Basics of Java Programming

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Basics of Java Programming

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- Overview
  - Building blocks of a Java program
    - Classes
    - Objects
    - Primitives
    - Methods
  - Memory management
  - Making a (simple) Java program
    - Baby example
    - Bank account system

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- A Java program
  - Consists of **classes** (existing ones and/or new ones)
  - Has one class with a **main** method (to start the program)
- Syntax of a class
  - Comments and embedded documentation
  - Import from libraries (by default: java.lang.*)
  - Class declaration: collection of **variables** and **methods**
- Compiling and running
  - javac Hello.java
  - java Hello

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- A simple Java program (1)

```
// Hello.java

// Print "Hello, world" to the console

public class Hello {

   public static void main(String[] args) {
      System.out.println("Hello, world");
   }

}
```

Comments

Class declaration

Note: every statement ends with semi-colon ;

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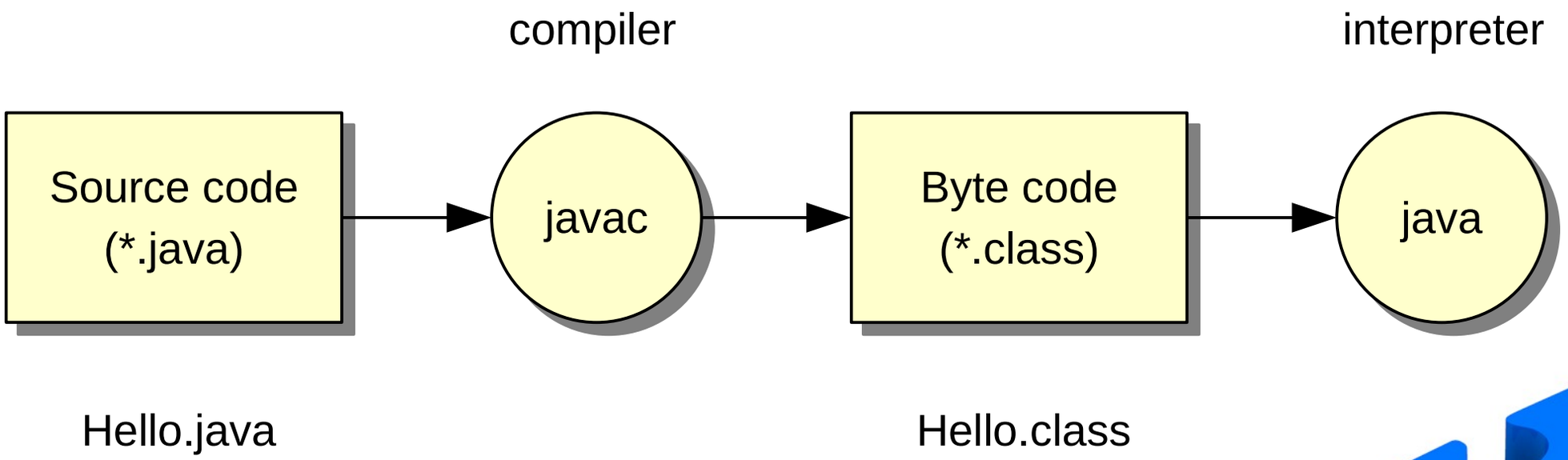
- A simple Java program (1)



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- A simple Java program (2)

```
// HelloDate.java

import java.util.*;

public class HelloDate {
   public static void main(String[] args) {
      System.out.println("Hello, it is");
      Date date = new Date();
      System.out.println(date.toString());
   }
}
```

Comments

Import from library

Class declaration

Note: every statement ends with semi-colon ;

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- Comments
  - Intended for the reader as documentation
  - Two possibilities
    - Multi-line comment between /* and */

```
/* This is a comment that
*  continues across lines
*/
```

    - Single-line comment after //

```
// This is a one-line comment
```

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- Declaration of classes

```
<modifiers> class <class name> {
    <variable declarations>
    <method declarations>
}
```

  - Collection of **variables** (storage of data) and **methods** (actions on data)
  - In our example:
    - Modifiers: public (3 access modifiers: public – private – protected)
    - Name: HelloDate
    - Fields: no class variables
    - Methods: main

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- Declaration of methods

```
<modifiers> <return type> <method name> (<parameters>) {
    <method body>
}
```

  - In our example:
    - Modifiers: public static (it belongs to the class instead of a specific object)
    - Return type: void (= no return value)
    - Name: main
    - Parameters: String args[] (array of strings)
  - Exiting method with value `return <variable> ;`

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- Variables: primitive types
  - Same syntax and operations as in C++

	Type	Meaning	Memory size
integers	**byte**	very small integer (-128,...,127)	8 bits
	short	small integer	16 bits
	int	integer	32 bits
	long	long integer	64 bits
reals	**float**	single-precision floating point number	32 bits
	double	double-precision floating point number	64 bits
	char	character (Unicode)	16 bits
	boolean	true or false	

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- Variables: primitive types
  - Declaration and assignment

```
<data type> <variables> ;
```

```
<variable> = <expression> ;
```

```
final <data type> <variable> = <expression> ;
```

constant variable

  - Examples:

```
int i = 10, j;
j = i + 5;
final double PI = 3.141592;
```

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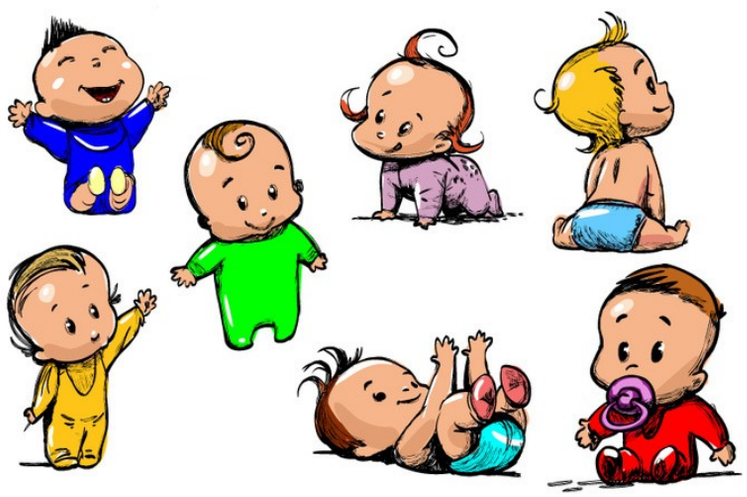
- Baby example



Class **Baby**

Objects **Baby** **Baby** **Baby** **Baby** **Baby** **Baby** **Baby**

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- Baby example
  - A class for babies containing
    - name
    - sex (m/f)
    - weight (kg)
    - # poops so far
  - How to make Baby objects ?

```
public class Baby {
    String name = "Unknown";
    boolean isMale = true;
    double weight = 0.0;
    int nbPoops = 0;

    void poop() {
        nbPoops = nbPoops + 1;
        System.out.println(
            "Mam, I have pooped."
          + " Ready the diaper."
        );
    }
}
```

Variables

Methods

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- Declaration and creation of objects
  - Creating an object variable (object declaration)

```
<class name> <object name> ;
```

object:
an instance of a class

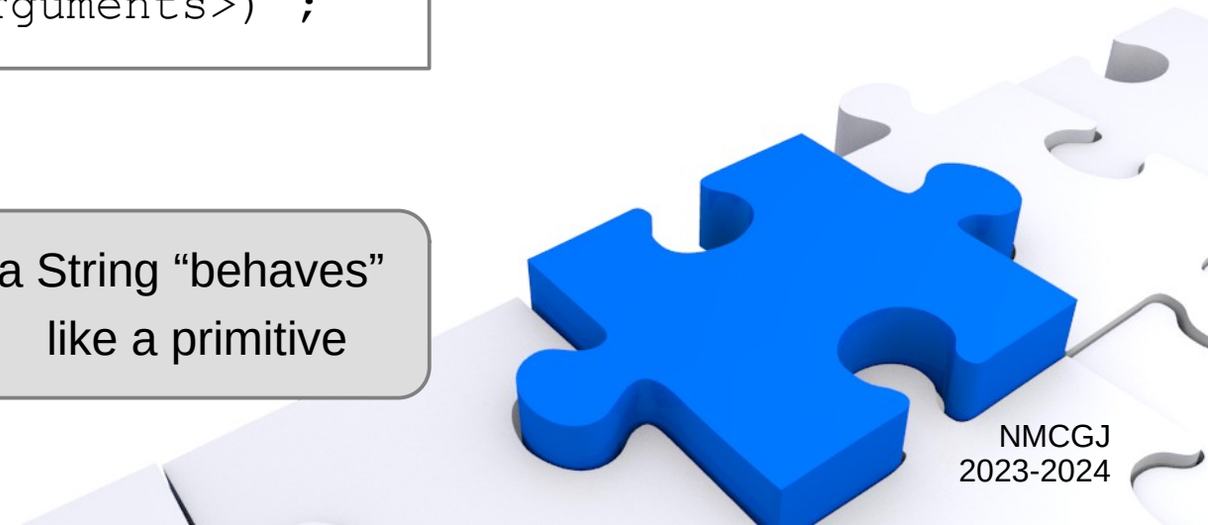
  - Creating an object with the **new** keyword

```
<object name> = new <class name> (<arguments>) ;
```

  - Example: creating a **String** object

```
String str = new String("abc");
String str = "abc";
```

a String “behaves” like a primitive



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- Initialization of objects
  - The **constructor**: a special method with class name

```
<access modifier> <class name> (<parameters>) {
    <constructor body>
}
```

    - Purpose: giving valid values to the class variables for the specific object
    - No return type
  - Default constructor: automatic, when no other constructors

```
public <class name> () {
}
```

no parameters
empty body

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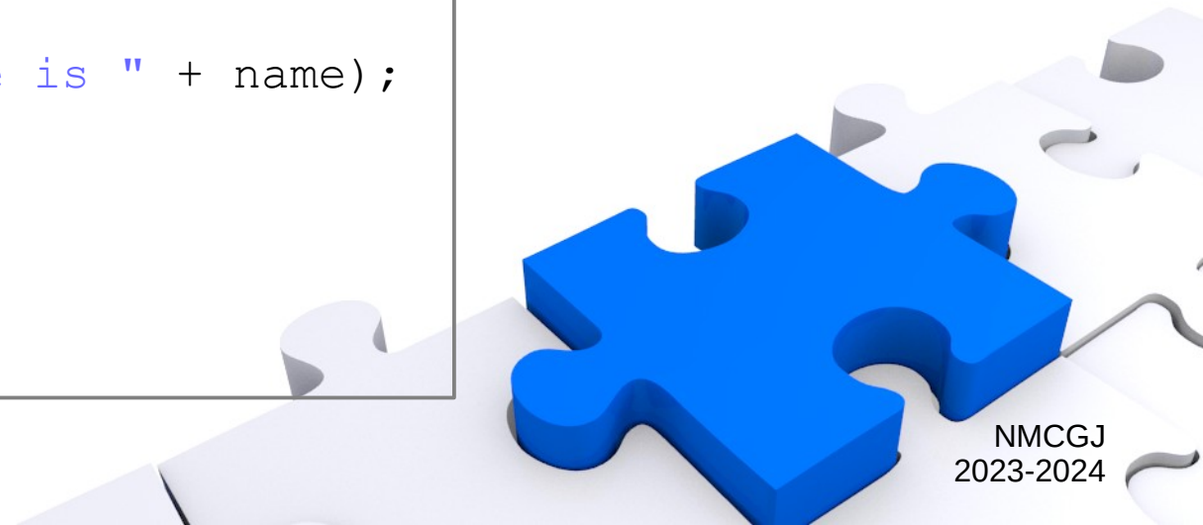
- Baby example
  - Let's update the baby class with constructor and some methods

```
public class Baby {
    ...
    Baby(String n, boolean m, double w) {
        name = n; isMale = m; weight = w;
    }
    void sayHi() {
        System.out.println("Hi, my name is " + name);
    }
    void eat(double food) {
        weight = weight + food;
    }
}
```



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- Using objects
  - Externally accessing a variable + sending a message to an object

```
<object name> . <variable name> ;
```

```
<object name> . <method name> (<arguments>) ;
```

  - Example: let's make a baby object

```
Baby david = new Baby("David", true, 4.0);
System.out.println(david.name);
david.eat(0.1);
david.poop();
```

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- Static types and methods
  - The **static** keyword implies
    - The variable/method is part of the class declaration
    - It is unique for the class and NOT for each instance (object)
  - Example: keeping track of number of babies made

```
public class Baby {
    static int nbBabiesMade = 0;
    Baby(String n, boolean m, double w) {
        name = n; isMale = m; weight = w;
        nbBabiesMade = nbBabiesMade + 1;
    }
}
```

External acces via class name

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- Arrays
  - An array is a sequence of elements of same type (primitives / objects)
  - Declaration and creation

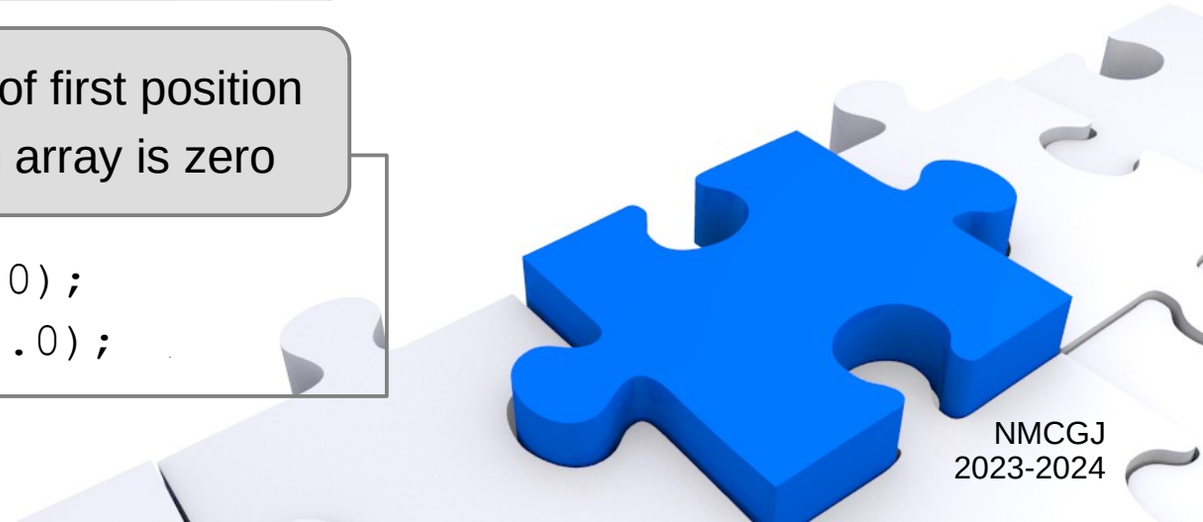
```
<type>[] <array name> = new <type>[<integer>] ;
```

an array is an object

  - Example:

index of first position in an array is zero

```
Baby[] twin = new Baby[2];
twin[0] = new Baby("Oliver", true, 4.0);
twin[1] = new Baby("Olivia", false, 4.0);
```



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- Baby example
  - Let's make a nursery

```
public class Nursery {
    final int CAPACITY = 25;
    Baby[] babies = new Baby[CAPACITY];
    int nbBabies = 0;
    ...
    void addBaby(Baby baby) {
        // Assume: nbBabies < CAPACITY
        babies[nbBabies] = baby;
        nbBabies = nbBabies + 1;
    }
}
```

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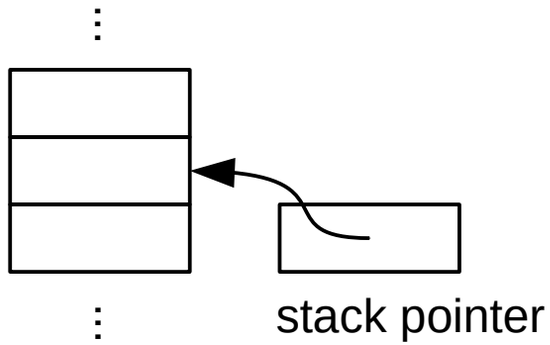
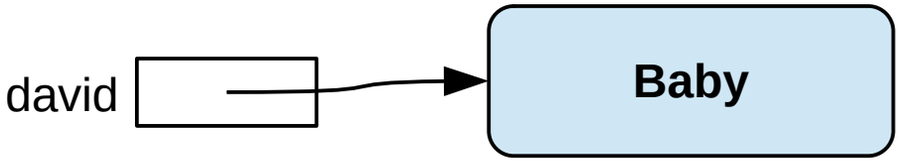
- Memory management
  - Different places to store data
    - Register: inside the processor, very fast but very limited
    - The stack: in RAM, direct support from processor (stack pointer)
    - The heap: in RAM, general-purpose pool of memory
  - Primitive types in the stack
  - Object declaration in the stack (a pointer)

    Object creation in the heap (with the **new** keyword)





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- Memory management
  - Working with primitives

```
int i = 10, j;
final double PI = 3.141592;
```

i	10
j	?
PI	3.14

Basics of Java Programming

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- Memory management
  - Working with primitives

```
int i = 10, j;
final double PI = 3.141592;
j = i;
i = 5;
```

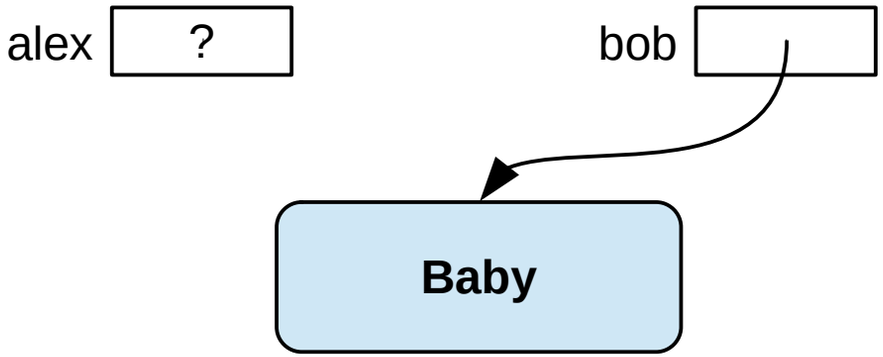
pass by value: value is copied

i	5
j	10
PI	3.14

Basics of Java Programming

- Memory management
  - Working with objects: be careful

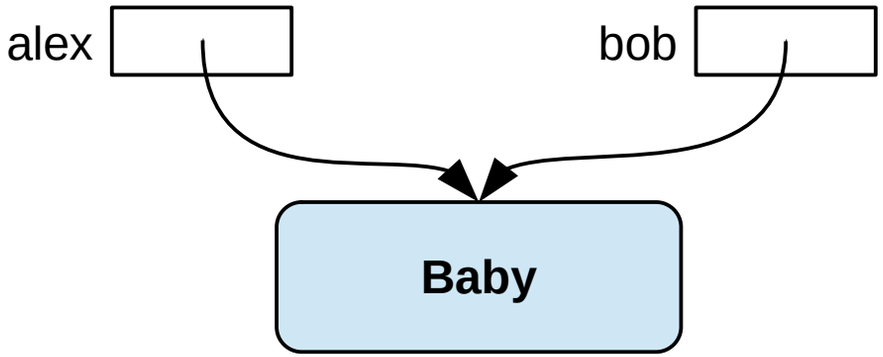
```
Baby alex, bob;
bob = new Baby(...);
```



Basics of Java Programming

- Memory management
  - Working with objects: be careful

```
Baby alex, bob;
bob = new Baby(...);
alex = bob;
```



pass by reference:
only reference is copied,
not the entire object

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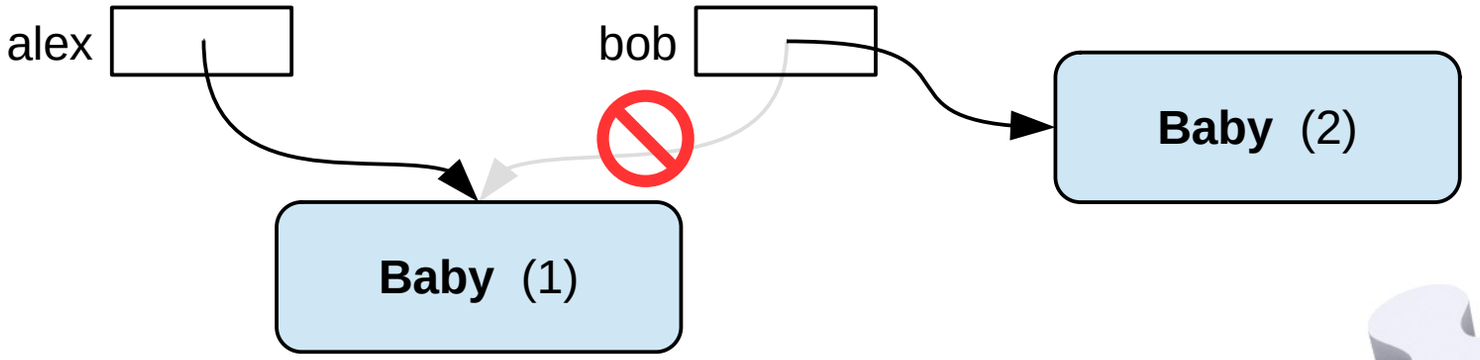
- Memory management
  - Working with objects: be careful

```
Baby alex, bob;
bob = new Baby(...);   // (1)
alex = bob;            // (1)
bob = new Baby(...);   // (2)
```



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- Memory management
  - Working with primitives: pass by value
  - Working with objects: pass by reference
- Lifetime of objects
  - Garbage collector: automatic release of memory after use
  - No memory leaks (cf. C++)

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- Scoping: visibility and lifetime of variables
  - Indicated by curly brackets
  - Primitives

```
int x = 10;
{
    int y = 15;
}
...
```

both x and y available

only x available

  - Objects
    - Same behavior for object reference (in the stack)
    - Object itself survives the scope (in the heap)

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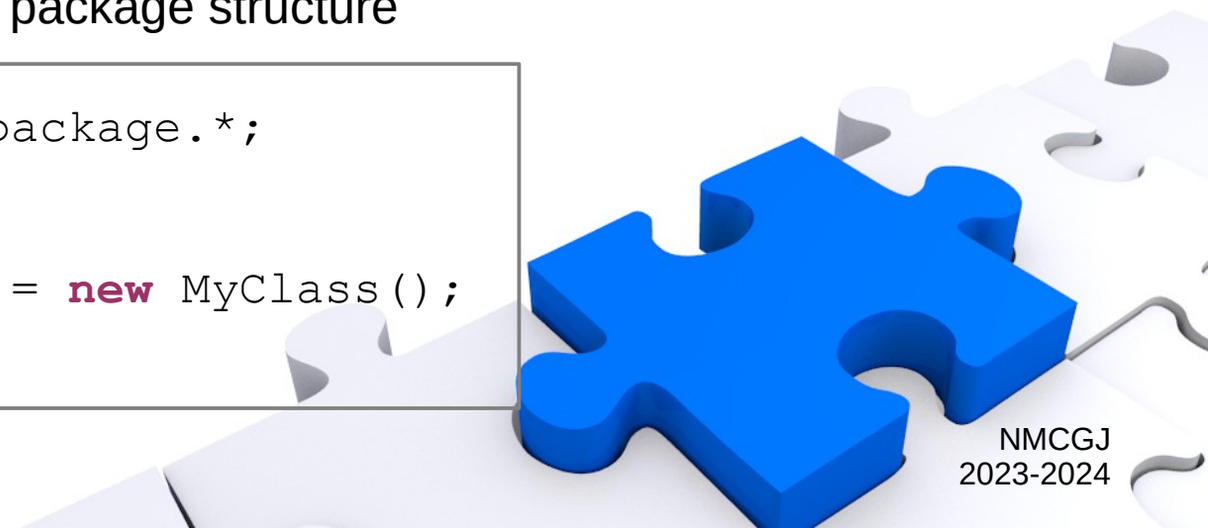
- Package: the library unit
  - A package is a collection of class files
    - A mechanism to manage “namespaces” and to avoid clashes with names
  - Loading a package with the **import** keyword
  - Adding a class to a package with the **package** keyword
    - File must belong to the directory specified by package structure

```
package mypackage;

public class MyClass {
    ...
}
```

```
import mypackage.*;

...
MyClass m = new MyClass();
...
```



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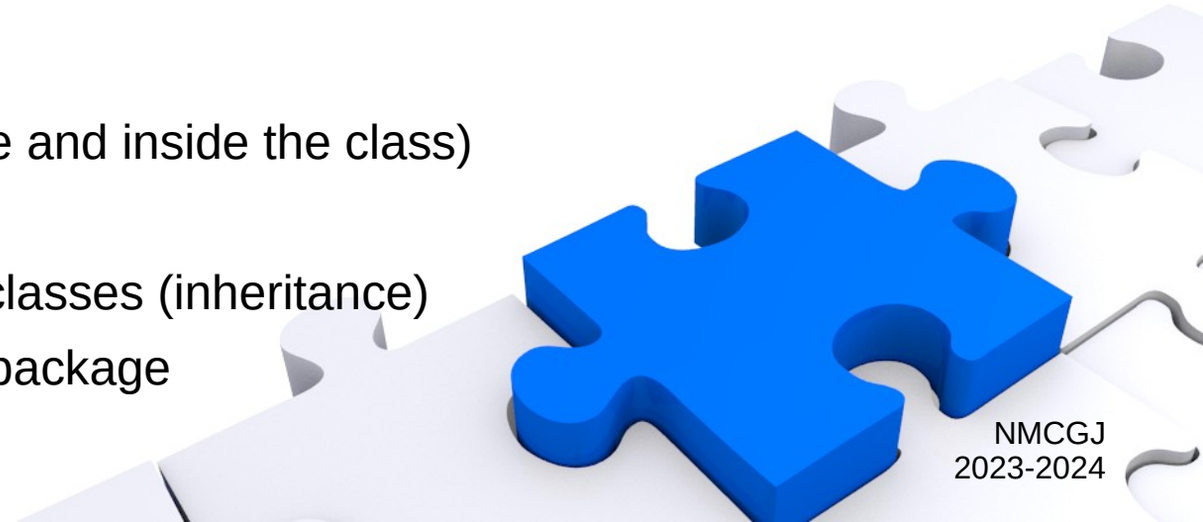
- Access modifiers
  - Purpose: enforcing rules to work with classes/objects
    - Protection of data / methods for internal use
      - separation between interface and implementation
    - Prevention of abuse
      - keep integrity of objects
  - Keywords: **public** – **private** – **protected**
    - Public: visible to the world (everybody outside and inside the class)
    - Private: visible only to the class
    - Protected: visible to the package and all subclasses (inheritance)
    - Default (friendly), no keyword: visible to the package



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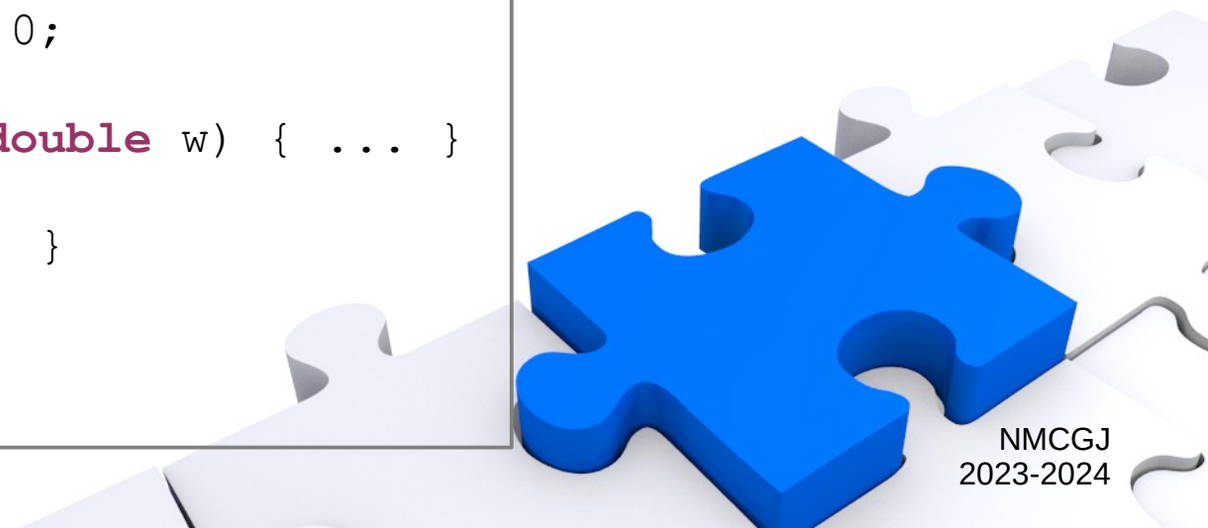
- Baby example
  - Let's update the baby class with access control

```
public class Baby {
   private String name = "Unknown";
   private boolean isMale = true;
   private double weight = 0.0;
   private int nbPoops = 0;
   private static int nbBabiesMade = 0;

   public Baby(String n, boolean m, double w) { ... }
   public void sayHi() { ... }
   public void eat(double food) { ... }
   public void poop() { ... }
}
```



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- Baby example
  - Let's update the baby class with access control

```
public class Baby {
   private String name = "Unknown";
   ...
   private static int nbBabiesMade = 0;

   ...
   public String getName() { return name; }
   public double getWeight() { return weight; }
   public int getNbPoops() { return nbPoops; }
   ...
   public static int getNbBabies() { ... }
}
```

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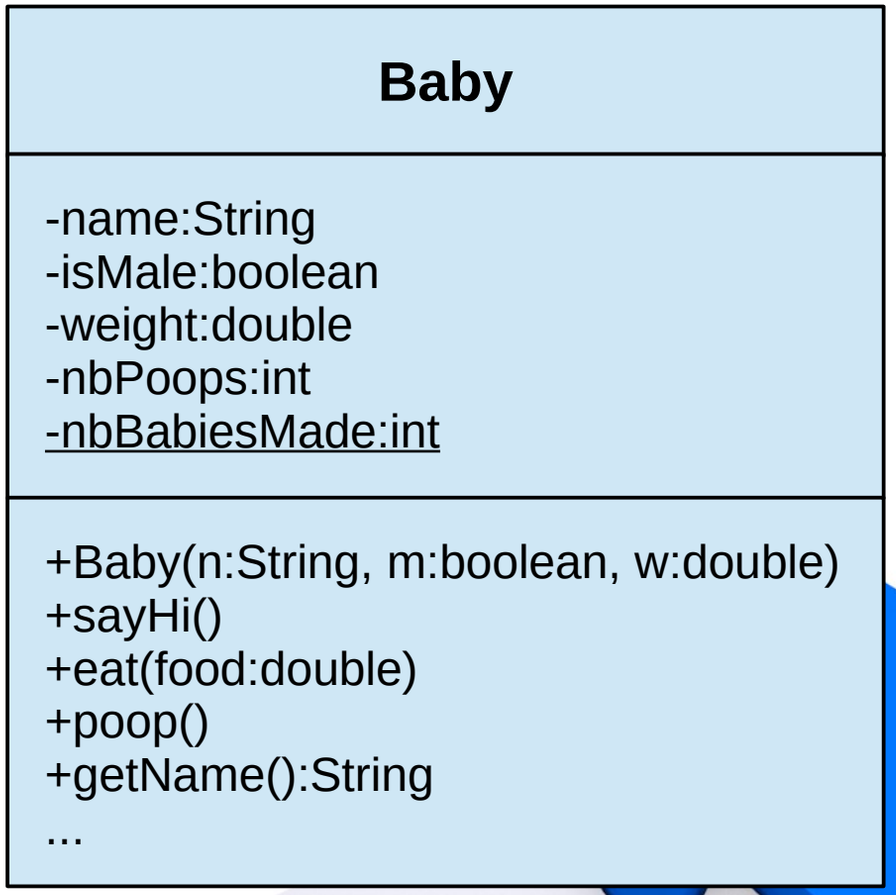
- UML class diagram
  - Each class is represented by a box
    - Sections: name, variables, methods
    - Special codes for modifiers:
      - public (+), private (−), protected (#)
      - static (underlined)
  - Relationships between classes
  - Keep it simple
    - Complete diagram is heavy
    - Display only the info required for your purpose



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- Correct use of names
  - Rules:
    - Sequence of Unicode letters and digits, dollar sign “$”, underscore “_”
    - Beginning with a letter and case-sensitive
  - Naming conventions:
    - Class names are a collection of nouns, with the first letter of each word capitalized
    - Variable names (object references, arguments, …) have the first letter lowercase, and first letter of other words capitalized
    - Method names are verbs with the first letter lowercase, and first letter of other words capitalized
    - Constants are all uppercase, words separated by underscores
    - Package names are all lowercase

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- Making a (simple) Java program
  - Objective
    - A program that can manage bank accounts
    - E.g., changing balance by deposits and withdrawals, computing interests, ...
  - Step 1: what do we need ?
    - A class BankAccount
      - Each individual account = object
      - Keep track of balance
      - Make deposits and withdrawals
      - Compute interest
      - ...
    - ...

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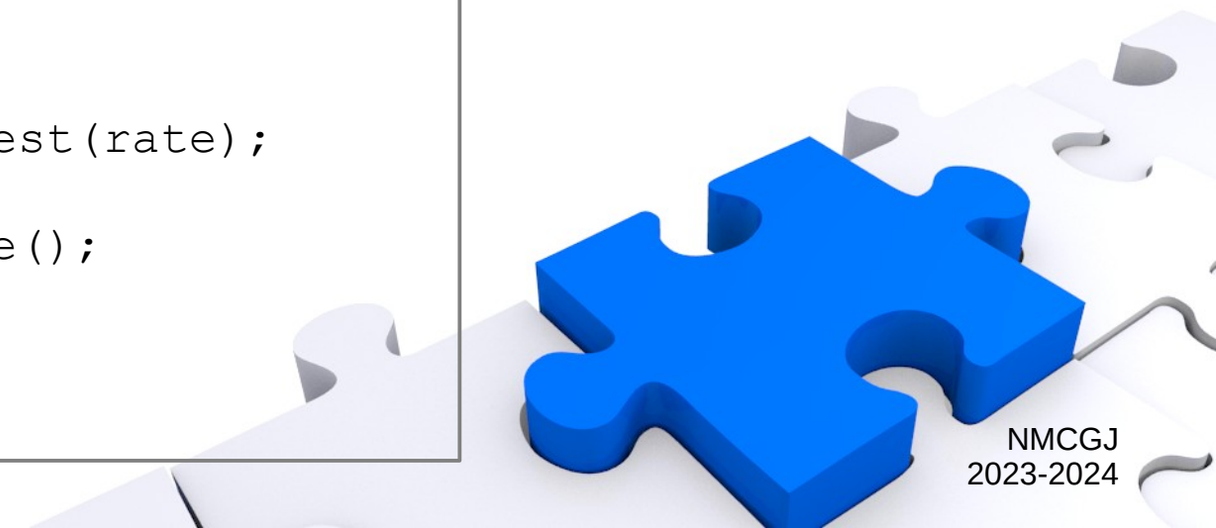
- Making a (simple) Java program
  - Step 2.1: defining interfaces

```
BankAccount myAccount = new BankAccount();

double amount1 = 100, amount2 = 50;
myAccount.deposit(amount1);
myAccount.withdraw(amount2);

double rate = 0.01;
double interest = myAccount.addInterest(rate);

double balance = myAccount.getBalance();
...
```



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- Making a (simple) Java program
  - Step 2.2: UML class diagram

BankAccount
−balance:double
+BankAccount() +BankAccount(initBalance:double) +getBalance():double +deposit(amount:double) +withdraw(amount:double) +addInterest(rate:double):double

UML diagrams help you understand, discuss, and design software programs

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- Making a (simple) Java program
  - Step 3.1: internal data (class variables) + get/set methods

```
public class BankAccount {
    private double balance; // balance (EUR)

    /**
     * Gets the current balance of the bank account.
     * @return the current balance
     */
    public double getBalance() {
        return balance;
    }
    ...
}
```

Javadoc standard
(skipped later on)

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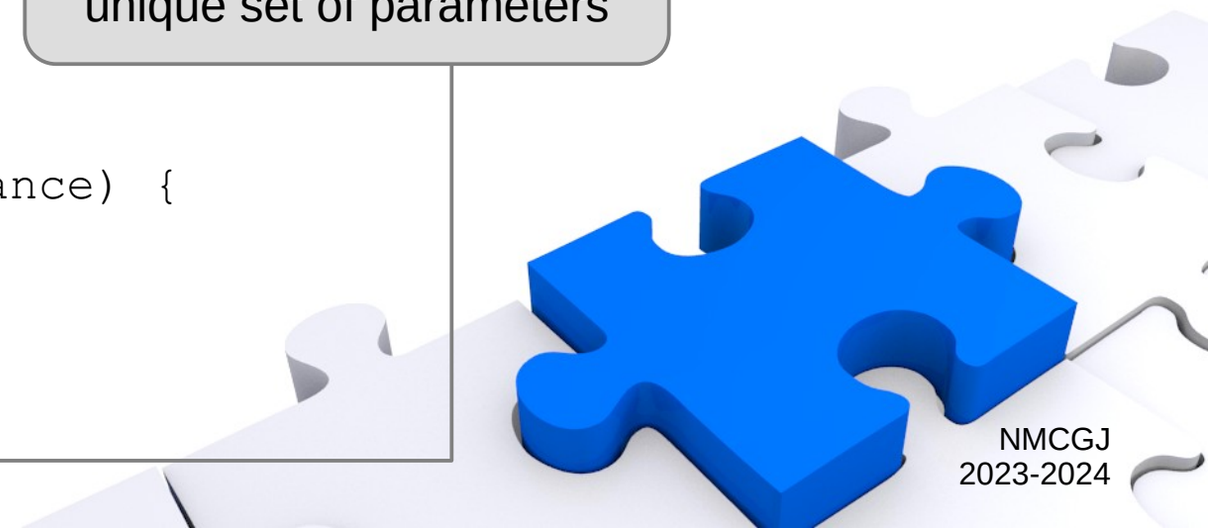
- Making a (simple) Java program
  - Step 3.2: constructors

```
public class BankAccount {
    private double balance; // balance (EUR)

    ...
    public BankAccount() {
        balance = 0.0;
    }

    public BankAccount(double initBalance) {
        balance = initBalance;
    }
    ...
}
```

constructor overloading: unique set of parameters



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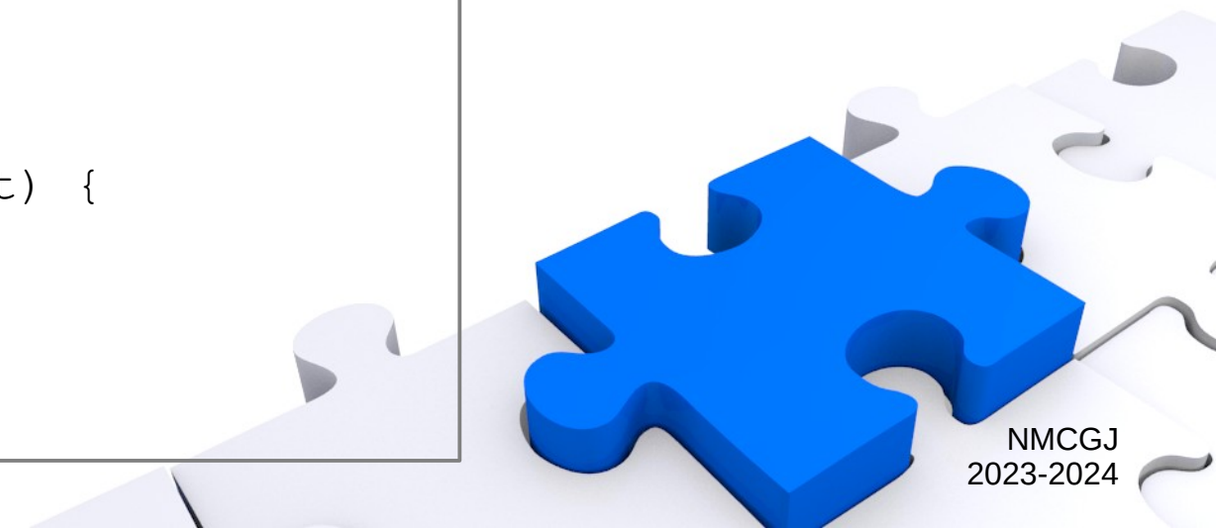
- Making a (simple) Java program
  - Step 3.3: other methods

```
public class BankAccount {
    private double balance; // balance (EUR)

    ...
    public void deposit(double amount) {
        balance = balance + amount;
    }

    public void withdraw(double amount) {
        balance = balance - amount;
    }
    ...
}
```



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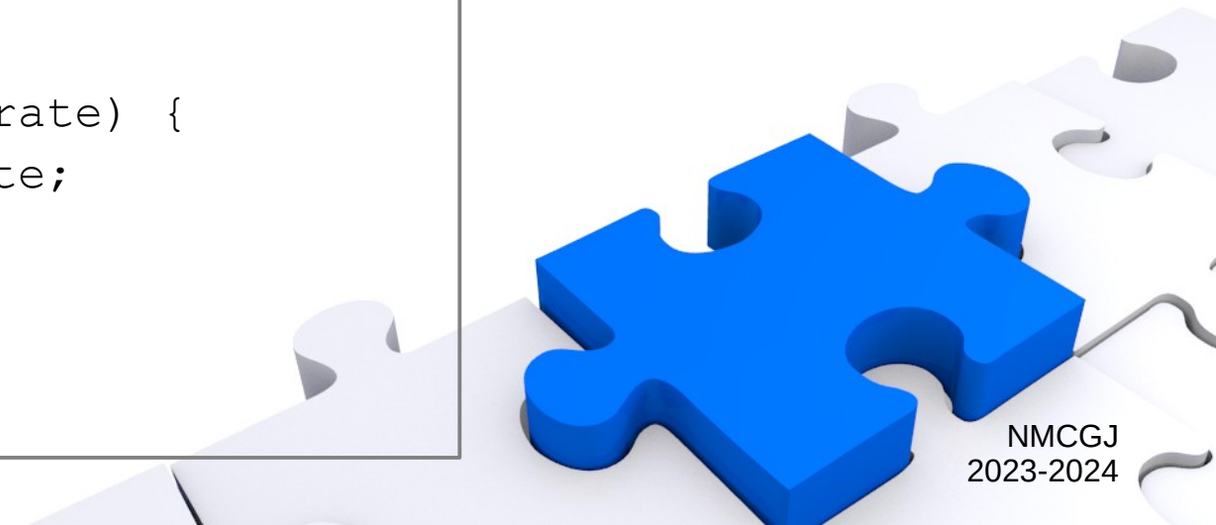
- Making a (simple) Java program
  - Step 3.3: other methods

```
public class BankAccount {
    ...
    /**
     * Adds interest to the bank account.
     * @param rate – the interest rate
     * @return the computed interest
     */
    public double addInterest(double rate) {
        double interest = balance * rate;
        balance = balance + interest;
        return interest;
    }
}
```



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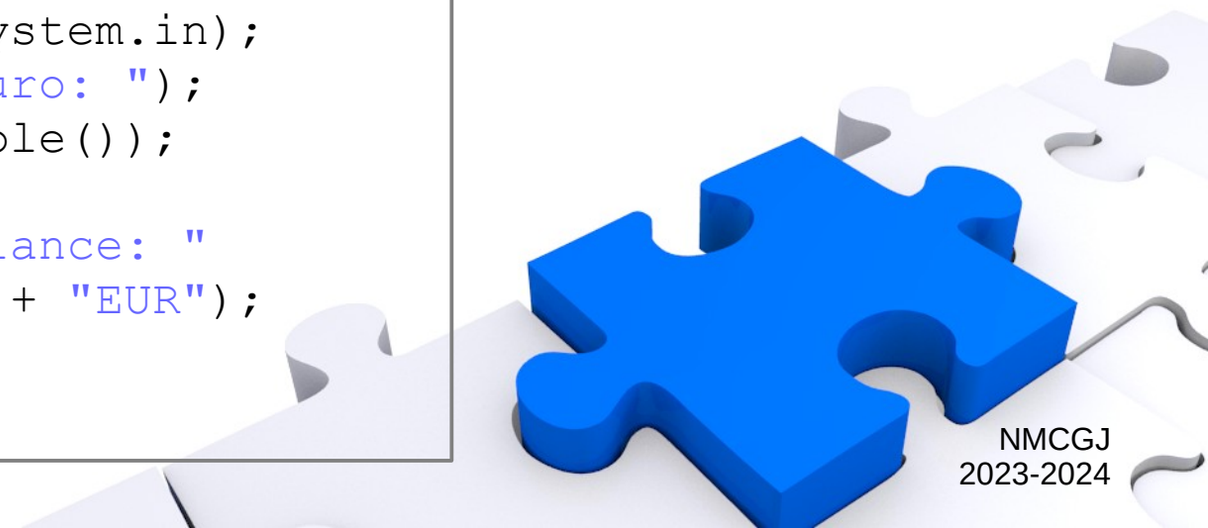
- Making a (simple) Java program
  - Step 4: the main program

```
import java.util.*;

public class BankProgram {
   public static void main(String[] args) {
      BankAccount account = new BankAccount();
      Scanner reader = new Scanner(System.in);
      System.out.print("Deposit in Euro: ");
      account.deposit(reader.nextDouble());
      reader.close();
      System.out.println("Account Balance: "
            + account.getBalance() + "EUR");
   }
}
```



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- Methods: visibility of variables

```
public double addInterest(double rate) {
    double interest = balance * rate;
    balance = balance + interest;
    return interest;
}
```

class variable: `balance`

parameter: `rate`

local variable: `interest`

- Variables inside scope of method
- Available during method execution

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- Methods: interchanging data

```
public double addInterest(double rate) {
    double interest = balance * rate;
    balance = balance + interest;
    return interest;
}
```

primitives: pass by value
objects: pass by reference

```
interest = myAccount.addInterest(rate);
```

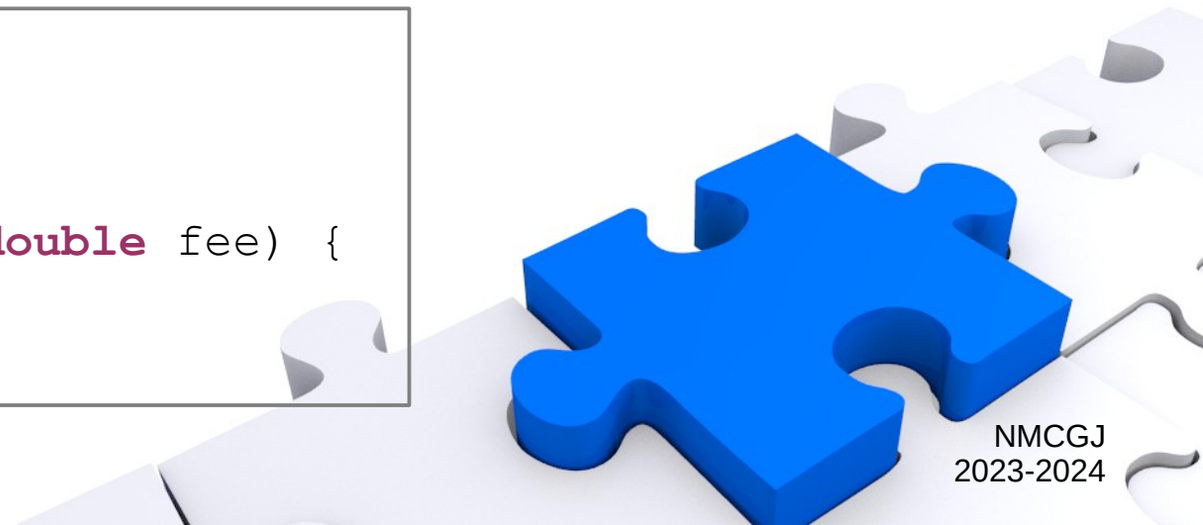
Basics of Java Programming

- Methods: overloading
  - We can deduce meaning from the context

“wash the shirt”		“washShirt the shirt”
“wash the car”	instead of	“washCar the car”
“wash the dog”		“washDog the dog”

  - Methods can have the same name, but unique set of parameter types

```
public void withdraw(double amount) {
    ...
}
public void withdraw(double amount, double fee) {
    ...
}
```



Basics of Java Programming

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- Ready for an exercise...