



Nested for loops

Subset of the Supplement Lesson slides from: Building Java Programs, Chapter 2
by Stuart Reges and Marty Stepp (<http://www.buildingjavaprograms.com/>)

Nested loops

- **nested loop:** A loop placed inside another loop.

```
for (int i = 1; i <= 5; i++) {  
    for (int j = 1; j <= 10; j++) {  
        System.out.print("*");  
    }  
    System.out.println();    // to end the line  
}
```

- Output:

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

- The outer loop repeats 5 times; the inner one 10 times.
 - "sets and reps" exercise analogy

Nested for loop exercise

- What is the output of the following nested for loops?

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

- Output:

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

Nested for loop exercise

- What is the output of the following nested for loops?

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

- Output:

```
1  
22  
333  
4444  
55555
```

Common errors

- Both of the following sets of code produce *infinite loops*:

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

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

Complex lines

- What nested `for` loops produce the following output?

inner loop (repeated characters on each line)

.....1
...2
..3
.4
5

outer loop (loops 5 times because there are 5 lines)

- We must build multiple complex lines of output using:
 - an *outer "vertical" loop* for each of the lines
 - *inner "horizontal" loop(s)* for the patterns within each line

Outer and inner loop

- First write the outer loop, from 1 to the number of lines.

```
for (int line = 1; line <= 5; line++) {  
    ...  
}
```

- Now look at the line contents. Each line has a pattern:
 - some dots (0 dots on the last line), then a number

```
....1  
...2  
..3  
.4  
5
```

- Observation: the number of dots is related to the line number.

Mapping loops to numbers

```
for (int count = 1; count <= 5; count++) {  
    System.out.print( ... );  
}
```

– What statement in the body would cause the loop to print:

4 7 10 13 16

```
for (int count = 1; count <= 5; count++) {  
    System.out.print(3 * count + 1 + " ");  
}
```


Loop tables

- What statement in the body would cause the loop to print:

2 7 12 17 22

- To see patterns, make a table of `count` and the numbers.
 - Each time `count` goes up by 1, the number should go up by 5.
 - But `count * 5` is too great by 3, so we subtract 3.

count	number to print	5 * count	5 * count - 3
1	2	5	2
2	7	10	7
3	12	15	12
4	17	20	17
5	22	25	22

Loop tables question

- What statement in the body would cause the loop to print:

17 13 9 5 1

- Let's create the loop table together.
 - Each time `count` goes up 1, the number printed should ...
 - But this multiple is off by a margin of ...

<code>count</code>	number to print	$-4 * \text{count}$	$-4 * \text{count} + 21$
1	17	-4	17
2	13	-8	13
3	9	-12	9
4	5	-16	5
5	1	-20	1

Nested for loop exercise

- Make a table to represent any patterns on each line.

.....1
....2
...3
..4
.4
5

line	# of dots	$-1 * \text{line}$	$-1 * \text{line} + 5$
1	4	-1	4
2	3	-2	3
3	2	-3	2
4	1	-4	1
5	0	-5	0

- To print a character multiple times, use a `for` loop.

```
for (int j = 1; j <= 4; j++) {  
    System.out.print(".");           // 4 dots  
}
```

Nested for loop solution

- Answer:

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

- Output:

```
.....1  
....2  
..3  
.4  
5
```

Nested for loop exercise

- What is the output of the following nested for loops?

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

- Answer:

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

Nested for loop exercise

- Modify the previous code to produce this output:

```
.....1
...2.
..3..
.4...
5.....
```

- Answer:

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