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Oracle Academy Java for AP Computer Science A

4-5

The Math Class

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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:
 - <https://docs.oracle.com/en/java/javase/17/docs/api/java.base/module-summary.html>

OVERVIEW MODULE PACKAGE **CLASS** USE TREE DEPRECATED INDEX HELP Java SE 15 & JDK 15

SUMMARY: NESTED | FIELD | CONSTR | METHOD DETAIL: FIELD | CONSTR | METHOD SEARCH:

Module java.base
Package java.lang
Class Math
java.lang.Object
java.lang.Math

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.

Of class StrictMath, all implementations of the equivalent functions of class Math are not defined to return the bit-for-bit same results. In implementations where strict reproducibility is not required, simply call the equivalent method in StrictMath for their implementation. Code generators are encouraged to use platform-specific instructions, where available, to provide higher-performance implementations of Math methods. Such higher-performance implementations must conform to the accuracy and monotonicity requirements 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 *ulps*, units in the last place. For a given floating-point format, an 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 approximation can be; however, it is impractical for many floating-point methods to be correctly rounded. Instead, for the Math class, a larger error bound of 1 or 2 ulps is allowed for certain methods. Informally, with a 1 ulp error bound, when the

Exercise 1

- Examine the Math class documentation
- 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

```
double rndNum = Math.random();
```

//Math.random() returns a double value greater than or equal to 0.0 and less than 1.0

- Alternatively, 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 |
|----------------------|--------------|
| <code>Math.E</code> | 2.7182818... |
| <code>Math.PI</code> | 3.1415926... |

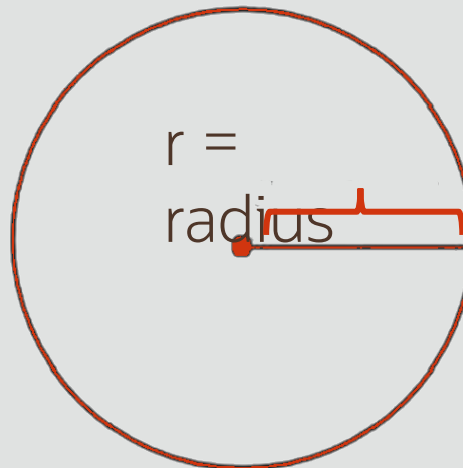


PI Field

- 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:
 - $\text{Area} = \text{PI} * \text{radius} * \text{radius}$
 - Where PI is a constant (approximately 3.1416)





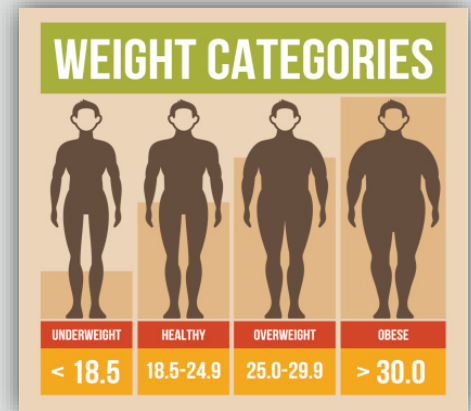
Computing the Area of a Circle

- 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
```

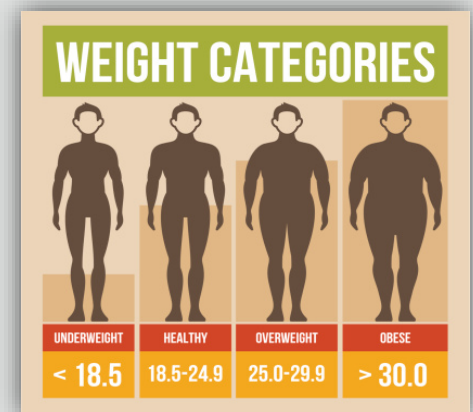
Exercise 4

- A person's body mass index (BMI) is computed like this:
$$BMI = \frac{weight}{height^2} \times 703$$
- Create a new project and add the `ComputeBMI.java` file to the project
- 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



Using `Math.random()`

- Random numbers are used to produce
 - encryption keys
 - simulation logic for gaming
 - scientific hypothesis testing
- `Math.random()` will generate a double between 0 and (not including) 1:
 - Values such as 0, 0.4567 or 0.901306 might be generated

Using Math.random()

- Can you predict the outcome of the following?

```
int number;  
number = (int)(Math.random() * 10);  
System.out.println("The random number is " + number + ".");
```

- Run the code example, and observe the output
- Remove (int)
- Why does this code produce an error?

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





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