COMP 410: Abstract Syntax Trees and Evaluation

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Abstract Syntax Tree

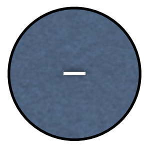
- Abbreviation: AST
- Unambiguous tree-based representation of a sentence in a language
- Very commonly used in compilers, interpreters, and related software

-Generally we work with ASTs instead of Strings or any other code representation

```
(1 + 2) - 3 * 4
```

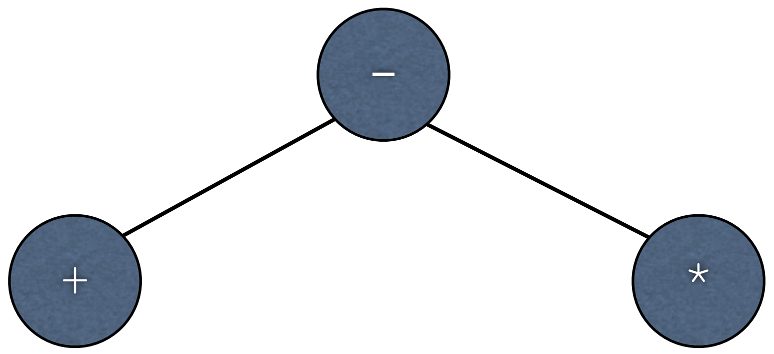
-Key parts: we need parentheses to direct that 1 + 2 happens first. We know that the 3 * 4 should happen after the part in parentheses from PEMDAS rules

```
(1 + 2) - 3 * 4
```



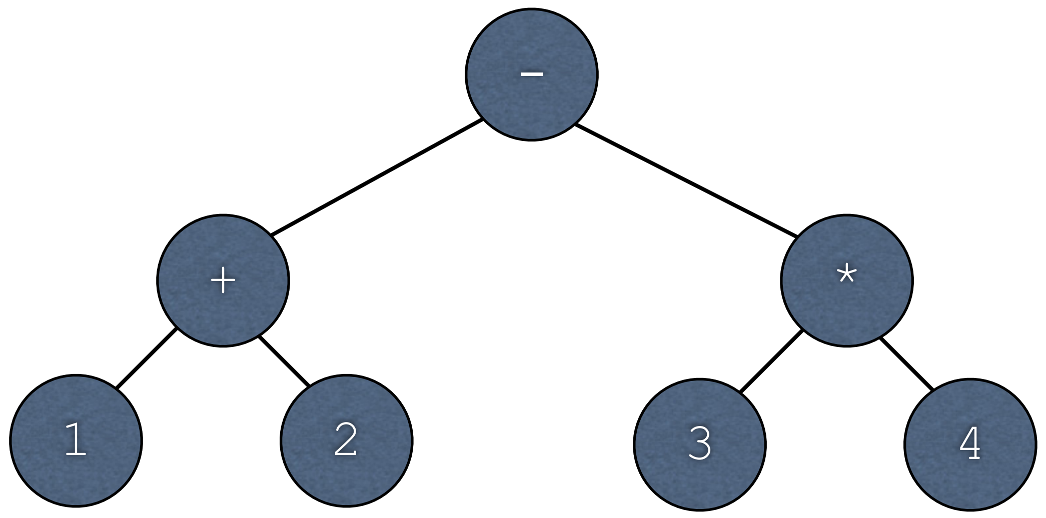
-Lowest priority thing ends up in the top of the tree

(1 + 2) - 3 * 4



-Next level of priority

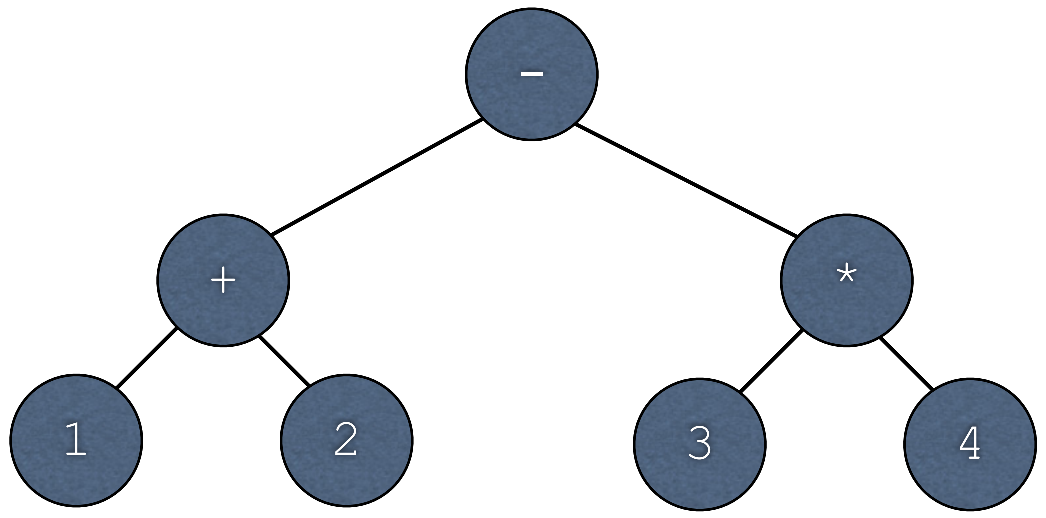
(1 + 2) - 3 * 4



-Next level of priority

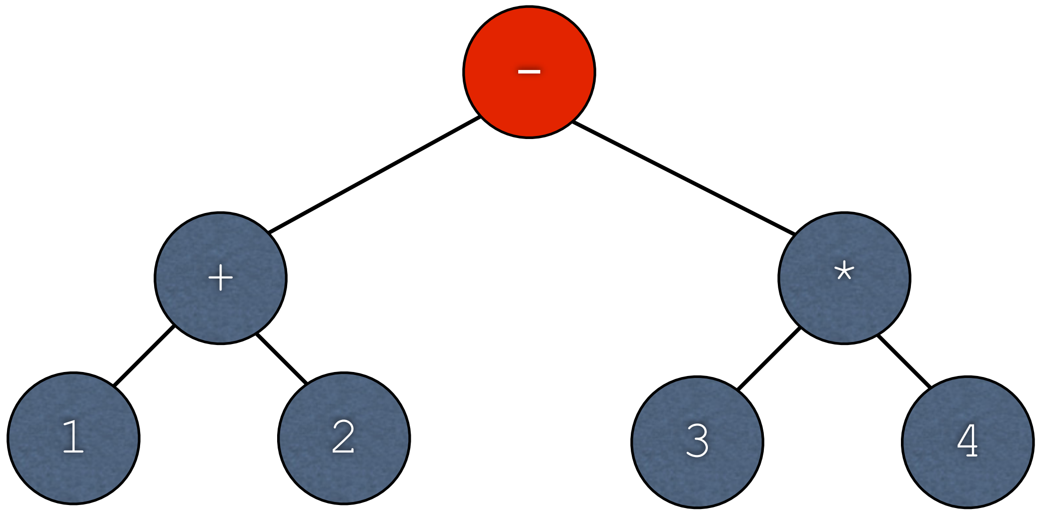
Exercise: First Side of AST/Evaluation Sheet

Evaluation



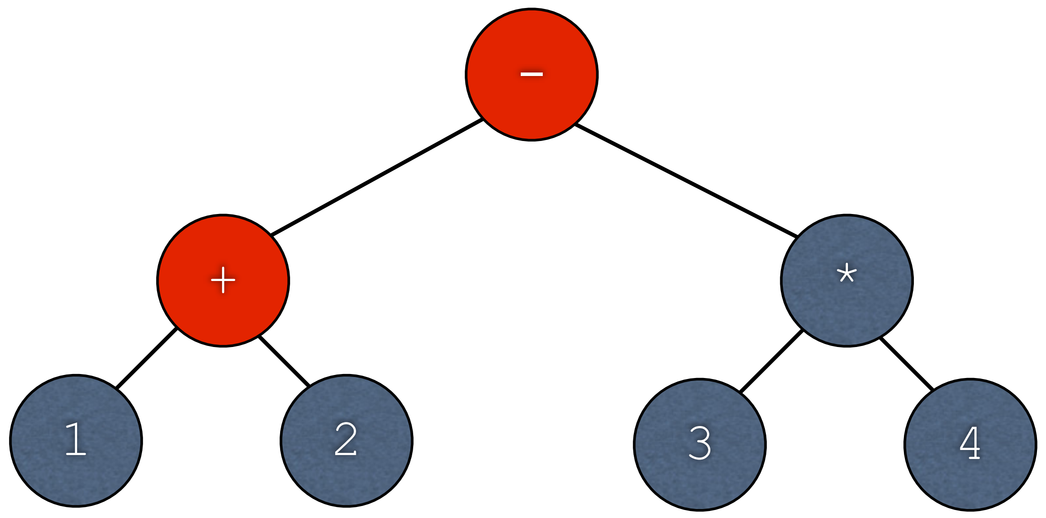
-Key point: bubble-up values from the leaves
-This can be implemented in code via a recursive function starting from the root (code in a bit later)

Evaluation



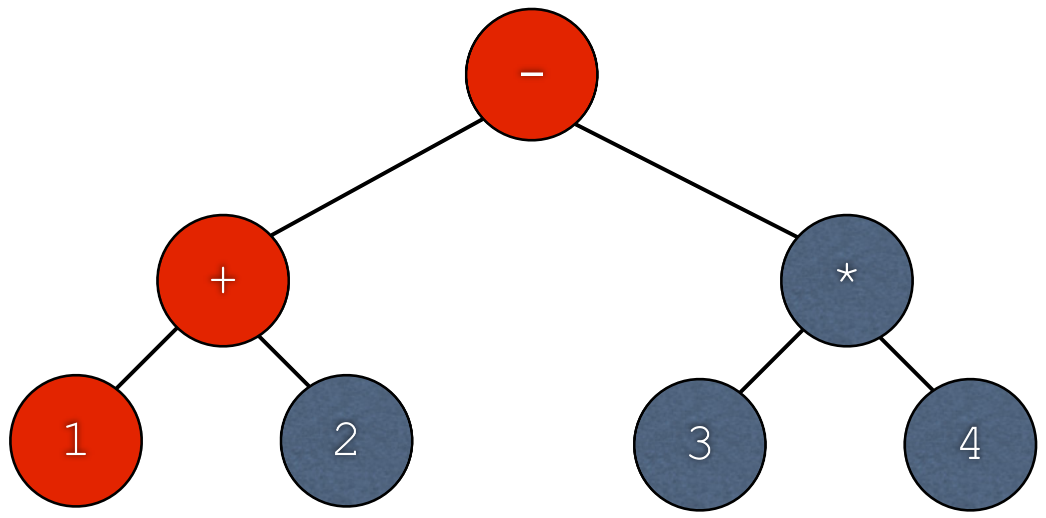
-We start evaluation from the root...

Evaluation



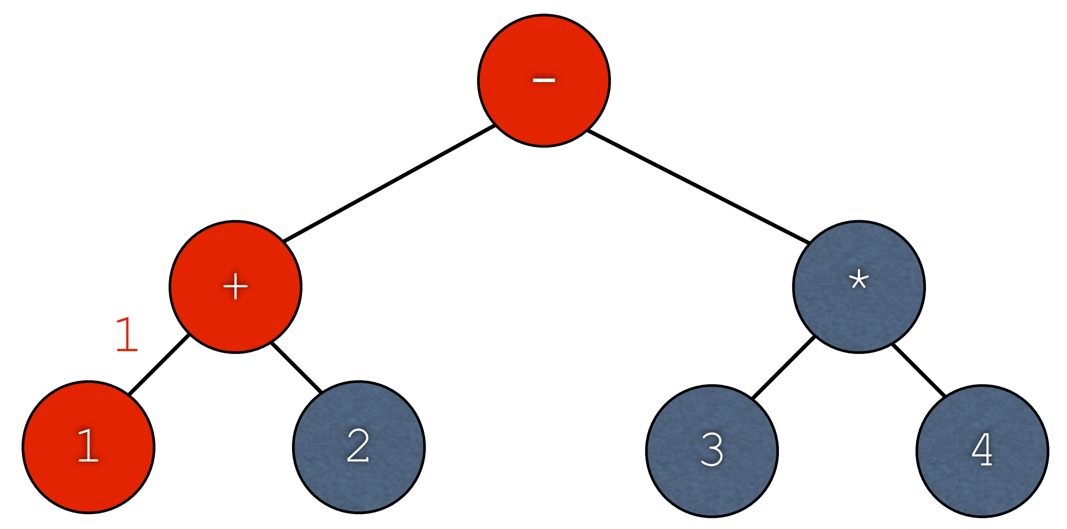
-In order to evaluate the root, we need to evaluate the left subtree of the root (+)

Evaluation

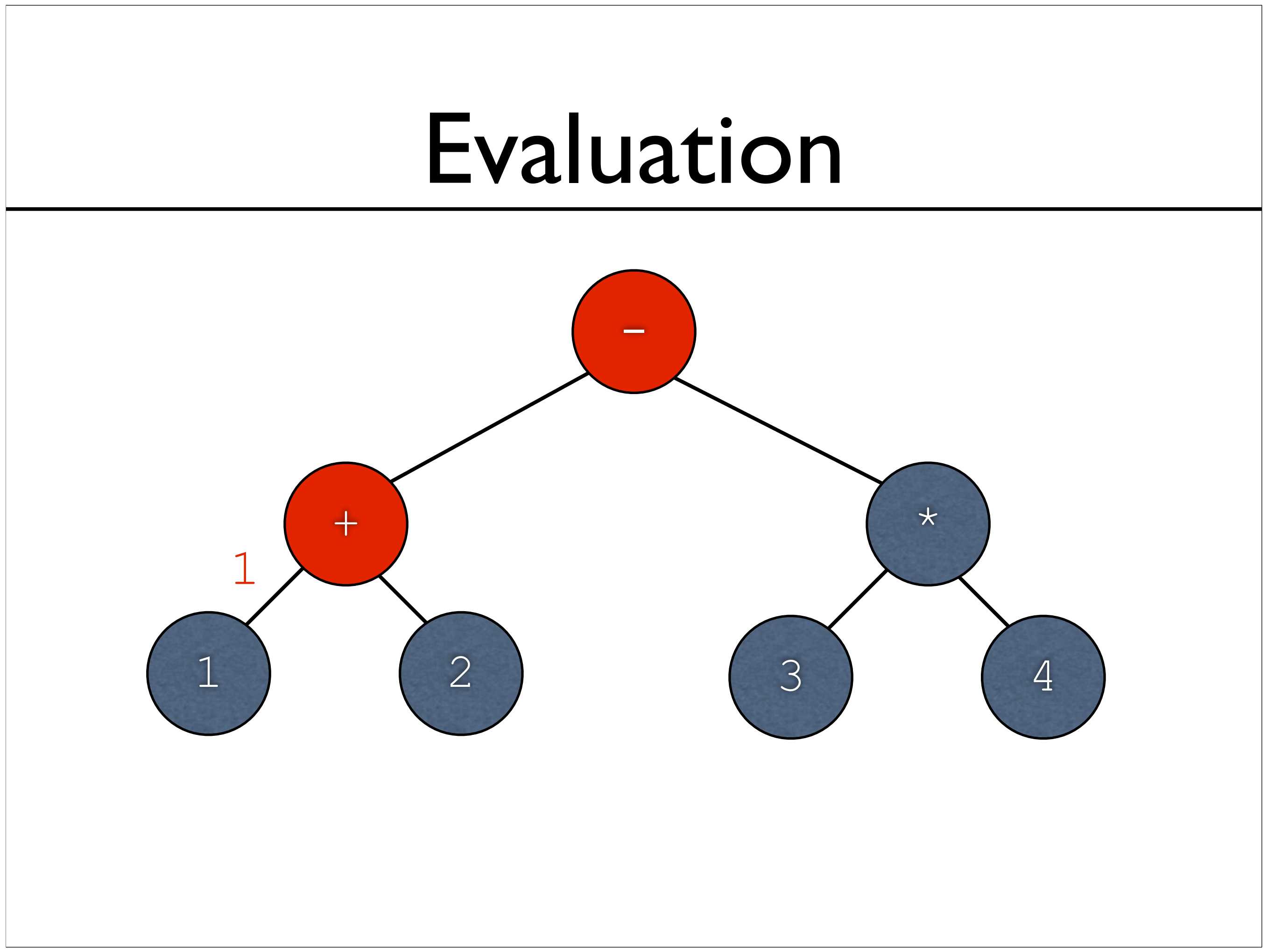


-In order to evaluate +, we need to evaluate the left subtree (as with the root)

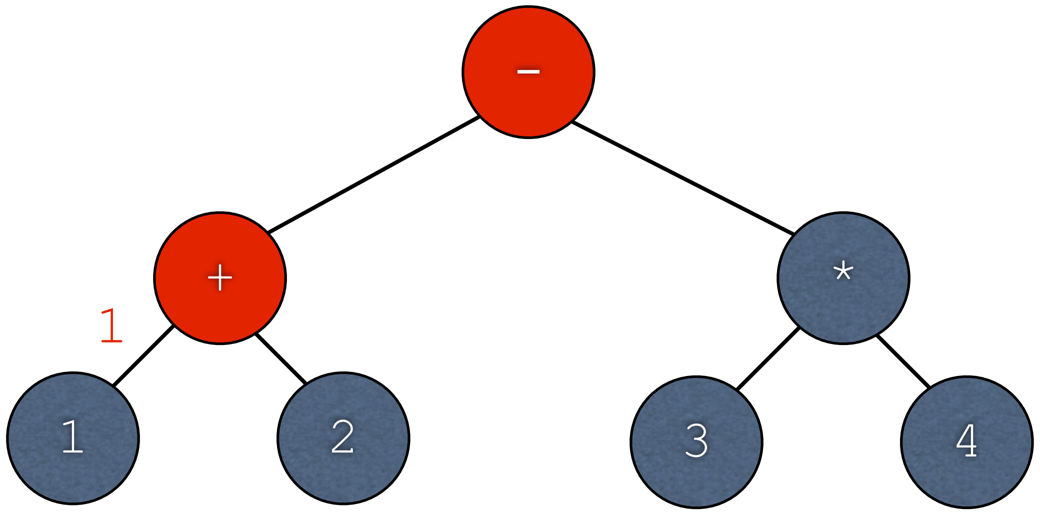
Evaluation



-For arithmetic, leaves are simply numbers
-Evaluating a leaf returns the number held within

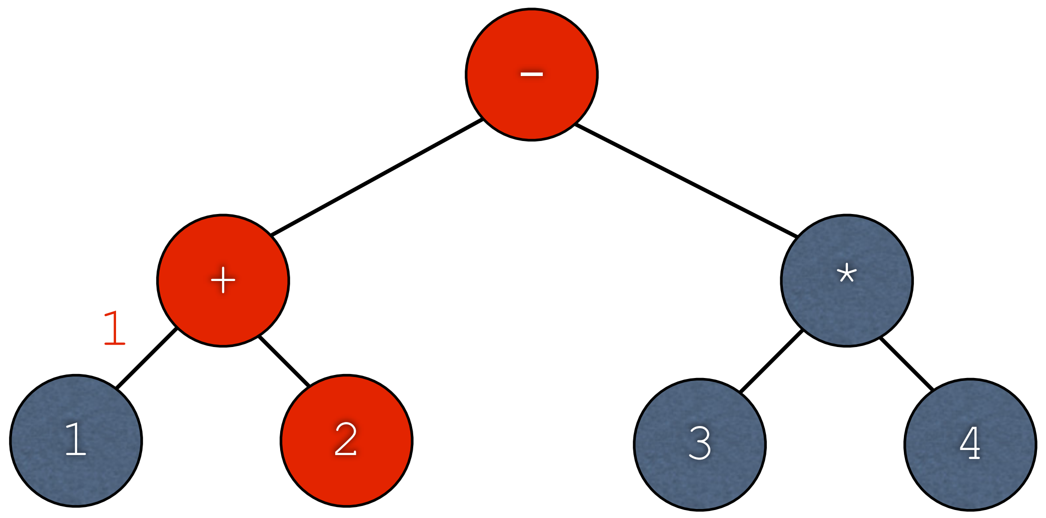


Evaluation



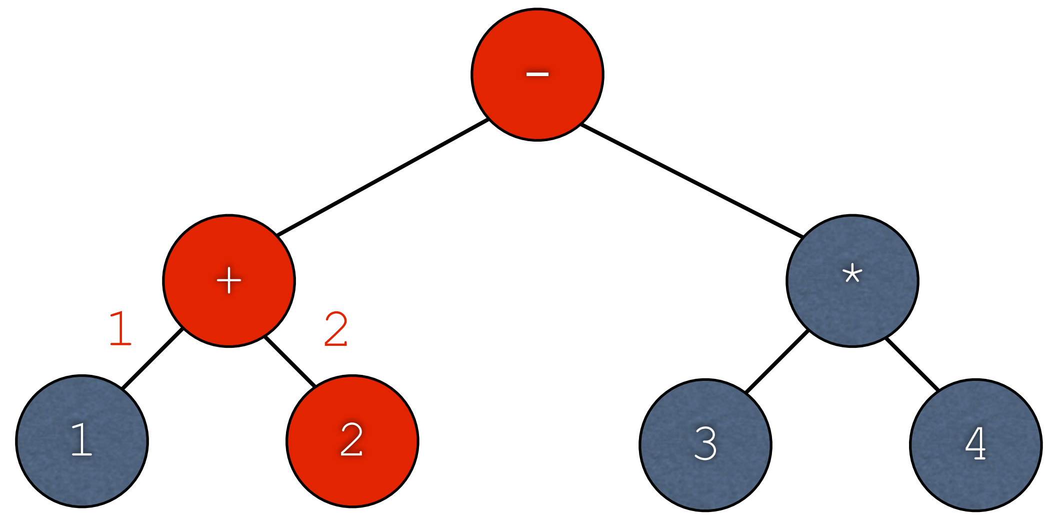
-The left subtree of + has now been evaluated
-Now + needs the value of the right subtree

Evaluation



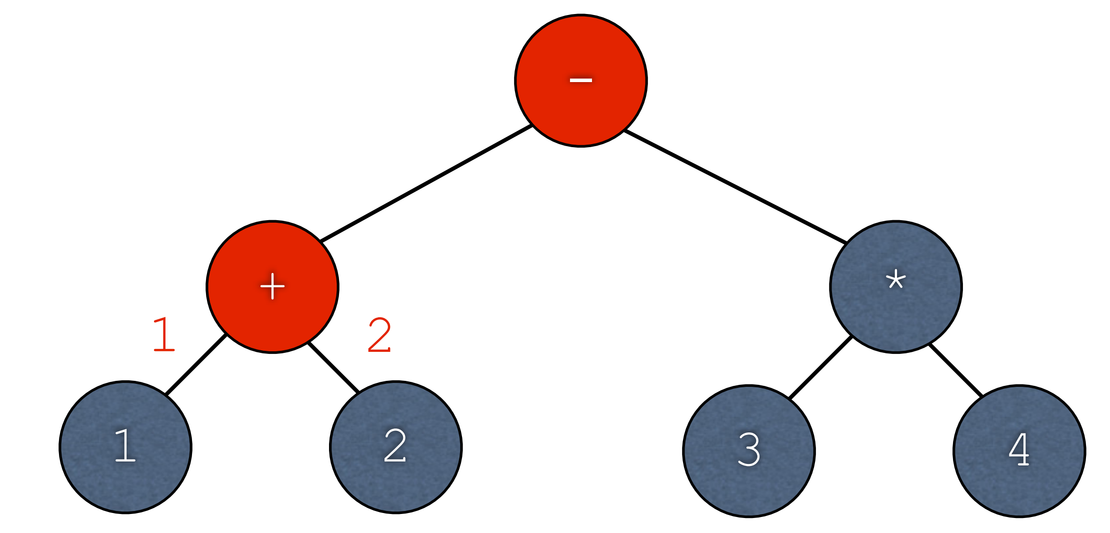
-The left subtree of + has now been evaluated
-Now + needs the value of the right subtree

Evaluation



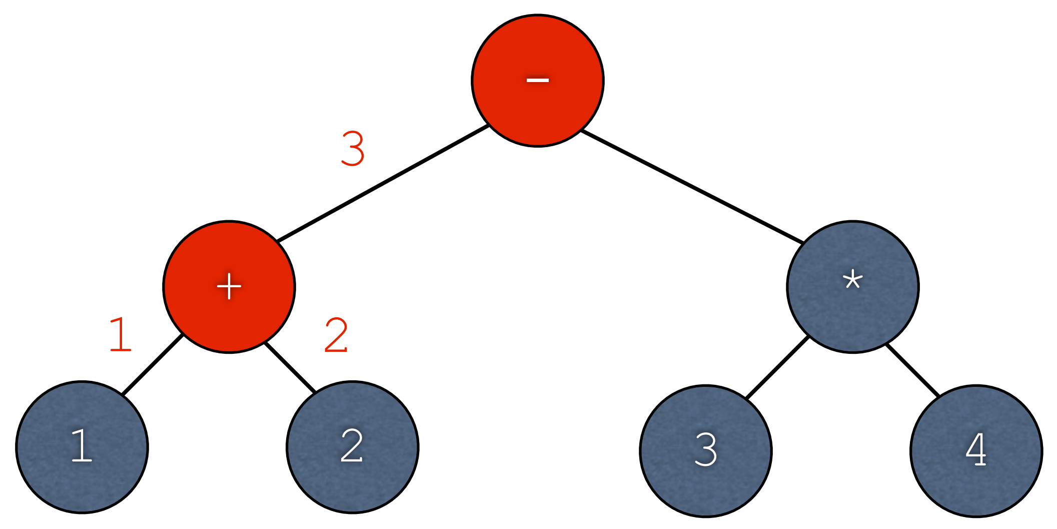
-As before, leaves just return the value held within

Evaluation

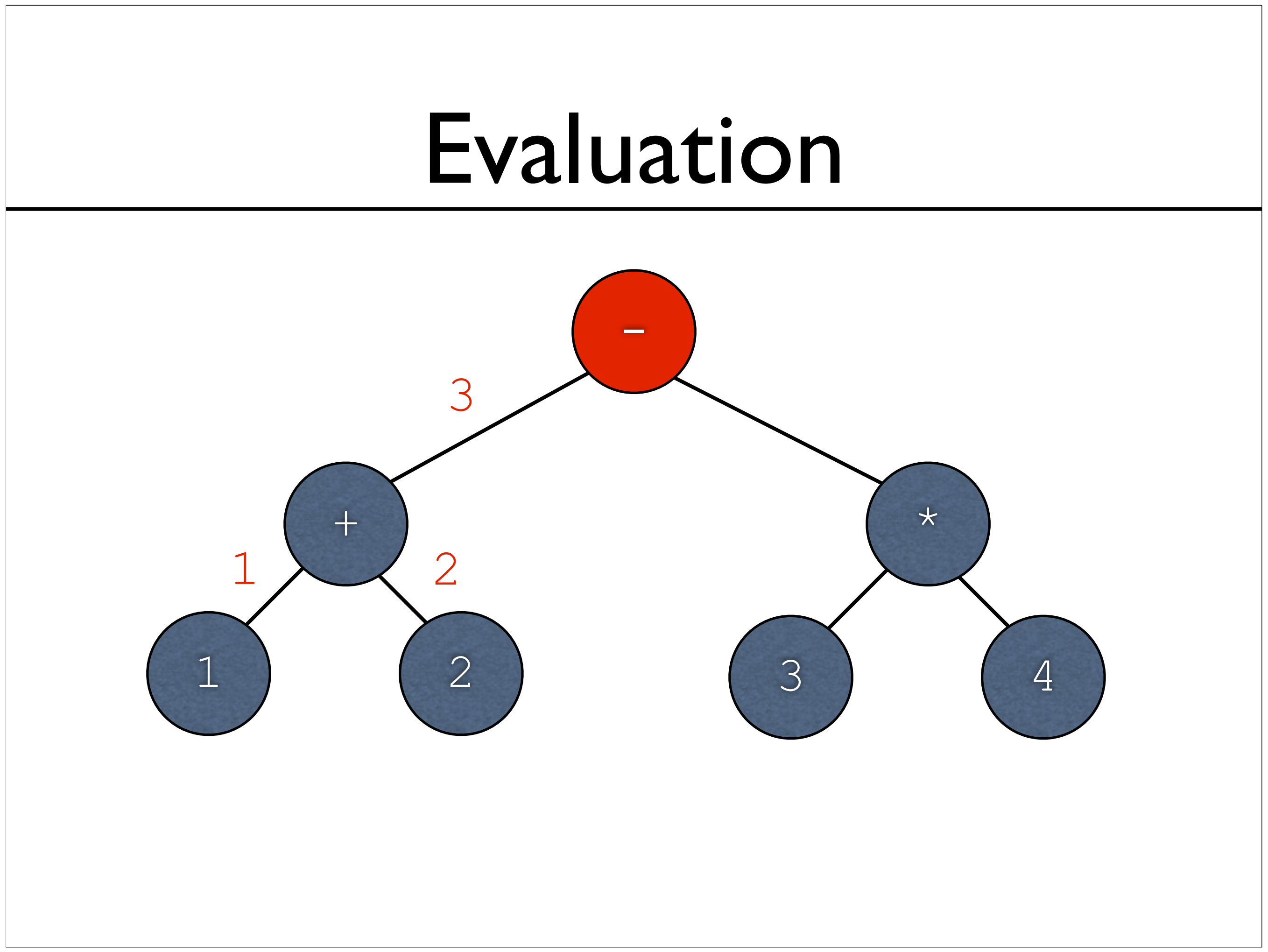


-Subtrees of + are now taken care of
-Now + has two values that it needs to work with...

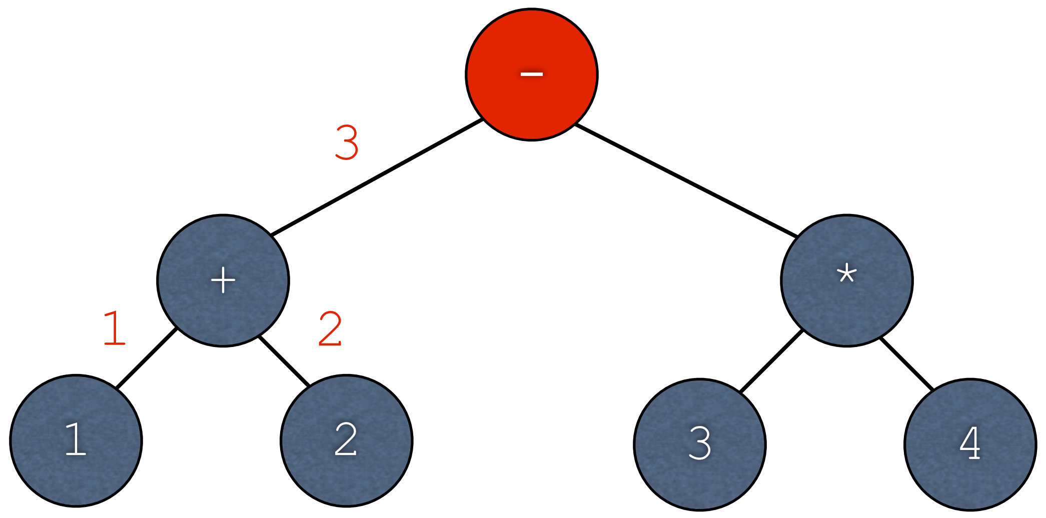
Evaluation



-+ performs the actual addition

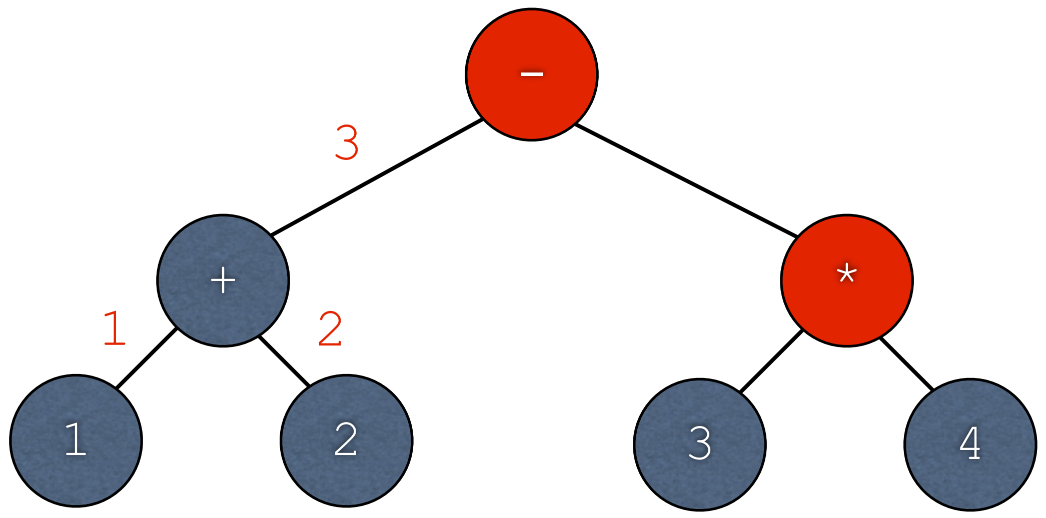


Evaluation

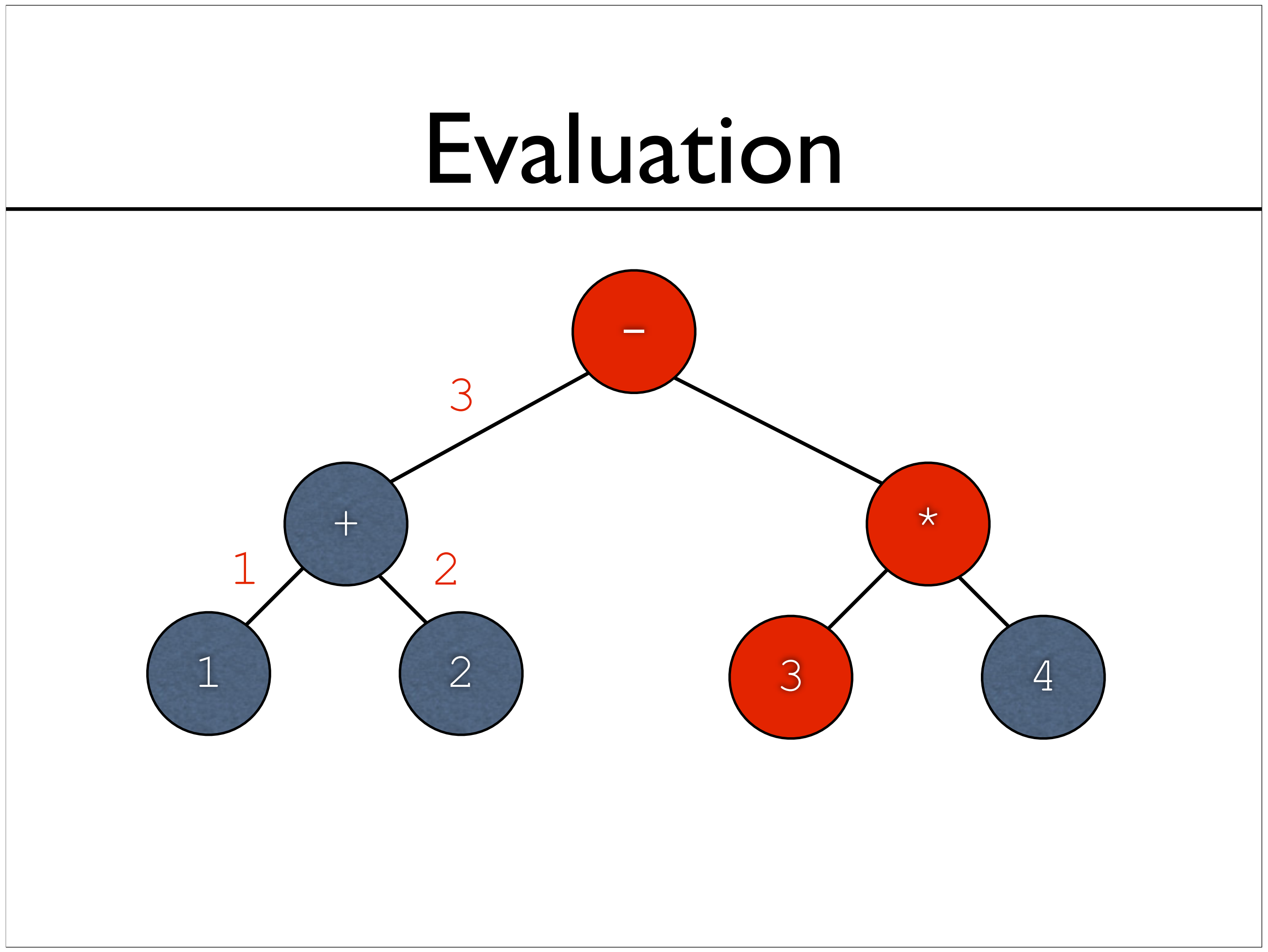


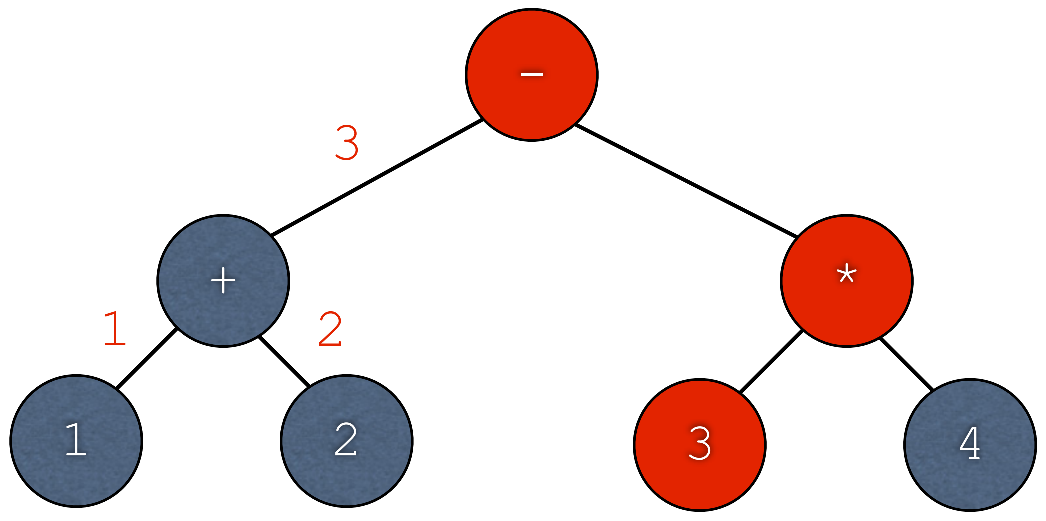
-Now + is taken care of
-Going back to -, - now has the value of the left subtree, and it needs the value of the right subtree

Evaluation



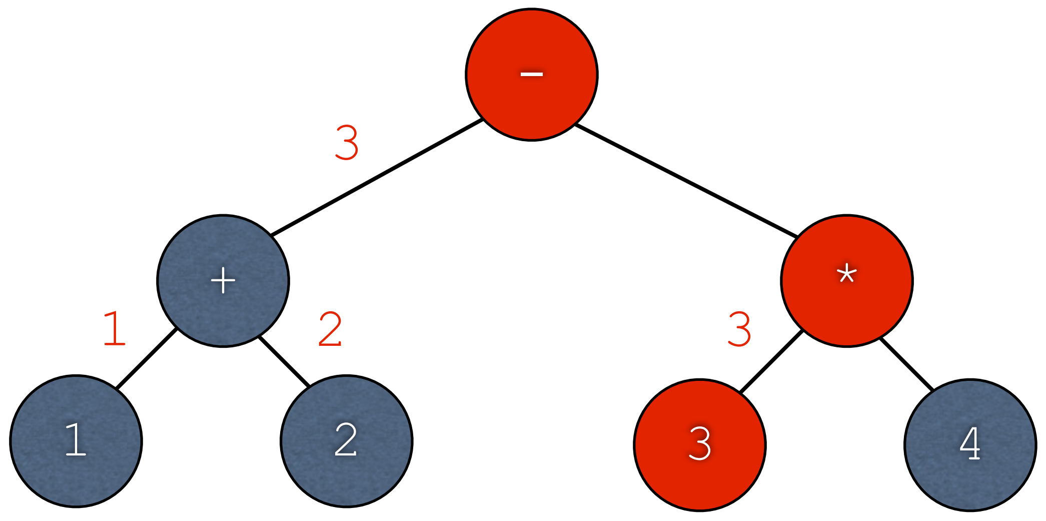
-Now we're on *, which needs the value of the left subtree...


Evaluation



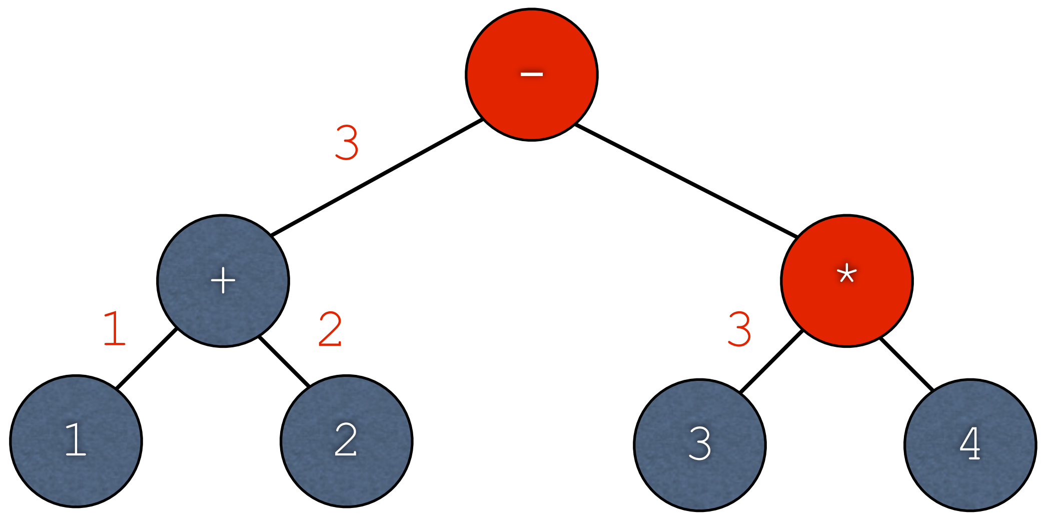
-Now we're on *, which needs the value of the left subtree...

Evaluation



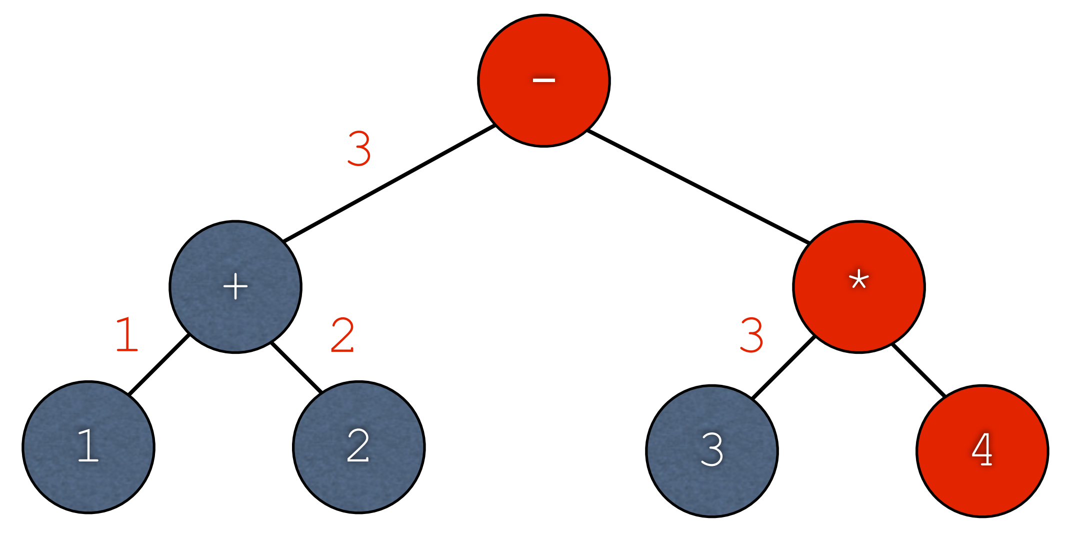
-Leaves again return the values held within...

Evaluation



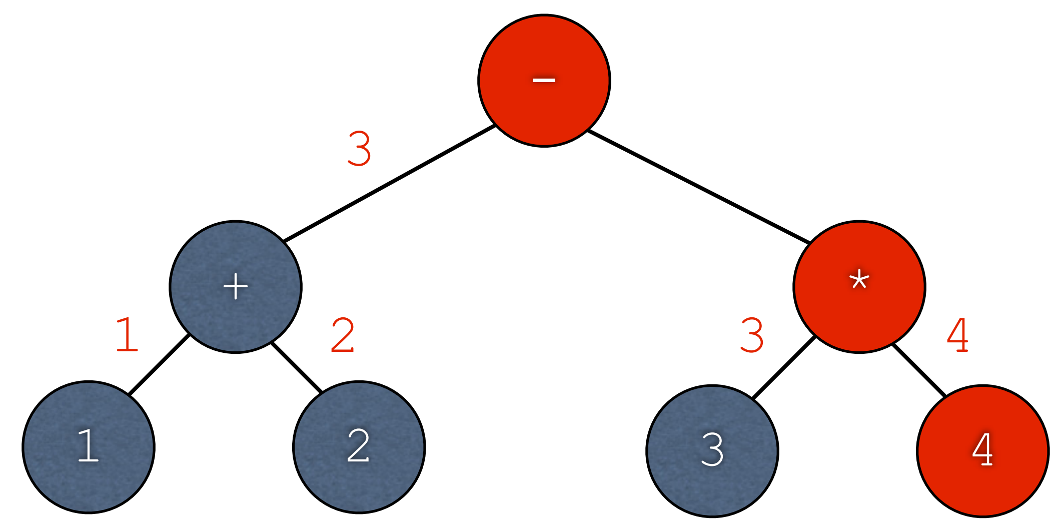
-Left subtree done; * now needs the value of the right subtree...

Evaluation



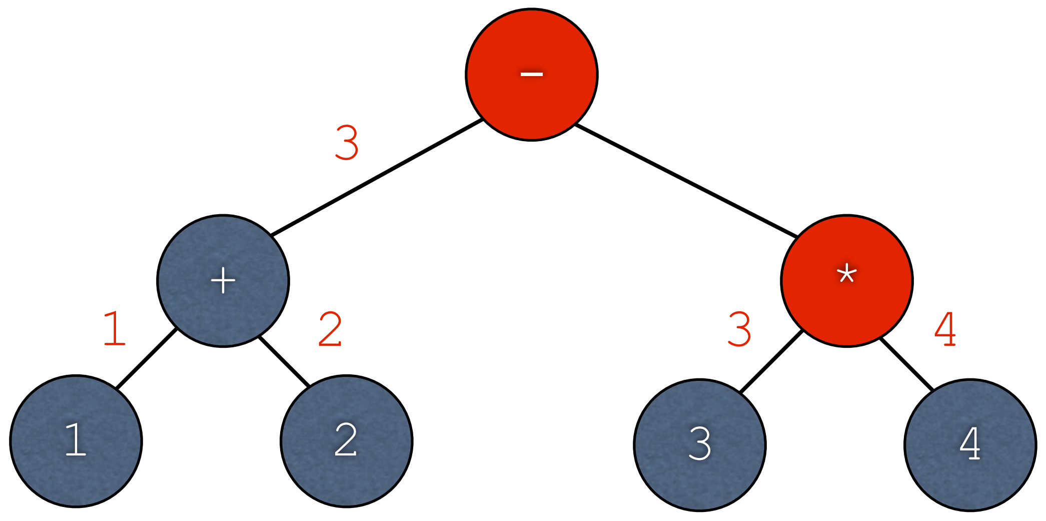
-Left subtree done; * now needs the value of the right subtree...

Evaluation



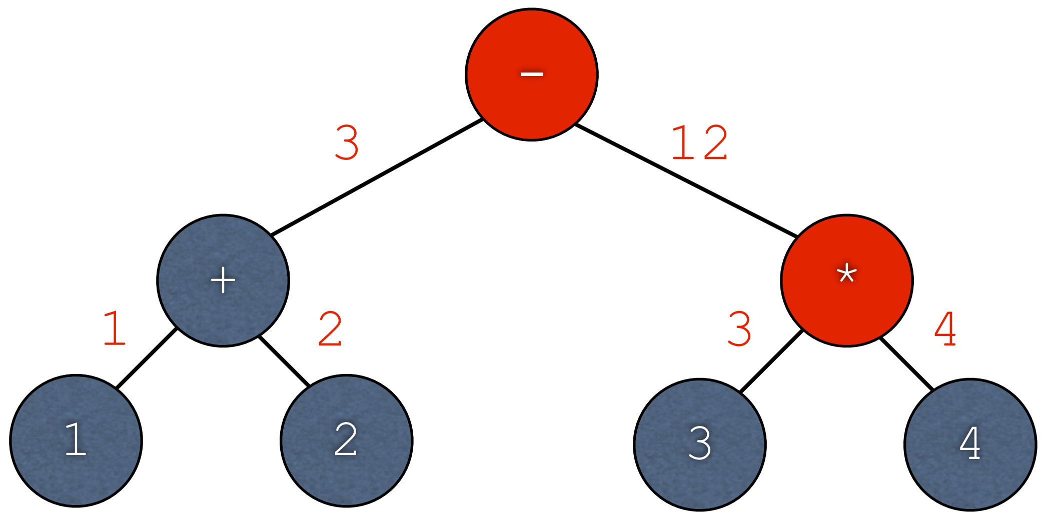
-Leaf returns value held within

Evaluation



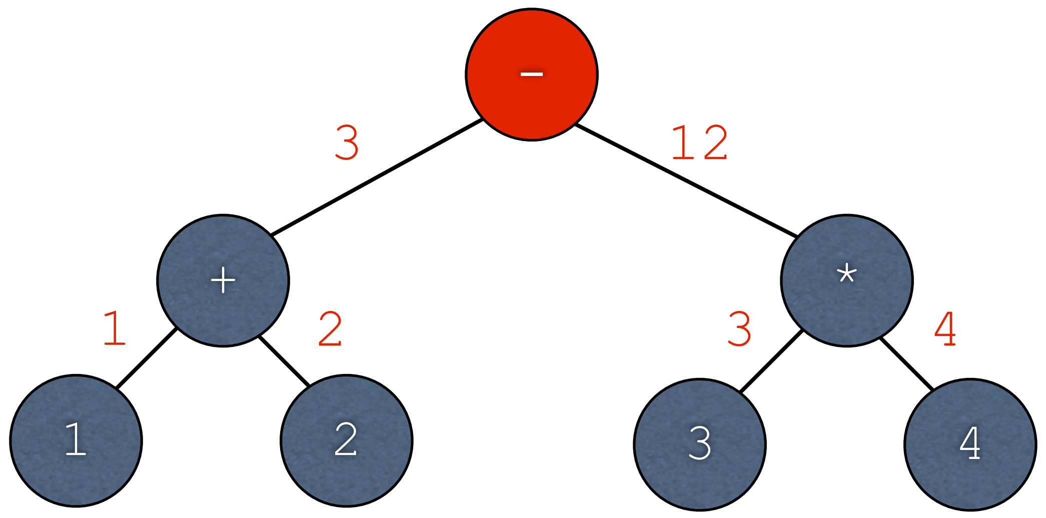
-Leaf is done. * now has both operands it needs...

Evaluation



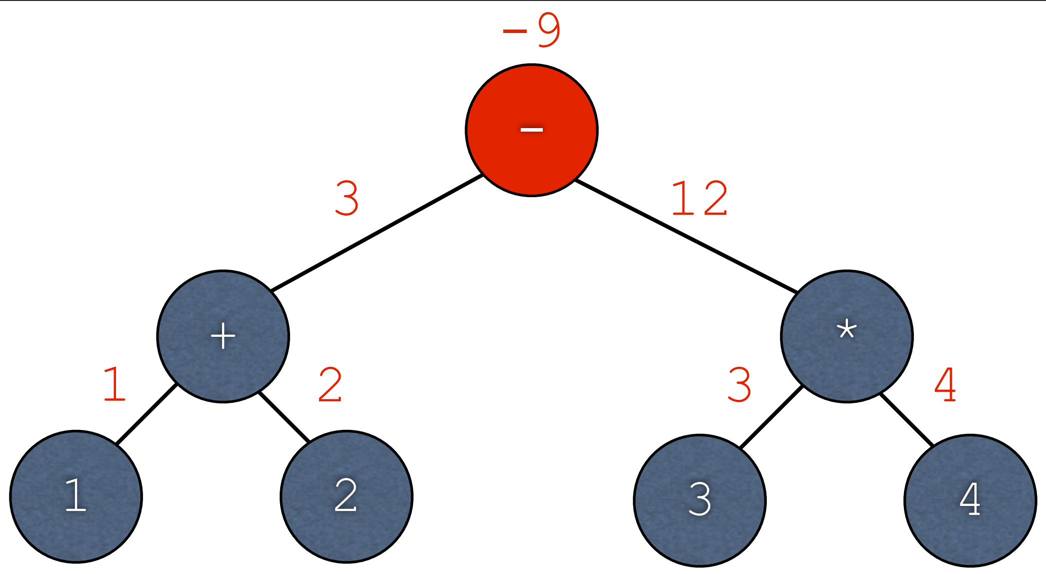
–* performs the multiplication and returns the value

Evaluation



-The root - node now has both operands...

Evaluation



-...and it returns the result of the subtraction

Exercise: Second Side of AST/Evaluation Sheet

Evaluator Example:
`arithmetic_evaluator.py`

-Complete example online; we’ll live-code this in class