

# Module 1-11

Inheritance

# Inheritance

Real world objects can exhibit parent-child relationships. Consider the following examples:

- Humans, dogs, elephants, and whales are clearly quite different from each other, but they have enough similarities prompting biologists to classify them as mammals.
- Cars, motorcycles, and trucks are all motor vehicles, but they each have sufficient differences for the Department of Motor Vehicles to regulate them differently.
- In finance, the word account can refer to a checking account, a savings account, or mutual fund, but they all share similarities like a monthly balance and account holder name.

# Inheritance

Java and most modern programming languages provide powerful tools that enable developers to model these parent-child relationships.

- More specifically in Java one class can be classified as a child of a parent class.
  - The child class can inherit properties and methods defined by the parent.
- Inheritance can take on several forms:
  - A **concrete class** (all the classes we have seen so far) inheriting from another concrete class.
  - A concrete class inheriting from an **abstract class**.
  - A concrete class inheriting from an **Interface**.

# Inheritance: Declaration

In this module, we will explore the situation where two concrete classes have a parent child relationship. A child class that will inherit from a parent must be defined following this syntax:

```
public class <<Name of Child Class>> extends <<Name of Parent Class>> {  
  
    ... // rest of your class declaration  
  
}
```

# Inheritance Example

Vehicle has defined several methods and data members. In this example, Vehicle serves as the parent class.

```
package te.mobility;

public class Vehicle {

    private int numberOfWheels;
    private double engineSize;
    private String bodyColor;

    public int getNumberOfWheels() {
        return numberOfWheels;
    }

    public void setNumberOfWheels(int numberOfWheels) {
        this.numberOfWheels = numberOfWheels;
    }

}
```

We use the **super** keyword to refer to the parent's members and variables.

Car is a child class of Vehicle.. Note how it is able to call Vehicle's methods. The extends syntax is used to create this relationship.

```
package te.mobility;

public class Car extends Vehicle {

    public void report() {
        System.out.println(super.getNumberOfWheels());
        // 0, inherited from parent class which will have the
        // default value for integers.

        super.setNumberOfWheels(4);
        // we are calling the setter defined on its parent

        System.out.println(super.getNumberOfWheels());
        // 4
    }

}
```

# Inheritance Example

Here we define another child class of Vehicle called Truck.

```
package te.mobility;

public class Truck extends Vehicle {

    public void report() {
        super.setNumberOfWheels(10);
        // we are calling the setter defined on its parent
    }

    public void coupleCargoContainer() {
        System.out.println("coupling cargo container");
        super.setNumberOfWheels(18);
    }

}
```

We now have a parent class with 2 child classes. Vehicle is the parent class. Both Truck and Car extends from vehicle, making them child classes of the vehicle.

The Truck class has its own unique method, it has a method called coupleCargoContainer() which is unique to the Truck class, and not part of the Vehicle or Car class.

# Inheritance Example

```
package te.main;

import te.mobility.Car;
import te.mobility.Truck;

public class Garage {

    public static void main(String args[]) {

        Car myCar = new Car();
        myCar.setup();
        System.out.println(myCar.getNumberOfWheels());

        Truck myTruck = new Truck();
        myTruck.setup();
        System.out.println(myTruck.getNumberOfWheels());
        myTruck.coupleCargoContainer();
        System.out.println(myTruck.getNumberOfWheels());

        // This is an invalid call:
        //myCar.coupleCargoContainer();

    }
}
```

Suppose have an orchestrator class called Garage with a main method that will instantiating new cars and trucks based on the setup we've established so far.

Output will be 4

Output will be 10

Output will be 18

This is an invalid statement, the coupleCargoContainer method is unique to the Truck class.

# Effect of Private Modifiers on Inheritance

The access modifiers present on the parent class' data members is not trivial.

- Data members and methods marked as private on a parent class cannot be inherited by a child class.
- Data members and methods marked as protected can be inherited by a child class even if it's on a different package.



# Effect of Private Modifiers on Inheritance

Consider the following example:

```
package te.mobility;

public class Vehicle {
    ...
    private String privateMethod() {
        return "private";
    }
    ...
}
```

We are assuming that the Car class extends from Vehicle like on the previous examples.

```
package te.main;

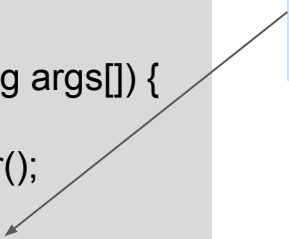
import te.mobility.Car;
import te.mobility.Truck;

public class Garage {

    public static void main(String args[]) {

        Car myCar = new Car();
        myCar.setup();
        myCar.privateMethod();
        ...
    }
}
```

This is an invalid call.



# Constructors on Parent Classes

If a parent has implemented a constructor, a child class must add a call using `super(...)` to invoke the parent's constructor with the correct arguments.

The syntax of `super(...)` is as follows:

```
public ChildClass(<<argument 1>>, <<argument2>>, ....) {  
  
    super(<<argument1>>, <<argument2>>, ...);  
  
}
```

The arguments listed are arguments on the parent's constructors

# Constructors on Parent Classes: Example

```
package te.mobility;
```

```
public class Vehicle {
```

```
    private int numberOfWheels;
```

```
    private double engineSize;
```

```
    private String bodyColor;
```

```
    public Vehicle(int numberOfWheels, double engineSize, String bodyColor) {
```

```
        this.numberOfWheels = numberOfWheels;
```

```
        this.engineSize = engineSize;
```

```
        this.bodyColor = bodyColor;
```

```
    }
```

```
    ...
```

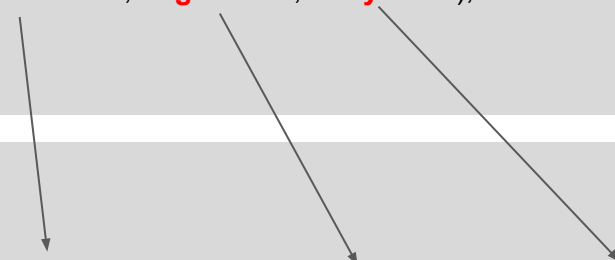
```
}
```

There is now a constructor in the parent Vehicle class.

# Constructors on Parent Classes: Example

Note how the child class, Truck will now have to implement a constructor with a `super(...)` call.

```
public class Truck extends Vehicle {  
  
    public Truck(int numberOfWheels, double engineSize, String bodyColor) {  
        super(numberOfWheels, engineSize, bodyColor);  
    }  
  
    ...  
}
```



```
public class Vehicle {  
    ...  
  
    public Vehicle(int numberOfWheels, double engineSize, String bodyColor) {  
        this.numberOfWheels = numberOfWheels;  
        this.engineSize = engineSize;  
        this.bodyColor = bodyColor;  
    }  
  
    ...  
}
```

The `super(...)` call is basically a call to the parent constructor, providing any required parameters

# Constructors on Parent Classes: Example

In the Garage orchestrator class note how we are able to instantiate a new Truck with the constructor.

```
package te.main;

import te.mobility.Truck;

public class Garage {

    public static void main(String args[]) {

        Truck cargoTruck = new Truck(10, 14.8, "red");

    }

}
```

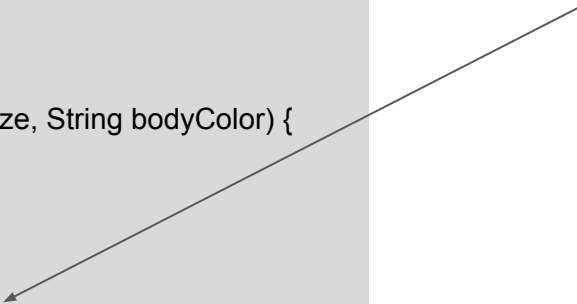
# Multiple Constructors

Classes can contain more than one constructor, each taking a different number of arguments.

# Multiple Constructors Example

Consider the following example:

```
public class Vehicle {  
  
    private int numberOfWheels;  
    private double engineSize;  
    private String bodyColor;  
  
    public Vehicle(int numberOfWheels, double engineSize, String bodyColor) {  
        this.numberOfWheels = numberOfWheels;  
        this.engineSize = engineSize;  
        this.bodyColor = bodyColor;  
    }  
  
    public Vehicle(int numberOfWheels, double engineSize) {  
        this.numberOfWheels = numberOfWheels;  
        this.engineSize = engineSize;  
    }  
  
    ...  
}
```



Note that there is now a second constructor that does not take a bodyColor argument.

# Multiple Constructors Example

```
public class Truck extends Vehicle {  
  
    public Truck(int numberOfWheels, double engineSize, String bodyColor) {  
        super(numberOfWheels, engineSize, bodyColor);  
    }  
  
    public Truck(int numberOfWheels, double engineSize) {  
        super (numberOfWheels, engineSize);  
    }  
}
```

Note how the child class has also implemented a matching second constructor and called the 2 argument parent constructor using super.

