Lesson 8-2: Strings and Random Numbers (in Loops)

Computer Science 46A: Introduction to Programming

San José State University

Announcements

- Lab tomorrow (3/21)
- Midterm ?

Learning Objectives

By the end of this lesson, you should be able to:

1. Format strings with space “padding”
2. Generate random integers and doubles
3. Generate a predictable set of random numbers using a “seed”

A few more string formatting tips

Recall: Formatting doubles with `printf`

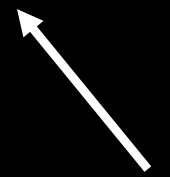
With the `printf` function, we can format `double` type numbers in strings with a specified number of decimal places

For example:

```
System.out.printf("The square root of 2 is %.4f.",Math.sqrt(2))
```

Output:

```
The square root of 2 is 1.4142.
```



Number of decimal places

Poll Everwhere: Question 1

Which of the following lines would print 3.14?

A) `System.out.printf("%.1f", 3.14)`

B) `System.out.printf("%.3f", 3.14)`

C) `System.out.printf("%.2f", Math.PI)`

D) `System.out.printf("%.3f", Math.PI)`

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Formatting integers with spaces

```
int number = 3456;
```

Recall: We can format integers in strings with the %d formatter

```
e.g. System.out.printf("%d", number)
```

0	1	2	3
3	4	5	6

← indices

← digits

We can "pad" integers with spaces with a number in the %d formatter

```
e.g. System.out.printf("%9d", number)
```

0	1	2	3	4	5	6	7	8
					3	4	5	6

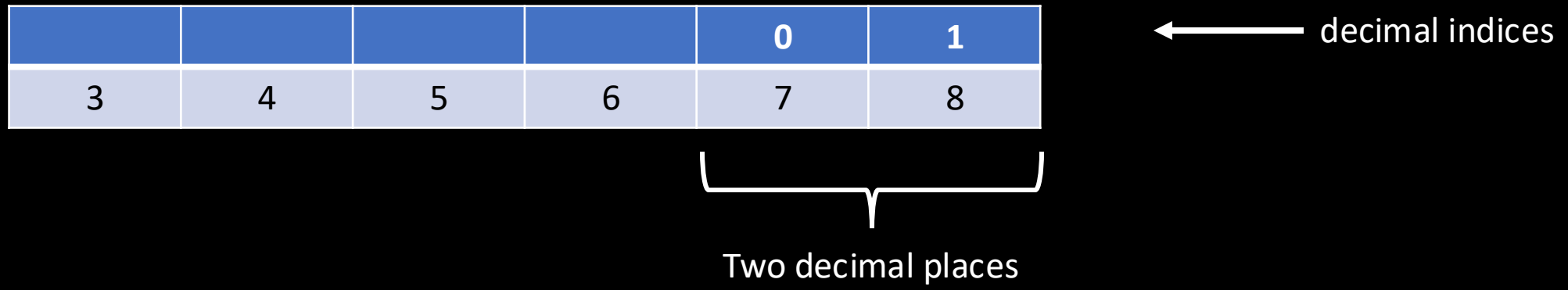
See example code in `IntegerAlignment`

Formatting doubles

```
double number = 3456.789;
```

Recall: We can format doubles in strings with the `%f` formatter

```
e.g. System.out.printf("%.2f", number)
```



See example code in `DoubleAlignment`

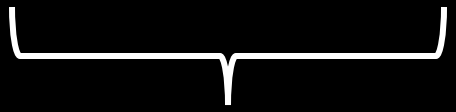
Formatting doubles with spaces

```
double number = 3456.78;
```

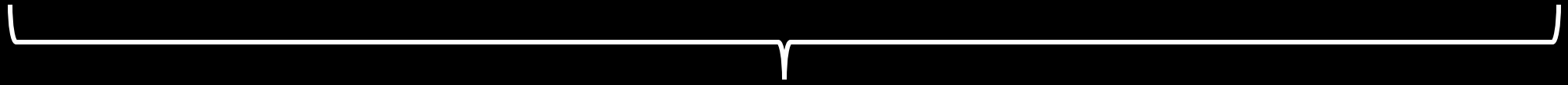
We can "pad" doubles with spaces with a number in the `%f` formatter

```
e.g. System.out.printf("%9.2f", number)
```

0	1	2	3	4	5	6	7	8
		3	4	5	6	.	7	8



Two decimal places



Nine possible characters

See example code in `DoubleAlignment`

Example: RotationMatrix

- In linear algebra, the rotation matrix (R) for an angle θ is:

$$\begin{bmatrix} \cos(\theta) & -\sin(\theta) \\ \sin(\theta) & \cos(\theta) \end{bmatrix}$$

- This matrix is used to rotate vectors in a plane

```
The rotation matrix for θ = 45.0 is
|    0.707   -0.707|
|    0.707    0.707|
```

Random Numbers

Random Numbers

- Often, we require randomly-generated numbers in our code
- Examples:
  - Encryption, Statistics, Code testing
- To generate random numbers we use the Random class
- First, we create a generator object:

```
Random generator = new Random();
```

- Then, we can use the generator to produce our random numbers

```
generator.nextInt(n);
```

The nextInt method will provide a random number between 0 and n (exlcusive)

Example: `FlippingACoin`

Code Description:

- Flip a coin a given amount of times, counting the number of heads and tails as you go

```
Flipping a coin 100 times...
Number of heads: 53
Number of tails: 47
Flipping a coin 100 times...
Number of heads: 54
Number of tails: 46
Flipping a coin 100 times...
Number of heads: 51
Number of tails: 49
Flipping a coin 100 times...
Number of heads: 55
Number of tails: 45
```

Output of the `FlippingACoin` class run 4 times

If you like stats and programming, THIS VIDEO is highly recommended!

Poll Everywhere: Question 2

- We can use `generator.nextInt(n)` to generate a random number between 0 and n (exclusive).
- How can we generate a random number between 7 and 17 (exclusive)?

A) `generator.nextInt(7,17)`

B) `7 + generator.nextInt(17)`

C) `17 + generator.nextInt(7)`

D) `7 + generator.nextInt(10)`

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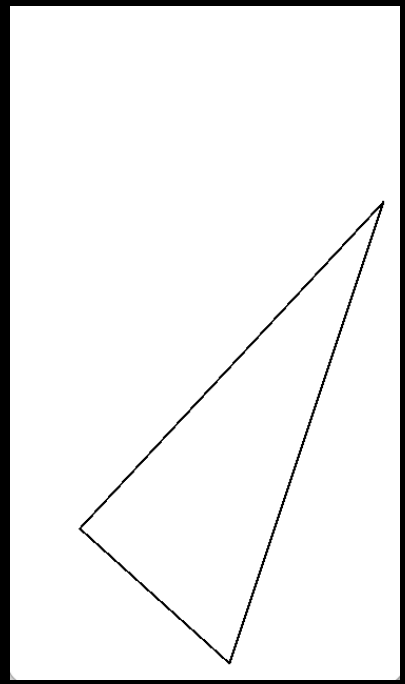
Example: `RandomTriangle`

Code Description:

- Draw a triangle with indices given at random points such that
  - $0 < x < 200$
  - $0 < y < 400$
- Print coordinates to the screen



```
Point 1: (178, 94)
Point 2: (34, 249)
Point 3: (105, 313)
```

Output of the `RandomTriangle` class

A Predictable Set of Random Numbers

- Each time you use a generator to produce random numbers, it provides a unique selection of random numbers
- Each time you run the code, the random numbers will change
- If you want a predictable set of random numbers, construct your generator using a “seed” – an integer value that specifies a specific set of random numbers

```
int seed = 10; //example
Random generator = new Random(seed);
```

See example code in **RandomTriangle**

Participation Exercise 8-2a: `MultiplicationTable`

Goal: Create a multiplication table such as the one displayed at the right

```
  1   2   3   4   5   6   7   8   9  10
  2   4   6   8  10  12  14  16  18  20
  3   6   9  12  15  18  21  24  27  30
  4   8  12  16  20  24  28  32  36  40
  5  10  15  20  25  30  35  40  45  50
  6  12  18  24  30  36  42  48  54  60
  7  14  21  28  35  42  49  56  63  70
  8  16  24  32  40  48  56  64  72  80
  9  18  27  36  45  54  63  72  81  90
 10  20  30  40  50  60  70  80  90 100
```

Output of `MultiplicationTable`

Codecheck Link: HERE and on Canvas

Participation Exercise 8-2b: RandomNumbersWithASeed

Goal: Create a list of random numbers with values between 45 and 55

Use the SEED to ensure your values match the values shown at the right

```
Enter the count of random numbers: 5
 54 50 46 51 54
```

Output of RandomNumbersWithASeed

Codecheck Link: HERE and on Canvas