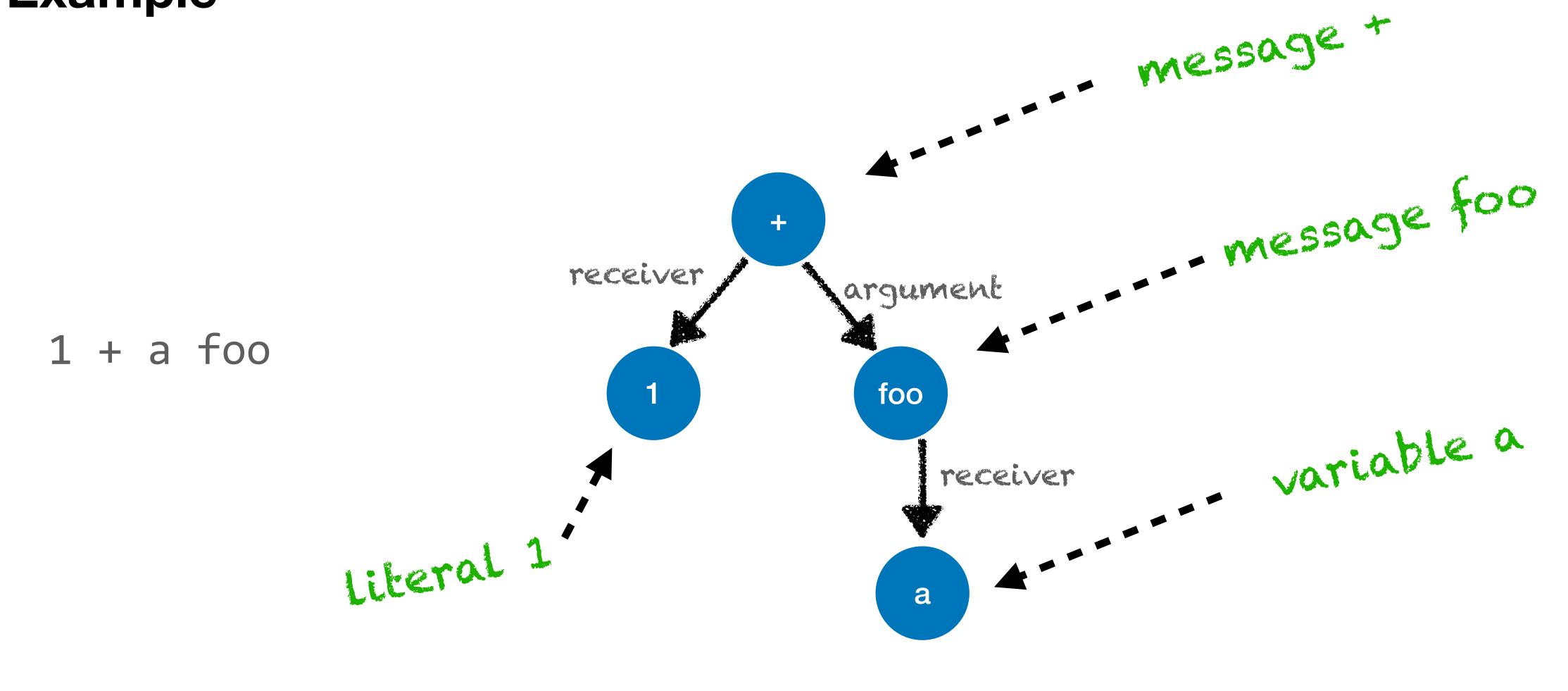
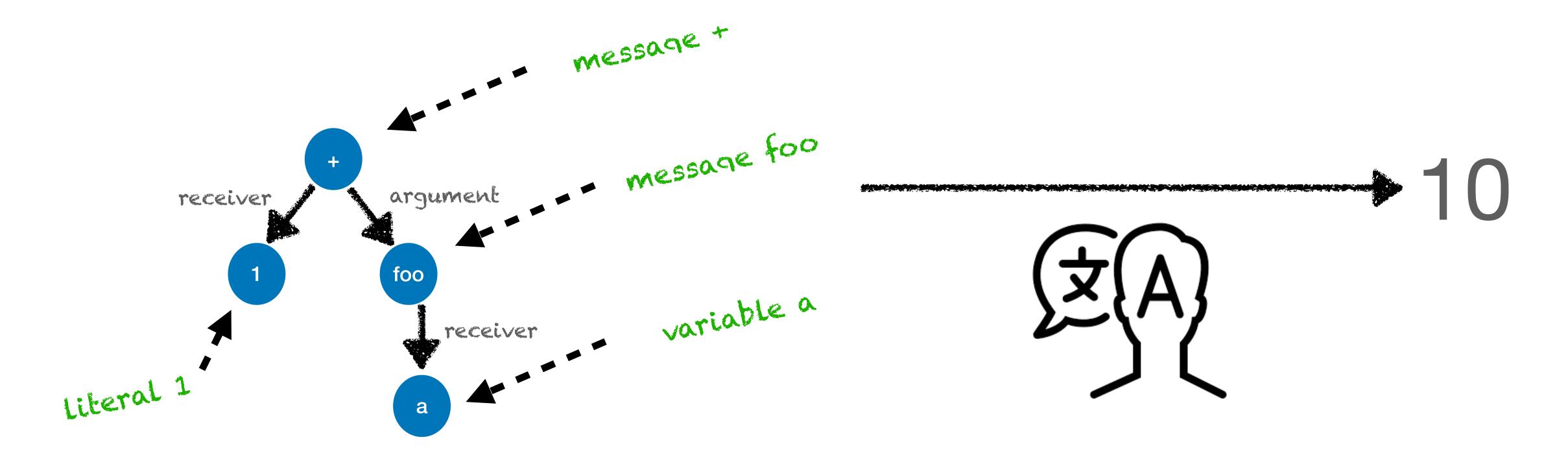
# AST Interpreters 101

# Reminding ASTs



## **AST Interpreters**

A program that takes ASTs and evaluates them to some value



## Why AST interpreters?

- ASTs are simple to manipulate
  - => AST interpreters are easy to write
- AST interpreters can have many shapes
  - Evaluator: executes the program and returns its result
  - Abstract interpreters / symbolic executors:
    - do approximate executions on "mock" values
  - Compilers can be build as interpreters!

# Adding Semantics to the Syntax

#### Example of an evaluator

- AST nodes do not have semantics attached
- It is the interpreter that says what to do with each node

likeral 1

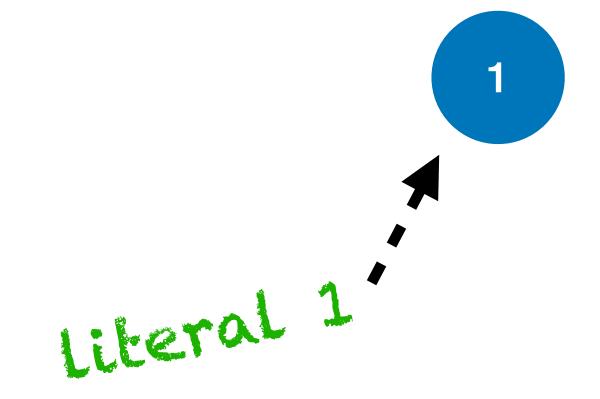
- E.g., in an evaluator each node is reduced to a value
- The interpreter does case analysis per node
  - using, e.g., a visitor pattern



## **Evaluating Literals**

• The value of a literal node is the parsed value

visitLiteralNode: aNode
 ^ aNode value



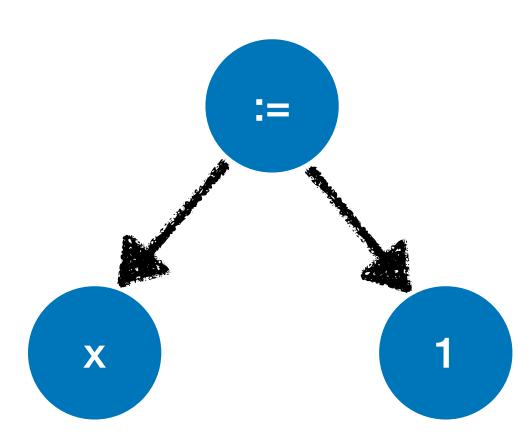
## Evaluating Variables

- The value of a variable node is the value stored in some memory location
- E.g., the value of instance variable #x has to fetch it from the receiver object

## Evaluating Assignment

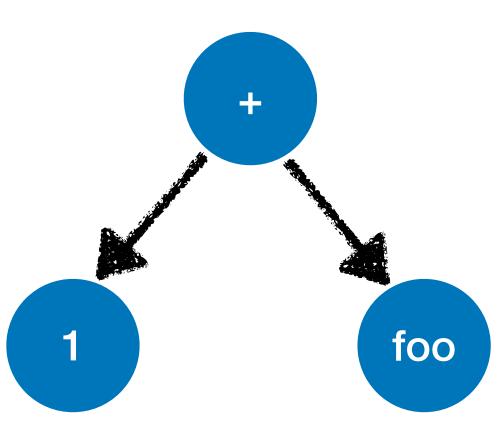
- An assigment has an effect! It stores the evaluation of the RHS on the LHS
- It also has a value: its value is the value stored

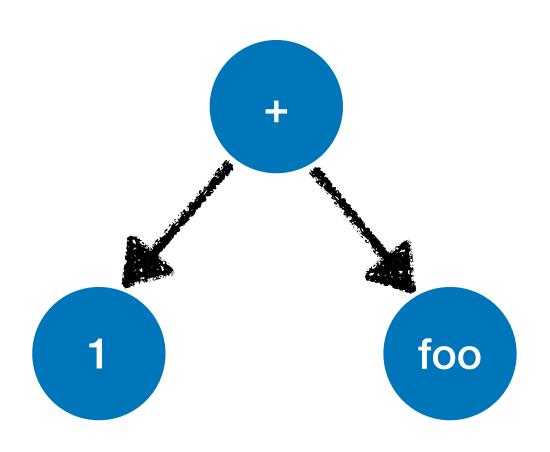
```
visitAssignmentNode: aNode
  ^ receiver
  instVarNamed: aNode variable name
  put: (aNode value acceptVisitor: self)
```

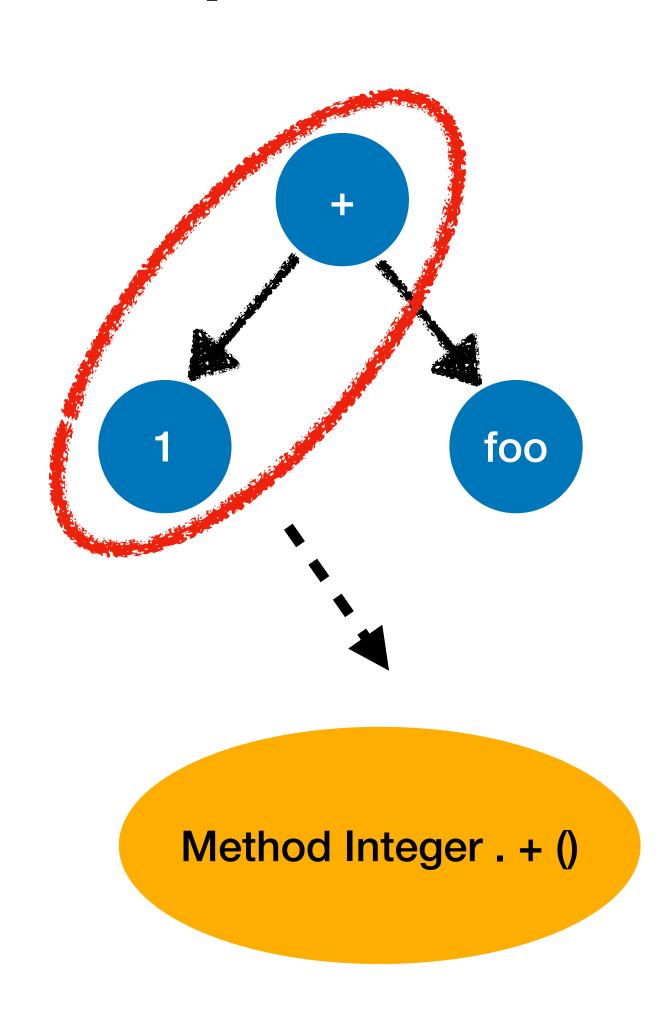


- The value of a message node is the value returned by the fact of invoking a method
- Given the receiver, we must lookup the method corresponding to the selector
- Then evaluate that method using the receiver as self
- E.g., the value of instance variable #x has to fetch it from the receiver object

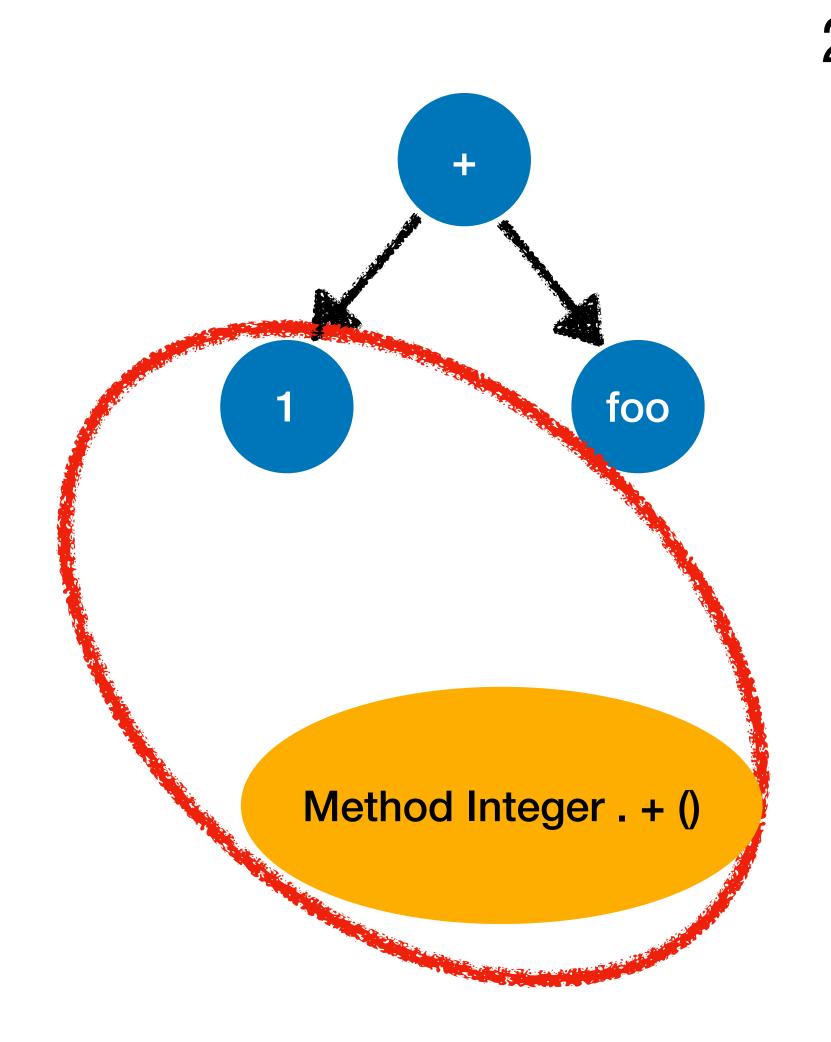
```
visitMessageNode: aNode
  receiver := aNode receiver accept: self.
  method := self lookup: aNode selector in: receiver.
  ^ self evaluateMethod: method withReceiver: receiver
```







- 1. Lookup
  - 1.1. Get the receiver's class (in class based language)
  - 1.2. Look in the hierarchy until you find a method that matches the signature of the message



- 2. Apply
  - 2.1. Get the method you found
  - 2.2. Execute it on the receiver (a.k.a. method activation)

## Implementing the method lookup

#### **Recursive definition**

```
lookup: aSymbol fromClass: aClass

(aClass includesSelector: aSymbol)
   ifTrue: [ ^ (aClass compiledMethodAt: aSymbol) ast ].

^ aClass superclass
   ifNil: [ nil ]
   ifNotNil: [ self lookup: aSymbol fromClass: aClass superclass ]
```

Questions? Refresh with the MOOC or your OOP course

### Method activation

- execute the new method binding:
  - the receiver as the self/this special variable
  - each argument (the values) with each parameter (the variables)
  - at the end of the evaluation of the method, return the result to the caller

### **Native Methods**

- Some language implementations include native methods:
  - special methods that have an implementation in the implementation language.
  - For example, when implementing Pharo in C, C is the implementation language
  - Typically used for special behaviours (low-level arithmetics, object allocation...)

### Conclusion

- An AST interpreter does a case analysis per node
- In object oriented languages, the juice is in the message sends
- Each message send activates a new method
- Special native methods implement low-level behaviour in the implementation language, because it usually cannot be expressed in the interpreted language