

# 2IP65

## Lecture 3

Arrays  
for loop  
for-each loop  
do-while loop  
ArrayList

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## Remarks

- `i++` and `i+=1` are shorthand for `i=i+1`
- don't mix them! `i=i++` is wrong!
- It is in some cases allowed to write the body of a loop or the branch of an if without braces `{ }`.  
Don't do this. It easily leads to errors.

idea of += works with many operators, such as \*=, -=, and %=

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## Control and data

- Two fundamental concepts of programming are control and data. Data are values stored in variables. Information is data with meaning. Control determines what you do with the data.
- A program executes the statements (lines or parts of it) one after the other. The order (called control) is determined by:
  1. the order in the text
  2. control structuring
- We have seen some ways to structure control: put statements after each other, make while-loops, make if-structures
- Can we structure data too?

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## Simple structuring of data: arrays

- An array is a sequence of numbered variables
- Instead of

```
int student1;
int student2;
int student3;
student1 = 7;
student2 = 5;
student3 = 3;
```
- you can do:

```
int[] students;
students = new int[3];
students[0] = 7;
students[1] = 5;
students[2] = 3;
```

declaration  
creation: gives 3 elements  
last one is `students[2]`

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# Arrays

- Number between [] is called index
- In Java, all arrays start with 0. Last index is number of elements - 1
- Declaration and creation are separate; often, you don't know directly how many variables you need, e.g., asked as input from the user
- declaration and creation can be combined, though:  
`int[] students = new int[3];`

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# Arrays - example

```
int[] students = new int[3];
students[0] = 7;
students[1] = 5;
students[2] = 6;

// bereken som
double som = 0.0;
int i = 0;
while (i<3) {
    som = som + students[i];
    i++;
}
double gemiddelde = som/3;
```

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# Intermezzo

- Now you can write any program
- that is, any computation or algorithm (method) that can be precisely described
- Java with arrays and loops is equivalent in power to Turing machines
- any computation that can be precisely described can be described by a Turing machine (Church-Turing thesis)
- since "any computation..." can not be formally defined, this is a conjecture

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# for-loop

- when you know the number of iterations (number of times you execute the loop-body) on beforehand
- when you want to do something for each member of a set (range) of values

```
for (int i = 0; i<100; i=i+1) {
    System.out.println(
        "Ik mag de accolades om loop-body's niet vergeten"
    );
}
```

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## for-loop - syntax

```
for ( <initialisation>; <guard>; <increment> ) {  
    <statements>  
}
```

- <initialisation>: starting assignment to counter
- <increment>: statement that "increases" counter (i=i+1, j=j-1, k=k+x, etc.)
- <guard>: boolean expression as in while

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## do-while loop

- when you have to do something at least once
- ```
double balance;  
String choice;  
// init balance  
do {  
    System.out.println("Type amount for deposit.");  
    deposit = sc.nextDouble();  
    balance = balance + deposit;  
    System.out.println("New balance is " + balance + ".");  
  
    System.out.println(  
        "Do you want to make a deposit? Type y/n");  
    choice = sc.next();  
} while (choice.equals("y"));
```

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## do-while loop

- when you have to do something at least once

```
int som = 0;  
int cijfer = 0;  
  
do {  
    som = som + cijfer;  
    System.out.println("type cijfer, -1 om te stoppen");  
    cijfer = scanner.nextInt();  
} while (cijfer > 0);
```

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## for loop - example

```
int[] students = new int[3];  
students[0] = 7;  
students[1] = 5;  
students[2] = 6;  
  
// bereken som  
double som = 0.0;  
  
int i = 0;  
while (i < 3) {  
    som = som + students[i];  
    i++;  
}  
  
double gemiddelde = som/3;
```

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## Flexibility - example

Using the number 3 is inflexible  
Make the program work for any number of students

```
System.out.println("Geef aantal studenten: ");
int n = scanner.nextInt();

int[] students = new int[n];
for (int i=0; i<n; i=i+1) {
    students[i] = scanner.nextInt();
}

students[0] = 7; students[1] = 5; students[2] = 6;
// bereken som
double som = 0.0;
for (int i=0; i<n; i=i+1) {
    som = som + students[i];
}
double gemiddelde = som/n;
```



beware: division does not work  
when som is an int

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## using length of arrays

- following program works for students array  
of any length not depend on

```
System.out.println("De volgende studenten zitten onder het gemiddelde:");
for (int i=0; i<students.length; i=i+1) {
    if (students[i] < gemiddelde) {
        System.out.println(i);
    }
}
```

- Advise: use .length whenever possible

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## for-each loop

- often each element of an array (or another collection) has to be visited
- for-each loop gives exactly this without need for index variable
- for-each works for all kinds of collections, such as lists, sets, trees (see later)

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## Improvement - example

students.length gives you the number of elements in the array  
works safer than the variable n  
Note: trying to access an array element that doesn't exist, gives nasty errors

```
System.out.println("Geef aantal studenten: ");
int n = scanner.nextInt();

int[] students = new int[n];
for (int i=0; i<n; i=i+1) {
    students[i] = scanner.nextInt();
}

students[0] = 7; students[1] = 5; students[2] = 6;
// bereken som
double som = 0.0;
for (int i=0; i<students.length; i=i+1) {
    som = som + students[i];
}
double gemiddelde = som/students.length;
```

This works for any number of students; only the input has to be adapted

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## for-each loop – example

```
int[] students = new int[3];
students[0] = 7;
students[1] = 5;
students[2] = 6;
```

```
// bereken som
double som = 0.0;
```

```
for (int i=0;
     i<students.length; i++) {
    som = som + students[i];
}
```

```
double gemiddelde = som/3;
```

read: "for each student in students"

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## for-each loop – syntax

```
for ( <type> <var> : <collection> ) {
    <statements>
}
```

- <type>: member (element) type of collection
- <collection>: array or other collection with members of type <type>
- <var>: variable that will contain the members of the collection

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## The devious division

- som/3 doesn't work when som is an int  
Why?

There are two versions of /

1. when one of the arguments is a double:  
ordinary division
2. when both arguments are int:  
integer division

e.g.,  $7/2 = 3$

- integer division can be handy in programming;  
it is confusing to have one symbol for two operations

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ArrayList

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## ArrayList: Growing and shrinking array

|                                                   | declaration                                     | comparison to arrays              |
|---------------------------------------------------|-------------------------------------------------|-----------------------------------|
| • <i>declaration</i>                              | <code>ArrayList&lt;String&gt; a;</code>         | <code>String[] a;</code>          |
| • <i>creation</i>                                 | <code>a = new ArrayList&lt;String&gt;();</code> | <code>a = new String[...];</code> |
| • <i>appending</i>                                | <code>a.add("aap");</code>                      | –                                 |
| • <i>insertion (elements after i are shifted)</i> | <code>a.add(i, "jet");</code>                   | –                                 |
| • <i>change</i>                                   | <code>a.set(0, "AAP");</code>                   | <code>a[0] = "AAP";</code>        |
| • <i>inspection</i>                               | <code>s = a.get(0) + a.get(1);</code>           | <code>a = a[0] + a[1];</code>     |
| • <i>deletion</i>                                 | <code>a.remove(i);</code>                       | –                                 |

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## ArrayList: more

- *visit all elements*

|                                   |                                                    |                                   |
|-----------------------------------|----------------------------------------------------|-----------------------------------|
| <code>for (String s : a) {</code> | <code>for (int i=0; i &lt; a.length; i++) {</code> | <code>for (String s : a) {</code> |
| <code>... s ...</code>            | <code>... a[i] ...</code>                          | <code>... s ...</code>            |
| <code>}</code>                    | <code>}</code>                                     | <code>}</code>                    |
- *number of elements*

|                       |                       |
|-----------------------|-----------------------|
| <code>a.size()</code> | <code>a.length</code> |
|-----------------------|-----------------------|
- for primitive types (int, double, boolean, ...)  
use **Integer**, **Double**, **Boolean**:  
`ArrayList<Integer> a;`  
`a = new ArrayList<Integer>();`

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## ArrayList: example

```
import java.util.*; // for Scanner and ArrayList
...
int n;
ArrayList<String> words;
String word;
double totallength = 0;
double averagelength;

words = new ArrayList<String>();
do {
    word = scanner.next();
    totallength += word.length();
    words.add(word);
} while (scanner.hasNext()); // doesn't work with keyboard input
// while(!scanner.hasNext("__END__")) stops when __END__ is encountered

averagelength = totallength / words.size();

for (String w : words) {
    if (w.length > averagelength) {
        System.out.println(w+" is above average");
    }
}
```

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## Hoe lang is een Chinees

- `length`  
number of members of an array
- `length()`  
number of characters in a String
- `size()`  
number of members of a Collection (ArrayList, etc.)

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# Input

- ⦿ console input: `scanner.next(); scanner.nextInt(); scanner.nextDouble();`  
every next-command reads an input word and advances to the next word
  - ⦿ `import java.util.Scanner;`
  - ⦿ Declare variable: `Scanner scanner;` (or any other name)
  - ⦿ Create and connect object: `scanner = new Scanner(System.in);`
  - ⦿ `scanner.hasNext()` is true when there is input left (always true in interactive situation, not always true when reading from file (such as in Peach))
  - ⦿ `scanner.hasNextInt(), hasNextDouble()` etc. are true when such a number is on top of input
- ⦿ dialog input: `JOptionPane.showInputDialog(null, "type wat");`

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# Scanner

- ⦿ `next()` reads next word (whitespace separated) and gives a String, without surrounding whitespace
- ⦿ `nextInt()` ditto, gives an int
- ⦿ `nextDouble(), next...` ditto, gives a double (or type ...)
- ⦿ `hasNext()` is true if there is still more than whitespace on input (never false when reading from keyboard, usually)
- ⦿ `hasNextInt()` is true if there is still a word on input and that word is an integer number
- ⦿ `hasNextDouble(), hasNext...` ditto, gives a double (or type ...)
- ⦿ NB: what separates the words (tokens) can be defined by programmer

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