National University of Computer & Emerging Sciences, Karachi
Computer Science Department
Spring 2023, Lab Manual – 08

Course Code: CL-1004	**Course : Object Oriented Programming Lab**
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<u>LAB - 8</u>

Abstract Classes & Interface

Abstract Class:

A class which is declared as abstract is known as an **abstract class**. It can have abstract and non-abstract methods. It needs to be extended and its method implemented. It cannot be instantiated.

- An abstract class must be declared with an abstract keyword.
- It can have abstract and non-abstract methods.
- It cannot be instantiated.
- It can have constructors and static methods also.
- It can have final methods which will force the subclass not to change the body of the method.

Syntax

abstract class A{}

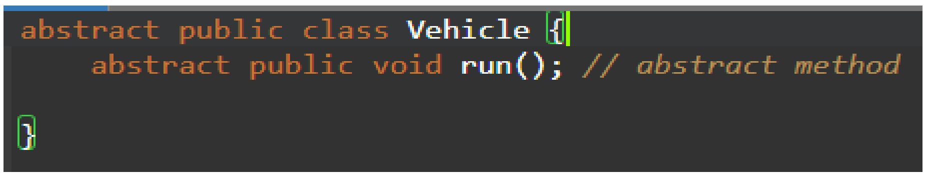
Abstract Method:

A method which is declared as abstract and does not have implementation is known as an **abstract method**.

Syntax

abstract *void myFunction( ); //no method body and abstract*

Example

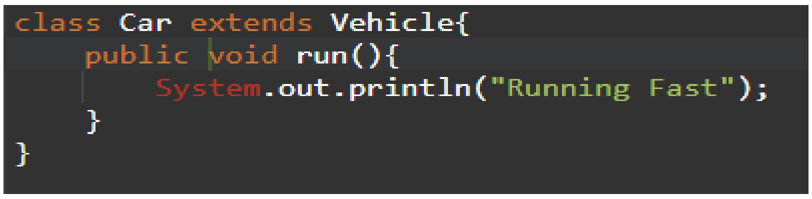


```
abstract public class Vehicle {
    abstract public void run(); // abstract method

}
```

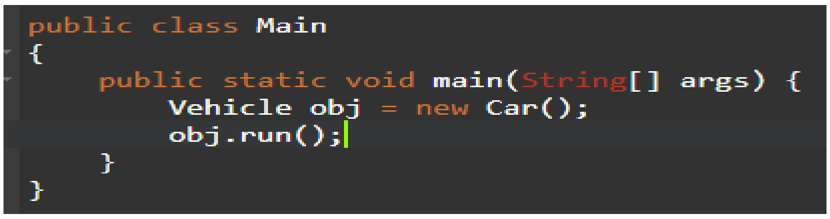
It is the responsibility of child class(es) to override the abstract function and "complete" the parent class.

Example



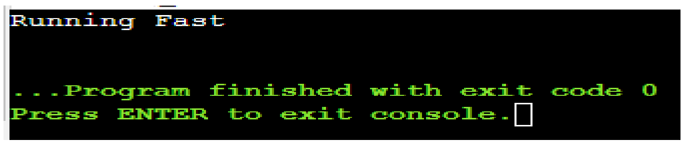
```
class Car extends Vehicle{
    public void run(){
        System.out.println("Running Fast");
    }
}
```

Example: (*Using abstract class from main)*



```
public class Main
{
    public static void main(String[] args) {
        Vehicle obj = new Car();
        obj.run();
    }
}
```

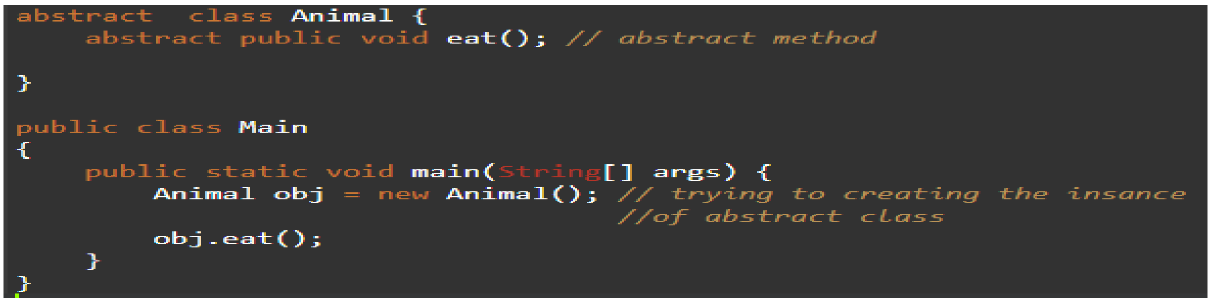
Output:



```
Running Fast


...Program finished with exit code 0
Press ENTER to exit console.
```

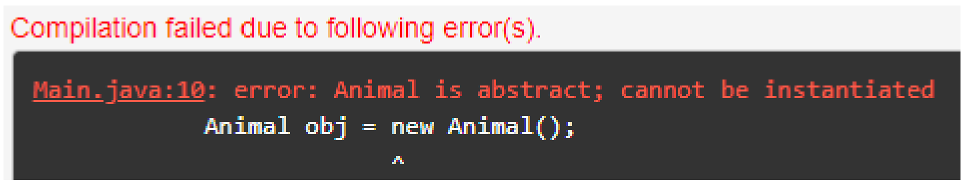
Point to Remember: We cannot create an instance of the abstract class.



```
abstract  class Animal {
    abstract public void eat(); // abstract method

}

public class Main
{
    public static void main(String[] args) {
        Animal obj = new Animal(); // trying to creating the insance
                                   //of abstract class
        obj.eat();
    }
}
```

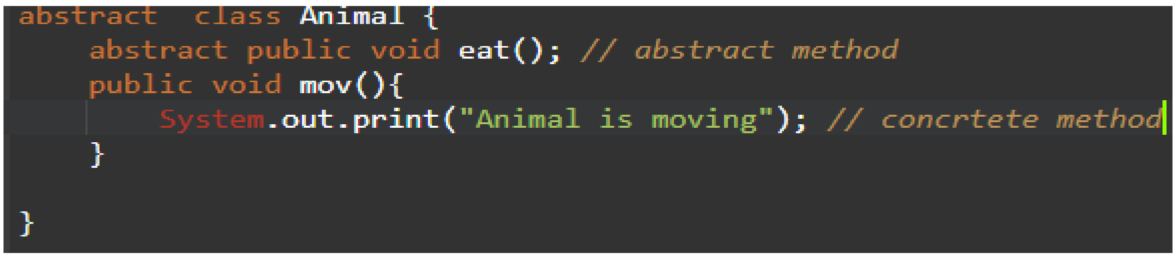


```
Compilation failed due to following error(s).

Main.java:10: error: Animal is abstract; cannot be instantiated
          Animal obj = new Animal();
                       ^
```

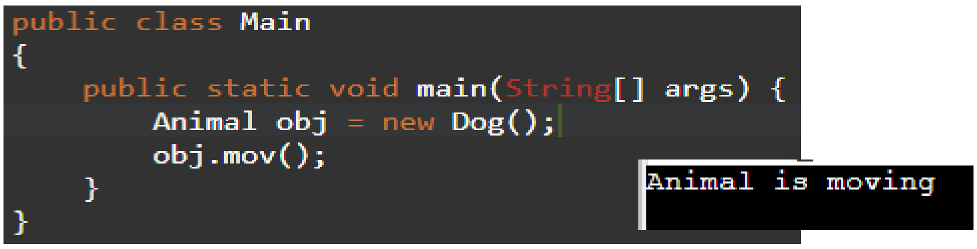
Point to Remember: An abstract class can contain concrete functions.

Example:



```
abstract  class Animal {
    abstract public void eat(); // abstract method
    public void mov(){
        System.out.print("Animal is moving"); // concrtete method
    }

}
```

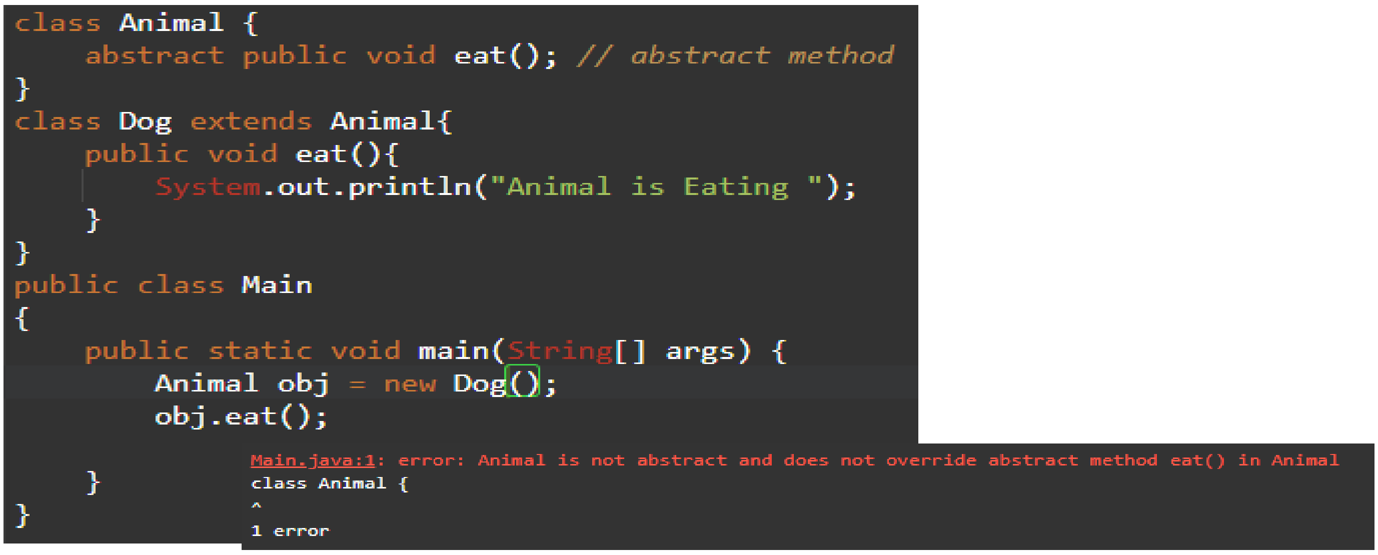


```
public class Main
{
    public static void main(String[] args) {
        Animal obj = new Dog();
        obj.mov();
    }
}
```

```
Animal is moving
```

Note: If there is an abstract method in a class, that class must be abstract.

Example:



```
class Animal {
    abstract public void eat(); // abstract method
}
class Dog extends Animal{
    public void eat(){
        System.out.println("Animal is Eating ");
    }
}
public class Main
{
    public static void main(String[] args) {
        Animal obj = new Dog();
        obj.eat();

    }
}
```

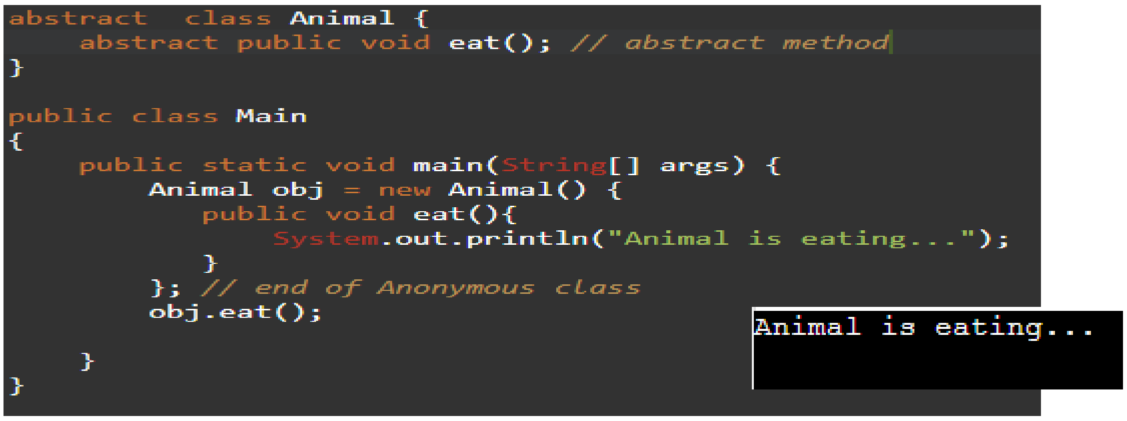
```
Main.java:1: error: Animal is not abstract and does not override abstract method eat() in Animal
class Animal {
^
1 error
```

Anonymous Class:

If we do not have a child class, we can still override the abstract function by creating an **Anonymous Class.**

- A new class is defined (without a name, so called anonymous class)
- This new class extends abstract base class
- Abstract methods are overriden in this new class
- New instance of this new class is created and assigned to the parent variable

Example



```
abstract  class Animal {
    abstract public void eat(); // abstract method
}

public class Main
{
    public static void main(String[] args) {
        Animal obj = new Animal() {
            public void eat(){
                System.out.println("Animal is eating...");
            }
        }; // end of Anonymous class
        obj.eat();

    }
}
```

```
Animal is eating...
```

Interfaces:

An **interface** in Java is a blueprint of a class. It has static constants and abstract methods. A difference between abstract classes and interface is that there can be concrete methods in abstract classes whereas interface cannot contain any.

How to create an interface:

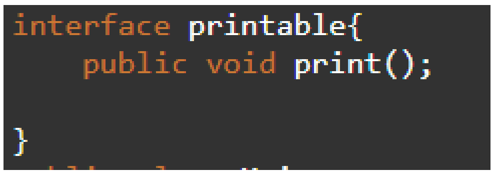
An interface is declared by using the interface keyword. It provides total abstraction; means all the methods in an interface are declared with the empty body, and all the fields are public, static and final by default. A class that implements an interface must implement all the methods declared in the interface.

Syntax:

interface *<interface_name>{*

// declare constant fields
// declare methods that are abstract
// by default.
}

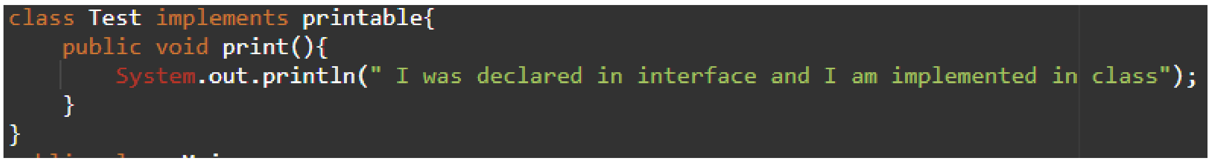
Example: *(Declaring an interface)*



```
interface printable{
    public void print();

}
```

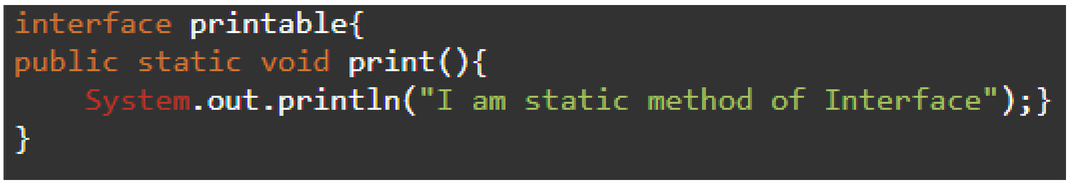
Example: *(Implementing interface in class)*



```
class Test implements printable{
    public void print(){
        System.out.println(" I was declared in interface and I am implemented in class");
    }
}
```

Points to Remember: We can create static methods in interfaces. But we must define their implementation inside the interface.

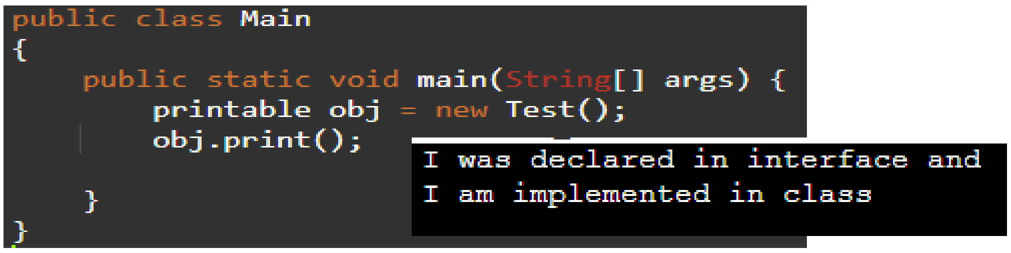
Example:



```
interface printable{
public static void print(){
    System.out.println("I am static method of Interface");}
}
```

Points to Remember: When a class implements an interface, we can save the object of that class in the interface variable.

Example:



```
public class Main
{
    public static void main(String[] args) {
        printable obj = new Test();
        obj.print();

    }
}
```

```
I was declared in interface and
I am implemented in class
```

Lab Exercise

1. Create an abstract class called Vehicle with the following properties and methods:
   - make: a string that stores the make of the vehicle.
   - model: a string that stores the model of the vehicle.
   - year: an integer that stores the year the vehicle was manufactured.
   - getSalePrice(): an abstract method that returns the sale price of the vehicle.

Next, create two concrete classes called Car and Truck that inherit from Vehicle. Car should have a constructor that takes in the make, model, and year of the car, as well as its base price. Truck should have a constructor that takes in the make, model, year, and weight capacity of the truck, as well as its base price.

Implement the getSalePrice() method in both Car and Truck as follows:

- For a car, the sale price is the base price multiplied by a coefficient determined by the year of manufacture. If the car is less than 3 years old, the coefficient is 1.2. If the car is between 3 and 10 years old (inclusive), the coefficient is 0.9. Otherwise, the coefficient is 0.5.
- For a truck, the sale price is the base price plus a premium determined by its weight capacity. If the weight capacity is less than 2 tons, the premium is 5000. If the weight capacity is between 2 and 5 tons (inclusive), the premium is 10000. Otherwise, the premium is 20000.

Finally, create a program that creates objects of Car and Truck (using vehicle class reference), calculates and prints their sale prices using the getSalePrice() method.

2. Define an abstract class **Character** that contains:
   - an integer health variable that represents the character's health,
   - an integer attackPower variable that represents the character's attack power
   - string name variable that represents the character's name.
   - specialAbility() (abstract method): An abstract method that must be implemented by the subclass for each character type. This method defines the unique special ability of each character type.
   - attack() (non-abstract method): A method that takes another Character object as a parameter and simulates an attack from the current character to the target character. It subtracts the attack power of the current character from the target character's health.

Define **Warrior** class that contains:

- specialAbility() (method implementation): Overrides the abstract specialAbility() method in the Character class to define the unique special ability for a Warrior character. In this implementation, the warrior's attack power is doubled.

Define **Mage** class that contains:

- specialAbility() (method implementation): Overrides the abstract specialAbility() method in the Character class to define the unique special ability for a Mage character. In this implementation, the mage's attack power is increased by 20.

Define class **Archer** that contains:

- specialAbility() (method implementation): Overrides the abstract specialAbility() method in the Character class to define the unique special ability for an Archer character. In this implementation, the archer's attack power is increased by 15.

Finally, create an instance of each subclass in Game(Main Class) class and set their attributes such as name, health, and attackPower. Then call the attack() method to simulate a battle between the characters. Also call the specialAbility() method to use the unique special ability of each character.

3. Define an interface called MessageService. The interface includes two methods:
   - send(String message, String recipient): This method takes two string values as parameters, representing the message content and the recipient's username. It sends the message to the recipient.
   - receive(): This method receives a message from the messaging service and returns it as a string value.

Create a WhatsApp class that implements interface and provides concrete implementations for methods in interface. In the Main class, create an instance of WhatsApp (using the Message Service reference), and ask the user to enter the message he wants to send also enter the name to whom he wants to send a message and print it.

4. Create an interface called Shape with the following methods:
   - getArea(): a method that returns the area of the shape.
   - getPerimeter(): a method that returns the perimeter of the shape.

   Next, create two classes called Rectangle and Circle that implement the Shape interface. Rectangle should have a constructor that takes in the length and width of the rectangle, while Circle should have a constructor that takes in the radius of the circle.
   Implement the getArea() and getPerimeter() methods in Rectangle and Circle as follows:
   - For Rectangle, the area is the product of its length and width, and the perimeter is twice the sum of its length and width.
   - For Circle, the area is pi times the square of its radius, and the perimeter is twice pi times its radius.

   Finally, create a program that creates objects of Rectangle and Circle (using the Shape as a reference), calculates and prints their areas and perimeters using the getArea() and getPerimeter() methods