Nested `for` loops

- A `for` loop can contain any kind of statement in its body, including another `for` loop.
  - The inner loop must have a different name for its loop counter variable so that it will not conflict with the outer loop.
- **nested loop**: Loops placed inside one another, creating a loop of loops.

```
for (int i = 1; i <= 3; i++) {
    for (int j = 1; j <= 2; j++) {
        printf("six\n");
    }
}
```

Output?

```
six
six
six
six
six
six
```

More nested `for` loops

- All of the statements in the outer loop's body are executed 5 times.
  - The inner loop runs 10 times for each of those 5 times, for a total of 50 numbers printed.

```
for (int i = 1; i <= 5; i++) {
    for (int j = 1; j <= 10; j++) {
        printf("%d  ",(i * j));
    }
    printf("\n");
}
```

Output?

```
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
```

Nested `for` loop exercise

- What is the output of the following nested `for` loop?

```
for (int i = 1; i <= 4; i++) {
    for (int j = 1; j <= 5; j++) {
        printf("*");
    }
    printf("\n");
}
```

- Output?
- *****
- *****
- *****
- *****

Nested `for` loop exercise

- What is the output of the following nested `for` loop?

```
for (int i = 1; i <= 6; i++) {
    for (int j = 1; j <= i; j++) {
        printf("*");
    }
    printf("\n");
}
```

- Output:

```
*
**
***
****
*****
******
```

Nested `for` loop exercise

- What is the output of the following nested `for` loop?

```
for (int i = 1; i <= 6; i++) {
    for (int j = 1; j <= i; j++) {
        System.out.print(i);
    }
    System.out.println();
}
```

- Output?

Nested `for` loop exercise

- Create a nested `for` loops produce the following output.

```
....1
...22
..333
.4444
55555
```

Nested `for` loop exercise

- A `for` loop can have more than one loop nested in it.
- What is the output of the following nested `for` loops?

```
for (int i = 1; i <= 5; i++) {
    for (int j = 1; j <= (5 - i); j++) {
        System.out.print(" ");
    }
    for (int k = 1; k <= i; k++) {
        System.out.print(i);
    }
    System.out.println();
}
```

- Answer:

```
    1
   22
  333
 4444
55555
```

Common nested loop bugs

- It is a common bug to accidentally type the wrong loop counter variable, which can lead to incorrect behavior.
  - What is the output of the following nested loops?

```
for (int i = 1; i <= 10; i++) {
    for (int j = 1; i <= 5; j++) {
        System.out.print(j);
    }
    System.out.println();
}
```

  - What is the output of the following nested loops?

```
for (int i = 1; i <= 10; i++) {
    for (int j = 1; j <= 5; i++) {
        System.out.print(j);
    }
    System.out.println();
}
```

How to comment: for loops

- Place a comment on complex loops explaining *what* they do from a conceptual standpoint, not the mechanics of the syntax.
  - Bad:

```
// This loop repeats 10 times, with i from 1 to 10.
for (int i = 1; i <= 10; i++) {
    for (int j = 1; j <= 5; j++) {  // loop goes 5 times
        System.out.print(j);  // print the j
    }
    System.out.println();
}
```

  - Better:

```
// Prints 12345 ten times on ten separate lines.
for (int i = 1; i <= 10; i++) {
    for (int j = 1; j <= 5; j++) {
        System.out.print(j);
    }
    System.out.println();  // end the line of output
}
```