Stack

Part 1/3

William Fiset

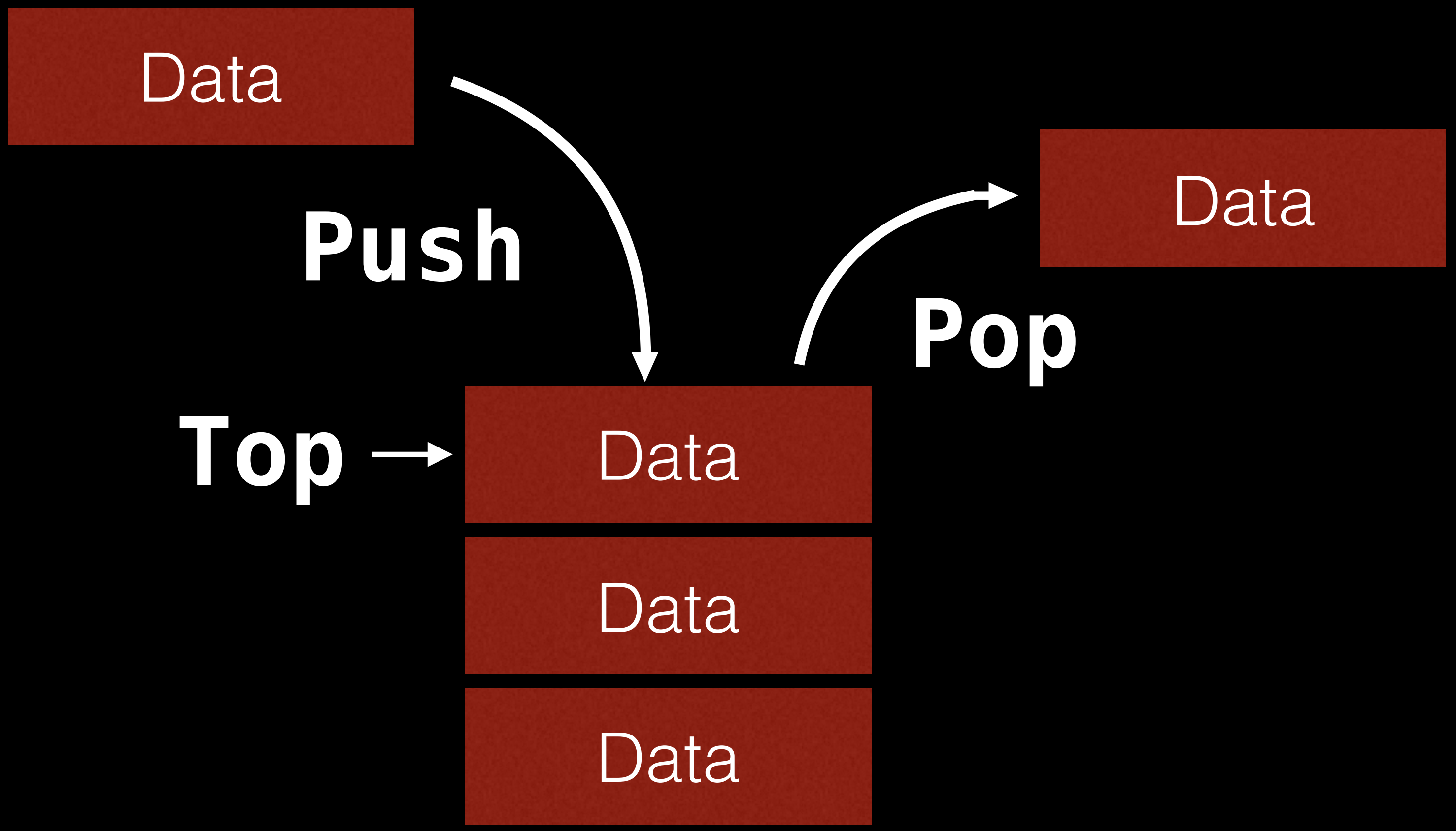
Outline

- Discussion about Stacks
  - What is a Stack?
  - When and where is a Stack used?
  - Complexity Analysis
  - Stack usage examples
- Implementation details
  - Pushing elements on stack
  - Popping elements from stack
- Code Implementation

Discussion

What is a Stack?

A stack is a one-ended linear data structure which models a real world stack by having two primary operations, namely **push** and **pop**.



What is a Stack?

Instructions

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pop()
push('Onion')
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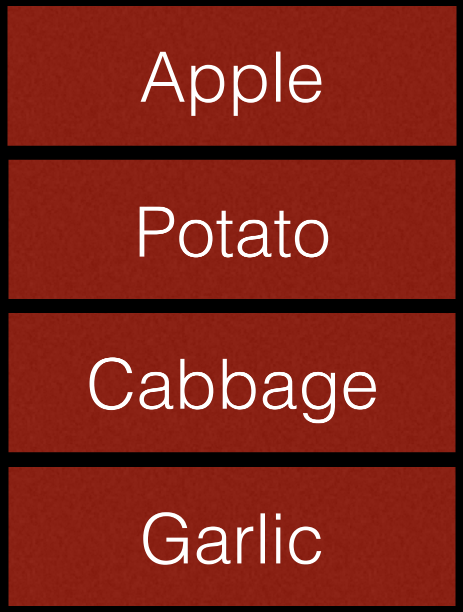

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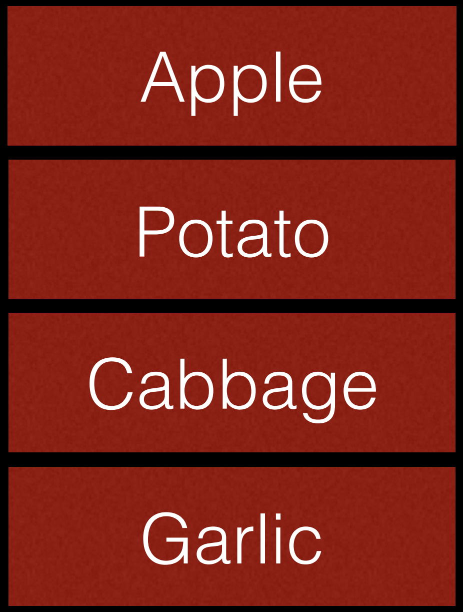

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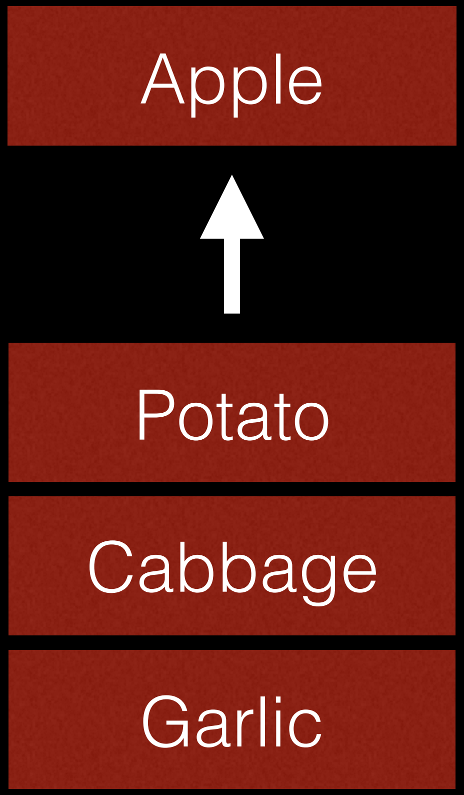

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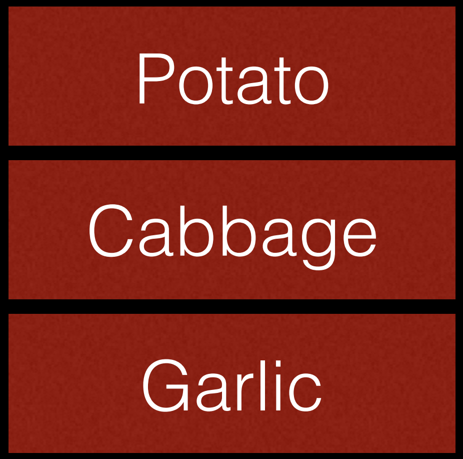

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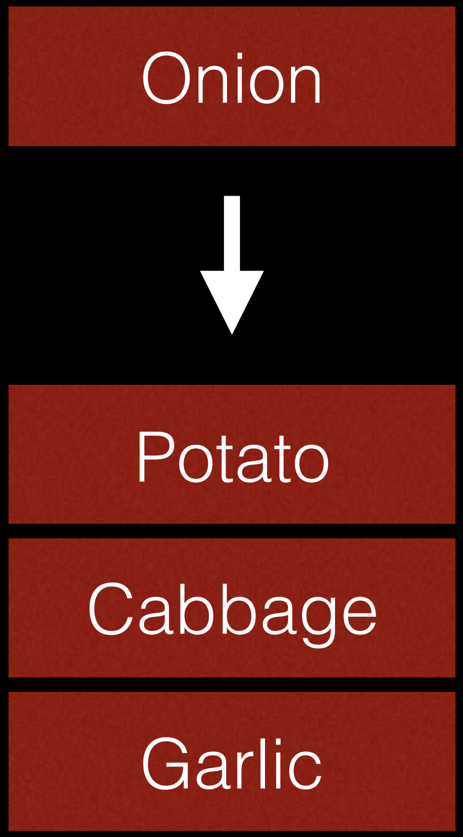

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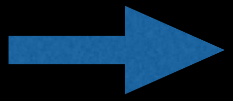

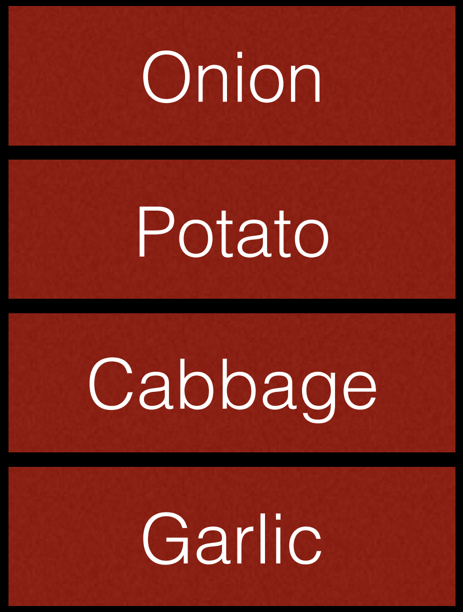

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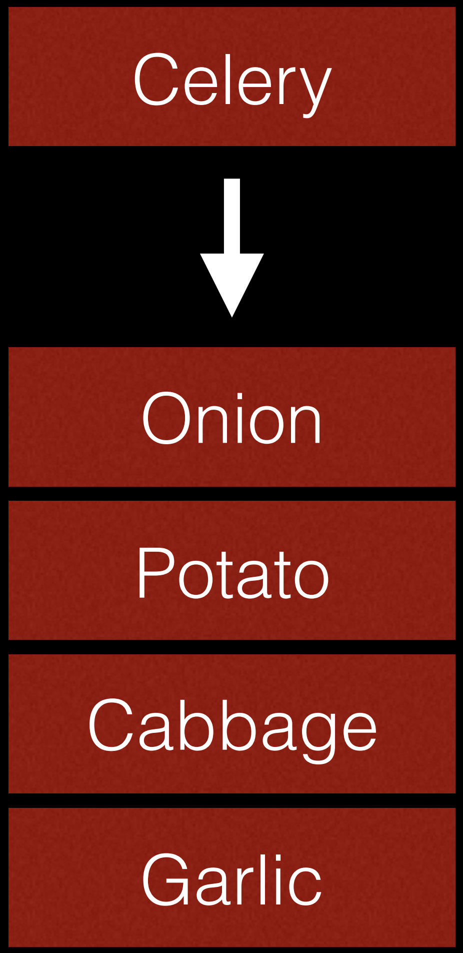

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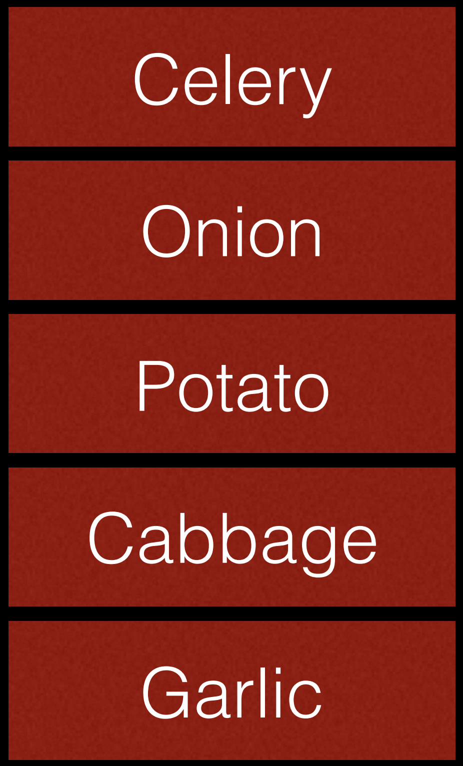

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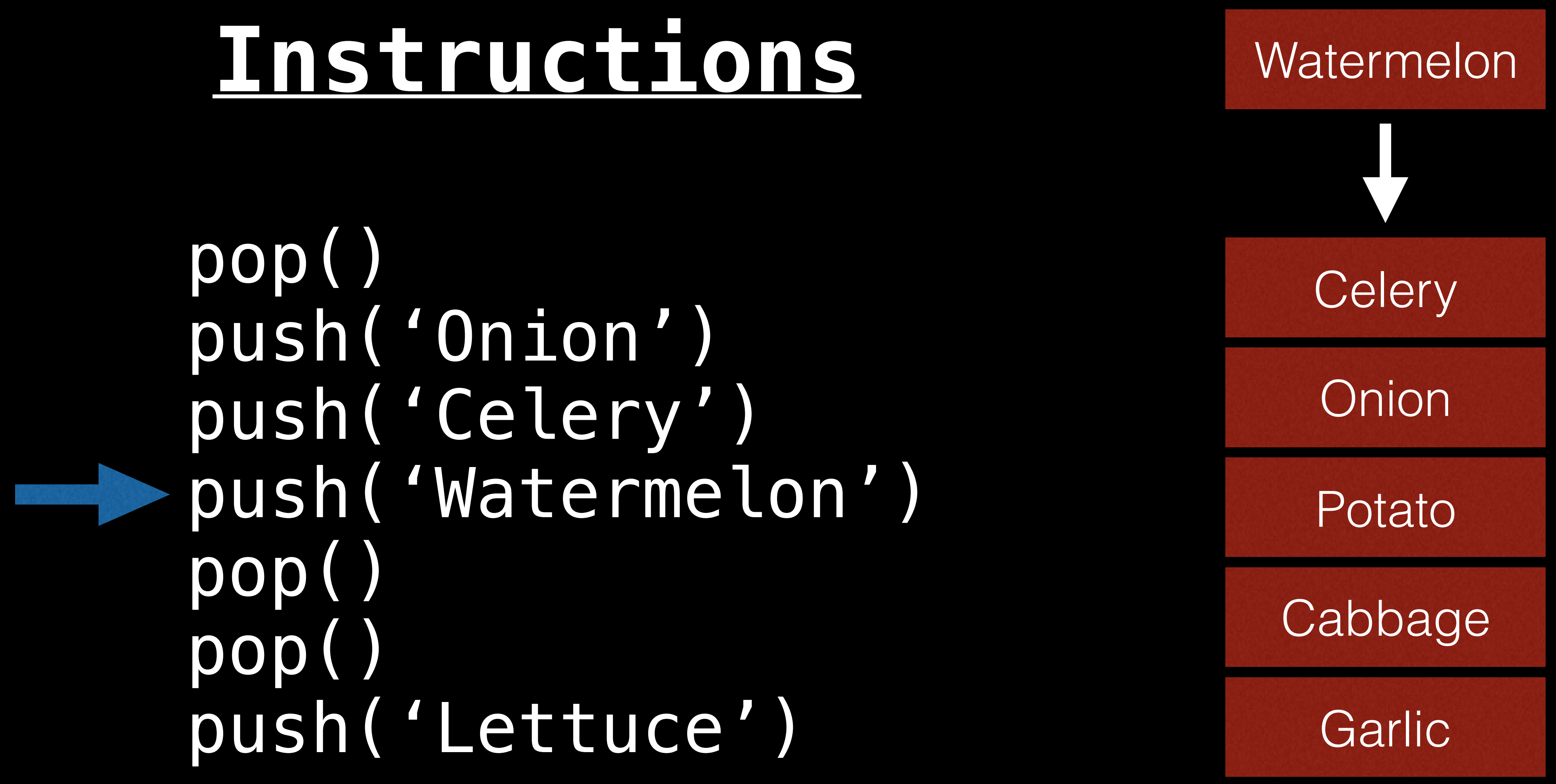

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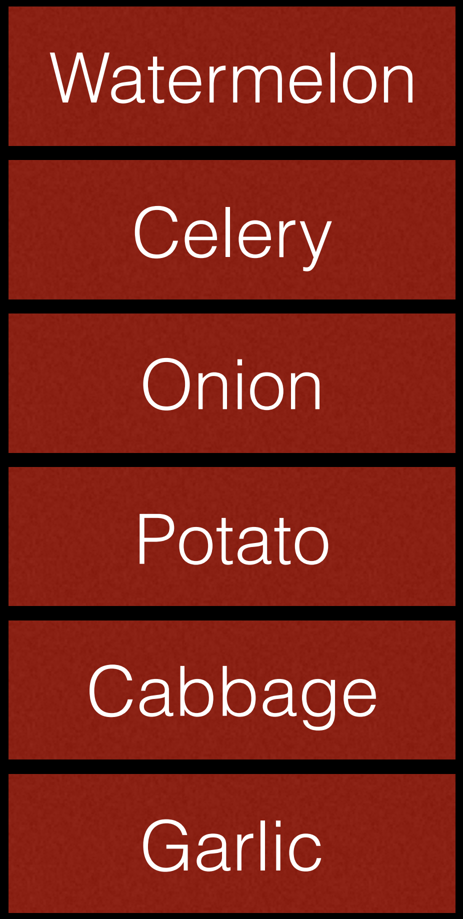

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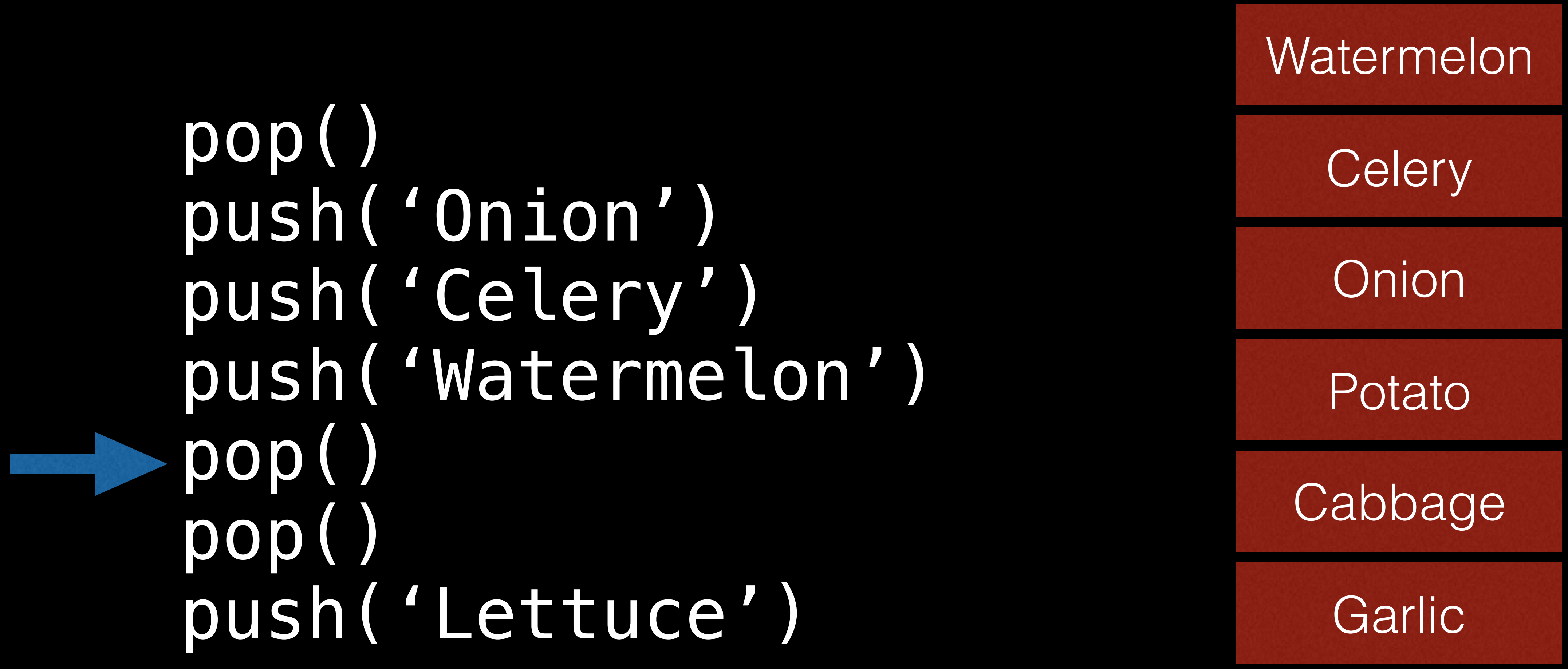

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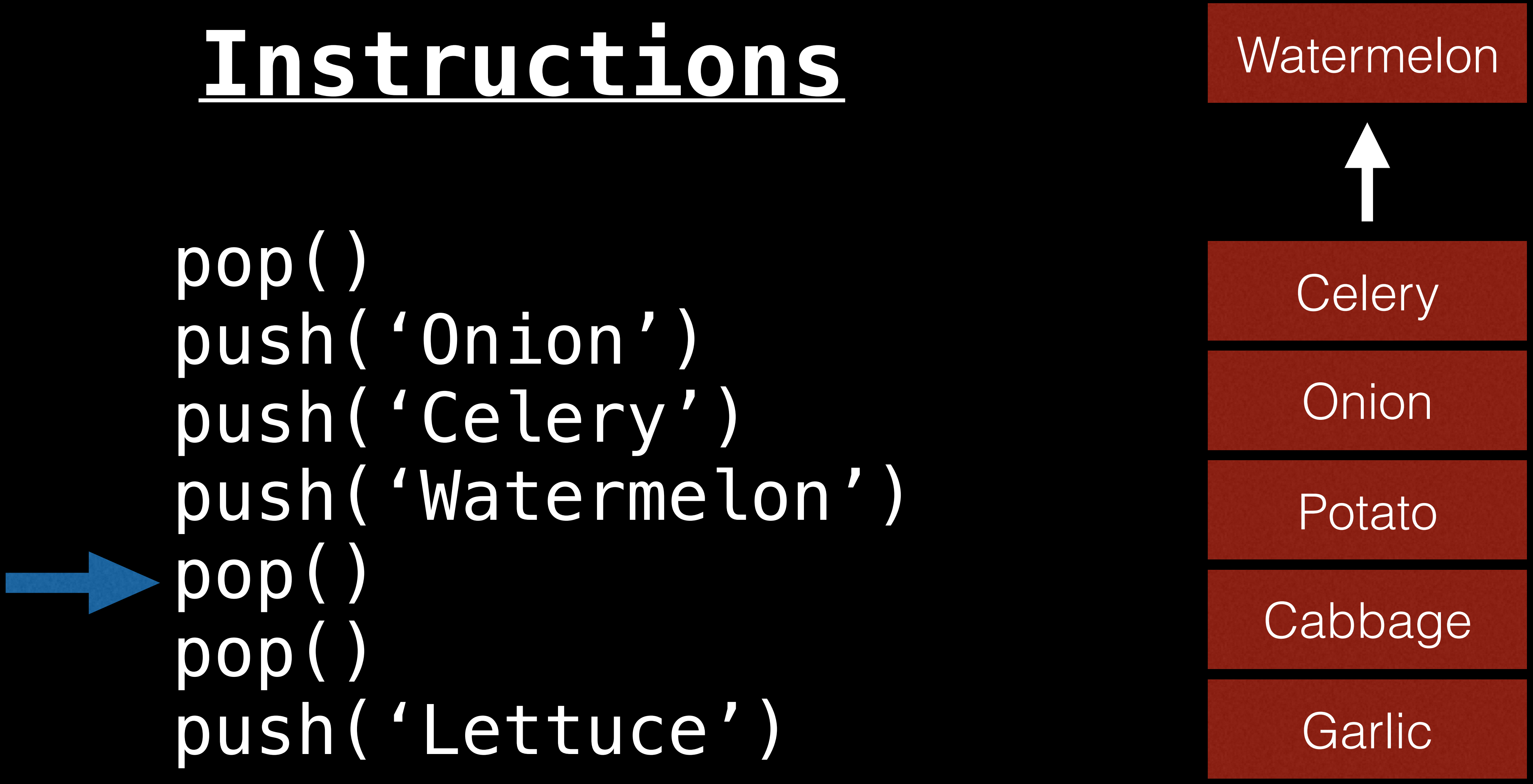

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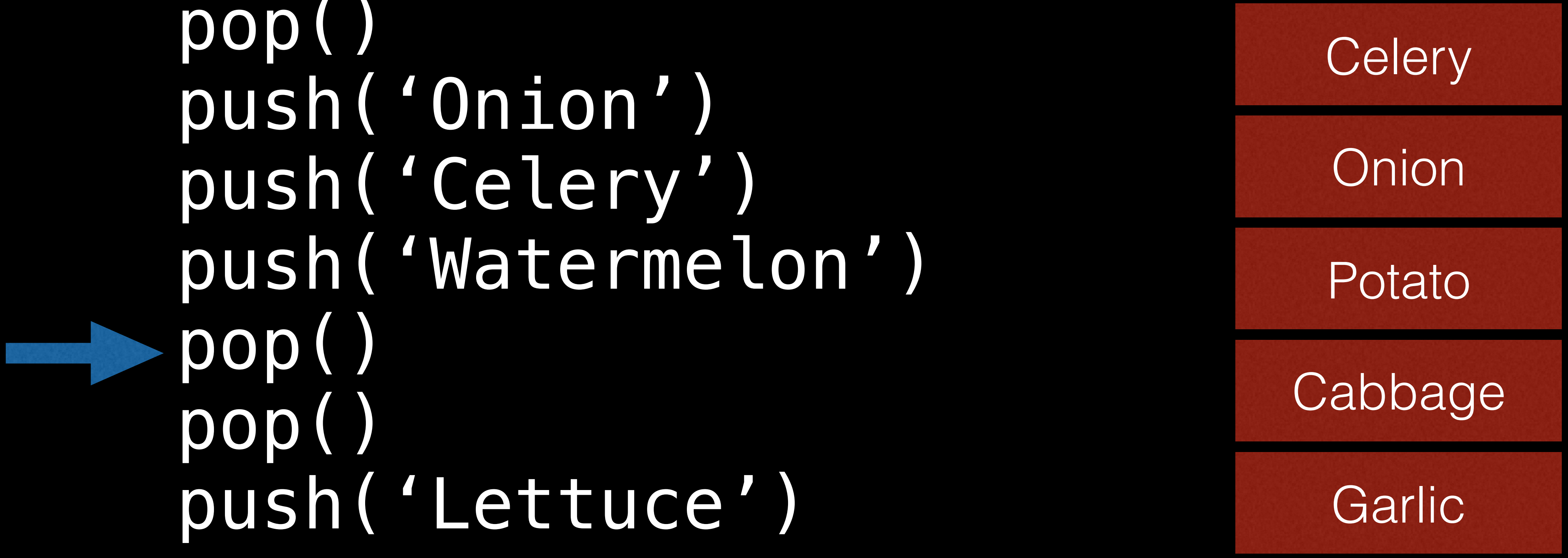

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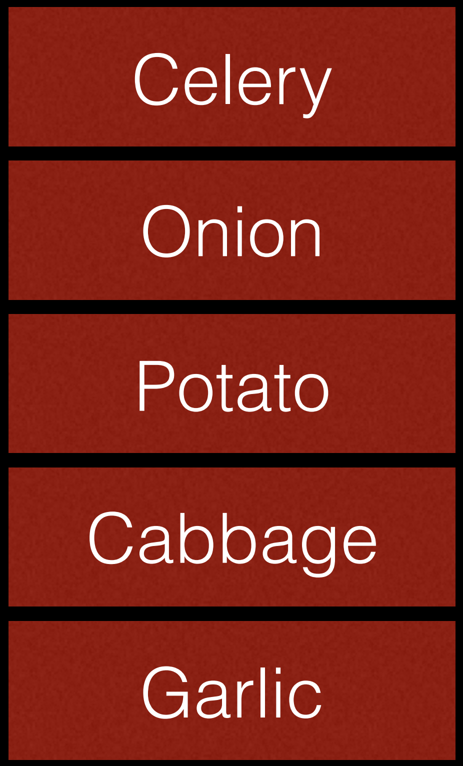

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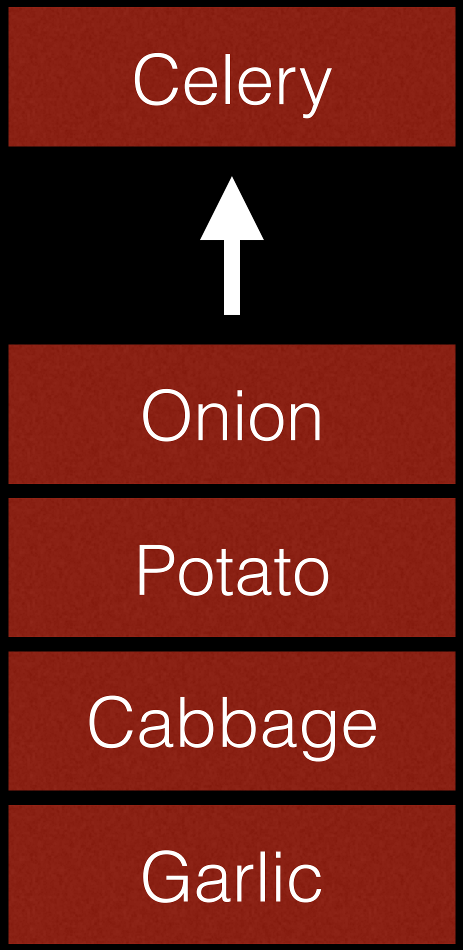

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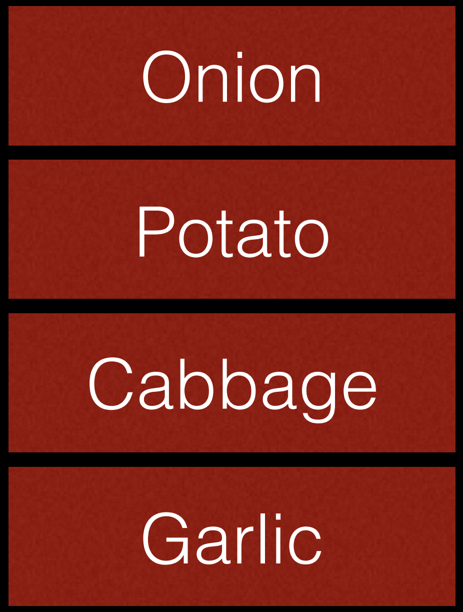

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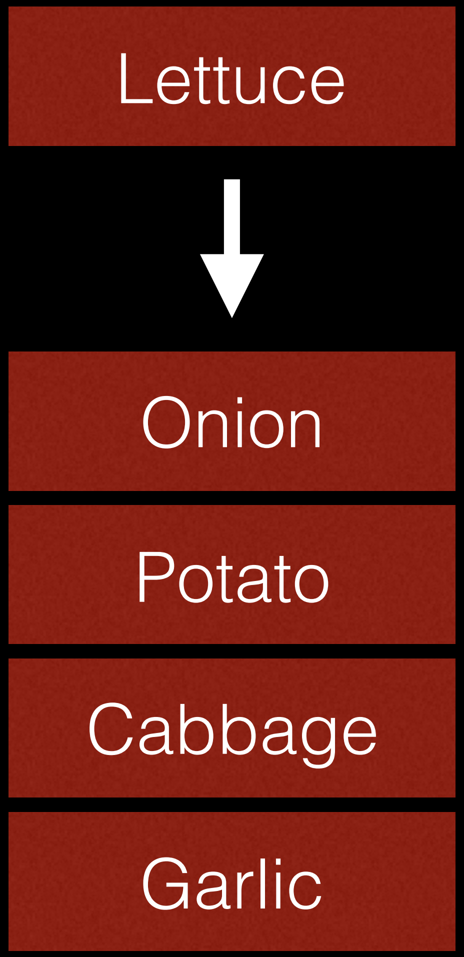

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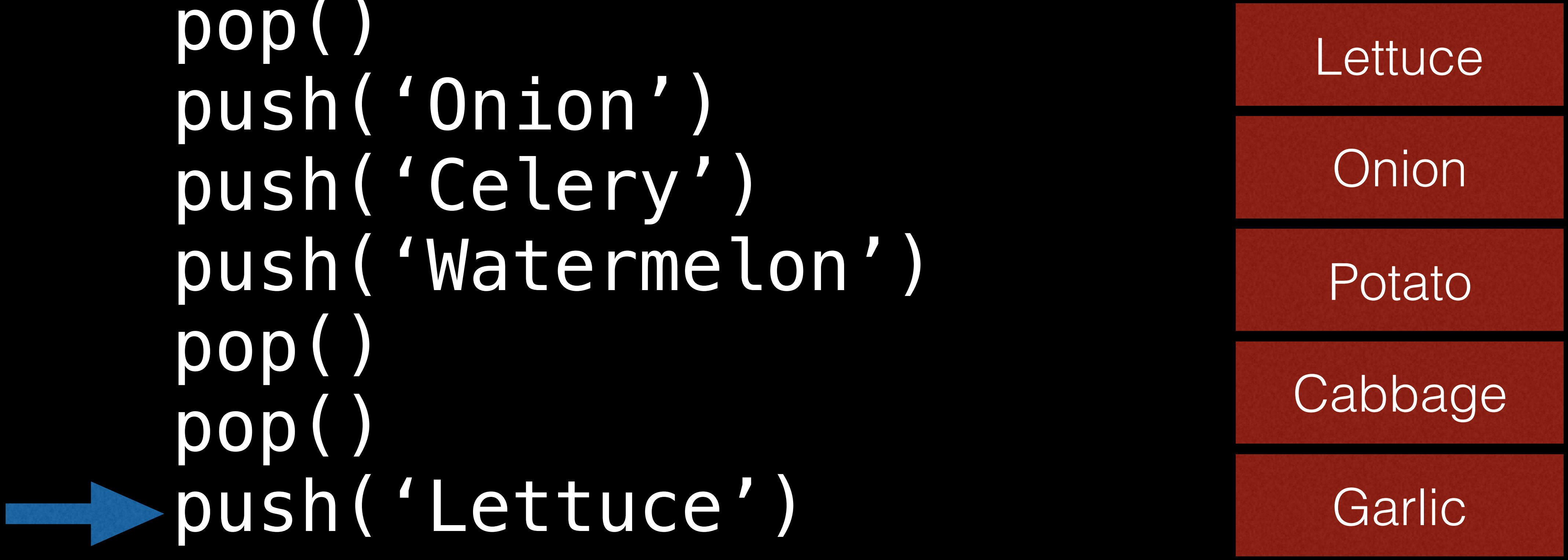

When and where is a Stack used?

- Used by undo mechanisms in text editors.
- Used in compiler syntax checking for matching brackets and braces.
- Can be used to model a pile of books or plates.
- Used behind the scenes to support recursion by keeping track of previous function calls.
- Can be used to do a Depth First Search (DFS) on a graph.

Complexity Analysis

Complexity

Pushing	O(1)
Popping	O(1)
Peeking	O(1)
Searching	O(n)
Size	O(1)

Example – Brackets

Problem: Given a string made up of the following brackets: ()[]{}, determine whether the brackets properly match.

[{}]	$\longrightarrow$	**Valid**
(()())	$\longrightarrow$	**Valid**
{]	$\longrightarrow$	**Invalid**
[()]))()	$\longrightarrow$	**Invalid**
[]{}({})	$\longrightarrow$	**Valid**

Example – Brackets

Bracket Sequence:

```
[[{}]()]
```

Current Bracket: ∅

Reversed Bracket: ∅

Example – Brackets

Bracket Sequence:

[[{}]()]

Current Bracket: [

Reversed Bracket:]

[

Example – Brackets

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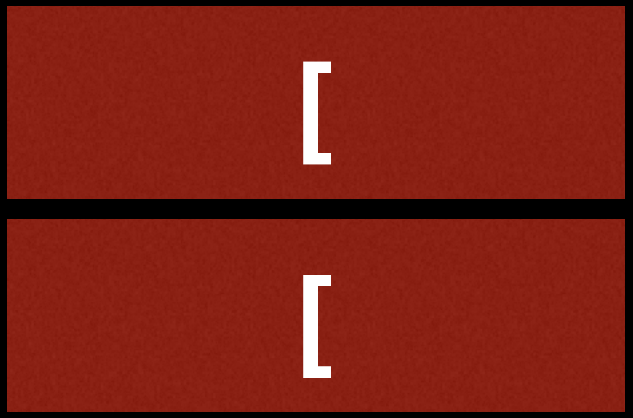


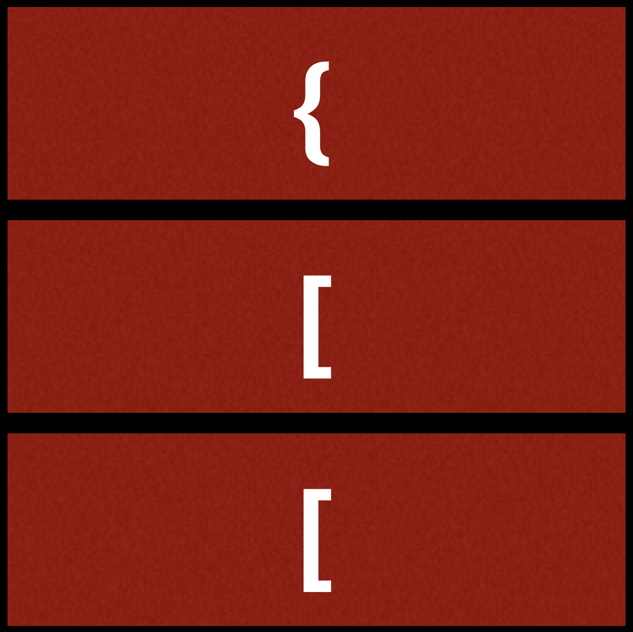
Example – Brackets

Bracket Sequence:

`[[{}]()]`

Current Bracket: {

Reversed Bracket: }



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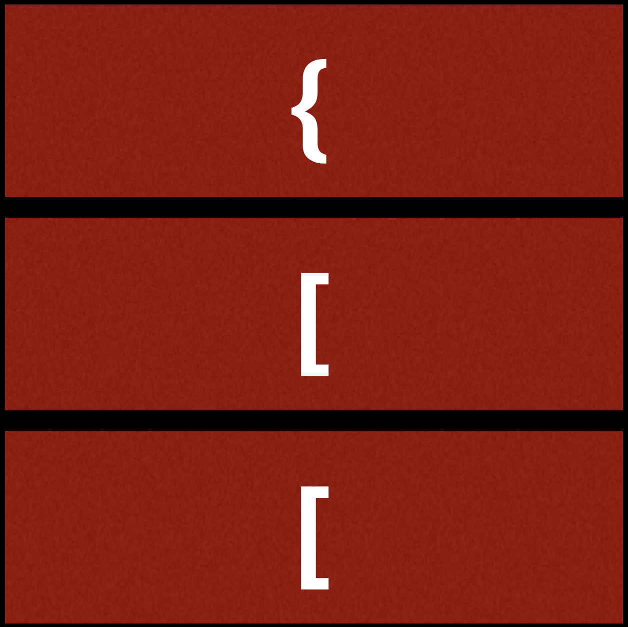

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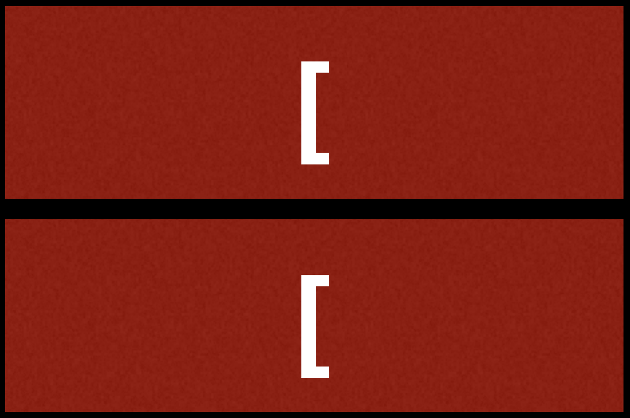

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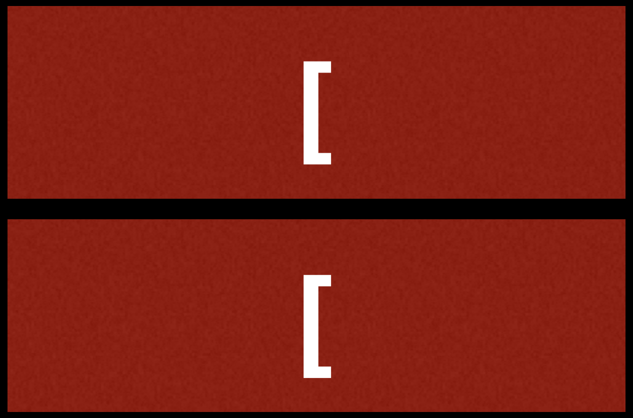
Reversed Bracket: [



Example – Brackets

Bracket Sequence:

[[{}]()]

Current Bracket:]

Reversed Bracket: [

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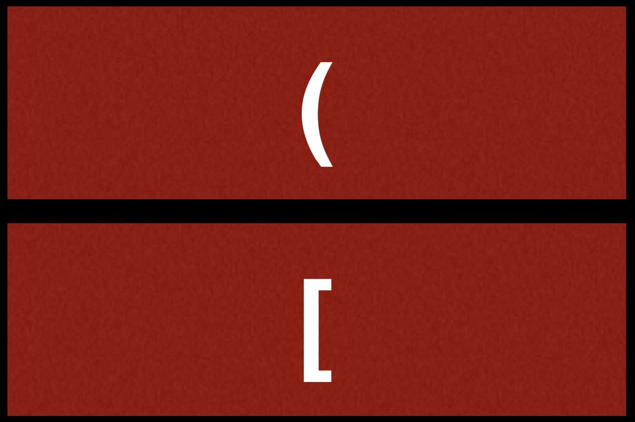

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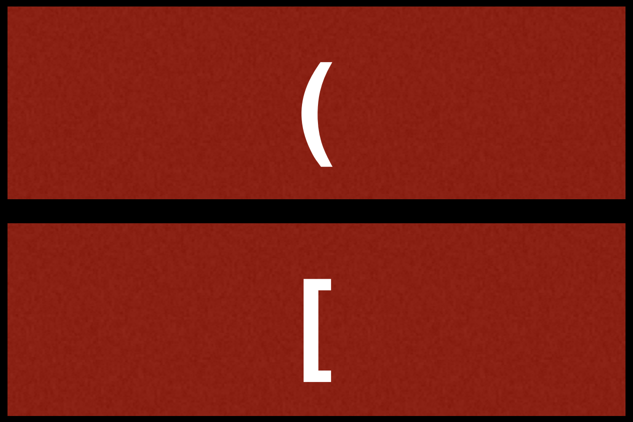

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Example - Brackets

Bracket Sequence:

$$[[\{\}]()] \longrightarrow \textbf{Valid}$$

Current Bracket:]

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Example – Brackets

Bracket Sequence:

```
[{})[]
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Current Bracket: ∅

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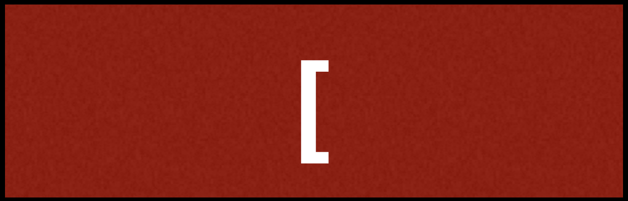

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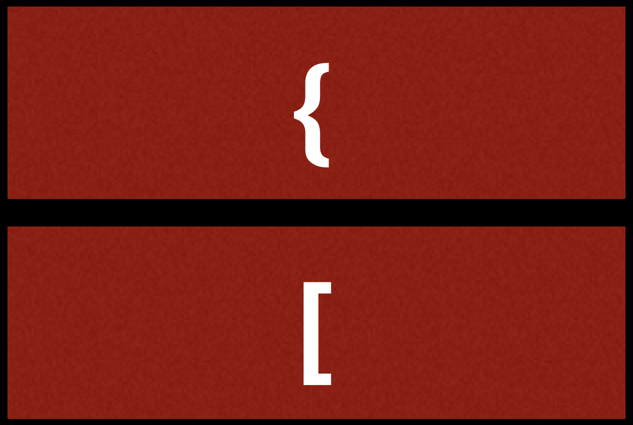

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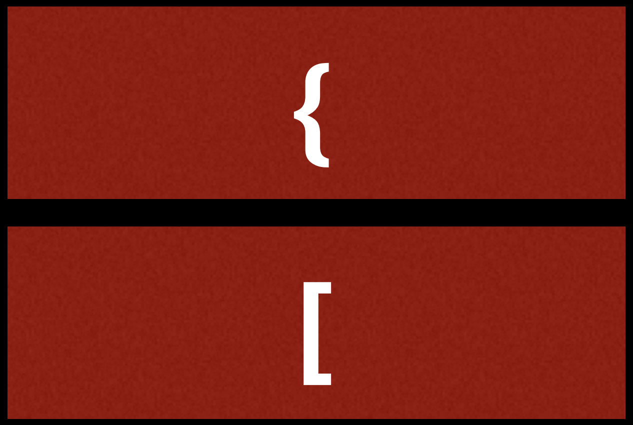

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`[`

Example - Brackets

Bracket Sequence:

$$\texttt{[\{\})[]} \longrightarrow \textbf{Invalid}$$

Current Bracket:)

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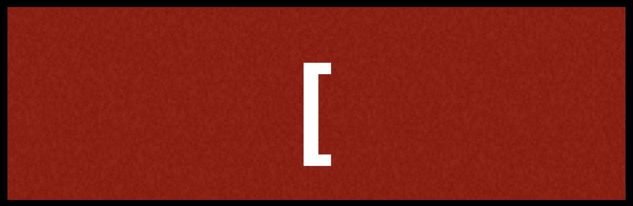


Example – Brackets

```
Let S be a stack
For bracket in bracket_string:

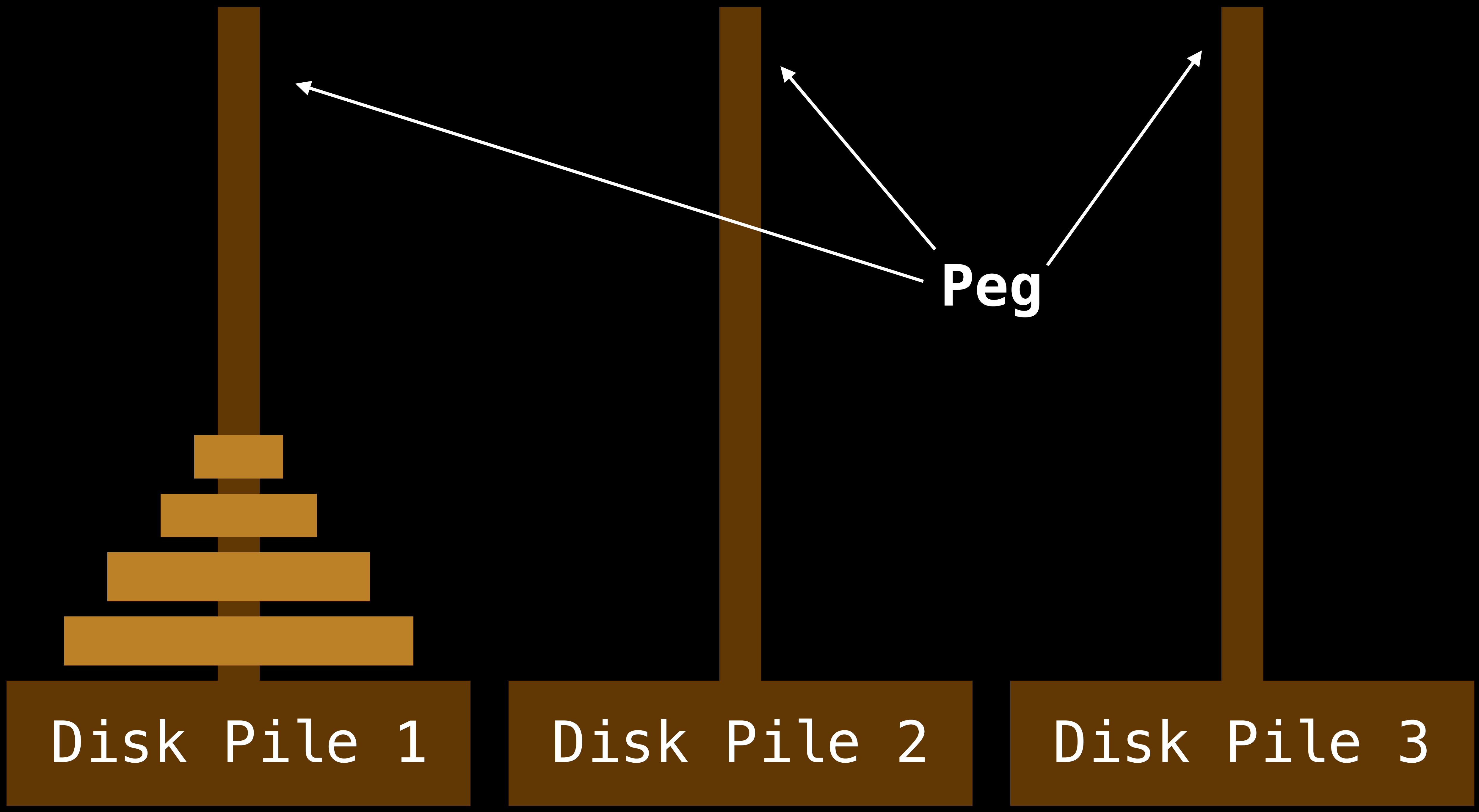
    rev = getReversedBracket(bracket)

    If isLeftBracket(bracket):
        S.push(bracket)

    Else If S.isEmpty() or S.pop() != rev:
        return false // Invalid

return S.isEmpty() // Valid if S is empty
```

Tower of Hanoi



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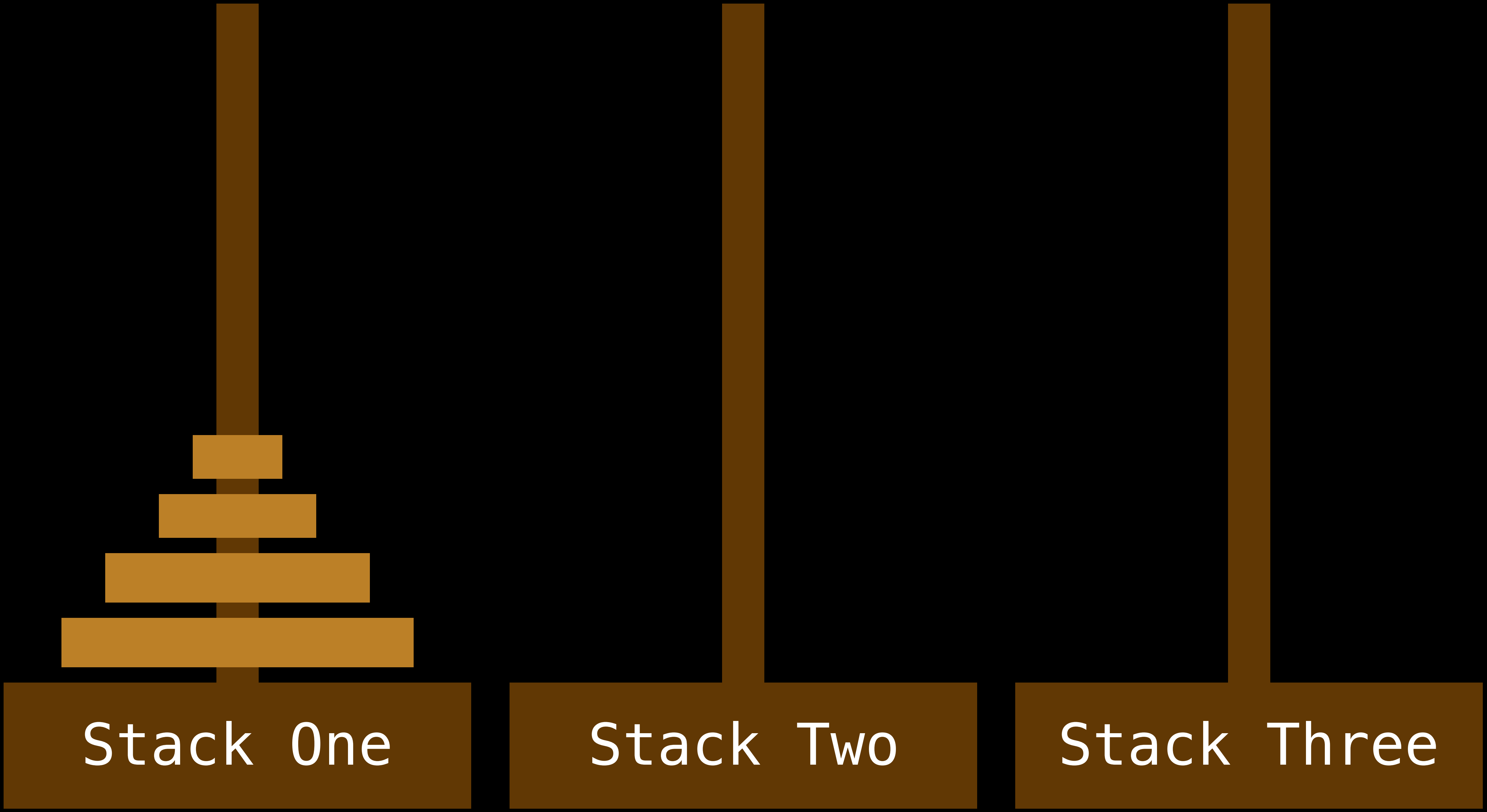

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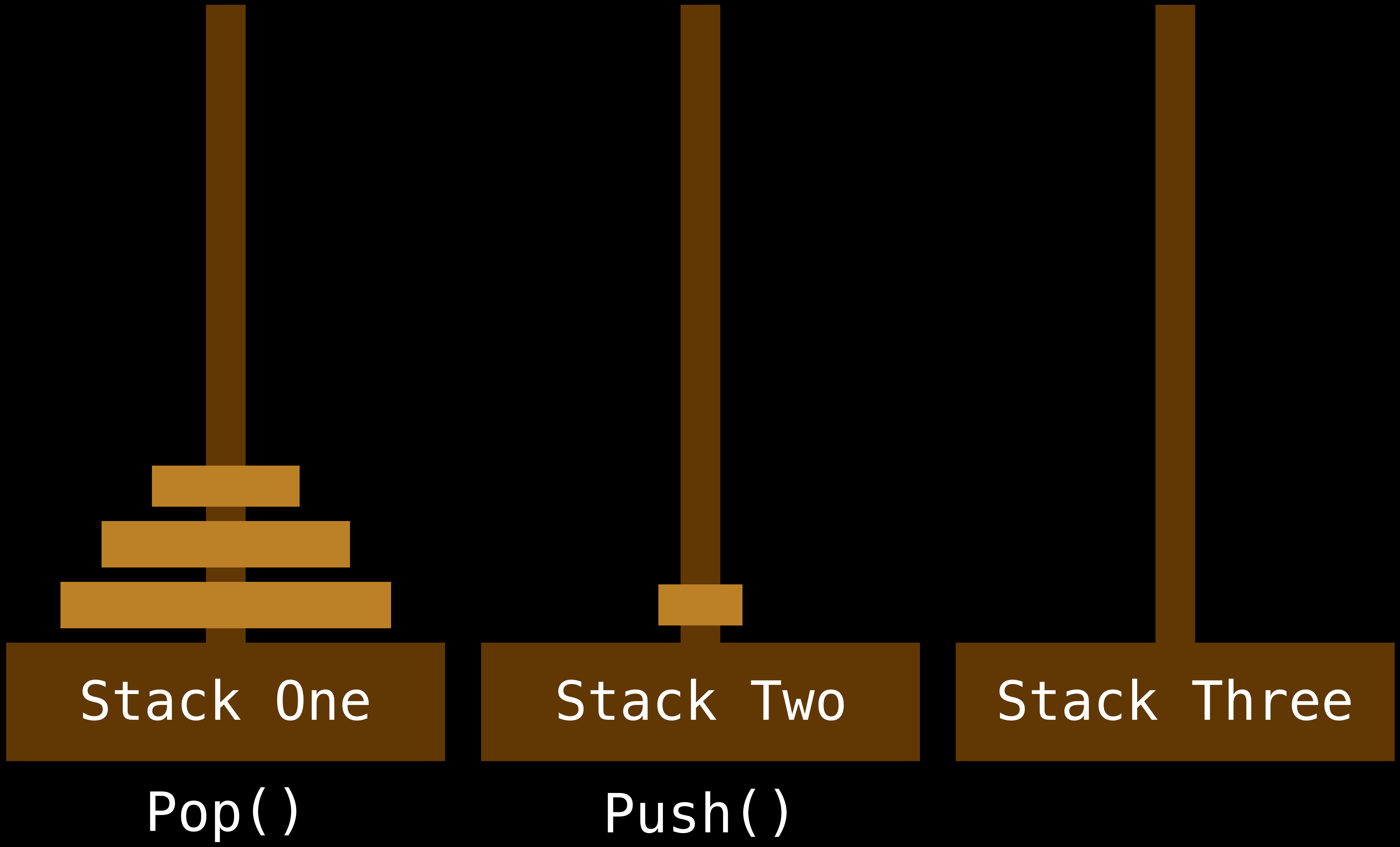

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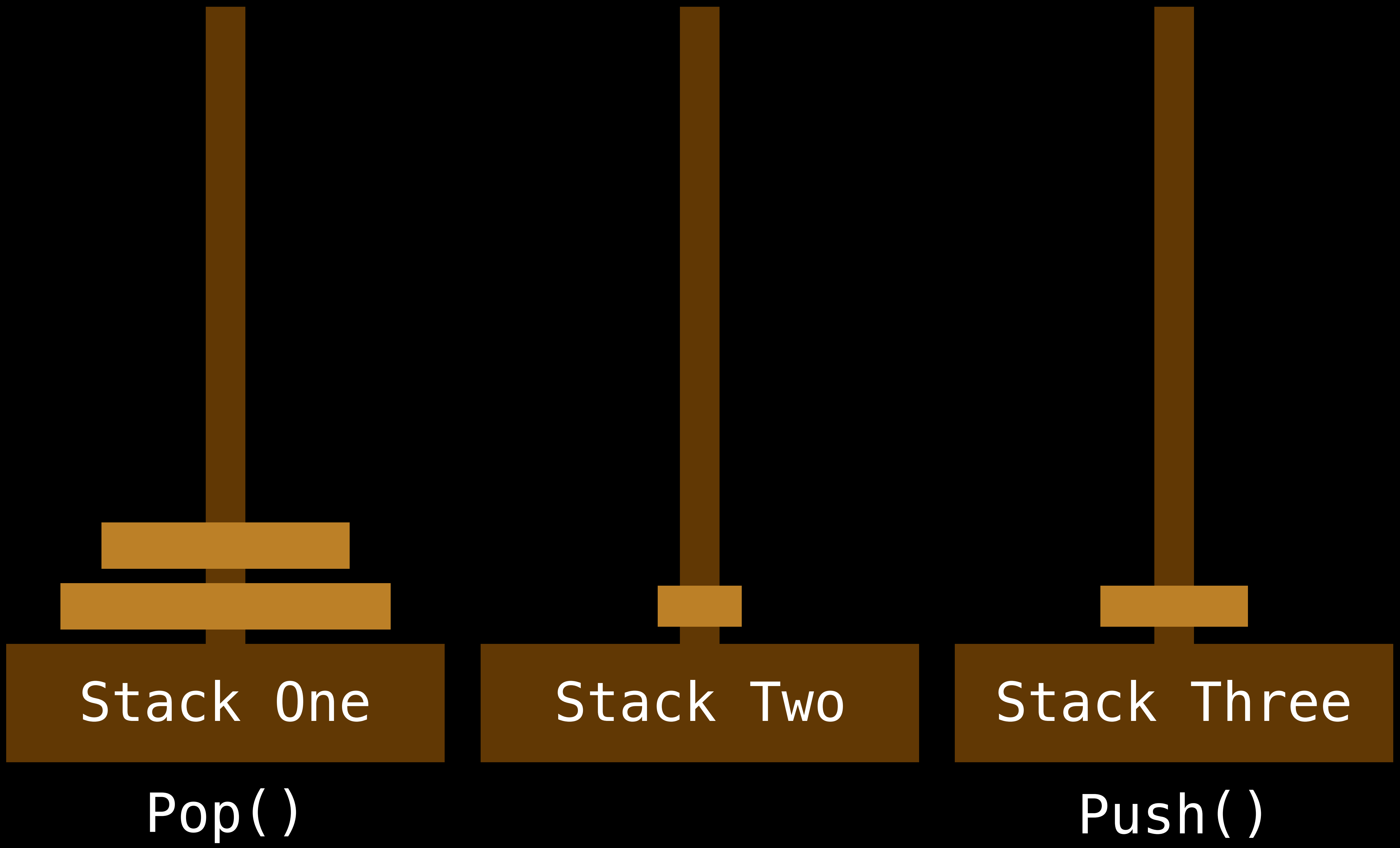

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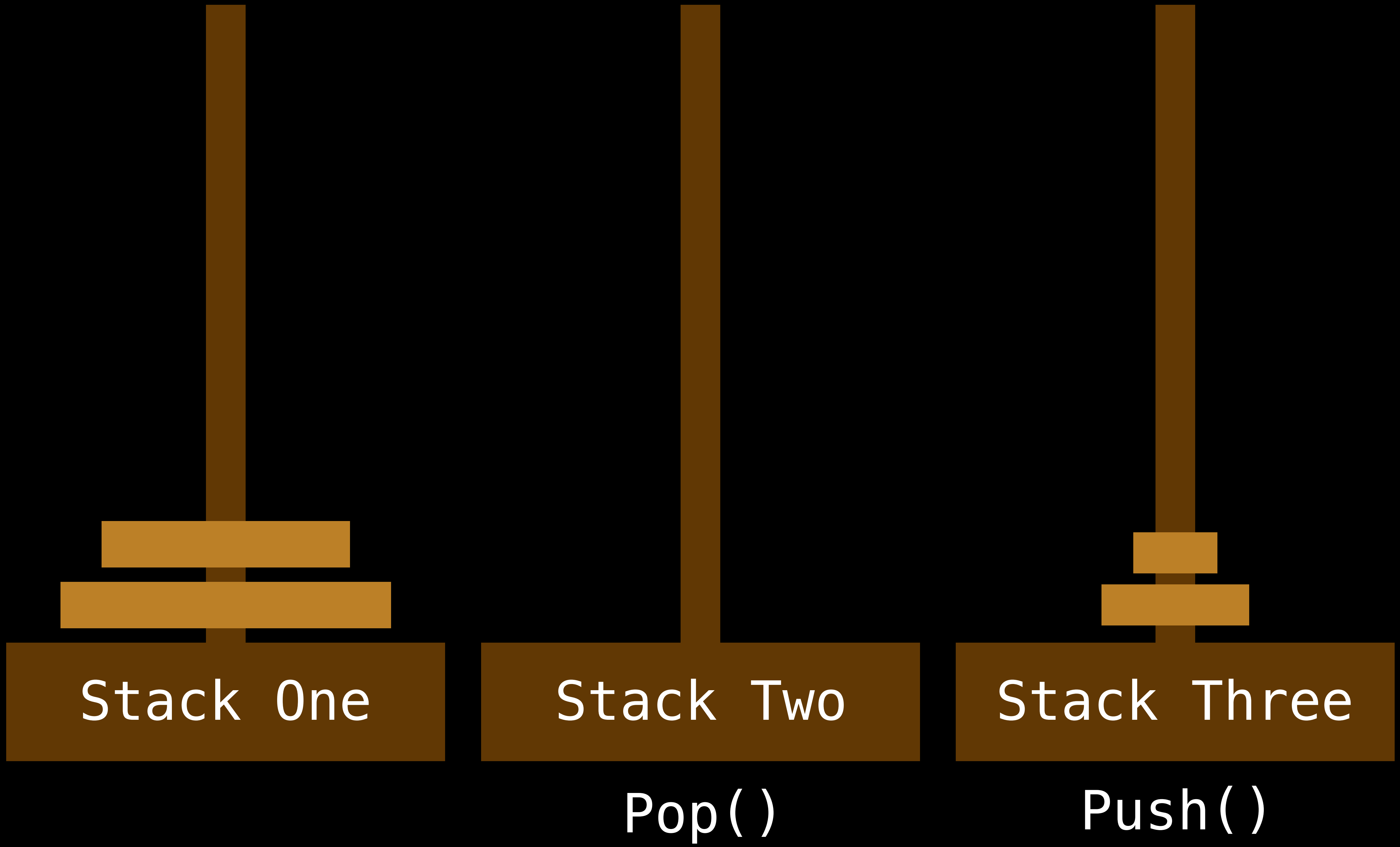

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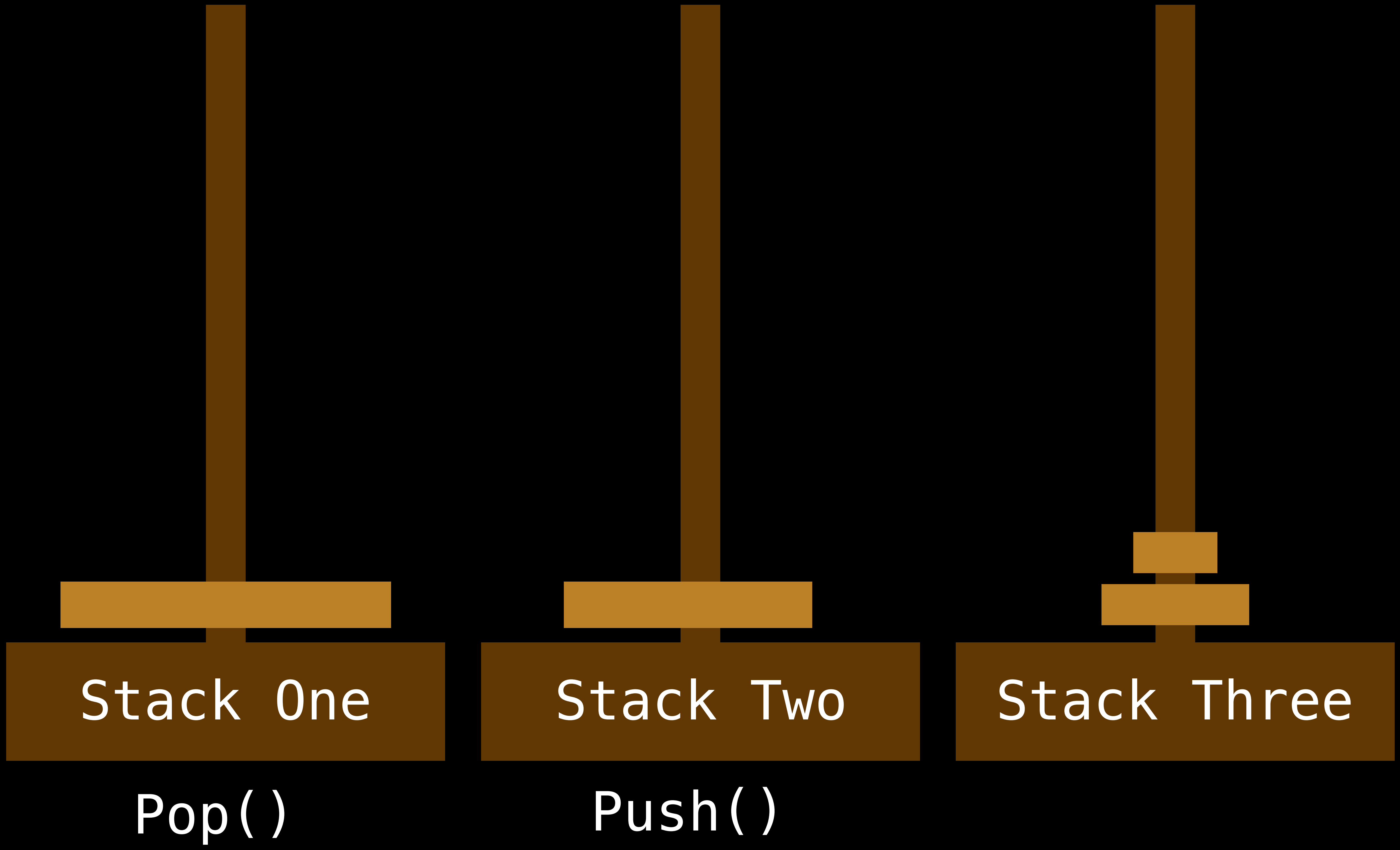

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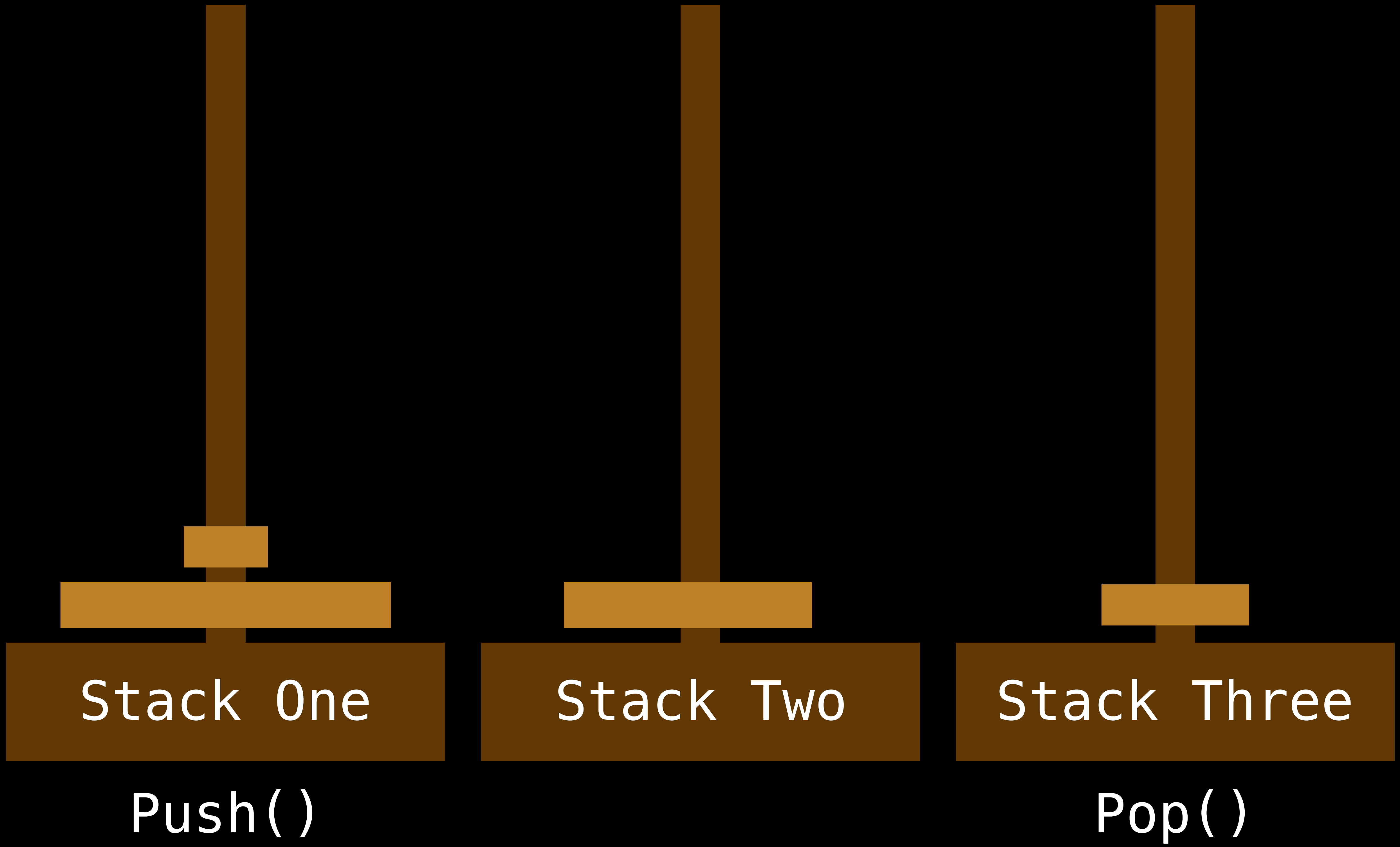

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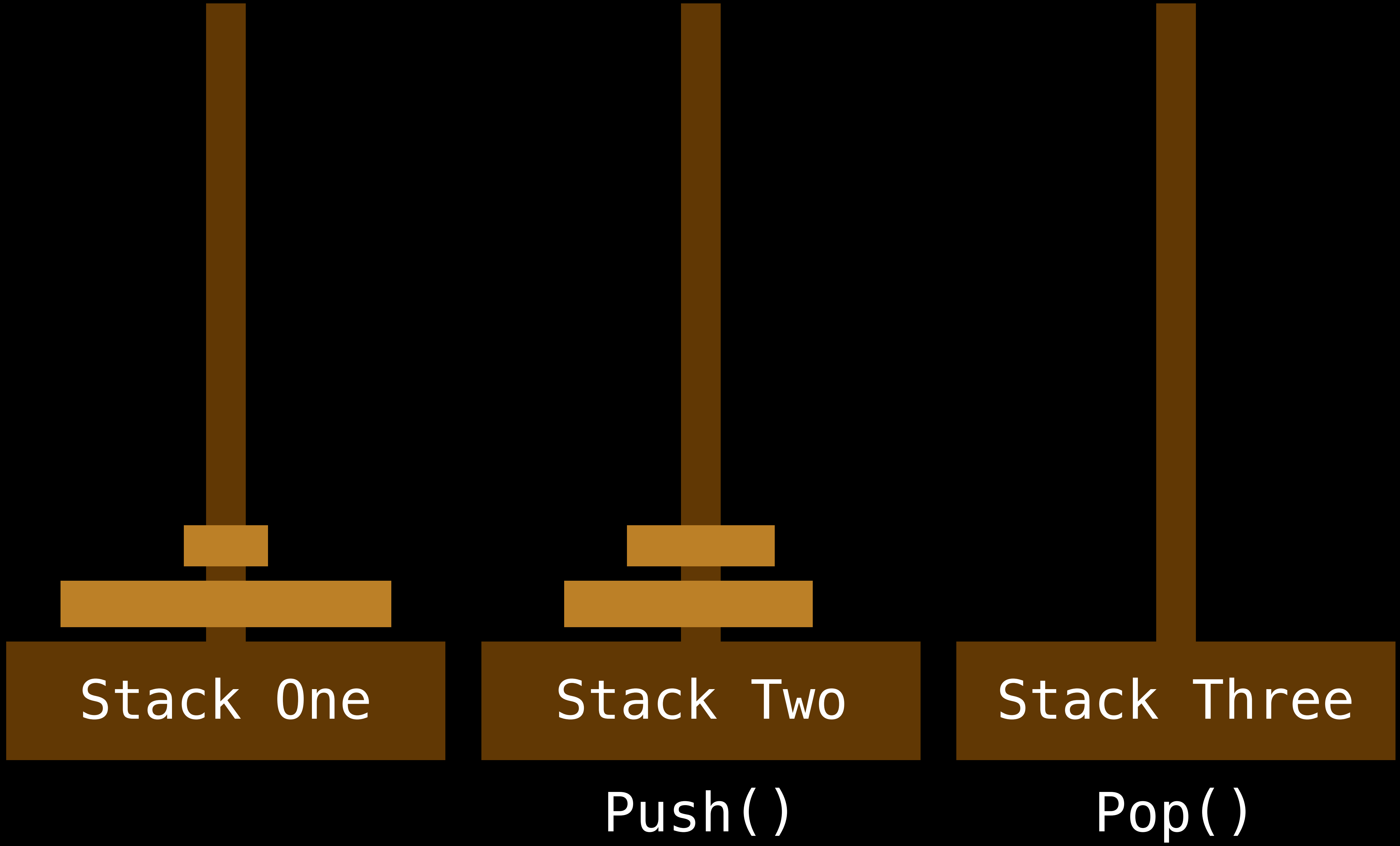

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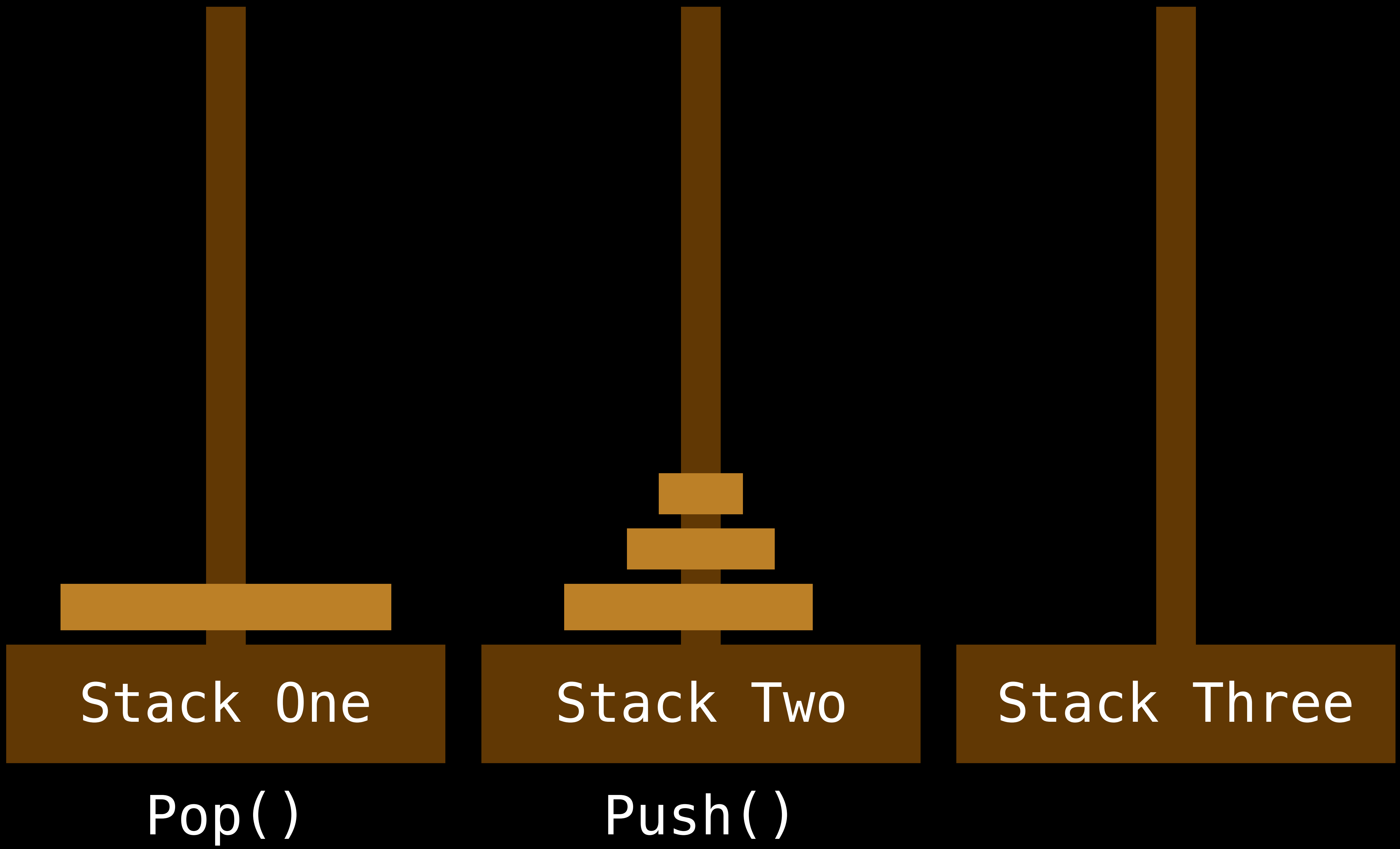

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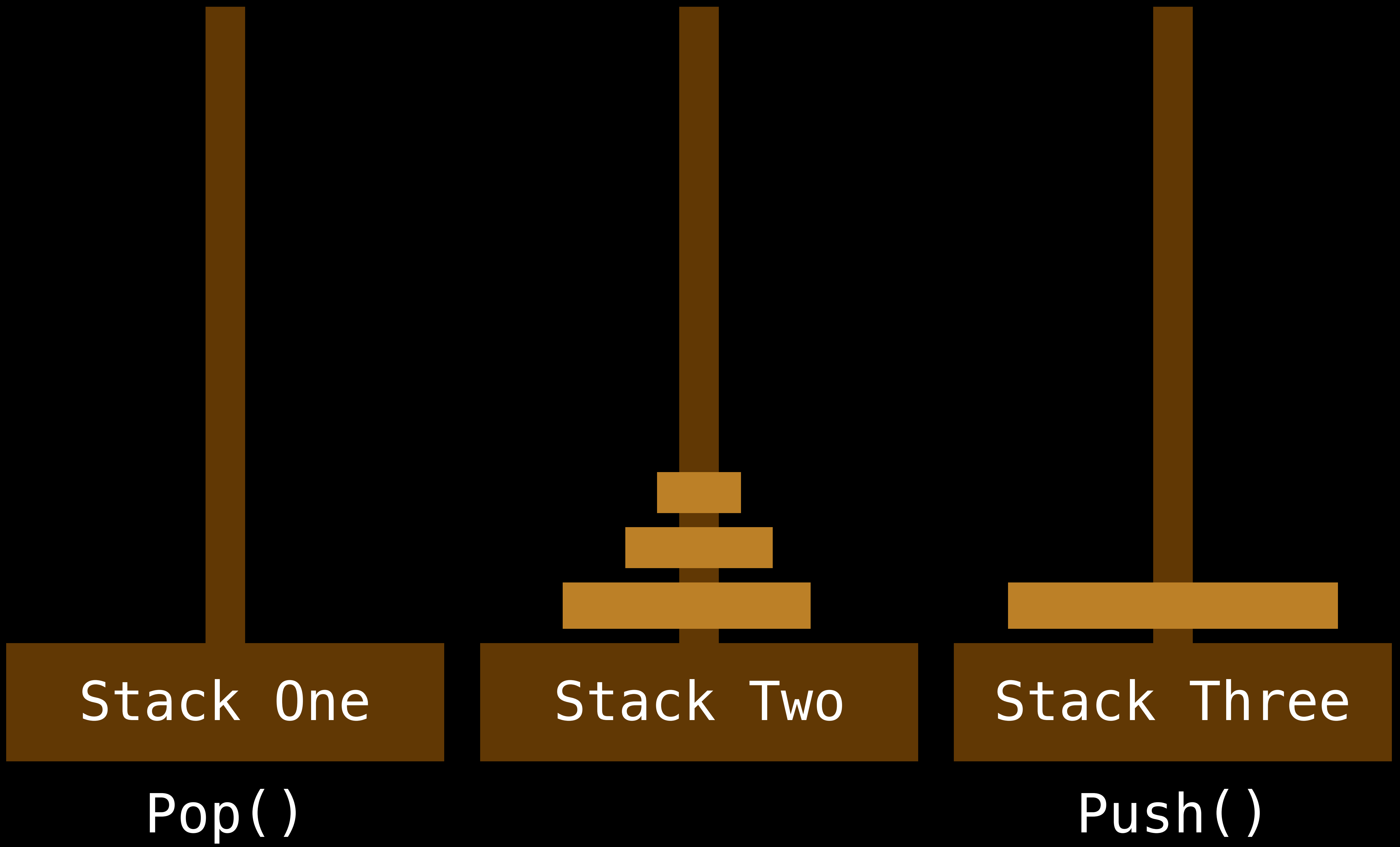

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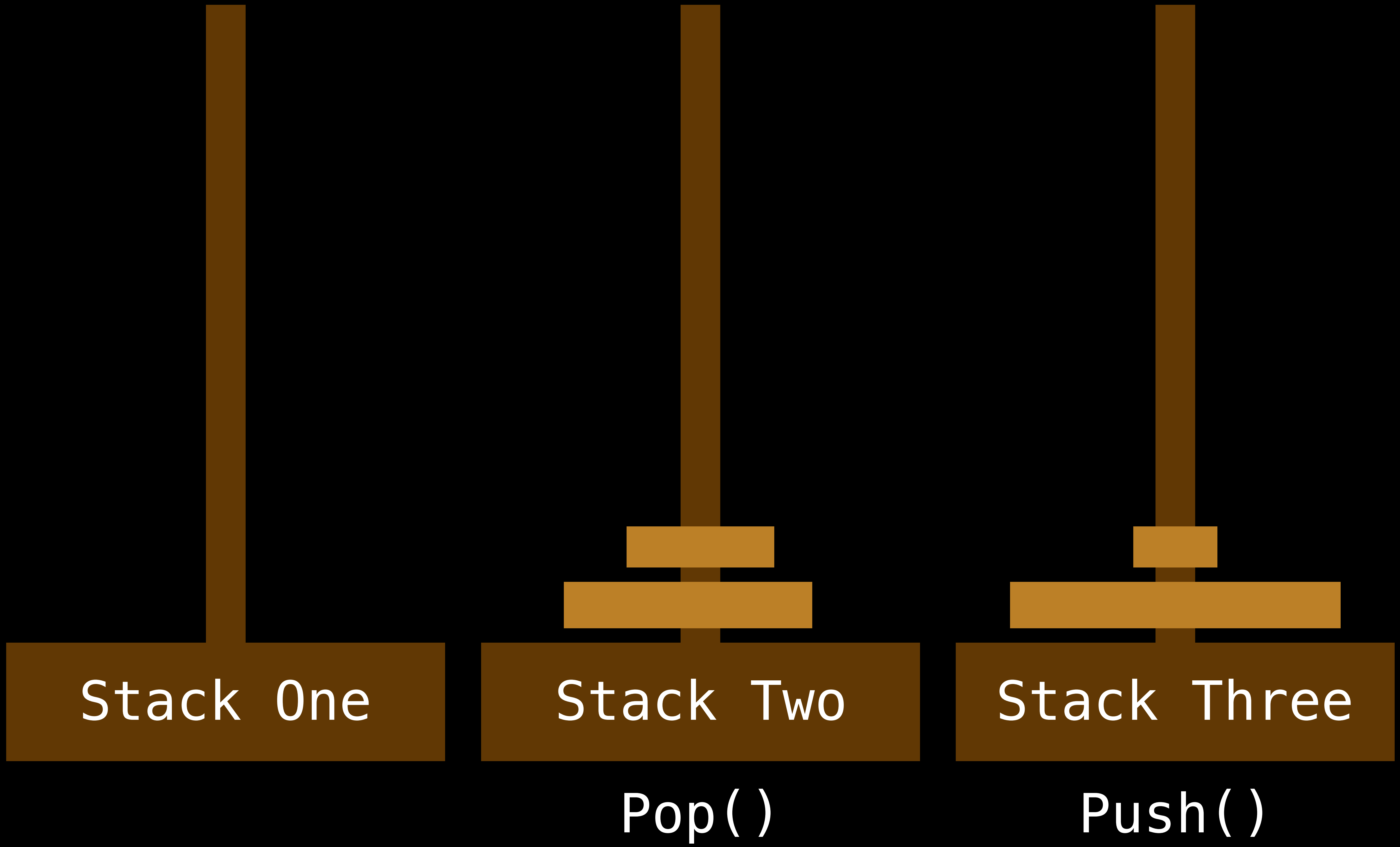

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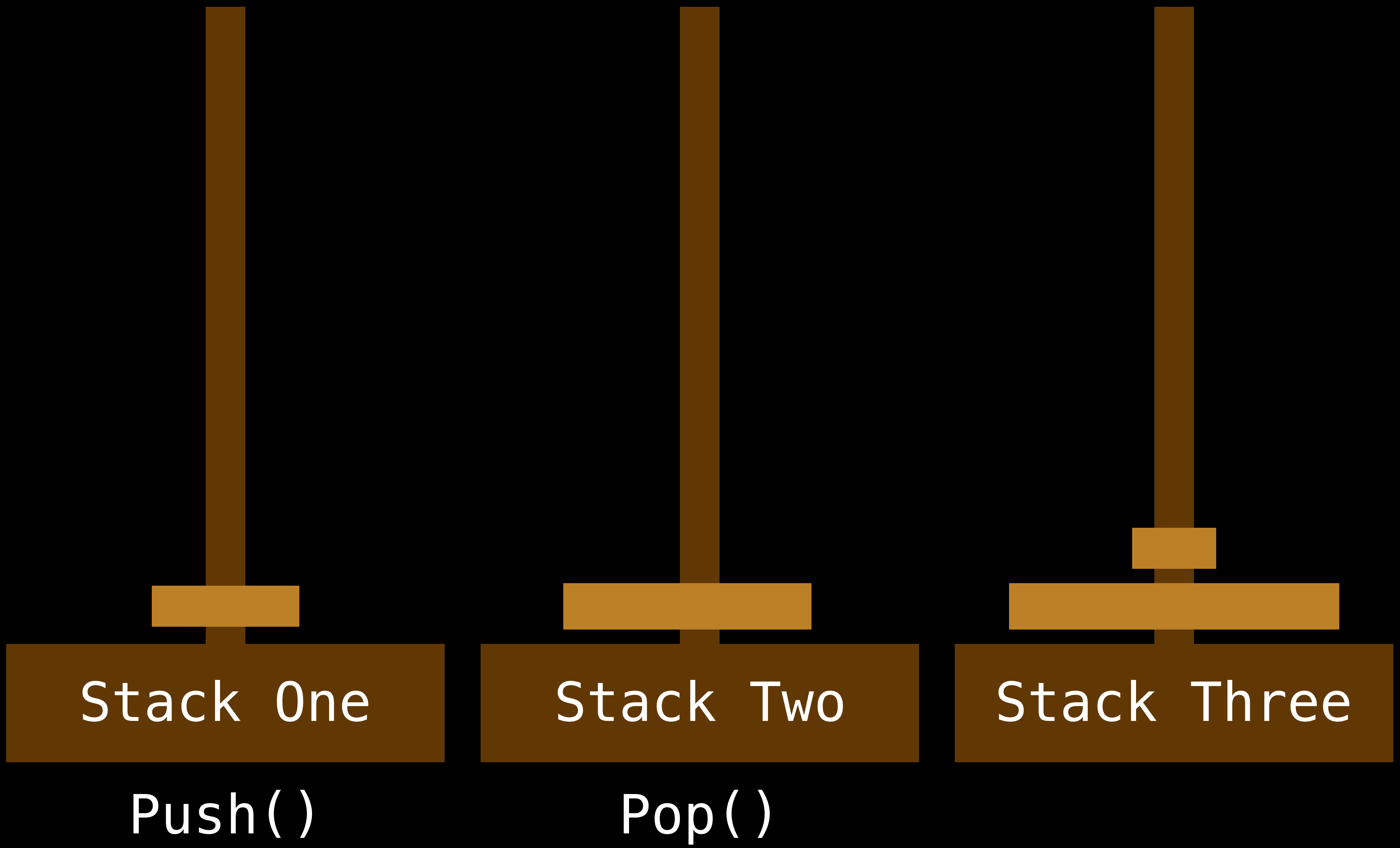

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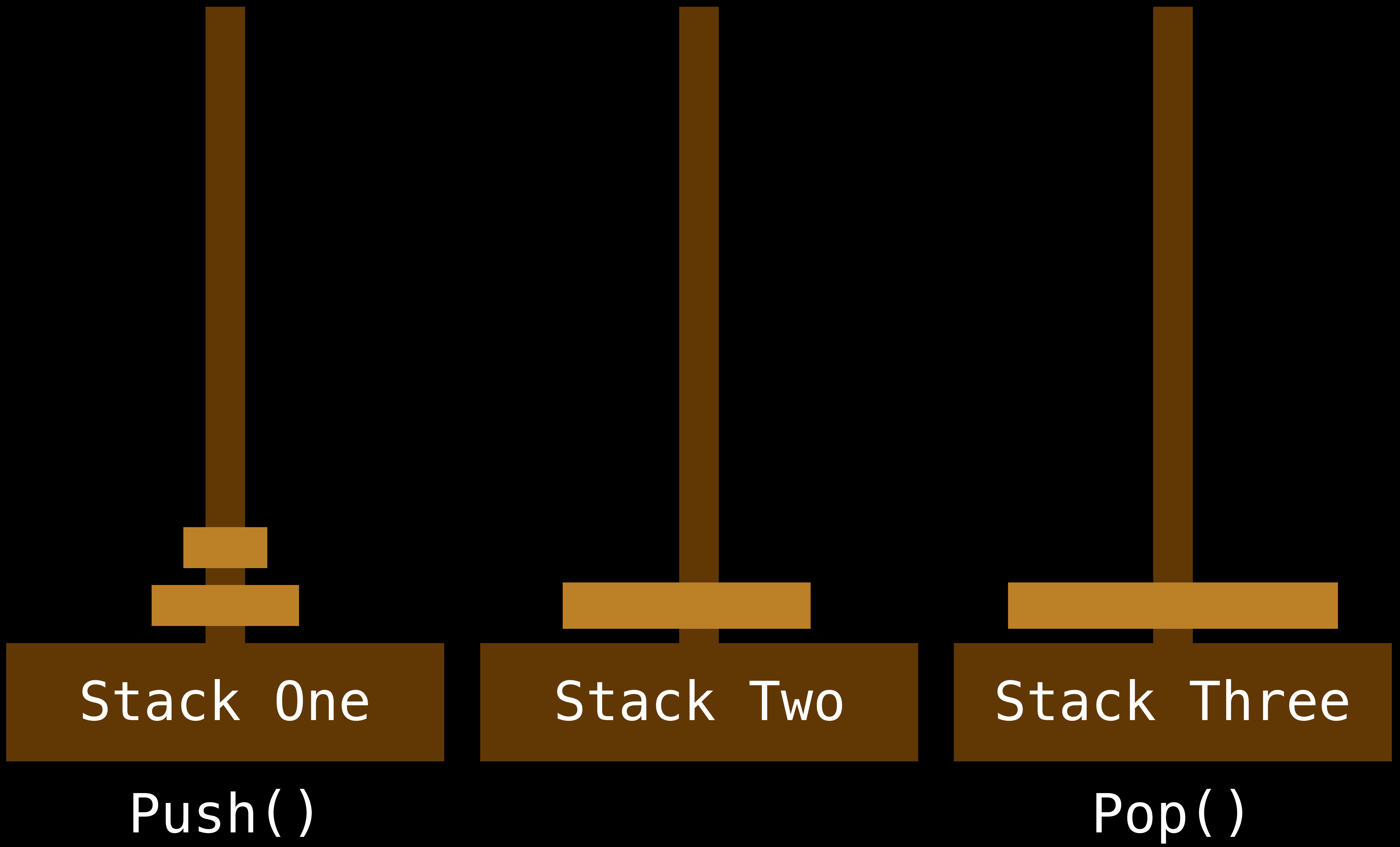

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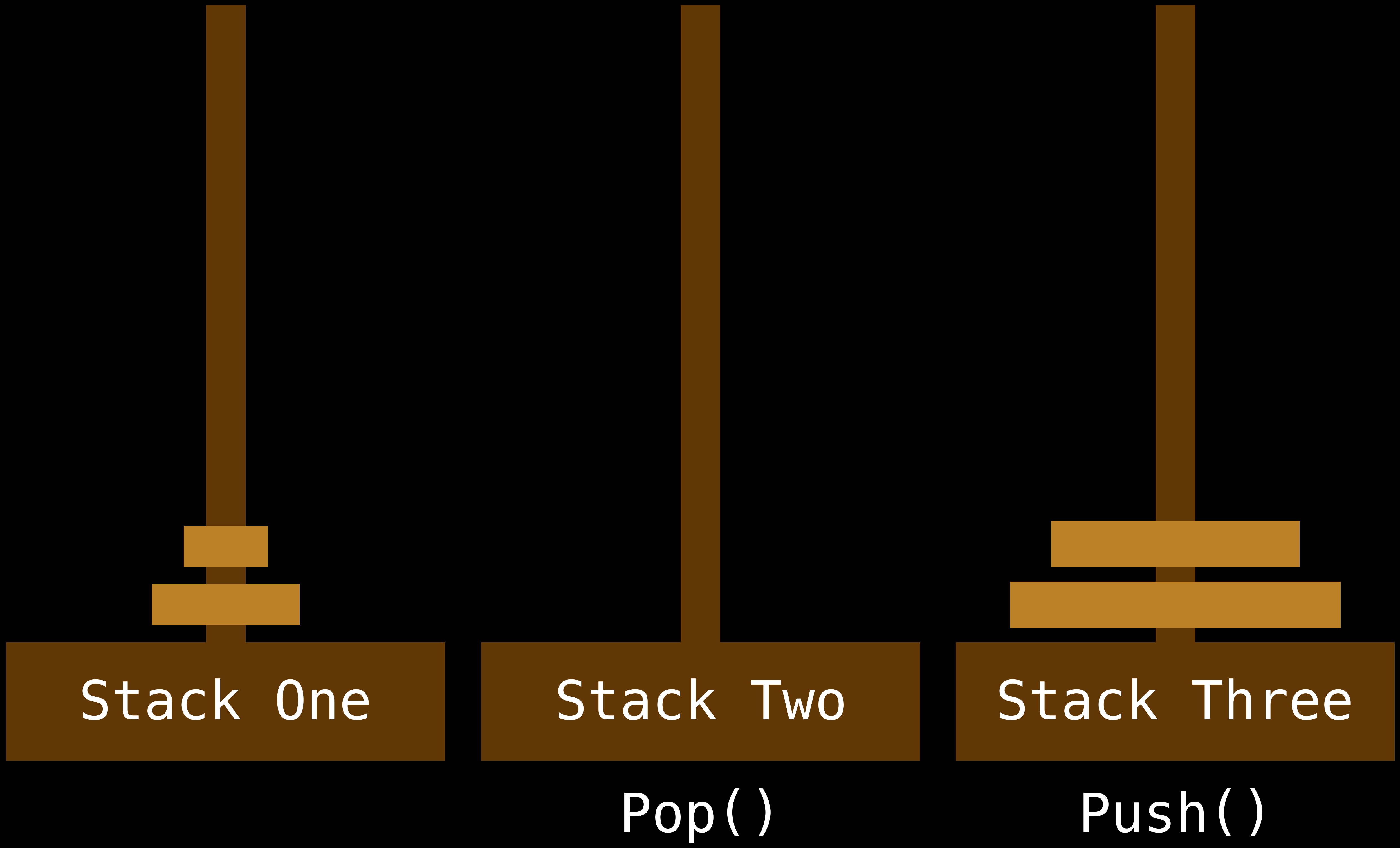

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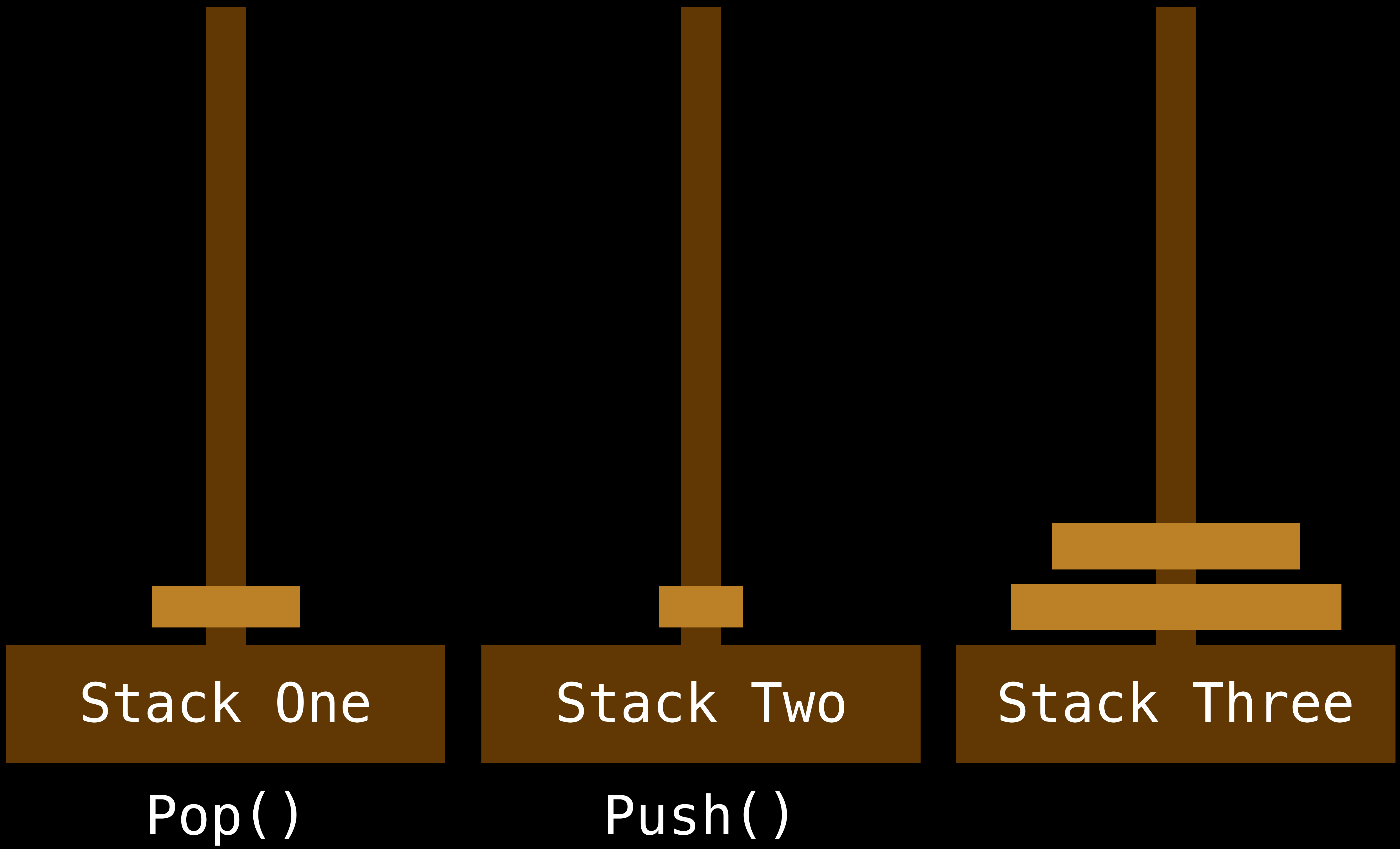

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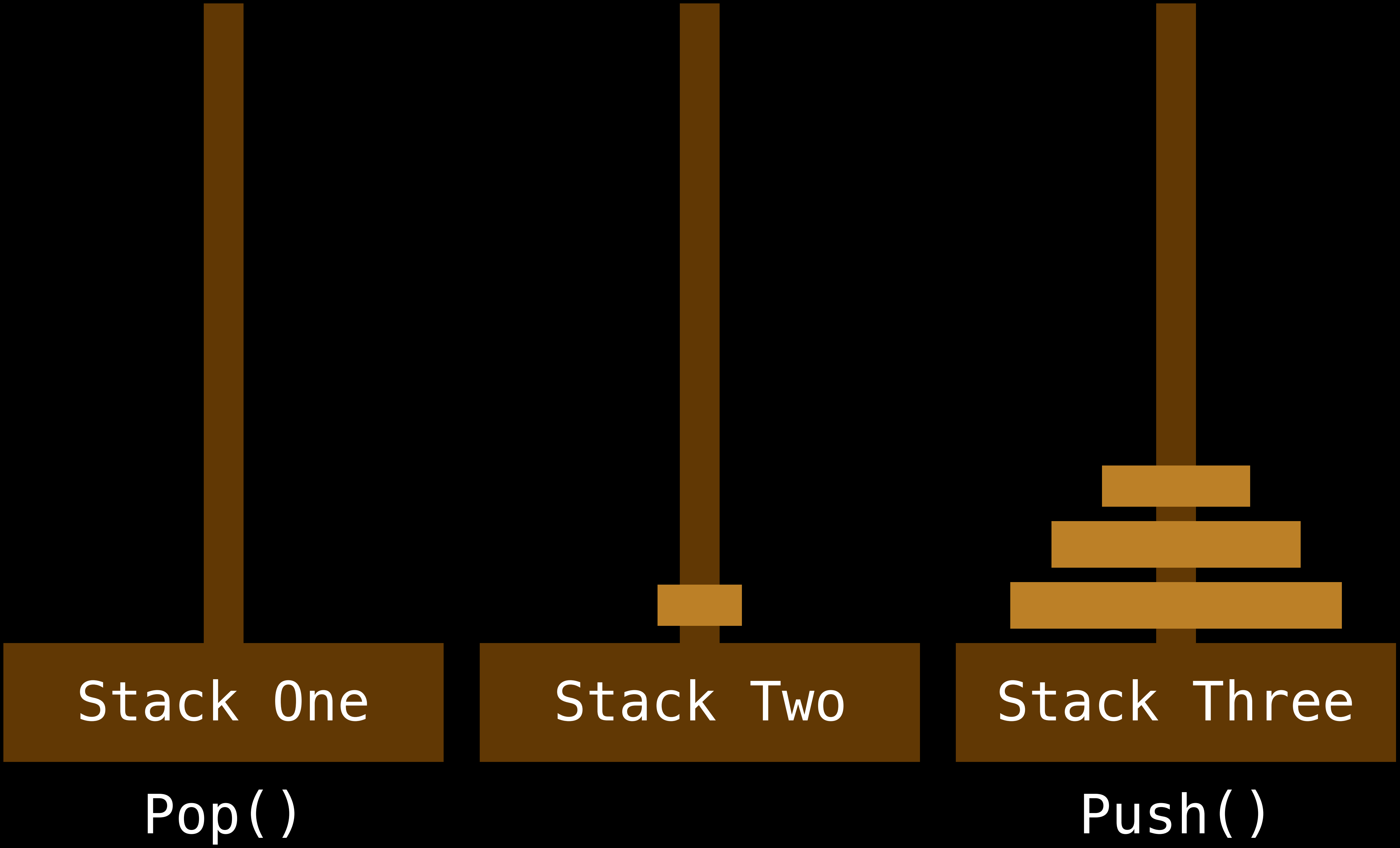

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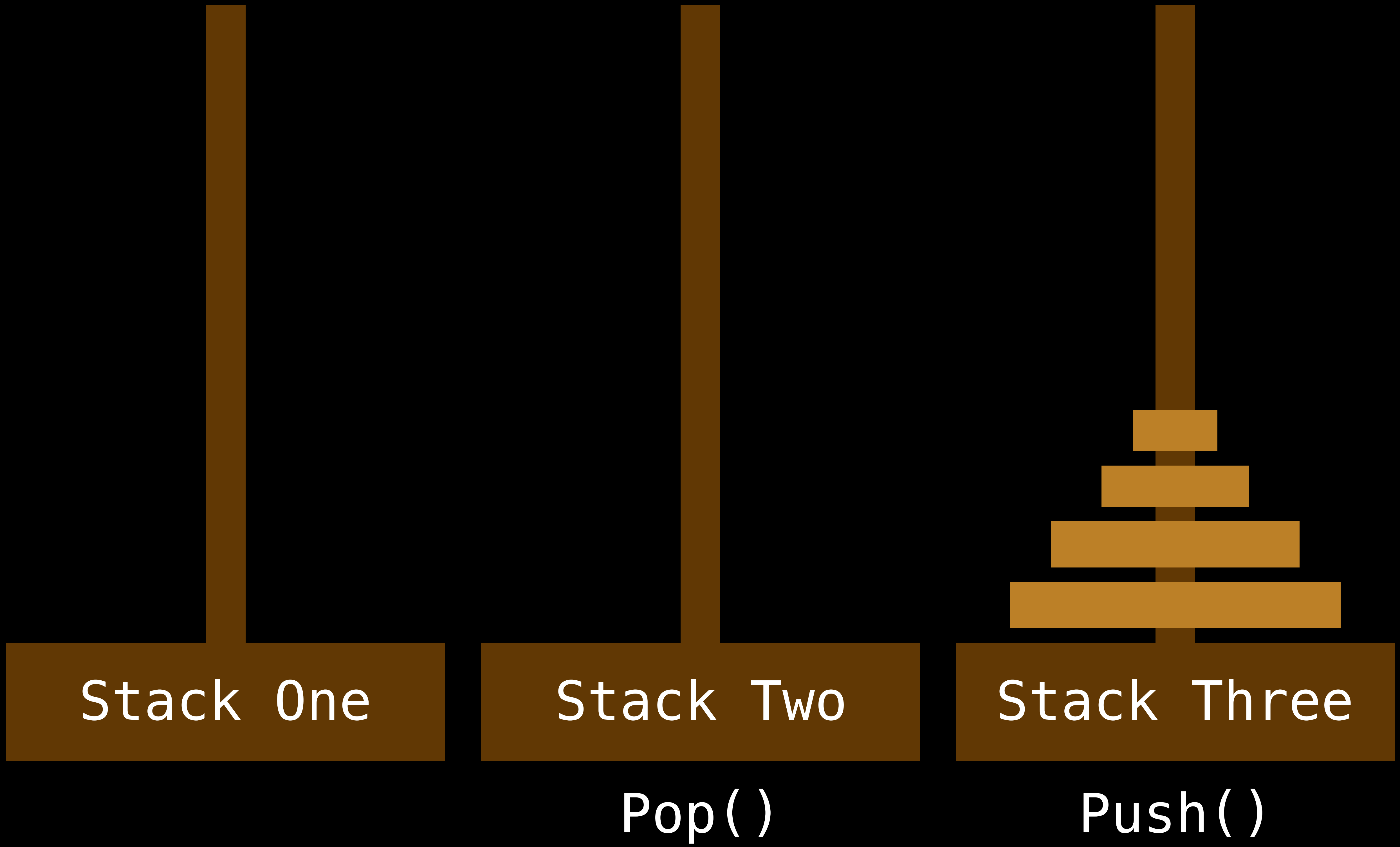

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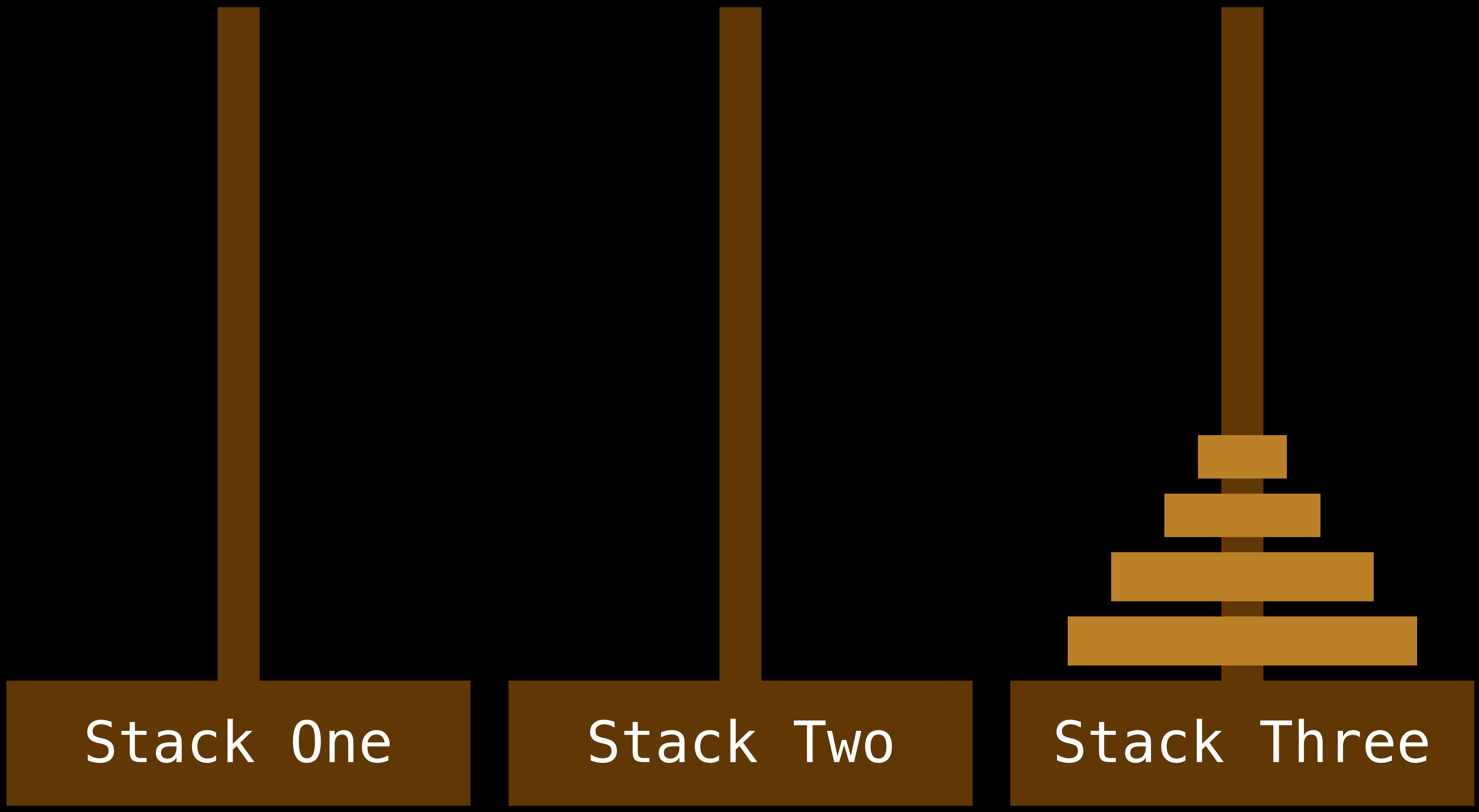

Stack implementation details in next video

Implementation source code and tests can all be found at the following link:

github.com/williamfiset/data-structures

Stack Implementation

Part 2/3

William Fiset

Pushing

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Push(4)
Push(2)
Push(5)
Push(13)
```

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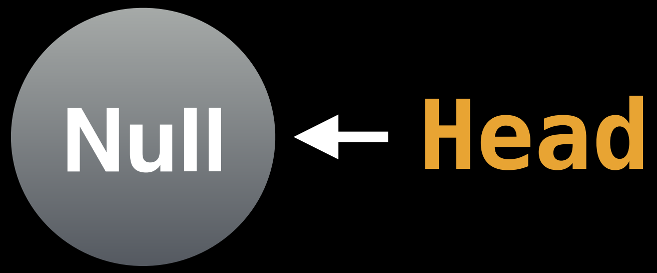

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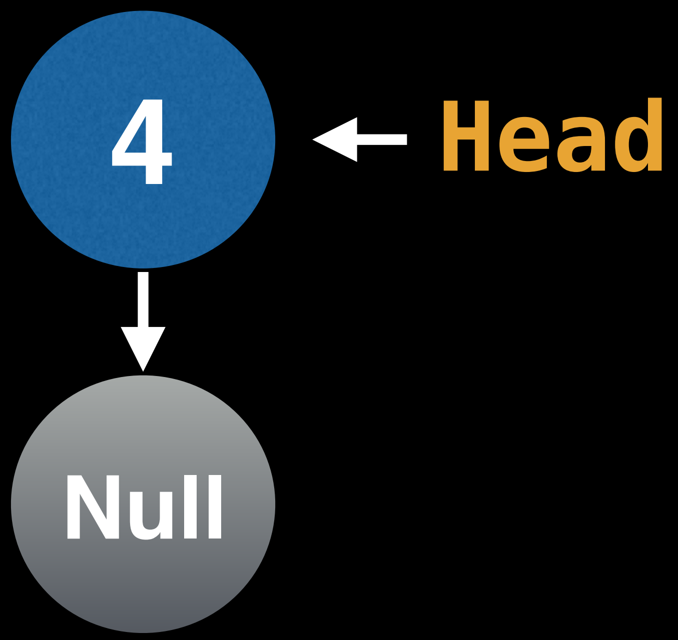

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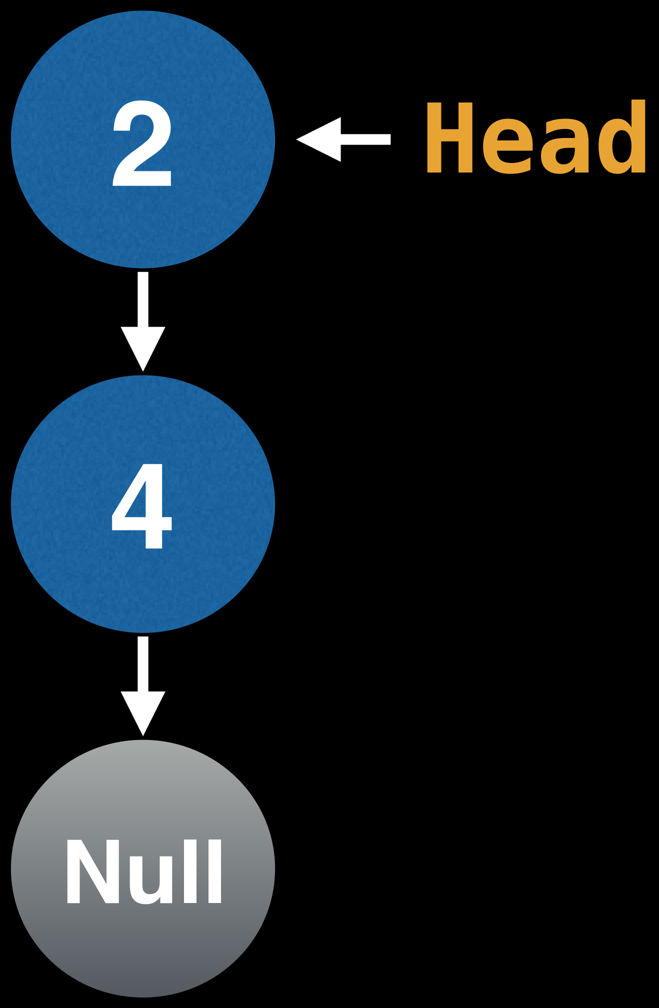

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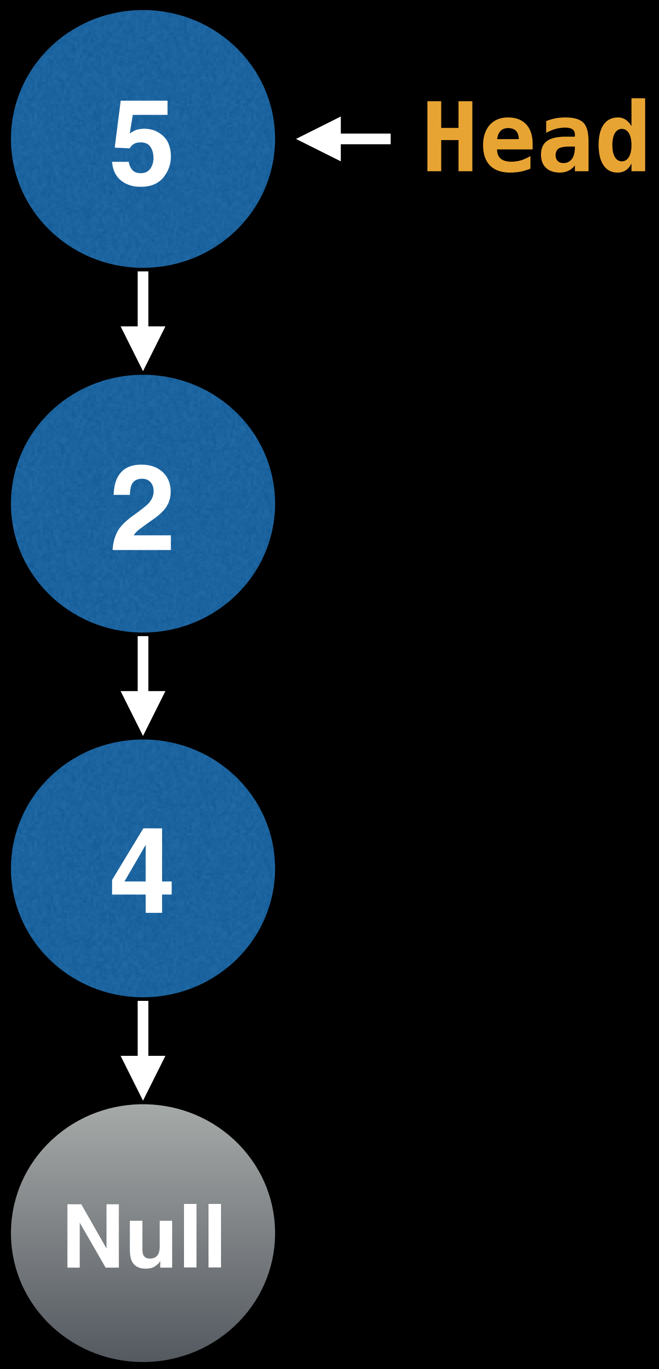
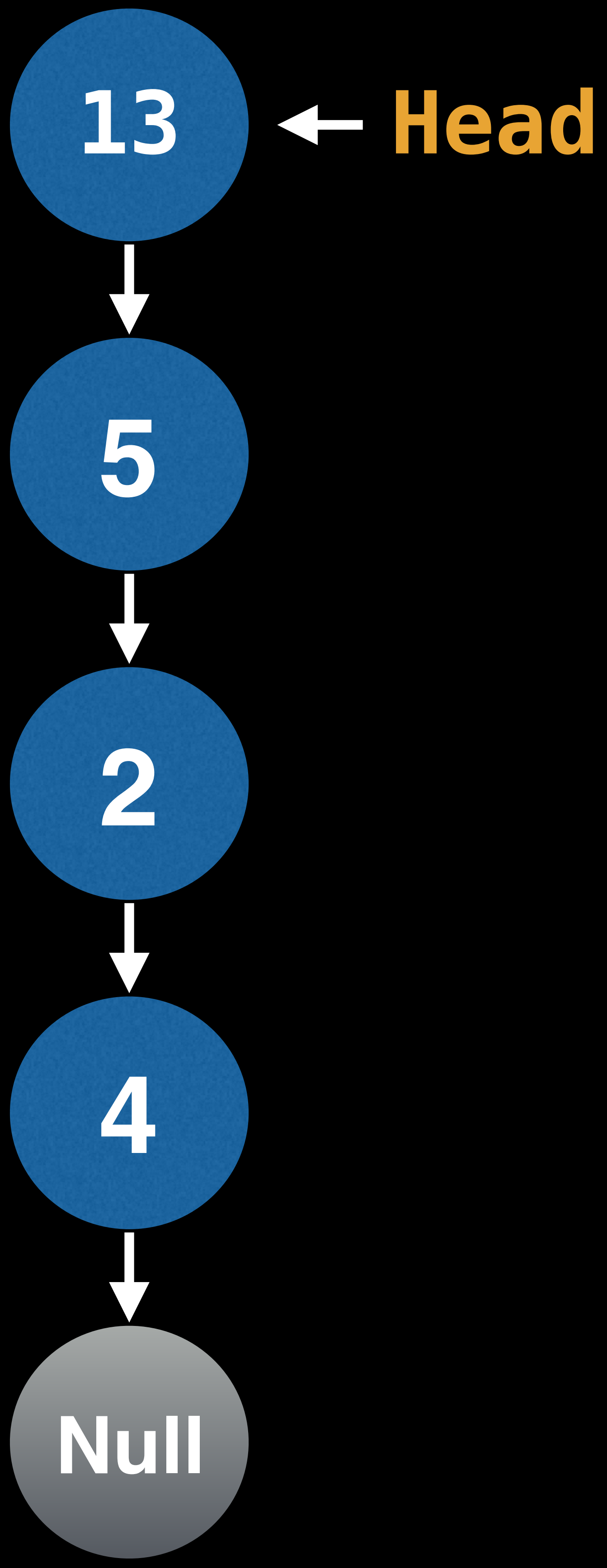
  Push(13)
```



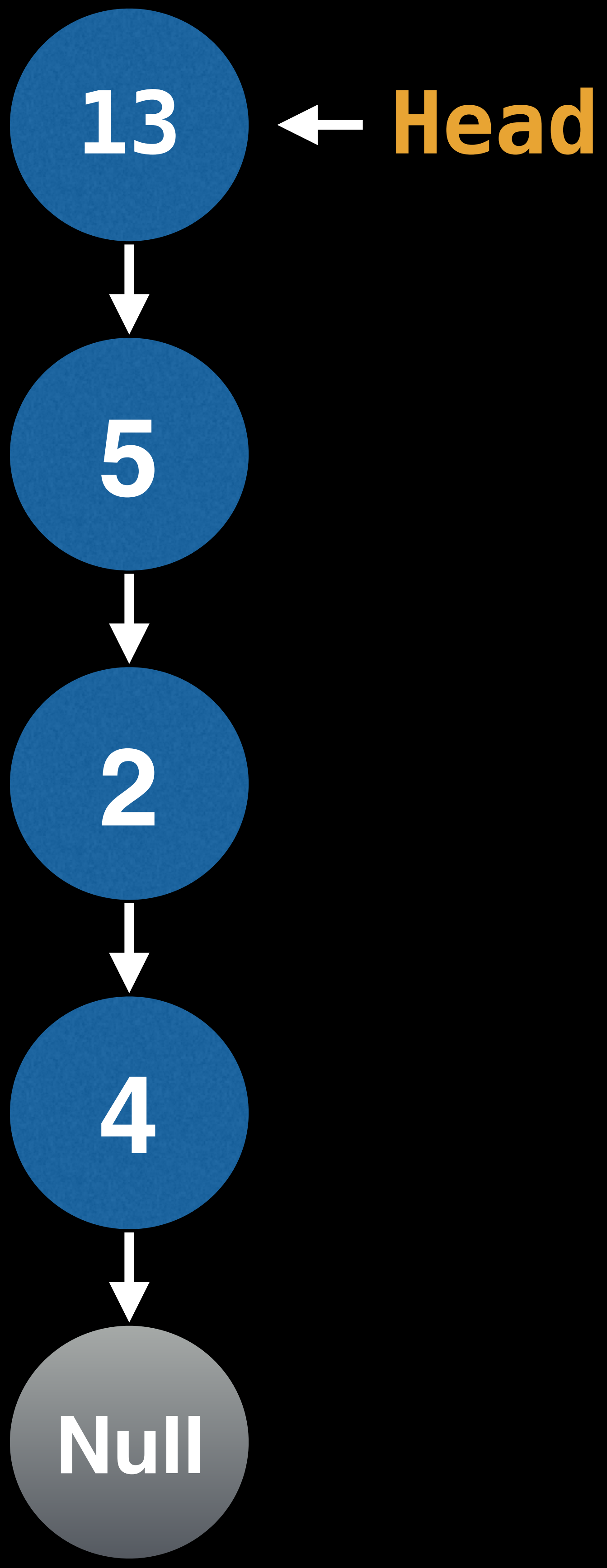
Pushing

Instructions

```
    Push(4)
    Push(2)
    Push(5)
→   Push(13)
```



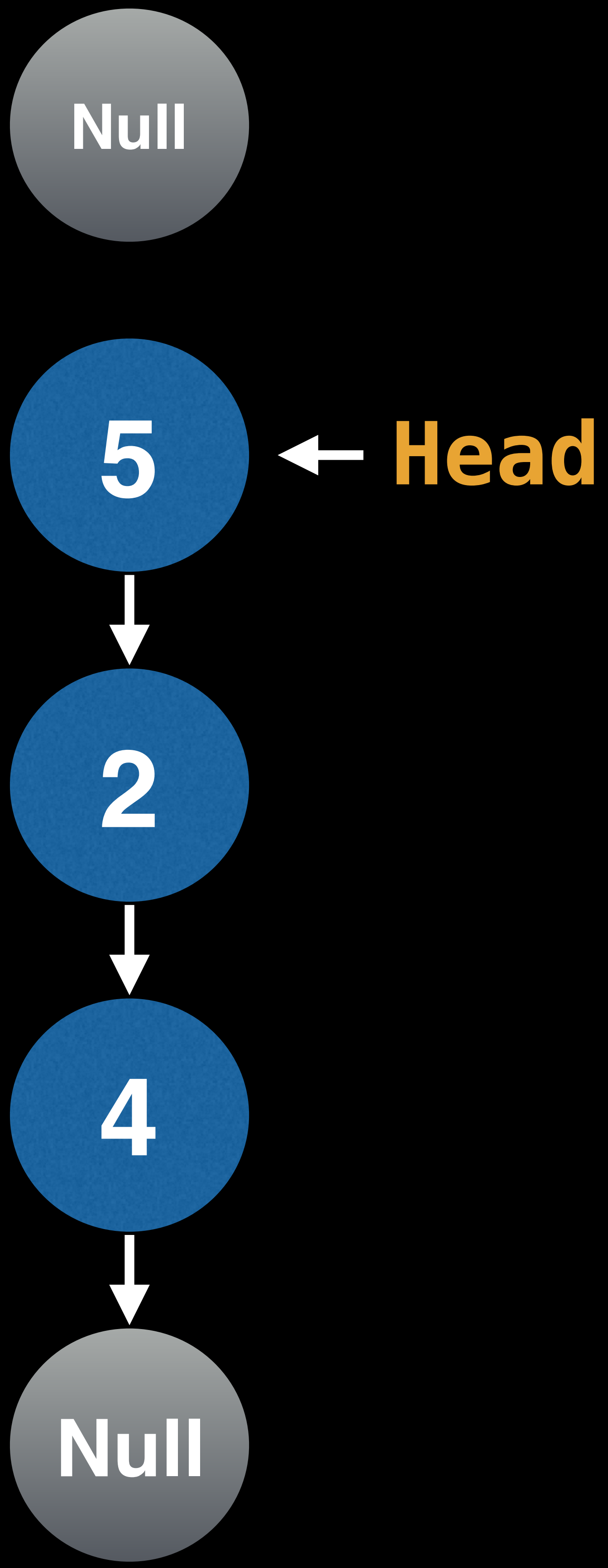
Popping



Instructions

```
Pop()
Pop()
Pop()
Pop()
```

Popping



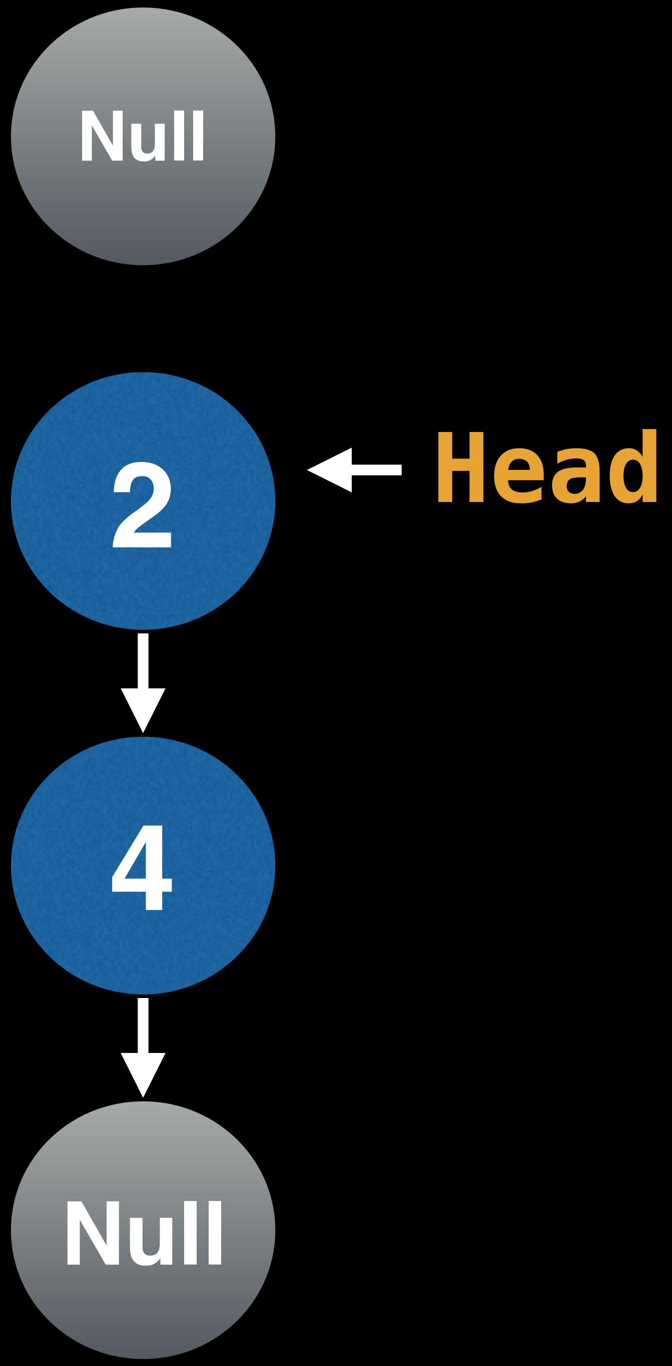
Instructions

→ Pop()
Pop()
Pop()
Pop()

Popping

Instructions

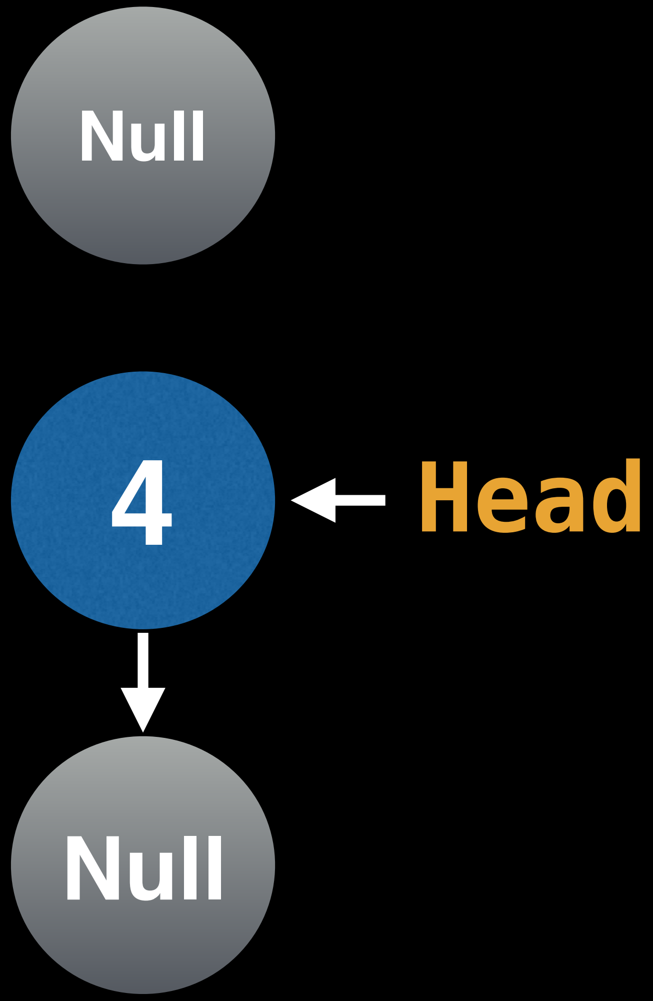
```
Pop()
Pop()
Pop()
Pop()
```



Popping

Instructions

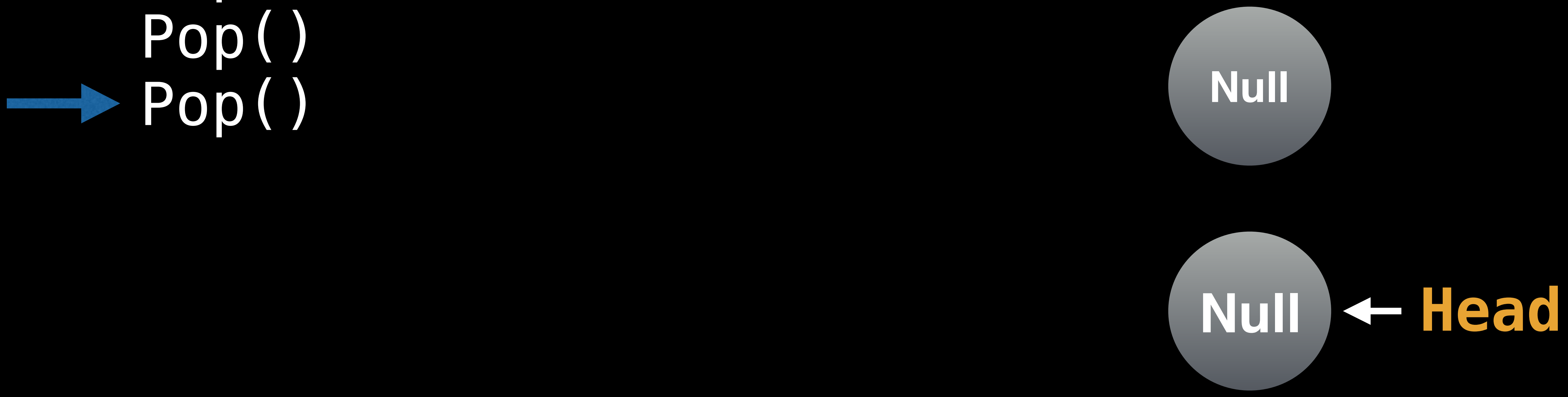
```
Pop()
Pop()
Pop()
Pop()
```



Popping

Instructions

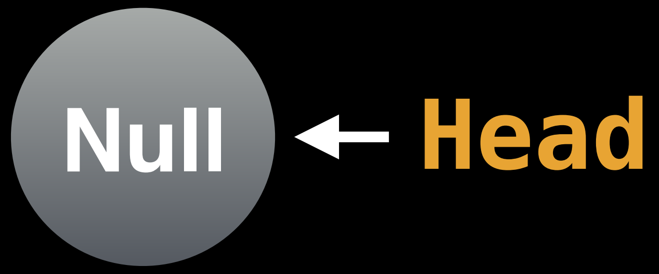
```
Pop()
Pop()
Pop()
Pop()
```



Popping

<u>Instructions</u>

```
    Pop()
    Pop()
    Pop()
    Pop()
```



Implementation in next video

Implementation source code and tests
can all be found at the following link:

github.com/williamfiset/data-structures

Stack Source Code

Part 3/3

William Fiset

Source Code Link

Implementation source code
and tests can all be found
at the following link:

github.com/williamfiset/data-structures

NOTE: Make sure you have understood part 1, 2
from the Stack series before continuing!