Installation of Java

Starting Java with JShell

Instructions of how to install Java 11 on Windows

- We will install Oracle Java 11 on a Windows 10 machine
- Installation is only slightly different on other operating systems

- Within the course we use Oracle Java 9 for the demos
- You can use any Oracle Java beginning from Java 9 for practising.

Using JShell for simple Math
or
Operators and Variables

Java from Scratch

Operators

- \+ : Adds two values
- \- : Subtracts two values
- * : Multiplies two values
- / : Divide to values
  - for integers without remainder, for floating numbers it produces a floating number
- % : Gives the remainder for integers
- ( ) : Braces can be used to overwrite math rules

Variables in Java

- Think of a variable as a **container** which can hold a value, text or even an object.
- Each variable gets a **name**.
- Within the rest of the code the variables are used as **placeholder** for the real value, text or object.
- Java is a **strongly typed language**. That means, every variable needs a **type** before anything is stored in it.

Types for Variables for Whole Numbers

- int : negative and positive whole numbers like 1, -1 , 1000
  - 32 Bit from –2,147,483,648 to 2,147,483,647
- byte : the same, smallest range
  - 8 Bit from -128 to +127
- short : the same, still a small range
  - 16 Bit from -32,768 to 32,767
- long : if you need more than int
  - 64 Bit from –9,223,372,036,854,775,808 to 9,223,372,036,854,775,807

Types for Variables for Floating Numbers

- double : floating double numbers like 3.1415
  - 64 Bit for double precision from 4.9E-324 to 1.8E+308
- float : floating numbers with simple precision
  - 32 Bit for numbers from 1.4E-45 to 3.4E+38

How to assign a value to a variable in Java?

- Remember: Java is a strongly typed language. So the type of the variable must be set before the variable is set:
  - int number;
- After the variable is introduced this way, you can use the equal sign to assign a value to it:
  - number = 42;
- And you can do both things in one line:
  - int number = 42;

Strings, Chars and Booleans and their Operators

Java from Scratch

Variable Types: String, Char & Boolean

- String : Text values like "Hello World!"
- char : For characters like 'J' or 74, which is the ASCII-value for J
- boolean : Logical values true or false

String Concatenation

- Strings are **sequences of characters**
- They are written in **double quotation marks** like this:
  - "Hello World“
- The values can be **concatenated** with the **plus** sign:
  - String h = "Hello " + "World“;
- Note that the String is the only **non-primitive** variable type, we want to talk about here. It is actually an object. That means you have to start with a capital ‘S’

Equality checks result in Booleans

- You can assign **true** or **false** to a boolean character
  - boolean b = true;
- But you can also run an equation like this:
  - boolean b = i == 1;
- It checks if ‘i’ equals 1.
  - If it does ‘i == 1’ returns true and so b is true.

Equality Operators & Relational Operators

- **==** : **equal to** – equality operator
- **!=** : **not equal to** – equality operator
- **>** : **greater than** – relational operator
- **>=** : **greater than or equal to** – relational operator
- **<** : **lesser than** – relational operator
- **<=** : **lesser than or equal to** – relational operator

Conditional Operators

- Equality & relational operators can be combined with **conditional operators:**
  - **&&** : means **AND**
  - **||** : means **OR**

- E.g. **(i<10) && (j >0)** can be assigned to a boolean because it results in a boolean value.

Compound-Assignment Operators & Unary Operators

Java from Scratch

Compound-Assignment Operators (1)

- += assigns the result of the addition
  - **a += b** is the same as **a = a + b**
- -= assigns the result of the subtraction
  - **a -= b** is the same as **a = a - b**
- *= assigns the result of the multiplication
  - **a *= b** is the same as **a = a * b**
- /= assigns the result of the division
  - **a /= b** is the same as **a = a / b**

Compound-Assignment Operators (2)

- %= assigns the remainder of the division
  - **a %= b** is the same as **a = a % b**

- &= assigns the result of bitwise AND
  - **a &= b** is the same as **a = a & b** which is the same as **a = a && b** for us
- |= assigns the result of bitwise OR
  - **a |= b** is the same as **a = a | b** which is the same as **a = a || b** for us

Unary Operators

- i++ : Postincrement
- ++i : Preincrement
- i-- : Postdecrement
- --i : Predecrement

And one more boolean operator:

- ! : Negation NOT

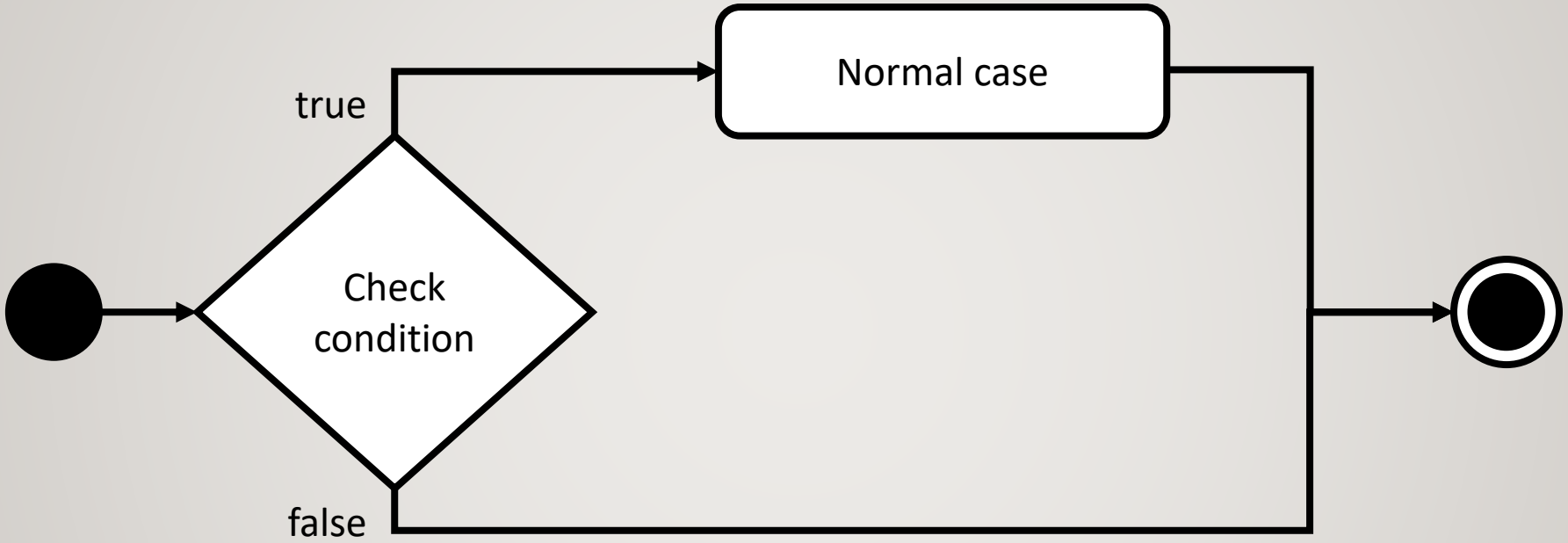
Summary

- Mathematical **operators**
- Types of **variables**
- Assignment of **variables**
- Strings, Chars, Booleans **variables**
- **Operators** for them
- Compound-Assignment **Operators**
- Unary **Operators**

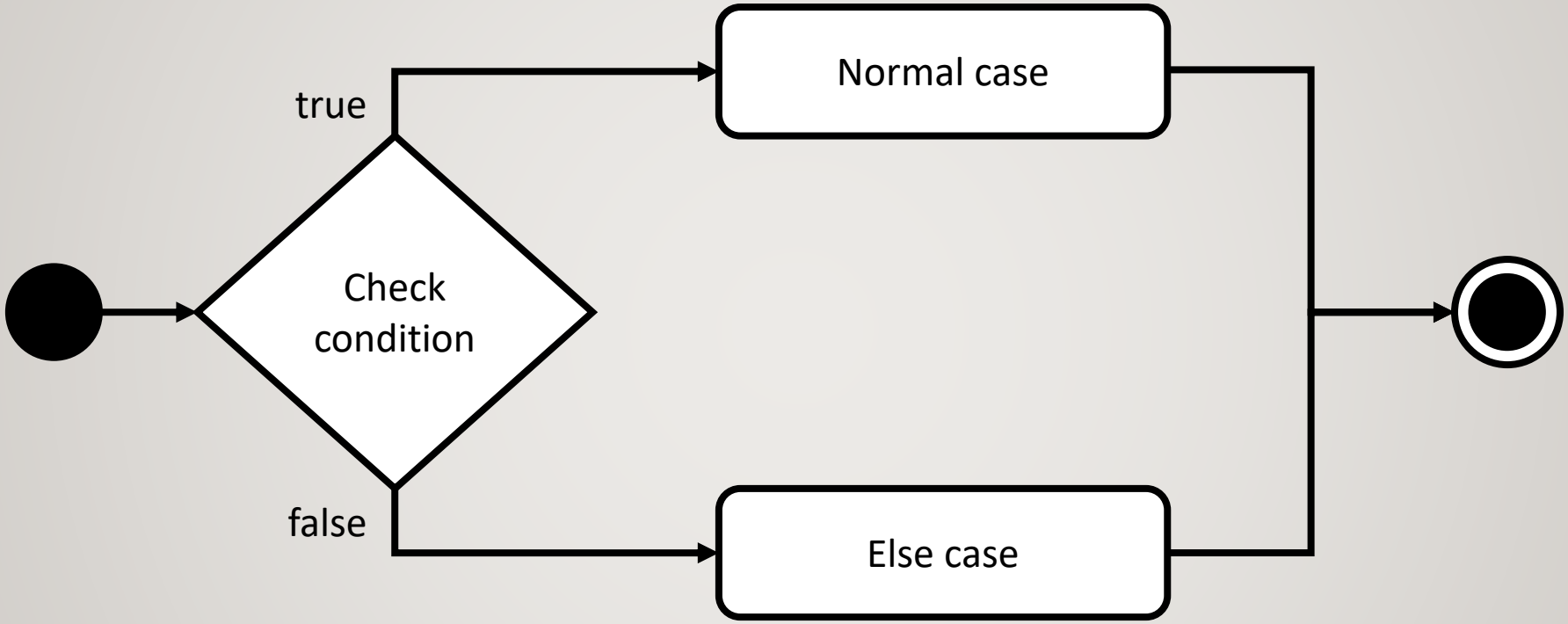
Running code depending on a condition: The If-Statement

Java from Scratch

If-Statement Visualization as Flow Chart



If-Statement Visualization as Flow Chart



The If-Statement in Java

```
if (i == 1) {
        System.out.println ("i is one");
    }
    else  {
        System.out.println ("i is something else");
    }
```

The If-Statement in Java


```
if (i == 1)
        System.out.println ("i is one");

    else
        System.out.println ("i is something else");
```

The If-Statement in Java


```
if (i == 1) {
        System.out.println ("i is one");
    }
    else
        System.out.println ("i is something else");
```

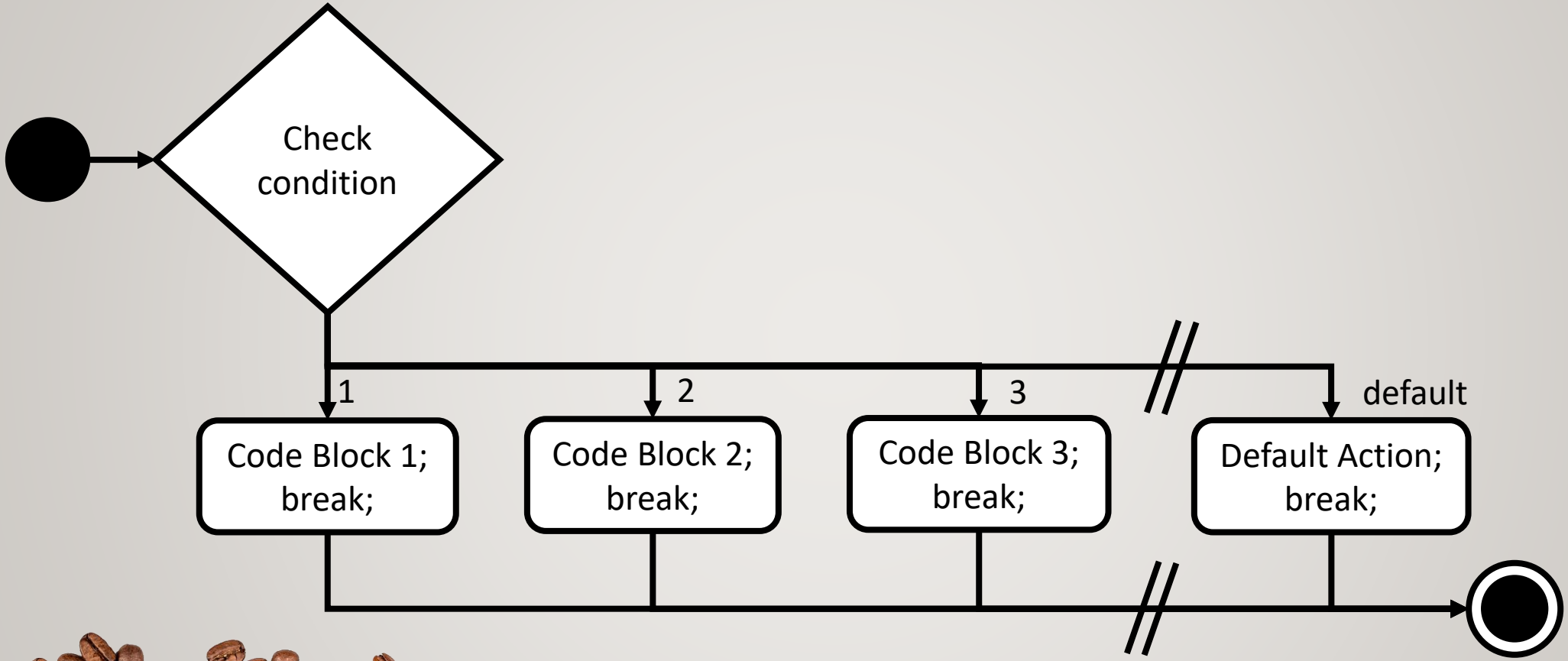
The Ternary Conditional Operator ? :

- The **Ternary Operator ? :** was introduced with Java 7 and is written this way
  - variable = condition **?** true-part **:** false-part;
  - If the **condition** is true, the **true-part** is evaluated and assigned to the variable, otherwise it is the **false-part**.
- So this gives the minimum of the two numbers a and b:
  - int minimum = (a < b) ? a : b;

Multiple Options: The Switch-Statement

Java from Scratch

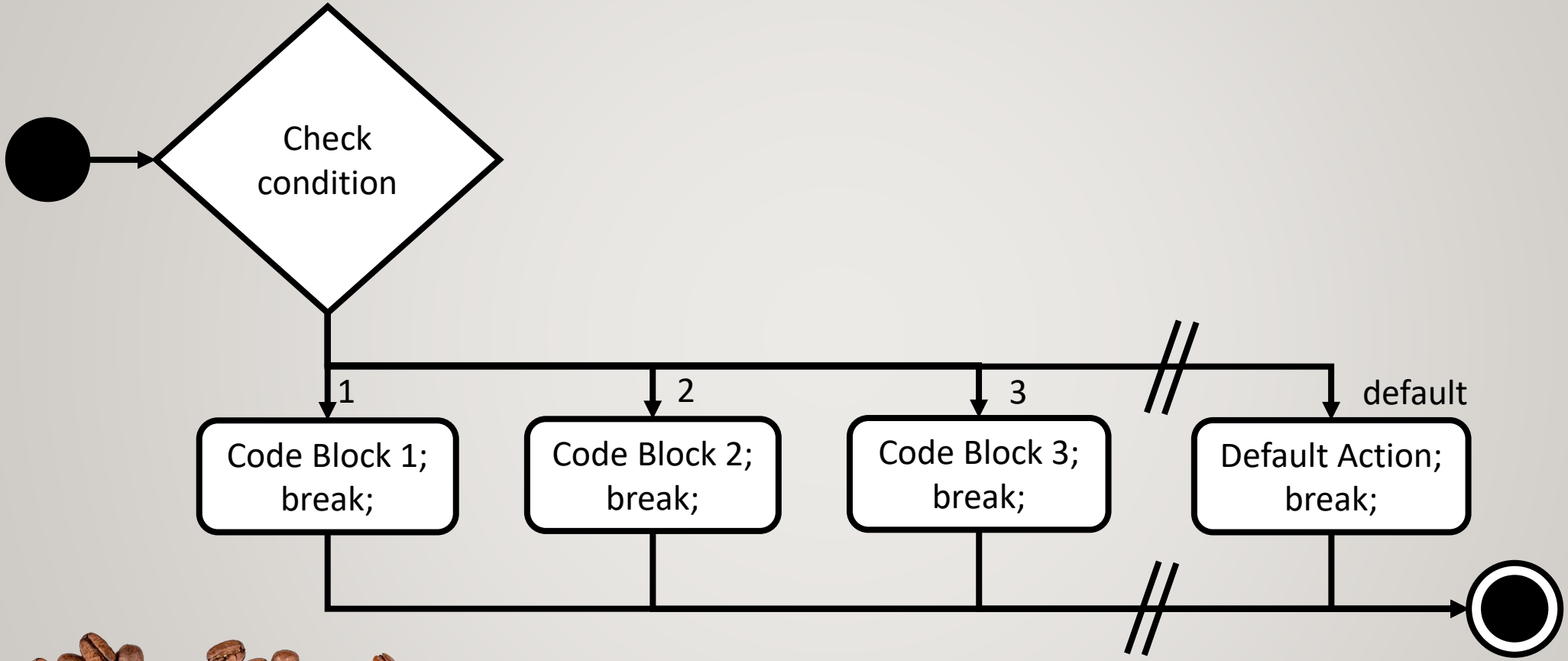
Switch-Statement visualized as Flow Chart



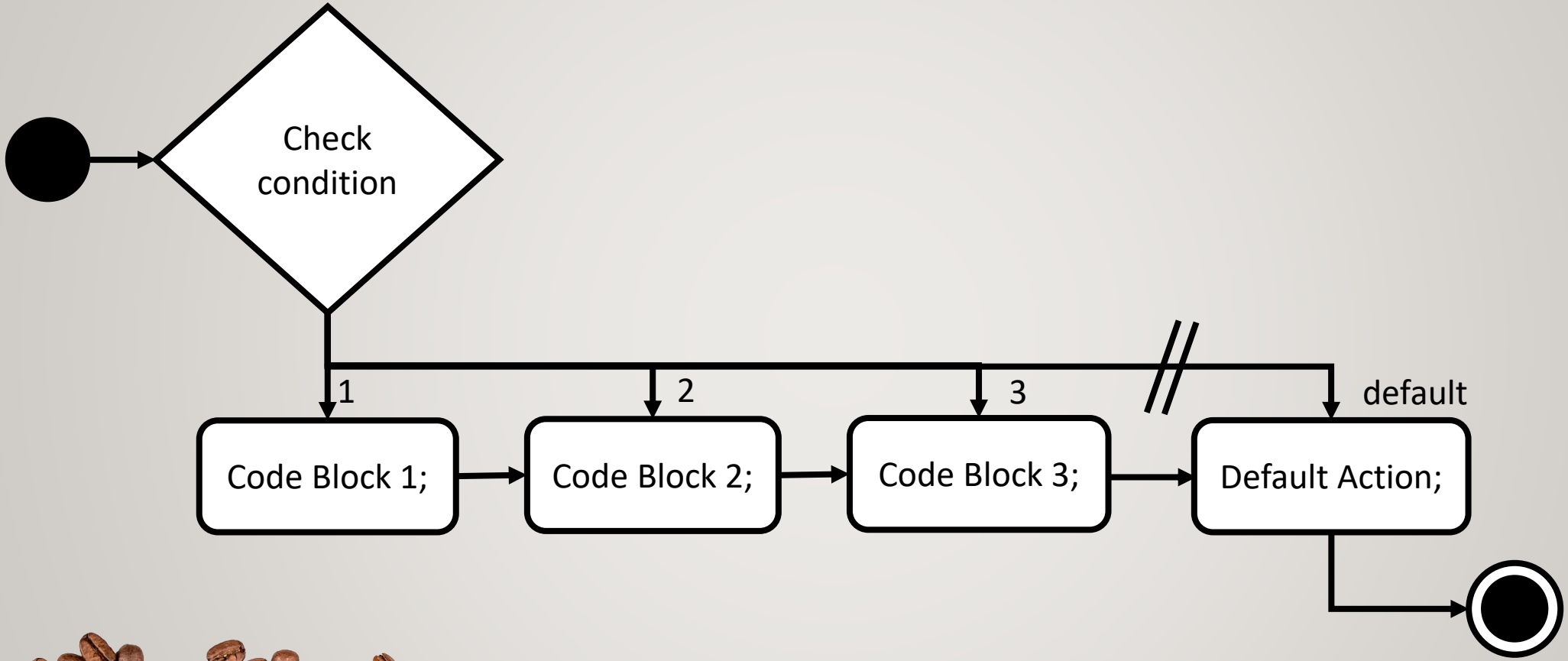
A exemplary Switch-Statement

```
int variable = 2;
switch (variable) {
    case 1:  System.out.println (“one”);
             break;
    case 2: System.out.println (“two”);
             break;
    default: System.out.println (“unknown”);
             break;
}
```

Never forget the break!



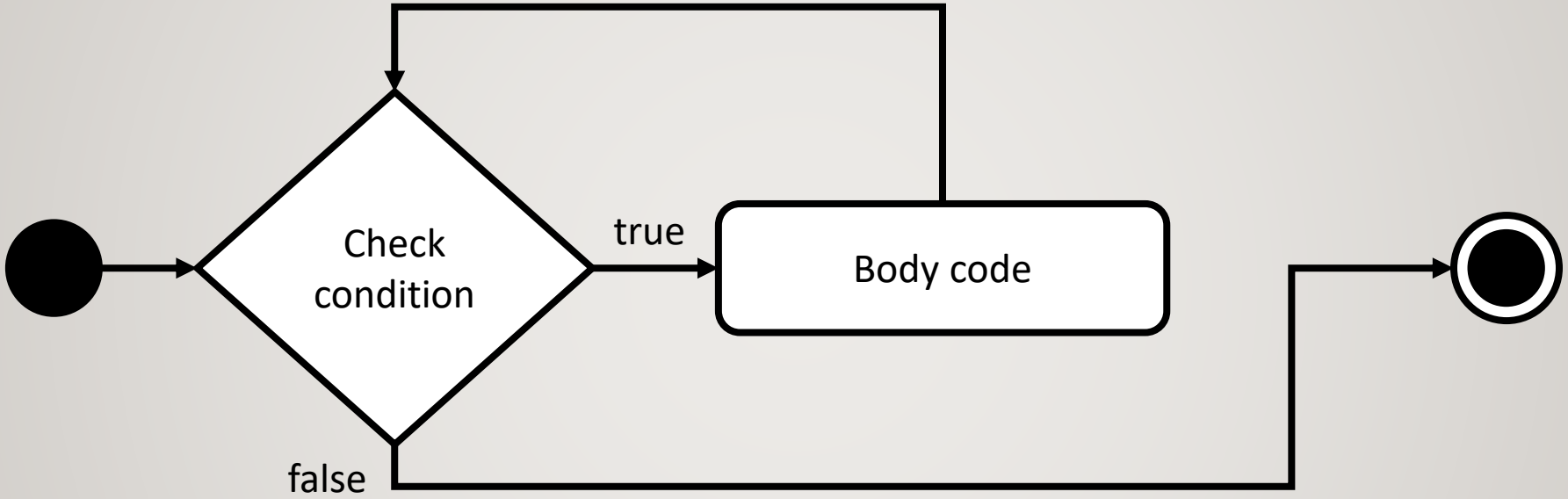
Never forget the break! This will happen!



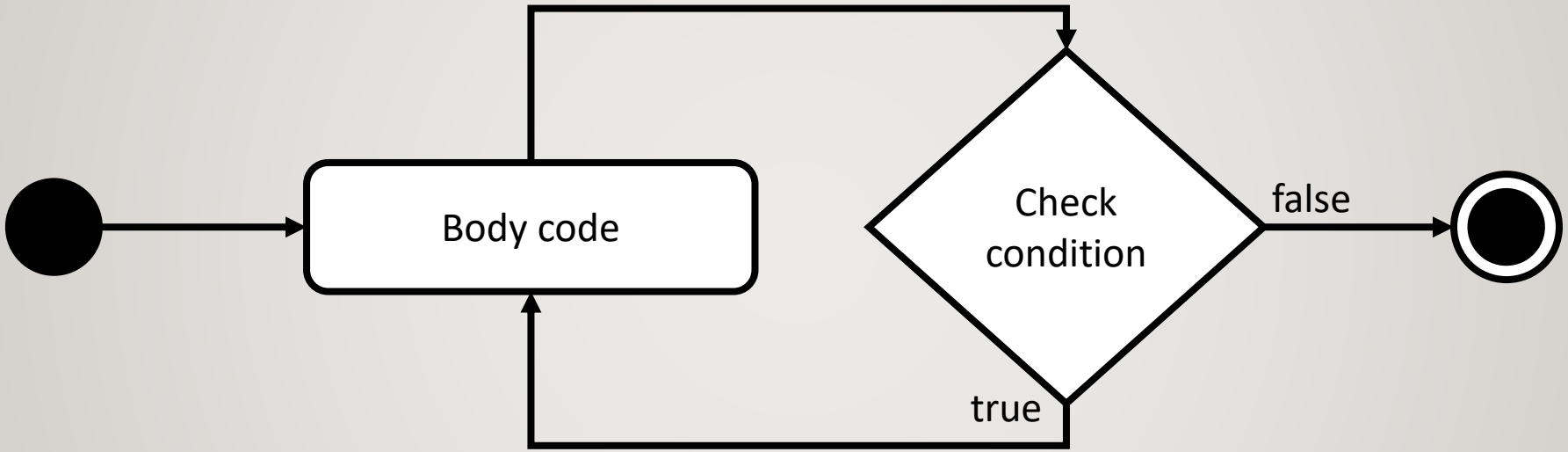
Running code repeatedly: The While-Loop and the Do-While-Loop

Java from Scratch

While-Loop visualized as Flow Chart



Do-While-Loop visualized as Flow Chart



While-Loop with Curly Braces and without

- ```
  int i = 0;
  while (i < 10) {
          i++;
  }
  ```

- ```
  int i = 0;
  while (i < 10)
          i++;
  ```

Do-While-Loop with Curly Braces and without

- ```
  int i = 0;
  do {
          i++;
  }
  while (i < 10);
  ```

- ```
  int i = 0;
  do i++;  while (i<10);
  ```

Multiple Values of the same Type: Arrays

Java from Scratch

Arrays are Collections of Variables

- Often you need a **collection of variables** of the **same type**
  - This variables can be put into an array
- An array is simply a **continuous list in memory** which consists of all variables **one by one**.

- The length of the array must be known **in advanced**, because Java needs to reserve memory for the array.
- You **cannot change the length** of an array.
- In Java the length of an array is limited to the **maximum int-number**. But that is a lot of space. To be precise: 2,147,483,647

Two Ways to define an Array

- **Preinitialized** it the moment the variable is defined:
  - int [] integerArray = { 1, 2, 3, 4, 5 };
  - String [] stringArray = {"blue", "green", "red"}
- Or **assign** it after the variable was defined:
  - int [] integerArray;
    integerArray = new int [5];
  - String [] stringArray;
    stringArray = new String [3];

Changing and Accessing Values

- Arrays begin at position 0. If you define an array of length 8, this is the resulting structure:

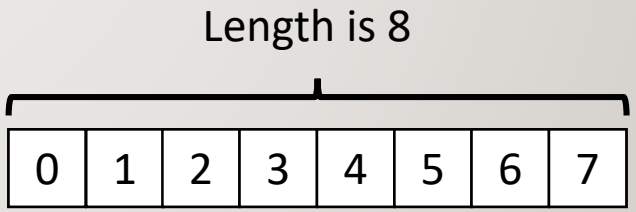
0	1	2	3	4	5	6	7

- You **put a value** into the array by determine its position:
  - integerArray [3] = 7;
    stringArray[2] = "white";
- You **get a value** out of the array by accessing its position:
  - integerArray [3]
  - stringArray[2]

Beyond the Limits

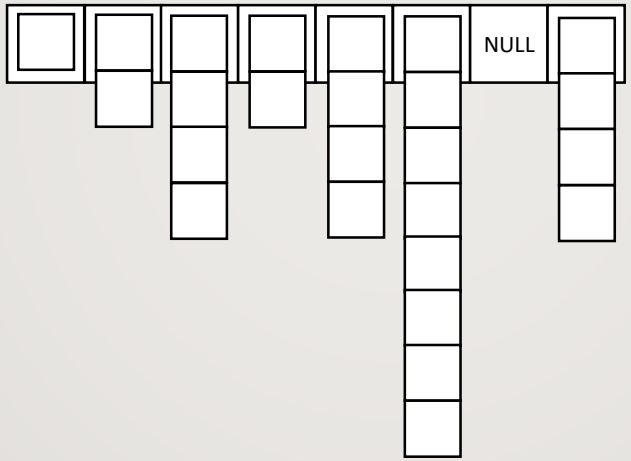
- But if you want to put a value into a position which is not available…
- … or you want to read a position which is not available…
- …you will get an **ArrayOutOfBoundsException** at runtime.

- To determine the length of an array you use length:
  - stringArray.length
  - integerArray.length



Multidimensional Arrays

- Multidimensional Arrays are implemented as **Arrays in Arrays**
- A two-dimensional Array can have a look like this:



Multidimensional Arrays

- **Definition** of a two-dimensional array with two squared braces:
  - int [][] integerArray = { {1,2}, {1,2,3}, {1,2,3,4}, {1,2,3,4,5}, {1,2,3,4,5,6} };
- **Access** of a two-dimensional array with two squared braces:
  - integerArray[0][1]

- If you want to have more dimensions you have to add more squared braces.

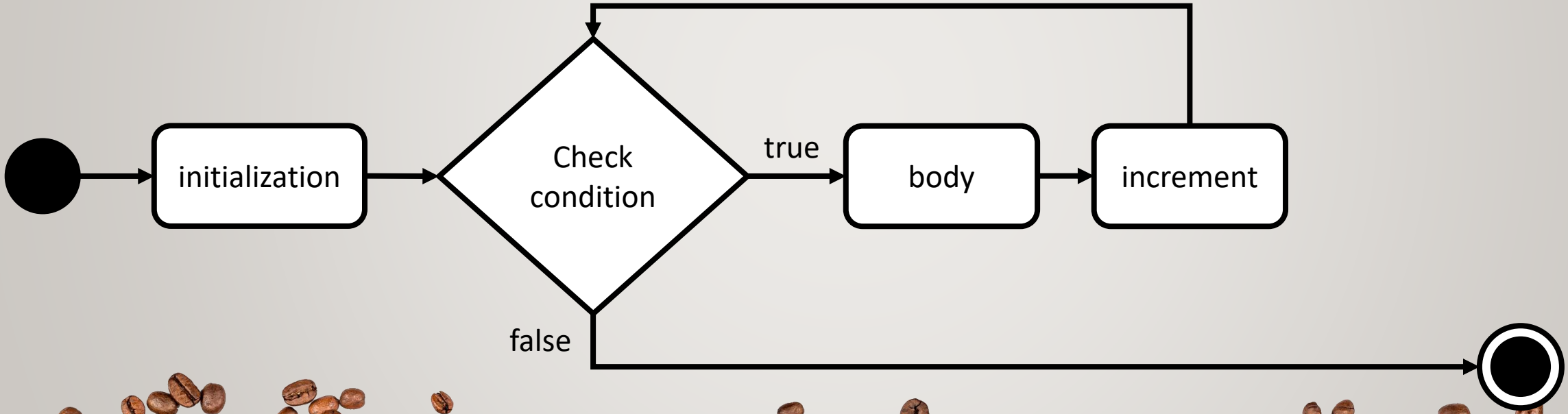
Running code a specific number of times: The For-Loop

Java from Scratch

For-Loop visualized as Flow Chart

```
for (initialization; check; increment) {
   body;
}
```

```
for (int i = 0; i < 100; i++) {
   System.out.println (array[i]);
}
```



The For-Loop

- for (int i = 0; i < array.length; i++) {
  // do something with array[i]
  }

- for (Iterator iterator = collection.iterator(); iterator.hasNext();) {
  Item item = (Item) iterator.next();
  // do something with item
  }

The For-Each-Loop

- for (Item item : collection) {
  // do something with item…
  }

- Came with Java 5
- collection must return an iterator

Curly Braces

It is possible to write any for-loop without Curly braces:

- for (int i = 0; i < array.length; i++) {
  command(array[i]);
  }

… is the same as …

- for (int i = 0; i < array.length; i++)
  command(array[i]);

Break & Continue

- With break you can jump out of a statement completly.
  - We saw this for the Switch-statement. But is is also possible with While- or For-loops.
- With continue you can skip the current run

- For both it is possible to specify a destination target
  - continue target;

    … jumps to …
  - target:

Methods: The Java-Way to create Subprograms

Java from Scratch

Methods in Java

- Methods are **subprograms**
  - In other programming languages methods are named **functions**, **procedures** or **subroutines**.
- Code is taken out from the main program and can **invoked at arbitrary positions** in the program.
- It can be invoked once, **multiple times** or never.
- **Arguments** can be passed into the method and the method may have a **return parameter**.

Declaration of a Method (1)

- Methods can be **declared** this way:

```
returntype methodname (paramtertype parametername, …) {
    // use parametername
    return variableofreturntype;
}
```

- The list of **passing parameters** is arbitrary long:
  - int methodWithOneParameter (int parameter1) {…
  - int methodWithTwoParameters(int parameter1, String parameter2) {…
  - int methodWithNoParameter() {…

Declaration of a Method (2)

- There can be **one** return value or **no** return value
  - int methodWithOneReturnValue () {
    int i = 1;
    return i;
    }
  - void methodWithnoReturnValue () {
    return;
    }
- If there's no return value writing **return;** is optional.

An Example of a Method

- An example method:

```
int sumOfTwoInts (int a, int b) {
    int r = a + b;
    return r;
}
```

- Within the main program we can **invoke** the method by writing e.g.:
  - int sum = sumOfTwoInts (1,2);

Methods with variable Parameter Lists

- There is a language feature to allow **variable parameter lists**.
- This can be used with the **last** parameter:
  - void foo(String a, int... b) {
    if (b.length > 0) System.out.println (b[0]);
    if (b.length > 1) System.out.println (b[1]);
    System.out.println (a);
    }
- Note that within this program either 0, 1 or 2 int-parameters can be passed. More parameters can be passed but are ignored.

Summary

- If-Statement
- Switch-Statement
- While-Loop, Do-While-Loop
- For-Loop, For-Each-Loop
- break; and continue;
- Methods

Practical Exercise

- Develop a compound interest calculator - method
- Header of the method should be:
  - double calculateResult (double startAmount, double interestRate, int years)
- The percentage of the interest rate should be given divided by 100 e.g. 3% is 0.03
- The final balance should be returned.

Some more cool features of JShell

- You can write out the complete history to a file using the save-command:
  - /save filename
  - This is useful if you want to hand in your function
- You can also read this file and execute it
  - /open filename

Pause the video now
to do the exercise

If you didn‘t manage to create the method, here it is:

```
double calculateResult (double startAmount, double interestRate, int years) {
        for (int i = 0; i< years; i++) {
                startAmount *= (interestRate+1);
                System.out.println ((i+1)+ " "+startAmount);
        }
        return startAmount;
}
```

A Java-file gets executed

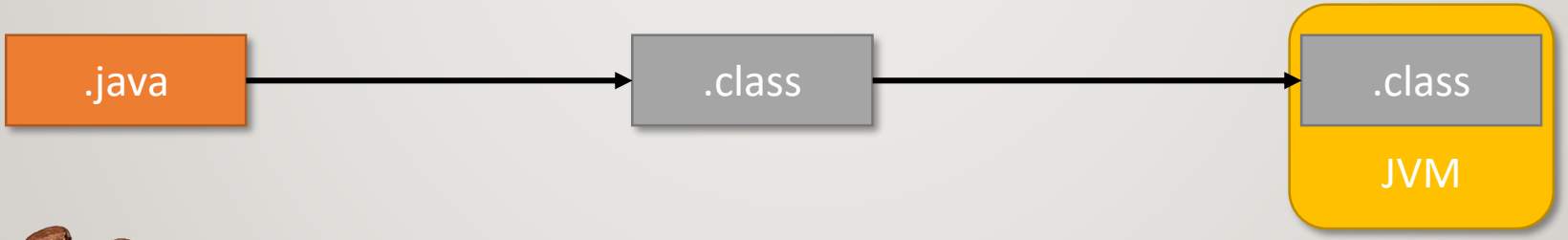
Java from Scratch

What is a Java-file?

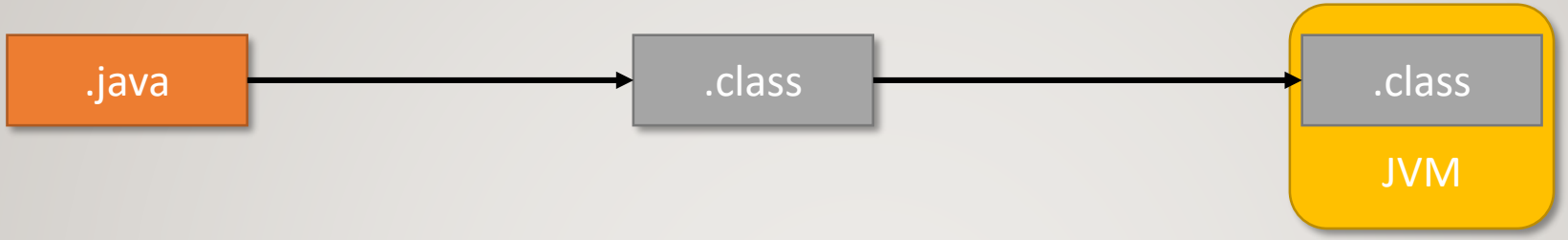
- Up to now we only worked with JShell, a REPL-console (**R**ead–**e**val–**p**rint **l**oop)
- We can write Java-programs as text files, compile and execute them.
- Let us write a small Java program, which prints out **“Hello world!”**

What steps are needed for a Java program to run?

- Every Java-program is actually build out of a set of **text-files** with the ending **.java**.
- These .java files are compiled to **bytecode-files** by a Java-compiler to **.class-files**.
- After this the .class-files can be run on a **J**ava **V**irtual **M**achine (JVM).

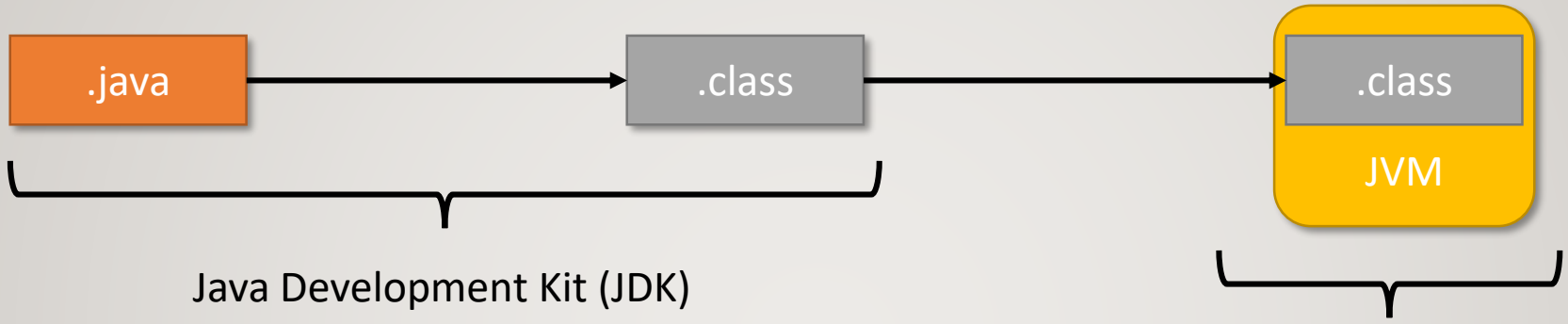


Why do we need a Java Virtual Machine?



- You may ask yourself: Why don‘t we directly have machine code which is directly executable?
- Java bytecode is translated on the fly to machine code while running the program but gives us the flexibility to run this code on different CPU architectures.

What is a JDK (a Java Developer Kit)?



- You need a Java Developer Kit (JDK) to **build / compile** Java programs.
- You need a Java Runtime Environment (JRE) to **run** Java programs. (included with the Java Development Kit (JDK))

Download and Installation of the Java Development Kit (JDK)

- Both are available for Windows, Linux, Mac and other platforms.
- Both are available from multiple vendors.
- We choose the vendor **Oracle** and download & install the Java Development Kit (JDK) for **Windows**

Installing the IDE –
the Integrated Development Environment

Java from Scratch

Our current state

- Every Java program is actually **only a set of text files**.
- You can edit them with **every text editor** and start the execution of them from the command line.
- But this is quite uncomfortable.
- An **Integrated Development Environment (IDE)** makes the life of a software developer much more comfortable.

What is an **I**ntegrated **D**evelopment **E**nvironment?

- It is first a **text editor** and an invoker of the **compiler** and executor
- But it also helps to **navigate between the text files**
  - By understanding the content of the files, very good navigation is possible.
- By knowing the Java API and your code, it knows how to **complete typed statements**.
- It is even possible to **rewrite the program code automatically** (This is called Refactoring).

Different IDEs (1)

- **NetBeans**
  - Very easy to install. It is possible to download it together with the JDK.
  - Free
  - Has a plugin architecture. But not many plugins are provided.
- **IntelliJ IDEA**
  - Upcoming new star in the area of IDEs
  - Has a free community version. But you pay for more features.
  - Has a great set of plugins.

Different IDEs (2)

- **Eclipse**
  - Free & OpenSource
  - Great community: Many subprojects & Many plugins
  - Stable
  - In my eyes still the best IDE
- And there are **some other IDEs** on the market which are not big players.

Our plan now

- Prerequisites: Installed JDK 9 on your machine.

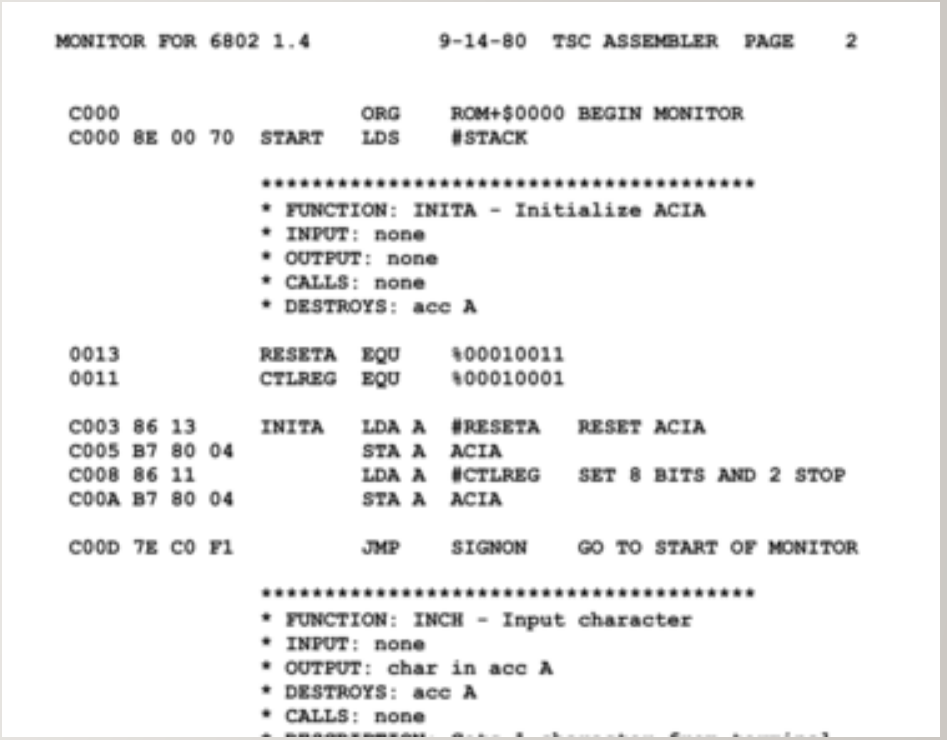
1. **Download** Eclipse
2. **Install** Eclipse
3. **Run** Eclipse & Create and Run the **HelloWorld-Program**.

Classes & Objects – Their variables and methods

Java from Scratch

Evolution of Programming Languages: The early Beginning

- Machine code:
  - Early programming happened in machine code.
  - Commands of the CPU where addressed by numbers.
- Assembler languages:
  - Later the “Assemblers” came up. They offer a more readable version of the programming with numbers.
  - Programmers need detailed knowledge of the hardware they program on.



```
MONITOR FOR 6802 1.4          9-14-80  TSC ASSEMBLER  PAGE    2


C000                          ORG    ROM+$0000 BEGIN MONITOR
C000 8E 00 70  START          LDS    #STACK

                    ****************************************
                    * FUNCTION: INITA - Initialize ACIA
                    * INPUT: none
                    * OUTPUT: none
                    * CALLS: none
                    * DESTROYS: acc A

0013                RESETA    EQU    %00010011
0011                CTLREG    EQU    %00010001

C003 86 13          INITA     LDA A  #RESETA   RESET ACIA
C005 B7 80 04               STA A  ACIA
C008 86 11                  LDA A  #CTLREG   SET 8 BITS AND 2 STOP
C00A B7 80 04               STA A  ACIA

C00D 7E C0 F1               JMP    SIGNON    GO TO START OF MONITOR

                    ****************************************
                    * FUNCTION: INCH - Input character
                    * INPUT: none
                    * OUTPUT: char in acc A
                    * DESTROYS: acc A
                    * CALLS: none
```

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Evolution of Programming Languages: The Process-oriented Model

- Imperative languages
  - Give commands on a higher level.
  - There's only one main program which commands are executed one by one.
- Procedural languages
  - Subroutines are introduced.
  - A subroutine takes arguments and returns back a result.

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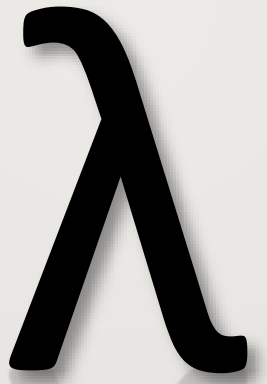
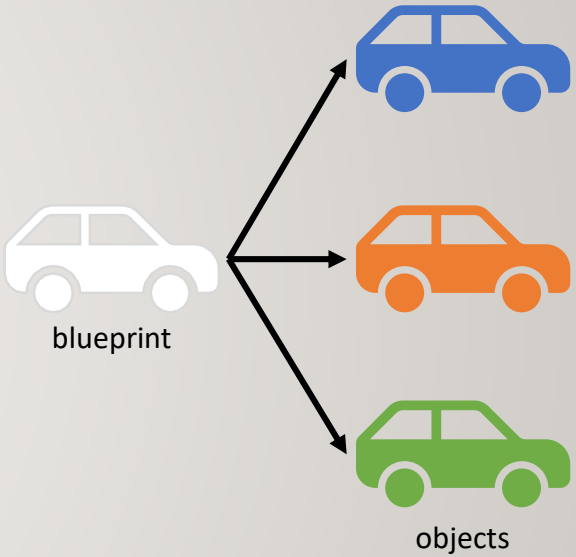
Evolution of Programming Languages: The Object-oriented and functional model

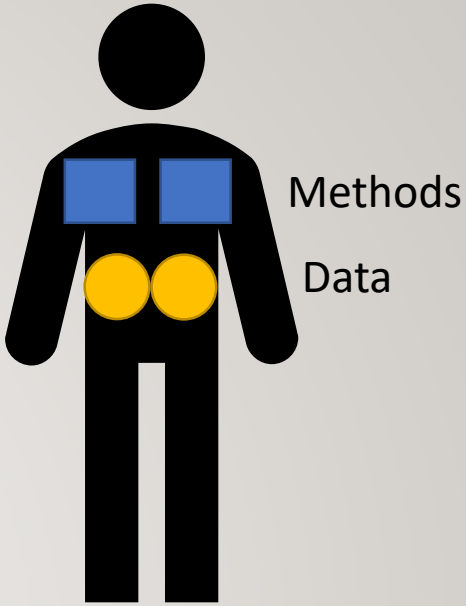
- Object-oriented languages
  - like Java
- Functional languages
  - Java 8 got a functional part

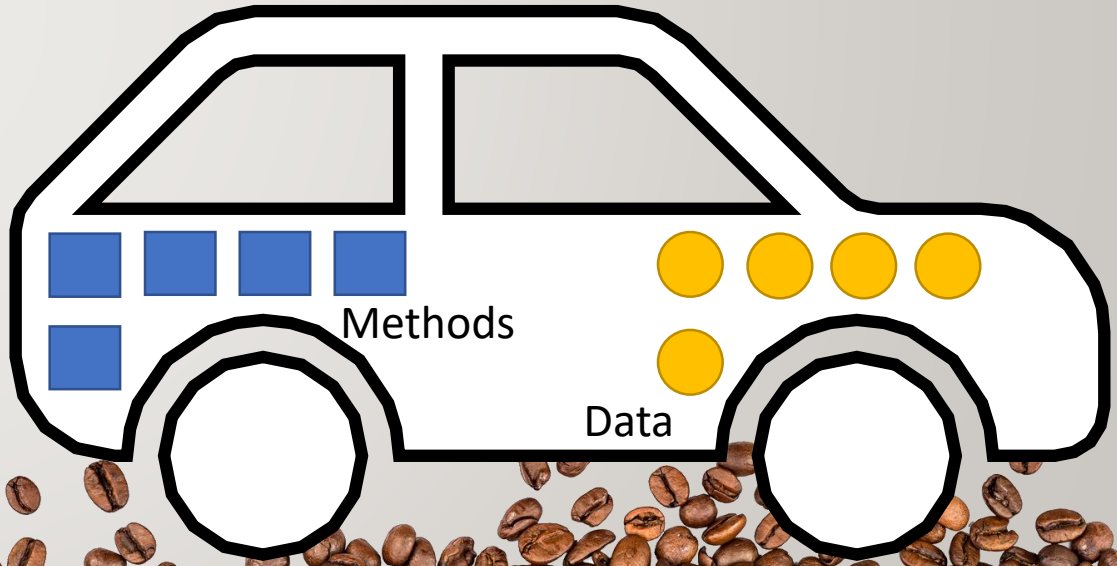




Variables and their Methods

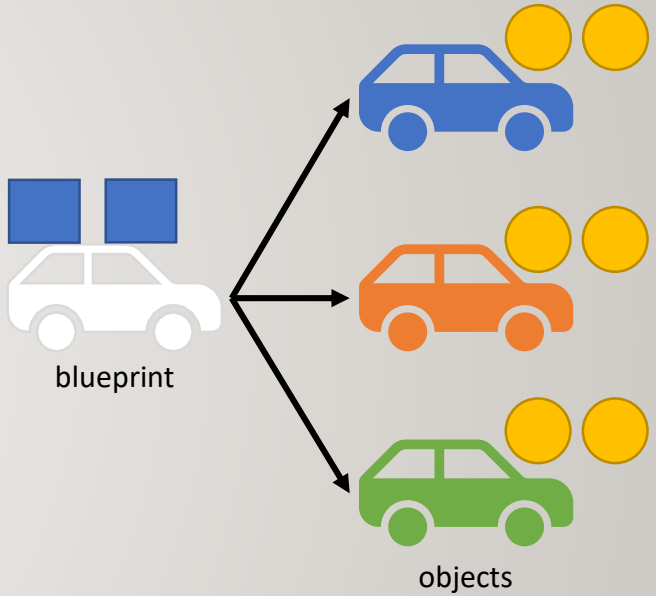
- In the world of computer programs we came to know that methods (procedures) and data **always go together**.
- The **same methods** and the **same type of data** is bounded to similar objects.
  - E.g. a person must have a first name and a last name. You can hire a person.
  - But a car doesn‘t have a first name and a last name. It has a serial number! And you can buy it. You do not hire it.
- Methods and data are **bounded together**. They are no separate things.
- This is the idea of **Object Oriented Programming (OOP)**





The Class is the Template of the Object

- It is possible that multiple objects of the same type are created.
  - Blue, orange and green car
- Each object has its own variable set…
- …but the methods over all the objects remain the same.
- An object is created out of a class:
  - The class is the template of the object.
  - The methods remain in the class.
  - The variables are created for the object.



A Class in Java

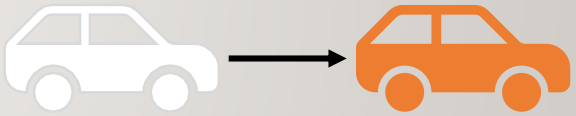
```
class Car {
        int serialNumber;
        String color;

        void drive (int kilometers) {
        }
        String getInformation (String parameter1) {
                return someInformationString;
        }
}
```

Car
serialNumber : int color : String
drive (kilometers : int) : void getInformation (parameter1 : String) : String

Instantiate an Object in Java

Creating an object with “new” and accessing the first class variable and invoking the first method:

```
Car myCar = new Car();
myCar.serialNumber = 1234567;
myCar.drive(100);
```



Learning Materials

Java from Scratch

Get help on the Internet

- Starting programming is not easy. It takes a lot of time to become a programmer.
- Learning is not happening automatically. You have to spend time and effort.
- So, do not panic. Do not give up. Ask someone.
  - Use the forum system inside the course.
  - There are many forums available on the Internet and beginners are welcome.

Internet pages

- Facebook group for help: https://www.facebook.com/groups/Javagroup123/ or https://www.facebook.com/groups/java.for.life/ or other
- Stack Overflow: https://stackoverflow.com/
- And others, maybe even in your mother tongue!
  - Use Google

How to ask good questions?

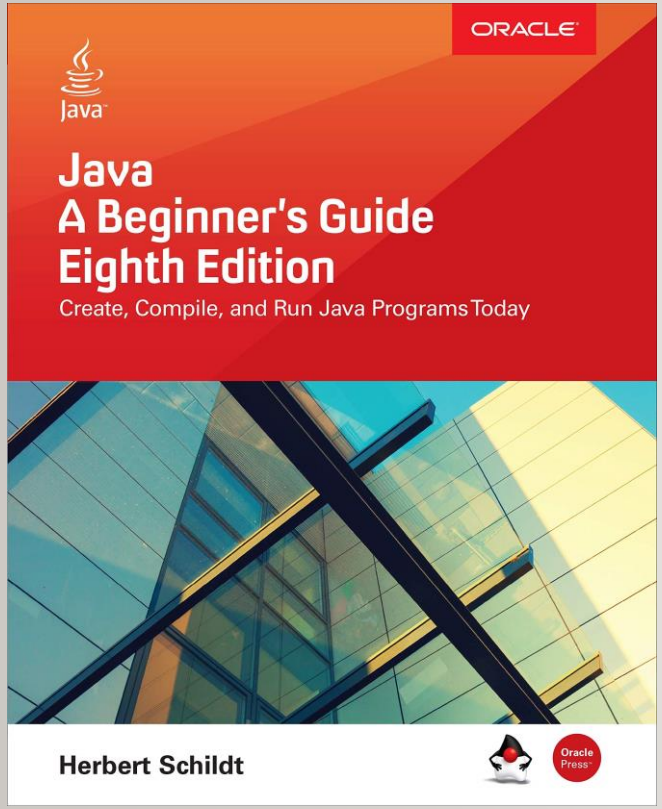
When you ask a question, do not simply drop a note: “It doesn’t work.”
Be precise:

- What exactly doesn’t work? Post compiler errors or runtime stacktraces.
- Post the code which doesn’t work.
- Give information about the surroundings: Your operating system, Java version you use, IDE you use…

Internet pages with more information

- GoJava https://go.java
- The official Oracle Java Tutorials: http://docs.oracle.com/javase/tutorial/
- Use the API Docs http://download.java.net/java/jdk9/docs/api/overview-summary.html

Books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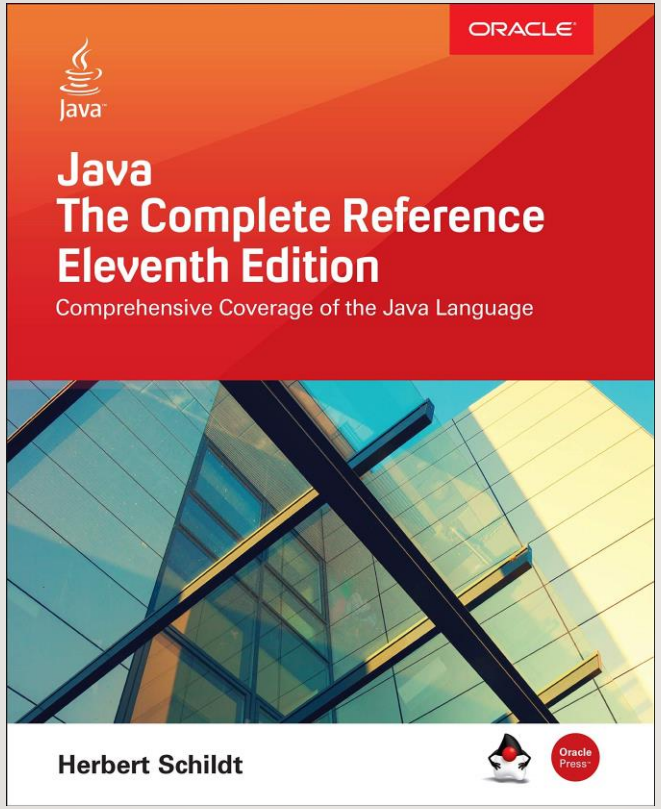
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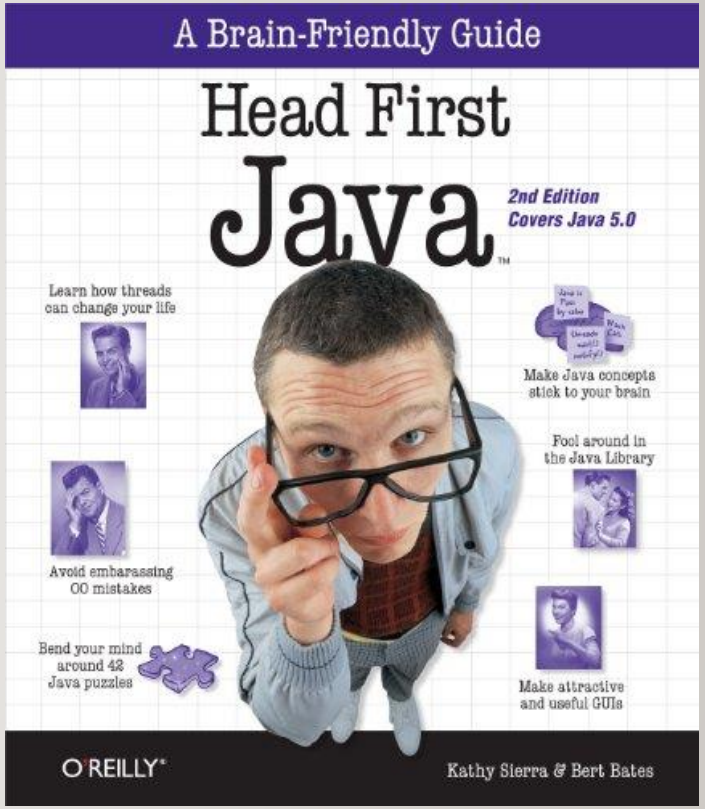
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Make Java concepts stick to your brain
Fool around in the Java Library
Avoid embarassing OO mistakes
Bend your mind around 42 Java puzzles
Make attractive and useful GUIs
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Kathy Sierra & Bert Bates