

JAVA

Classes

Class definition

- complete definition

```
[public] [abstract] [final] class Name
  [extends Parent]
  [implements ListOfInterfaces] {
    ... // class body
  }
```

- **public** – public class
- **abstract** – no instance can be created
- **final** – class cannot be extended

Constructor

- constructor
 - object initialization
- declaration
 - the same name as the class
 - no return type
 - modifier – only visibility
 - several constructors
 - with different arguments
 - selected by arguments of `new`

```
class MyClass {  
    int value;  
    public MyClass() { value = 10; }  
    public MyClass(int v) { value = v; }  
}
```

Object removal

- garbage collector
- `finalize()` method
 - present in every class
 - called before object's removal
 - **it is not a destructor like in other languages**
 - not known when it is called
 - calling is not guaranteed
 - object need not be removed by garbage collecting
 - e.g. at the end of the program
 - calls of `finalize()` are not chained

Deprecated since Java 9

Initialization of fields

- in constructor
or
- direct

```
class MyClass {  
    int a = 5;  
    float b = 1.2;  
    MyClass2 c = new MyClass2();  
    int d = fn();  
    int e = g(f); // error!  
    int f = 4;  
    ...  
}
```

Initialization: static

- just once
- before first access or before first instance of a class is created
- direct
 - `static int a = 1;`
- static initializer

```
class MyClass {  
    static int a;  
    static {  
        a = 10;  
    }  
    ...  
}
```

Initialization: "non-static"

- similar to `static` initializer
- necessary for initialization of *anonymous inner classes*

```
class MyClass {  
    int a;  
    int b;  
    {  
        a = 5;  
        b = 10;  
    }  
    ...  
}
```

Classes: inheritance

- parent specification – **extends** *ParentName*
- single inheritance
 - single parent only
- **class java.lang.Object**
 - each class inherits from this class
 - directly or indirectly
 - the only class without parent
- multiple inheritance only via **Interfaces**

Polymorphism

- polymorphism ~ inheritance
- cast
 - automated – child to parent

```
class A { /*...*/ }  
class B extends A { /*...*/ }
```

```
A a = new B();  
Object o = a;
```

```
B b = (B) o;
```

Polymorphism – constructor

- constructor of the parent
 - `super()`
- other constructor of the same object
 - `this()`
- calling other constructors
 - only as the first statement and just once
- parent's constructor is called always
 - even if not explicitly called
 - exception – `this()`
- class without constructor declared
 - has default constructor
 - calls `super()` only

java.lang.Object

```
Object clone()  
boolean equals(Object obj)  
void finalize()  
Class<?> getClass()  
int hashCode()  
void notify()  
void notifyAll()  
String toString()  
void wait()  
void wait(long timeout)  
void wait(long timeout, int nanos)
```

Classes: **visibility** of members

- must be specified for each member
- fields and methods
 - **public**
 - from everywhere (if the class is also visible)
 - **protected**
 - from the same package and children
 - **private**
 - just from the same class
 - without a visibility modifier
 - from the same package
- holds within a single module

Classes: other modifiers

- **final**
 - field
 - constant
 - must have initializer
 - after initialization cannot be changed
 - method
 - cannot be overridden in children
- **transient**
 - field
 - does not belong to a persistent state of the object
- **volatile**
 - field
 - non-synchronized access of multiple threads
 - no optimization can be performed

Classes: modifiers of methods

- **abstract**
 - no method body
 - the class must be also **abstract**
 - no instance can be created
 - method body – semicolon
- **synchronized**
 - calling thread must obtain a lock on the called object (or the class in the case the method is **static**)
- **native**
 - native method
 - implementation directly in native code for a particular platform (as an external library)
 - method body – semicolon
- **static**
 - see the previous lecture

Classes: method modifiers

- no modifier **virtual**
- all methods are virtual
 - static methods **are not** virtual

```
public class A {  
    public void foo() {  
        System.out.print("A");  
    }  
}
```

```
public class B extends A {  
    public void foo() {  
        System.out.print("B");  
    }  
}
```

.....

```
A a = new B();  
a.foo();    // prints out B
```

```
public class As {  
    public static void foo() {  
        System.out.print("A");  
    }  
}
```

```
public class Bs extends As {  
    public static void foo() {  
        System.out.print("B");  
    }  
}
```

.....

```
A a = new B();  
a.foo();    // prints out A
```

Static methods

- static methods are called on a class
 - do not belong to any object

```
class As {  
    public static void foo() { ..... }  
}
```

```
As.foo();
```

- they can be “called” on an object (a class instance); but in reality only a type of the reference is taken
 - value of the object is ignored
 - type (and thus a method to be called) is determined at compile time
 - see the previous slide

this

- reference to the object of the executed method
- can be used in methods and initializers only

```
public class MyClass {  
    private int a;  
    public MyClass(int a) {  
        this.a = a;  
    }  
}
```

super

- access to members of the direct parent
- in the case S is direct parent of C
`((S) this).name ~ super.name`
- `super.super` **cannot be used**

```
class T1 { int x = 1; }
class T2 extends T1 { int x = 2; }
class T3 extends T2 {
    int x = 3;
    void test() {
        System.out.println(x);           // 3
        System.out.println(super.x);     // 2
        System.out.println(((T2) this).x); // 2
        System.out.println(((T1) this).x); // 1
    }
}
```

super

- `super` can be used with methods too
- **WARNING** – casting `this` does not work
 - a code can be compiled but the same method will be called recursively

```
class TX1 {
    public void foo() { /*...*/ }
}
class TX2 extends TX1 {
    public void foo() { /*...*/ }
}
public class TX3 extends TX2 {
    public void foo() {
        ((TX1) this).foo();
        System.out.println("TX3.foo()");
    }
}
```

Java

Interfaces

Interface

- only interface
- no implementation
 - since Java 8, there can be an implementation
- can contain
 - method headers
 - fields
 - inner interfaces

```
public interface Iterator {  
    boolean hasNext();  
    Object next();  
    void remove();  
}
```

Interface: fields

- implicitly they are `public, static and final`
- must be initialized
- `super` and `this` cannot be used in initialization

```
public interface Iface {  
    int a = 5;  
    String s = "hello";  
}
```

Interface: methods

- without implementation
 - implicitly **abstract** and **public**
 - cannot be
 - **synchronized**
 - **native**
 - **final**
- **default** methods
 - since Java 8
 - contains implementation
 - intended for extending interfaces
- **static** methods
 - since Java 8
 - the same as the static methods in classes

Interface: inheritance

- multiple inheritance

```
interface Iface1 { ... }
```

```
interface Iface2 { ... }
```

```
interface Iface3 extends Iface1, Iface2  
    { ... }
```


Classes and interfaces

- classes implement interfaces

```
public interface Colorable {  
    void setColor(int c);  
    int getColor();  
}  
public class Point { int x,y; }  
public class ColoredPoint extends Point  
                    implements Colorable {  
    int color;  
    public void setColor(int c) {  
        color = c; }  
    public int getColor() { return color;}  
}  
  
Colorable c = new ColoredPoint();
```

Classes and interfaces

- a class must implement all methods of its interfaces except the default methods
 - not true for abstract classes
- a single method in a class can implement several interfaces

```
interface A { void log(String msg); }  
interface B { void log(String msg); }
```

```
public class C implements A, B {  
    public void log(String msg) {  
        System.out.println(msg);  
    }  
}
```

Interfaces and default methods

- the implementation in a class has always precedence over the implementation in interfaces
- if implementing two interfaces with the same **default** method, then the method has to be implemented in the class
 - otherwise the class cannot be compiled

```
interface If1 {  
    default void foo() {...}  
}
```

```
interface If2 {  
    default void foo() {...}  
}
```

```
class Mixed implements  
    If1, If2 {  
}
```

cannot be compiled

Interfaces and default methods

- it is forbidden to define a default method for a public method from `java.lang.Object`

```
interface Iface {  
    public default boolean equals(Object obj) {  
        return false;  
    }  
}
```

- the implementation in a class has always precedence over the implementation in interfaces
 - even an inherited one

Interfaces and default methods

```
interface If1 {  
    default void foo() {  
        System.out.println("interface");  
    }  
}
```

```
class A {  
    public void foo() {  
        System.out.println("class");  
    }  
}
```

```
class B extends A implements If1 {  
    public static void main(String[] args)  
        B b = new B();  
        b.foo();    // -> "class"  
    }  
}
```

Java

Arrays

Array definition

- array ~ object
- variable ~ reference

```
int[]      a;      // array
short[][] b;      // 2-dimensional array
Object[]   c,      // array
           d;      // array
long       e,      // non-array
           f[];    // array
```

Array initialization

- "static"

```
int[] a = { 1, 2, 3, 4, 5 };  
char[] c = { 'h', 'e', 'l', 'l', 'o' };  
String[] s = { "hello", "bye" };
```

```
int[][] d = { { 1, 2 }, { 3, 4 } };
```


Array initialization

- dynamic

```
int[] array = new int [10];  
float[][] matrix = new float[3][3];
```

- just several dimensions can be specified

- but first ones
- empty brackets for the rest

```
float[][] matrix = new float[3][];  
for (int i=0;i<3;i++)  
    matrix[i] = new float [3];
```

```
// wrong
```

```
int[][][][] a = new int[3][][3][];
```

Array initialization

- "non-rectangular" array

```
int a[][] = { {1, 2}, {1, 2, 3}, {1, 2, 3, 4, 5} };
```

```
int b[][] = new int [3][];  
for (int i=0; i<3; i++)  
    b[i] = new int [i+1];
```

Array initialization

- no constructor is called
- elements in the created array (using `new`) – default values
 - references – null
 - int – 0
 - ...
- expressions in array creation (**`new`**) – fully evaluated from left

```
int i = 4;  
int ia[][] = new int[i][i=3];  
// array 4x3
```

Access to array

- `array[index]`
- **indexes – always** `0..length-1`
- **bounds always checked**
 - cannot be switched off
 - exception thrown for out of bounds access
`ArrayIndexOutOfBoundsException`
- **array length – field `length`**

```
int[] a = { 1, 2, 3 };  
for (int i=0; i < a.length; i++) {  
    ....  
}
```

Array ~ object

- `int[] intArray = new int [100];`
- `String[] strArray = new String [100];`
- array is object

```
Object o1 = strArray;    // OK
Object o2 = intArray;    // OK
```

- but

```
Object[] oa1 = strArray; // OK
Object[] oa2 = intArray; // error
```

Array ~ object

```
Object[] oa = new Object [2];  
oa[0] = new String("hello");  
oa[1] = new String("world");
```

```
String[] sa1 = oa; // error
```

```
String[] sa2 = (String[]) oa;  
    // error too  
    // can be compiled but run-time error
```



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