Chapter 7

The Random Class

- Part of the java.util package
  - import java.util.Random;
- A Random object can generate random integers (`nextInt()`) or random floating point numbers (`nextDouble()`).
- For example,

```
Random r = new Random();
int numLessThan10;
numLessThan10 = r.nextInt(10);//0-9
```

Chapter 7

The Random Class

- A random integer in a range is generated by using the formula:

  r.nextInt(highNum – lowNum + 1) + lowNum

- For example (an integer between 1 and 3)
  - R.nextInt(3-1+1) + 1
  - R.nextInt(3) + 1

Topic 15
boolean methods
and random numbers

> **"The Analytical Engine [computer] has no pretensions whatever to *originate* anything. It can do *whatever we know how to order it to perform*."**

Ada Lovelace

Creator of first computer algorithm & programs

An Account of the Analytical Engine, 1842, reprinted in *Faster than Thought*, ed. B.V. Bowden (Pitman, 1953), cited in Andrew Hodges *Alan Turing: The Enigma of Intelligence* (Unwin 1985)

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Slides adapted from Chand John
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https://www.cs.utexas.edu/~chand/cs312/
topic15_string_boolean_methods_random_numbers.pdf

Based on slides by Marty Stepp and Stuart Reges
from http://www.buildingjavaprograms.com/

Random numbers

reading: 5.1

The Random class

- A Random object generates pseudo-random numbers.
  - Class Random is found in the java.util package.

```
import java.util.Random;
```

Method name	**Description**
nextInt()	returns a random integer
nextInt(***<max>***)	returns a random integer in the range [0, *max*) in other words, 0 to *max*-1 inclusive
nextDouble()	returns a random real number in the range [0.0, 1.0)

  - Example:

```
Random rand = new Random();
int randomNumber = rand.nextInt(10);// 0-9
```

Generating random numbers

- Common usage: to get a random number from 1 to *N*

```
int n = rand.nextInt(20) + 1;
// 1-20 inclusive
```

- To get a number in arbitrary range [*min*, *max*] inclusive:

  <name>.nextInt(***<size of range>***) + ***<min>***

  - Where ***<size of range>*** is (***<max>*** - ***<min>*** + 1)

  – Example: A random integer between 4 and 10 inclusive:

```
int n = rand.nextInt(7) + 4;
```

`Random` questions

- Given the following declaration, how would you get:

```
Random rand = new Random();
```

  - A random number between 1 and 47 inclusive?

```
int random1 = rand.nextInt(47) + 1;
```

  - A random number between 23 and 30 inclusive?

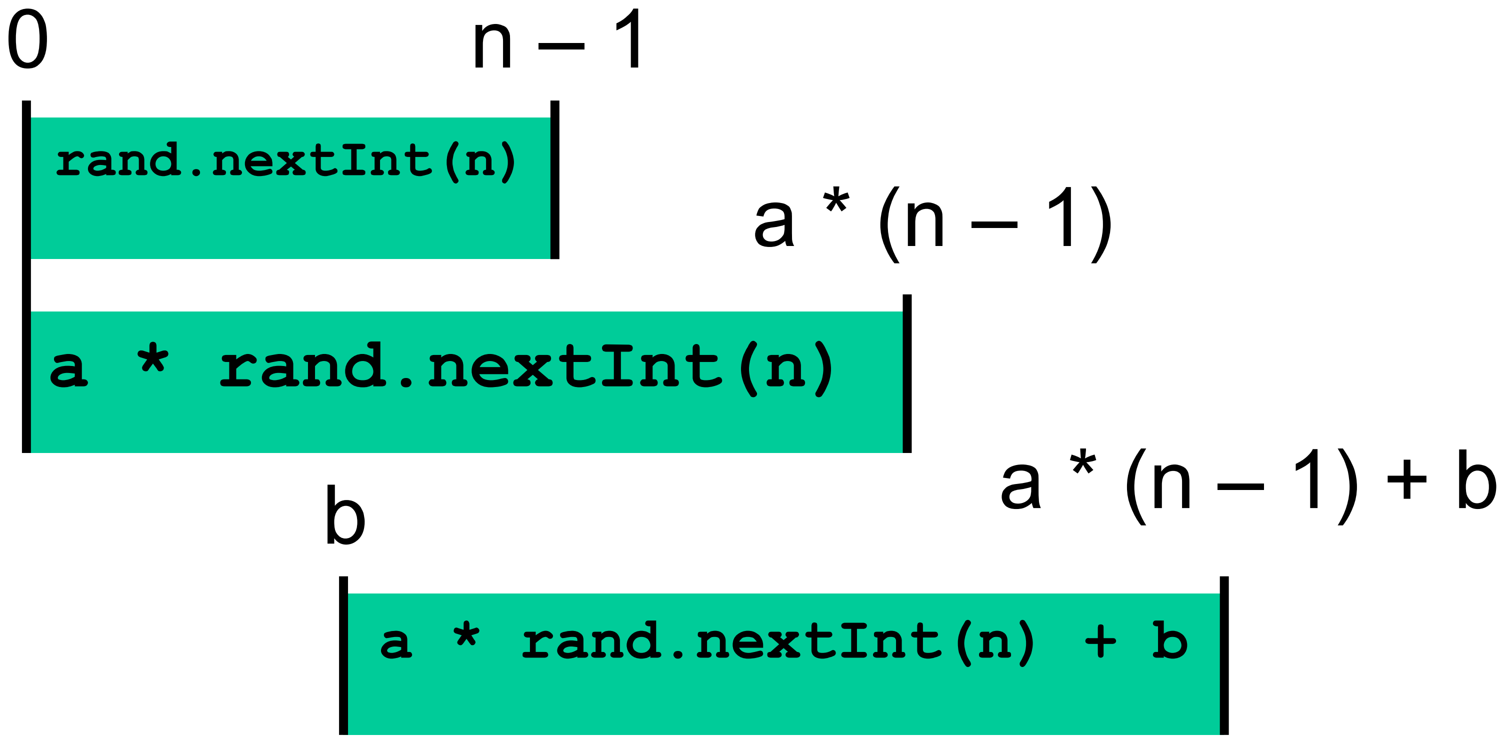
```
int random2 = rand.nextInt(8) + 23;
```

  - A random even number between 4 and 12 inclusive?

```
int random3 = rand.nextInt(5) * 2 + 4;
```

What’s the pattern?

```
int n = <some integer>;
Random rand = new Random();
int randomNumber = a * rand.nextInt(n) + b;
```



0

n – 1

`rand.nextInt(n)`

a * (n – 1)

`a * rand.nextInt(n)`

b

a * (n – 1) + b

`a * rand.nextInt(n) + b`

Random and other types

- nextDouble method returns a double between [0.0 - 1.0)
  - Example: Get a random GPA value between 1.5 and 4.0:

```
double randomGpa
                = rand.nextDouble() * 2.5 + 1.5;
```

- Any set of possible values can be mapped to integers
  - code to randomly play Rock-Paper-Scissors:

```
int r = rand.nextInt(3);
if (r == 0) {
    System.out.println("Rock");
} else if (r == 1) {
    System.out.println("Paper");
} else {  // r == 2
    System.out.println("Scissors");
}
```

Random question

- Write a program that simulates rolling of two 6-sided dice until their combined result comes up as 7.

```
2 + 4 = 6
3 + 5 = 8
5 + 6 = 11
1 + 1 = 2
4 + 3 = 7
You won after 5 tries!
```

Random answer

```
// Rolls two dice until a sum of 7 is reached.
import java.util.*;

public class Dice {
    public static void main(String[] args) {
        Random rand = new Random();
        int tries = 0;

        int sum = 0;
        while (sum != 7) {
            // roll the dice once
            int roll1 = rand.nextInt(6) + 1;
            int roll2 = rand.nextInt(6) + 1;
            sum = roll1 + roll2;
            System.out.println(roll1 + " + " + roll2 + " = " + sum);
            tries++;
        }

        System.out.println("You won after " + tries + " tries!");
    }
}
```

`Random` question

- Write a program that plays an adding game.
  - Ask user to solve random adding problems with 2-5 numbers.
  - The user gets 1 point for a correct answer, 0 for incorrect.
  - The program stops after 3 incorrect answers.

```
4 + 10 + 3 + 10 = 27
9 + 2 = 11
8 + 6 + 7 + 9 = 25
Wrong! The answer was 30
5 + 9 = 13
Wrong! The answer was 14
4 + 9 + 9 = 22
3 + 1 + 7 + 2 = 13
4 + 2 + 10 + 9 + 7 = 42
Wrong! The answer was 32
You earned 4 total points.
```

Random answer

```
// Asks the user to do adding problems and scores them.
import java.util.*;

public class AddingGame {
    public static void main(String[] args) {
        Scanner console = new Scanner(System.in);
        Random rand = new Random();

        // play until user gets 3 wrong
        int points = 0;
        int wrong = 0;
        while (wrong < 3) {
            int result = play(console, rand);   // play one game
            if (result == 0) {
                wrong++;
            } else {
                points++;
            }
        }

        System.out.println("You earned " + points + " total points.");
    }
```

Random answer 2

```
    ...
    // Builds one addition problem and presents it to the user.
    // Returns 1 point if you get it right, 0 if wrong.
    public static int play(Scanner console, Random rand) {
        // print the operands being added, and sum them
        int operands = rand.nextInt(4) + 2;
        int sum = rand.nextInt(10) + 1;
        System.out.print(sum);

        for (int i = 2; i <= operands; i++) {
            int n = rand.nextInt(10) + 1;
            sum += n;
            System.out.print(" + " + n);
        }
        System.out.print(" = ");

        // read user's guess and report whether it was correct
        int guess = console.nextInt();
        if (guess == sum) {
            return 1;
        } else {
            System.out.println("Wrong! The answer was " + total);
            return 0;
        }
    }
}
```