Computer Science Introductory Course MSc - Introduction to Java

Lecture 1: Diving into java

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ENST

Outline

1. Introduction
2. Primitive types
3. Operators
4. Basic OOP
5. Control Flow

Introduction : Execution model

- Java programs run inside a Virtual Machine (JVM), ”a software implementation” of a computer (making Java programs portable among different architectures).
- For the sake of performance and space, the JVM reads bytecode (a low level language).
- It is easier for humans to write programs in a more expressive, high level language, like Java.
- The Java compiler is an automatic translator from Java to Bytecode.

Introduction : Concepts

- A computer program can be seen as a transformation from a state of a computer to a new one.
- So very informally, programming is a matter of transforming data :
  - Find a computer representation of data
  - Write methods to transform this data
- In this lecture we will learn about :

primitive types : Basic representations of data.

operators : Simple operations on data.

objects : Combine data representation and methods to transform data.

control flow : Control which operations are done and how many times.

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Representing data

Data is encoded in memory as a binary string.

```
bin :  00000000  01001000  00000000  01101001
dec :  0         72        0         105
```

What does this value represent ?

Example

2d line	: (0,72) to (0,105)
integer	: 4718697
float	: 6.612303E-39 (IEEE 754)
string	: 'H' 'i'
...	

Variables and Types

- To lift this ambiguity we introduce types, which specify how a value should be used.
- We also give each value a name (should start with {letter, $, _ } and contain only {alphanumeric, $, _}).
- We call the association (name, type, value) a variable.

Example

boolean is_it_raining = **true**;	1 bit logic value
byte life_expectancy = 70;	8 bit range $[-128..127]$
short year;	16 bit defined on $[-2^{15}..2^{15}-1]$
char unicode_character = 'A';	UTF-16 caracter
int city_population = 2167994;	32 bit range $[-2^{31}..2^{31}-1]$
long molecules;	64 bit range $[-2^{63}..2^{63}-1]$
float mean_grade = 13.54;	single precision(ex. 8 mt. 23)
double angular_speed;	double precision(ex. 11 mt. 52)

Mutable variables, assignment, final variables

The value of a variable can be modified during the execution of a program, except for final variables (which can only be assigned once).

```
int a; // variable declaration
float b = 3; /* variable declaration with
                initial assignment */
final float pi;
pi = 3.14159;

a = 8;  // assignment
b = 1;  // assignment
pi = 0; // illegal (won't compile)
```

Arrays

Arrays model a contiguous, random access, fixed-length, collection of values. The values of an array are of the same type.

```
// The type of the array price is float[]
float[] price;

// reserve memory for 3 elements
price = new float[3];

// initialize the values of the elements
price[0] = 1.00;
price[1] = 5.99;
price[2] = 3.25;

// Syntax sugar for this is:
float[] price = {1.00, 5.99, 3.25};
```

Strings

Strings represent a collection of characters.

```
String message = "Hello␣World";
```

Caution

- Strings and arrays are a mix between objects and primitive types and thus some care must be taken when manipulating them.
- In the next lecture we will explain why when we'll talk about references and immutability.

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Simple Operators

- Operators are special symbols which perform an operation on some operands.
- The semantic of the operator depends on the type of the operands.

Example

a = 5; b[4] = 30	assignment
5 + 4 ⟶ 9	sum
5 − 4 ⟶ 1	substraction
”hello␣” + ”world” ⟶ ”hello␣world”	concatenation
4 ∗ 4 ⟶ 16	multiplication
15 / 2 ⟶ 7, 15.0 / 2 ⟶ 7.5	integer or float division
15 % 2 ⟶ 1	modulo
15 > 12 ⟶ **true**	bigger than
< >= <=	other comparison operators

Increment operators

- Increment (++), decrement (−−) operators :

```
int a,b,c;

a = 42;
b = a++;
\\here b evaluates to 42 and a to 43

a = 42;
b = ++a;
\\here b evaluates to 43 and a to 43
```

- with ++a the value of a is incremented, then the right side of the assignment is evaluated.
- with a++ the right side of the assignment is evaluated, then a is incremented.

More Operators

- Operation + assignment (+= −= *= /= etc ...)

```
a += b;     // equivalent to:
a = a + b;
```

- Equality == and Inequality !=

```
int a, b;
a = 5;
c = 2;
b = c + 3;
a == b; // --> true
a != c; // --> true
```

- Referential equality when used with objects, strings and arrays (we'll come back to this later)

Boolean operators

- Boolean Operators

```
bool a = false;
bool b = true;

/* not */       !a // --> true
/* and */       a && b // --> false
/* or */        a || b // --> true

/* Careful: Lazy */
int a = 0;
(false) && (a++ > 0) // a evaluates to 0
(true)  || (a++ > 0) // a evaluates to 0
```

Other operators

- Ternary Operator (condition ?true_stm: false_stm) ex : (a>b) ? a : b
- Bitwise Operators (>> << >>> & |)
- **instanceof**

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Objects

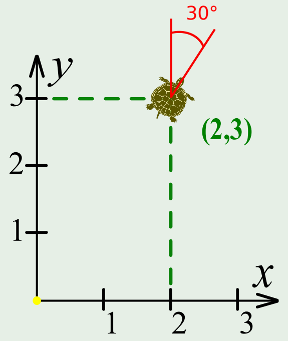
Definition

An object is the association of :

- a State (i.e. data)
- some Methods (i.e. operations that change/read state)

Example

A turtle has a state composed of its color, its position and its orientation, and some methods : turn, advance and readPosition.



Turtle

State { color: green
position: (2, 3)
rotation: 30.0°

Methods { turn(double angle)
advance()
readPosition()

Classes

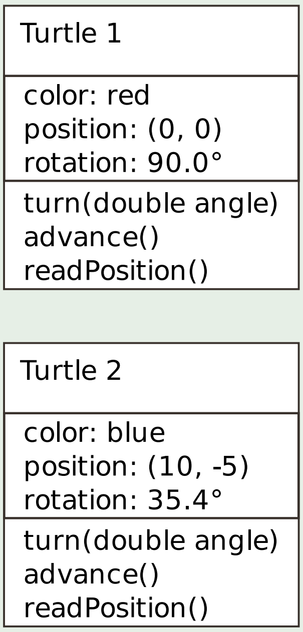
Definition

A class is a blueprint for making objects. A class defines the common attributes of a family of objects :

- the methods they share
- the types of variables they have

Classes

Example



Turtle 1

color: red
position: (0, 0)
rotation: 90.0°

turn(double angle)
advance()
readPosition()

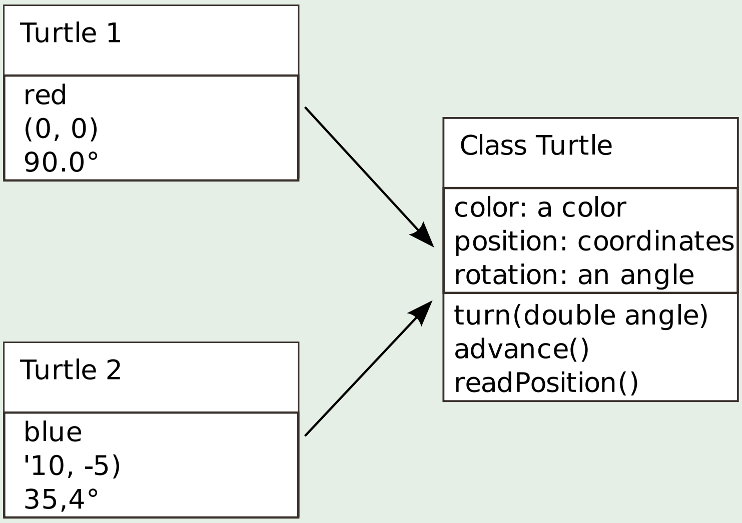
Turtle 2

color: blue
position: (10, -5)
rotation: 35.4°

turn(double angle)
advance()
readPosition()

Classes

Example



Turtle 1

red
(0, 0)
90.0°

Turtle 2

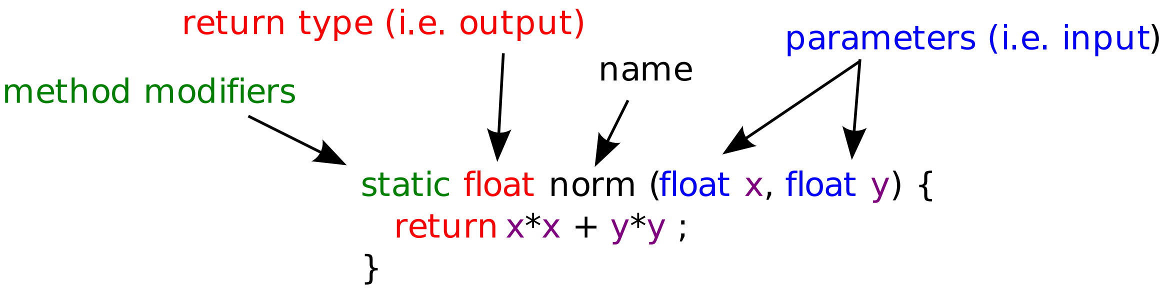
blue
'10, -5)
35,4°

Class Turtle

color: a color
position: coordinates
rotation: an angle

turn(double angle)
advance()
readPosition()

Anatomy of a method



```
static float norm (float x, float y) {
  return x*x + y*y ;
}
```

In Java

```java
class Turtle {
  Color color;
  Position position;
  double rotation;

  void turn(double angle) { rotation += angle; }
  void advance() {
    int step_size = 5;
    position.x += step_size * cos(rotation*Math.PI/180);
    position.y += step_size * sin(rotation*Math.PI/180);
  }

  Position readPosition() {
    return position;
  }
}
```

```java
Turtle turtle1 = new Turtle();
Turtle turtle2 = new Turtle();

Position pos = turtle1.readPosition();
turtle2.turn(20); turtle2.advance();
```

Instance Methods/Variables

- Objects turtle1 and turtle2 are called instances of class Turtle,
- turtle2 . color represents the color for the specific instance turtle2 :
  → color is an instance variable
- turtle1 . readPosition () returns the position of the specific instance turtle1 :
  → readPosition() is an instance method

Definition

An instance method or instance variable is only relevant in the context of a particular object.

Static Methods/Variables

Q : how to share a common variable between all the objects in a class?

```
class Turtle {
  static int step_size = 5;
}
```

Q : how to write a method independent from a particular instance?

```
class Turtle {
  static double degreesToRadians(double deg) {
    return deg * Math.PI/180;
  }
}

Turtle.degreesToRadians(30); -> 1.0471975512
```

Definition

A static variable is shared among all the objects of a class. A static method is called in the context of a class and not for a specific object. Static variables are also called class variables.

Local Variables / Scope

Definition

Variables defined inside a method are called local variables.
The scope of a variable is the portion of code where it is visible (ie. where you can read it, or modify it).

- Local variables are only visible inside their method.
- Instance and Static variables are visible in all the methods from their class.

In the next lecture we will talk about the visibility of methods, and about access modifiers that regulate the visibility of methods/variables outside their class.

Main : the program entry point

Q : (At last ...) How do we start things up ?

```
class MyFirstJavaProgram{
  public static void main (String args[]) {
    System.out.println("Hello␣world!");
  }
}
```

(Note : public means this method can be called from anywhere, this is a prerequisite for the main method)

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If - else

Depending on a predicate choose which branch to execute

```
if (predicate) block1 else block2

static int collatz (int n) {
  if (n % 2 == 0) {
    return n/2;
  } else {
    return 3*n + 1;
  }
}
```

code between {} is called a block, variables defined inside a block are not visible outside

while

Execute a block repeatedly while a predicate is true

```
while(predicate)
  block;

static int gcd(int a, int b) {
  while (b != 0) {
    int t = b;
    b = a % b;
    a = t;
  }
  return a;
}
```

Above if the predicate is false the block is never executed. When appropriate, you can use instead **do** { ... } **while** (predicate); which always executes the block at least once.

for

More sophisticated loop

```
for (statement; predicate; statement)
  block

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

Syntax sugar for :

```
int i = 0;
while (i < 100) {
  System.out.println(i);
  i++;
}
```

break and continue

Escaping from loops

- break will exit the loop from which it is called
- continue will jump to the next iteration of the loop from which it is called

```
int whereIs(int element, int[] set) {
  int i;
  for (i = 0; i < set.length; i++) {
    if (element == set[i]) {
      break;
    }
  }
  return (i < set.length) ? i : -1;
}
```

You can also escape using return, which here avoids a test and is more elegant.

```java
int whereIs(int element, int[] set) {
  for (int i = 0; i < set.length; i++) {
    if (element == set[i]) {
      return i;
    }
  }
  return -1;
}
```

We won't discuss switch/case control structure. If interested you may look it up!

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