

Object Oriented Programming

Java Classes and Objects

Learning Outcomes

At the end of the Lecture students should be able to get a revision on OOC you learnt in Year 1

- Object Oriented Programming
 - Classes and Objects
 - Abstraction
 - Encapsulation
 - Inheritance
 - Polymorphism
 - Interfaces
-
- We will also look at key differences between writing Simple Object Oriented Programs in C++ and Java.

Object Oriented Programming

- Object Oriented programming is a method of implementation in which programs are organized as cooperative collections of objects, each of which represents an instance of some class, and whose classes are all members of a hierarchy of classes united via inheritance relationships.

(Reference : Grady Booch, eta (2008), Object Oriented Analysis and Design with Applications 3rd Edition, pg 41)

Object Oriented Programming

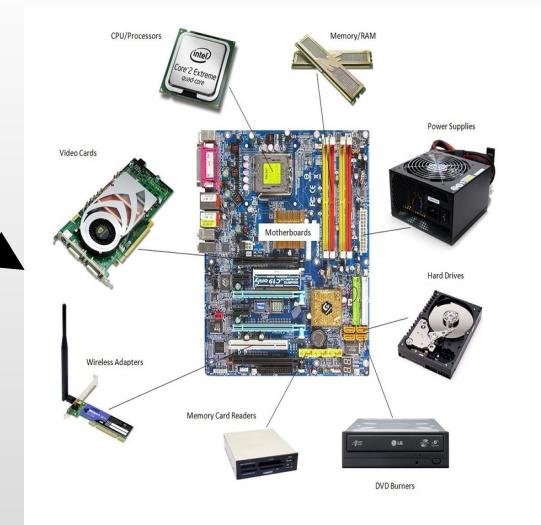
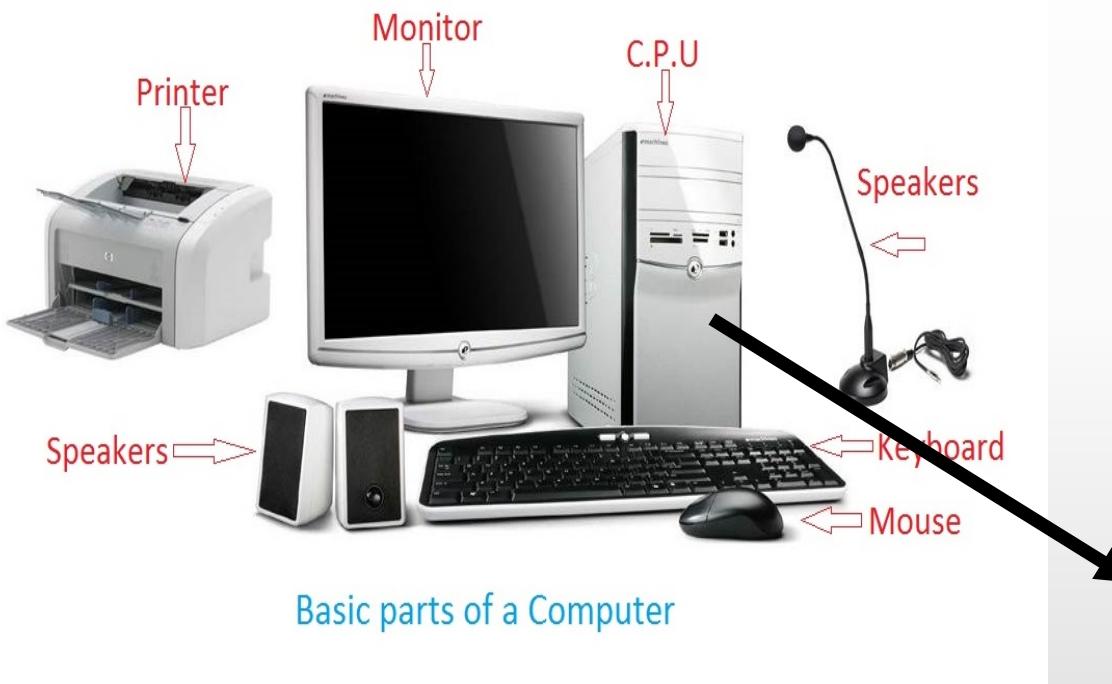
- Object Oriented Programming is a method of implementation in which programs are organized as a collection of objects which cooperate to solve a problem.
- Allows to solve more complex problems easily



Object Oriented Programming

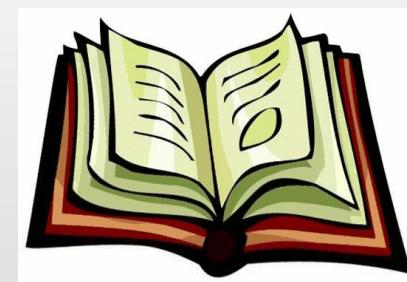
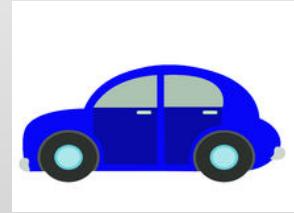
- A complex system is developed using smaller sub systems
- Sub systems are independent units containing their own data and functions
- Can reuse these independent units to solve many different problems

A Computer System



Classes

- A class is the abstract definition of the data type. It includes the data elements that are part of the data type, and the operations which are defined on the data type.
- It is an Entity which could be a thing, person or something that is imaginary.

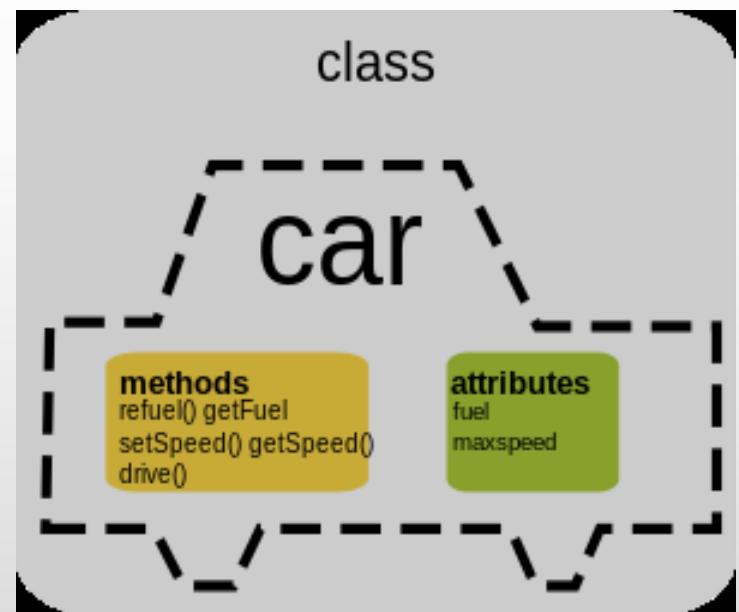


Classes

- An entity can be described by the data (Properties) and its behavior (methods)

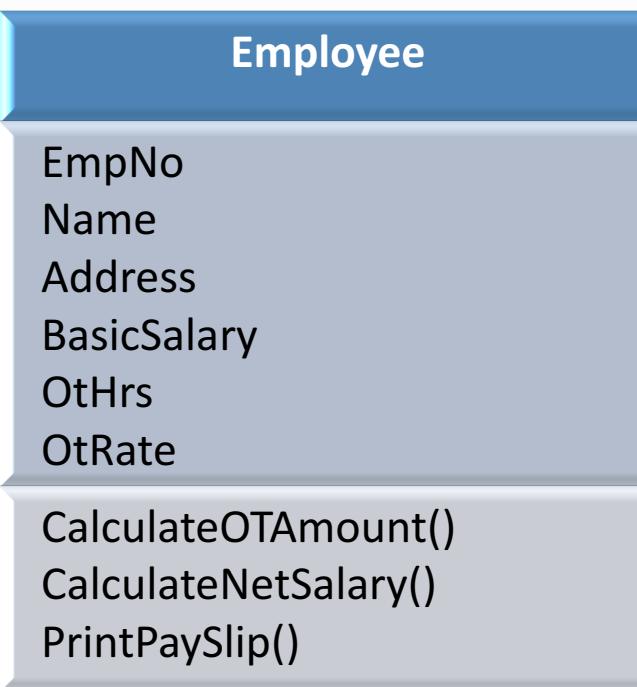
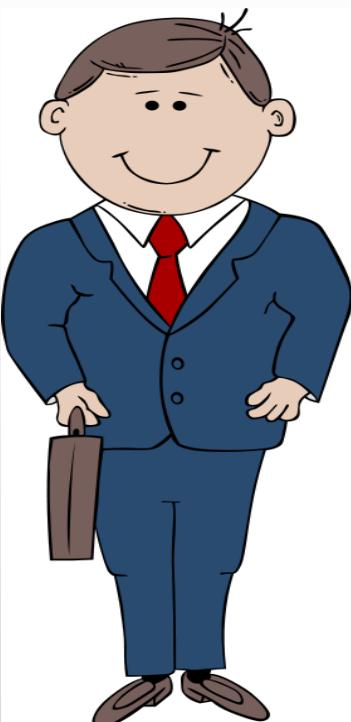
Class Name
Attributes/Properties
Methods

e.g.:



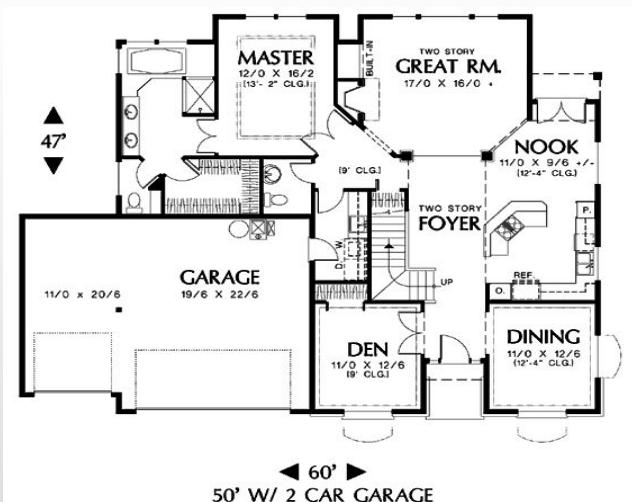
Classes cont...

- Eg : Person working in a Company

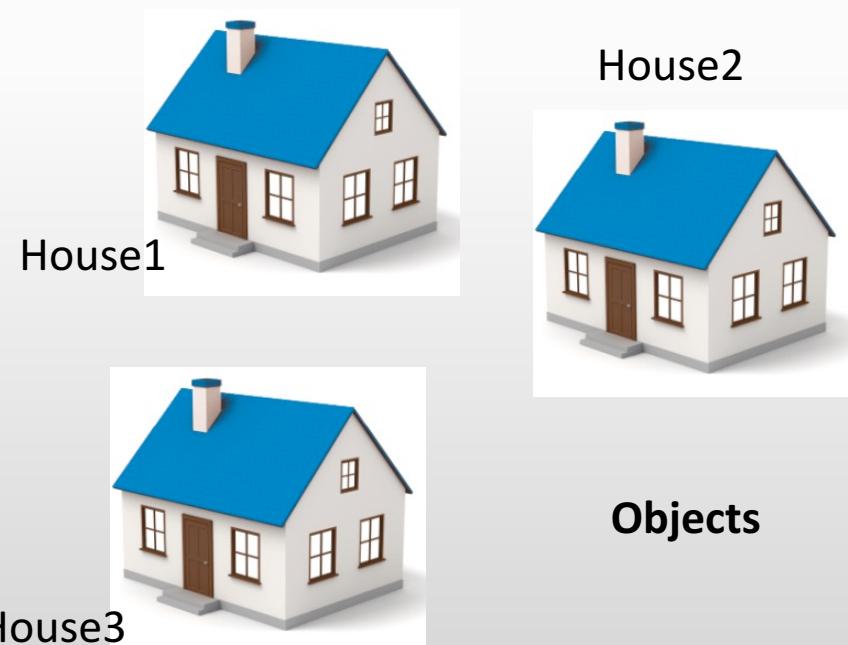


Classes and Objects

- An Object is a specific instance of the data type (class)
- A class is a blue print of an object.



Class House



Objects

- Objects are instances of classes, which we can use to store data and perform actions
- We need to define a class including the properties and methods and then create as many objects which has the same structure of the class (House example)

Class in C++

Student

StudentNo

Name

CA_marks

Private

Final_mark

Total

assignMarks ()

calculateTotal() Public

printDetails()

```
class Student{
```

```
private :
```

```
    int studentNo;
```

```
    char name[30];
```

```
    int CA_mark;
```

```
    int Final_mark;
```

```
public:
```

```
    void assignMarks(int pCA, int pFin);
```

```
    int calculateTotal();
```

```
    void printDetails();
```

```
}
```

Class in Java

```
class Student{  
    private :  
        int studentNo;  
        char name[30];  
        int CA_mark;  
        int Final_mark;  
    public:  
        void assignMarks(int pCA, int pFin) {  
        }  
        int calculateTotal() {  
        }  
        void printDetails() {  
        }  
};
```

C++

```
class Student {  
    private int studentNo;  
    private String name;  
    private int CA_mark;  
    private int Final_mark;  
  
    public void assignMarks(int pCA,  
                           int pFin) {  
    }  
    public int calculateTotal() {  
    }  
    public void printDetails() {  
    }  
}
```

Java

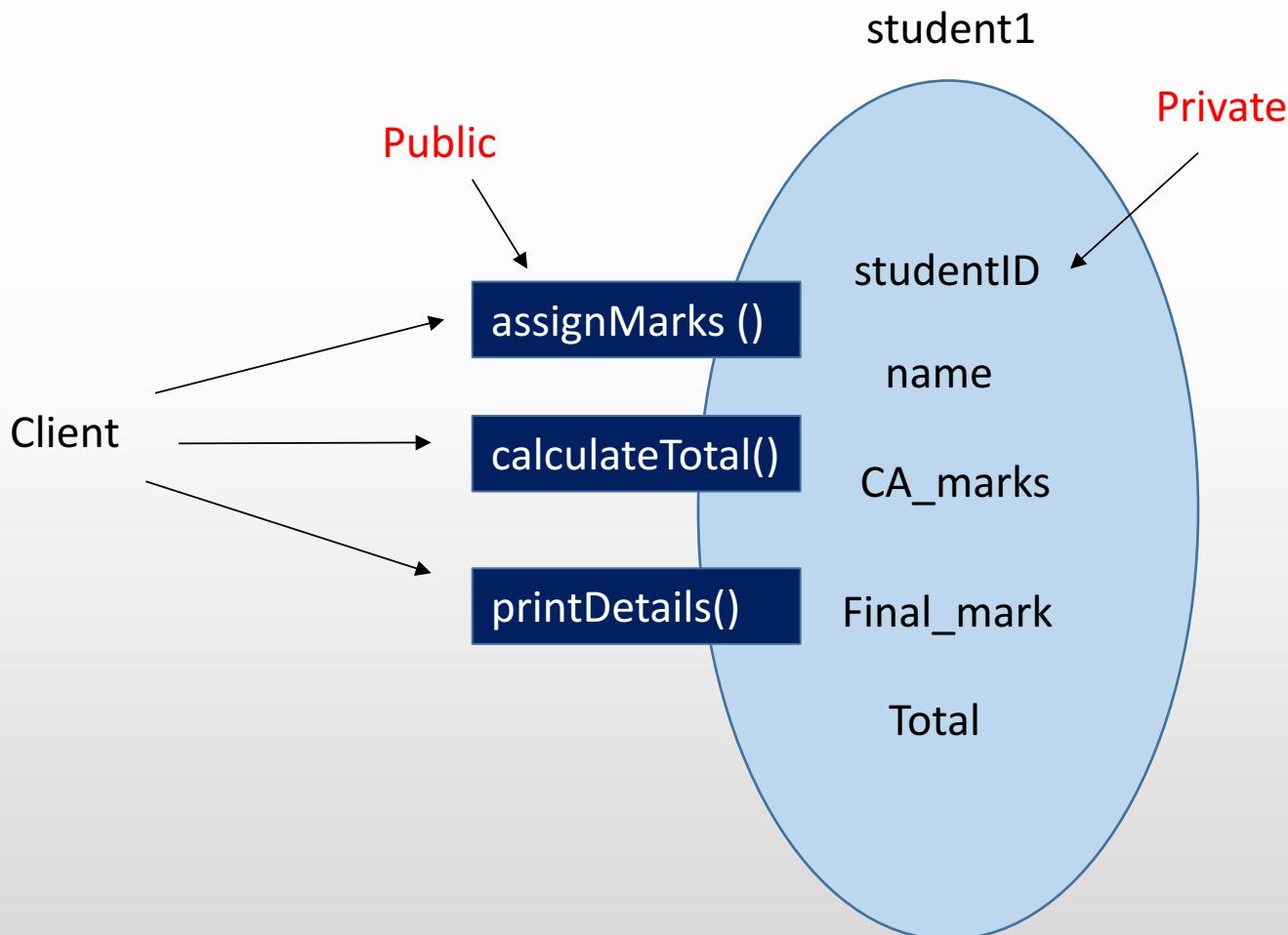
Java vs C++

- All methods are implemented in the class definition in Java.
- Each property, method needs a specific access modifier e.g. private, public, protected
- In Java there is no semi colon at the end of the class
- In Java you only have dynamic objects.
- Since Java has an automatic garbage collector, you do not need to use a command line delete to remove objects from memory.
- We use the dot operator instead of the -> operator to access methods in Java.

Private & Public

- The private part of the definition specifies the data members of a class
- These are hidden from outside the class and can only be accessed through the operations defined for the class
- The public part of the definition specifies the operations as function prototypes
- These operations, or methods as they are called, can be accessed by the main program.

Private & Public



Creating Objects

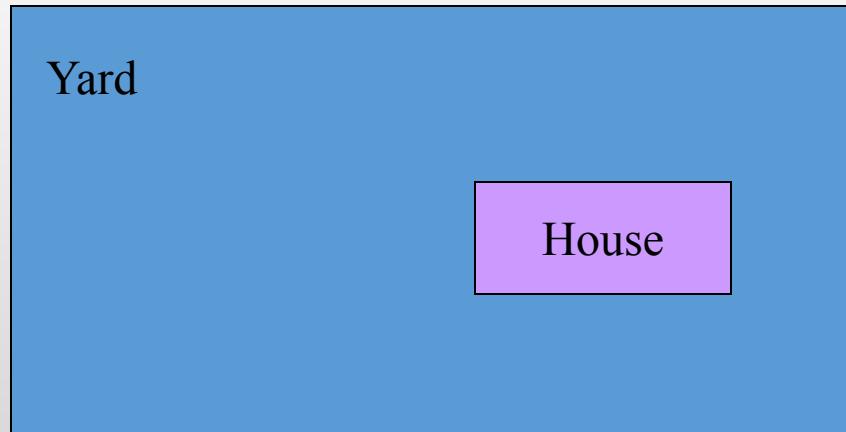
```
Student student1 = new Student();  
Student student2 = new Student();  
// We do not use * for pointers in Java
```

student1
studentNo – 1011
Name – Ajith Silva
CA_mark - 56
Final_mark -60

student2
studentNo – I131
Name – Surani Fernando
CA_mark - 70
Final_mark -65

Sample Client Program

- Write a program which will determine the square yardage to be mowed for a rectangular yard, given the dimensions of the yard and the dimensions of the house on that yard. It will also determine the cost of mowing the lawn which is so much per square yard.



Rectangle Problem

```
2  public class Rectangle {  
3      // private:  
4      private int width;  
5      private int length;  
6  
7      // public  
8      public void setWidth(int w) {  
9          if (w > 0)  
10             width = w;  
11         else  
12             width = 10;  
13     }  
14  
15     public void setLength(int l) {  
16         if (l > 0)
```

Rectangle.cpp

Rectangle.java

Classes and Objects

`Rectangle rectangle1, rectangle2;`

- This is somewhat similar to us defining simple variables. However rectangle1 and rectangle2 are dynamic objects. Memory is allocated when you use the new command.

`int marks1, marks2;`

- Rectangle is an example of a class. It's a user defined data type.
- Objects are also known as instances.

Rectangle Problem

```
27  class RectangleApp {  
28      public static void main(String args[]) {  
29          Rectangle a,b;  
30          a = new Rectangle();  
31          b = new Rectangle();  
32  
33          a.setWidth(30);  
34          a.setLength(100);  
35          b.setWidth(20);  
36          b.setLength(50);  
37          int total = a.area()- b.area();
```

Rectangle.java

Rectangle.cpp

System.out.println("Area is " + total);

16

Methods and Properties

- The Rectangle class has length and width as **properties**.
- In C++ properties are called **data members**, other popular names for **properties** are **attributes**, **variables**.
- area(), perimeter() are examples of **methods** in the Rectangle class.
- In C++ **methods** are called **member functions**, other popular names are **operations**, **behaviors**. These are really functions.

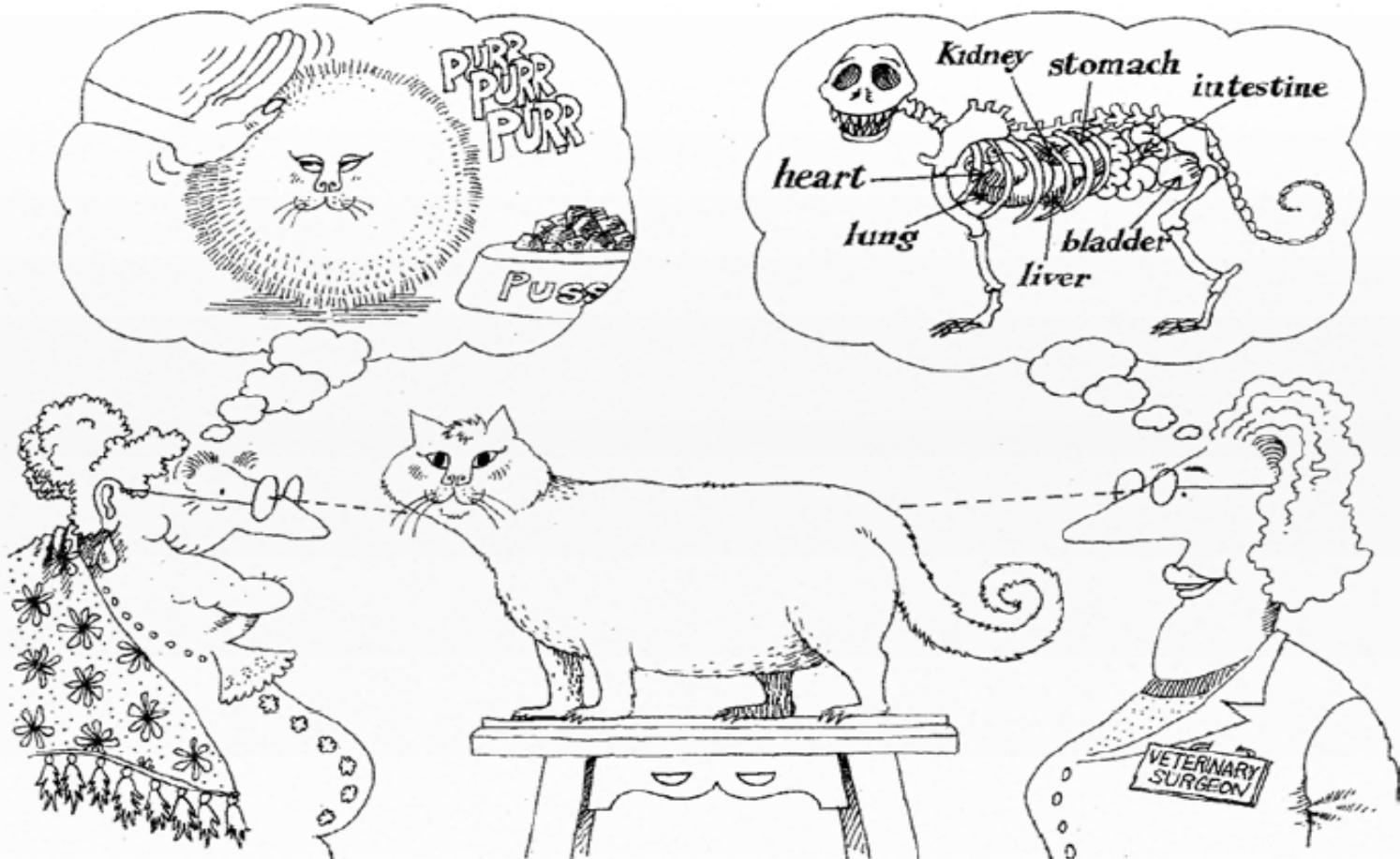
Abstraction

- An abstraction denotes the essential characteristics of an object that distinguish it from all other kinds of objects and thus provide crisply defined conceptual boundaries, relative to perspective of the viewer.
- (Reference : Grady Booch, eta (2008), Object Oriented Analysis and Design with Applications 3rd Edition, pg 44)

Abstraction

- Abstraction is the process of removing characteristics from ‘something’ in order to reduce it to a set of essential characteristics that is needed for the particular system.

Abstraction



Abstraction focuses on the essential characteristics of some object, relative to the perspective of the viewer.

Example

- Payroll system

Object : Employee

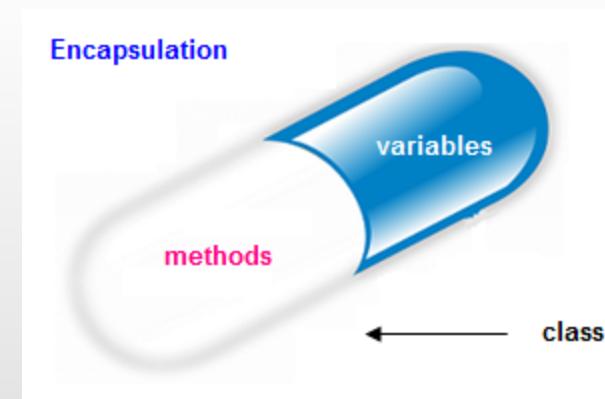
What are the attributes needed ?



Employee number	Marital status	Designation
OT Hours	Age	Loan Installment
OT Rate	Basic Salary	Height
Address	weight	Name
Hobbies	Bonus	Allowance
		Number of children
		Insurance payment
		Favourite Movie

Encapsulation

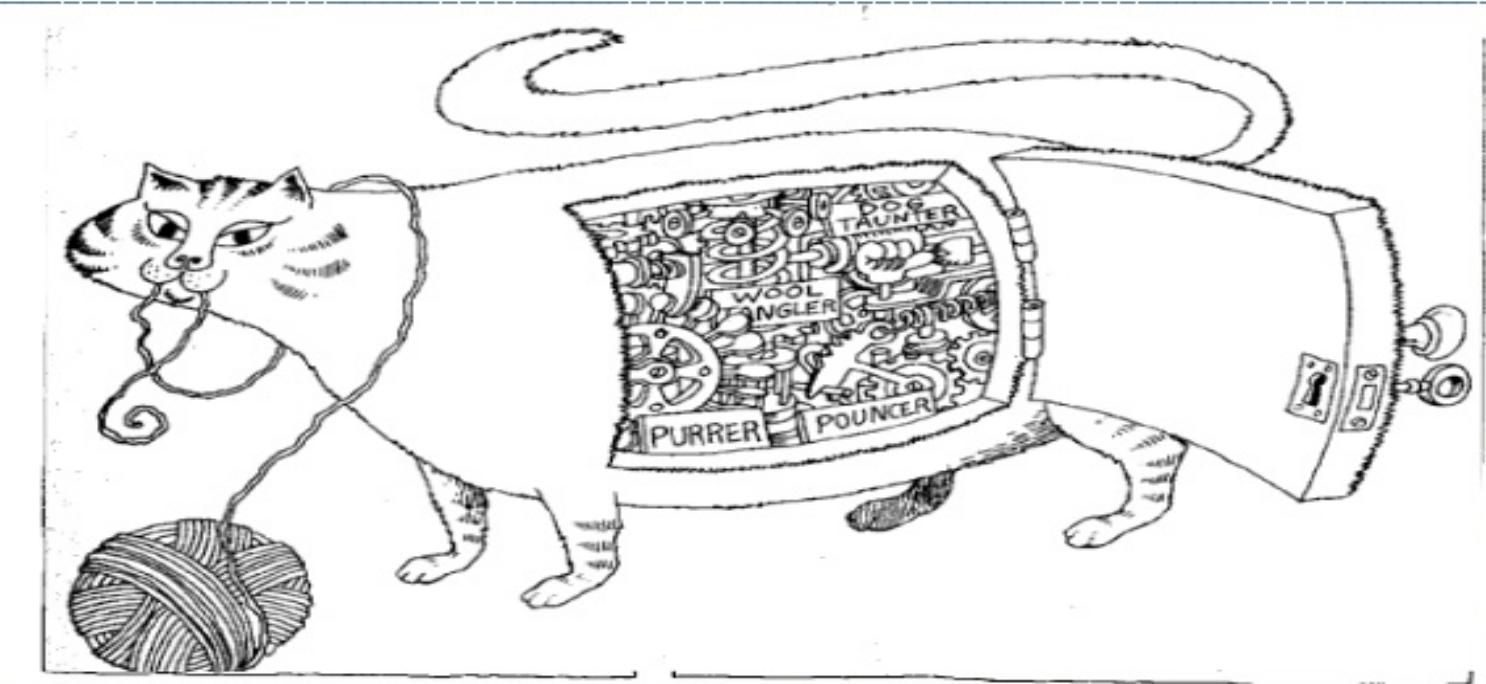
- Encapsulation is the process of compartmentalizing the elements of an abstraction that constitute its structure and behavior; encapsulation serves to separate the contractual interface of an abstraction and its implementation.



- (Reference : Grady Booch, eta (2008), Object Oriented Analysis and Design with Applications 3rd Edition, pg 52)

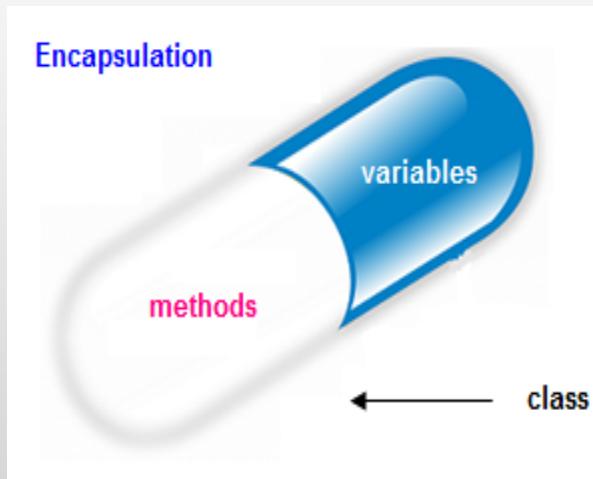
Encapsulation

Encapsulation hides the details of the implementation of an object



Encapsulation

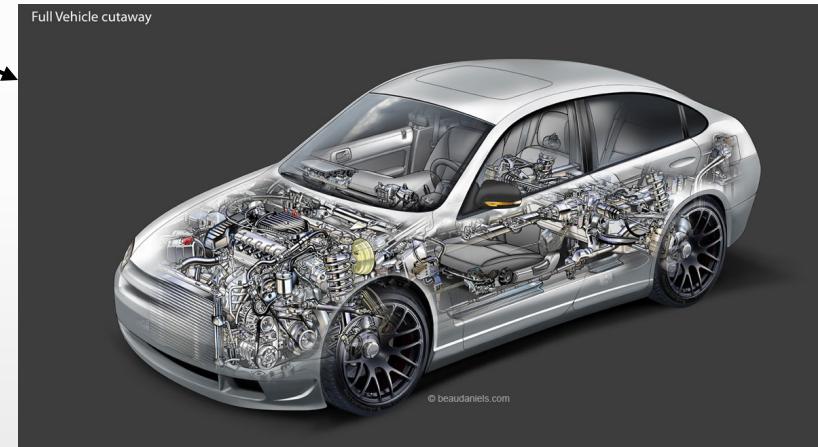
- It is the process of grouping related attributes and methods together, giving a name to the unit and providing an interface for outsiders to communicate with the unit.



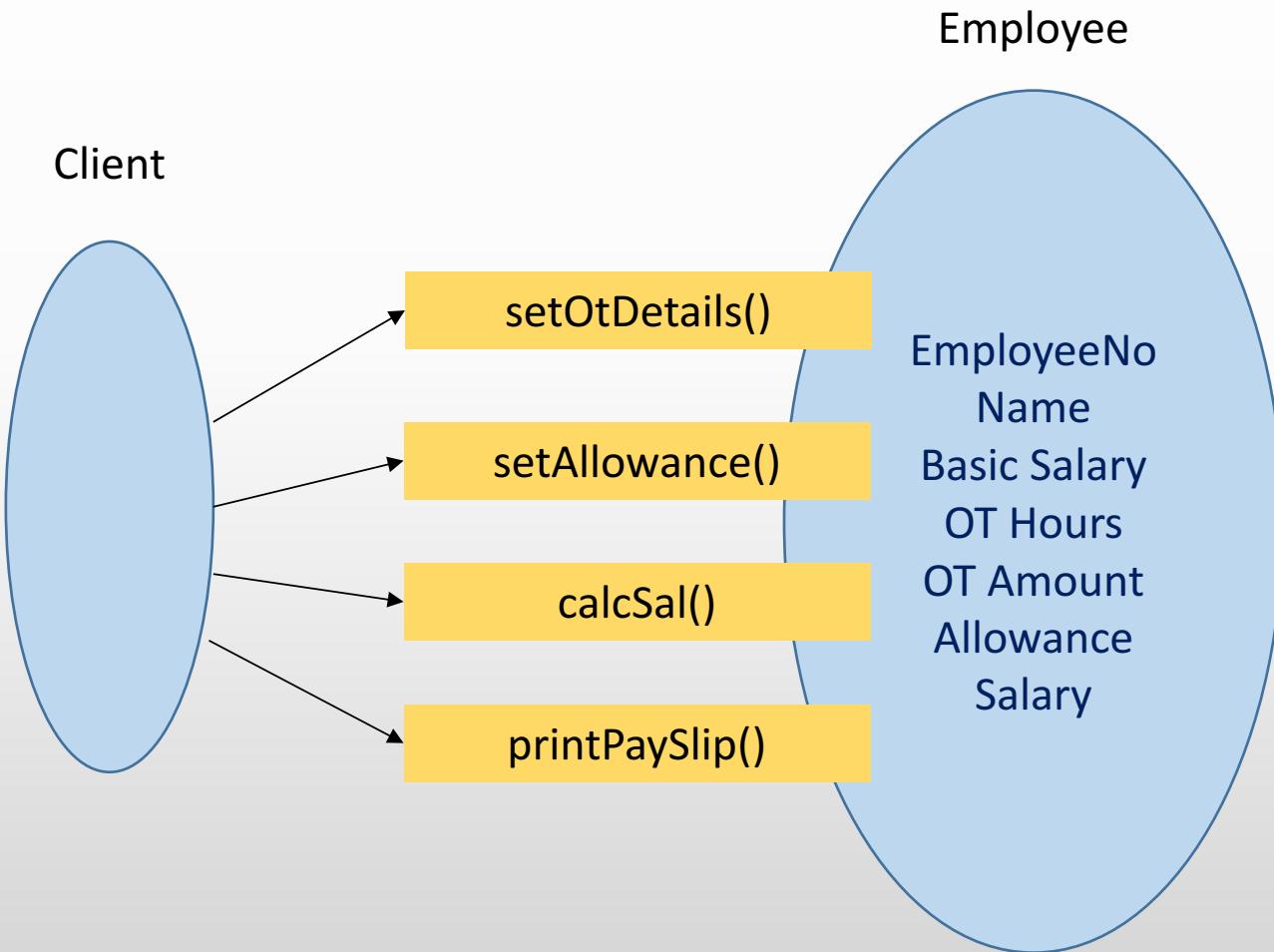
Information Hiding

- Hide certain information or implementation decision that are internal to the encapsulation structure (class)
- The only way to access an object is through its public interface
 - Public – anyone can access / see it
 - Private – no one except the class can see/ use it

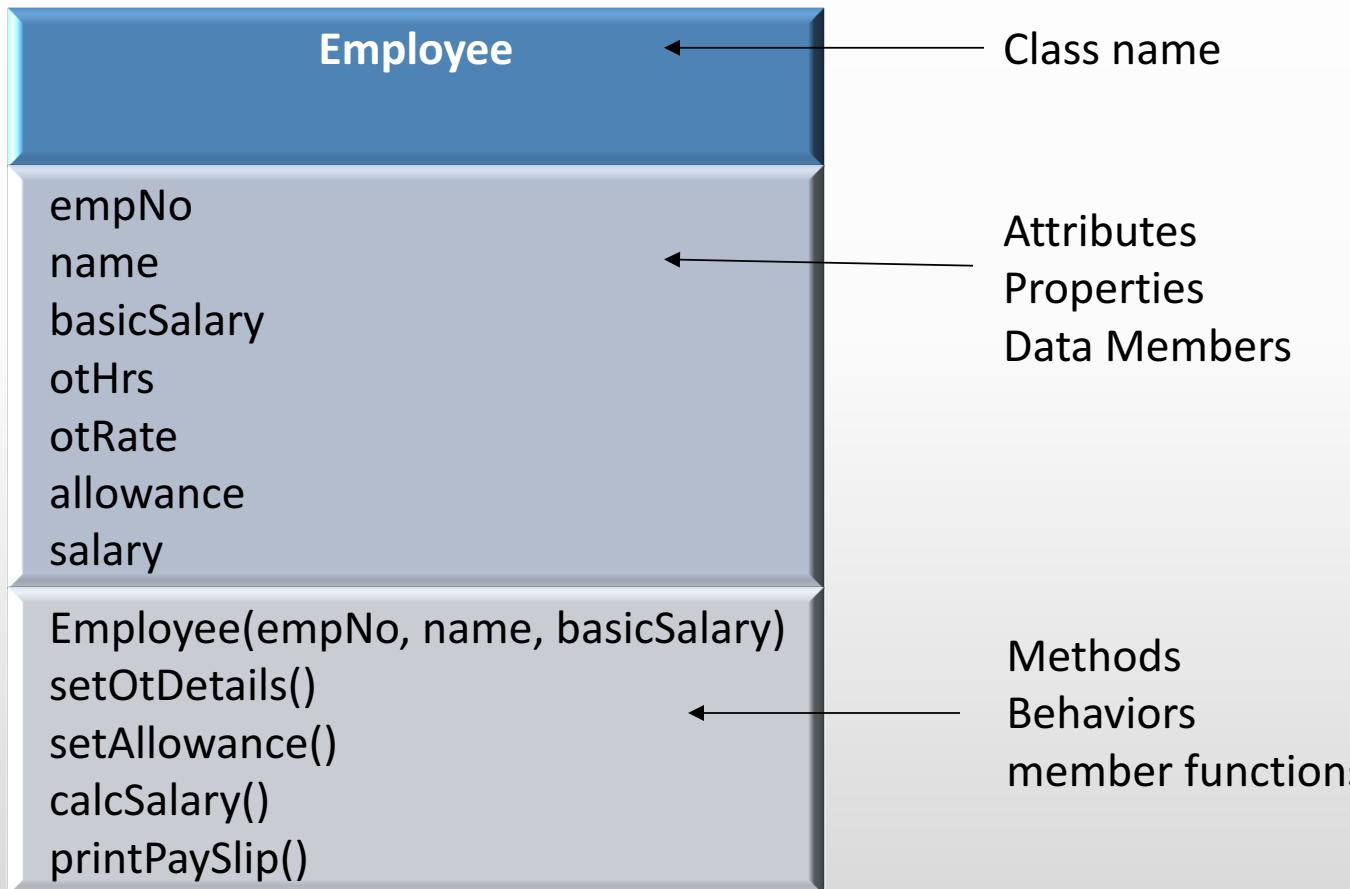
Interface



Interface



Terminology



Exercise 1

- Implement the Employee class shown in the earlier Slide.
- Implement a class called SalaryApp with a main method and Create Objects of the Employee class to calculate salaries.

Accessing Public Methods

```
class SalaryApp {  
    public static void main(String args[]) {  
        Employee emp1 = new Employee("IT143456",  
            "Rasika", 75000);  
        emp1.setOtDetails( 25, 1500.00);  
        emp1.setAllowance( 10000.00);  
        emp1.calcSal();  
        emp1.printPaySlip();  
    }  
}
```

Constructor

```
// default Constructor
public Rectangle () {
    width = 0;
    length = 0;
}
```

```
// Constructor with parameters
public Rectangle (int w, int l) {
    width = w;
    length = l;
}
```

```
public static void main(String args[]) {
    // default constructor called
    Rectangle r1 = new Rectangle();
    // Second constructor called
    Rectangle r2 = new Rectangle(10,20);
}
```

Constructor

- The constructor is used to initialize the object when it is declared.
- The constructor does not return a value, and has no return type (not even void)
- The constructors has the same name as the class.
- There can be default constructors or constructors with parameters
- When an object is declared the appropriate constructor is executed.

Constructors

- Default Constructors
 - Can be used to initialized attributes to default values

```
public Rectangle () {  
    width = 0;  
    length = 0;  
}
```

- Overloaded Constructors (Constructors with Parameters)
 - Can be used to assign values sent by the main program as arguments

```
public Rectangle (int w, int l) {  
    width = w;  
    length = l;  
}
```

Getters and Setters

- In general properties are declared as private preventing them from being accessed from outside the class.
- Typically an attribute will have a getter (accessor) (A get method to return its value) and a setter (mutator) (A set method to set a value).
- e.g. a property called length will have a getter defined as `int getLength()` and a setter defined as `void setLength()`. Both these methods will be declared as public methods.

Getters and Setters

```
4      private int width;
5      private int length;
6
7      // Constructors
8  [+]
11     }
12  [+]
15     }
16     // public
17  [-]
18  [-]
19     if (w > 0)
20     |
21     |   width = w;
22     |
23  [-]
24     return width;
25 }
```

this keyword

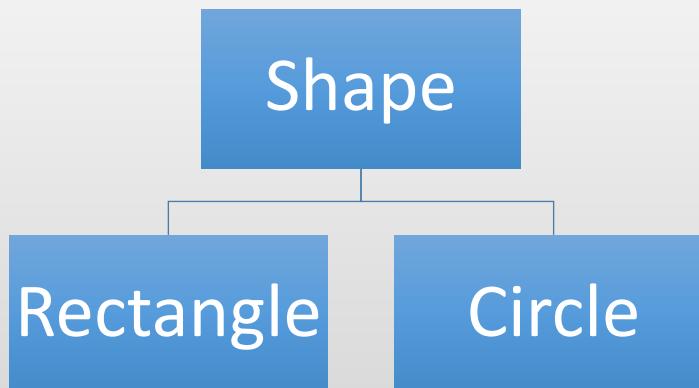
- The this **keyword** can be used to refer to any member of the current object from within an instance Method or a constructor.

```
public Employee(int pempno, String name, double pbasicSal) {  
    employeeNo = pempno;  
    this.name = name;  
    basicSalary = pbasicSal;  
}
```

- We need to use this.name to refer to the property name to distinguish it from the parameter name.

Generalization/Inheritance

- Child class **is a type** of the parent class
- Used to showcase reusable elements in the class diagram
- Child classes “inherit” the attributes and methods defined in the parent class



C++ vs Java - Inheritance

C++

```
class Circle : public Shape {
```

Java

```
class Circle extends Shape {
```

Java has a simpler inheritance mechanism where base class is extended as public.

C++ has multiple inheritance compared to Java's Single Inheritance.

C++ vs Java - Inheritance

C++

```
Circle (string tname, int r) : Shape ( tname ) {  
    radius = r;  
}
```

Java

```
public Circle (String tname, int r) {  
    super(tname);  
    radius = r;  
}
```

When you want to call a base class constructor C++ Requires to explicitly name the base class. In Java we use the super keyword to access the direct descendent class.

However this implies that in Java you can't directly call a class higher in the hierarchy e.g. the Grandfather class which is not in C++

C++ vs Java - Inheritance

C++

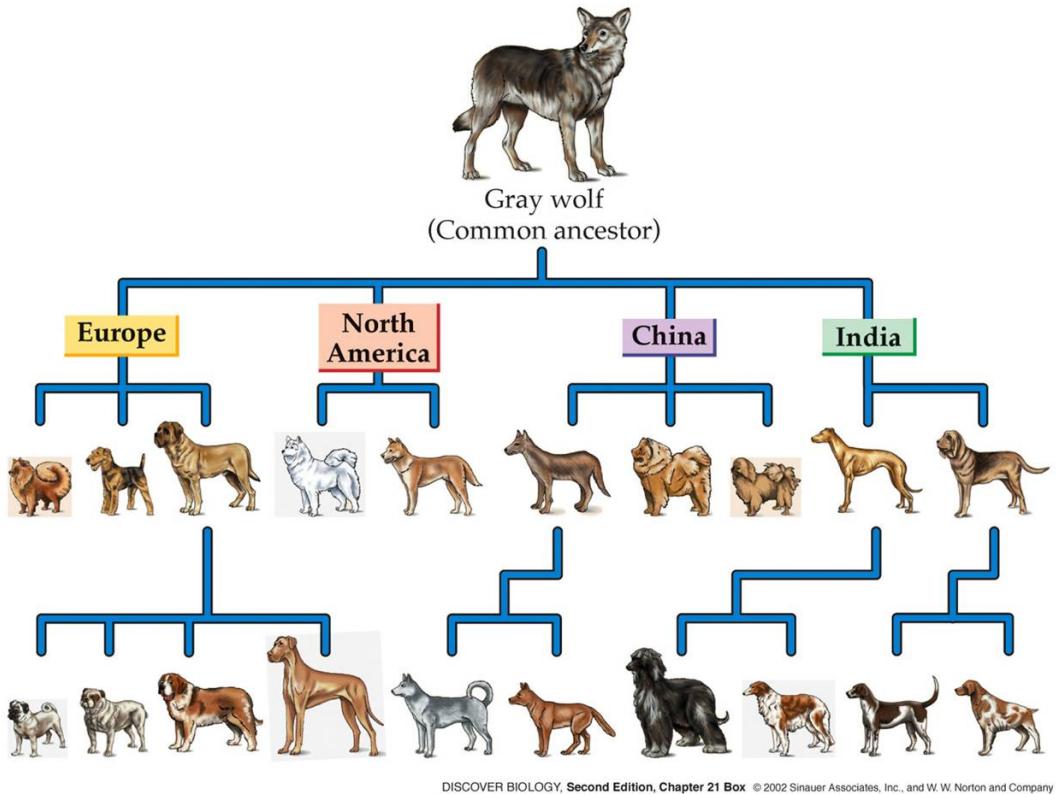
```
virtual void speak() {}
```

Java

```
public void speak() {}
```

All methods in Java are virtual by default. In C++ we need to explicitly define polymorphic methods.

Object Class



- A class hierarchy is similar to the taxonomy of animals that shows their ancestry.
- There are many breeds of dogs. A well known fact is that the common origin of a dog is the Gray Wolf.
- All Java classes are derived from a class called Object. This includes all the existing Java built in classes and the classes that you write. The methods and properties of the Object class is accessible to any Java class that you create.

Inheritance Shapes Example C++

```
23  class Rectangle: public Shape{  
24      protected:  
25          int width;  
26          int height;  
27      public :  
28          Rectangle (string tname, int w, int h) : Shape ( tname)  
29          {  
30              width = w;  
31              height = h;  
32          }  
33          int area( )
```

Shape_example.cpp

Inheritance Shapes Example Java

```
1  class Shape {  
2      protected String name;  
3      public Shape() {};  
4      public Shape (String tname) { ...  
5      }  
6      public void print() { ...  
7      }  
8      public int area(){ return 0;}  
9  }  
10 class Rectangle extends Shape { ...  
11 }  
12 class Circle extends Shape { ...  
13 }  
14 class ShapeApp {  
15     public static void main(String args[]) {  
16         Rectangle R = new Rectangle("Rectangle", 4 , 6);  
17         Circle C = new Circle("Circle", 3 );  
18     }  
19 }
```

Shape_example.java

Polymorphism

- Greek meaning “*having multiple forms*”
- Ability to assign a different meaning or usage to something in different contexts
- Specifically, to allow an entity such as a variable, a function, or an object to have more than one form

An example

- Consider the request (analogues to a method)
“please cut this in half” taking many forms



For a cake:

- Use a knife
- Apply gentle pressure

For a cloth:

- Use a pair of scissors
- Move fingers in a cutting motion

“please cut this in half”

- Imagine this task is automated...
- Without polymorphism
 - Need to tell the computer how to proceed for each situation
- With polymorphism
 - Just tell *please cut this in half*
 - The computer will handle the rest!

Animal Example

```
2  + class Animal { ...
20 }
21 + class Cat extends Animal { ...
30 }
31 + class Dog extends Animal { ...
40 }
41 + class Cow extends Animal { ...
50 }
51 - class AnimalApp {
52     public static void main(String args[]) {
53         Animal ani[] = new Animal[4];
54         ani[0] = new Cat("Micky the Cat");
55         ani[1] = new Dog("Rover the Dog");
56         ani[2] = new Cow("roo the Cow");
57         ani[3] = new Animal("no name");
58     - for (int r=0;r<4; r++)
59         ani[r].song();
```

Animal_example.cpp

Animal_example.java

Exercise 2

- In the Shape Example, extend the Rectangle class and create a class called Square.
- This should only have one dimension length as the parameter for the constructor.
- Minimize the code that needs to be written in the Square class making much as possible calls to the Rectangle Class.
- Create and use objects of the Square class.