



Programming and Software Development
COMP90041

Lecture 4

Methods

- A method is an operation defined by a class
- I.e., it defines how to do something
- The Java library defines many methods
- And you can define your own
- Similar to functions, subroutines, procedures in other languages
- Java supports two kinds of methods:
 - ▶ Class or static methods, and
 - ▶ Instance or non-static methods
- Instance methods are more common, but Class methods are simpler, so we start there



- Calling a class method runs the code in the body of the method before returning to execute the code following the method call
- Form: *Class .method(expr1, expr2, ...)*
- Can omit *Class.* if caller defined in same class
- The *exprs*, called arguments, provide data for the method to use
- Arguments are evaluated before executing method
- On completion, the called method can return a value to the caller
- The caller can then use the returned value in further computations



The **Math** class is a library of class methods and constants, including (among many more):

Method	Type	Description
abs(int)	int	absolute value
ceil(double)	double	ceiling
E	double	$e = 2.71828\dots$
max(int, int)	int	larger of two ints
min(int, int)	int	smaller of two ints
floor(double)	double	floor
PI	double	$\pi = 3.14159\dots$
pow(double, double)	double	a^b
sqrt(double)	double	\sqrt{a}

`sqrt` is a class method to compute square root

```
import java.util.Scanner;
public class Hypot {
    public static void main(String[] args) {
        System.out.print("Enter triangle sides: ");
        Scanner kbd = new Scanner(System.in);
        double side1 = kbd.nextDouble();
        double side2 = kbd.nextDouble();
        double hypot = Math.sqrt(side1*side1 +
                               side2*side2);
        System.out.println("Hypot = " + hypot);
    }
}
```



Program Use

```
nomad% java Hypot
Enter triangle sides: 3 4
Hypot = 5.0
```

- Many other classes provide class methods
- For each primitive type, there is a wrapper class that defines some useful class methods:

Primitive	Wrapper
byte	Byte
short	Short
int	Integer
long	Long
float	Float
double	Double
boolean	Boolean
char	Character

Wrapper classes provide methods to convert primitive types to strings

Type	Convert to String
byte x	Byte.toString(x)
short x	Short.toString(x)
int x	Integer.toString(x)
long x	Long.toString(x)
float x	Float.toString(x)
double x	Double.toString(x)
boolean x	Boolean.toString(x)
char x	Character.toString(x)

Command line arguments are always strings.

To convert to number types:

Type	Convert from String s
byte	Byte.parseByte(s)
short	Short.parseShort(s)
int	Integer.parseInt(s)
long	Long.parseLong(s)
float	Float.parseFloat(s)
double	Double.parseDouble(s)
boolean	Boolean.parseBoolean(s)
char	s.charAt(0)



- **main** is a class method we've been defining
- Java executes the **main** method when running an application
- Begins with:

```
public static void main(String[] args) {
```

- Ends with:

```
}
```



- General form (for now):

```
public static type name(type1 var1, type2 var2, ...) {  
    :  
}
```

- Each *var* is called a parameter
- Parameter is a variable initialised to value of corresponding expression in method call
- Then body (:
 part) of method is executed
- Types of corresponding arguments and parameters must match
- type* is type of result returned



- Return result of method with `return` statement
- Form: `return expr`
- Value of expression `expr` is result of method
- Method completes as soon as `return` statement is reached (even if there is code after)
- Type of `expr` must match `type` of method
- Can have multiple `return` statements, but every execution of method must reach a `return` (but see exception below)
- Compiler error if either is violated
- Can use `return` to terminate loop and return from method



```
public class Hypot2 {  
    public static void main(String[] args) {  
        double side1 = Double.parseDouble(args[0]);  
        double side2 = Double.parseDouble(args[1]);  
        double hypot = hypot(side1, side2);  
        System.out.println(hypot);  
    }  
  
    public static double hypot(double side1,  
                               double side2) {  
        return Math.sqrt(side1*side1 + side2*side2);  
    }  
}
```



Program Use

```
nomad% java Hypot 3 4.0  
5.0
```

- Original Hypot program was interactive: it asked for input it needed and explained its output
- This version takes all input on the command line
- Interactive version is more user-friendly
- This version is more machine-friendly: easier for another program to control
- You will be asked to write many machine-friendly programs for this reason



What will `test(4)` return?

```
public static int test(int j) {  
    int i = 0;  
    while (j>0) {  
        --j;  
        if (i >= 2) return j;  
        ++i;  
    }  
    return i;  
}
```

- A 0
- B 1
- C 2
- D 3
- E Compiler error: bad returns



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- In this example, we turned a chunk of code (hypotenuse computation) into a new method
- This is called refactoring
- When to define a new method:
 - ▶ When a method gets too big (more than can be easily viewed at once, more than ≈ 60 lines)
 - ▶ When you repeat similar code multiple times
 - ▶ When you can give a good name to a chunk of code (e.g., `hypot`)
- How to break up the work of a program into methods is an important and complex issue
- We will revisit later



- Use method call as an expression
- Value of expression is value returned by method
- But can also use method call as statement
- Ignore returned value, just execute for effect (e.g., printing)
- If always want to ignore, use return type `void`
- Means don't return anything
- `main` method has return type `void`
- Then don't need `return` statement
- Can use `return` with no expression to immediately return nothing

Method Example

- First part of method definition (up to `{`) is called the method header
- Header defines return type, method name, number and types of parameters, and parameter names
- Method name plus number and types of arguments together are called the method signature
- Signature is used to decide which method to call



- `abs`, `min`, and `max` all work on all of `double`, `float`, `int`, and `long` types
- They return the same types
- Overloading: when a method name has multiple definitions, each with different signature
- Java automatically selects the method whose signature matches the call
- You can define your own overloaded methods, too
 - ▶ Just define multiple methods with same name but different signatures
- Uses: support multiple types, simulate default arguments



Limitations of Overloading

- You cannot define two methods with the same name and all the same argument types
- You cannot overload based on return type, only parameter types
- You cannot overload operators (e.g., `+`, `*`, etc.)
- Beware of combining overloading with automatic type conversion!

```
int      bad(int x, double y) {...}  
double  bad(double x, int y) {...}
```

What if you call `bad(6, 7)`?



- The keyword public in method header means the method may be used by any method in any class
- The keyword private in header means the method may be used from any method only within that class
- Visibility: from where method can be seen
- public implicitly promises to (try hard to) maintain that method without changing its signature
- Best practice: make methods private unless they need to be public
- Best practice: make signature of public methods as simple as possible



- Scope: where variable can be referenced
- Variables declared inside methods are local to the method (cannot be used outside)
- Cannot be referenced before declaration is executed
- Variable's value is forgotten when it goes out of scope; gets a fresh value next time in scope
- Variable declared inside a block is scoped to that block
- Parameters are also local to the method
- Local variables cannot be declared **public** or **private**

- **Math** class defines constants **PI** and **E**
- You can define your own constants for your code
- Form:

```
public static final type name = value;
```

- At top level of class declaration
- Can be **public** or **private**
- Java naming convention: all uppercase, words separated with underscores
- *E.g.:*

```
public static final int DAYS_PER_WEEK = 7;  
public static final int CARDS_PER_SUIT = 13;
```

- Best practice: don't sprinkle mysterious numbers in your code, define constants instead
- Makes code much easier to understand
- What does this do?

```
x += 168;
```



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Compare that with:

```
x += DAYS_PER_WEEK * HOURS_PER_DAY;
```



- Best practice: don't sprinkle mysterious numbers in your code, define constants instead
- Makes code much easier to understand
- What does this do?

```
x += 168;
```

Compare that with:

```
x += DAYS_PER_WEEK * HOURS_PER_DAY;
```

- Also symbolic constants defined in one place are much easier to change if necessary, eg:

```
private static final int CHARS_IN SUBJECT_CODE = 6;
```

- Don't define a constant for something you can't meaningfully name
- This is useless:

```
public static final int SEVEN = 7;
```

- Don't (usually) define a name for 0 or 1: `n == 0` is just as good as `n == NONE`



- Class variable is a variable that is local to a class
- Lifetime of variable: when it first has a value until it ceases to exist
- Lifetime of class variable is from start of program until exit
- Value survives through message calls and returns
- Value is unchanged until reassigned
- Only one “copy” of each class variable at a time
- Can be declared either **public** or **private**
- It should almost always be **private**
 - ▶ Difficult to control if every method can modify it



```
public class ClassVar {  
    private static String name = "Someone";  
    public static void main(String[] args) {  
        greet("Hello");  
        setName("Kitty");  
        greet("Hello");  
        greet("Aloha");  
    }  
    private static void setName(String name) {  
        ClassVar.name = name; // 2 vars called name!  
    }  
    private static void greet(String greeting) {  
        System.out.printf("%s, %s!%n", greeting, name);  
    }  
}
```

Program Output

Hello, Someone!

Hello, Kitty!

Aloha, Kitty!

- This program is stateful: behaviour depends on what has come before
- `greet("Hello")` does two different things!
- Makes it harder to predict program behaviour
- Keep use of class variables to a minimum



- Executing class (static) methods executes their definition
- Method calls can pass arguments
- Methods can return a value with a `return` statement
- Methods declared with `private` instead of `public` can only be used inside the same class
- Multiple methods can have same name, if number/types of arguments are different



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