

# Introduction to Programming

*with Java, for Beginners*

## Inheritance

## Example: Bot and BetterBot

```
public class Bot{
    private int x;
    private int y;

    public int getX() { .. }
    public int getY() { .. }

    public void eatDot(){ ..}
    public void move(){.. }
    public void turnLeft(){.. }
}

public class BetterBot extends Bot{
    ...
    public void turnRight(){
        turnLeft();
        turnLeft();
        turnLeft();
    }
}
```

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## Inheritance

One of the key concepts of OOP

- A hierarchical relationship among classes
- Establishes a superclass/subclass relationship
- Establishes "is a" relationships
  - e.g. a BetterBot "is a" Bot

Benefits:

- Reusability of code
  - Put code in one class, use it in all the subclasses
  - Revisions only needs to be done in 1 place
- Polymorphic code (works on "many forms")
  - Write general purpose code designed for a supertype that works for all subtypes

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## The "extends" keyword

Inheritance is established via the "extends" keyword

```
public class Bot{
}

public class BetterBot extends Bot{
}
```

Now we say

- BetterBot *inherits* from Bot
  - However, based on the visibility modifiers, certain instance variables and methods defined in Bot may not be accessible
- A BetterBot "is a" Bot
- BetterBot is a *subclass/subtype* of Bot
- Bot is the *superclass/supertype* of BetterBot

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## What can you inherit ?

- Visibility modifiers determine which class members are accessible and which do not
- Members (variables and methods) declared with **public** visibility are accessible, and those with **private** visibility are not
- Problem: How to make class instance variables visible only to its subclasses?
  - Solution: Java provides a third visibility modifier that helps in inheritance situations: **protected**

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## Constructors and Inheritance

```
BetterBot b = new BetterBot();
```

- When an object is created, its constructor is called
  - But first, a constructor from its highest ancestor (Object) is called, then the next highest (Bot), then its own (BetterBot)
  - The default behavior is such that the default (no-argument constructor) is executed
- A constructor can explicitly call its parent's (its superclass') constructor by making a call to **super(arguments)**

```
public class BetterBot extends Bot{  
  
    public BetterBot (BotWorld world){  
        super(world);  
    }  
    ...  
}
```

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## Another Example with super

```
public class Dog{  
    private String name;  
    private int age;
```

```
    Dog(String name, int age){  
        this.name = name;  
        this.age = age;  
    }  
}
```

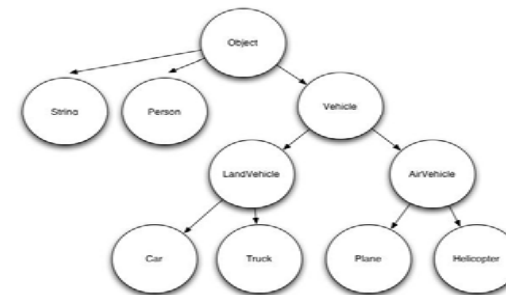
```
class BetterDog extends Dog{  
    public Dog(String name, int age){  
        super(name, age);  
    }  
}
```

- super refers to the object that contains the piece of code
- super is for use in a subclass

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## Inheritance Tree



- Java has *single inheritance*; each node has one parent
- Except for Object which has no parent

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## The Object Class

All classes inherit from the Object class

- The Object class is the root of the class hierarchy
- When we create a new class, "extends Object" is implied/implicit

```
public class Car {  
}  
  
public class Car extends Object{  
}
```

The Object class has several methods which all object *inherit*, most notably: **toString()** and **equals()**

- Once we inherit these, we can also override the behavior i.e. make it conform to what the object of subclass will do when this method is called.

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## The toString() Method

- By default, it returns a String containing an object's *heap* address
- By convention, it is *overridden* to describe the object's state
- Most common usage: debugging

```
public class Car {  
    private int miles;  
    private String model;  
}  
  
public Car(String model) {  
    this.model = model;  
    miles = 0;  
}  
  
public String toString() {  
    return "model: " + model + ", miles: " + miles;  
}
```

Recall toString()  
from RealVector  
Assignment

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## The toString() Method contd..

- When you try to print a reference variable's value, the toString() method is called
- This happens behind scenes
- E.g. Dog d = new Dog();
  - In Dr Java  
> d  
Dog@a010ba  
Is equivalent to  
> d.toString()
  - Using System.out.println(d) is equivalent to System.out.println(d.toString())

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## Need for equals(): Comparison of Strings

- If the == operator is used for Strings
  - Java compares the addresses where the String objects are stored, not the letters in the String
  - For example:
    - > String a = "hi";
    - > String b = "hi";
    - > a == b
    - > false
- Use the String class' *equals* method to compare two Strings for equality
  - > a.equals(b)
  - > true
  - > b.equalsIgnoreCase("HI")
  - > true

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## The equals() Method

- By default, compares heap addresses
- By convention, it is *overridden* to match the developer's notion of equality

```
public class Person {
    private int social; // social security #
    private String name;
}

public int getSocial() { return social; }

public boolean equals(Person p) {
    return this.social == p.getSocial();
}
```

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## Type Rules

- A reference variable of type *t* may hold a value of its own type or any subtype (but not of a supertype).
- Given the following variable declaration:

```
Bot b;
```

Which of the following assignments are valid (compile)?

```
b = new Bot();
b = new String();
b = new BetterBot();
b = new Object();
```

How about these?

```
BetterBot bb;
bb = new Bot();
bb = new String();
bb = new BetterBot();
bb = new Object();
```

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## The "instanceof" Operator

```
> Bot b = new Bot();
> b instanceof Bot
true
> b instanceof Object
true
> b instanceof BetterBot
false

> BetterBot bb = new BetterBot();
> bb instanceof BetterBot
true
> bb instanceof Object
true
> bb instanceof Bot
true

> Bot bbb = new BetterBot(); //a variable can store a subtype
> bbb instanceof BetterBot()
true
> bbb instanceof Bot
true
```

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