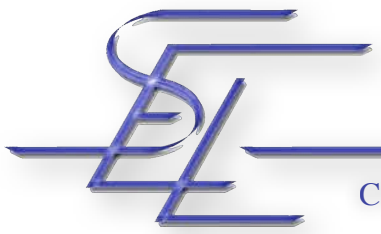
Java Libraries and Methods



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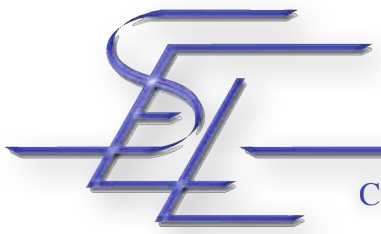
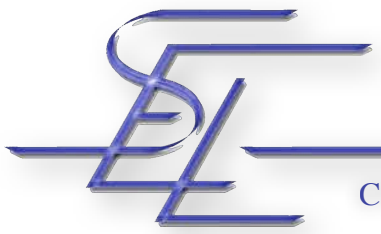
Chapter Outline

- Using Library Methods
  - Java.Math example
- Writing your own Methods
  - Void Methods
  - Methods with Return Value
- Writing Comments



Using Library Methods



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Java Libraries

- The Java Development Kit comes with many libraries which contain classes and methods for you to use
- These are classes and methods that other people have written to solve common tasks
- Some of these include:
  - a Math library (java.lang.Math)
  - String library (java.lang.String)
  - Graphics library (java.awt.* and javax.swing.*)
  - Networking library (java.net)

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The Math Library

- Math class
  - Provides many methods that you can use "off the shelf"
    - No need to know how they are implemented
  - Contains constants such as E and PI
- To access:
  - `Math.x` or `Math.m()` , where `x` stands for the name of the constant / `m` for the name of the method you want to use

Math Library Examples

```
double positiveNumber = Math.abs(-10);
double twoCubed = Math.pow(2,3);
double someTrigThingy = Math.sin(Math.PI);
```

To discover the details of a method
(i.e. how to call it),
look at the online documentation!

http://download.oracle.com/javase/6/docs/api/java/lang/Math.html

For each method it lists what the method needs as input and what it *returns* as output.

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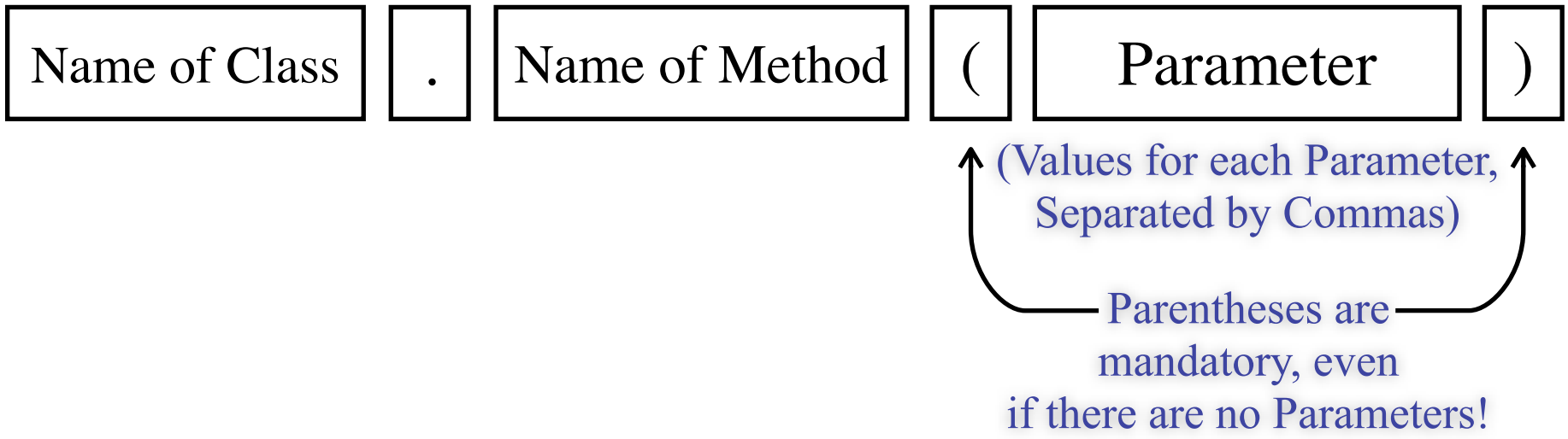
How to Call a Static Method



- Look at the method headers in the Javadoc to determine the number of parameters and their types!
- http://download.oracle.com/javase/6/docs/api/

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Example: Math

- Class: `java.lang.Math`
- Provides many useful mathematical functions
  - `static double sin(double a)`
  - `static double sqrt(double a)`
  - `static double pow(double a, double b)`
  - `static int abs(int a)`
  - `static int max(int a, int b)`

Return Type, i.e. what the Method Produces as Output

Name of the Method

Method Parameters, i.e. what the Method Requires as Input

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Detailed Example: `sin` (Parameters)

- `static double sin(double a)`

- The `sin` method expects as parameter one double expression
- When you call `sin`, you must put an expression that evaluates to a double between the `( )`
- Examples:
  - `... Math.sin(3.0)`
  - `... Math.sin(2 * Math.PI)`
- Bad Examples:
  - `... Math.sin()`
  - `... Math.sin(2.3, 5.2)`
  - `... Math.sin("3.0")`

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Detailed Example: `sin` (Return Type)

- `static double sin(double a)`

- The `sin` method produces as *return value* a double
- You must call `sin` in a place where a double expression is valid
- Examples:
  - `double angle = Math.sin(3.0);`
  - `System.out.println(Math.pow(Math.sin(angle),2));`
- Bad Example:
  - `int angle = Math.sin(3.0);`

Other Libraries

- There are many other libraries that come with the Java SDK
  - See http://download.oracle.com/javase/6/docs/api/
- They are organized in *packages*
- Anything in the `java.lang` package is available to your program by default
- Anything else needs to be *imported*
- Example:
  - To use the `Scanner` class in `java.util`, write:
  - `import java.util.Scanner;`

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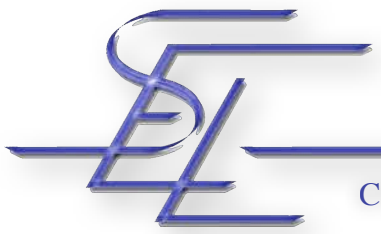
Writing Your Own Methods



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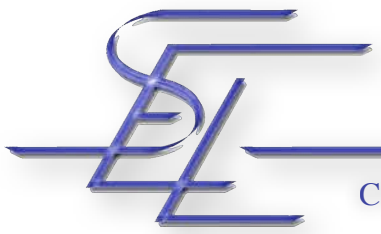
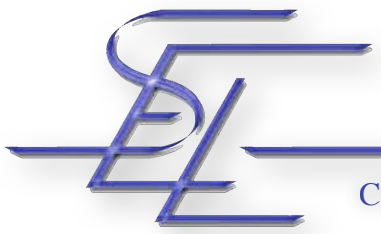
Methods

- Often, we can use a library method to solve our problem
  - Why reinvent the wheel?
- Sometimes we can't do this, because:
  - Our need is very specific, and so no one else has bothered to write a library
  - The is a library method that solves our need, but not in a satisfactory way
    - Too slow
    - Uses too much memory
- That's when you write your own method!



Example: Convert Numbers to Binary

- Convert a decimal number (which is assumed to be smaller than 128) to binary format



Binary Conversion (1)

```
import java.util.Scanner;
public class BinaryConversion {
  public static void main(String [] args) {
    Scanner keyboard = new Scanner(System.in);
    System.out.println("Please type a positive number < 128:");
    byte number = keyboard.nextByte();

    System.out.print(number + " decimal = ");
    // print out one digit after the other
    System.out.print(number/64);
    System.out.print((number%64)/32);
    System.out.print((number%32)/16);
    System.out.print((number%16)/8);
    System.out.print((number%8)/4);
    System.out.print((number%4)/2);
    System.out.print(number%2);
    System.out.println(" binary.");
  }
}
```

Binary Conversion (2)

- What if we want to display the number together with the 4 following ones in binary?
  - Possible Solution: Copy Paste!

```
import java.util.Scanner;
public class BinaryConversion {
  public static void main(String [] args) {
    Scanner keyboard = new Scanner(System.in);
    System.out.println("Please type a positive number < 128:");
    byte number = keyboard.nextByte();

    System.out.print(number + " decimal = ");
    System.out.print(number/64);
    System.out.print((number%64)/32);
    System.out.print((number%32)/16);
    System.out.print((number%16)/8);
    System.out.print((number%8)/4);
    System.out.print((number%4)/2);
    System.out.print(number%2);
    System.out.println(" binary.");

    System.out.print(number + 1 + " decimal = ");
    System.out.print((number+1)/64);
    System.out.print(((number+1)%64)/32);
    System.out.print(((number+1)%32)/16);
    System.out.print(((number+1)%16)/8);
    System.out.print(((number+1)%8)/4);
    System.out.print(((number+1)%4)/2);
    System.out.print((number+1)%2);
    System.out.println(" binary.");

    System.out.print(number + 2 + " decimal = ");
    System.out.print((number+2)/64);
    System.out.print(((number+2)%64)/32);
    System.out.print(((number+2)%32)/16);
    System.out.print(((number+2)%16)/8);
    System.out.print(((number+2)%8)/4);
    System.out.print(((number+2)%4)/2);
    System.out.print((number+2)%2);
    System.out.println(" binary.");

    System.out.print(number + 3 + " decimal = ");
    System.out.print((number+3)/64);
    System.out.print(((number+3)%64)/32);
    System.out.print(((number+3)%32)/16);
    System.out.print(((number+3)%16)/8);
    System.out.print(((number+3)%8)/4);
    System.out.print(((number+3)%4)/2);
    System.out.print((number+3)%2);
    System.out.println(" binary.");

    System.out.print(number + 4 + " decimal = ");
    System.out.print((number+4)/64);
    System.out.print(((number+4)%64)/32);
    System.out.print(((number+4)%32)/16);
    System.out.print(((number+4)%16)/8);
    System.out.print(((number+4)%8)/4);
    System.out.print(((number+4)%4)/2);
    System.out.print((number+4)%2);
    System.out.println(" binary.");

  }
}
```

Problems with Copy / Paste

- Very long repetitive code is not readable
- Error-prone
  - Wrong adjustments after Copy / Paste
- What if we discover that our initial code was wrong?
  - We have to change the code many times

- Better solution: write a method and call it multiple times!

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Before Writing a Method

- To write the method, we need to determine:
  - What *name* do we want to give the method?
  - How many *parameters* does it need?
    - (i.e. How many inputs does the method need)
  - What are the types of each parameter?
  - What names should we give the parameters?
  - Should the method be usable in an expression?
    - If yes, determine the *return type* of the method
    - If no, the return type is `void`

Binary Conversion (3)

- What *name* do we want to give the method?
  - `displayInBinary`
- How many *parameters* does it need?
  - `1`
- What are the types of each parameter?
  - `byte`
- What names should we give the parameters?
  - `n`
- Should the method be usable in an expression?
  - No ⇒ the return type is `void`

Binary Conversion (4)

```
public static void displayInBinary(byte n) {
  System.out.print(n + " decimal = ");
  // print out one digit after the other
  System.out.print(n/64);
  System.out.print((n%64)/32);
  System.out.print((n%32)/16);
  System.out.print((n%16)/8);
  System.out.print((n%8)/4);
  System.out.print((n%4)/2);
  System.out.print(n%2);
  System.out.println(" binary.");
}
```

Parameter Passing

- When we call a method, we must provide values of the correct type for each parameter of the method
- Example: `public static displayInBinary(byte n)`
  - The method requires one value of type byte
- Actual call: `BinaryConversion.displayInBinary(27);`
  - When executing the code inside the method, the variable n takes the value 27

Binary Conversion (5)

- Call the Method as often as desired, passing a different value as a parameter

```
import java.util.Scanner;
public class BinaryConversion {
  public static void displayInBinary(byte n) {
    // see previous slide
  }
  public static void main(String [] args) {
    Scanner keyboard = new Scanner(System.in);
    System.out.println("Please type a positive number < 128:");
    byte number = keyboard.nextByte();

    displayInBinary(number);        // or BinaryConversion.displayInBinary
    displayInBinary(number + 1);
    displayInBinary(number + 2);
    displayInBinary(number + 3);
    displayInBinary(number + 4);
  }
}
```

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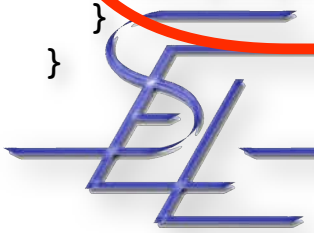
Binary Conversion Execution

```
import java.util.Scanner;
public class BinaryConversion {
  public static void displayInBinary(byte n) {
    System.out.print(n + " decimal = ");
    System.out.print(n/64);
    System.out.print((n%64)/32);
    System.out.print((n%32)/16);
    System.out.print((n%16)/8);
    System.out.print((n%8)/4);
    System.out.print((n%4)/2);
    System.out.print(n%2);
    System.out.println(" binary.");
  }
  public static void main(String [] args) {
    Scanner keyboard = new Scanner(System.in);
    System.out.println("Please type a positive number < 128:");
    byte number = keyboard.nextByte();
    displayInBinary(number);
    displayInBinary(number + 1);
    displayInBinary(number + 2);
    displayInBinary(number + 3);
    displayInBinary(number + 4);
  }
}
```

When a Method is Called,
The Flow of Control
Jumps Into the Method

When a Method is Done,
The Flow of Control Jumps Back to
Where it Came From

Execution starts here



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Void Methods

- When a method returns `void`, you can't use it as part of an expression
- The purpose of the method is to have a *side-effect*, not to perform a direct computation
- One possible side-effect is to display something on the screen
- `System.out.println()` is a void method

Methods with Return Value

- If you want to use a result from a computation in your method in an expression, you have to do the following:
  - Change the method header to specify the type of data you want your method to produce
  - Add at least *one return statement* in the method definition
    - The expression after in the return statement must be of the same type as what is specified in the method header

```
public static double hypotenuse(double a, double b) {
  double h = Math.sqrt(Math.pow(a,2.0) + Math.pow(b,2.0));
  return h;
}
```

- Now we can call the method

```
double x = 3.0;
double y = 4.0;
double z = hypotenuse(x,y);
```

Example: Method that tests if a Number is Even

- Method Header

```
boolean isEven(int n)
```

- Implementation

```
boolean isEven(int n) {
    return (n%2 == 0);
}
```

Pro's and Con's of Methods

- Advantages of Methods
  - Code reusability
  - Reduces code duplication
  - Easier debugging
  - Problems are decomposed
  - Hides tricky logic
  - Easier to read and understand
- Disadvantages of Methods
  - It takes initially a little more time to set them up

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Method Exercises

- Write a method called "sayGreeting" that displays a greeting message on the screen. The method should take as input two Strings. One String should be the name of the speaker, the other String should be the name of the listener.
- Write a method called "computeAreaCircle". The method should take as input the radius of the circle and return a double representing the area of the circle.
- Write a main program that asks the user to enter 3 numbers (one at a time) and for each of these output the area of a circle with that radius.

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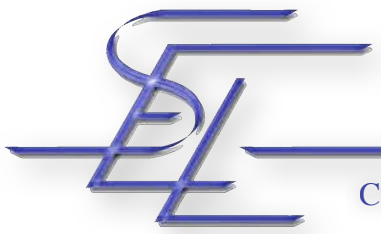
Writing Comments



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Syntax for Comments

- Single line comments
  - Write `//` anywhere in the code, and the rest of the line is ignored by the compiler
- Multi-line comments
  - Write `/*` anywhere in the code, and everything that follows is ignored by the compiler until it sees `*/`

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Purpose of Comments

- Comments are generally used to help a programmer understand what the code is doing.
  - This is useful both for when other people read your code or if you go back to your code at a later point.
- A good comment will make it clear what a complicated piece of code will do.
- A bad comment will either mislead the user or provide unnecessary information (i.e. over commenting)
- Generally, it's better to err on the side of too many comments.
- Every method should be preceeded by a brief comment saying what it's purpose is.

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Good Comment Example (1)

```
// This method takes as input a double representing a
// radius of a circle. It calculates the area of a circle
// using the equation PI*r^2.
// The method returns a double representing the area.
public static double computeAreaCircle(double radius) {
   return radius * radius * Math.PI;
}
```

Bad Comment Example (1)

```
// This method takes as input a thing that represents the
// thing that measures how long it takes to go from
// the center of a round circle to the outer edge of it. I
// learned in elementary school that the equation for
// this is to take the number PI and multiply it by
// that distance and then multiply it by that distance
// again. The number PI does not really have anything
// to do with apple pie, although I kind of wish it did
// because it's really delicious. However, one thing the
// two have in common is they both are round.
public static double computeAreaCircle(double radius) {
   return radius * radius * Math.PI;
}
```

Good Comment Example (2)

```
// This method converts the number n, which
// must be strictly smaller than 128, to binary format
// and displays the result on the screen
static void displayInBinary(byte n) {
  // TODO: make sure method also works with negative numbers
  System.out.print(n + " decimal = ");
  // print out one digit after the other
  System.out.print(n/64);
  System.out.print((n%64)/32);
  System.out.print((n%32)/16);
  System.out.print((n%16)/8);
  System.out.print((n%8)/4);
  System.out.print((n%4)/2);
  System.out.print(n%2);
  System.out.println(" binary.");
}
```

Bad Comment Examples (2)

```
// sometimes I believe the compiler ignores all my comments


/*
*  You may think you know what the following code does.
*  But you dont. Trust me.
*  Fiddle with it, and you'll spend many a sleepless
*  night cursing the moment you thought you'd be clever
*  enough to "optimize" the code below.
*  Now close this file and go play with something else.
*/


// drunk, fix later
```

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