

# COMP 250

## INTRODUCTION TO COMPUTER SCIENCE

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Week 3-4: OOD3 Other methods, mutable vs immutable, final variables

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Giulia Alberini, Fall 2020

## OBJECTS – QUICK REVIEW

Book.java

```
public class Book {  
    public String title;  
    public String author;  
}
```

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TestBook.java

```
public class TestBook {  
    public static void main(String[] args) {  
        Book b = new Book();  
        b.title = "Matilda";  
        b.author = "Roald Dahl";  
        System.out.println(b);  
    }  
}
```

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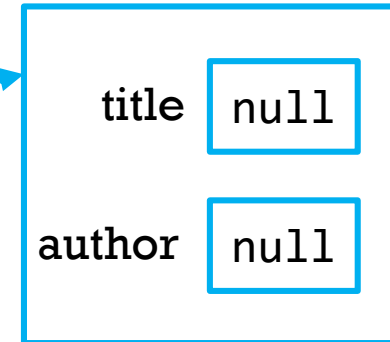
## OBJECTS – QUICK REVIEW

```
public class Book {  
    public String title;  
    public String author;  
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```

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b



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```

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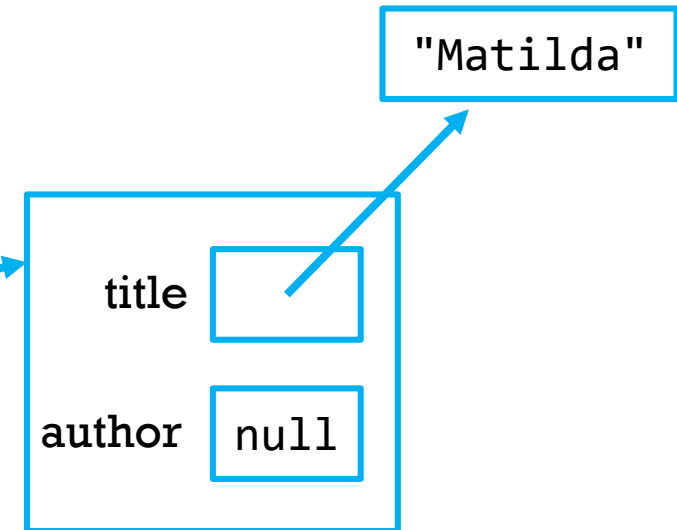
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```

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b



## OBJECTS – QUICK REVIEW

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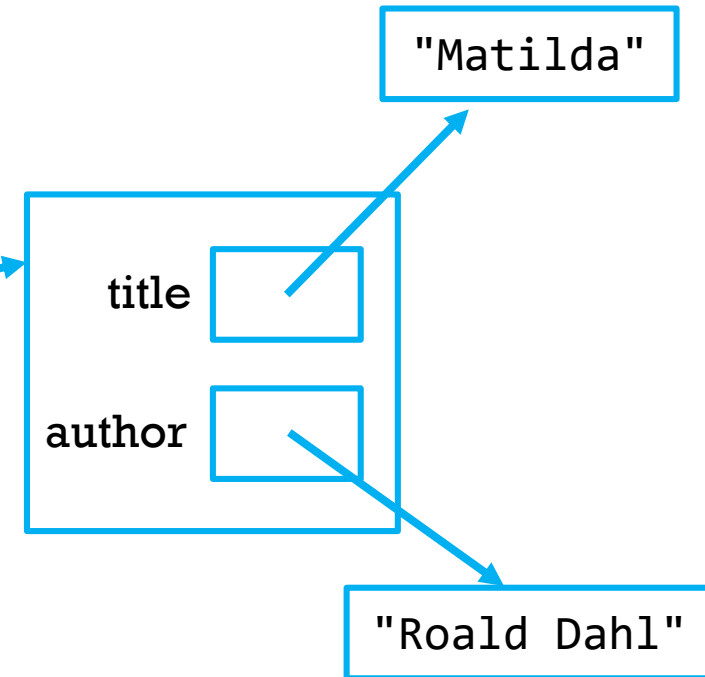
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```

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b



## OBJECTS – QUICK REVIEW

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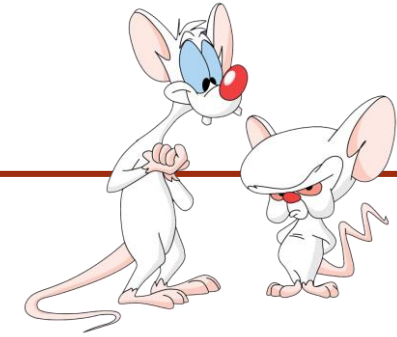
<https://powcoder.com>

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        System.out.println(b);  
    }  
}
```

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A reference

# WHAT ARE WE GOING TO DO IN THIS VIDEO?



OOD3

- Other methods

- Mutable vs Immutable

- `final` variables

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OTHER METHODS

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## STEP 3

```
public class ClassName {
```

```
// some data declared here
```

```
<modifier> <type> <variable_name>;
```

```
public ClassName () {
```

```
//constructor
```

```
}
```

```
// declare other methods
```

```
}
```

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Data

Method to create an object

Other methods

File name: **ClassName.java**

## OTHER METHODS

- You write all the other methods as before, except:
  - If the method is static, it has access to the class variables.
  - If the method is not static, it has access to both the class and the instance variables

## RECOMMENDED EXERCISES

In the `Patient` class:

- add a method `printName` that prints out the name of the patient.
- add a method `addTemp` that takes as input a `double` and appends it at the end of the array of temperature of the patient. To do this, you need to create a new array whose length is *greater*, copy all the values over, append the `double`, and update the value of the corresponding field.

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**GET/SET METHODS**  
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# GETTERS AND SETTERS

- In general, all fields should be declared as `private`. We can then declare `public` methods to regulate how they can be accessed.

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- Those methods that give access to the value of a field are formally called "accessors", but commonly referred to as **getters**.

- Those methods that allows you to modify the value of a field are formally called "mutators", but commonly referred to as **setters**.

## GET (ACCESSOR) METHOD

Most getters have a very similar format:

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```
public <type> getField() {  
    return this.field;  
}
```

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## SET (MUTATOR) METHOD

Most setters have a very similar format:

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```
public void setField(<type> value) {  
    this.field = value;  
}
```

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## SET, GET, AND REFERENCES



Careful when writing get/set methods:

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- If you are returning a reference type, be sure you are actually giving access to the thing you intend.
- If you are setting a value, be sure that you are using the thing you intend.

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TRY IT!

---

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- Modify the `Patient` class to include get and set methods.  
How should you do it?

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# ENCAPSULATION

- Process of wrapping data and the code acting on that data in one unit. The idea is to better control the data.

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- What to do?

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- Make all the fields `private`
- Provide getters and setters as needed.

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- Note: through the methods we can do data validation, while we have little control over the data stored in a `public` field.

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toString()  
<https://powcoder.com>

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## PRIVATE AND INFORMATION DISPLAY

- When your fields are all private, it might be difficult to display the content of an Object outside of the class.  
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- If we try to use `println` on the Object, we just see a reference.  
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- References are not very useful when trying to debug a code.

## toString() AND println()

- Each time we use `println()` with objects, it calls the method `toString()` on the object and displays the result.

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<https://powcoder.com>

- By default, `toString()` on an Object returns a String representing the address at which the contents of the Object can be found.

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- This is not the case for all the Objects, though. If the method `toString()` is included inside the class, then when we use `println()` on variables of such type, not the default `toString()`, but the one from the class is used.

## THE toString() METHOD

You can write a `toString()` method in any class.

It must have the following header:

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```
public String toString() {  
    // returns a value of type String  
}
```

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If you do that, then when you call `print()` / `println()` on an instance of that class, this method is called automatically!

## TRY IT!

In the `Patient` class, add a `toString()` method that returns a `String` in the following format:

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Name: [name]

Age: [age]

Reported Temperatures: [list of temperatures]

Now, try to use `print` on an object of type `Patient`.

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# MUTABLE VS IMMUTABLE

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## IMMUTABLE REFERENCE TYPES

- If when you create a class, you make all the fields private, and you do not write any mutator methods, then you have effectively created an Immutable Type!

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- If the only way to assign values to fields is through the constructor, then the values of the Object cannot be changed after it has been created.

## MUTABLE

Mutator methods change the content of the object.

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```
Cat myCat = new Cat("Spritz");  
myCat.setName("Small Cat");
```

The content of object reference by `myCat` has changed by changing the name of the cat.

## MUTABLE

If we add a second `Cat` variable referencing to the same cat

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```
Cat myCat = new Cat("Spritz");  
Cat aCat = myCat;  
myCat.setName("Small Cat");
```

Then, also the content of `aCat` is changed after the last instruction.

# IMMUTABLE

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```
String s = "cats";  
s.charAt(0) = 'r'; // compile-time error!
```

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There is no method in `String` that allows us to set the value of a character.

# IMMUTABLE

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```
String s = "cats";
```

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```
String t = s;
```

```
t = "dogs";
```

The value of `s` does not change!

## MUTABLE VS IMMUTABLE

- Mutable objects: more flexible in what they allow users to do with the object and more efficient because you don't create a new object each time you want to modify the content. But, they can be error-prone.  
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- Immutable: easier to keep track of what changes when the contents of the object change. They can save you from long hours of debugging.  
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- Immutable reference types behave like primitive data type.

# CONSTRUCTORS AND MUTABLE REFERENCE TYPES

Remember the Patient class:

```
public class Patient{  
    private String name;  
    private int age;  
    private double[] temps;  
  
    public Patient(String n, int a, double[] t) {  
        this.name = n;  
        this.age = a;  
        this.temps = t;  
    }  
}
```

Code like this can cause issues!

## EXAMPLE

Patient.java

```
public class Patient{
    private String name;
    private int age;
    private double[] temps;

    public Patient(String n, int a, double[] t){
        this.name = n;
        this.age = a;
        this.temps = t;
    }
}
```

TestPatient.java

```
public class TestPatient{

    public static void main(String[] args) {
        double[] tempsForP= {37.8, 38.6, 40.0, 37.4, 36.5};
        Patient p = new Patient("John", 42, tempsForP);
        tempsForP[0] = 0.0;
    }
}
```

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The last statement in `TestPatient.java` will change the value of the field `temps` even though it is a private field!



## GETTERS AND MUTABLE REFERENCE TYPES

Let's add a get method for the field `temps`:

```
public class Patient {  
    private String name;  
    private int age;  
    private double[] temps;  
  
    public Patient(String n, int a, double[] t) {  
        ...  
    }  
    public double[] getTemps() {  
        return this.temps;  
    }  
}
```

Also code like this can cause issues!

## EXAMPLE

Patient.java

```
public class Patient{
    private String name;
    private int age;
    private double[] temps;

    public Patient(String n, int a, double[] t){
        ...
    }
    public double[] getTemps() {
        return this.temps;
    }
}
```

TestPatient.java

```
public class TestPatient{

    public static void main(String[] args) {
        double[] tempsForP= {37.8, 38.6, 40.0, 37.4, 36.5};
        Patient p = new Patient("John", 42, tempsForP);
        double[] x = p.getTemps();

        x[0] = 0.0;
    }
}
```

Similarly, the last statement in `TestPatient.java` will change the values of the field `temps` even though it is a private field!

## GUIDELINE

---

- Don't write a constructor initializing a mutable reference type without making a copy!  
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- Don't add a get/set method to access/mutate a mutable reference type without making a copy!

## EXAMPLE

Patient.java

```
public class Patient{
    private String name;
    private int age;
    private double[] temps;

    public Patient(String n, int a, double[] t){
        ...
    }
    public double[] getTemps() {
        // create a copy
        int n = this.temps.length;
        double[] c = new double[n];
        for(int i=0; i<n; i++) {
            c[i] = this.temps[i];
        }
        return c;
    }
}
```

TestPatient.java

```
public class TestPatient{
    public static void main(String[] args) {
        double[] tempsForP= {37.8, 38.6, 40.0, 37.4, 36.5};
        Patient p = new Patient("John", 42, tempsForP);

        double[] x = p.getTemps();
        x[0] = 0.0;
    }
}
```

Now it doesn't matter because the get method returns a copy of the array.

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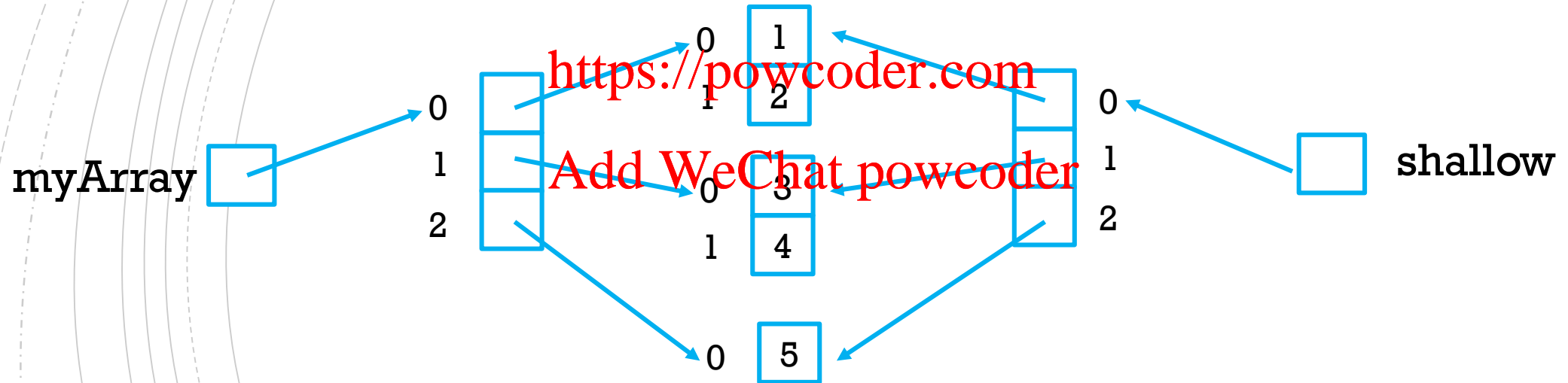
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## SHALLOW VS DEEP COPY

Consider a 2-dimensional array. A shallow copy is obtained by creating a new array and copying to it the references stored in the original array one by one.

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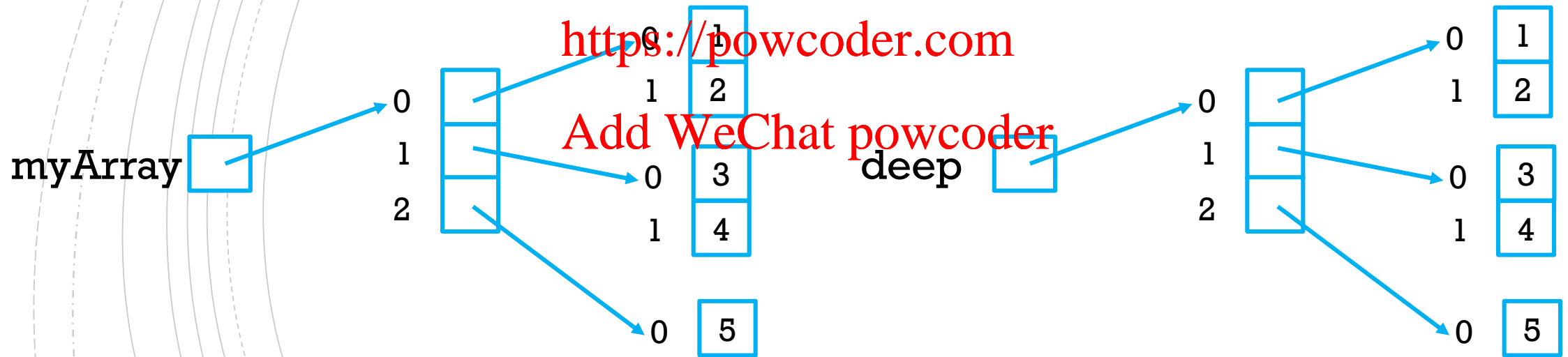


```
shallow[0][0] = 5; # affects also myArray
shallow[0] = new int[1]; # does not affect myArray
shallow = new int[5][1]; # does not affect myArray
```

## SHALLOW VS DEEP COPY

Consider a 2-dimensional array. A deep copy is obtained by creating a new array and copying to it a (deep) copy of the objects in the original array one by one.

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Nothing we can do through `deep` can affect `myArray` (and vice versa)

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FINAL

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# FINAL VARIABLES

If a variable is declared to be final, its value can **never** be changed after it has been initialized.

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```
final int x = 3;  
x = 10; // compile-time error!
```

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```
final Cat myCat = new Cat("Small cat");  
myCat = new Cat("Spritz"); // compile-time error!
```



## MUTABLE REFERENCE TYPES AND FINAL

```
final Cat myCat = new Cat("Small cat");  
myCat = new Cat("Spritz"); // compile-time error!
```

<https://powcoder.com>

However, you can still change the object that `myCat` points at, without changing `myCat`'s value.

```
myCat.setName("Spritz"); // no problem!
```

## FINAL FIELDS

- Final fields must be initialized!

(Otherwise **compile-time error**)

- If the class has a final instance variable (i.e., a final non-static field), you must initialize it in every constructor!

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- If the class has a final class variable (i.e. a final static field), you should initialize it in place (on the same line of the declaration) or in a Static Initializer Block.



# Coming Soon

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In the next video:

- UML Diagrams
- Inheritance

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