

Programming using Java

Java: final, static

Math class

Constants: `final`

- ❑ A `final` variable is a constant
- ❑ Once its value has been set, it cannot be changed
- ❑ Named constants make programs easier to read and maintain
- ❑ Convention: use all-uppercase names for constants

Constants: `final`

```
final double QUARTER_VALUE = 0.25;
final double DIME_VALUE = 0.1;
final double NICKEL_VALUE = 0.05;
final double PENNY_VALUE = 0.01;
payment = dollars + quarters * QUARTER_VALUE
        + dimes * DIME_VALUE
        + nickels * NICKEL_VALUE
        + pennies * PENNY_VALUE;
```

Constants: `static final`

- ❑ If constant values are needed in several methods, declare them together with the instance fields of a class and tag them as `static` **and** `final`
- ❑ **Give** `static final` constants `public` access to enable other classes to use them

Constants: static final

```
public class Math
{
    . . .
    public static final double E =
        2.7182818284590452354;
    public static final double PI =
        3.14159265358979323846;
}

double circumference = Math.PI * diameter;
```

Constant Definition

In a method:

```
final typeName variableName = expression ;
```

In a class:

```
accessSpecifier static final  
    typeName variableName = expression;
```

Example:

```
final double NICKEL_VALUE = 0.05;  
public static final double  
    LITERS_PER_GALLON = 3.785;
```

Purpose:

To define a constant in a method or a class

Self Check

- ❓ What is the difference between the following two statements?

```
final double CM_PER_INCH = 2.54;
```

and

```
public static final double CM_PER_INCH = 2.54;
```

- ❓ What could go wrong with the following statement?

```
double circumference = 3.14 * diameter;
```

Answers

- ❓ The first definition is used inside a method, the second inside a class
- ❓ (1) You should use a named constant, not the "magic number" 3.14
(2) 3.14 is not an accurate representation of π

The Math class

- ❑ Math class: contains methods like `sqrt` and `pow`
- ❑ To compute x^n , you write `Math.pow(x, n)`
- ❑ However, to compute x^2 it is significantly more efficient simply to compute `x * x`
- ❑ To take the square root of a number, use the `Math.sqrt`; for example, `Math.sqrt(x)`

The Math class

❓ In Java,

$$\frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

can be represented as

```
(-b + Math.sqrt(b * b - 4 * a * c)) / (2 * a)
```

Mathematical Methods in Java

<code>Math.sqrt(x)</code>	square root
<code>Math.pow(x, y)</code>	power x^y
<code>Math.exp(x)</code>	e^x
<code>Math.log(x)</code>	natural log
<code>Math.sin(x)</code> , <code>Math.cos(x)</code> , <code>Math.tan(x)</code>	sine, cosine, tangent (x in radian)
<code>Math.round(x)</code>	closest integer to x
<code>Math.min(x, y)</code> , <code>Math.max(x, y)</code>	minimum, maximum

Analyzing an Expression

The diagram illustrates the simplification of the quadratic formula expression through several steps, using curly braces to group parts of the expression:

- Step 1:** The initial expression is $(-b + \text{Math.sqrt}(b * b - 4 * a * c)) / (2 * a)$. Braces are placed under $b * b$, $4 * a * c$, and $2 * a$.
- Step 2:** The terms under the first two braces are simplified to b^2 and $4ac$.
- Step 3:** A brace groups b^2 and $4ac$, which are then simplified to $b^2 - 4ac$.
- Step 4:** A brace groups the entire expression inside the square root, which is simplified to $\sqrt{b^2 - 4ac}$.
- Step 5:** A brace groups $-b$ and $\sqrt{b^2 - 4ac}$, which are then simplified to $-b + \sqrt{b^2 - 4ac}$.
- Step 6:** A final brace groups the entire expression, which is then simplified to the final form: $\frac{-b + \sqrt{b^2 - 4ac}}{2a}$.

Analyzing an Expression

Self Check

? What is the value of $1729 / 100$?
Of $1729 \% 100$?

? Why doesn't the following statement compute the average of `s1`, `s2`, and `s3`?

```
double average = s1 + s2 + s3 / 3; // Error
```

? What is the value of

```
Math.sqrt(Math.pow(x, 2) + Math.pow(y, 2))
```

Answers

- 17 and 29
- Only $s3$ is divided by 3. To get the correct result, use parentheses. Moreover, if $s1$, $s2$, and $s3$ are integers, you must divide by 3.0 to avoid integer division:

$$(s1 + s2 + s3) / 3.0$$

8.

$$\sqrt{x^2 + y^2}$$

Calling Static Methods

- ❓ A static method does not operate on an object

```
double x = 4;  
double root = x.sqrt(); // Error
```

- ❓ Static methods are defined inside classes
- ❓ Naming convention: Classes start with an uppercase letter; objects start with a lowercase letter

```
Math  
System.out
```

Static Method Call

ClassName. methodName(parameters)

Example:

`Math.sqrt(4)`

Purpose:

To invoke a static method (a method that does not operate on an object)
and supply its parameters

Self Check

- ❓ Why can't you call `x.pow(y)` to compute x^y ?
- ❓ Is the call `System.out.println(4)` a static method call?

Answers

- ❓ `x` is a number, not an object, and you cannot invoke methods on numbers
- ❓ No—the `println` method is called on the object `System.out`