# COMP 250

# INTRODUCTION TO COMPUTER SCIENCE

Week 2-3: Reference types, and Random

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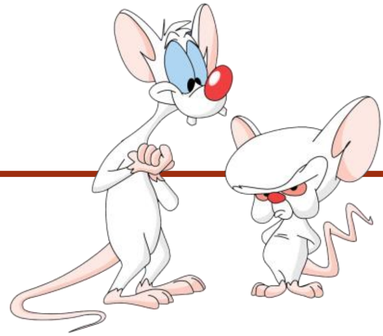
# WHAT ARE WE GOING TO DO IN THIS VIDEO?



- **Reference types**
- Random

# REFERENCE TYPES

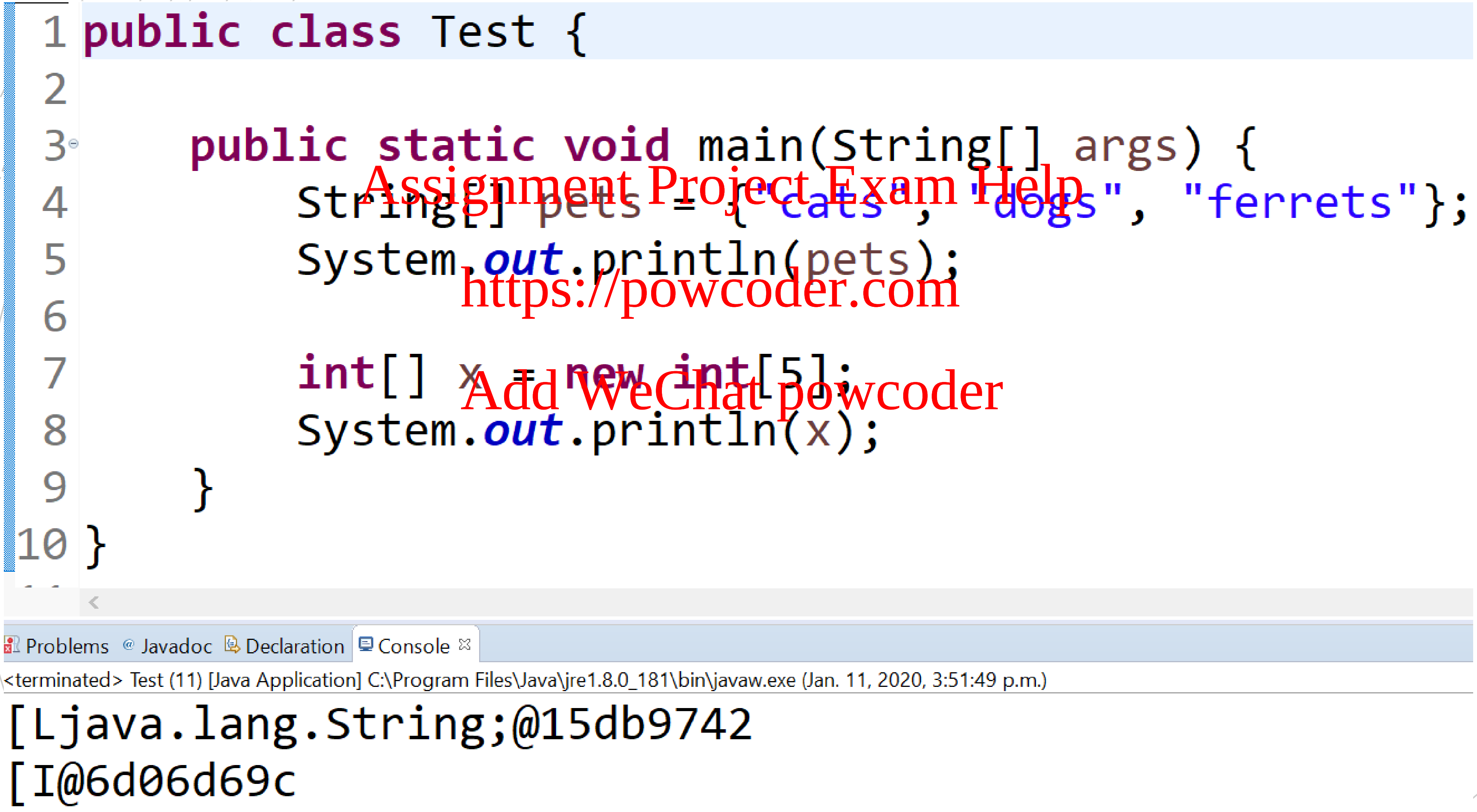
# PRIMITIVE VS REFERENCE TYPES

- Both arrays and Strings are Objects.

- In java, except for the primitive data types (those whose names start with lowercase letters like `int`, `double`, etc.), everything is an `Object`.

- Variables of `Object`s, arrays included, don't store the values of the objects, but a **reference** to the location in memory containing that value. You can think of it as an address which points to where the data is located in memory.

# REFERENCE TYPES



```
public class Test {

    public static void main(String[] args) {
        String[] pets = {"cats", "dogs", "ferrets"};
        System.out.println(pets);

        int[] x = new int[5];
        System.out.println(x);
    }
}
```

```
<terminated> Test (11) [Java Application] C:\Program Files\Java\jre1.8.0_181\bin\javaw.exe (Jan. 11, 2020, 3:51:49 p.m.)
[Ljava.lang.String;@15db9742
[I@6d06d69c
```

# PRIMITIVE VS REFERENCE TYPES – EXAMPLES

```
public static void main(String[] args) {
   int x = 5;
   int y = x;
   x++;
   System.out.println(x + " " + y);
}
```

- **What does the program print?**

```
6 5
```

# PRIMITIVE VS REFERENCE TYPES – EXAMPLES

```
public static void main(String[] args) {
   int[] x = {1, 2, 3};
   int[] y = x;
   y[0] = 4;
   System.out.println(x[0] + " " + y[0]);
}
```

- **What does the program print?**

```
4 4
```

# PRIMITIVE VS REFERENCE TYPES – EXAMPLES

```
public static void main(String[] args) {
    int x = 5;
    example(x);
    System.out.println(x);
}
public static void example(int x) {
    x = x*5;
}
```

- What does the program print?

5

# PRIMITIVE VS REFERENCE TYPES – EXAMPLES

```
public static void main(String[] args) {
   int[] x = {1,2,3};
   example(x);
   System.out.println(x[0]);
}
public static void example(int[] x) {
   x[0] = 4;
}
```

- What does the program print?

```
4
```

# ARRAY VS STRING

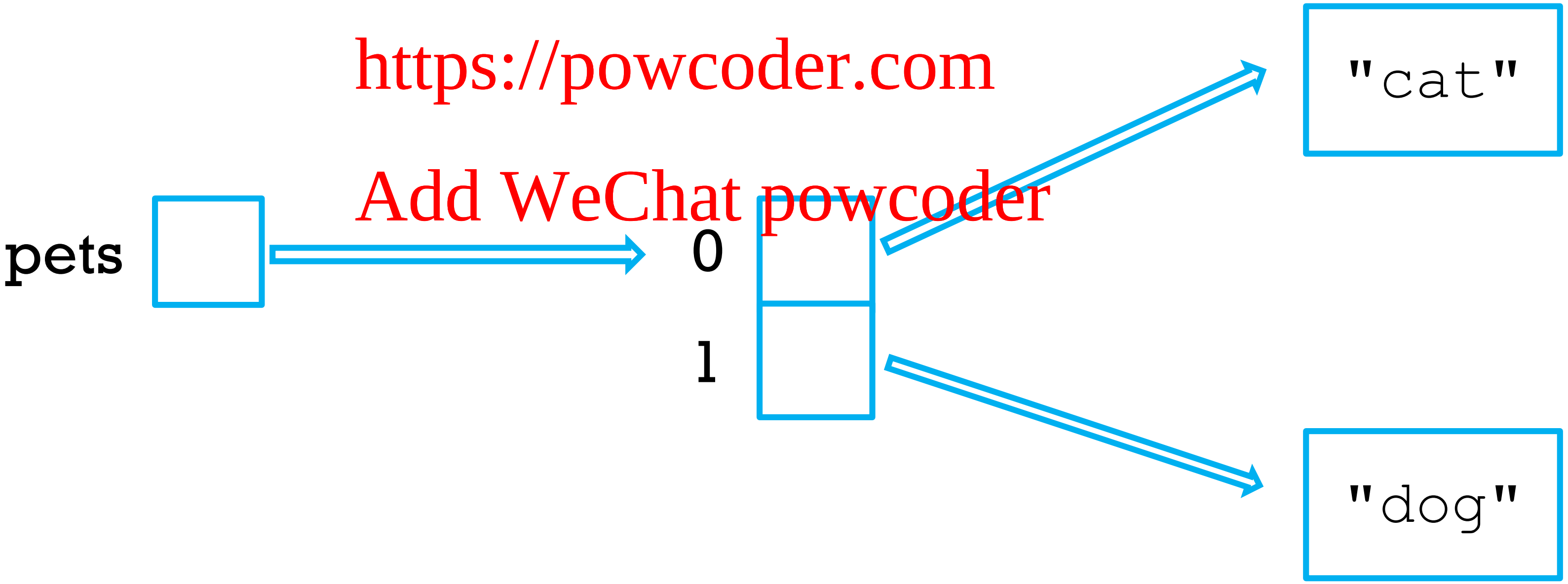
- Both arrays and strings are reference types.

- Variables of array-type and String-type both store the address in memory at which the elements of the object begins.

- Arrays are mutable, Strings are immutable!!
    - Once a String has been created it cannot be changed!
    - The elements of an array can be updated anytime we want.

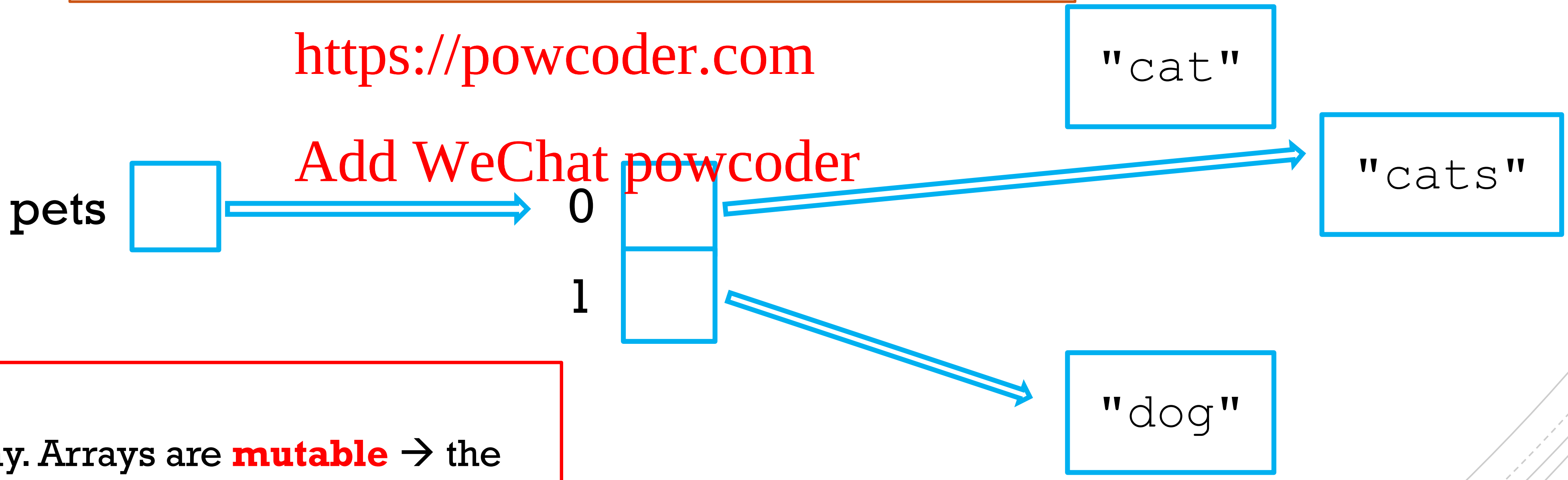
# REFERENCE TYPES

```
String[] pets = {"cat", "dog"};
```



# REFERENCE TYPES

```
String[] pets = {"cat", "dog"};
pets[0] = pets[0] + "s";
```



To note:

- We changed the array. Arrays are **mutable** → the reference stored in pets did not change!
- We changed the first String. Strings are **immutable** → the reference in pets[0] did change!

# ARRAY VS STRING – EXAMPLE 1

```
public static void main(String[] args) {
    int[] x = {1, 2, 3, 4};
    myMethod(x);
    System.out.println(Arrays.toString(x));
}

public static void myMethod(int[] a) {
    for(int i=0; i<a.length; i++) {
        a[i] = i;
    }
}
```

- What prints?
  - `[0, 1, 2, 3]`

# ARRAY VS STRING – EXAMPLE 1

```
public static void main(String[] args) {
   String s = “word”;
   myMethod(s);
   System.out.println(s);
}

public static void myMethod(String t) {
   t = t + “s”;
}
```

- What prints?
  - word

# ARRAY VS STRING – EXAMPLE 2

```
char[] letters = {‘w’, ‘o’, ‘r’, ‘d’};
for(int i=0; i<letters.length; i++){
   if(letters[i]==‘o’) {
      letters[i] = ‘a’;
   }
}
System.out.println(Arrays.toString(letters));
```

- **What prints?**
  - `[w, a, r, d]`

# ARRAY VS STRING – EXAMPLE 2

```
String s = “word”;
for(int i=0; i<s.length(); i++) {
   if(s.charAt(i)==‘o’) {
      s.charAt(i) = ‘a’;
   }
}
System.out.println(s);
```

- **What prints?**
  - ➢ `compile time error: unexpected type. Required: variable. Found: value.`

# ARRAY VS STRING – EXAMPLE 2

```
String s = “word”;
String t = “”;
for(int i=0; i<s.length(); i++) {
   if(s.charAt(i)==‘o’) {
      t = t + “a”;
   } else {
      t = t + s.charAt(i);
   }
}
System.out.println(t);
```

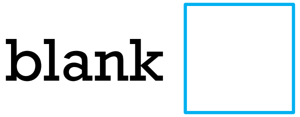
# THE NULL KEYWORD

- Any reference type variable can have a `null` value.

- `null` indicates the absence of an address.

- We can think of a variable with value `null` as a box with no arrow/pointing nowhere.

```
int[] blank = null;
```



# NullPointerException

- If we try to access information through a variable with value `null`, the code will throw a `NullPointerException`.

```
int[] blank = null;

System.out.println(blank.length);

System.out.println(blank[0]);
```

# DEFAULT VALUES

- In java, **local variables** (those declared within the body of a method, i.e. all the variables we have seen up to now) are **not** given an initial default value!
  - This is why if we try to use a variable without initializing it, the compiler will throw the following error: "variable ___ might not have been initialized"

- On the other hand, **array elements** (and other kind of variables, tbd) are initialized with default values:
  - int/short/byte/long with 0
  - double/float with 0.0
  - boolean with false
  - char with 0
  - **reference types with `null`.**

# EXAMPLES – LOCAL VARIABLES

```
int base;
int area = squareArea(base);
```

```
String day;
System.out.println("Today is " + day);
```

```
int[] grades;
int size = grades.length;
```

**Compile-time error! Variable not initialized!**

# EXAMPLES – ARRAYS' ELEMENTS

```
int[] num = new int[3];
int sum = num[0] + num[1] + num[2];
```

sum has value 0

```
String[] days = new String[7];
System.out.println("Today is " + days[4]);
```

```
> Today is null
```

```
String[] days = new String[7];
int numLettersMonday = days[0].length();
```

```
NullPointerException
```

# RANDOM

# THE RANDOM CLASS

- Up to now you probably learned how to use `Math.random()` to get random numbers between a minimum value and a maximum value.

- We can also use the `Random` class to generate random numbers.

- The `Random` class allows us to ***seed*** the random numbers such that we will see ***the same*** sequence of ‘random’ numbers each time.
  - Why is it useful?
    Easier to debug code that is not working.
    Comparing outputs from different codes (for instance your assignments)

# HOW TO USE RANDOM

First import the `Random` class: add `import java.util.Random;`

Then you can create a random number generator using the following statement:

```
int seed = 123;
Random randomGenerator = new Random();
Random otherGenerator = new Random(seed);
```

# HOW TO USE RANDOM

**First import the** `Random` **class: add** `import java.util.Random;`

**Then you can create a random number generator using the following statement:**

```
int seed = 123;
Random randomGenerator = new Random();
Random otherGenerator = new Random(seed);
```

**Declaration of two variables of type** `Random`**.**

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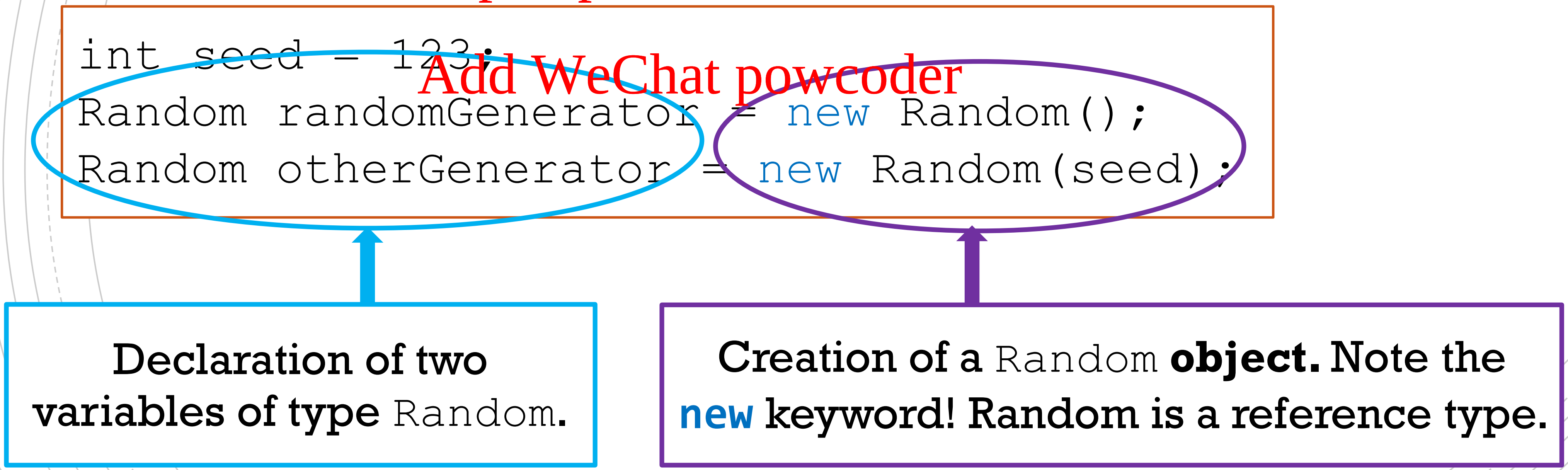
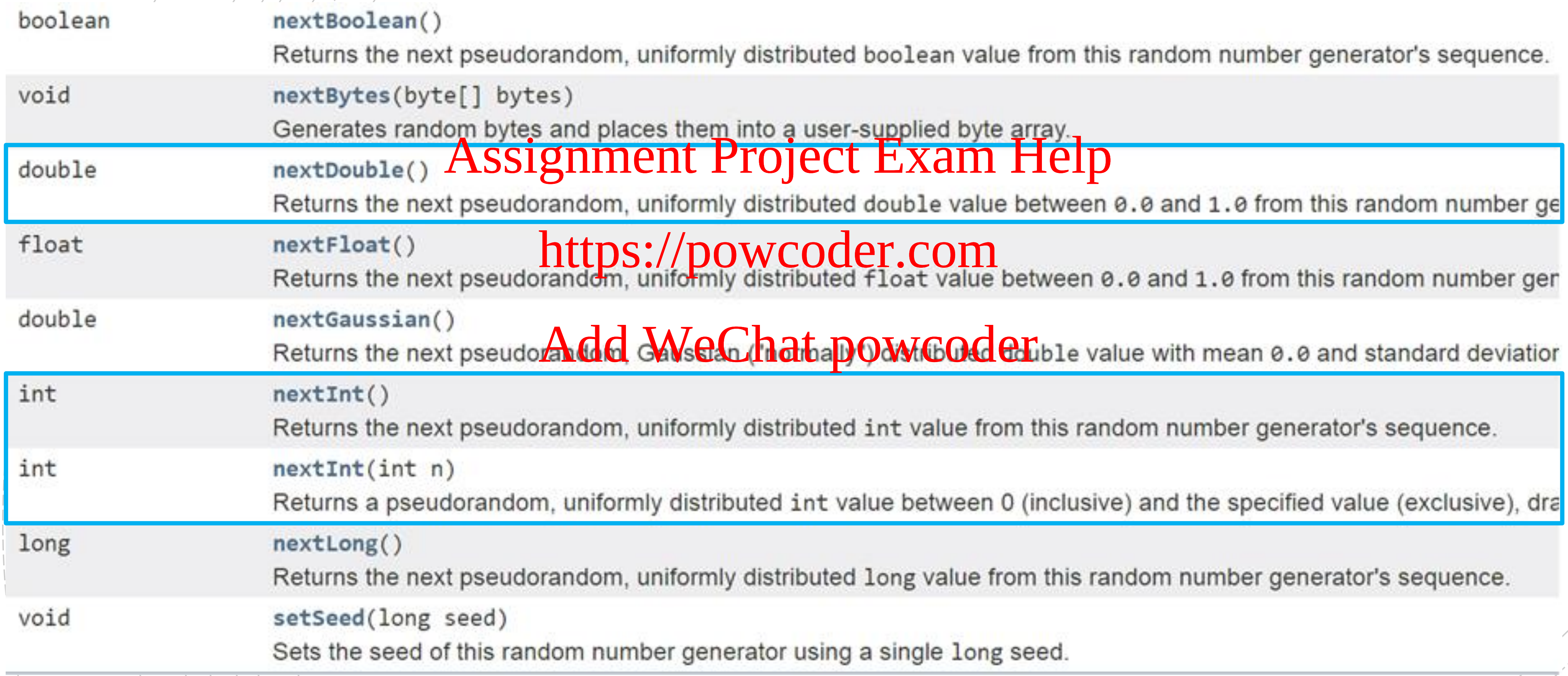


```
int seed = 123;
Random randomGenerator = new Random();
Random otherGenerator = new Random(seed);
```

Declaration of two variables of type `Random`.

Creation of a `Random` **object.** Note the **new** keyword! Random is a reference type.

# METHODS IN RANDOM



| | |
|---|---|
| boolean | nextBoolean()<br>Returns the next pseudorandom, uniformly distributed boolean value from this random number generator's sequence. |
| void | nextBytes(byte[] bytes)<br>Generates random bytes and places them into a user-supplied byte array. |
| double | nextDouble()<br>Returns the next pseudorandom, uniformly distributed double value between 0.0 and 1.0 from this random number ge |
| float | nextFloat()<br>Returns the next pseudorandom, uniformly distributed float value between 0.0 and 1.0 from this random number ger |
| double | nextGaussian()<br>Returns the next pseudorandom, Gaussian ("normally") distributed double value with mean 0.0 and standard deviatior |
| int | nextInt()<br>Returns the next pseudorandom, uniformly distributed int value from this random number generator's sequence. |
| int | nextInt(int n)<br>Returns a pseudorandom, uniformly distributed int value between 0 (inclusive) and the specified value (exclusive), dra |
| long | nextLong()<br>Returns the next pseudorandom, uniformly distributed long value from this random number generator's sequence. |
| void | setSeed(long seed)<br>Sets the seed of this random number generator using a single long seed. |

https://docs.oracle.com/javase/7/docs/api/java/util/Random.html

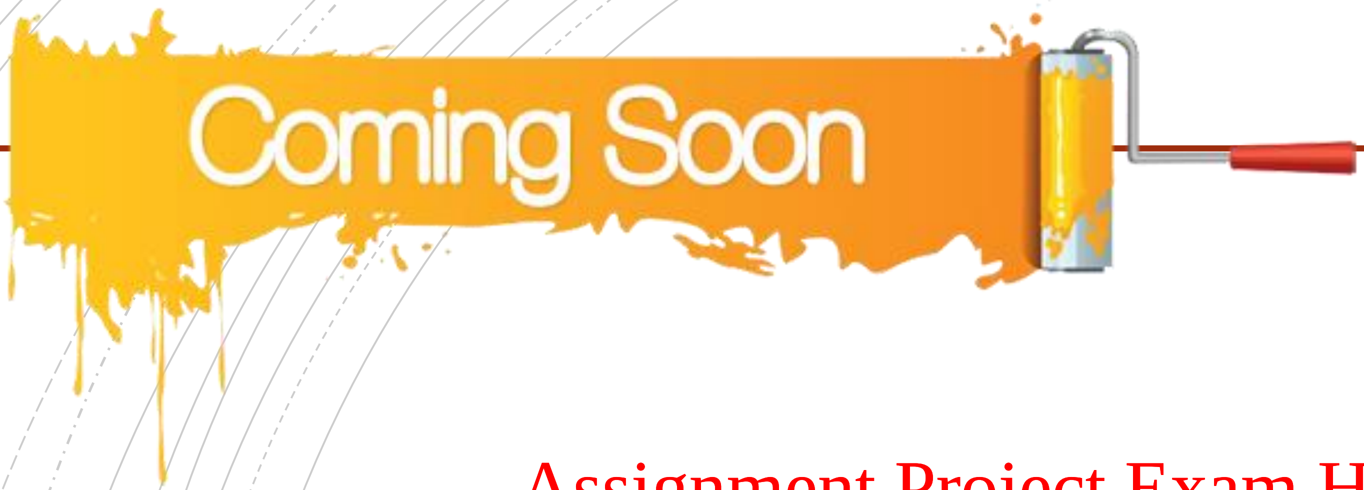
# DICE ROLL

**Here's an example of using** `Random` **to simulate a dice roll**

```
Random randomGenerator = new Random();

int diceRoll = randomGenerator.nextInt(6) + 1;

System.out.println("The dice rolled " + diceRoll);
```



In the next video we will be talking about errors and exceptions, as well as try/catch blocks.