INTRO TO OBJECT ORIENTED PROGRAMMING

Problem Solving with Computers-II

Today's goals

- Intro to Object Oriented Programming
- Defining classes and declaring objects
- Access specifiers: private, public
- Different ways of initializing objects and when to use each:
  - Default constructor
  - Parametrized constructor
  - Parameterized constructor with default value
- Operator overloading
  - what is operator overloading?
  - why/when would we need to overload operators?
  - how to overload operators in C++ ?

Procedural Programming

- Break down a problem into sub tasks (functions)
- Algorithm to bake a cake

    Preheat the oven to 350F

    Get the ingredients: 2 eggs, 1 cup flour, 1 cup milk

    Mix ingredients in a bowl

    Pour the mixture in a pan

    Place in the over for 30 minutes

Object Oriented Programming: A cake baking example

- Solution to a problem is a system of interacting **objects**
- An object has attributes and behavior
- What are the objects in this example?

1. Preheat the oven to 350F
2. Get the ingredients: 2 eggs, 1cup flour, 1 cup milk
3. Mix ingredients in a bowl
4. Pour the mixture in a pan
5. Place in the over for 30 minutes

Objects have attributes and behavior: A cake baking example

Object	Attributes	Behaviors
Oven	Size Temperature Number of racks	Turn on Turn off Set temperature
Bowl	Capacity Current amount	Pour into Pout out
Egg	Size	Crack Separate(white from yolk)

A class: pattern for describing similar objects

A generic pattern that is used to describe objects that have similar attributes and behaviors

e.g. a bowl and a pan may be described by the same class

```
class Dish{
     void pourIn( double amount);
     void pourOut(double amount);
     double capacity;
     double currentAmount;
};
```

member functions

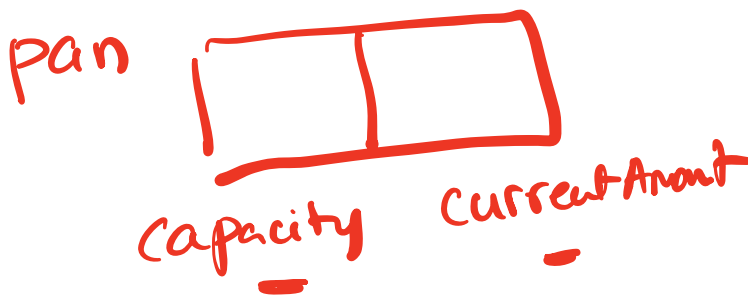
member variables

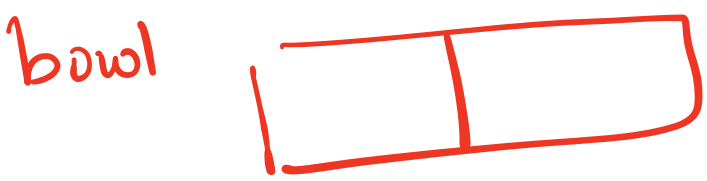
Objects vs classes

```
class Dish{
     void pourIn( double amount);
     void pourOut(double amount);
     double capacity;
     double currentAmount;
};
 //Creating objects of this class
```

Dish pan; ← object

Dish bowl;





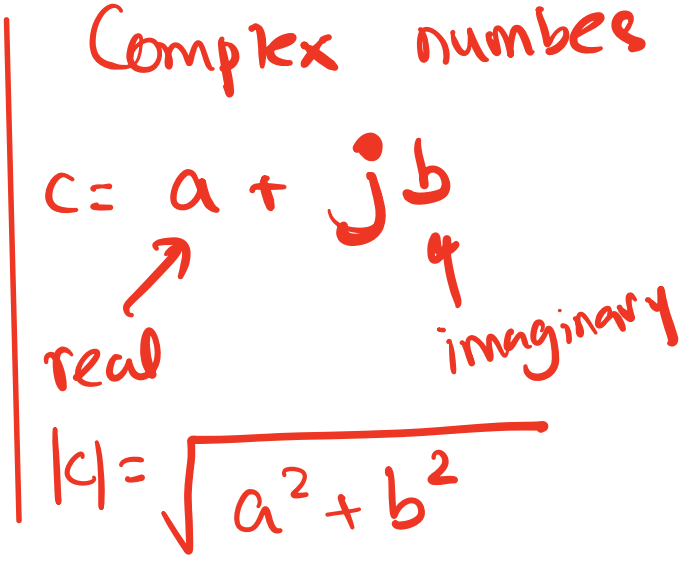
Concept: Classes describe objects

- Every object belongs to (is an instance of) a class
- An object may have fields, or variables
  - The class describes those fields
- An object may have methods
  - The class describes those methods
- A class is like a template, or cookie cutter

Abstract Data Types (ADT)

- Abstract Data Type is defined by data + operations on the data.
- Key features
  - **Abstraction:** hide implementation details
  - **Encapsulation:** bundle data and operations on the data, restrict access to data only through permitted operations

```
class Dish{
public:
      void pourIn( double amount);
      void pourOut(double amount);
private:
      double capacity;
      double currentAmount;
};
```

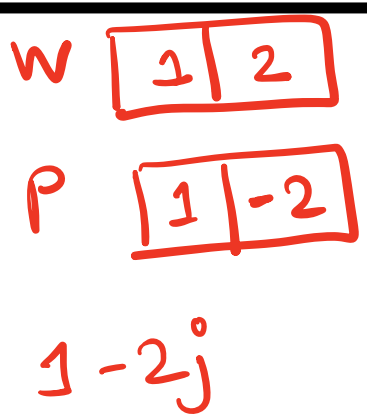


Approximate Terminology

- instance = object
- field = instance variable
- method = function
- sending a message to an object = calling a function

How many objects of the ADT Complex are created in main()?

```
int main(){
  Complex p;
  Complex w;
   w.setReal(1);
   w.setImag(2);
   p = w;
   p.conjugate();
   p.print();
}
```



A. One
B. Two
C. Three
D. Four
E. I am not sure . . .

```
class Complex
{
private:
    double real;
    double imag;
public:
    double getMagnitude() const;
    double getReal() const;
    double getImaginary() const;
    void print() const;
    void conjugate();
    void setReal(double r);
    void setImag(double r);
};
```

Will this code compile?

```
int main(){
  Complex p;
  Complex w(1, 2);
  p = w;
  p.conjugate();
  p.print();
}
```

A. Yes
B. No
C. I am not sure . . .

```
class Complex
{
private:
    double real;
    double imag;
public:
    double getMagnitude() const;
    double getReal() const;
    double getImaginary() const;
    void print() const;
    void conjugate();
    void setReal(double r);
    void setImag(double r);
};
```

Will this code compile?

```
int main(){
  Complex p;
  Complex w(1, 2);
  p = w;
  p.conjugate();
  p.print();
}
```

A. Yes
B. No: We need a parametrized constructor
C. I am not sure . . .

```
class Complex
{
private:
    double real;
    double imag;
public:
    Complex(double re = 0, double im = 0);
    double getMagnitude() const;
    double getReal() const;
    double getImaginary() const;
    void print() const;
    void conjugate();
    void setReal(double r);
    void setImag(double r);
};
```

Clever things in C++

x

1

"Hello"

1+2j

y

2

"World"

-1+5j

x+y

3

"Hello World"

0+7j

New method: add()

```
int main(){
  Complex p;
  Complex q(2, 3);
  Complex w(10, -5);
  w.conjugate();
  p = add(q, w);
  p.print();
}
```

Approach 1

```
int main(){
  Complex p;
  Complex q(2, 3);
  Complex w(10, -5);
  w.conjugate();
  p = q.add(w);
  p.print()
}
```

Approach 2

New method: add()

```
int main(){
  Complex p;
  Complex q(2, 3);
  Complex w(10, -5);
  w.conjugate();
  p = add(q, w);
  p.print();
}
```

Approach 1

```
int main(){
  Complex p;
  Complex q(2, 3);
  Complex w(10, -5);
  w.conjugate();
  p = q.add(w);
  p.print()
}
```

Approach 2

Overloading the + operator for Complex objects

```
p = add(q, w);
```

```
p = q.add(w);
```

```
p = q + w;
```

Goal: We want to apply the + operator to Complex type objects

Overloading the << operator

```
int main(){
  Complex w(10, -5);
  w.conjugate();
  w.print();
}
```

```
int main(){
  Complex w(10, -5);
  w.conjugate();
  cout << w;
}
```

```
Before overloading the << operator
```

```
After overloading the << operator
```

```
cout << w;
```

Select any equivalent C++ statement:

```
w.operator<<(cout);
```

A

```
cout.operator<<(w);
```

B

```
operator<<(cout, w);
```

C

```
operator<<(cout, w);
```

Select the function declaration that does NOT match the above call

A
```
void operator<<(ostream &out,
                const Complex &c);
```

B
```
void Complex::operator<<(ostream &out);
```

C
```
Complex operator<<(ostream &out,
                   Complex c);
```

Operator Overloading

We would like to be able to perform operations on two objects of the class using the following operators:

<<

==

!=

+

-

and possibly others

Some advice on designing classes

- Always, *always* strive for a narrow interface
- Follow the principle of abstraction and encapsulation:
  - the caller should know as little as possible about how the method does its job
  - the method should know little or nothing about where or why it is being called
  - Your class is responsible for it's own data; don't allow other classes to easily modify it! Make as much as possible private

What we have spoken about so far?

- Class = Data + Member Functions.
- Abstract Data Type = abstraction + encapsulation (uses classes)
- How to call member functions.
- How to implement a class's methods.