

Java Foundations

The Math Class



Objectives

- This lesson covers the following objective:
 - Understand the methods of the Math class
 - Use methods of the Math class to perform mathematical calculations
 - Use fields of the Math Class



Performing Mathematical Calculations

- While developing programs, you may need more advanced mathematical calculations than what the basic Java math operators provide
- For example:
 - Finding the maximum or minimum of two values
 - Rounding values
 - Logarithmic functions
 - Square root
 - Trigonometric functions
- The Java Math class contains methods for performing mathematical calculations

The Math Class

- Is one of the many classes included in the Java class libraries
- Contains methods that perform various mathematical functions
- Is part of the `java.lang` package

Documentation for the Math Class

- You can access the documentation from here:
 - <http://docs.oracle.com/javase/8/docs/api/index.html>

Scroll to see a list of fields and methods available in this class

The screenshot shows the Java API documentation for the `Math` class. The left sidebar lists various Java packages and classes. The main content area is titled "Class Math" and contains the following text:

`public final class Math
extends Object`

The class `Math` contains methods for performing basic numeric operations such as the elementary exponential, logarithm, square root, and trigonometric functions.

Unlike some of the numeric methods of class `BigDecimal`, all implementations of the equivalent functions of class `Math` are not defined to return the bit-for-bit same results. This relaxation permits better performance in implementations where strict reproducibility is not required.

Implementation of the `Math` methods simply call the equivalent method in `BigDecimal` for their implementation. Code generators are encouraged to use platform-specific native library or microprocessor instructions, where available, to provide higher-performance implementations of `Math` methods. Such higher-performance implementations still must conform to the specification for `Math`.

The quality of implementation specifications concern two properties: accuracy of the returned result and monotonicity of the method. Accuracy of the floating-point `Math` methods is measured in terms of *ulp*s and in the last place. For a given floating-point format, an *n*-ulp of a specific real number value is the distance between the two floating-point values bracketing that numerical value. When discussing the accuracy of a method as a whole rather than at a specific argument, the number of ulps cited is for the worst-case error at any argument. If a method always has an error less than 0.5 ulps, the method always returns the floating-point number nearest the exact result; such a method is correctly rounded. A correctly rounded method is generally the best a floating-point method can be; however, it is impossible for many floating-point methods to be correctly rounded. Instead, in the `Math` class, a larger error bound of 1 or 2 ulps is often tolerable. Informally, with a 1-ulp error bound, the computed result is guaranteed to be within 1 ulp of the exact result should be returned as the computed result; otherwise, either of the two floating-point values which bracket the exact result may be returned. For exact results large in magnitude, one of the endpoints of the bracket may be infinity. Besides accuracy at individual arguments, maintaining proper relations between the method at different arguments is also important. Therefore, most methods with more than 0.5 ulp errors are required to be semi-monotonic: whenever the mathematical function is non-decreasing, so is the floating-point approximation, likewise, whenever the mathematical function is non-increasing, so is the floating-point approximation. Not all approximations that have 1 up accuracy will automatically meet the monotonicity requirements.

Since: JDK1.0

Field Summary

Fields	Modifier and Type	Field and Description
	static double	E

Exercise 1

- Examine the Math class documentation:
 - Standard Edition for Java SE 8:
<http://docs.oracle.com/javase/8/docs/api/>
- See if you can find a value for PI and a method for computing the square root of a number



Some of the Methods Available in Math Class

Method Name	Description
abs(value)	absolute value
ceil(value)	rounds up
cos(value)	cosine, in radians
floor(value)	rounds down
log(value)	logarithm base e
log10(value)	logarithm base 10
max(value1, value2)	larger of two values
min(value1, value2)	smaller of two values
pow(base, exponent)	base to the exponent power
random()	random double between 0 and 1
round(value)	nearest whole number
sin(value)	sine, in radians
sqrt(value)	square root

What's Different About the Math Class?

- The methods of the Math class are static methods
- Static methods can be invoked through the class name
- That means you don't have to create an object of the Math class to call the methods
- For example, to invoke the methods of the Random class, you have to create an object of the Random class like this:

```
Random rndNum = new Random();
int randomNum = rndNum.nextInt();
```

How Do You Call the Methods of the Math Class?

- You can call methods of the Math class without creating an instance of the Math class, like this:
- Syntax:
 - `Math.methodName(parameters)`
- Example:
 - `Math.sqrt(121.0);`

Call methods by prefacing them with Math dot operator

Calling a Method and Observing Its Result

- Let's see an example of calling a method and observing its result:

```
public static void main(String[] args) {  
  
    Math.sqrt(121.0);  
} //end method main
```

- Observe the output:
 - No output is displayed
 - Simply calling these methods produces no visible result

How Do the Methods of the Math Class Work?

- The Math methods don't print the results to the console
- Each method returns a numerical result
- The returning value is more flexible than printing
- You can store, print, or combine it with a larger expression

Storing and Printing the Results

- To see the result, you must print it or store it in a variable
- For example:

– Print the result:

```
public static void main(String[] args) {  
    System.out.println("Square root: " + Math.sqrt(121.0)); //11.0  
}//end method main
```

– Store the value:

```
public static void main(String[] args) {  
    double sqroot= Math.sqrt(121.0);  
    System.out.println("Square root: " + sqroot); //11.0  
}//end method main
```

Combining the Results

- You can combine the results and use it in a larger expression, like this:

```
public static void main(String[] args) {  
    double result = Math.min(3, 7) + Math.abs(-50);  
    System.out.println("Result is " + result); //53  
}//end method main
```

Exercise 2



- On paper, evaluate the following Java statements and record the results:
 - `Math.abs(-1.23)`
 - `Math.pow(3, 2)`
 - `Math.sqrt(121.0) - Math.sqrt(256.0)`
 - `Math.abs(Math.min(-3, -5))`



Exercise 3

- Consider an integer variable named age
- Use Math.max and Math.min methods to answer the following questions:
 - What expression would replace negative ages with 0?
 - What expression would limit the maximum age to 40?

Fields in the Math Class

- The Math class contains two constant fields:
 - PI and E

Field	Description
Math.E	2.7182818...
Math.PI	3.1415926...

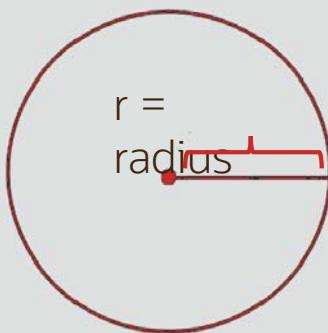
PI Field

π

- The Math class contains a constant, PI
- It contains a double value:
 - 3.14159265358979323846
- Remember, Math class methods are static methods and are accessed by using the Math class name
- Similarly, PI is a static variable in the Math class, and it is accessed by using the Math class name
- To use PI in a program, specify the class name (Math) and PI, separated by the dot operator:
 - Math.PI

Calculating the Area of a Circle

- Suppose that you have to write a Java program to compute the area of a circle
- Here's the formula to compute the area of a circle:
 - Area = PI * radius * radius
 - Where PI is a constant (approximately 3.1416)



Computing the Area of a Circle

- Using the Math.PI field for calculating the area yields a more accurate result than using a constant value for pi like 3.14

```
public class AreaOfCircle {  
    public static void main(String args[]) {  
        Scanner sc = new Scanner(System.in);  
        System.out.print("Enter the radius: ");  
        double radius = sc.nextDouble();  
        double area = Math.PI * radius * radius;  
        System.out.println("The area of circle is: " + area);  
    }//end method main  
}//end class AreaOfCircle
```

Exercise 4



- A person's body mass index (BMI) is computed like this: $BMI = \frac{weight}{height^2} \times 703$
- Import and open the MathEx project
- Examine ComputeBMI.java
- Write a program that computes the BMI and rounds off the BMI





Exercise 4

- Use the methods of the Math class and display the output as:
 - Enter the weight in pounds: 132.5
 - Enter the height in inches: 62.5
 - Your Body Mass Index is 24



Summary

- In this lesson, you should have learned how to:
 - Understand the methods of the Math class
 - Use methods of the Math class to perform mathematical calculations
 - Use fields of the Math Class

