in C++
    - Property: Radius
    - Action: getArea()

# Class Definition

```
class Circle {
public:
   double radius;

   Circle() {
      radius = 1;
    }

   Circle (double r){
      radius = r;
   }

   double getArea() {
      return radius * radius *  3.14159;
   }
};
```

Member Variable

Default Constructor

Constructor

Member Function

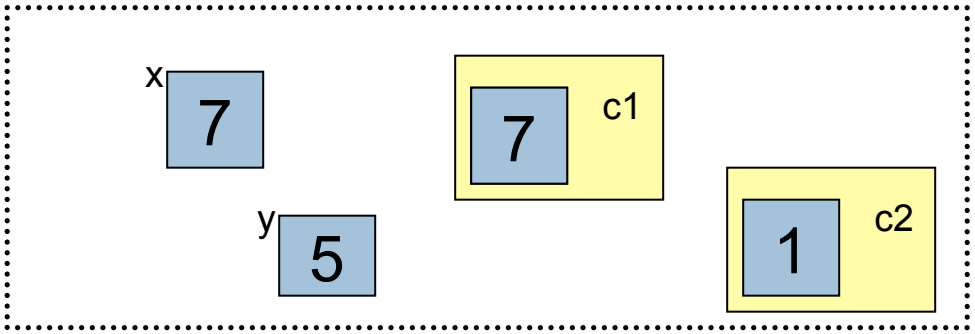
# IMPORTANT!

- A class *definition* is **not** a program
  - Its job is to define a new type (or thing)
  - It is a *blueprint* for how its instances are built and behave
- To create an instance, you use the same syntax as regular variables (mostly)
  - `int x;`
  - `Circle c;`

# Properties: Member Variables

- The semantics of Properties are different than you are used to.
- Think of an object as a collection of member variables
  - Each Circle instance has its own radius
- Later we will add more properties and functionality to our classes - we will come to think of them as "containers"

```
int x = 7;
int y = 5;
Circle c1;
Circle c2;
c1.radius = 7;
```



# Constructors

- When creating a primitive, C++ allocates memory for you, but that's it..
- When creating an object, C++ provides a way for you to perform some initialization to *prepare* your object
  - Each class defines one or more ***constructors***.
  - Special "functions" that automatically get called whenever an instance/object is created.

# Constructor Syntax

- Constructors have **no** return type.
  - Their return is implicit - it's the newly initialized object
- Default constructors
  - No parameters
  - Called somewhat "magically"

```
class Circle {
public:
    double radius;

    Circle() {
        radius = 1;
    }
};

int main() {
     Circle c;
     cout << c.radius << endl;
}
```

# Constructor Syntax

- You can provide "custom" constructors which accept arguments as parameters also.
- If you have custom constructors, you **must** write a default constructor

```
class Circle {
public:
    double radius;

    Circle() {
        radius = 1;
    }
    Circle(double r) {
        radius = r;
    {
};

int main() {
     Circle c(15);
     cout << c.radius << endl;
}
```

# Actions: Member Functions

- Our objects can perform actions - which we call *member functions.*
- The operate just like normal functions - but:
  - They have direct access to the member variables
  - They are called on **specific** instances of our objects

```
class Circle {
public:
    double radius;
        …
    double getArea(){
      return radius * radius *
             2 * PI;
    )
};

int main() {
     Circle c;
     cout << c.getArea() << endl;
}
```

# Using instances

- Write a program that creates two circles
  - One using default constructor
  - User enters radius of the other
  - Print area of both circles

# Assignment

- When primitives are involved, the assignment operator works fairly simply:

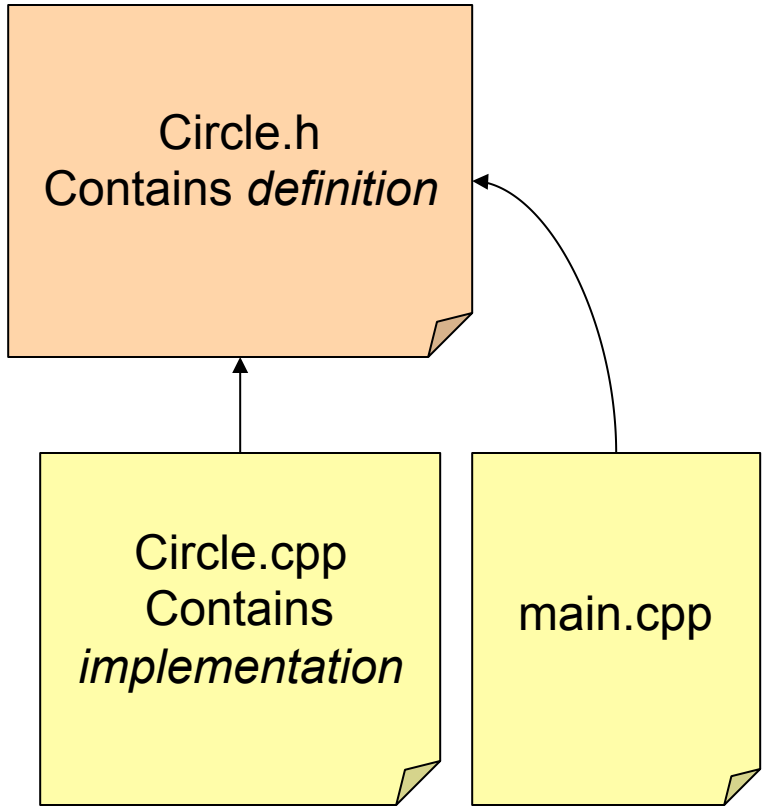
```
int x = 5;
int y;
y = x;
```

- For classes, the assignment operator performs a little more work on your behalf
  - Each member variable is copied

```
Circle c1;
Circle c2(4);
c1 = c2;  (copies c2's radius into c1's radius)
```

# Header Files

- Classes often contain many member variables and functions.
- To use someone else's class, you don't need to know how each function is implemented
  - You just need to know what is available.



# Definition / Implementation

```
class Circle {
public:
    double radius;

    Circle() ;
    Circle(double r);
    double getArea();
};
```

Circle.h

```
#include "Circle.h"

Circle :: Circle() {
   radius = 1;
}

Circle :: Circle(double r) {
   radius = r;
}

double Circle :: getArea() {
        return 2 * PI *
                  radius * radius;
}
```

Scoping Operator

Circle.cpp

# Data Encapsulation

```
class Circle {
public:
    double radius;

    Circle() ;
    Circle(double r);
    double getArea();
};
```

- The keyword public tells C++ to allow "others" to use the variables and functions below
- Often it would be nice to keep all the variables, and some of the functions, private
- Private means **only** member functions within Circle can use those variables and functions.

# Data Encapsulation

- Lets modify our Circle class to do the following:
  - Prevent "user" from setting negative radius
  - Pre-Calculate area so it doesn't need to be recomputed if radius has not changed since the last time getArea() was called.

# Variable Scope

- Variable scope is a potential issue when dealing with member functions.
  - Member variables are "global" to all member functions
  - Local parameters or variables *within* member functions will *hide* member variables of the same name.

```
double setRadius(double radius) {
  radius = radius; ??????
}
```

# Lab 6

- Create a BankAccount Class
  - Properties (Member Variables):
    - Balance
    - Interest Rate (yearly)
  - Actions (Member Functions):
    - Withdrawl(double amountToWithdraw)
    - Deposit(double amountToDeposit)
    - ApplyYearlyInterest() *use Deposit function*
- Write a main program that uses your class and lets the user perform the three actions.

# “Example” main

```
int main() {
    BankAccount account;

    account.Deposit(400);
    cout << "Balance:  $" << account.getBalance() << endl;

    account.ApplyInterest();
    cout << "Balance:  $" << account.getBalance() << endl;

    account.Withdraw(50);
    cout << "Balance:  $" << account.getBalance() << endl;

    system("pause");
}
```

*Prints 400*

*Prints 420*

*Prints 370*