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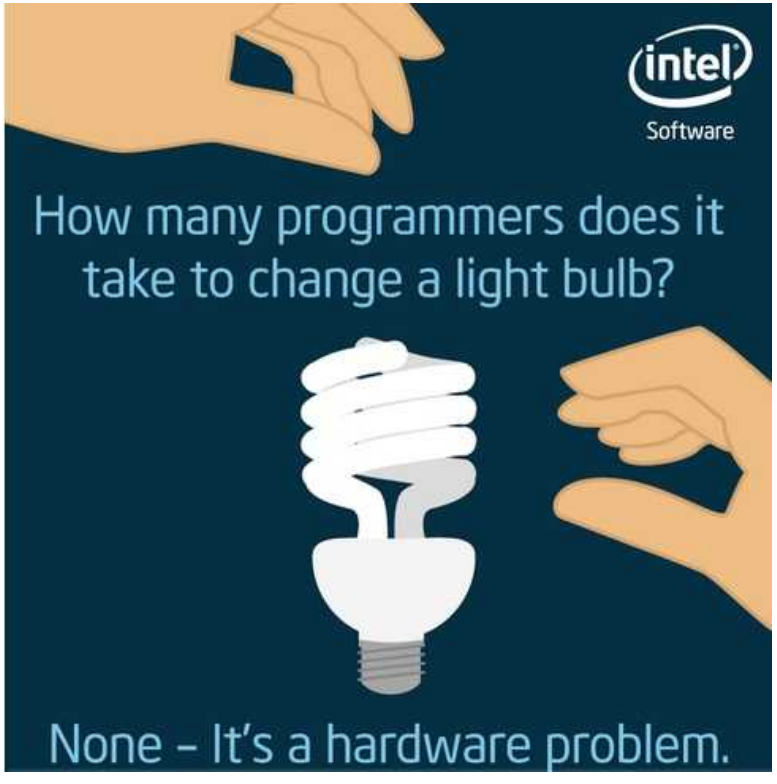
Math Functions and Characters



CS2011: Introduction to Programming I

Math Functions

Trigonometric Methods

Method	Description
`Math.sin(radians)`	Returns the sine of an angle in radians.
`Math.cos(radians)`	Returns the cosine of an angle in radians.
`Math.tan(radians)`	Returns the tangent of an angle in radians.
`Math.toRadians(degree)`	Returns a radian value for the given degree value.
`Math.toDegree(radians)`	Returns a degree value for the given radian value.
`Math.asin(a)`	Returns the angle in radians for the inverse of sine.
`Math.acos(a)`	Returns the angle in radians for the inverse of cosine.
`Math.atan(a)`	Returns the angle in radians for the inverse of tangent.

Exponent Methods

Method	Description
`Math.exp(x)`	Returns e raised to the power of x (e^x).
`Math.log(x)`	Returns the natural log of x ($\ln(x) = \log_e(x)$)
Math.log10(x)	Returns the base 10 lg of x ($\log_{10}(x)$).
Math.pow(a, b)	Returns a raised to the power of b (a^b).
Math.sqrt(x)	Returns the square root of x for x >= 0

Rounding Methods

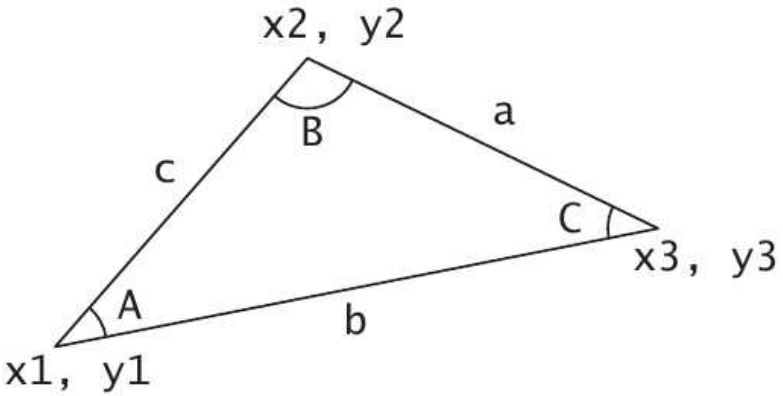
Method	Description
`Math.ceil(x)`	x is rounded up to its nearest integer. Returns a double.
`Math.floor(x)`	x is rounded down to its nearest integer. Returns a double.
Math.rint(x)	x is rounded up to its nearest integer. If x is equally close to two integers, the even one is returns. Returns a double.
Math.round(x)	Returns (int)Math.floor(x + 0.5) if x is a float, and (long)Math.floor(x + 0.5) if x is a double.

Min, Max and Absolute Value

- Math.min(a, b)
  - returns the minimum of a and b.
- Math.max(a, b)
  - returns the maximum of a and b.
- Math.abs(x)
  - returns the absolute value of x.

Example: Compute Triangle Angles

- Given the three sides of a triangle we can calculate the angles by using the formulas in the following diagram.




```
A = acos((a * a - b * b - c * c) / (-2 * b * c))
B = acos((b * b - a * a - c * c) / (-2 * a * c))
C = acos((c * c - b * b - a * a) / (-2 * a * b))
```

- See Code: **`ComputeAngles.java`**

Character Data Type

The char Data Type

- The **`char`** data type represents a single character.

- A character literal is enclosed in single quotation marks `' '`

- Example:

```
char letter = 'A';
char numChar = '4';
```

- NOTE: The increment and decrement operators can also be used on char variables to get the next or preceding character. For example, the following statements display character 'b'.

```
char ch = 'a';
System.out.println(++ch);
```

Unicode and ASCII Code

- Remember that computers use binary numbers internally.

- How then, is a character stored?
  - as a sequence of 0s and 1s
  - each character is mapped to a binary representation ***encoding***
  - characters can be encoded in different ways and how they are encoded is defined by an ***encoding scheme***

Unicode and ASCII Code

- Java supports Unicode,
  - encoding scheme established by the Unicode Consortium
  - supports the interchange, processing, and display of written texts in many of the world's languages
  - originally designed as a 16-bit character encoding.

- the **`char`** data type was originally designed to support character encoding
  - 16 available bits means we can represent 65,536 different types of characters

- Unicode was developed to extend the encoding to include 1,112,064 unique characters.
  - characters beyond the original 16-bit limit are called supplementary characters.

Unicode and ASCII Code

- A 16-bit Unicode takes two bytes, preceded by **`\u`**, expressed in four hexadecimal digits that run from **`\u0000`** to **`\uFFFF`**.

- Example:

```
char letter = '\u0041'; (Unicode)
char numChar = '\u0034'; (Unicode)
```

Unicode and ASCII Code

- Most computers use ASCII (American Standard Code for Information Interchange) to represent the characters.

- 8-bit encoding scheme for representing all uppercase and lowercase letters, digits, punctuation marks, and control characters.

- Unicode includes ASCII code, with \u0000 to \u007F corresponding to the 128 ASCII characters. (So the ASCII characters are a subset of the Unicode standard)

Unicode and ASCII Code

- You can use ASCII characters such as 'X', '1', and '$' or you can use the Unicode values.

- Example:

```
char letter = 'A';
char letter = '\u0041';
```

Escape Sequences

- How do you print a message with quotation marks in the output?

```
System.out.println("He said "Java is fun"");
```

  - The statement has a syntax error
  - The compiler thinks the 2nd quotation character is the end of the string.

- Java defines escape sequences to represent special characters
  - An escape sequence begins with '\'

Escape Sequences

- \b Backspace
- \t Tab
- \n New Line
- \\ Backslash
- \" Double Quote
- \' Single Quote

Escape Sequences

- Example:
  - Wrong:
    - `System.out.println("He said "Java is fun"");`
  - Correct:
    - `System.out.println("He said \"Java is fun\"");`

- Note: \ and " together are considered to be one character \"

Casting between `char` and Numeric Types

- A `char` can be cast into any numeric type and vice versa.

- When a char is cast into a numeric type, the character's unicode is cast into the specified numeric type

- Example:
  - `int i = (int)'A'; //i is now equal to 65`
  - `char ch = (char)65.25; //ch is now 'A'`

Operations on Characters

- The math operators can be used on characters
  - The math operation is applied to the unicode values of each character.
  - Example:
    - `int i = '2' + '3'`
    - '2' is 50 and '3' is 51 so 50 + 51 = 101

- You can also compare characters using the relational operators.
  - The comparison is applied to the unicode values of each character.
  - Example:
    - 'a' < 'b' is true
    - 'a' is 97 and 'b' is 98

The Character Class

- The `Character` class also provides some methods for testing characters.

- `Character.isDigit(ch)` : Returns true if the given character is a digit.
- `Character.isLetter(ch)` : Returns true if the given character is a letter.
- `Character.isLetterOrDigit(ch)` : Returns true if the given character is a letter or digit.
- `Character.isLowerCase(ch)` : Returns true if the given character is a lowercase letter.
- `Character.isUpperCase(ch)` : Returns true if the given character is an uppercase letter.
- `Character.toLowerCase(ch)` : Returns the lowercase of the character.
- `Character.isUpperCase(ch)` : Returns the uppercase of the character.

References

- Liang, Chapter 04: Math Functions, char Datatype and Strings.