Classes

Part 1

CMSC 202

Programming & Abstraction

- All programming languages provide some form of ***abstraction***.
  - Also called ***information hiding***
  - Separates code use from code implementation
- Procedural Programming
  - Data Abstraction: using data structures
  - Control Abstraction: using functions
- Object Oriented Programming
  - Data and Control Abstraction: using classes

Procedural vs. Object Oriented

Procedural

Calculate the area of a circle given the specified radius

Sort this class list given an array of students

Calculate the student's GPA given a list of courses

Object Oriented

Circle, what's your radius?

Class list, sort your students

Transcript, what's the student's GPA?

What is a Class?

- From the Dictionary
  - A kind or category
  - A set, collection, group, or configuration containing members regarded as ***having certain attributes or traits in common***
- From an Object Oriented Perspective
  - A group of objects with ***similar properties, common behavior, common relationships with other objects, and common semantics***
  - We use classes for ***abstraction*** purposes.

Classes

Classes are "blueprints" for creating a group of objects.

A bird class to create bird objects

A car class to create car objects

A shoe class to create shoe objects

The blueprint defines

The class's state/attributes as variables

The class's behavior as methods

Class or Object?

- Variables of class types may be created just like variables of built-in types.
  - Using a set of blueprints you could create a bakery.
- You can create as many instances of the class type as you like.
  - There is more than one bakery in Baltimore.
- The challenge is to define classes and create objects that satisfy the problem.
  - Do we need an Oven class?

Structures

2nd collection data type: structures (**`struct`**)

Structure: aggregate of values of different types
- Compare to array: collection of values of same type

Treated as a single item, like arrays

Must first define struct before declaring any variables.

Structure Types

Define struct globally (typically)

No memory is allocated
- Just a placeholder for what our structure will look like

Example definition:

```
struct CDAccountV1    ← Name of new struct
   {
      double balance;       ← member names
      double interestRate;
      int term;
   };
```


Declare Structure Variable

With structure type defined, now declare variables of this new type:

`CDAccountV1 account;`

- Just like declaring simple types
- Variable **`account`** now of type **`CDAccountV1`**

Dot operator to access *member variables*:

```
account.balance
account.interestRate
account.term
```

Structure Example: **Display 6.1** A Structure Definition (1 of 3)

Display 6.1 A Structure Definition

```
1   //Program to demonstrate the CDAccountV1 structure type.
2   #include <iostream>
3   using namespace std;

4   //Structure for a bank certificate of deposit:
5   struct CDAccountV1
6   {
7       double balance;
8       double interestRate;
9       int term;//months until maturity
10  };

11  void getData(CDAccountV1& theAccount);
12  //Postcondition: theAccount.balance, theAccount.interestRate, and
13  //theAccount.term have been given values that the user entered at the keyboar
```

An improved version of this structure will be given later in this chapter.

Structure Example: **Display 6.1** A Structure Definition (2 of 3)

```
14  int main( )
15  {
16      CDAccountV1 account;
17      getData(account);

18      double rateFraction, interest;
19      rateFraction = account.interestRate/100.0;
20      interest = account.balance*(rateFraction*(account.term/12.0));
21      account.balance = account.balance + interest;

22      cout.setf(ios::fixed);
23      cout.setf(ios::showpoint);
24      cout.precision(2);
25      cout << "When your CD matures in "
26           << account.term << " months,\n"
27           << "it will have a balance of $"
28           << account.balance << endl;

29      return 0;
30  }
```

(continued)

Structure Example: **Display 6.1** A Structure Definition (3 of 3)

Display 6.1 A Structure Definition

```
31  //Uses iostream:
32  void getData(CDAccountV1& theAccount)
33  {
34      cout << "Enter account balance: $";
35      cin >> theAccount.balance;
36      cout << "Enter account interest rate: ";
37      cin >> theAccount.interestRate;
38      cout << "Enter the number of months until maturity: ";
39      cin >> theAccount.term;
40  }
```

Sample Dialogue

Enter account balance: **$100.00**
Enter account interest rate: **10.0**
Enter the number of months until maturity: **6**
When your CD matures in 6 months,
it will have a balance of $105.00

Structures

Good
- Simple
- Can be parameters to functions
- Can be returned by functions
- Can be used as members of other structs

Bad
- No operations
- Data is not protected
  - Any code that has access to the struct object has direct access to all members of that object

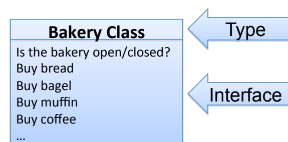
Classes – a Struct Replacement

Good
- Simple
- Objects can be parameters to functions
- Objects can be returned by functions
- Objects can be members of other classes
- Operations linked to data
- Data ***is*** protected
  - Code that uses an object MUST use the operators of the class to access/modify data of the object (usually)

Bad
- Nothing really…

Class Interface

- The requests you can make of an object are determined by its ***interface***.
- Do we need to know how bagels are made in order to buy one?
  - All we actually need to know is which bakery to go to and what action we want to perform.



Implementation

Code and ***hidden data*** in the class that satisfies requests make up the class's ***implementation***.

What's hidden in a bakery?

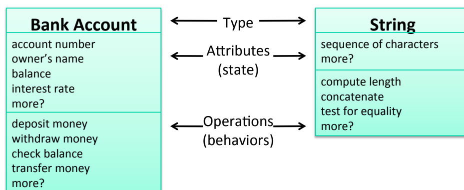
Every request made of an object must have an associated method that will be called.

In OO-speak we say that you are ***sending a message*** to the object, which responds to the message by executing the appropriate code.

Recall . . .

Class

– A ***complex data type*** containing:
- Attributes – make up the object's ***state***
- Operations – define the object's ***behaviors***



Class Example

```
class Car                          ← Class-name
{
   public:                         ← Protection Mechanism
      bool AddGas(float gallons);  ┐
      float GetMileage();          │ Operations
      // other operations          ┘

   private:                        ← Protection Mechanism
      float m_currGallons;         ┐
      float m_currMileage;         │ Data
      // other data                ┘
};
```

Struct vs. Class

```
struct DayOfYear
{
  int month;
  int day;
};

// Code from main()
DayOfYear july4th;
july4th.month = 7;
july4th.day = 4;
```

```
class DayOfYear
{
  public:
   int m_month;
   int m_day;
};

// Code from main()
DayOfYear july4th;
july4th.m_month = 7;
july4th.m_day = 4;
```

Class Rules – Coding Standard

- Class names
  - Always begin with capital letter
  - Use mixed case for phrases
  - General word for class (type) of objects
    - Ex: Car, Boat, Building, DVD, List, Customer, BoxOfDVDs, CollectionOfRecords, …
- Class data
  - Always begin with m_
    - Ex: m_fuel, m_title, m_name, …
- Class operations/methods
  - Begin with lower-case or capital letter
    - Ex: addGas() or AddGas(), modifyTitle() or ModifyTitle(), …

Class - DayOfYear

```
// Represents a Day of the Year
class DayOfYear
{
    public:
        void Output();
        int m_month;
        int m_day;
};

// Output method – displays a DayOfYear
void DayOfYear::Output()
{
    cout << m_month << "/" << m_day;
}

// Code from main()
DayOfYear july4th;
july4th.m_month = 7;
july4th.m_day = 4;
july4th.Output();
```

Method Implementation

Class Name

Scope Resolution Operator: indicates which class this method is from

Method Name

```
void DayOfYear::Output()
{
  cout << m_month
       << "/" << m_day;
}
```

Method Body

Classes

```
// Represents a Day of the Year
class DayOfYear
{
  public:
   void Output();
   int m_month;
   int m_day;
};
```

Class Declaration

Goes in file ClassName.h

```
// Output method – displays a DayOfYear
void DayOfYear::Output()
{
  cout << m_month << "/" << m_day;
}
```

Class Definition

Goes in file ClassName.cpp

Dot and Scope Resolution Operator

Used to specify "of what thing" they are members

Dot operator:
- Specifies member of particular object

Scope resolution operator:
- Specifies what class the function definition comes from

A Class's Place

- Class is full-fledged type!
  - Just like data types int, double, etc.
- Can have variables of a class type
  - We simply call them "objects"
- Can have parameters of a class type
  - Pass-by-value
  - Pass-by-reference
- Can use class type like any other type!

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Encapsulation

- Any data type includes
  - Data (range of data)
  - Operations (that can be performed on data)
- Example:
  - *int* data type has:
  - Data: -2147483648 to 2147483647 (for 32 bit int)
  - Operations: +,-,*,/,%,logical,etc.
- Same with classes
  - But WE specify data, and the operations to be allowed on our data!

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Abstract Data Types

- "Abstract"
  - Programmers don't know details
- Abbreviated "ADT"
  - Collection of data values together with set of basic operations defined for the values
- ADT's often "language-independent"
  - We implement ADT's in C++ with classes
    - C++ class "defines" the ADT
  - Other languages implement ADT's as well

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More Encapsulation

- Encapsulation
  - Means "bringing together as one"
- Declare a class → get an object
- Object is "encapsulation" of
  - Data values
  - Operations on the data (member functions)