Inheritance Semantics and Method Lookup

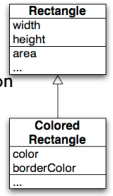
Stéphane Ducasse
Stephane.Ducasse@univ-savoie.fr
http://www.iam.unibe.ch/~ducasse/

Goal

- Inheritance
- Method lookup
- Self/super difference

Inheritance

- Do not want to rewrite everything!
- Often we want small changes
- We would like to reuse and extend existing behavior
- Solution: class inheritance
- Each class defines or refines the definition of its ancestors



Inheritance

- New classes
  - Can add state and behavior:
    - color, borderColor, borderWidth,
    - totalArea
  - Can specialize ancestor behavior
    - intersect:
  - Can use ancestor's behavior and state
  - Can redefine ancestor's behavior
    - area to return totalArea

Inheritance in Smalltalk

- ***Single inheritance***
- ***Static for the instance variables***
- At class creation time the instance variables are collected from the superclasses and the class. No repetition of instance variables.
- ***Dynamic for the methods***
- Late binding (all virtual) methods are looked up at run-time depending on the dynamic type of the receiver.

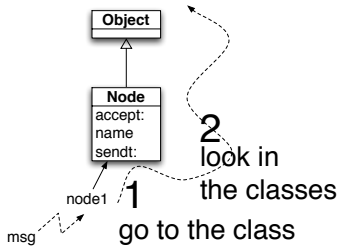
Message Sending

- ***receiver selector args***
- Sending a message = looking up the method that should be executed and executing it
- ***Looking up*** a method: When a message (receiver selector args) is sent, the method corresponding to the message selector is looked up through the inheritance chain.

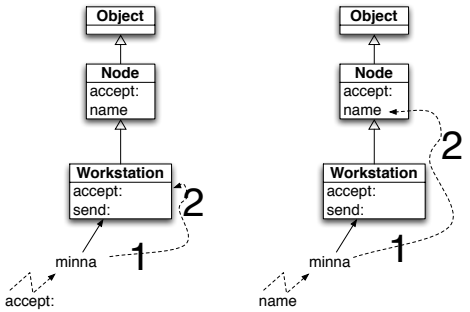
Method Lookup

- Two steps process
- The lookup starts in the ***CLASS*** of the ***RECEIVER***.
- If the method is defined in the method dictionary, it is returned.
- Otherwise the search continues in the superclasses of the receiver's class. If no method is found and there is no superclass to explore (class Object), this is an ERROR

Lookup: class and inheritance



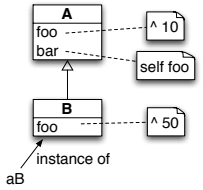
Some Cases



Method Lookup starts in Receiver Class

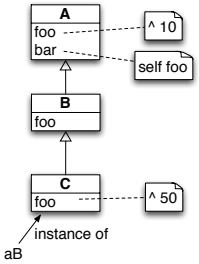
aB foo
(1) aB class => B
(2) Is foo defined in B?
(3) Foo is executed -> 50

aB bar
(1) aB class => B
(2) Is bar defined in B?
(3) Is bar defined in A?
(4) bar executed
(5) Self class => B
(6) Is foo defined in B
(7) Foo is executed -> 50



self **always** represents the receiver

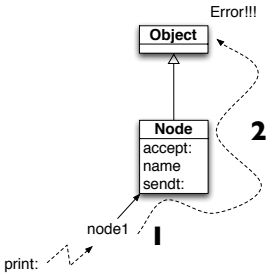
- A new foo
- -> 10
- B new foo
- -> 10
- C new foo
- -> 50
- A new bar
- -> 10
- B new bar
- -> 10
- C new bar
- -> 50



When message is not found

- If no method is found and there is no superclass to explore (class Object), a new method called #doesNotUnderstand: is sent to the receiver, with a representation of the initial message.

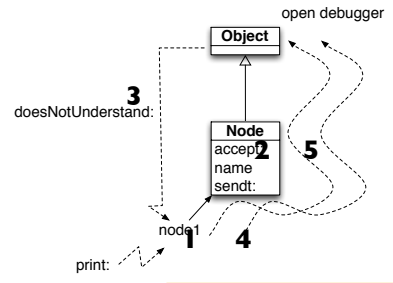
Graphically…



…in Smalltalk

- node1 print: aPacket
  - node is an instance of Node
  - print: is looked up in the class Node
  - print: is not defined in Node > lookup continues in Object
  - print: is not defined in Object => lookup stops + exception
  - message: node1 doesNotUnderstand: #(#print aPacket) is executed
  - node1 is an instance of Node so doesNotUnderstand: is looked up in the class Node
  - doesNotUnderstand: is not defined in Node => lookup continues in Object
  - doesNotUnderstand: is defined in Object => lookup stops + method executed (open a dialog box)

Graphically…



Roadmap

- Inheritance
- Method lookup
- ***Self/super difference***

How to Invoke Overridden Methods?

- Solution: Send messages to super
- When a packet is not addressed to a workstation, we just want to pass the packet to the next node, i.e., we want to perform the default behavior defined by Node.

```
Workstation>>accept: aPacket
    (aPacket isAddressedTo: self)
        ifTrue:[Transcript show: 'Packet accepted by the Workstation ',
self name asString]
    ifFalse: [super accept: aPacket]
```

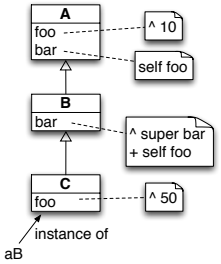
- Design Hint: Do not send messages to super with different selectors than the original one. It introduces implicit dependency between methods with different names.

The semantics of super

- Like self, ***super*** is a pseudo-variable that refers to the ***receiver*** of the message.
- It is used to invoke overridden methods.
- When using self, the lookup of the method begins in the class of the receiver.
- When using super, the lookup of the method begins in the ***superclass of the class of the method containing*** the super expression

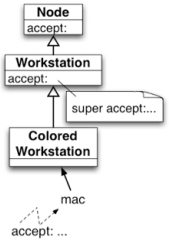
super *changes* lookup starting class

- A new bar
- -> 10
- B new bar
- -> 10 + 10
- C new bar
- -> 50 + 50



super is NOT the superclass of the receiver class

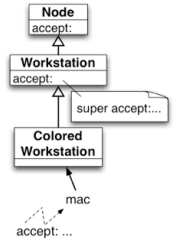
Suppose the WRONG hypothesis: *"The semantics of super is to start the lookup of a method in the superclass of the receiver class"*



super is NOT the superclass of the receiver class

mac is instance of ColoredWorkStation
Lookup starts in ColoredWorkStation
Not found so goes up...

accept: is defined in Workstation
lookup stops
method accept: is executed
Workstation>>accept: does a super send
Our hypothesis: start in the super of the class of the receiver
=> superclass of class of a ColoredWorkstation is ... **Workstation !**



Therefore we look in workstation ***again***!!!

What you should know

- Inheritance of instance variables is made at class definition time.
- Inheritance of behavior is dynamic.
- self ****always**** represents the receiver.
- Method lookup starts in the class of the receiver.
- ***super*** represents the ***receiver*** but method lookup starts in the superclass of the class ***using*** it.
- ***Self is dynamic vs. super is static.***