# Objects and Classes

# Lecture Question

**Question**: In a package named "execution" create a Scala **class** named "VoteCounter" with the following:

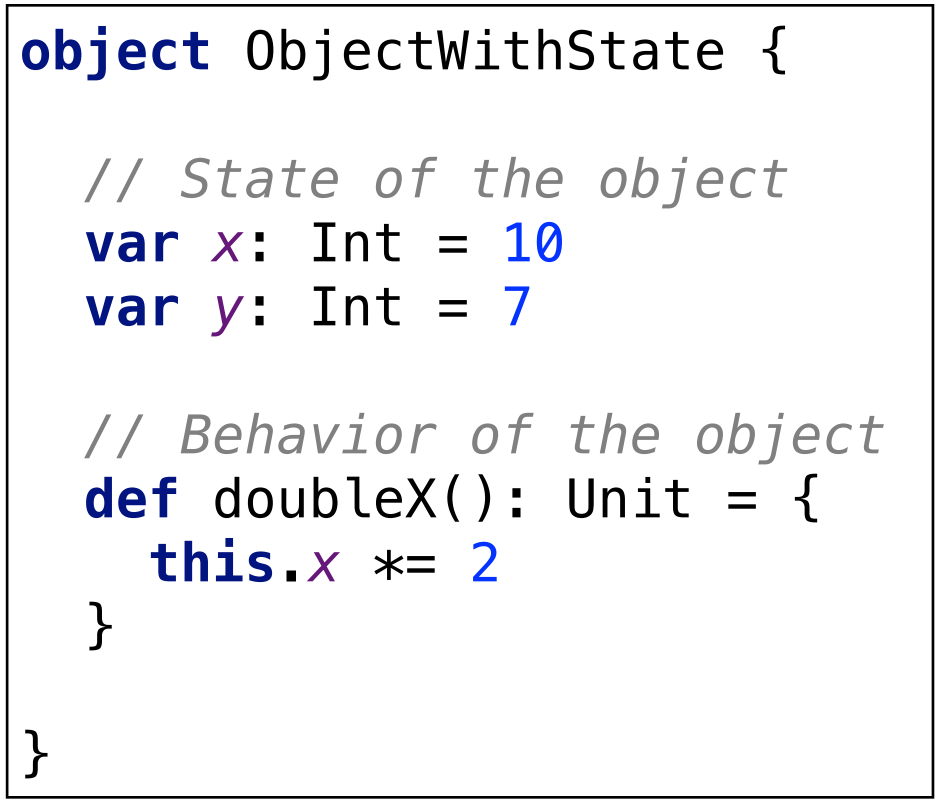
- A constructor that takes a List of Strings representing the possible options for voting
- A method named addVotes that takes a String and an Int as parameters and returns Unit. This method adds this many votes to the option specified by the string
    - If the option is not in the list given in the constructor, the votes should be ignored
    - Example: voteCounter.addVotes("Boaty McBoatface", 1000) will add 1000 votes to this option if it was listed in the constructor call
- A method named getVotes that takes an option as a String and returns the total number of votes for this option as an Int
    - If the input is not a valid option, return 0

**Testing**: In a package named "tests" create a Scala class named "TestVoting" as a test suite that tests all the functionality listed above

# Objects

- State / Variables
  - Objects store their state in variables
  - [Vocab] Often called fields, member variables, or instance variable
- Behavior / Functions
  - Objects contains functions that can depend on its state
  - [Vocab] When a function is part of an object it's called a **method**

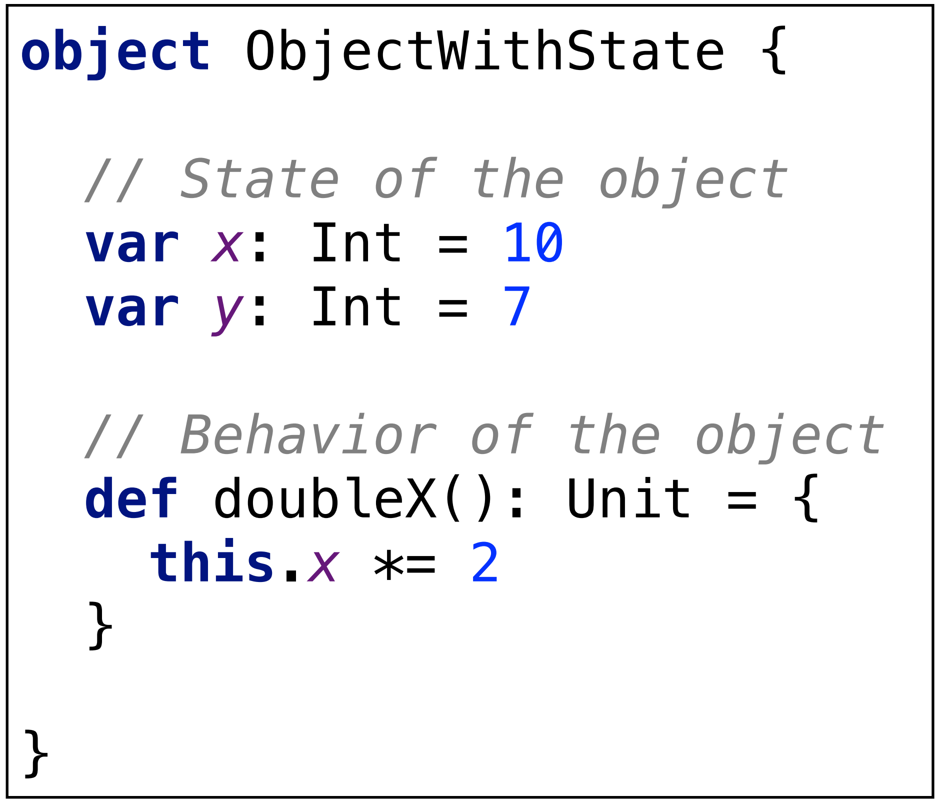
# Object With State



```scala
object ObjectWithState {

  // State of the object
  var x: Int = 10
  var y: Int = 7

  // Behavior of the object
  def doubleX(): Unit = {
    this.x *= 2
  }

}
```

- Any variable outside of all methods is part of the state of that object
- Keyword **this** stores a reference to the enclosing object
- Use this.<variable_name> to access state from within the object

# Object With State



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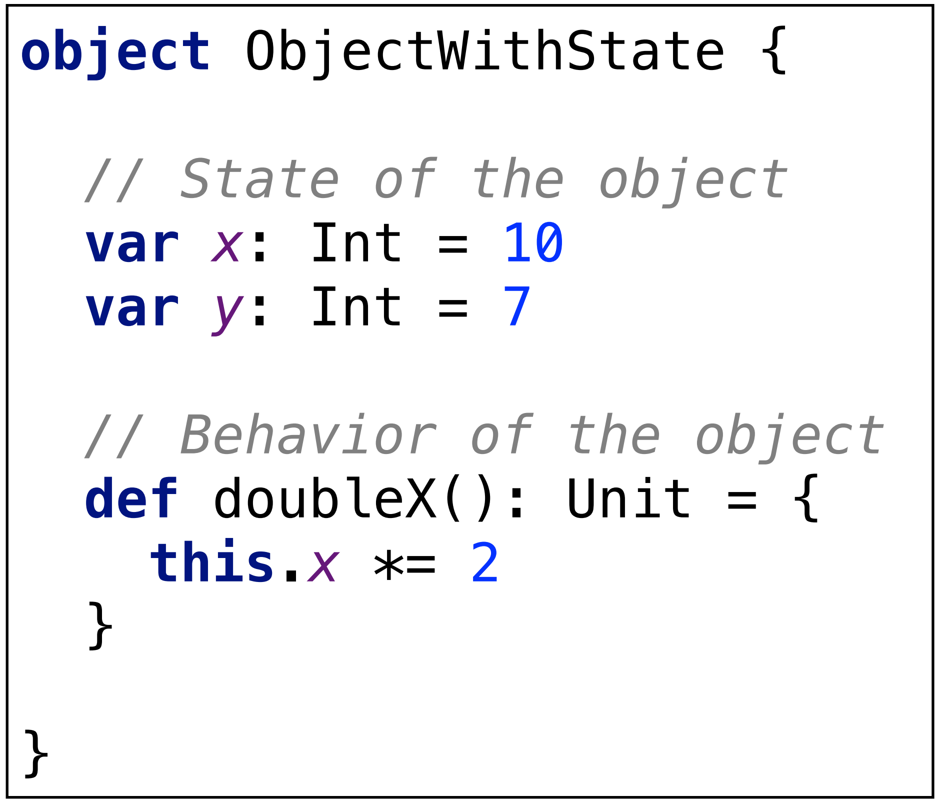
```

- Declare variables using **var** if the value can change
- Declare variables using **val** to prevent the value from changing
    - Changing the value of a variable declared with val will cause an error

# Object With State



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```
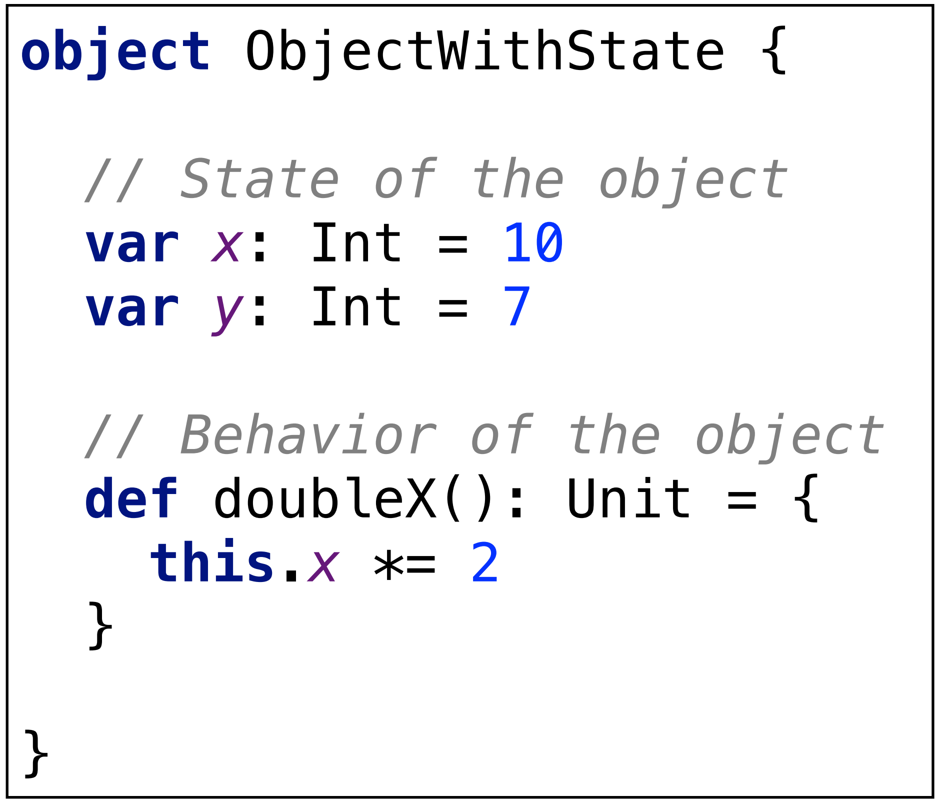

- The variables defining the state of an object have many different names
    - Instance variables
    - Member variables
    - Fields
    - State variables

# Object With State



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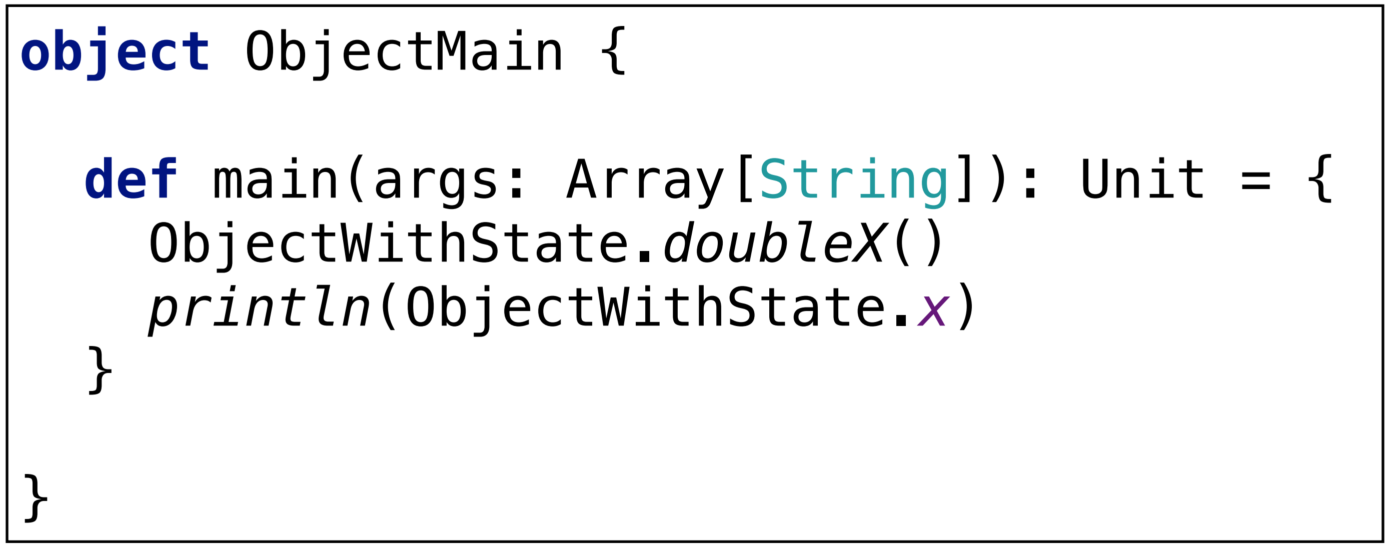


```scala
object ObjectMain {

  def main(args: Array[String]): Unit = {
    ObjectWithState.doubleX()
    println(ObjectWithState.x)
  }

}
```

- Any code with access to an object can also access it's state/behavior with the dot notation
- Can also change the state of an object

Every **value** in Scala is an **object**

# Classes

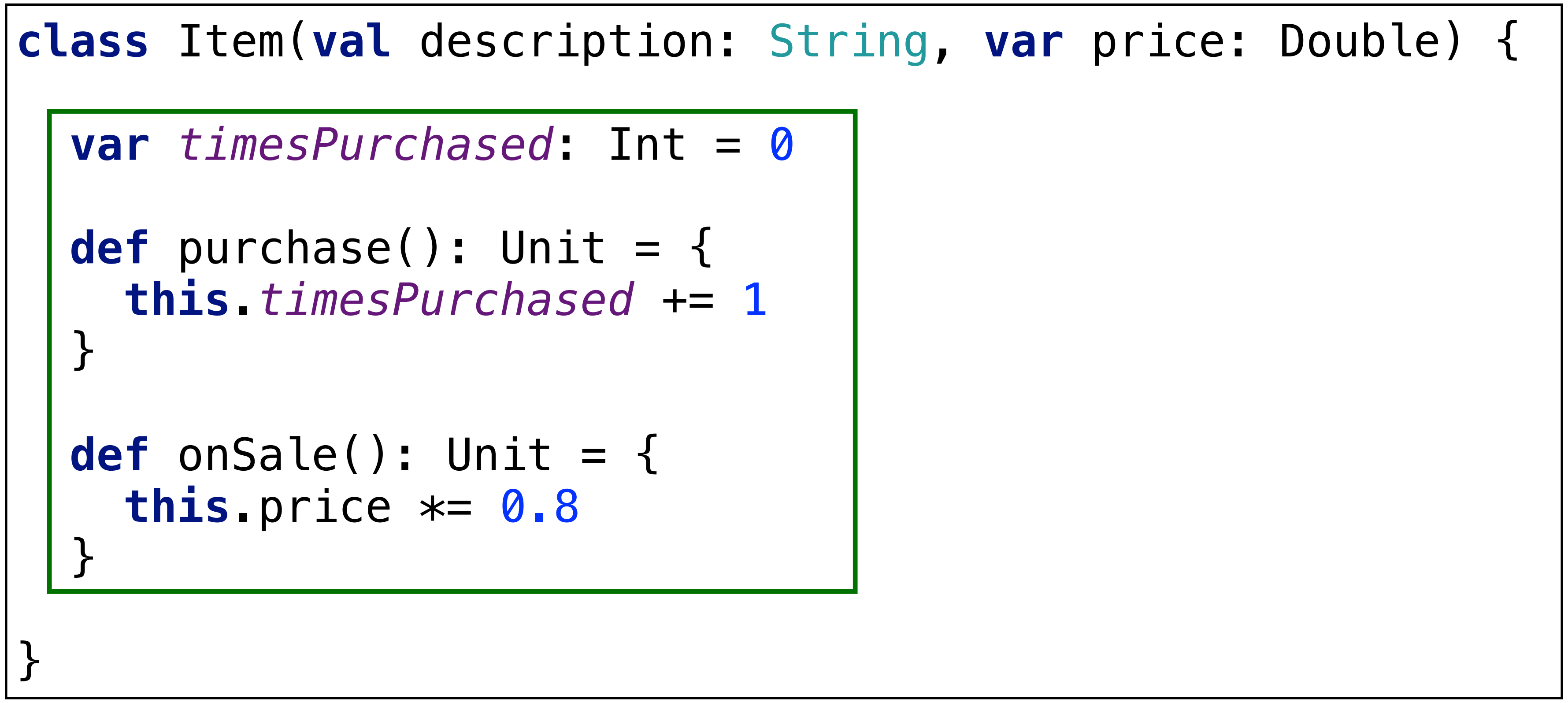
- Classes are templates for creating objects with similar state and behavior
  - Objects are **instantiated** from classes using the keyword **new**
- Used to create many objects
  - Each object can have a different state
  - Each has its own copies of the instance variables

# Classes

```scala
class Item(val description: String, var price: Double) {

  var timesPurchased: Int = 0

  def purchase(): Unit = {
    this.timesPurchased += 1
  }

  def onSale(): Unit = {
    this.price *= 0.8
  }

}
```

- Define a class to represent an item in a store

# Classes



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  def purchase(): Unit = {
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  def onSale(): Unit = {
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  }

}
```

- State and behavior is defined the same way as objects

- We define one state variable to track the number of times this item was purchased along with a method/behavior to purchase an item

- We define more behavior to mark an item as on sale by reducing its price by 20%

# Classes

```
class Item(val description: String, var price: Double) {

  var timesPurchased: Int = 0

  def purchase(): Unit = {
    this.timesPurchased += 1
  }

  def onSale(): Unit = {
    this.price *= 0.8
  }

}
```

- Classes also contain special methods called constructors
- This method is called when a new object is created using this class
- Any code calling the constructor can use its parameters to set the initial state of the created object
- [Scala] All constructor parameters become member variables
    - Use **var** in the constructor if the state can be change

# Classes

```
object ItemMain {

  def printPrice(item: Item): Unit = {
    println("Current price of "+ item.description +" is: $" + item.price)
  }

  def main(args: Array[String]): Unit = {

    val cereal: Item = new Item("cereal", 3.0)
    val milk: Item = new Item("milk", 2.0)

    // Change state using behavior
    cereal.purchase()
    cereal.onSale()
    cereal.purchase()

    println(cereal.description + " has been purchased " + cereal.timesPurchased + " times")
    printPrice(cereal)

    // Change state directly
    milk.price = 1.5

    printPrice(milk)
  }

}
```

- Call a constructor using the **new** keyword
- The constructor returns a reference to the created class of the type of the class

# Classes

```
object ItemMain {

  def printPrice(item: Item): Unit = {
    println("Current price of "+ item.description +" is: $" + item.price)
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  def main(args: Array[String]): Unit = {

    val cereal: Item = new Item("cereal", 3.0)
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    // Change state using behavior
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    println(cereal.description + " has been purchased " + cereal.timesPurchased + " times")
    printPrice(cereal)

    // Change state directly
    milk.price = 1.5

    printPrice(milk)
  }

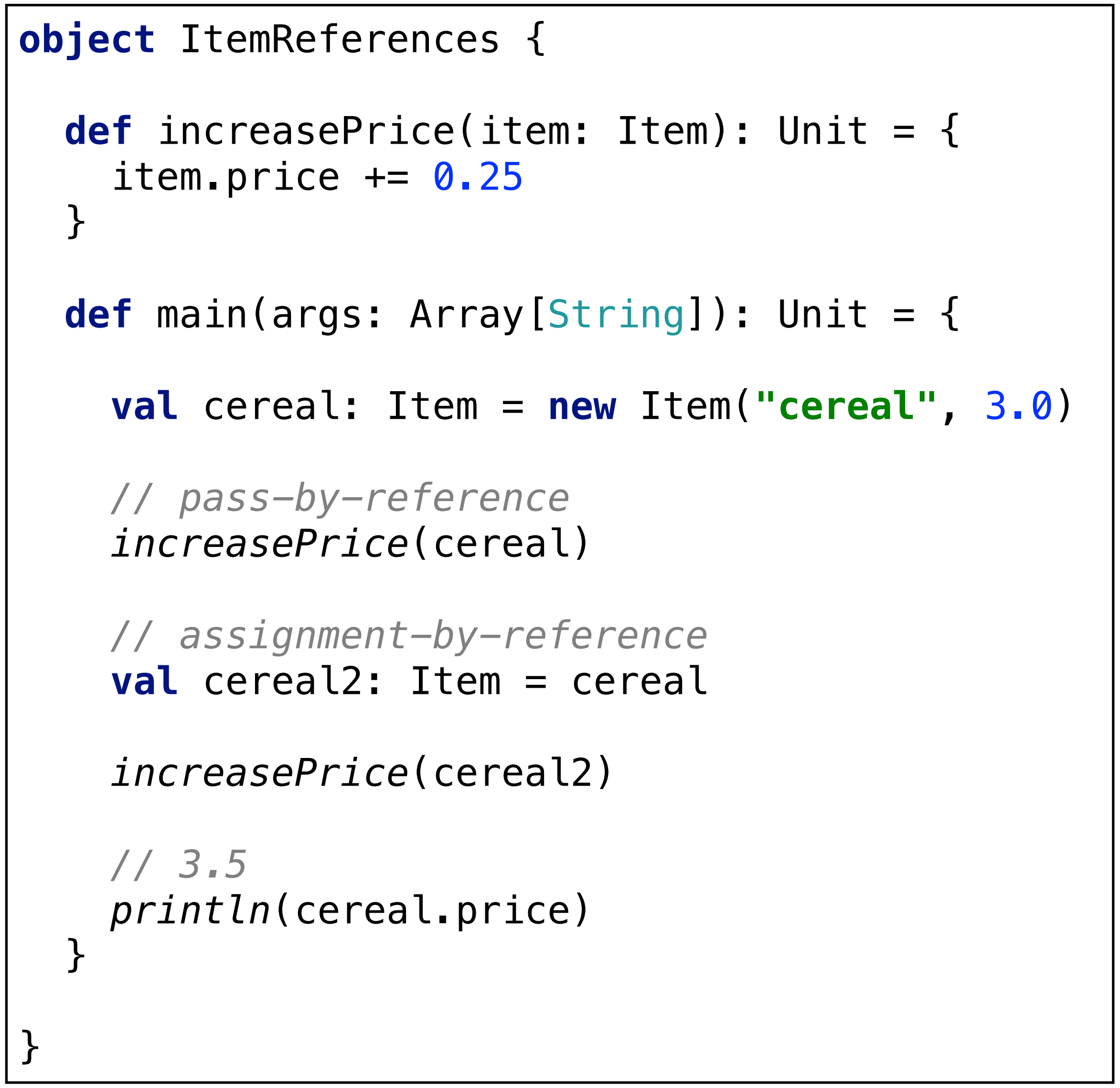
}
```

- We have two different objects of type Item
- cereal and milk have their own copies of each instance variable

# References

- Every class you create will be passed by reference
  - Also data structure (List, Map, Array) and other built-in classes
- Pass-by-reference means that a copy is not made when a variable is assigned a value

# References



```
object ItemReferences {

  def increasePrice(item: Item): Unit = {
    item.price += 0.25
  }

  def main(args: Array[String]): Unit = {

    val cereal: Item = new Item("cereal", 3.0)

    // pass-by-reference
    increasePrice(cereal)

    // assignment-by-reference
    val cereal2: Item = cereal

    increasePrice(cereal2)

    // 3.5
    println(cereal.price)
  }

}
```

- increasePrice returns Unit, yet it is able to modify an item
- cereal and cereal2 "refer" to the same object
  - Changes made to one will change both variables

# Classes

- Method parameters, including constructors, can have default values
    - Any missing arguments are set to the default value

```
class PhysicsVector(var x: Double = 0.0, var y: Double = 0.0, var z: Double = 0.0) {

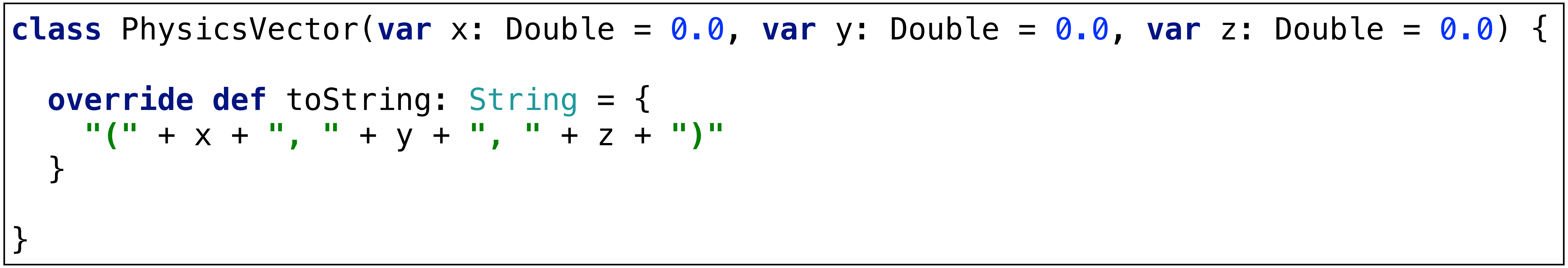
  override def toString: String = {
    "(" + x + ", " + y + ", " + z + ")"
  }

}
```

```
val vector: PhysicsVector = new PhysicsVector(4.0, -3.5, 0.7)
// (4.0, -3.5, 0.7)
val vector2: PhysicsVector = new PhysicsVector(-6.0)
// (-6.0, 0.0, 0.0)
val vector3: PhysicsVector = new PhysicsVector()
// (0.0, 0.0, 0.0)
```

# Classes

- Can define a toString method to print an object with custom formatting



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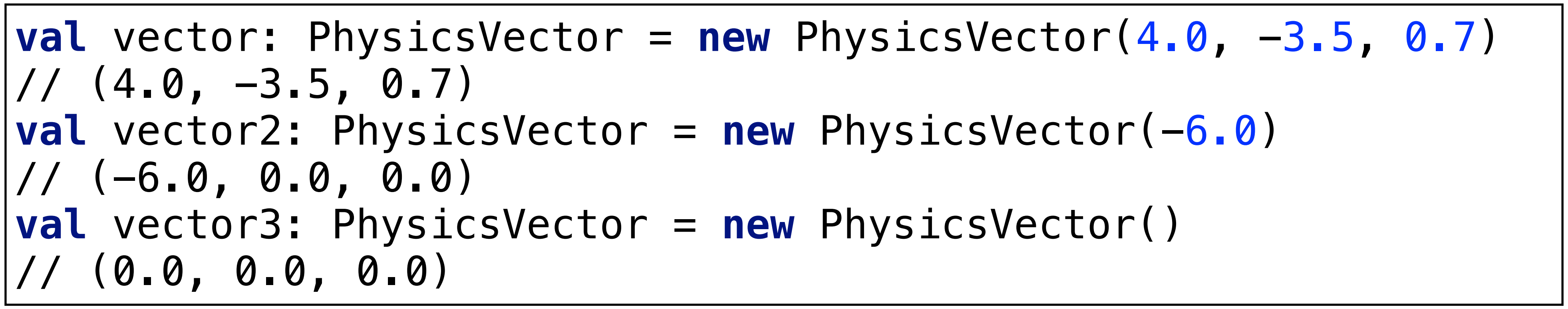

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```

# References: Warning

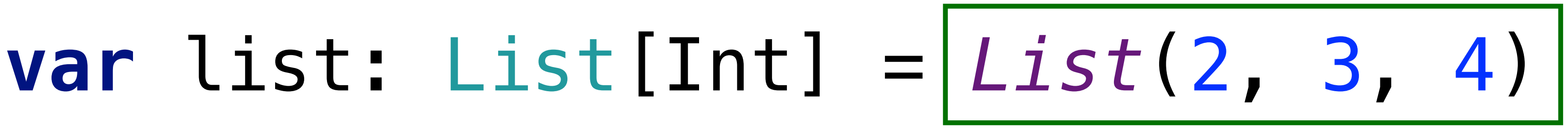
```
def updateObject(dynamicObject: DynamicObject, deltaTime: Double, magnitudeOfGravity: Double): Unit = {
  dynamicObject.previousLocation = dynamicObject.location

  // ... rest of the method

}
```

- previousLocation and location are the same object!!
  - Changing location will change previousLocation!

- Create a new PhysicsVector for previousLocation or copy x, y, z one at a time

# Classes

- Int, Double, Boolean, List, Array, Map
  - Are all classes
  - We use these classes to create values



```
var list: List[Int] = List(2, 3, 4)
```

- Create objects by calling the constructor for that class
- List is setup in a way that we don't use **new**
- For our classes we will use the **new** keyword

# A Note on Access Modifiers

- Determine who (which classes/objects) can alter state and control behavior of an object

- Access modifiers are Controversial

- Communities around different languages cannot agree on these

# Access Modifiers

- If you're familiar with **Java** you're familiar with these
  - public / private / protected
  - default is package private
- In **Scala**
  - private / protected
  - default is public
- In **Python**
  - No access modifiers
  - Everything is public
- In **JavaScript**
  - No access modifiers
  - Everything is public
  - Can create work-arounds to simulate private variables

# Accessor/Mutator

- Common in some languages to make all member variables private
  - Java
  - C++
- State is never accessed directly from outside the object
- Use accessor (getter) and mutator (setter) methods instead

```
package oop_classes;

public class AccessModifiers{

    // NOTE: This is Java code

    private int x;

    public int getX(){
        return this.x;
    }

    public void setX(int x){
        this.x = x;
    }
}
```

# Lecture Question

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