

Building Java Programs

Chapter 3

Lecture 5: Parameters and Scope

reading: 3.1

Scope

- **scope:** The part of a program where a variable exists.
 - From its declaration to the end of the { } braces
 - A variable declared in a `for` loop exists only in that loop.
 - A variable declared in a method exists only in that method.

```
public static void example() {  
    int x = 3;  
    for (int i = 1; i <= 10; i++) {  
        System.out.println(x);  
    }  
    // i no longer exists here  
} // x ceases to exist here
```

i's scope

x's scope

Promoting reuse

- Programmers build increasingly complex applications
 - Enabled by existing building blocks, e.g. methods
- The more general a building block, the easier to reuse
- **Abstraction**: focusing on essential properties rather than implementation details
- Algebra is all about abstraction
 - Functions solve an entire class of similar problems

Redundant recipes

- Recipe for baking **20** cookies:
 - Mix the following ingredients in a bowl:
 - **4** cups flour
 - **1** cup butter
 - **1** cup sugar
 - **2** eggs
 - **40** oz. chocolate chips ...
 - Place on sheet and Bake for about **10** minutes.
- Recipe for baking **40** cookies:
 - Mix the following ingredients in a bowl:
 - **8** cups flour
 - **2** cups butter
 - **2** cups sugar
 - **4** eggs
 - **80** oz. chocolate chips ...
 - Place on sheet and Bake for about **10** minutes.

Parameterized recipe

- Recipe for baking **20** cookies:
 - Mix the following ingredients in a bowl:
 - 4 cups flour
 - 1 cup sugar
 - 2 eggs
 - ...
- Recipe for baking **N** cookies:
 - Mix the following ingredients in a bowl:
 - **N/5** cups flour
 - **N/20** cups butter
 - **N/20** cups sugar
 - **N/10** eggs
 - **2N** oz. chocolate chips ...
 - Place on sheet and Bake for about 10 minutes.
- **parameter**: A value that distinguishes similar tasks.

A redundant solution

```
public class Stars1 {
    public static void main(String[] args) {
        lineOf13();
        lineOf7();
        lineOf35();
        box10x3();
        box5x4();
    }

    public static void lineOf13() {
        for (int i = 1; i <= 13; i++) {
            System.out.print("*");
        }
        System.out.println();
    }

    public static void lineOf7() {
        for (int i = 1; i <= 7; i++) {
            System.out.print("*");
        }
        System.out.println();
    }

    public static void lineOf35() {
        for (int i = 1; i <= 35; i++) {
            System.out.print("*");
        }
        System.out.println();
    }
    ...
}
```

- This code is redundant.
- Would variables help?
Would constants help?
- What is a better solution?
 - line - A method to draw a line of any number of stars.
 - box - A method to draw a box of any size.

Parameterization

- **parameter:** A value passed to a method by its caller.
- Instead of `lineOf7`, `lineOf13`, write `line` to draw any length.
 - When *declaring* the method, we will state that it requires a parameter for the number of stars.
 - When *calling* the method, we will specify how many stars to draw.



Declaring a parameter

Stating that a method requires a parameter in order to run

```
public static void <name> (<type> <name>) {  
    <statement>(s);  
}
```

- Example:

```
public static void favoriteNumber(int num) {  
    ...  
}
```

- When `favoriteNumber` is called, the caller must specify the integer code to print.

Passing a parameter

Calling a method and specifying values for its parameters

<name> (**<expression>**) ;

- Example:

```
public static void main(String[] args) {  
    favoriteNumber (42) ;  
    favoriteNumber (12345) ;  
}
```

Output:

```
Favorite number is 42
```

```
Favorite number is 12345
```

Using a parameter

Parameter is a local variable that can be used throughout the method by its name

- **Example:**

```
public static void favoriteNumber(int num) {  
    System.out.println("Favorite number is: " + num);  
}
```

- When `favoriteNumber` is called, parameter `num` is a local variable declared and is initialized to the value given by the caller

Parameters and loops

- A parameter can guide the number of repetitions of a loop.

```
public static void main(String[] args) {  
    chant(3);  
}
```

```
public static void chant(int times) {  
    for (int i = 1; i <= times; i++) {  
        System.out.println("Just a salad...");  
    }  
}
```

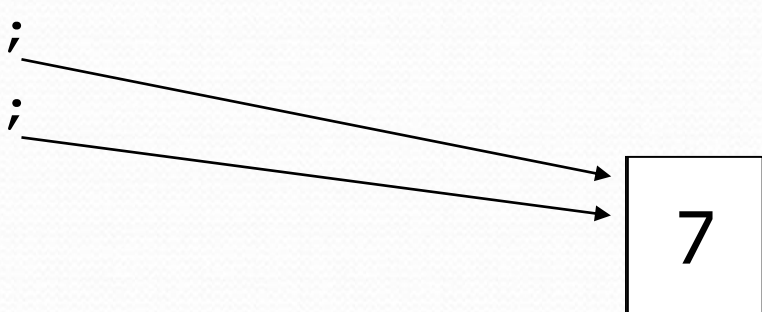
Output:

```
Just a salad...  
Just a salad...  
Just a salad...
```

How parameters are passed

- When the method is called:
 - The value is stored into the parameter variable.
 - The method's code executes using that value.

```
public static void main(String[] args) {  
    chant(3);  
    chant(7);  
}  
  
public static void chant(int times) {  
    for (int i = 1; i <= times; i++) {  
        System.out.println("Just a salad...");  
    }  
}
```



The diagram illustrates the process of passing parameters. In the `main` method, two calls to `chant` are shown: `chant(3);` and `chant(7);`. Arrows from the arguments `3` and `7` point to a box containing the number `7`, indicating that the value `7` is passed to the `times` parameter of the `chant` method.

Common errors

- If a method accepts a parameter, it is illegal to call it without passing any value for that parameter.

```
chant(); // ERROR: parameter value required
```

- The value passed to a method must be of the correct type.

```
chant(3.7); // ERROR: must be of type int
```

- Exercise: Change the `Stars` program to use a parameterized method for drawing lines of stars.

Stars solution

```
// Prints several lines of stars.  
// Uses a parameterized method to remove redundancy.  
public class Stars2 {  
    public static void main(String[] args) {  
        line(13);  
        line(7);  
        line(35);  
    }  
  
    // Prints the given number of stars plus a line break.  
    public static void line(int count) {  
        for (int i = 1; i <= count; i++) {  
            System.out.print("*");  
        }  
        System.out.println();  
    }  
}
```

Multiple parameters

- A method can accept multiple parameters. (separate by ,)
 - When calling it, you must pass values for each parameter.

- Declaration:

```
public static void <name>(<type> <name>, ..., <type> <name>)  
{  
    <statement>(s);  
}
```

- Call:

```
<name> (<exp>, <exp>, ..., <exp>);
```


Multiple parameters example

```
public static void main(String[] args) {  
    printNumber(4, 9);  
    printNumber(17, 6);  
    printNumber(8, 0);  
    printNumber(0, 8);  
}  
  
public static void printNumber(int number, int count) {  
    for (int i = 1; i <= count; i++) {  
        System.out.print(number);  
    }  
    System.out.println();  
}
```

Output:

```
4444444444  
171717171717  
  
00000000
```

- Modify the `Stars` program to draw boxes with parameters.

Stars solution

```
// Prints several lines and boxes made of stars.  
// Third version with multiple parameterized methods.
```

```
public class Stars3 {  
    public static void main(String[] args) {  
        line(13);  
        line(7);  
        line(35);  
        System.out.println();  
        box(10, 3);  
        box(5, 4);  
        box(20, 7);  
    }  
  
    // Prints the given number of stars plus a line break.  
    public static void line(int count) {  
        for (int i = 1; i <= count; i++) {  
            System.out.print("*");  
        }  
        System.out.println();  
    }  
    ...  
}
```

Stars solution, cont'd.

...

```
// Prints a box of stars of the given size.
```

```
public static void box(int width, int height) {  
    line(width);  
  
    for (int line = 1; line <= height - 2; line++) {  
        System.out.print("*");  
        for (int space = 1; space <= width - 2; space++) {  
            System.out.print(" ");  
        }  
        System.out.println("*");  
    }  
  
    line(width);  
}  
}
```

Value semantics

- **value semantics:** When primitive variables (`int`, `double`) are passed as parameters, their values are copied.
 - Modifying the parameter will not affect the variable passed in.

```
public static void strange(int x) {  
    x = x + 1;  
    System.out.println("1. x = " + x);  
}
```

```
public static void main(String[] args) {  
    int x = 23;  
    strange(x);  
    System.out.println("2. x = " + x);  
    ...  
}
```

Output:

```
1. x = 24  
2. x = 23
```

A "Parameter Mystery" problem

```
public class ParameterMystery {  
    public static void main(String[] args) {  
        int x = 9;  
        int y = 2;  
        int z = 5;  
  
        mystery(z, y, x);  
  
        mystery(y, x, z);  
    }  
}
```

```
public static void mystery(int x, int z, int y) {  
    System.out.println(z + " and " + (y - x));  
}  
}
```

Strings

- **string**: A sequence of text characters.

```
String <name> = "<text>";
```

```
String <name> = <expression resulting in String>;
```

- Examples:

```
String name = "Marla Singer";
```

```
int x = 3;
```

```
int y = 5;
```

```
String point = "(" + x + ", " + y + " )";
```

Strings as parameters

```
public class StringParameters {
    public static void main(String[] args) {
        sayHello("Marty");
        String teacher = "Bictolia";
        sayHello(teacher);
    }
    public static void sayHello(String name) {
        System.out.println("Welcome, " + name);
    }
}
```

Output:

```
Welcome, Marty
Welcome, Bictolia
```

- Modify the `Stars` program to use string parameters. Use a method named `repeat` that prints a string many times.

Stars solution

```
// Prints several lines and boxes made of stars.  
// Fourth version with String parameters.
```

```
public class Stars4 {  
    public static void main(String[] args) {  
        line(13);  
        line(7);  
        line(35);  
        System.out.println();  
        box(10, 3);  
        box(5, 4);  
        box(20, 7);  
    }  
  
    // Prints the given number of stars plus a line break.  
    public static void line(int count) {  
        repeat("*", count);  
        System.out.println();  
    }  
  
    ...  
}
```


Stars solution, cont'd.

...

```
// Prints a box of stars of the given size.
```

```
public static void box(int width, int height) {  
    line(width);  
  
    for (int line = 1; line <= height - 2; line++) {  
        System.out.print("*");  
        repeat(" ", width - 2);  
        System.out.println("*");  
    }  
  
    line(width);  
}
```

```
// Prints the given String the given number of times.
```

```
public static void repeat(String s, int times) {  
    for (int i = 1; i <= times; i++) {  
        System.out.print(s);  
    }  
}  
}
```