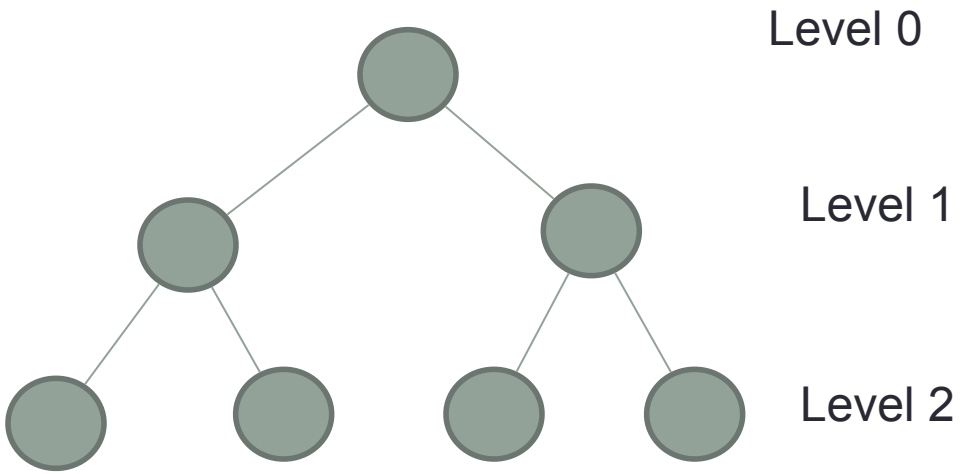
STANDARD TEMPLATE LIBRARY STACKS

Problem Solving with Computers-II

Height of a completely filled tree



Finally, what is the height (exactly) of the tree in terms of N?

Balanced trees

- Balanced trees by definition have a height of O(log N)
- A completely filled tree is one example of a balanced tree
- Other Balanced BSTs include AVL trees, red black trees and so on
- Visualize operations on an AVL tree: https://visualgo.net/bn/bst

C++ STL

- The C++ Standard Template Library is a very handy set of three built-in components:
  - Containers: Data structures
  - Iterators: Standard way to search containers
  - Algorithms: These are what we ultimately use to solve problems

C++ STL container classes

```
array
vector
forward_list
list
set
stack
queue
priority_queue
multiset (non unique keys)
deque
unordered_set
map
unordered_map
multimap
bitset
```

Stacks – container class available in the C++ STL

- Container class that uses the Last In First Out (LIFO) principle
- Methods

i. push()
ii. pop()
iii. top()
iv. empty()

Demo reversing a string

Lab05 – part 1: Evaluate a fully parenthesized infix expression

(4 * ((5 + 3.2) / 1.5)) // okay

(4 * ((5 + 3.2) / 1.5) // unbalanced parens - missing last ‘)’

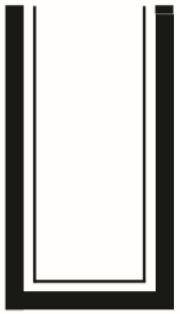
(4 * (5 + 3.2) / 1.5)) // unbalanced parens - missing one ‘(‘

4 * ((5 + 3.2) / 1.5) // not fully-parenthesized at ‘*’ operation

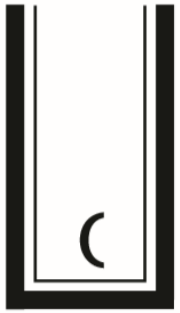
(4 * (5 + 3.2) / 1.5) // not fully-parenthesized at ‘/’ operation

((2 * 2) + (8 + 4))

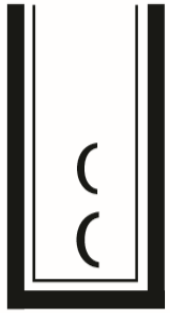
Initial
empty
stack



Read
and push
first (

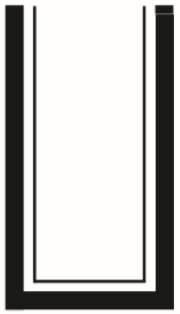


Read
and push
second (

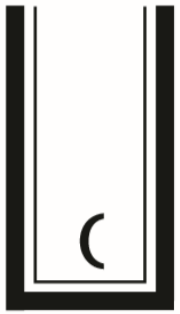


((2 * 2) + (8 + 4))

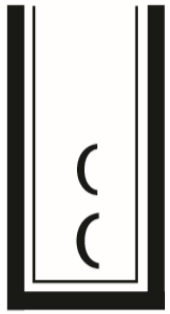
Initial empty stack



Read and push first (



Read and push second (

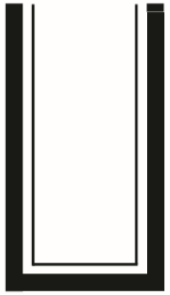


What should **be the next step after the first right parenthesis is encountered**?

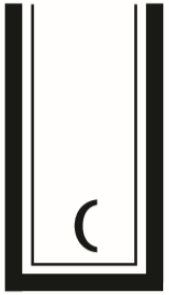
A. Push the right parenthesis onto the stack
B. If the stack is not empty pop the next item on the top of the stack
C. Ignore the right parenthesis and continue checking the next character
D. None of the above

((2 * 2) + (8 + 4))

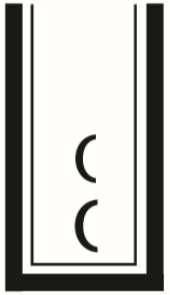
Initial empty stack



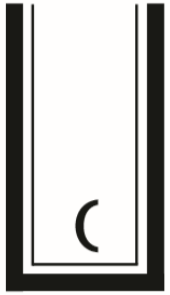
Read and push first (



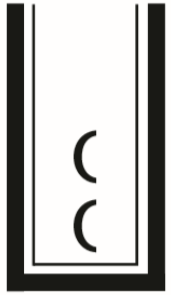
Read and push second (



Read first) and pop matching (

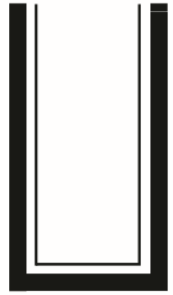


Read and push third (



Read second) and pop matching (

Read third) and pop the last (



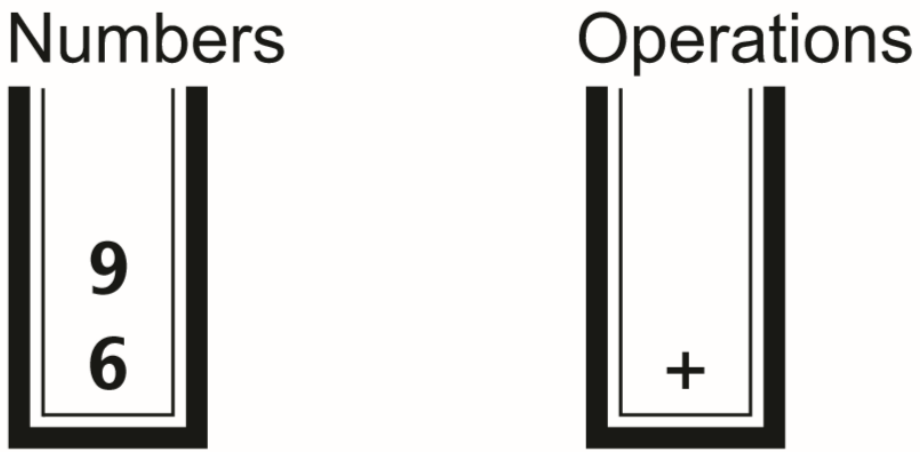
Evaluating a fully parenthesized infix expression

```
(((6 + 9)/3)*(6 - 4))
```

Evaluating a fully parenthesized infix expression

Characters read so far (shaded):

```
(((6 + 9) / 3) * (6 - 4))
```



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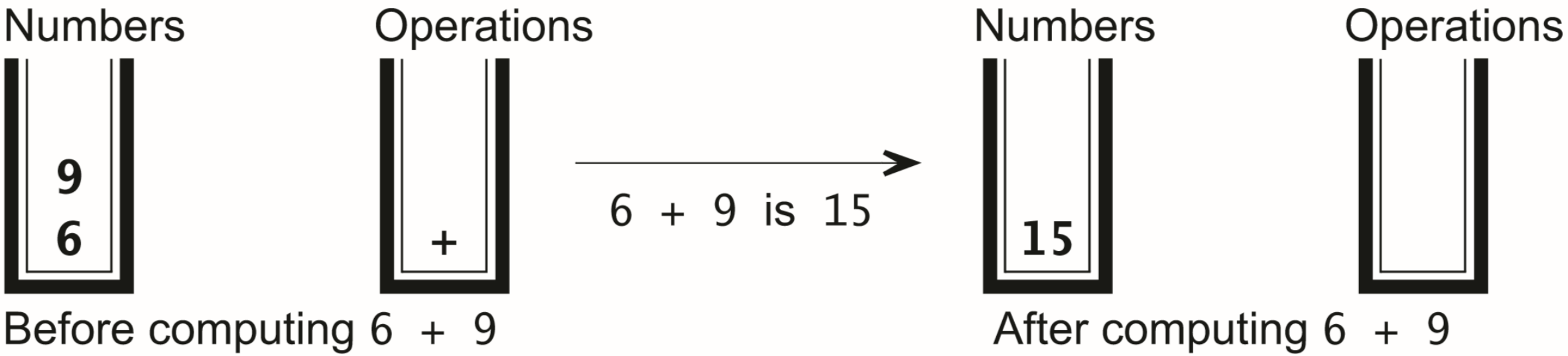

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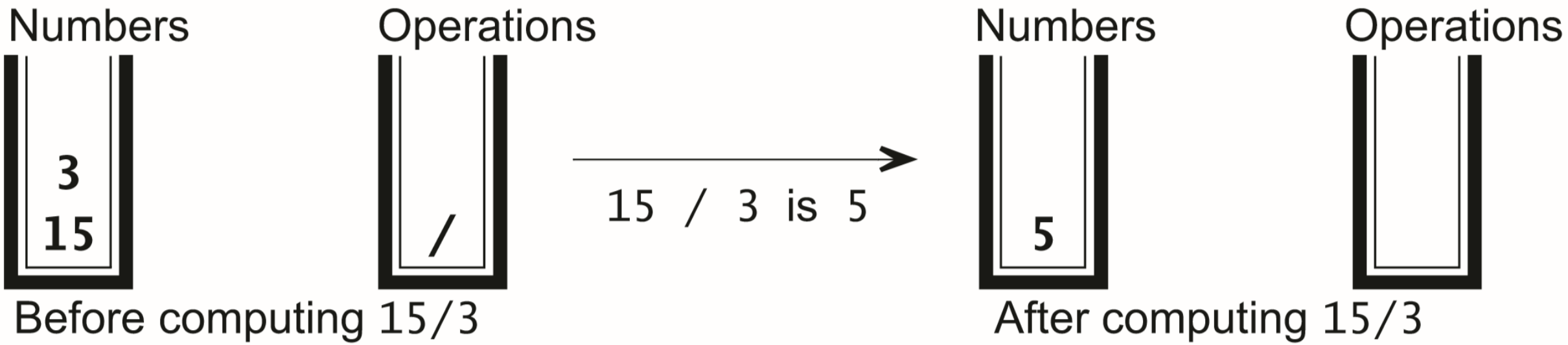


Notations for evaluating expression

- Infix number operator number
- (Polish) Prefix operators precede the operands
- (Reverse Polish) Postfix operators come after the operands

- 3 * 5
- 4 / 2
- 7 + (3 * 5)
- (7 + (3 * 5)) – (4 / 2)

Lab 05, part2 :
Evaluating post fix expressions using a single stack

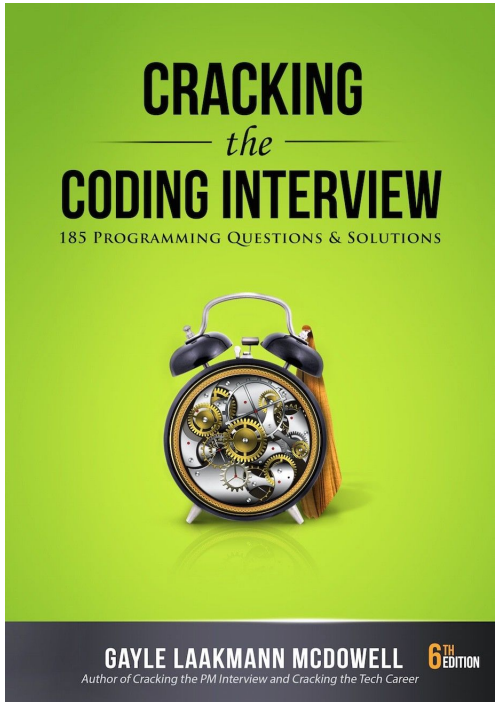
Postfix: 7 3 5 * + 4 2 / -

Infix: (7 + (3 * 5)) – (4 / 2)

Small group exercise

Write a ADT called in minStack that provides the following methods

- push() // inserts an element to the “top” of the minStack
- pop() // removes the last element that was pushed on the stack
- top () // returns the last element that was pushed on the stack
- min() // returns the minimum value of the elements stored so far



Summary of operations

Operation	Sorted Array	Binary Search Tree	Linked List
Min			
Max			
Median			
Successor			
Predecessor			
Search			
Insert			
Delete			