Inheritance Semantics and Lookup

Inheritance

- Do not want to rewrite everything!
- Often times want small changes
- Class hierarchies for sharing of definitions
- Each class defines or refines the definition of its ancestors
- => inheritance

Inheritance

New classes

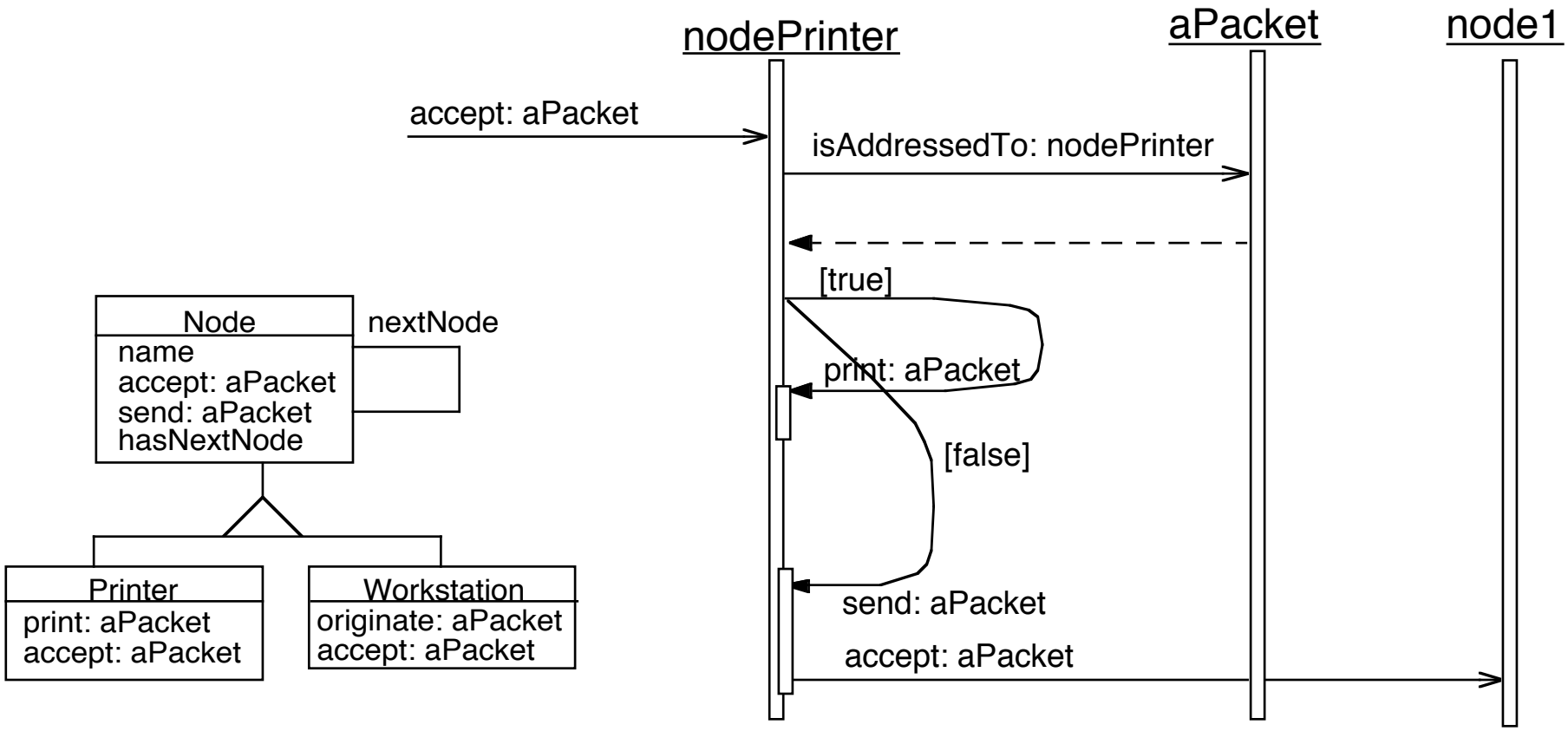
- Can add state and behavior
- Can specialize ancestor behavior
- Can use ancestor's behavior and state
- Can redefine ancestor's behavior

to existing ones

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.

Remember...


nodePrinter
aPacket
node1
accept: aPacket
isAddressedTo: nodePrinter
[true]
print: aPacket
[false]
send: aPacket
accept: aPacket
Node
name
accept: aPacket
send: aPacket
hasNextNode
nextNode
Printer
print: aPacket
accept: aPacket
Workstation
originate: aPacket
accept: aPacket

Node

```
Object subclass: #Node
        instanceVariableNames: 'name nextNode '
        ...

Node>>accept: aPacket
  "Having received the packet, send it on. This is the default behavior
  subclasses will probably override me to do something special."

        self hasNextNode ifTrue: [self send: aPacket]

Node>>send: aPacket
  "Precondition: there is a next node. Send a packet to the next node."

        self nextNode accept: aPacket
```

Workstation

```
Node subclass: #Workstation
        instanceVariableNames: ''
        ...

Workstation>>accept: aPacket
  "when a workstation accepts a packet addressed to it, it prints
  some trace on the transcript"
        (aPacket isAddressedTo: self)
                ifTrue:[ Transcript show: 'A packet  is accepted
  by the Workstation ', self name asString]
                ifFalse: [super accept: aPacket]

  Workstation>>originate: aPacket

        aPacket originator: self.
        self send: aPacket
```

Message Sending & Method Lookup

receiver selector args

- 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.
- The lookup starts in the CLASS of the RECEIVER.
- If the method is defined in the class 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), a new method called #doesNotUnderstand: is sent to the receiver, with a representation of the initial message.

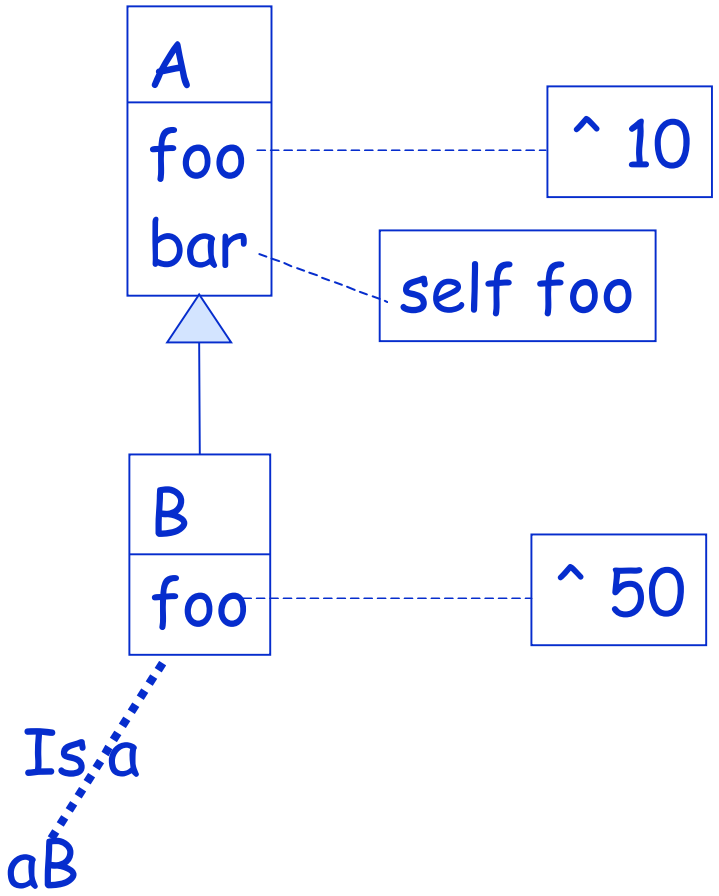
In Smalltalk

- 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.

Method Lookup starts in Receiver Class

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

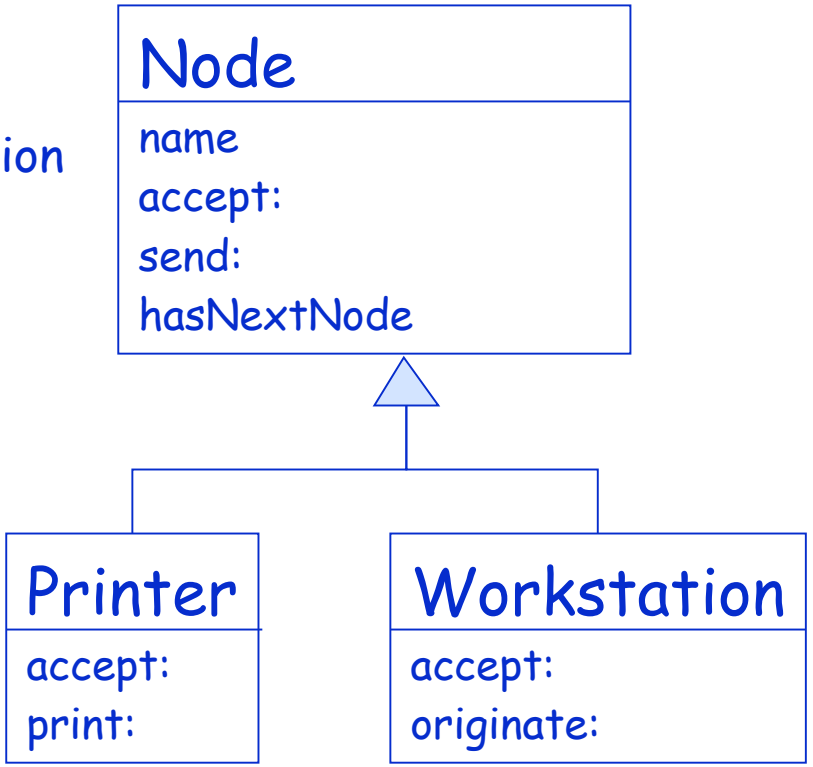
aB bar
(1) aB class => B
(2) Is bar defined in B?
(3) Is bar defined in A?
(4) bar executed
(5) Self class => B
(6) Is foo defined in B
(7) Foo is executed -> 50



Method Lookup Examples

- node1 accept: aPacket
  - node1 is an instance of Node
  - accept: is looked up in the class Node
  - accept: is defined in Node => lookup stops + method executed

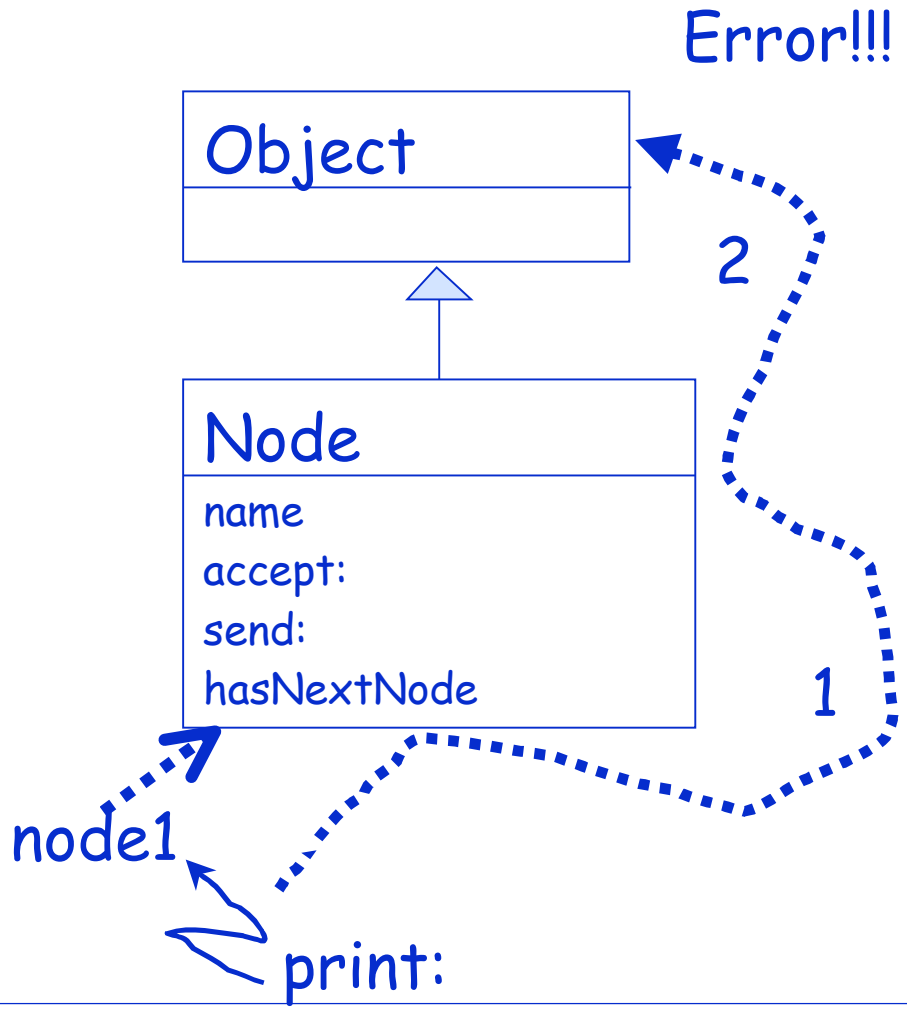
- macNode accept: aPacket
  - macNode is an instance of Workstation
  - accept:
  is looked up in the class Workstation
  - accept: is defined in Node
  => lookup stops + method executed



Method Lookup Examples (II)

- macNode name
  - macNode is an instance of Workstation.
  - name: is looked up in the class Workstation
  - name is not defined in Workstation => lookup continues in Node
  - name is defined in Node => lookup stops + method executed
- 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

Graphically…

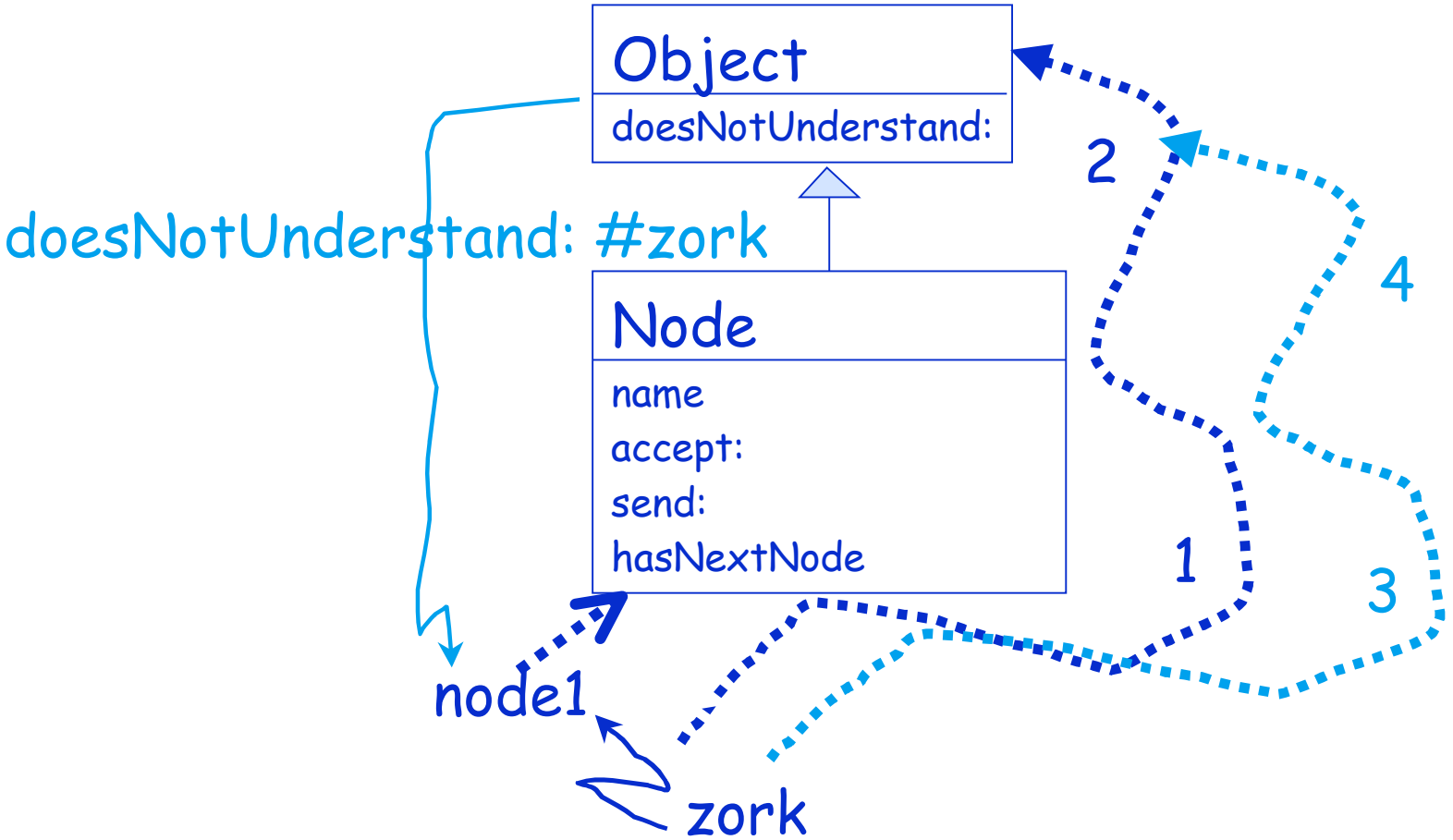


...in Smalltalk

- 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

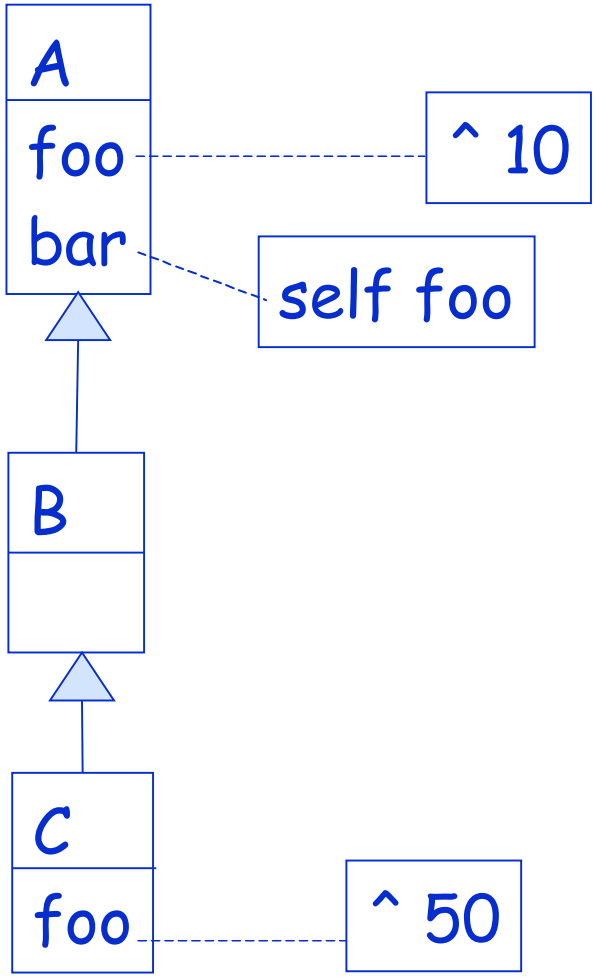
  - message: node1 doesNotUnderstand: #(#print aPacket) is executed
  - node1 is an instance of Node so doesNotUnderstand: is looked up in the class Node
  - doesNotUnderstand: is not defined in Node => lookup continues in Object
  - doesNotUnderstand: is defined in Object => lookup stops
    + method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

Graphically…



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



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.

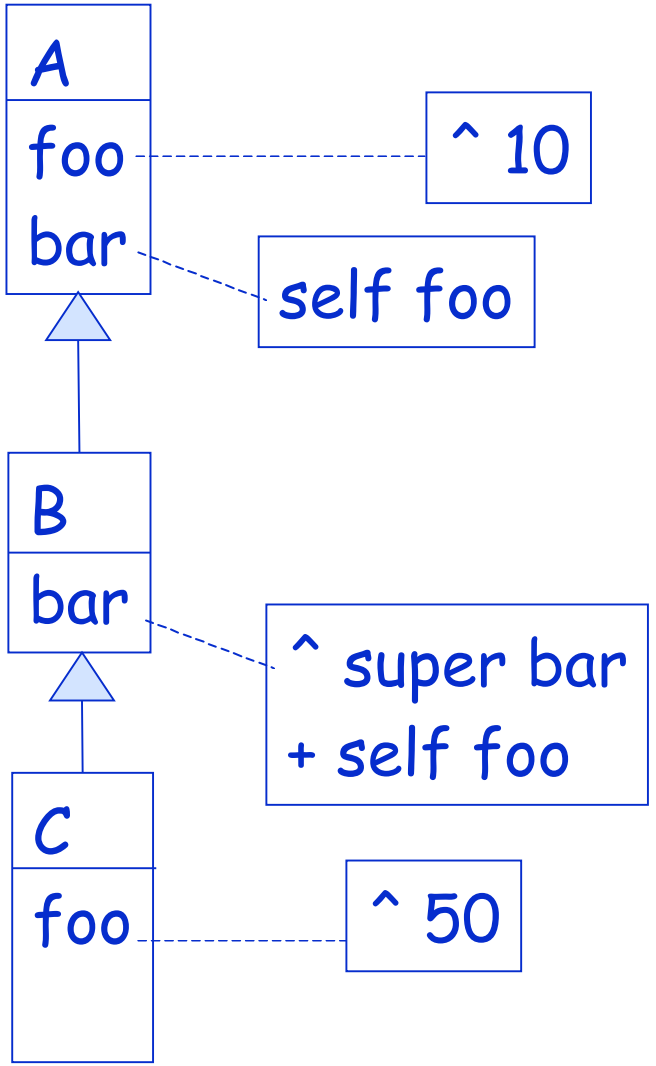
The semantics of super

- 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 and NOT in the superclass of the receiver class.

- This means, super causes the method lookup to begin searching in the superclass of the class of the method containing super

super changes lookup starting point

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



Why super is **not** the superclass of the receiver class?

- Let us suppose the WRONG hypothesis: "The semantics of super is to start the lookup of a method in the superclass of the receiver class"

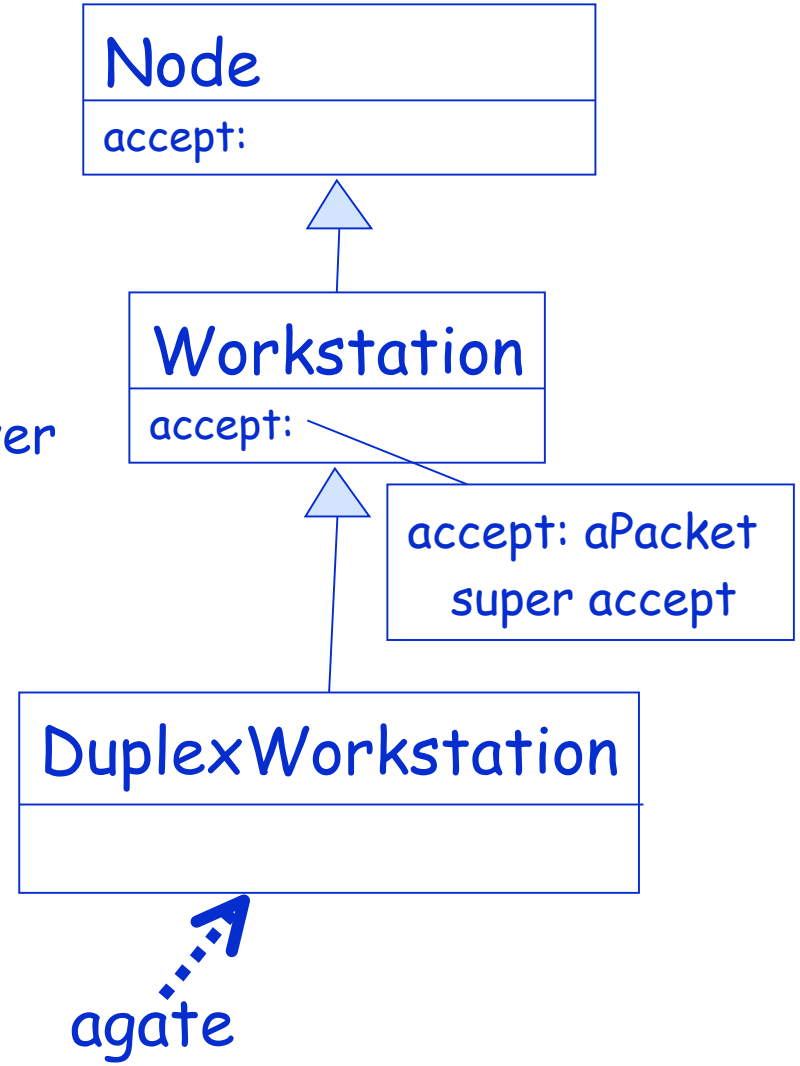
  agate accept: aPacket

- agate is an instance of DuplexWorkstation. accept: is looked up in the class DuplexWorkstation
- accept: is not defined in DuplexWorkstation, so the lookup continues in Workstation

Yes Why?

- accept: is defined in Workstation, so the lookup stops, and the method is executed
- Workstation>>accept: does a super accept:
- Our hypothesis: super = start the lookup in the superclass of the receiver class. The superclass of the receiver class is Workstation

- This will result in a loop, therefore the hypothesis is WRONG



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 // super is static