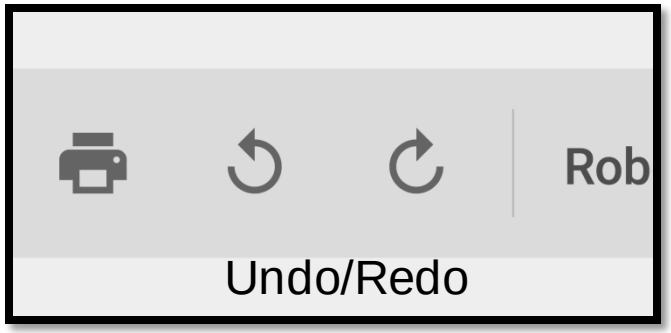
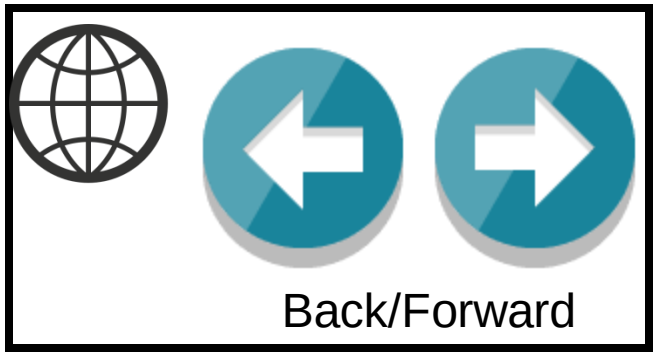
Stacks and Queues

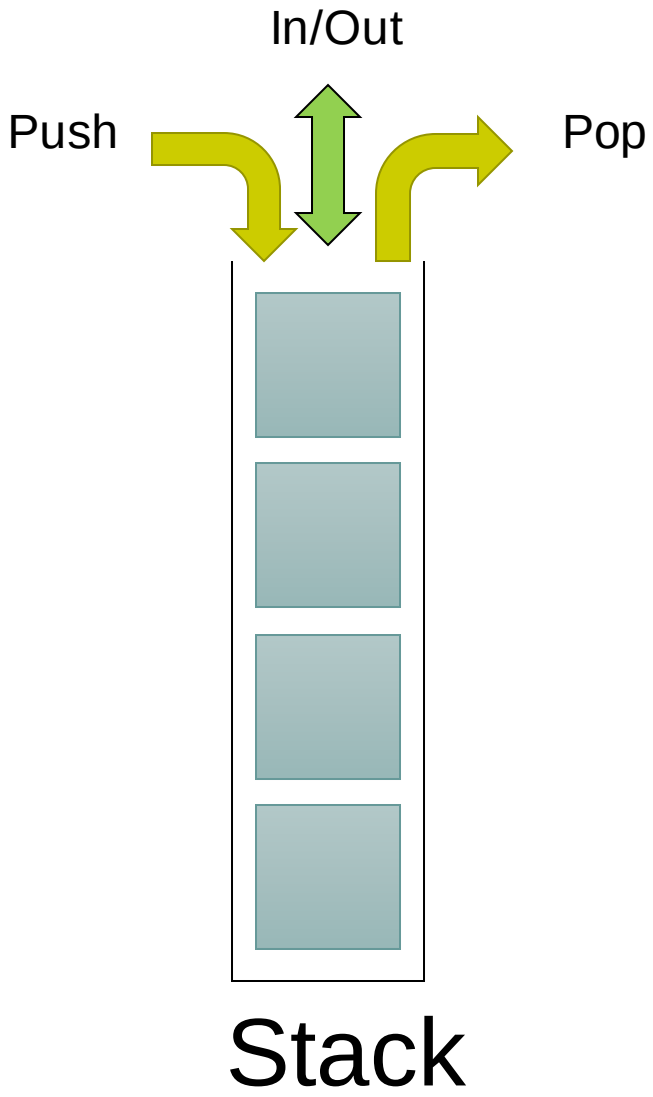
Stack

- LIFO: Last-in First-out



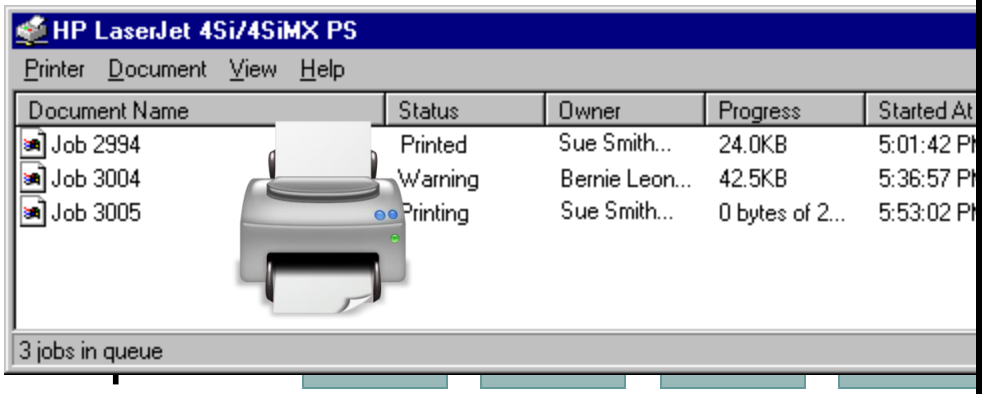


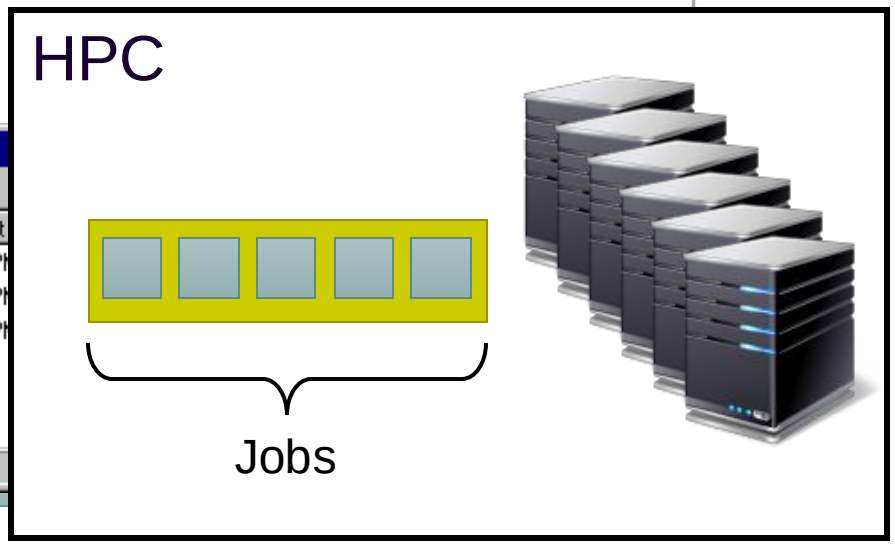
Function call/return



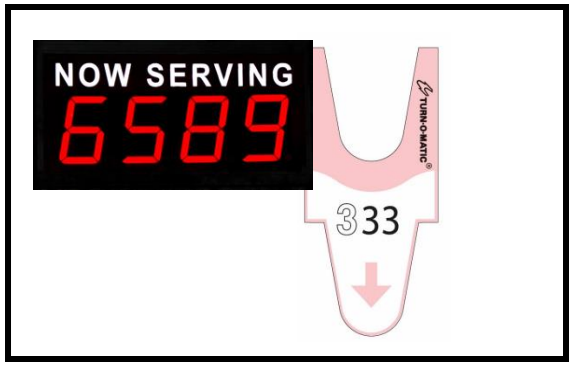
Queue

- FIFO: First-in First-out





Queue



Queue and Stack ADT

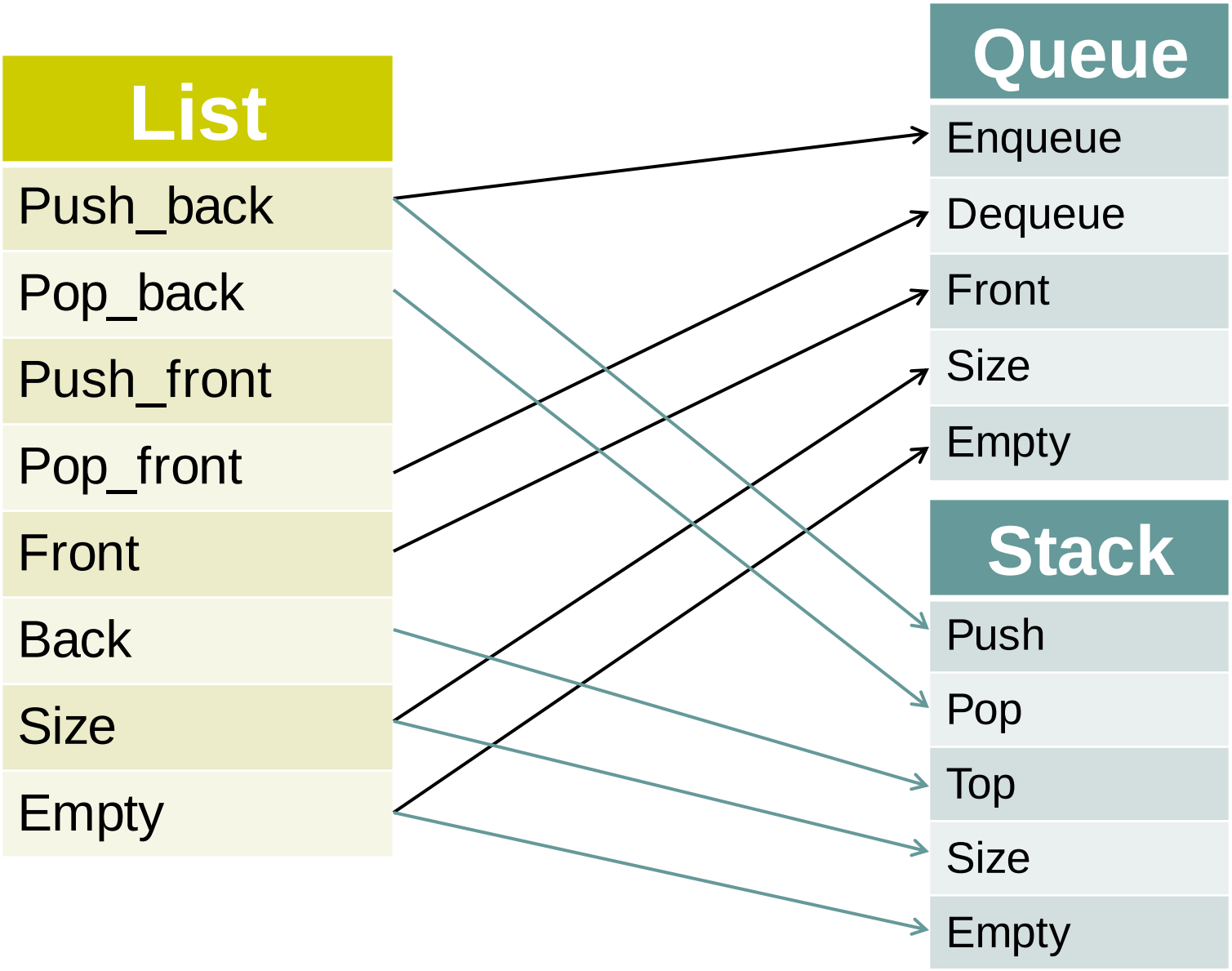
Queue

- Enqueue
- Dequeue
- Front
- Size
- Empty?

Stack

- Push
- Pop
- Top
- Size
- Empty?

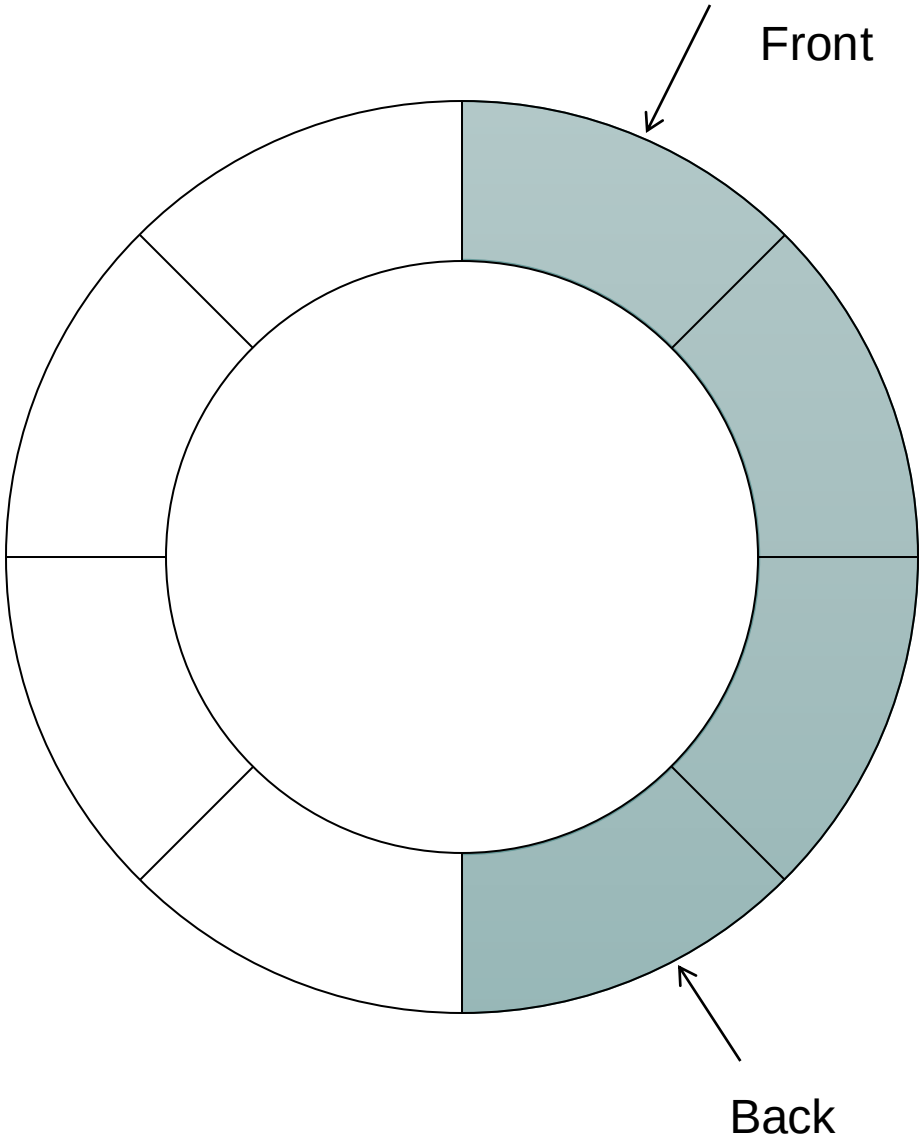
Stack/Queue Implementation



Queue Implementation

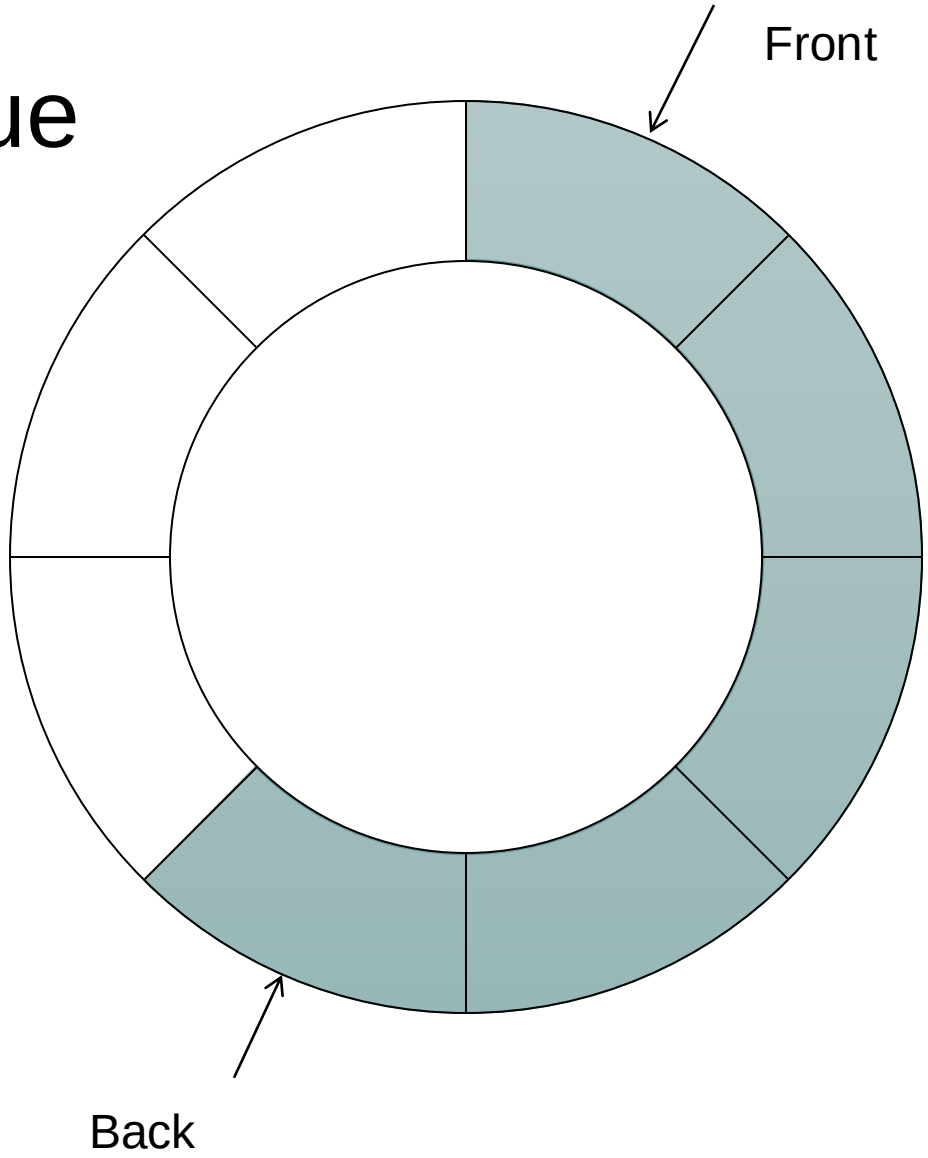
Queue	Array Impl.	Linked List Impl.
Enqueue	O(1)	O(1)
Dequeue	O(n)	O(1)
Front	O(1)	O(1)
Memory overhead	Small	Big
Random access	O(1)	O(n)

Circular Array Queue



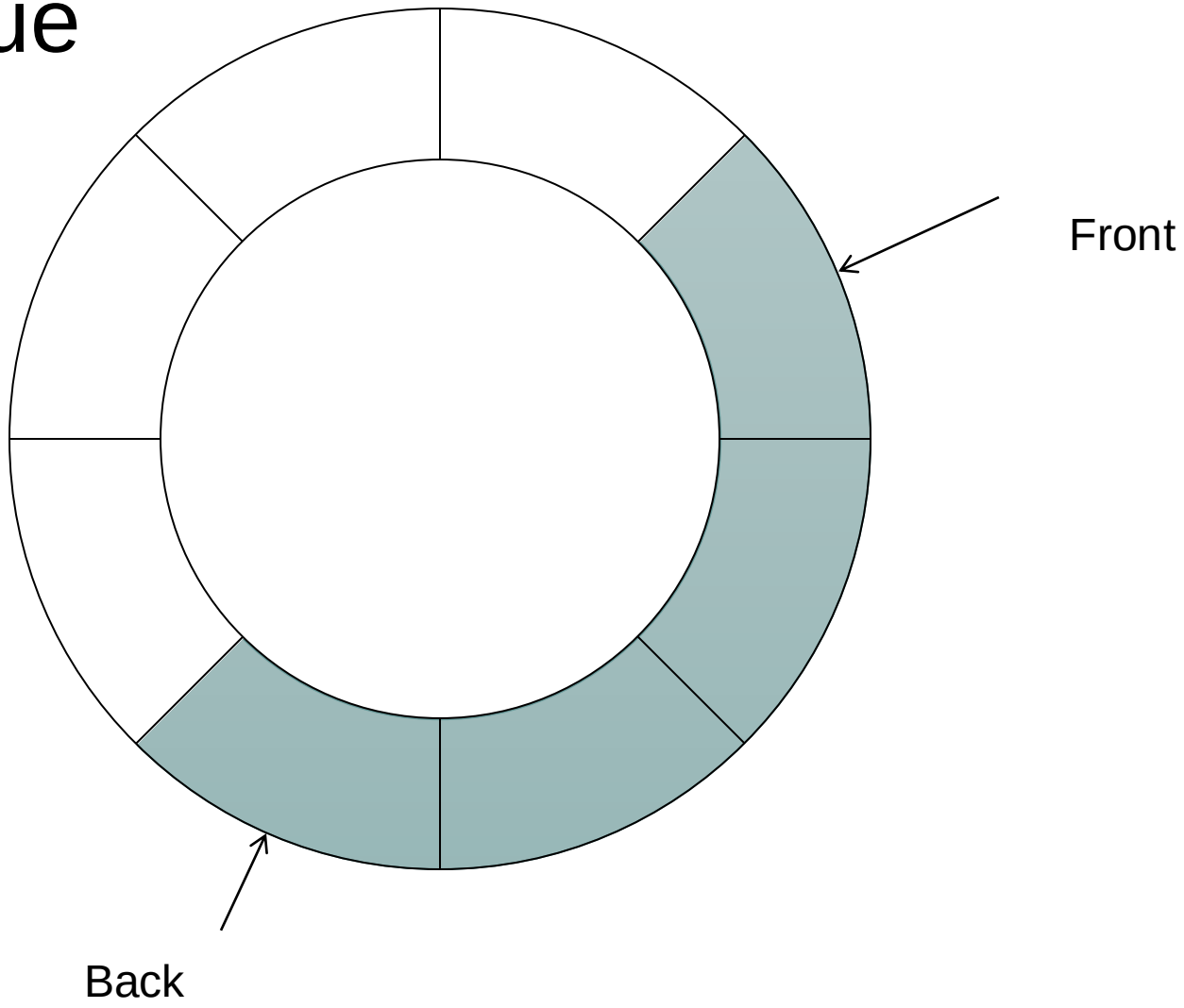
Circular Array Queue

Enqueue

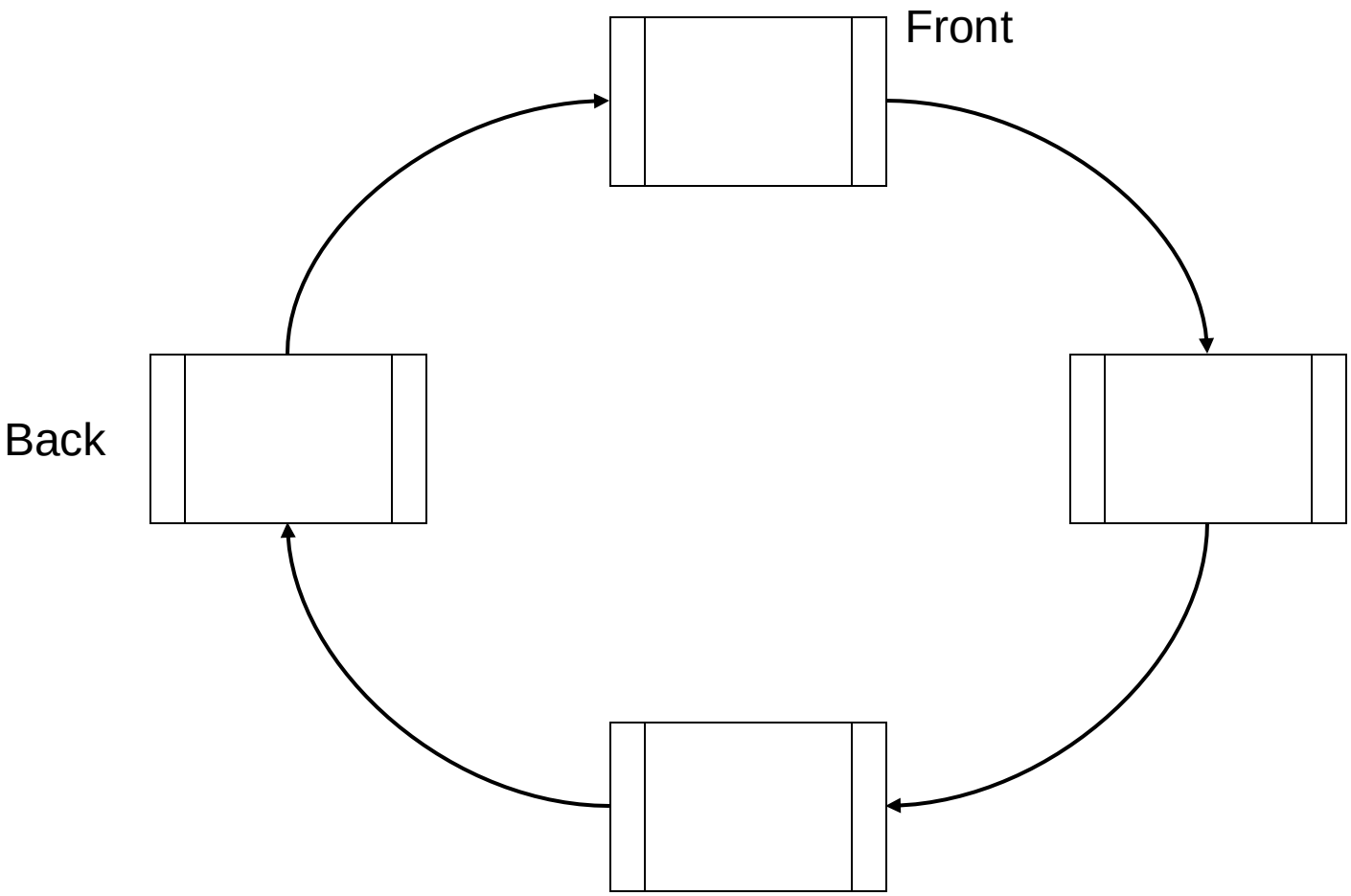


Circular Array Queue

Dequeue



Circular Linked List Queue



Queue Implementation

Queue	Circular Array Impl.	Circular Linked List Impl.
Enqueue	O(1)	O(1)
Dequeue	O(1)	O(1)
Front	O(1)	O(1)
Memory overhead	Small	Big

Standard Template Library (STL)

- Lists, stacks, and queues are all implemented in STL
- In a *real* program, you would better use them; why?
- For the sake of learning, you are not allowed to use STL during this class unless otherwise mentioned

Stack Applications

- Expression evaluation
- Human-friendly infix expressions
  - The operator falls between the two operands

$$3 + 2 \times 5 = 13$$

  - Easier to read and understand
  - Can be easily broken into pieces
- Machine-friendly postfix expressions
  - The operator is placed *after* the two operands

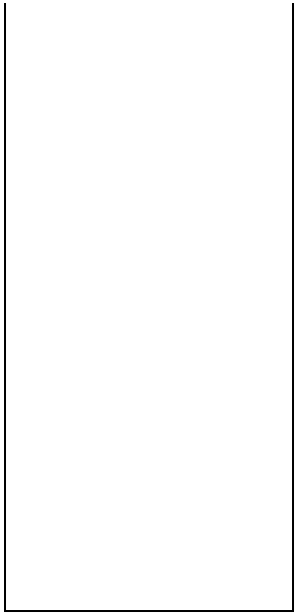
$$325 \times + = 13$$

  - Easier to compute in one pass
  - No need for parentheses

Evaluate postfix expressions

- Infix: $(3 \times 5 + 4/2) \times 2 = 34$
- Postfix: $35 \times 42/+2 \times$

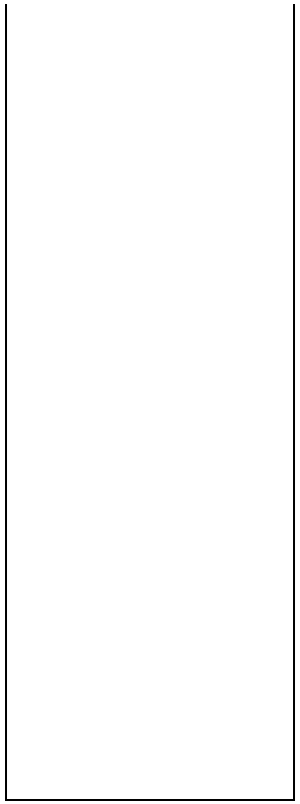
3	5	×	4	2	/	+	2	×



Stack of operands

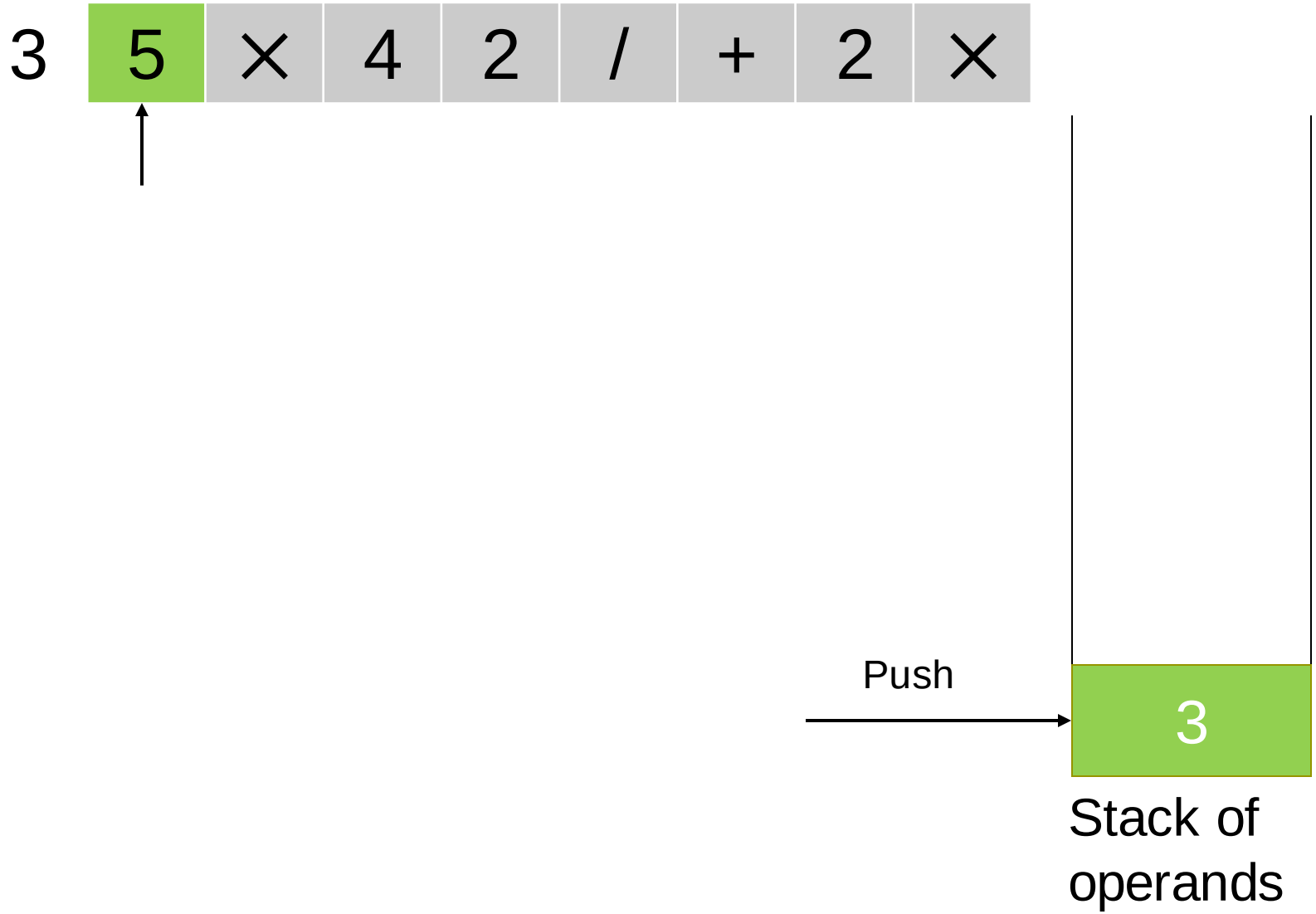
Postfix Evaluation Example

3	5	×	4	2	/	+	2	×

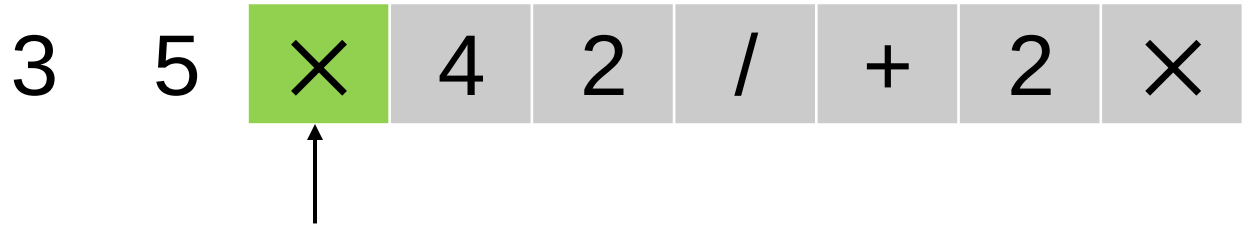


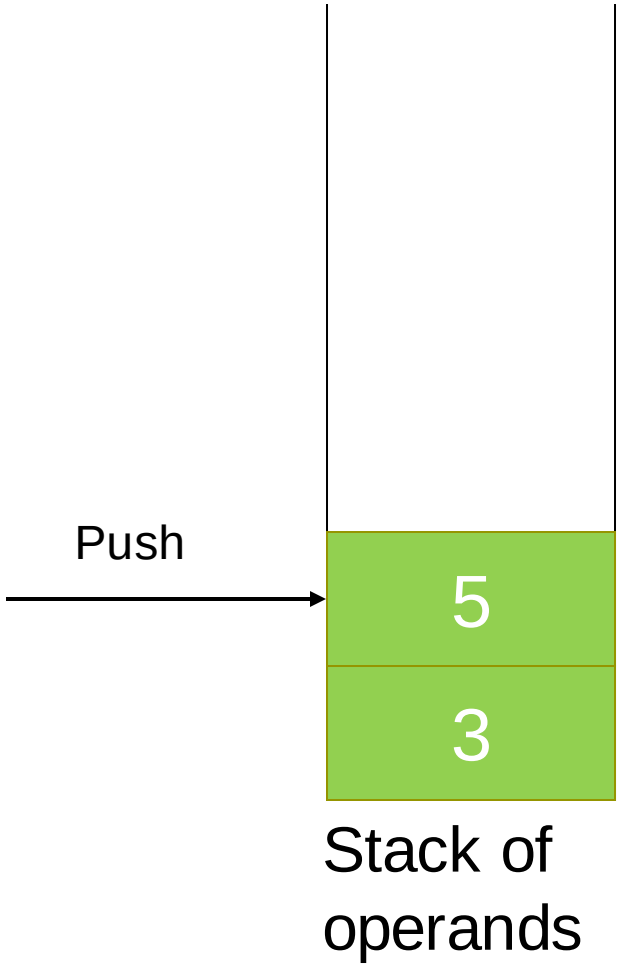
Stack of operands

Postfix Evaluation Example

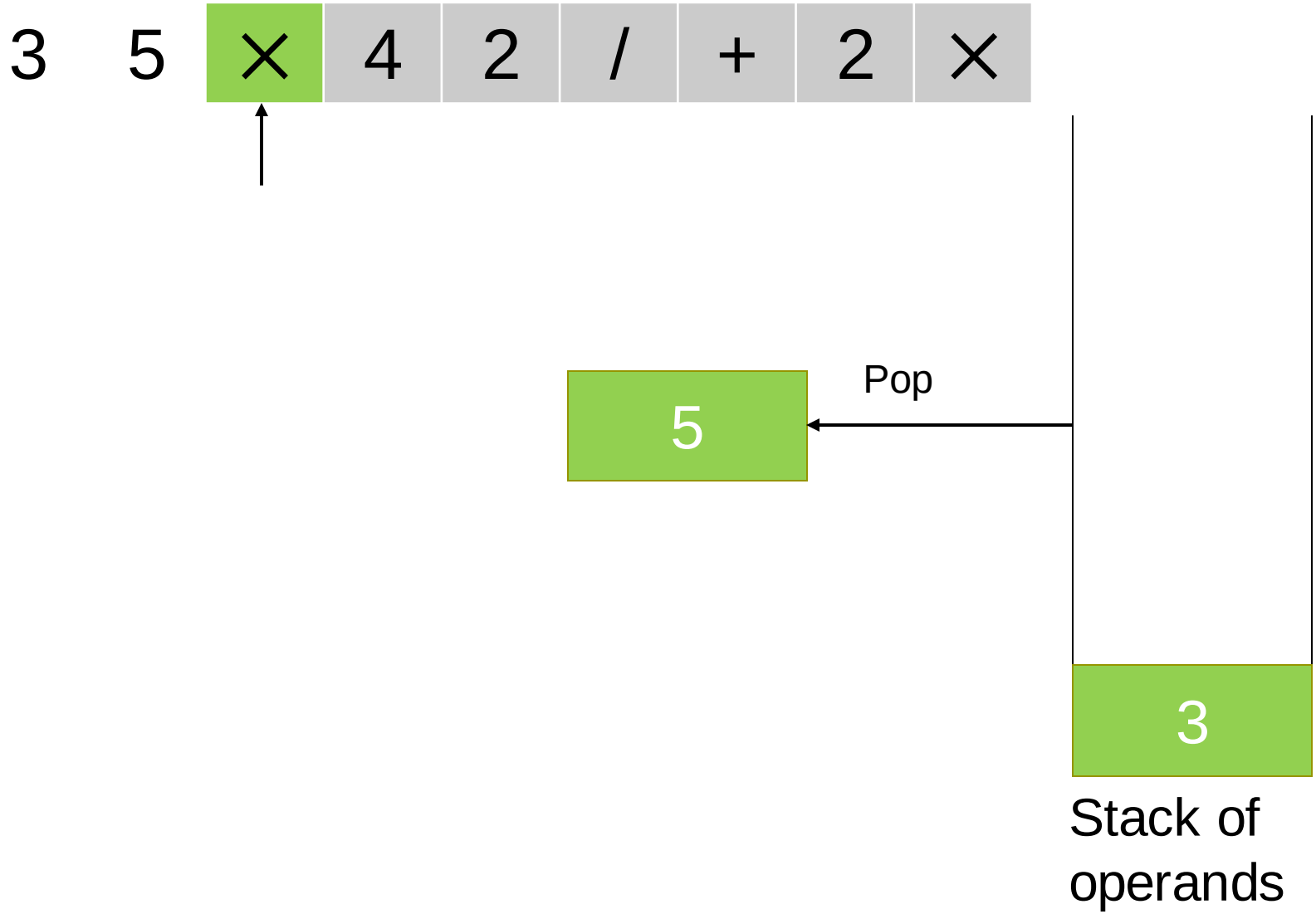


Postfix Evaluation Example

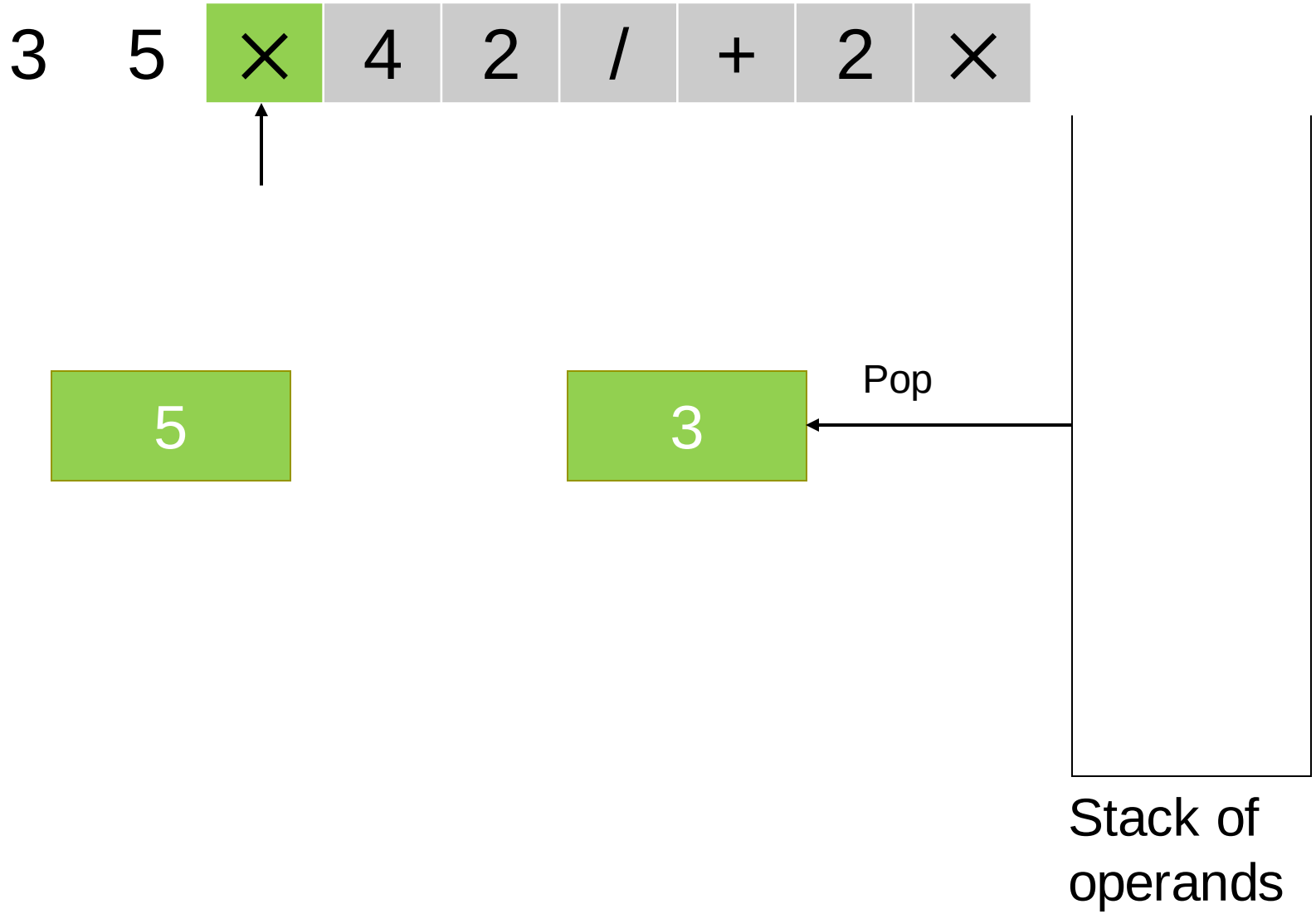




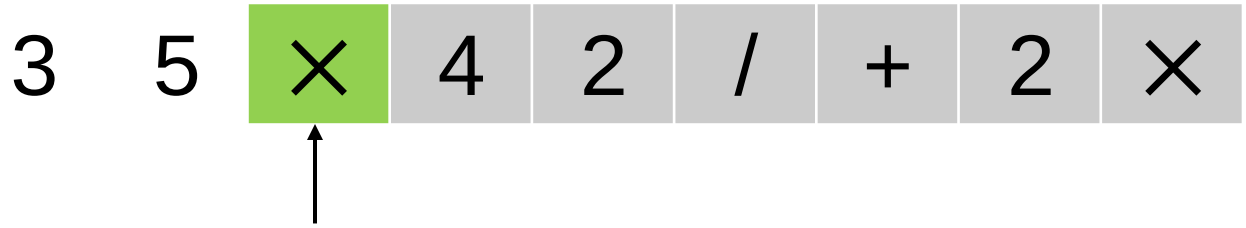
Postfix Evaluation Example

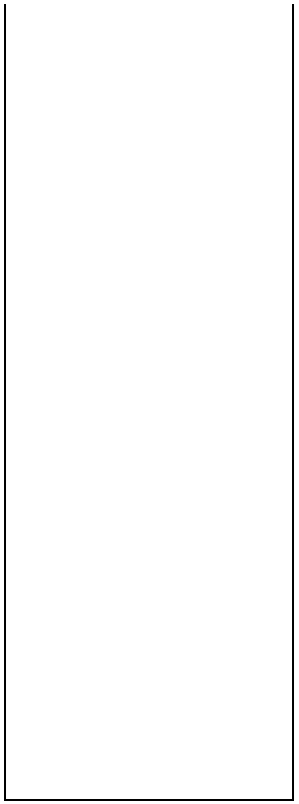


Postfix Evaluation Example



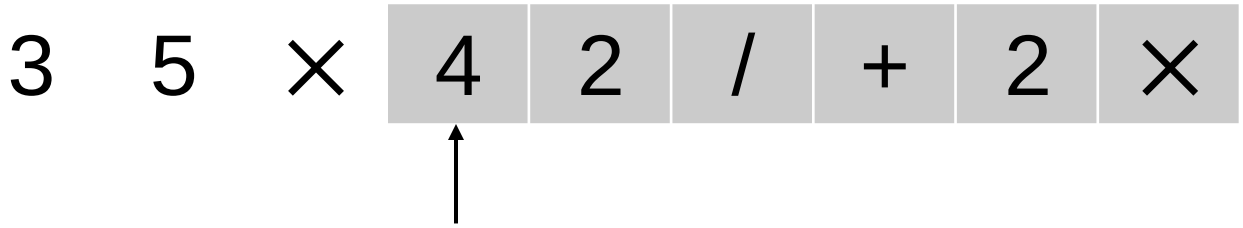
Postfix Evaluation Example

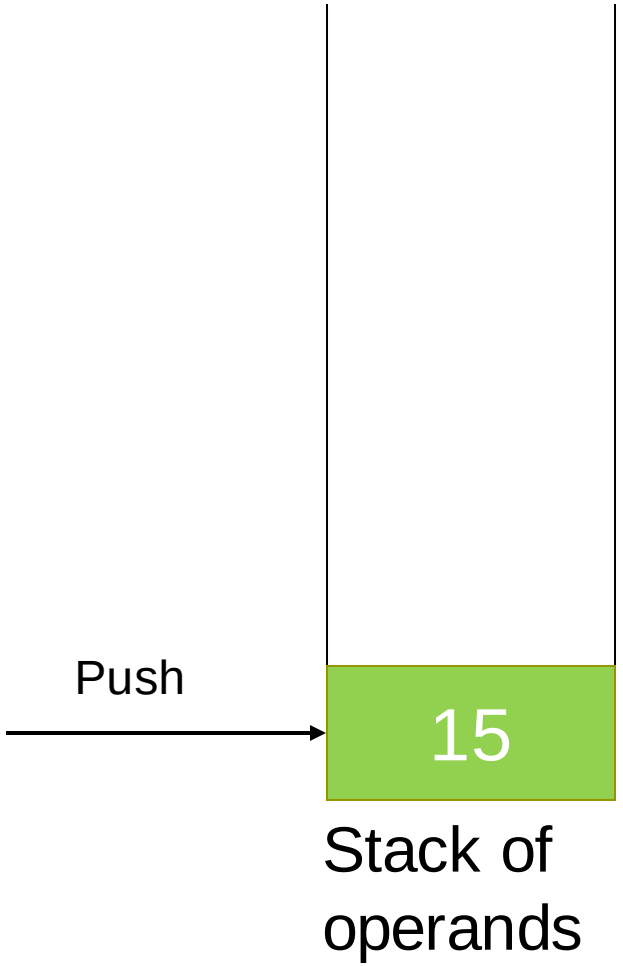




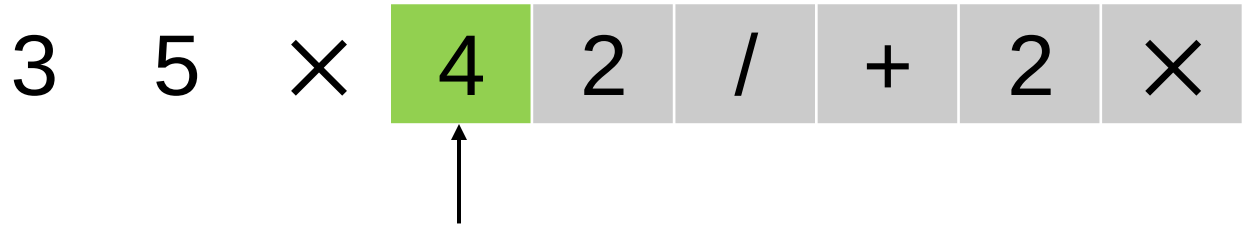
Stack of operands

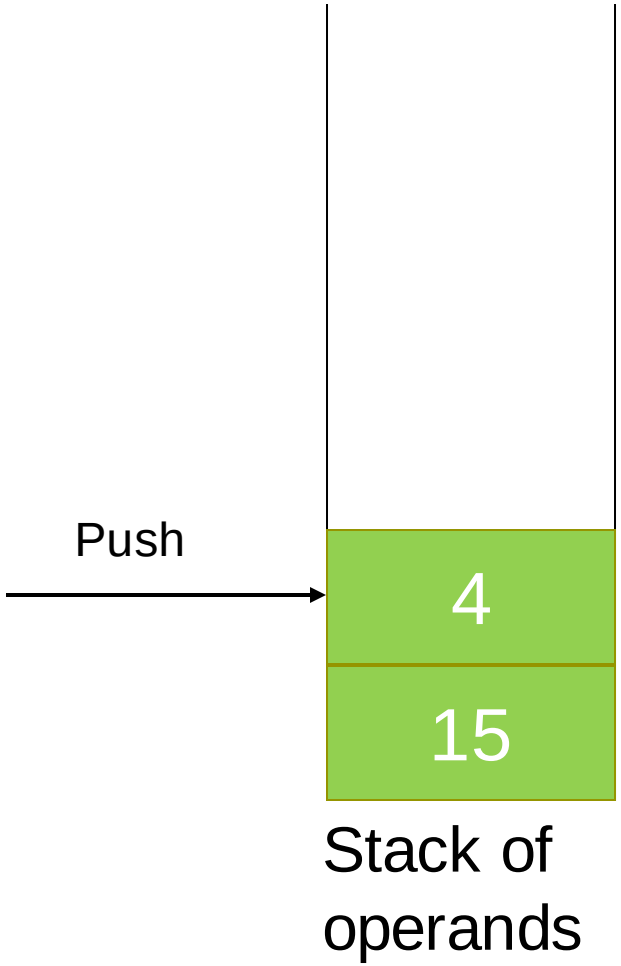
Postfix Evaluation Example



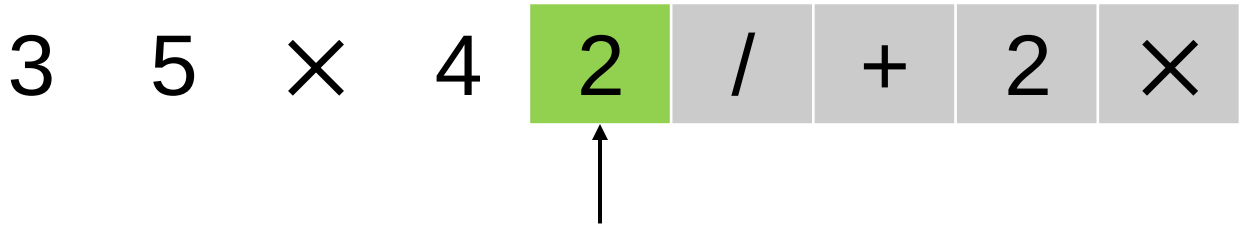


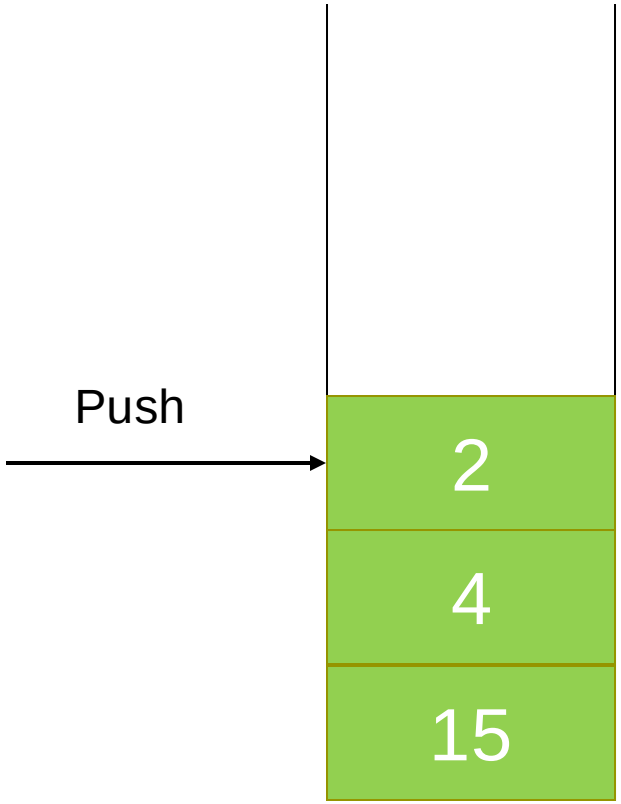
Postfix Evaluation Example



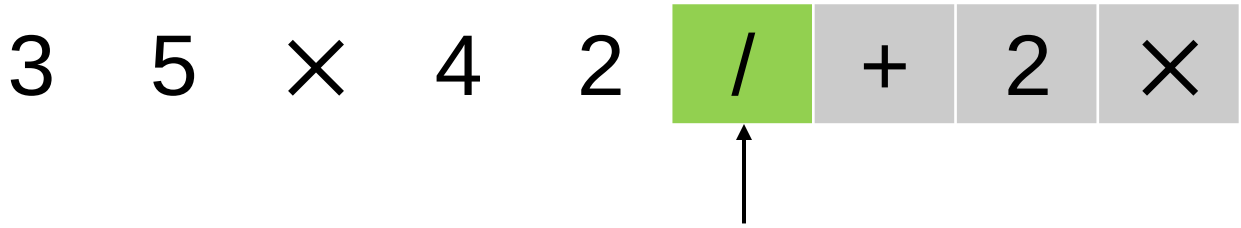


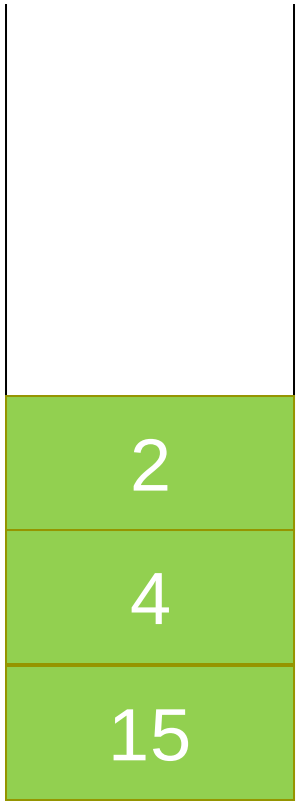
Postfix Evaluation Example





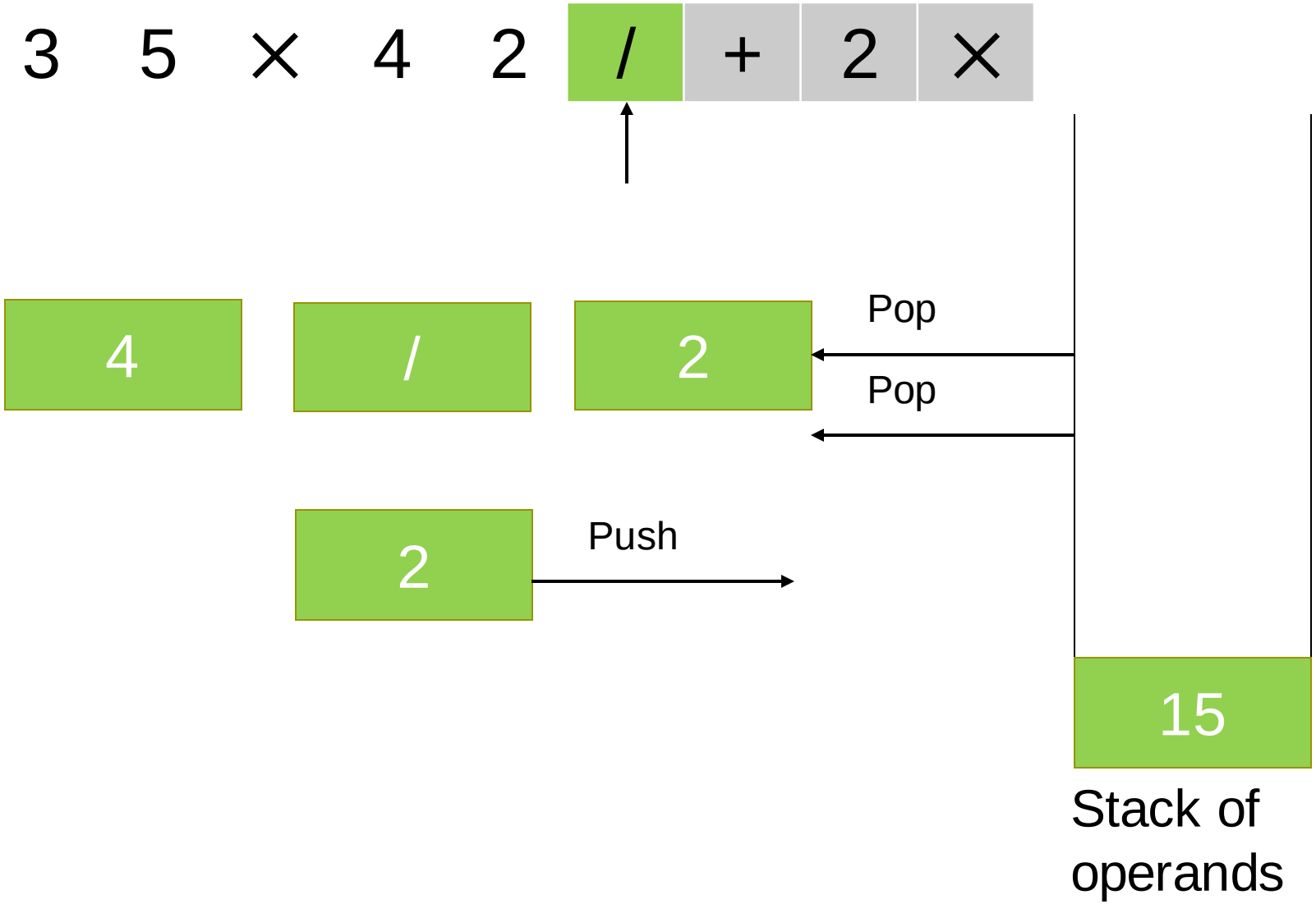
Postfix Evaluation Example



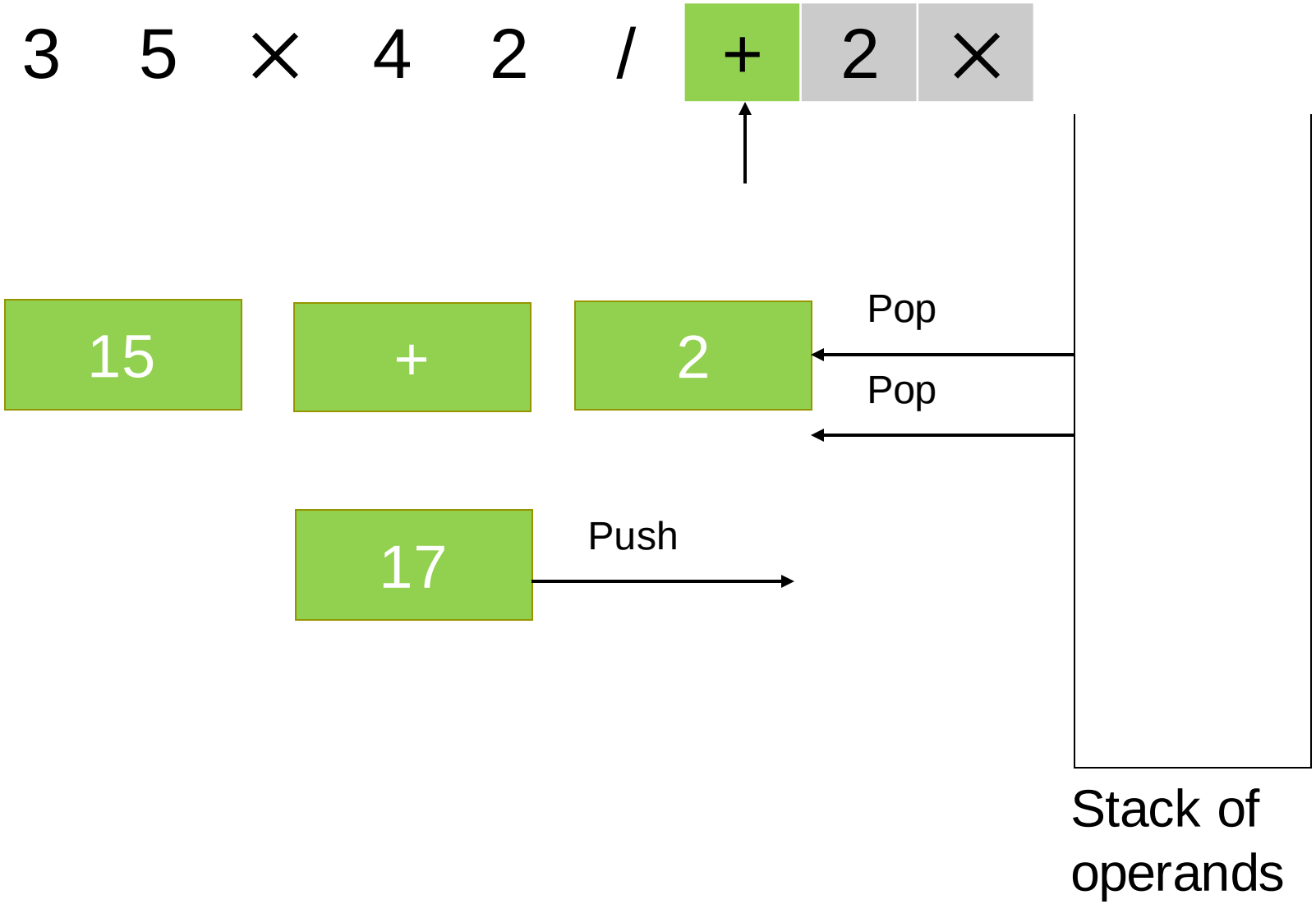


Stack of operands

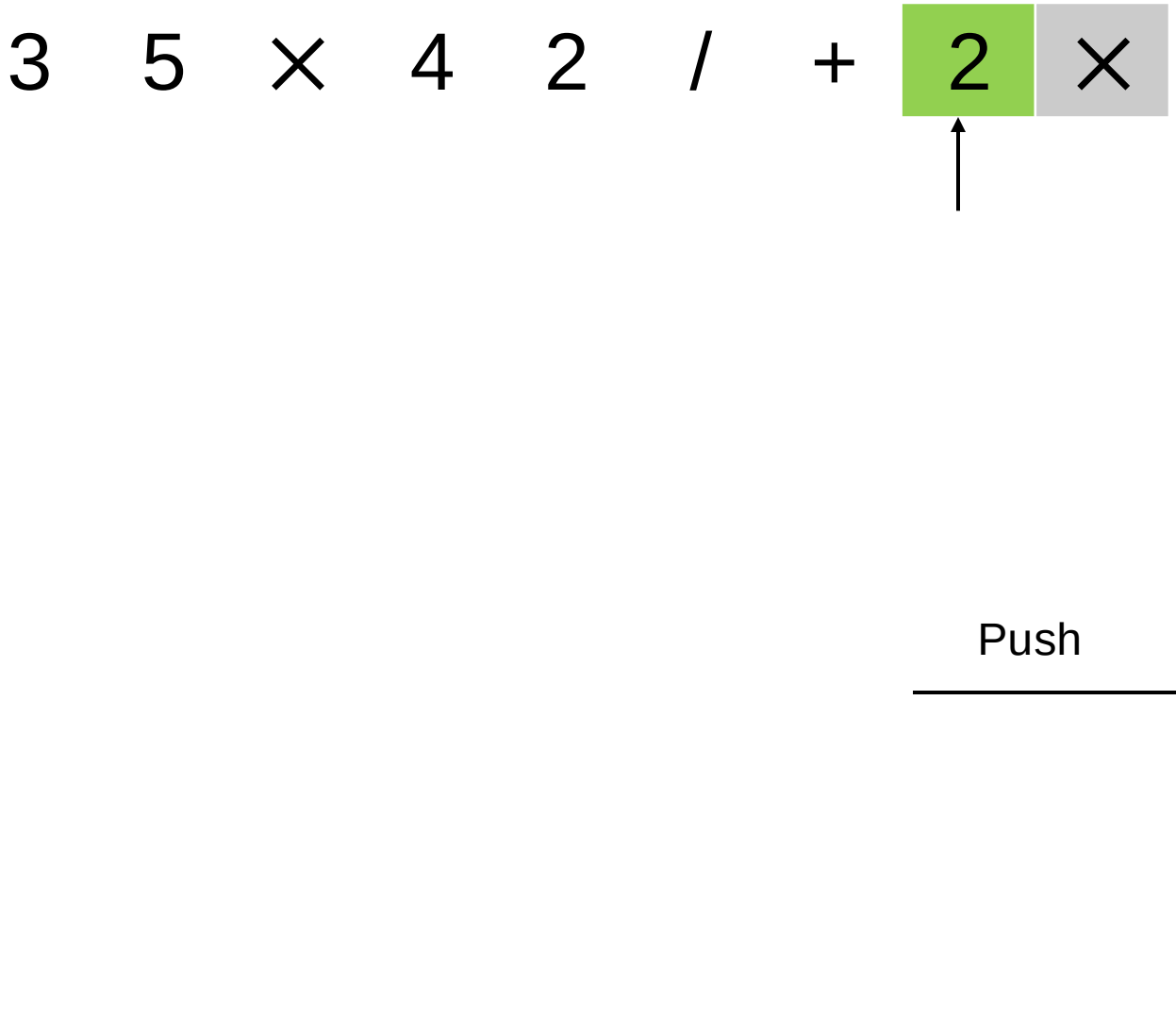
Postfix Evaluation Example



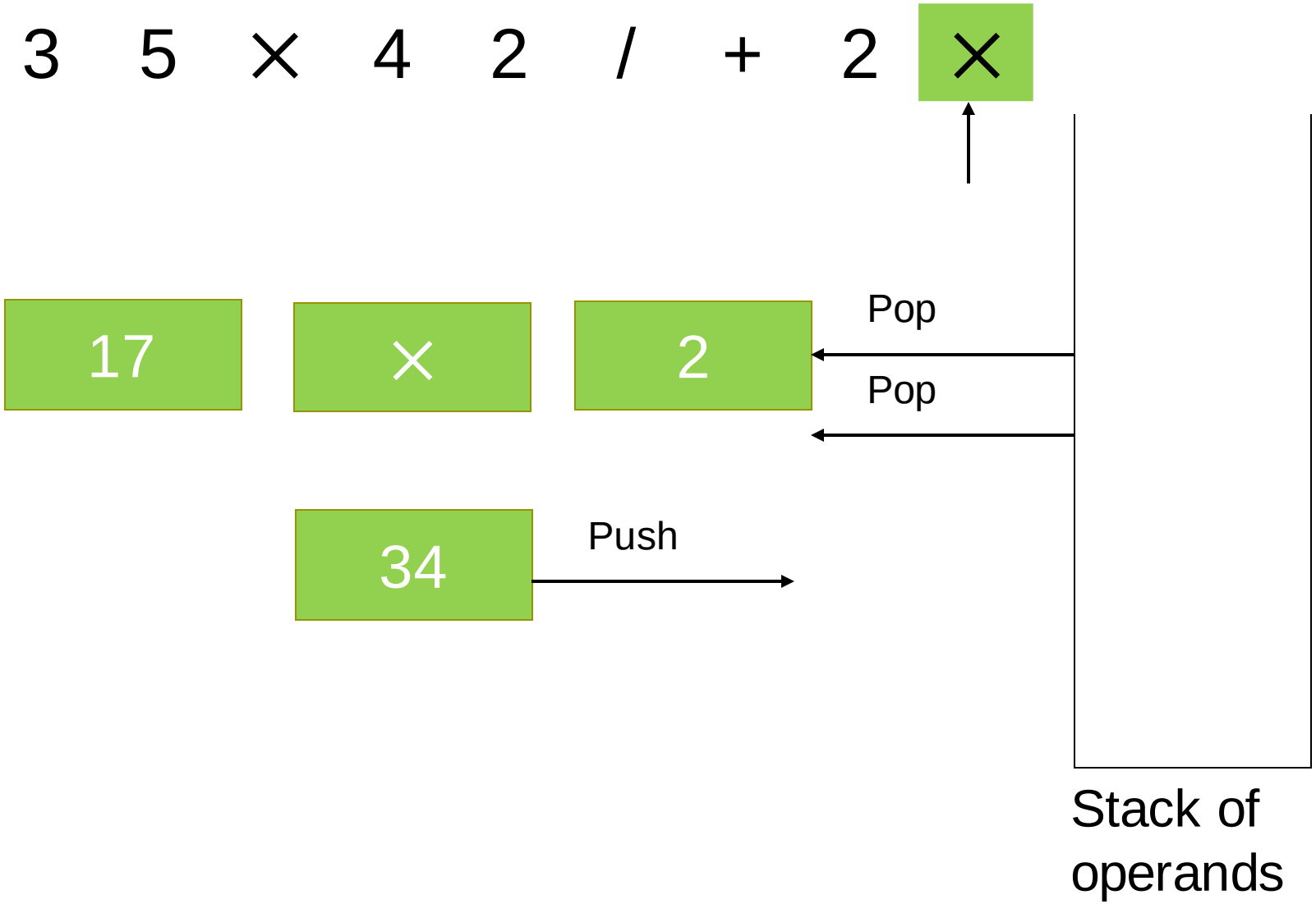
Postfix Evaluation Example



Postfix Evaluation Example

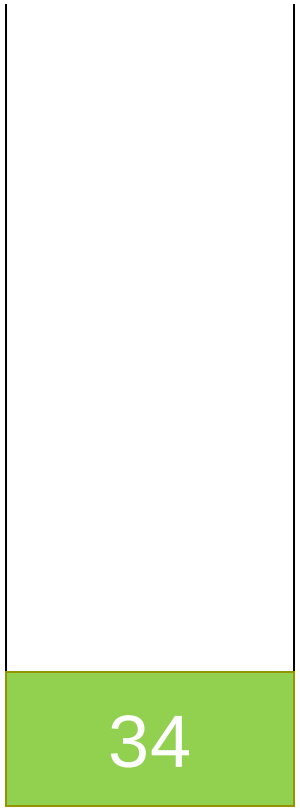


Postfix Evaluation Example



Postfix Evaluation Example

3 5 × 4 2 / + 2 ×



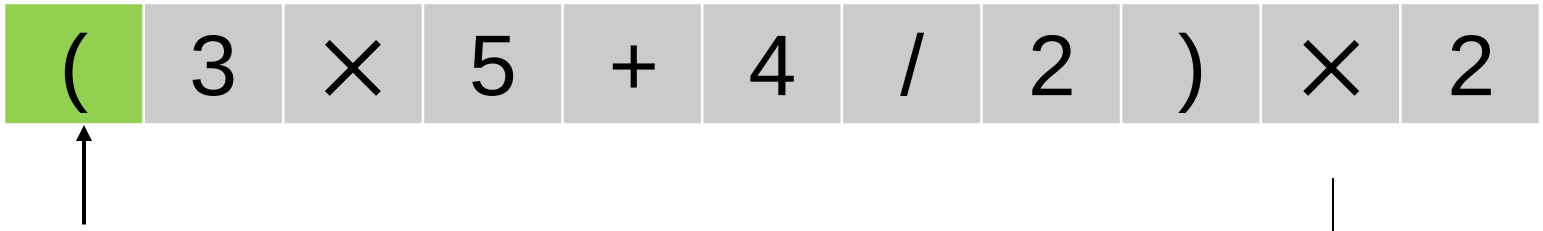
Stack of operands

Infix to Postfix Conversion

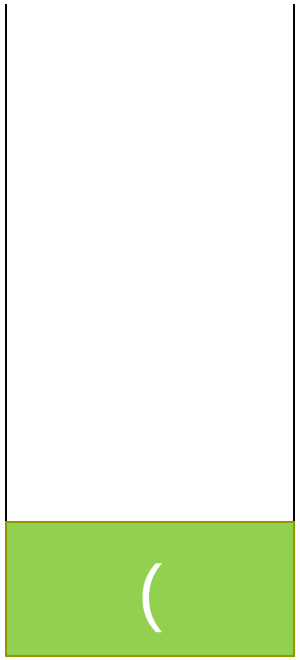
- Convert the input into a sequence of operators and operands
- Account for operator precedence
- Account for parentheses
- Example
  - Infix (input): $(3 \times 5 + 4/2) \times 2$
  - Postfix (desired output): $35 \times 42/+2 \times$

Example

Input



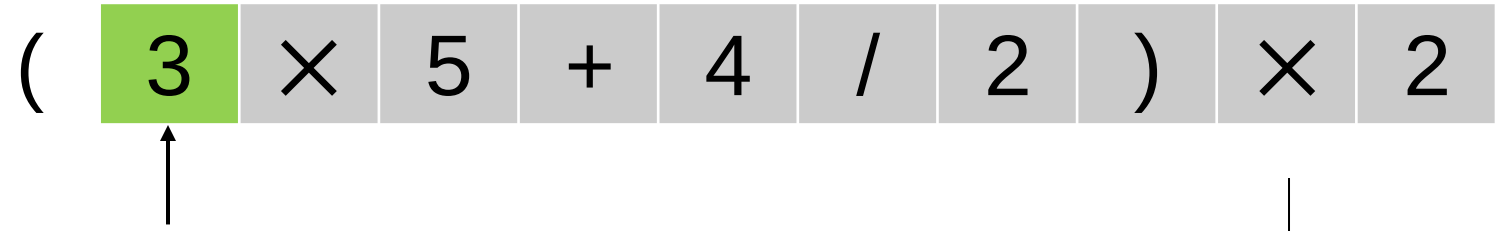
Output



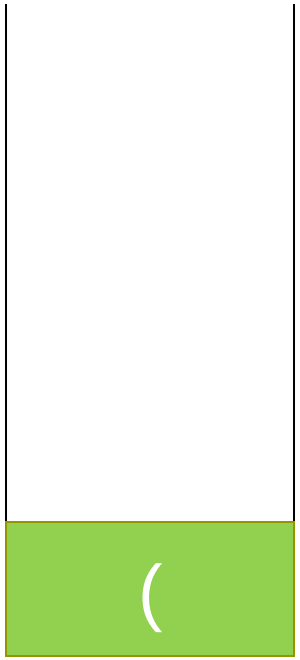
Stack of operators

Example

Input



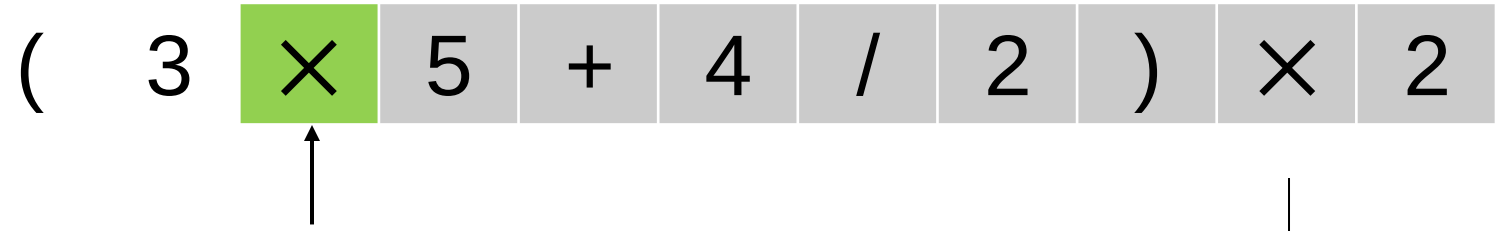
Output



Stack of operators

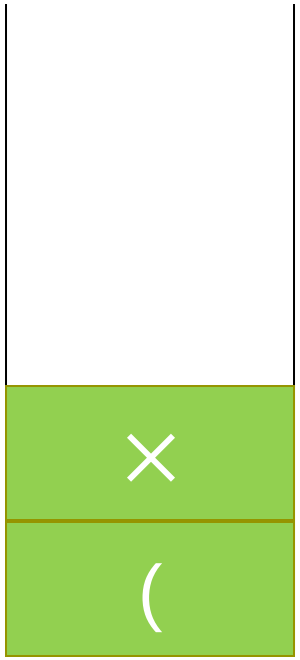
Example

Input



Output

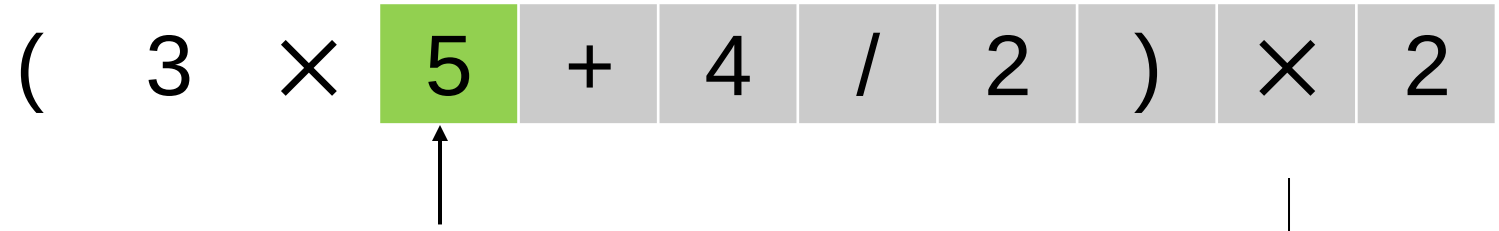
3



Stack of operators

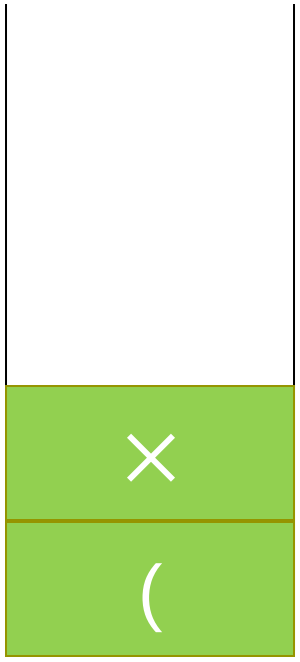
Example

Input



Output

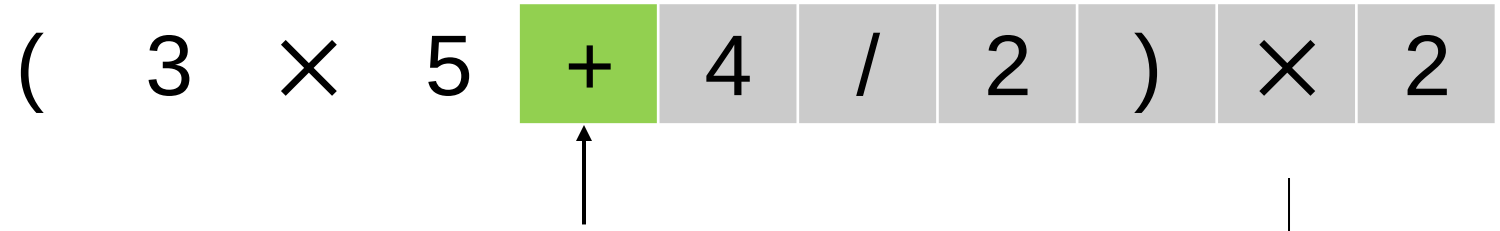
35



Stack of operators

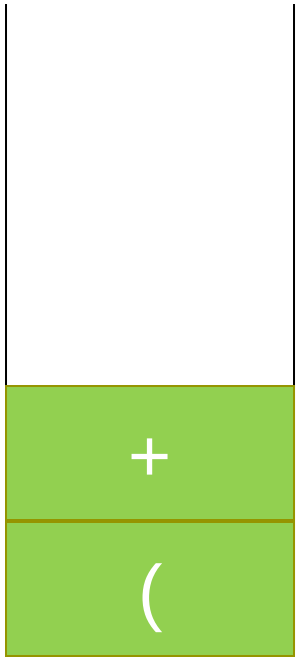
Example

Input



Output

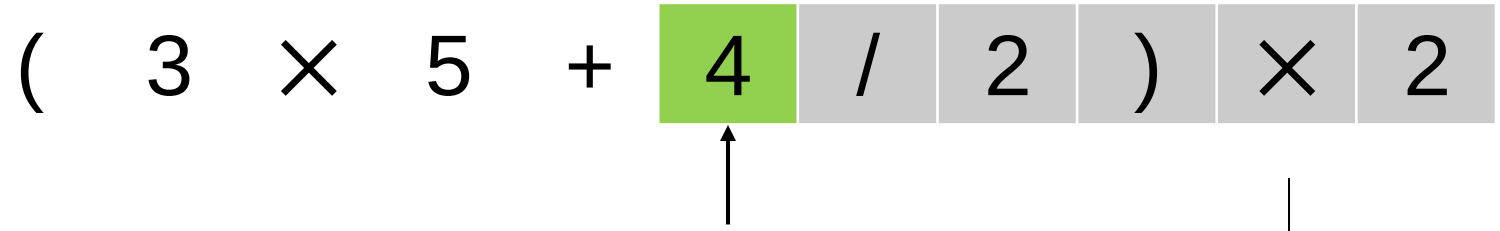
35×



Stack of operators

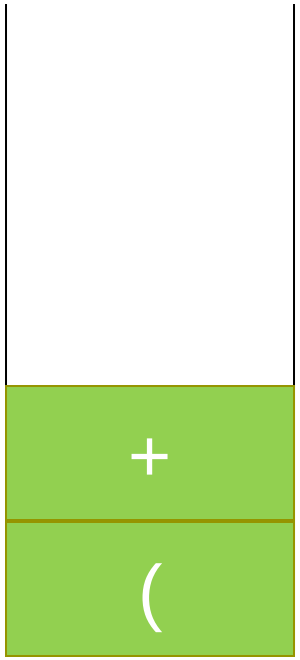
Example

Input



Output

35×4



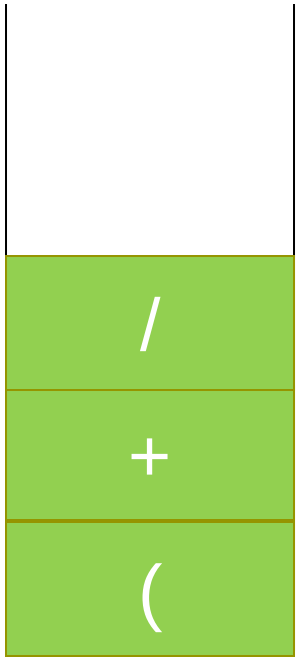
Stack of operators

Example

Input

Output

35×4



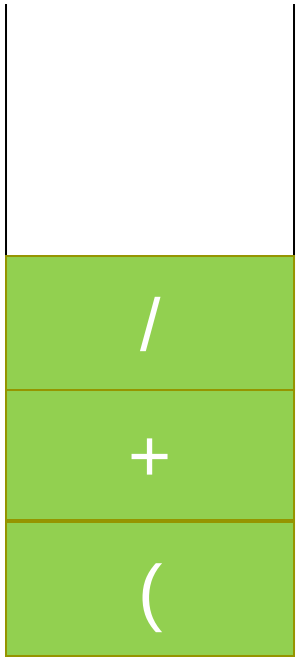
Stack of operators

Example

Input

Output

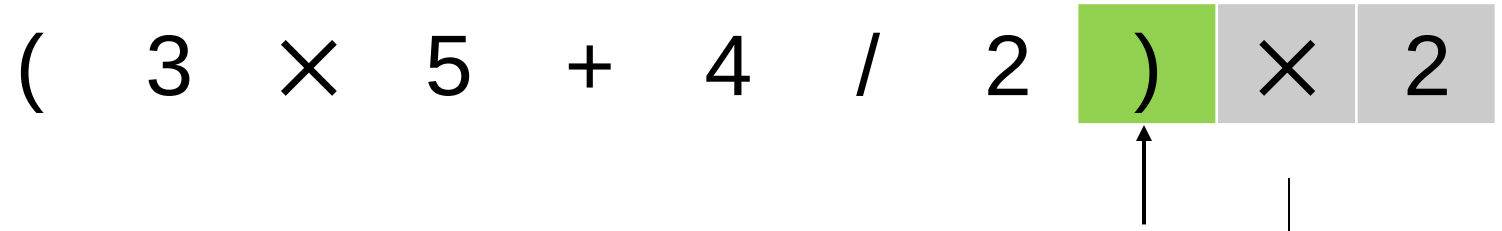
35×42



Stack of operators

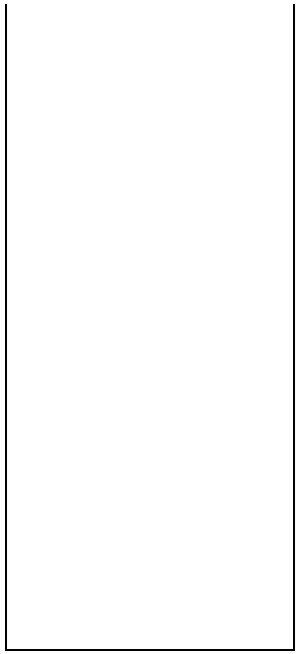
Example

Input



Output

35×42/+



Stack of operators

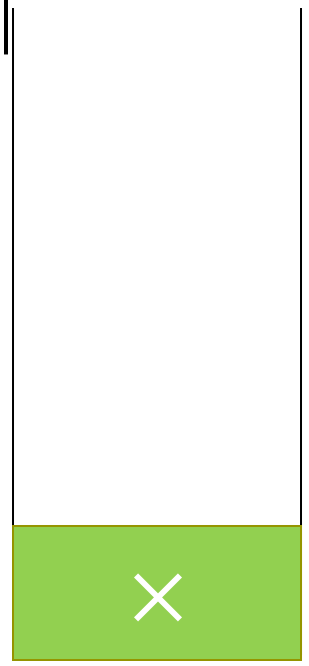
Example

Input

(3 × 5 + 4 / 2) × 2

Output

35×42/+



Stack of operators

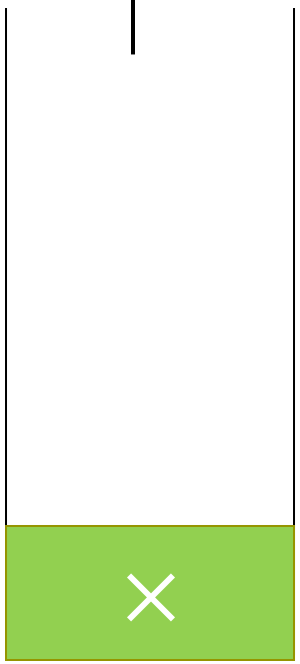
Example

Input

(3 × 5 + 4 / 2) × 2

Output

35×42/+2



Stack of operators

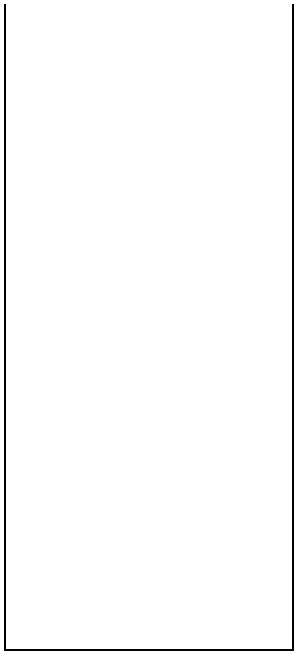
Example

Input

(3 × 5 + 4 / 2) × 2

Output

35×42/+2×



Stack of operators