# Reflection

## Episode II
## The return of the Java virtual machine
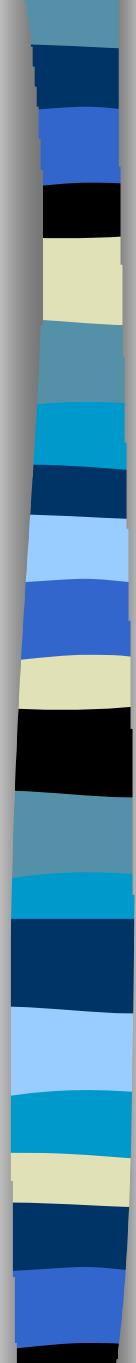
# Summary

- **Remainder**
  - Structural / Behavioural
  - Comparison between Smalltalk and Java
- **Remainder**
  - Pierre's exercises
- **More**
  - Proxy
  - HotSwap
  - Blocks
  - …
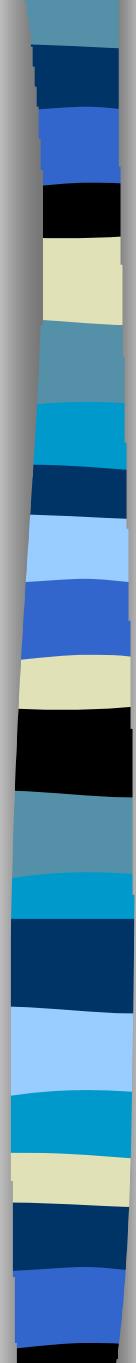
# Structural vs. Behavioural

- Structural reflection
  - Reification of the program being executed
  - Reification of the program abstract data types

- Behavioural reflection
  - Reification of the language semantics (its interpreter)
  - Reification of the data used to execute the program
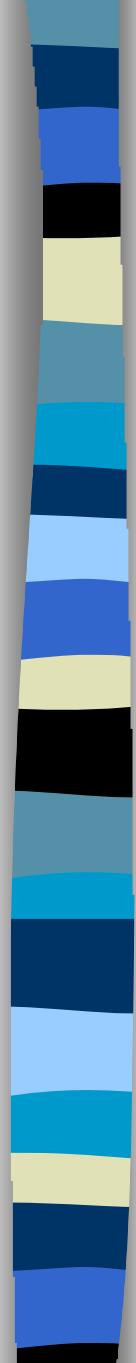
# Structural vs. Behavioural

Structural and behavioural reflection are strongly coupled!
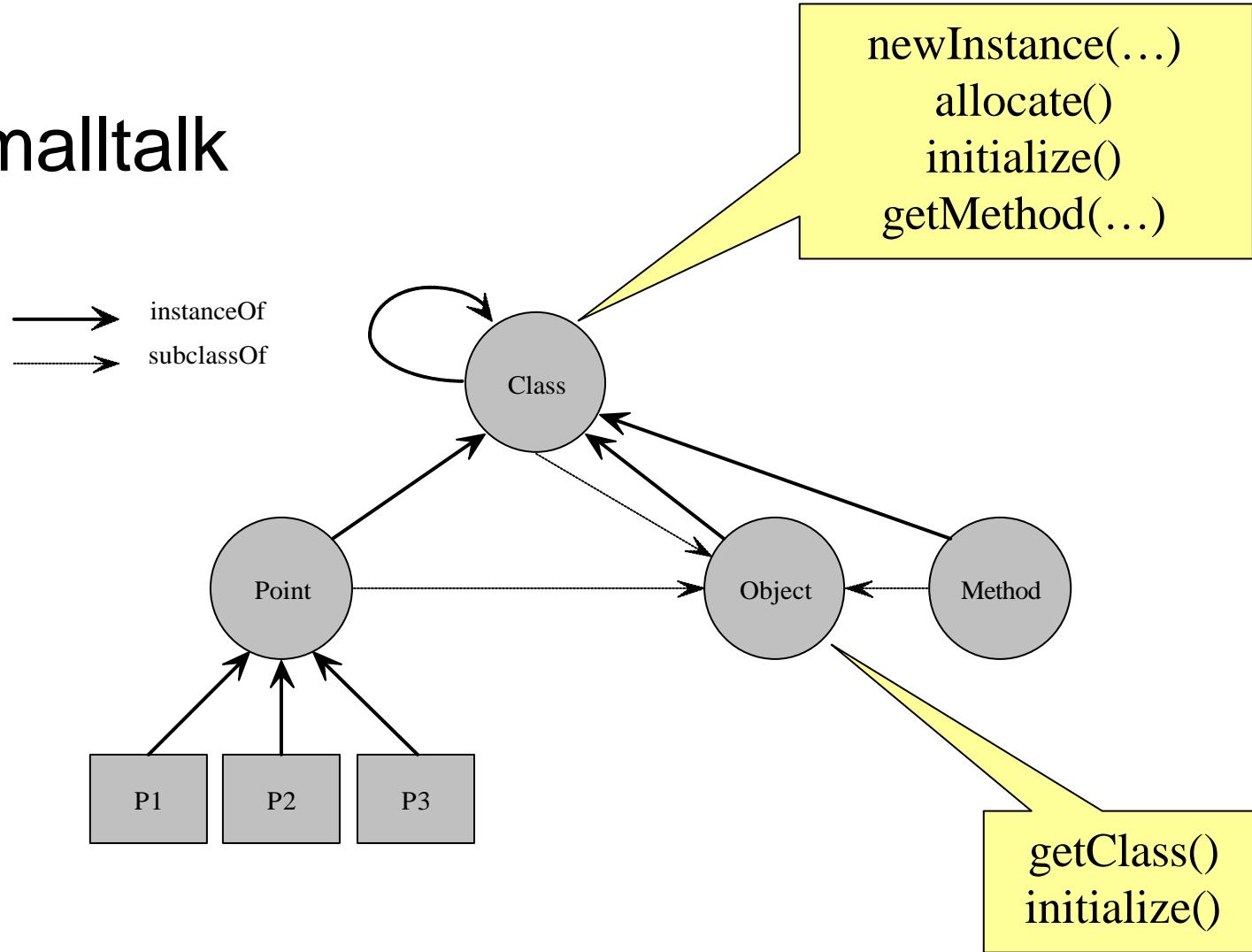
# Structural reflection

- Smalltalk

# Structural reflection

■ **Smalltalk**

instanceOf →

MetaClass class

MetaClass

allocate()

Point3D class · Point class · Object class · Class class · Class Description class · Behavior class

Point3D · Point · Object · Class · Class Description · Behavior

1@2@3 · 1@2 · myObject

getClass()

allocate()
getMethod()
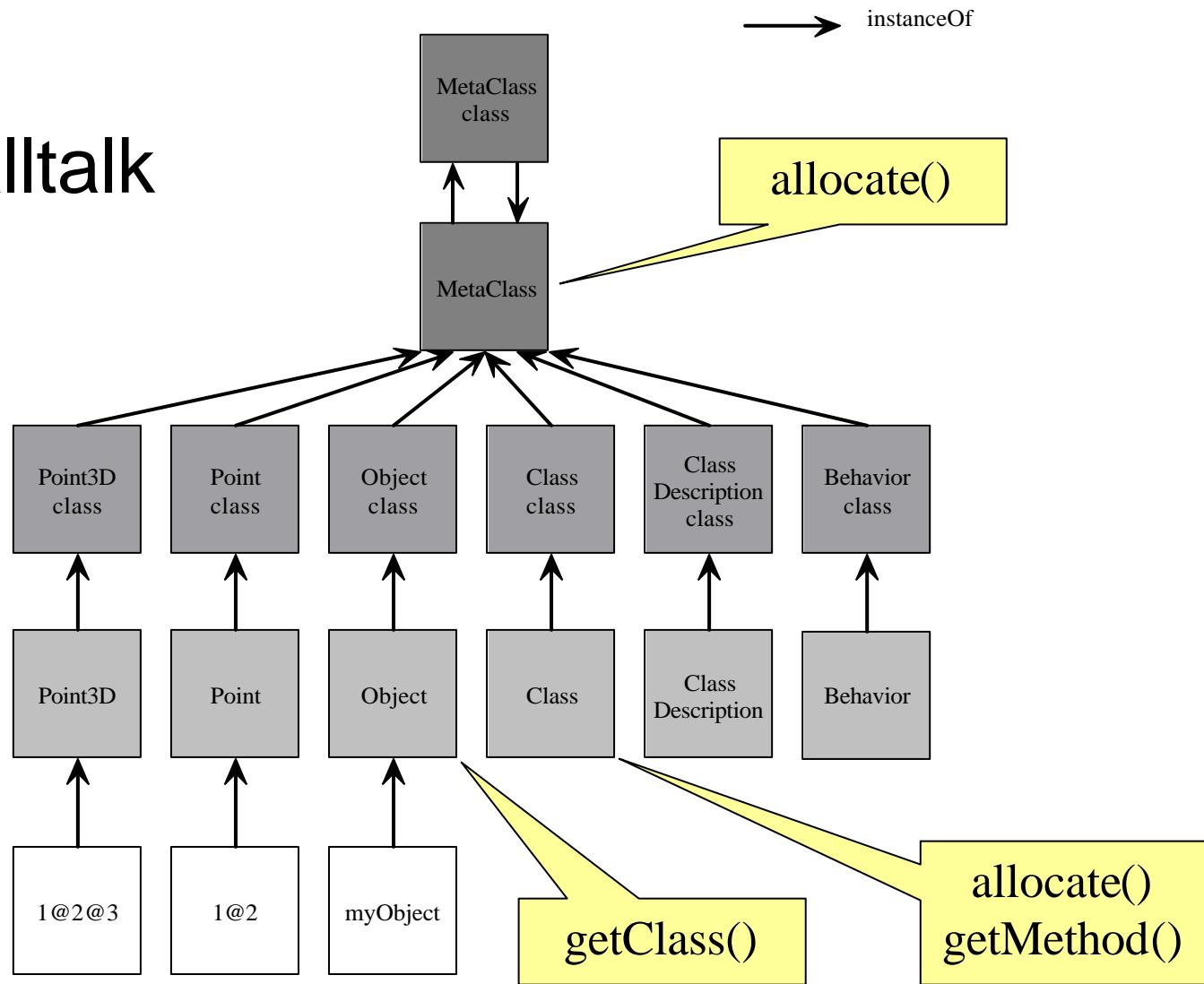
# Structural reflection

- Java



instanceOf

subclassOf
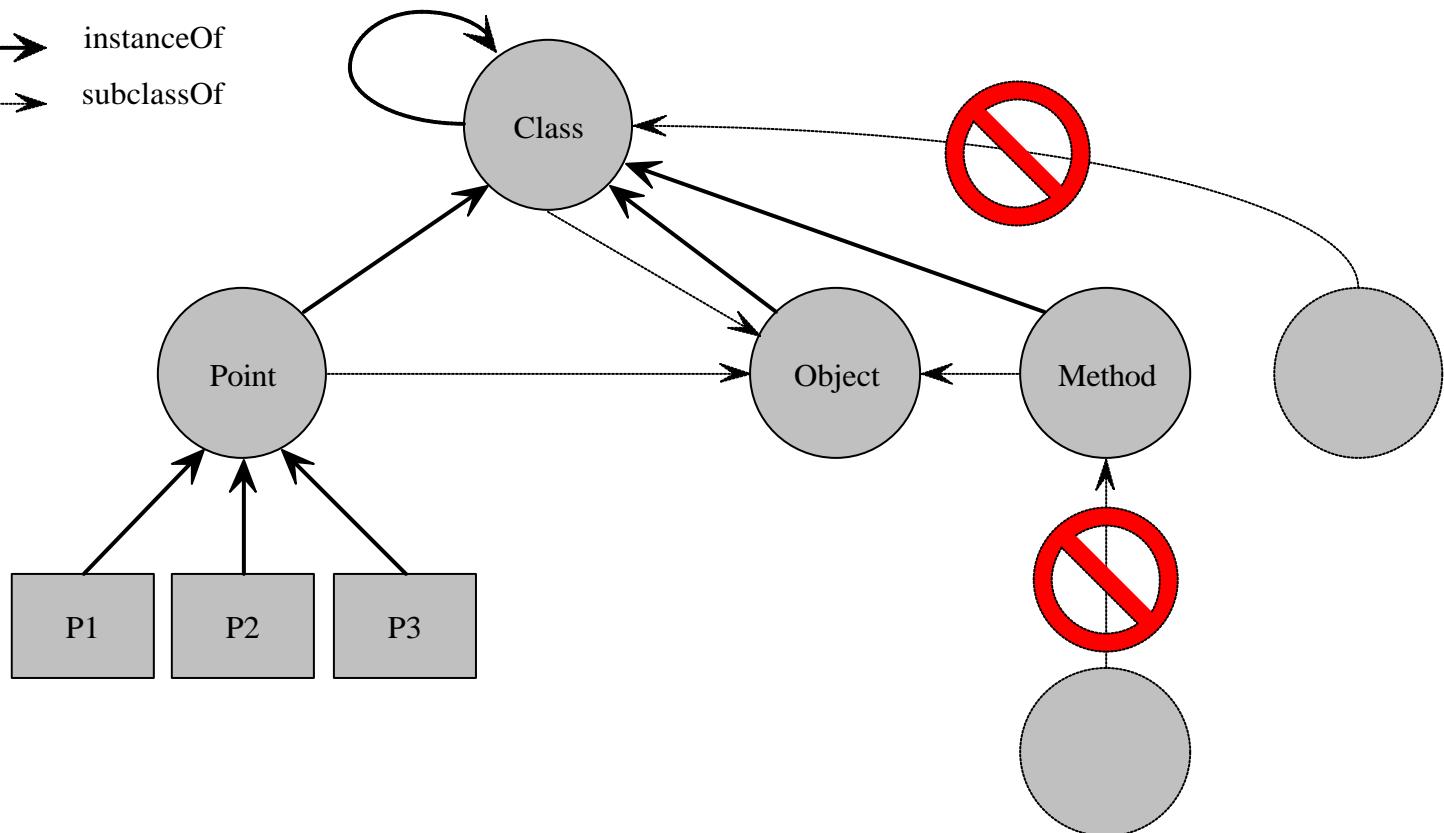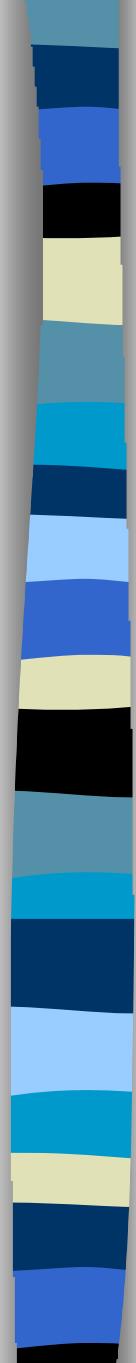
# Behavioural reflection

- Smalltalk
  - Meta-object
  - Meta-object protocol (MOP)

# Behavioural reflection

- Smalltalk hidden MOP
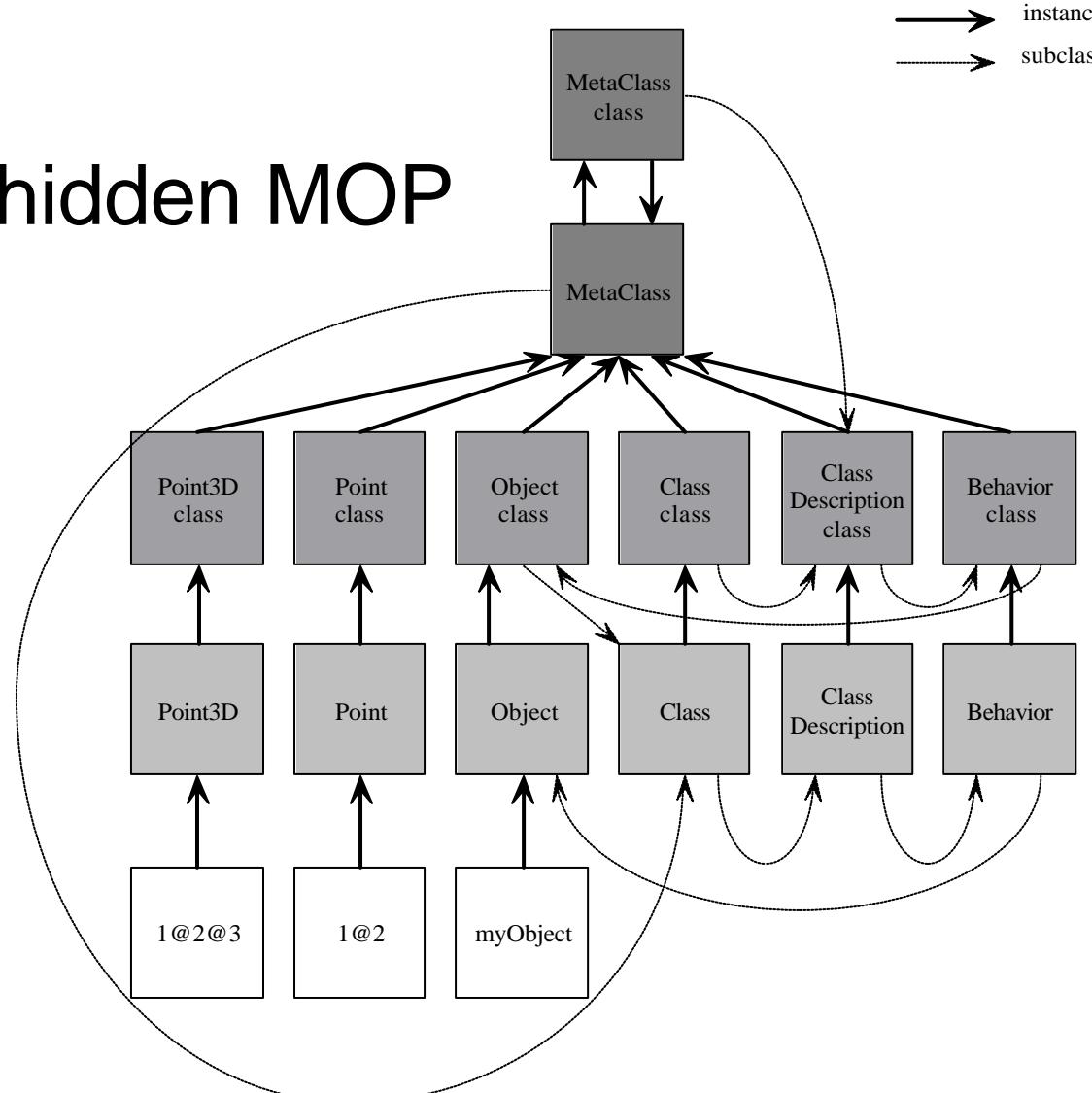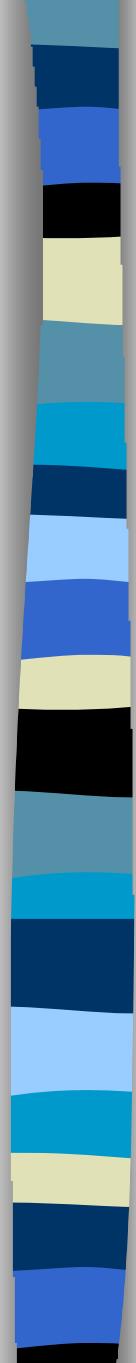
# Behavioural reflection

- Java
  - New?
  - Message send?
  - Finalization?
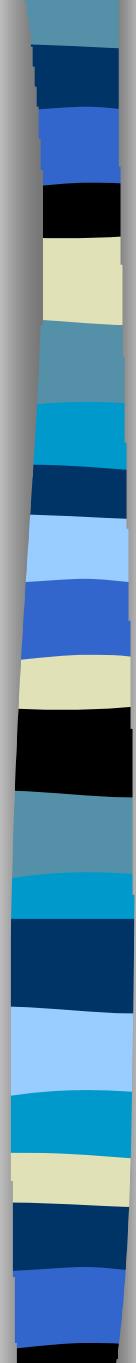
# Behavioural reflection

- Java
  - ExtendedObject
  - ClassDescription
  - MetaObject
  - Proxy
  - Blocks
  - HotSwap

# ExtendedObject

```
System Browser: Object
```

| Yann-Tests | Boolean | -- all -- | asOop |
| Kernel-Objects | EventModel | accessing | becomeForward: |
| Kernel-Classes | False | testing | className |
| Kernel-Methods | MessageSend | comparing | creationStamp |
| Kernel-Processes | Model | copying | instVarAt: |
| Kernel-Magnitudes | MorphObjectOut | dependents access | instVarAt:put: |
| Kernel-Numbers | Object | updating | instVarNamed: |
| Kernel-ST80 Remnants | ObjectOut | printing | instVarNamed:put: |
| Collections-Abstract | ObjectTracer | class membership | oopString |
| Collections-Unordered | ObjectViewer | message handling | rootStubInImageSegment: |
| Collections-Sequenceable | ProtoObject | error handling | someObject |
| Collections-Text | True | user interface | tryNamedPrimitive |
| Collections-Arrayed | UndefinedObject | system primitives | tryNamedPrimitive: |
| Collections-Streams | | private | tryNamedPrimitive:with: |
| Collections-Weak | | associating | tryNamedPrimitive:with: |
| Collections-Support | | converting | tryNamedPrimitive:with: |
| Graphics-Primitives | | casing | tryNamedPrimitive:with: |
| Graphics-Display Objects | | binding | tryNamedPrimitive:with: |
| Graphics-Transformation | | macpal | tryNamedPrimitive:with: |
| Graphics-Files | | flagging | tryNamedPrimitive:with: |
| Graphics-Text | | translation support | tryPrimitive:withArgs: |
| Graphics-FXBlt | | objects from disk | |
| Graphics-External | | finalization | |
| Sound-Synthesis | | filter streaming | |
| Sound-Scores | | events | |
| Sound-Interface | | scripting | |
| Speech-TTS | | drag and drop | |
| Speech-Support | | world hacking | |
| Speech-Gestures | | logging | |
| Speech-Klatt | instance | ? | class | undo | |
| Speech-Phonetics | | | | viewer | |

**instVarAt: index**

> "Primitive. Answer a fixed variable in an object. The numbering of the
> variables corresponds to the named instance variables. Fail if the index
> is not an Integer or is not the index of a fixed variable. Essential. See
> Object documentation whatIsAPrimitive."
>
> <primitive: 73>
> "Access beyond fixed variables."
> ↑self basicAt: index - self class instSize

# ClassDescription

```
System Browser: ClassDescription

Kernel-Classes

ProtoObject          -- all --                   allSubclasses
  Object             initialize-release          classesThatImplementAllOf:
    Behavior         accessing                   printSubclassesOn:level:
      ClassDescription   copying                 removeUninstantiatedSubclassesSilently
        Class        printing                    subclasses
        Metaclass    instance variables          subclassesDo:
                     method dictionary           withAllSubclasses
                     organization
                     compiling
                     fileIn/Out
                     private
   instance  |  ?  |  class    accessing class hierarchy

allSubclasses
    "Answer a Set of the receiver's and the receiver's descendent's subclasses."

    | scan scanTop |
    scan ← OrderedCollection withAll: self subclasses.
    scanTop ← 1.
    [scanTop > scan size] whileFalse:
        [scan addAll: (scan at: scanTop) subclasses.
        scanTop ← scanTop + 1].
    ↑ scan asSet
```
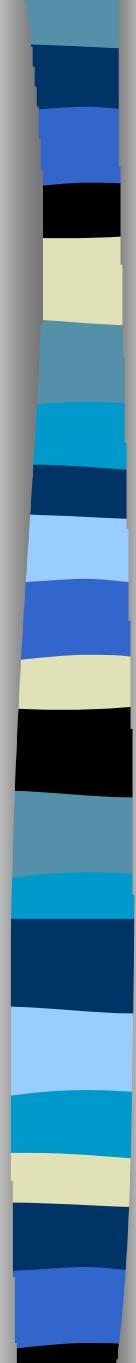
# MetaObject

■ Reification of the message send
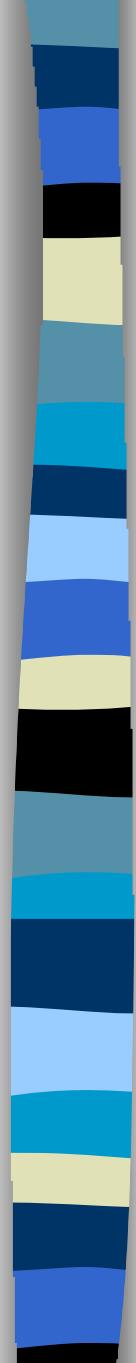
# Proxy

- Interception of the message send

# Blocks

# HotSwap

- Re-definition of a class without stopping the virtual machine