# Stack

William Fiset

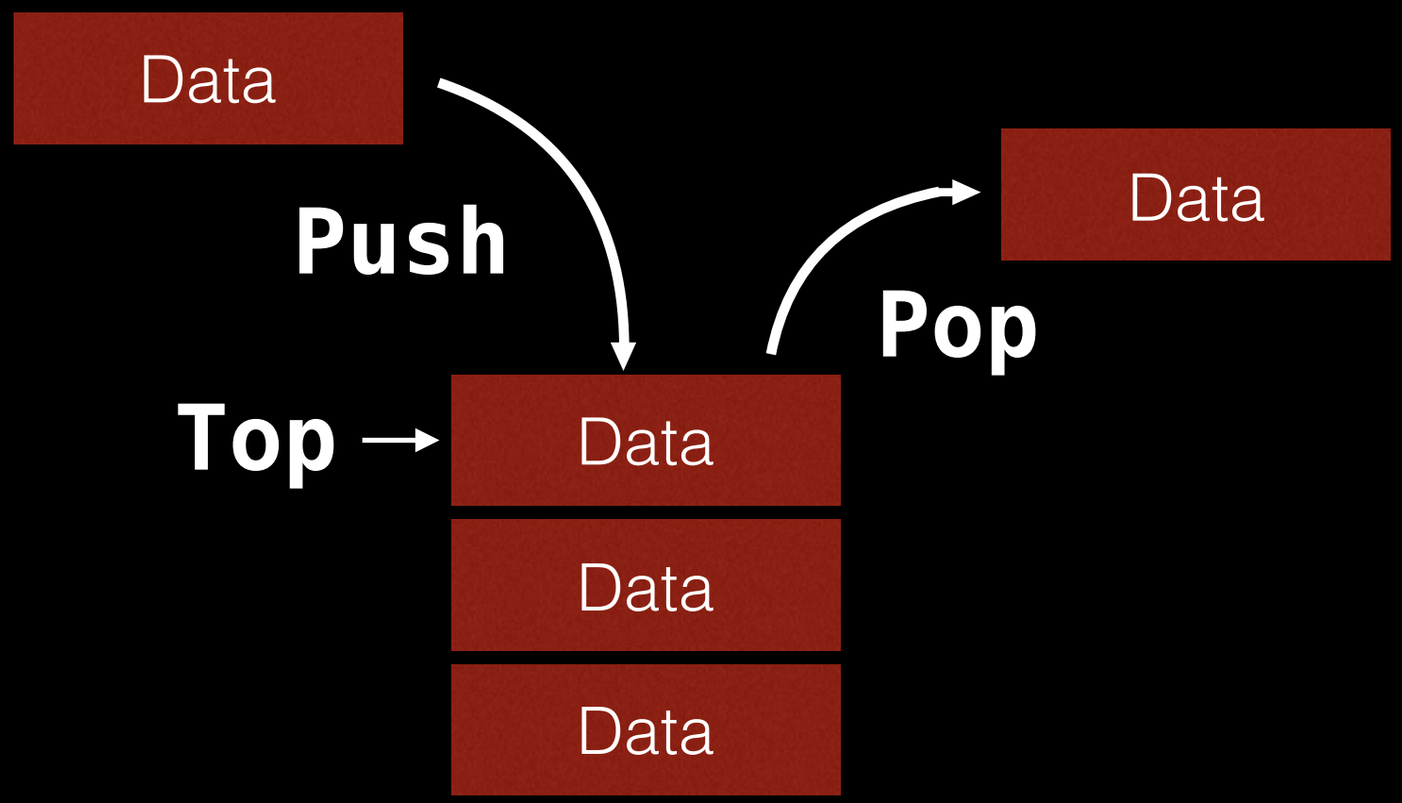
# Outline

- 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**.



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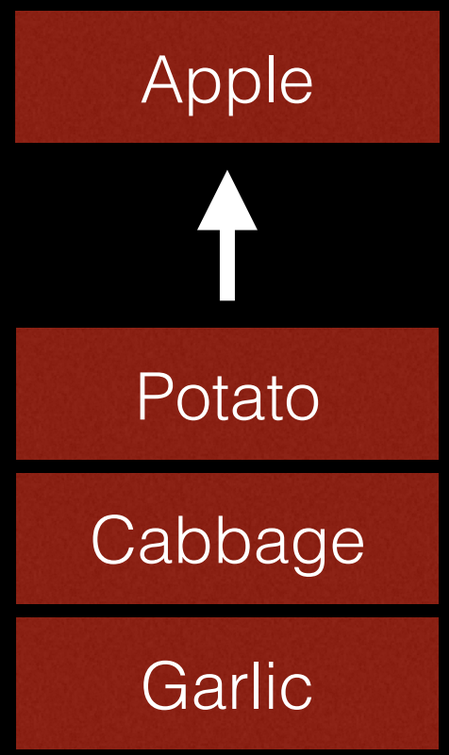

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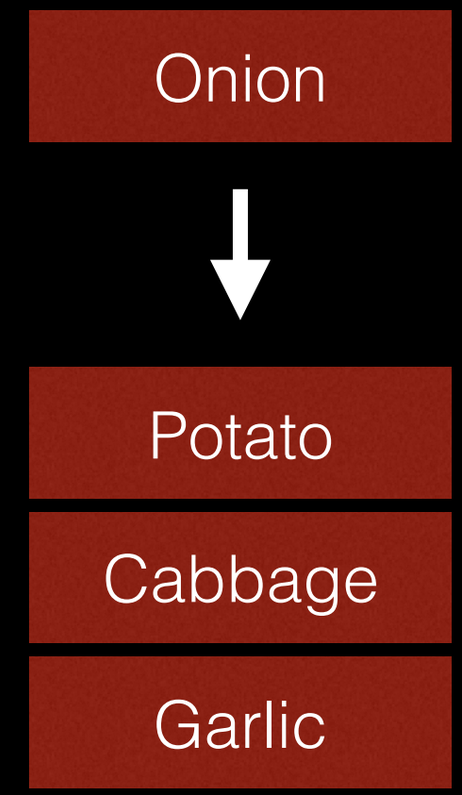

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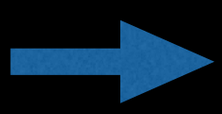

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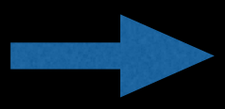

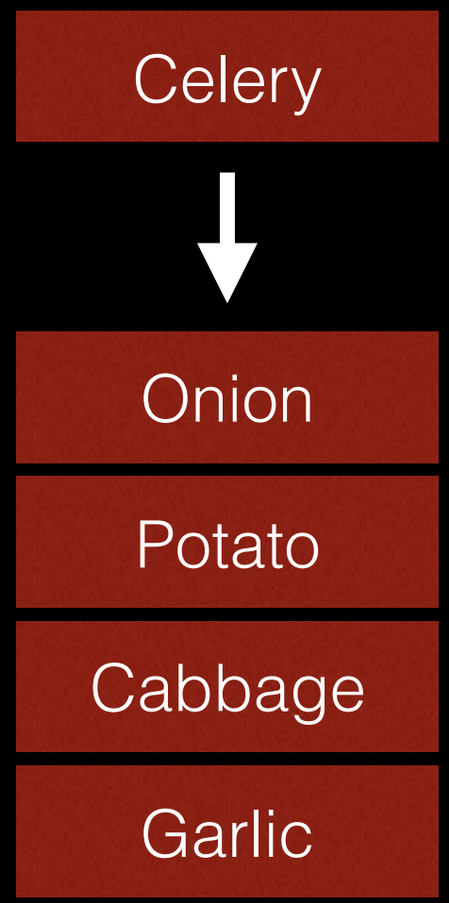

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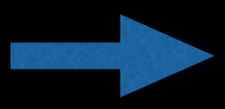

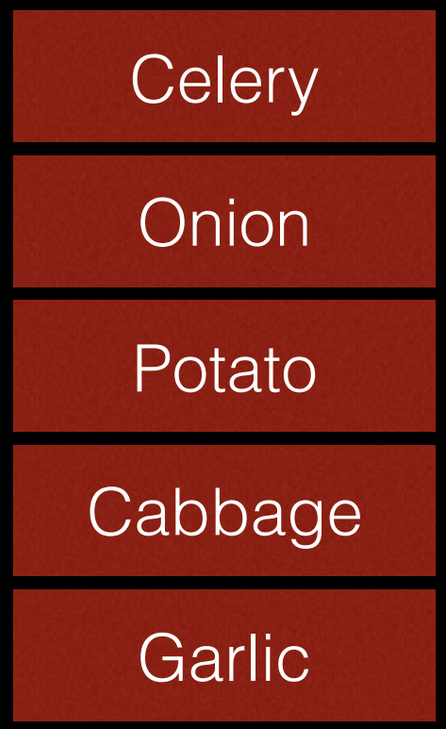

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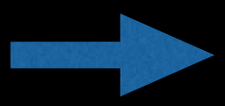

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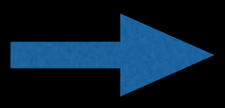

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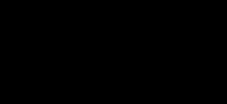

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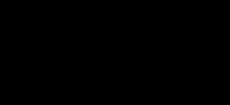

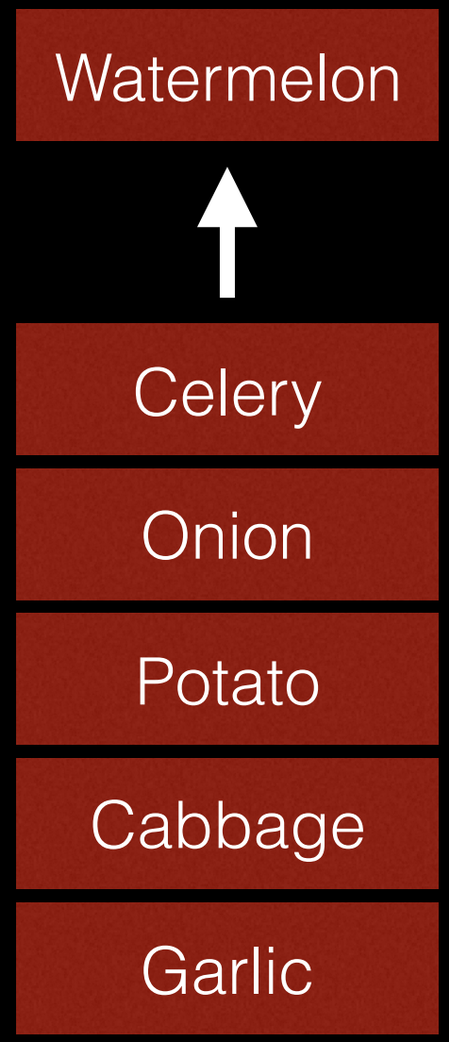

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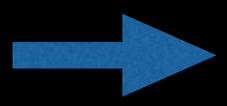

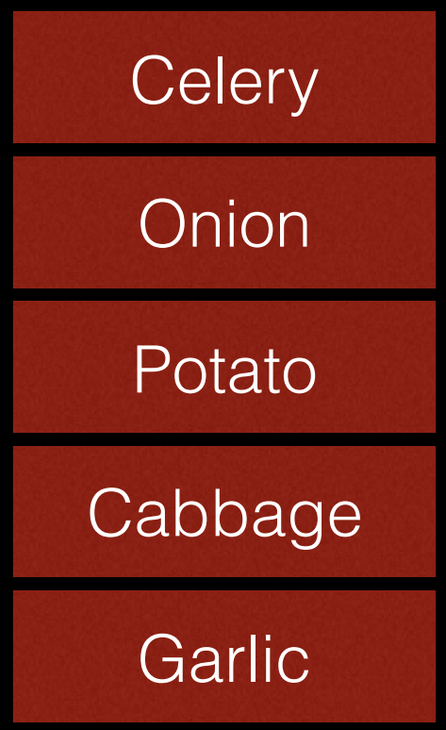

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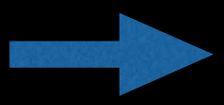

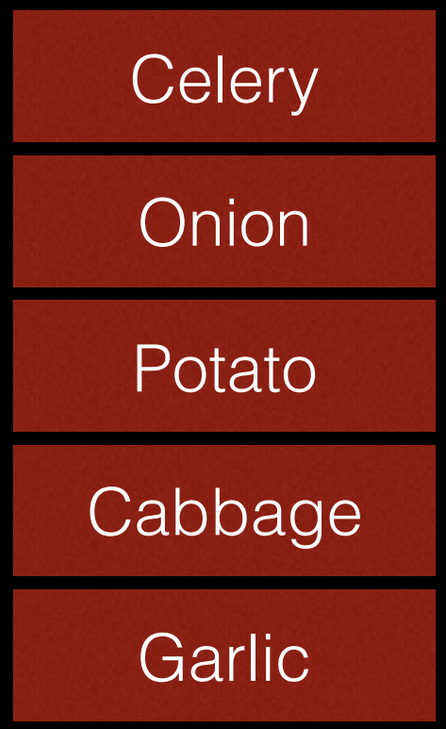

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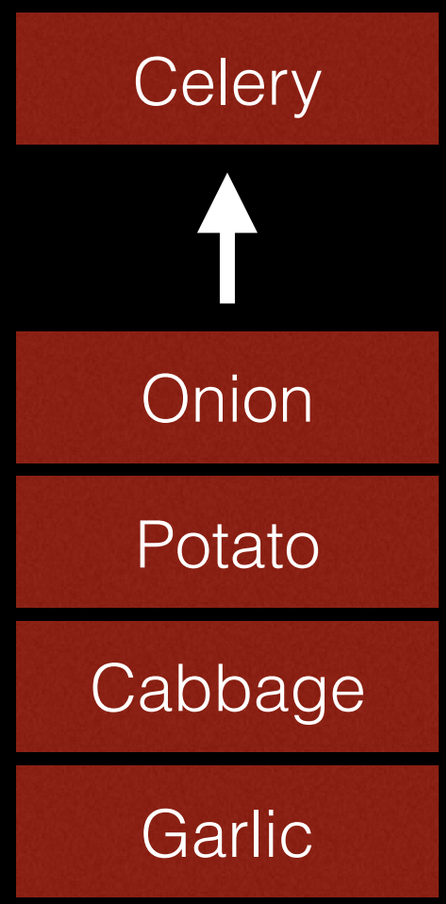

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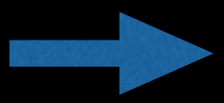

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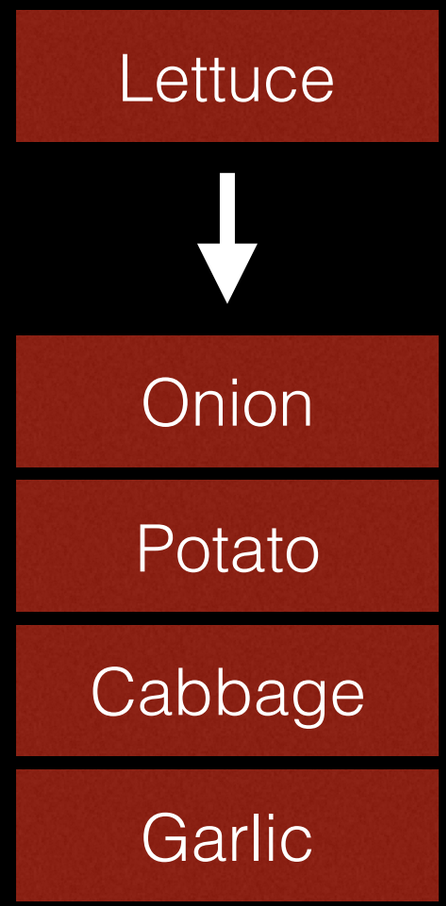

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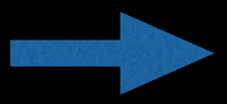

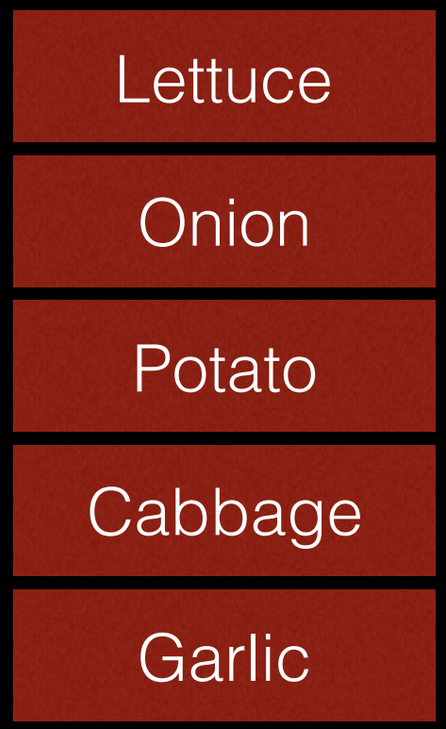

# When and where is a Stack used?

- 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.

| | | |
|---|---|---|
| [{}] | → | **Valid** |
| (()()) | → | **Valid** |
| {] | → | **Invalid** |
| [()]))() | → | **Invalid** |
| []{}({}) | → | **Valid** |

# Example – Brackets

Bracket Sequence:

[[{}]()]

Current Bracket: ∅

Reversed Bracket: ∅

# Example – Brackets

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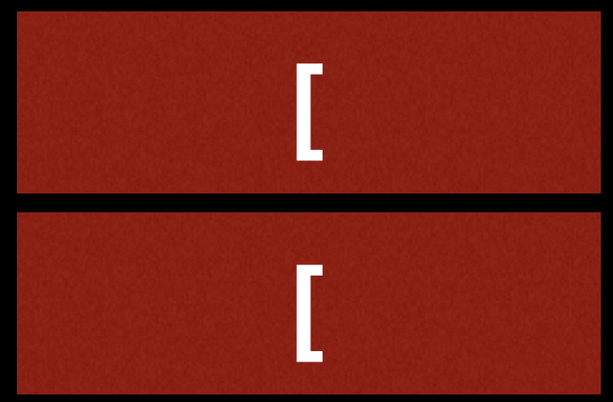

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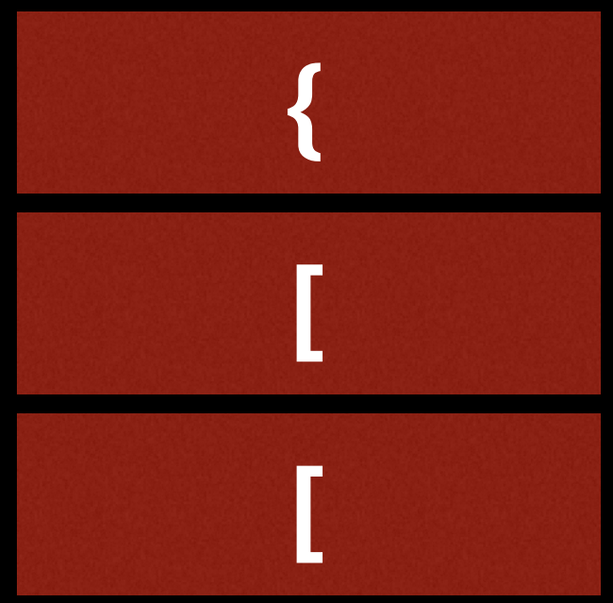

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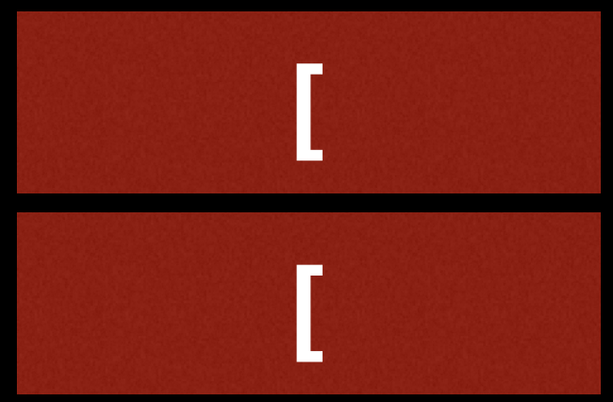

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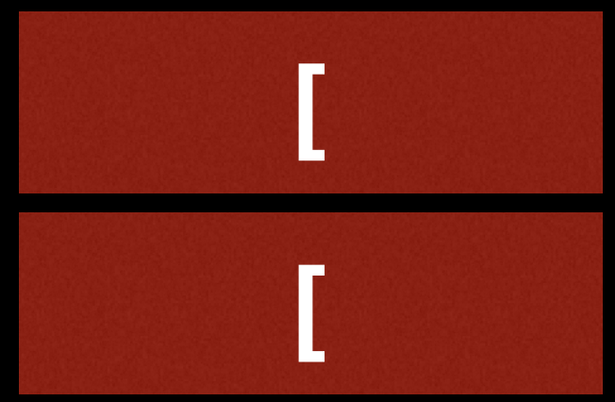

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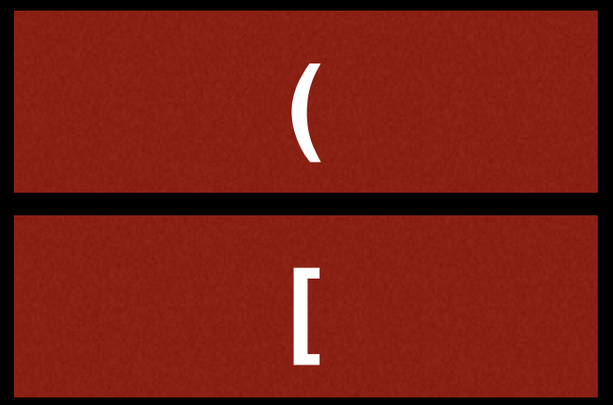

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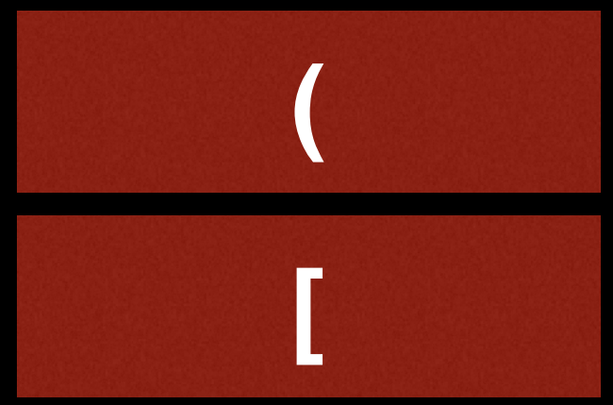

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Bracket Sequence:

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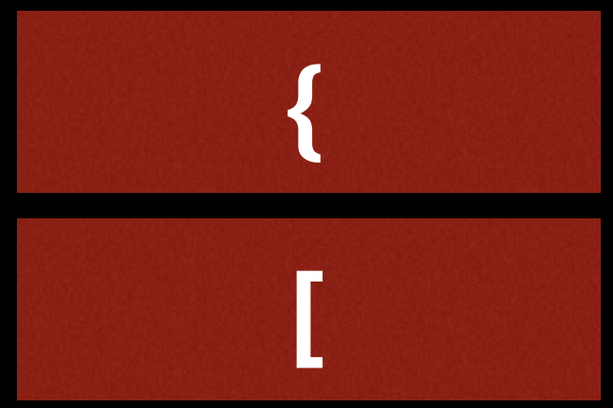

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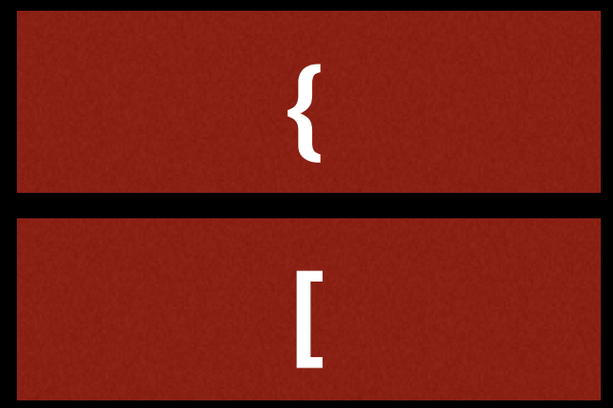

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# Example – Brackets

Bracket Sequence:

[{})[] ⟶ Invalid

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Reversed Bracket: (

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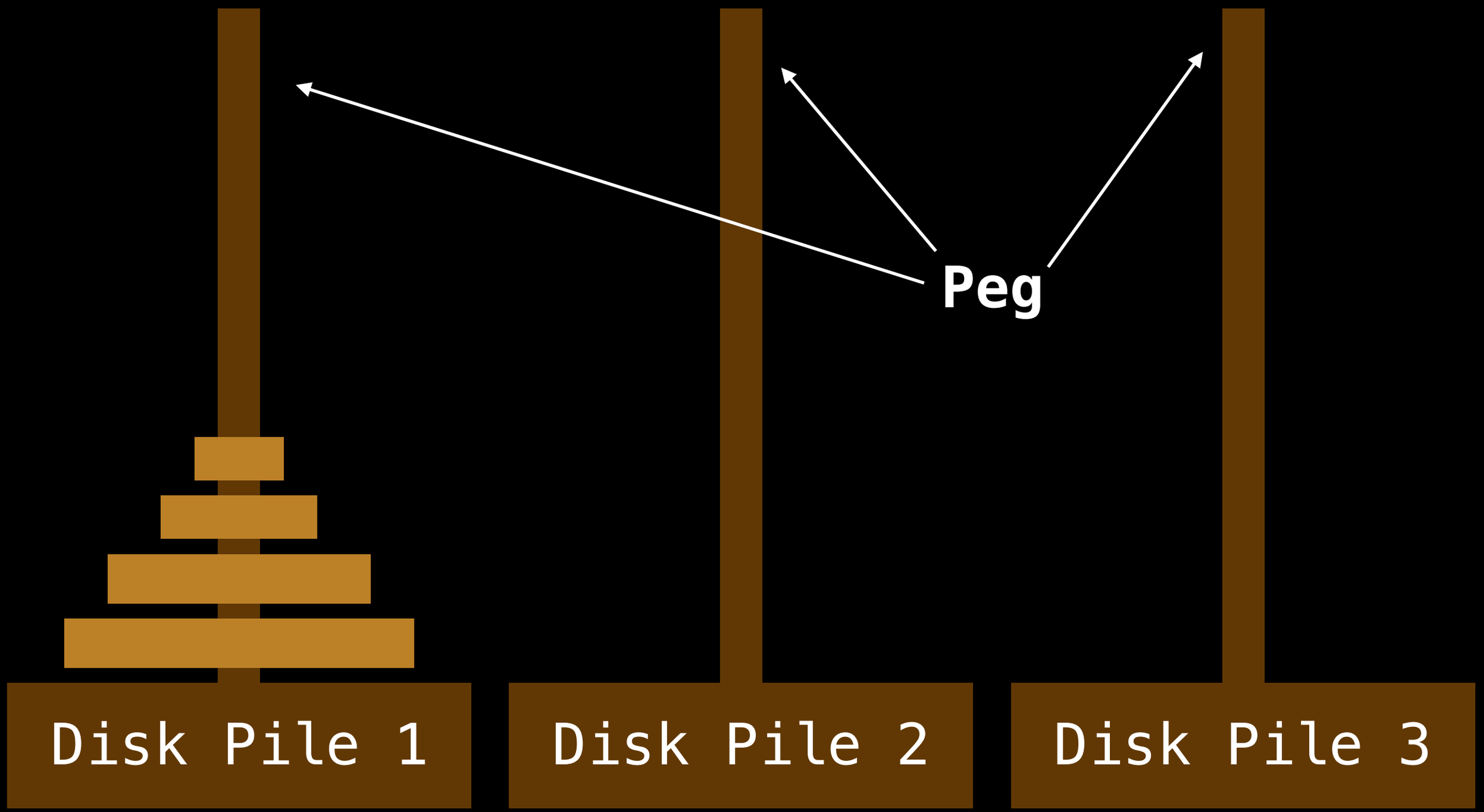
# Example – Brackets

```
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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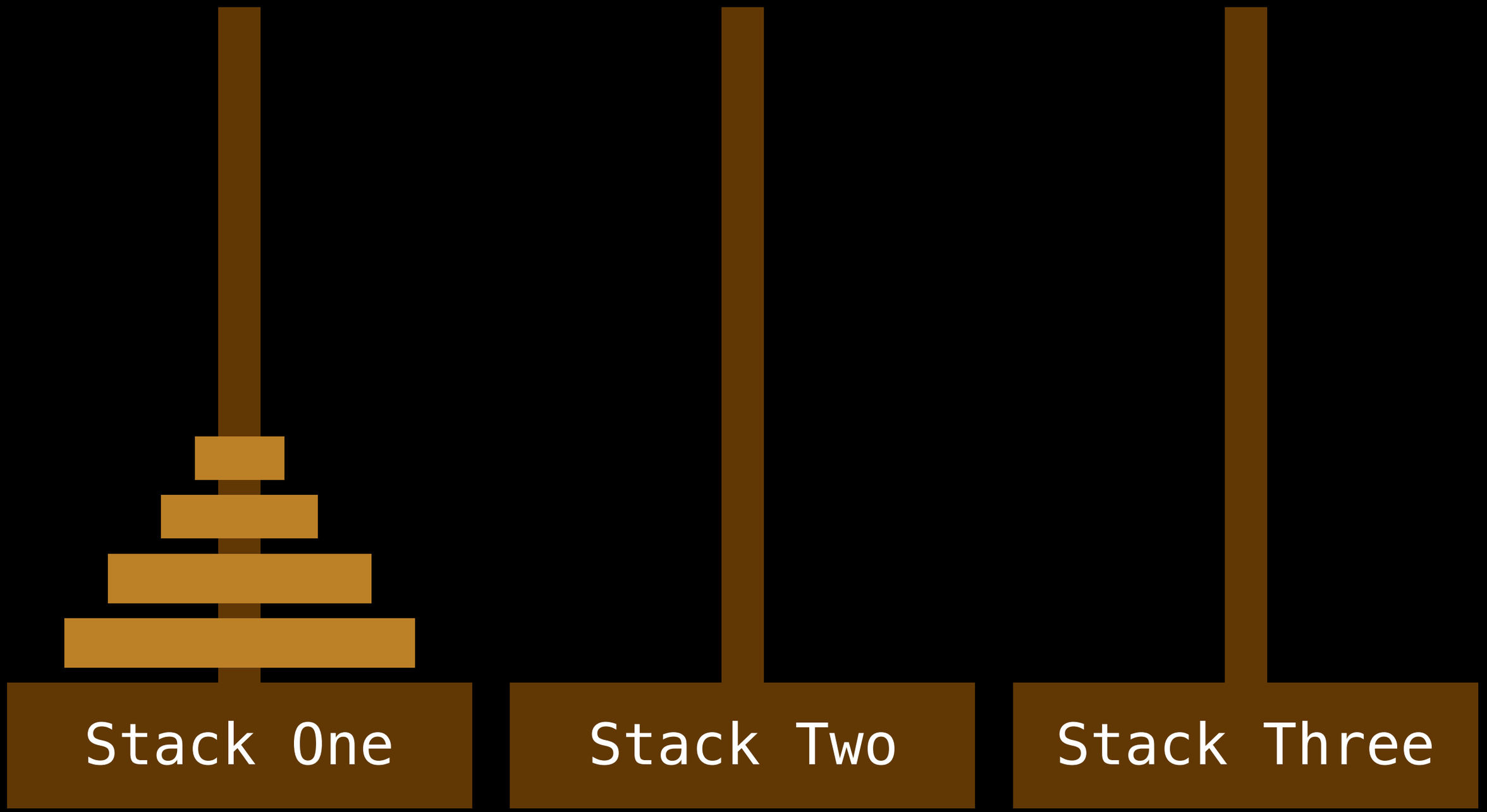

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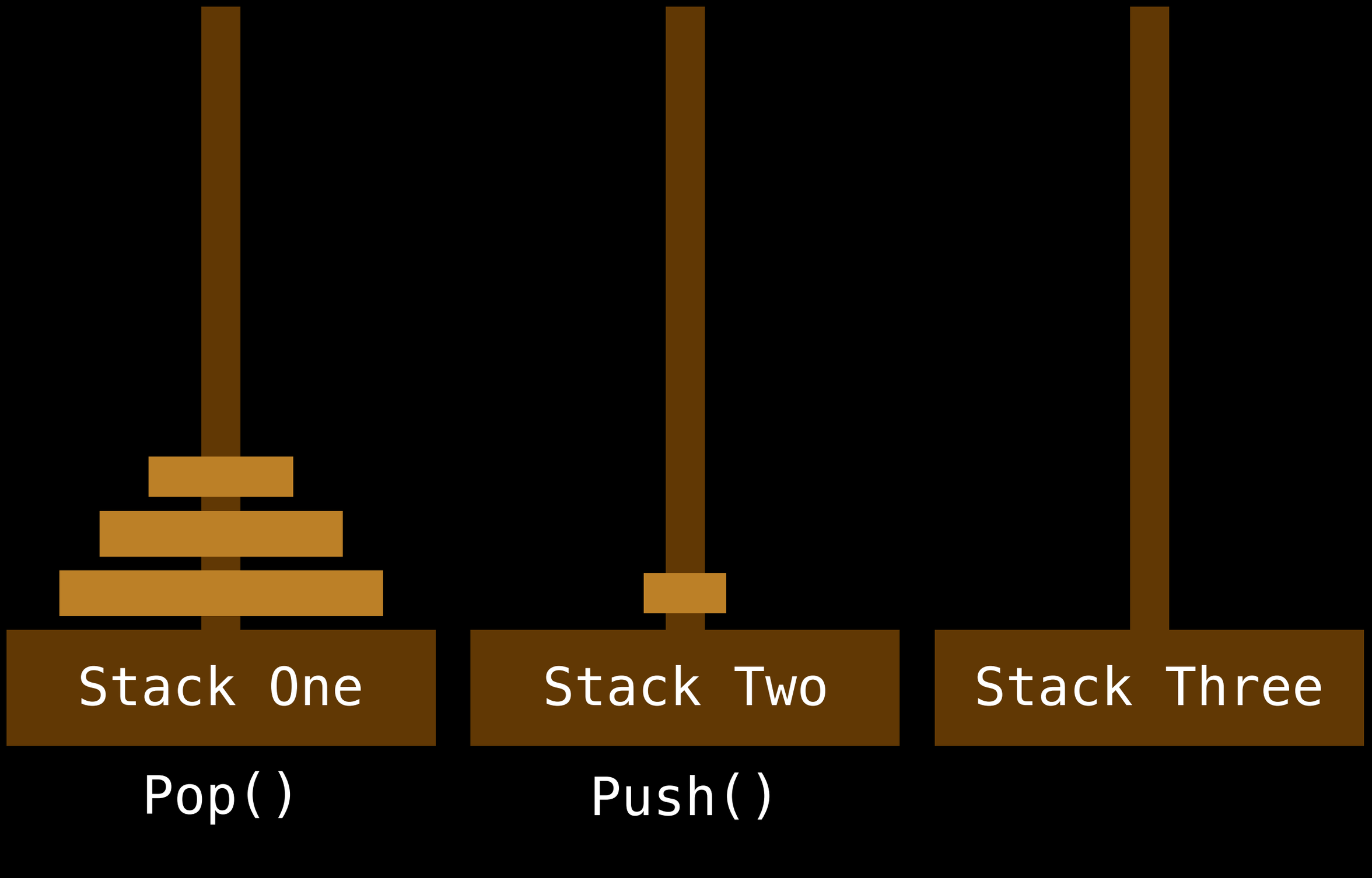

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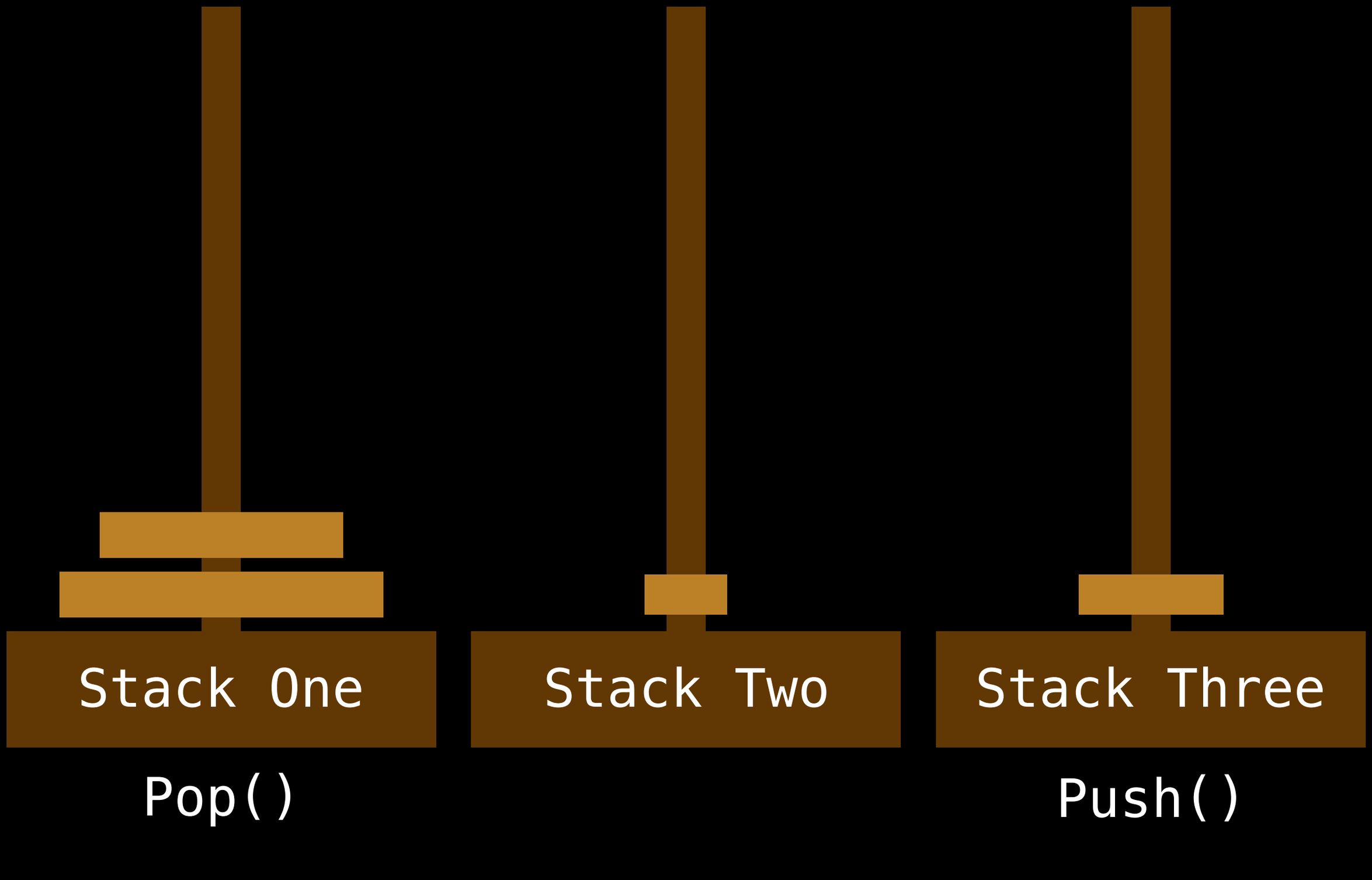

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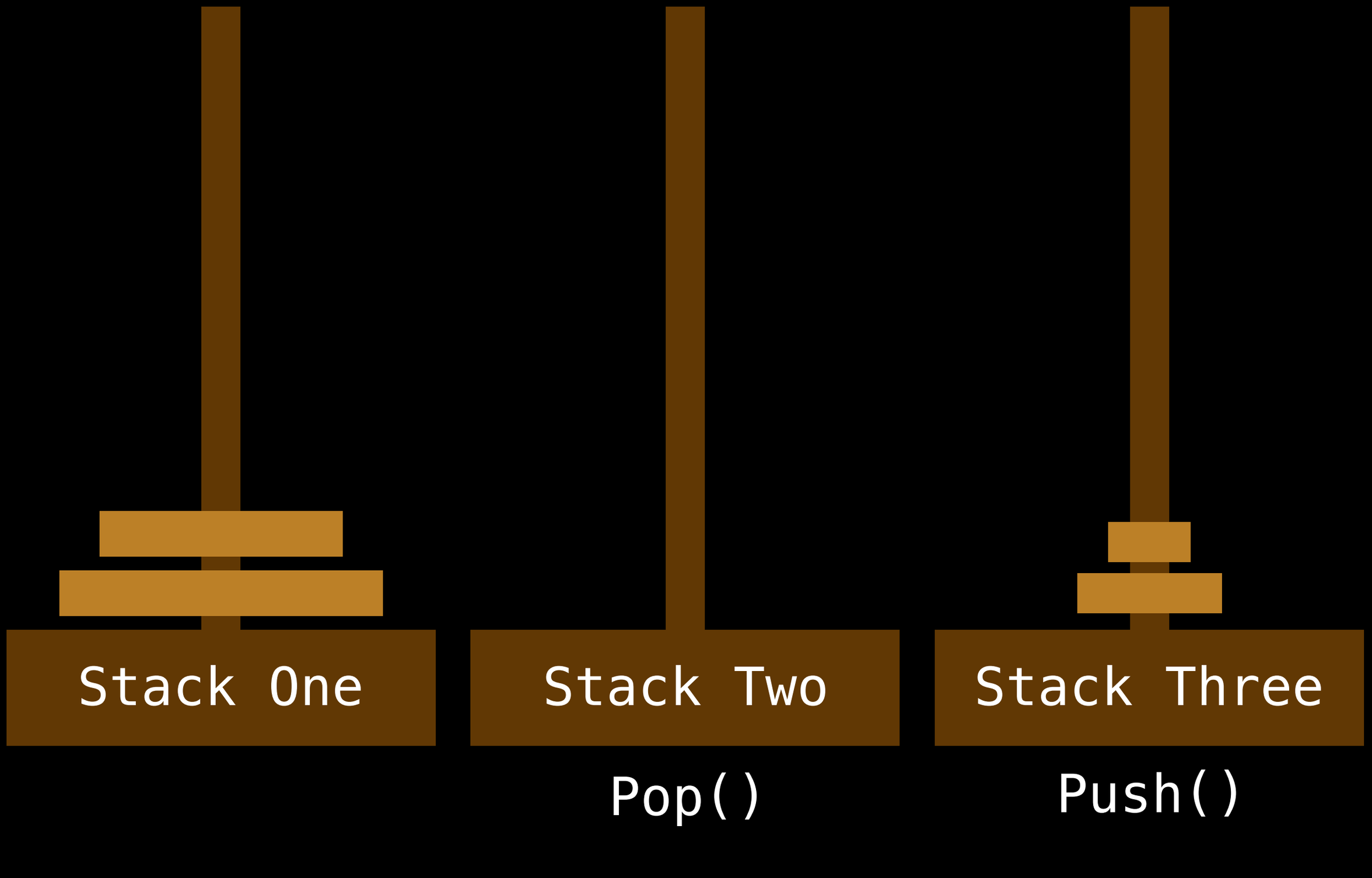
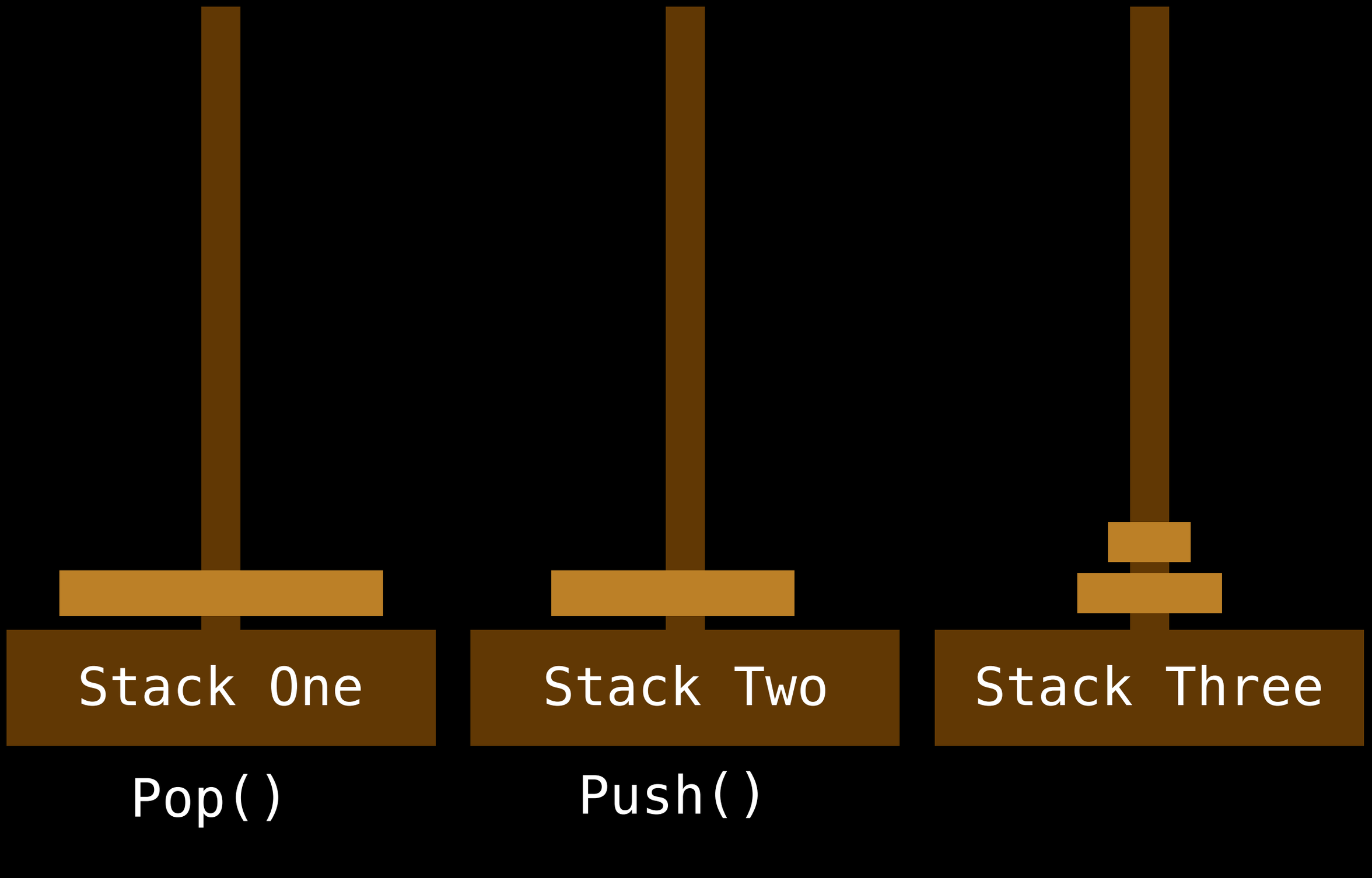
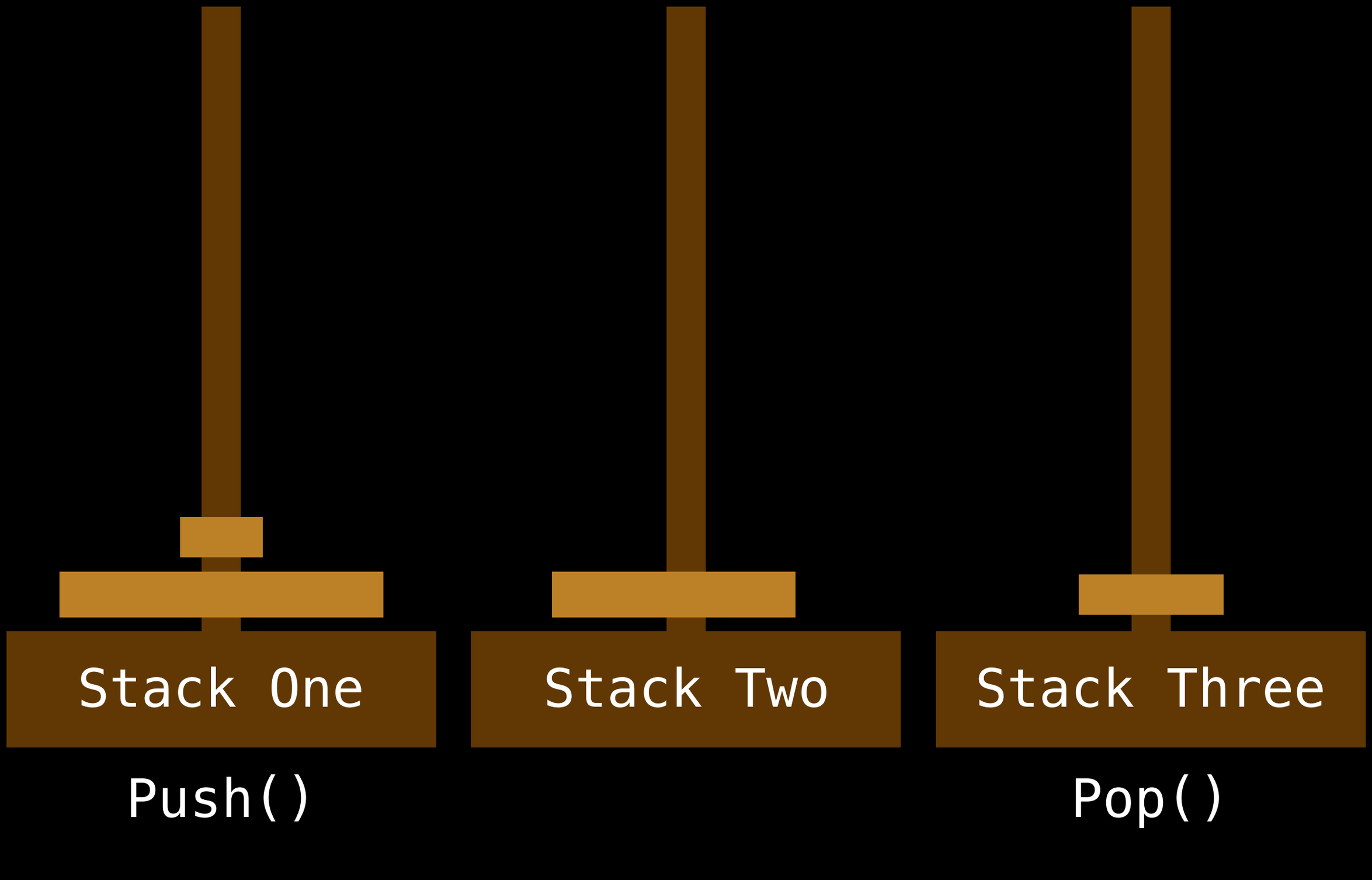


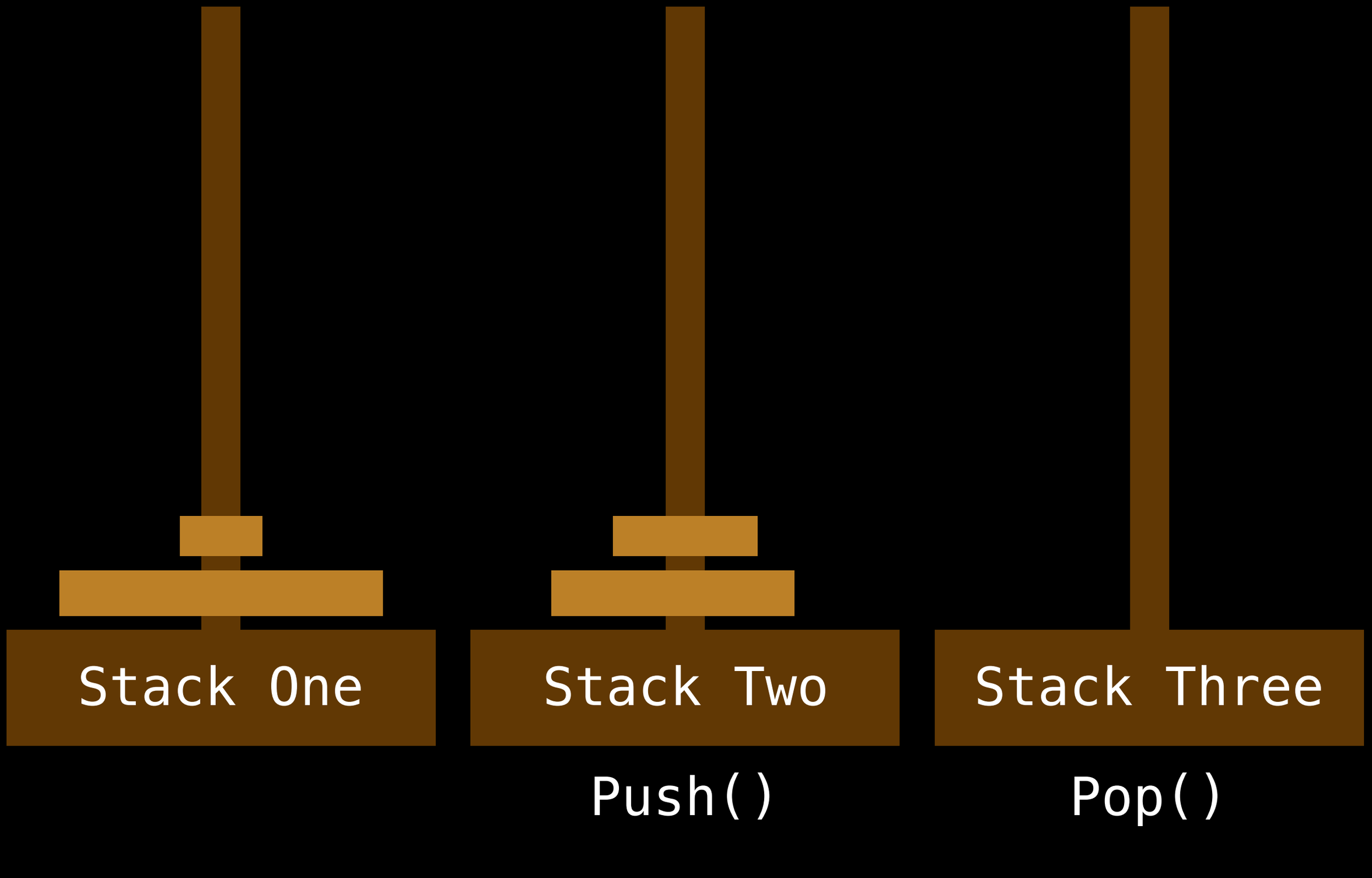
# Tower of Hanoi



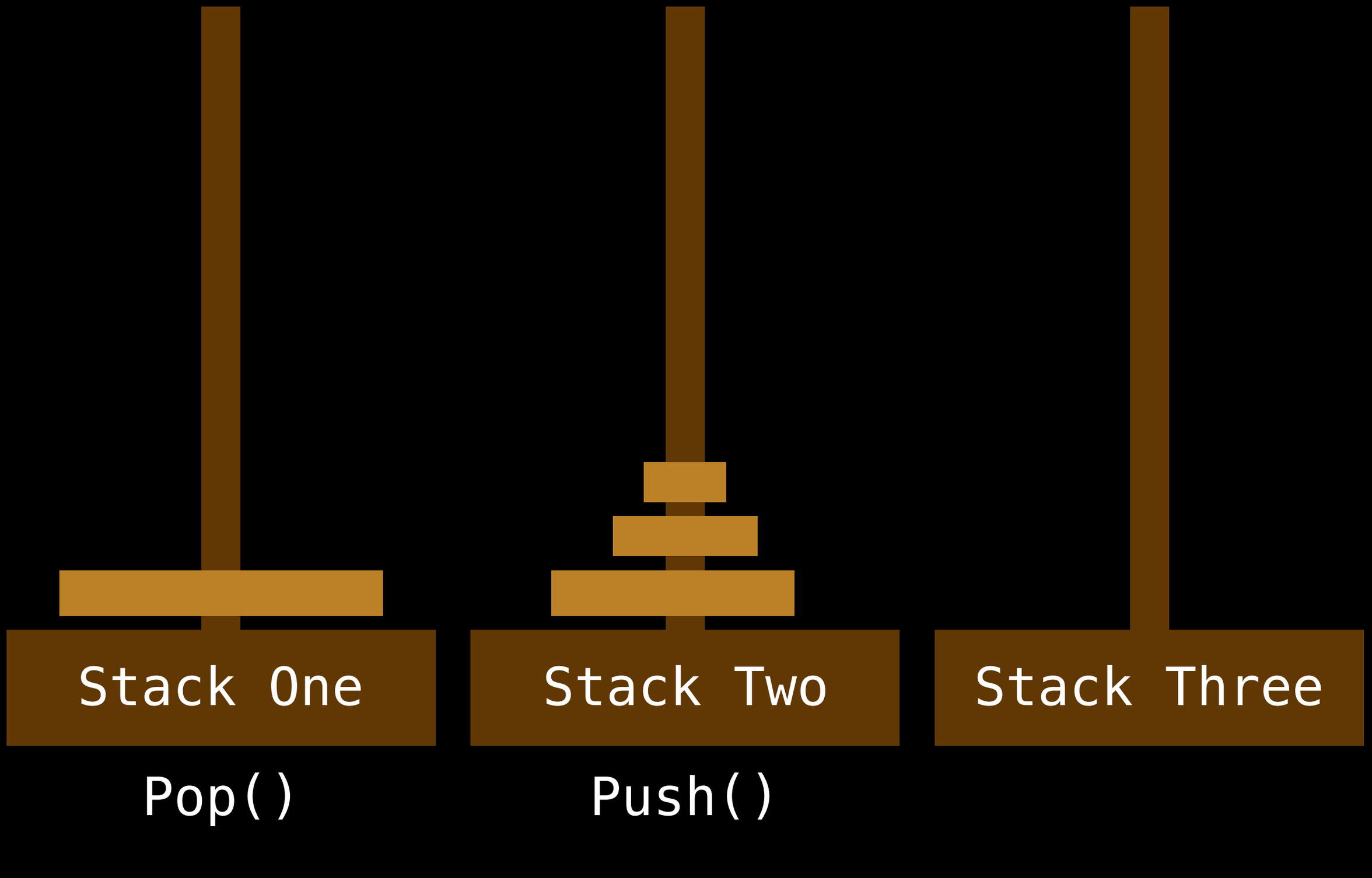
# Tower of Hanoi



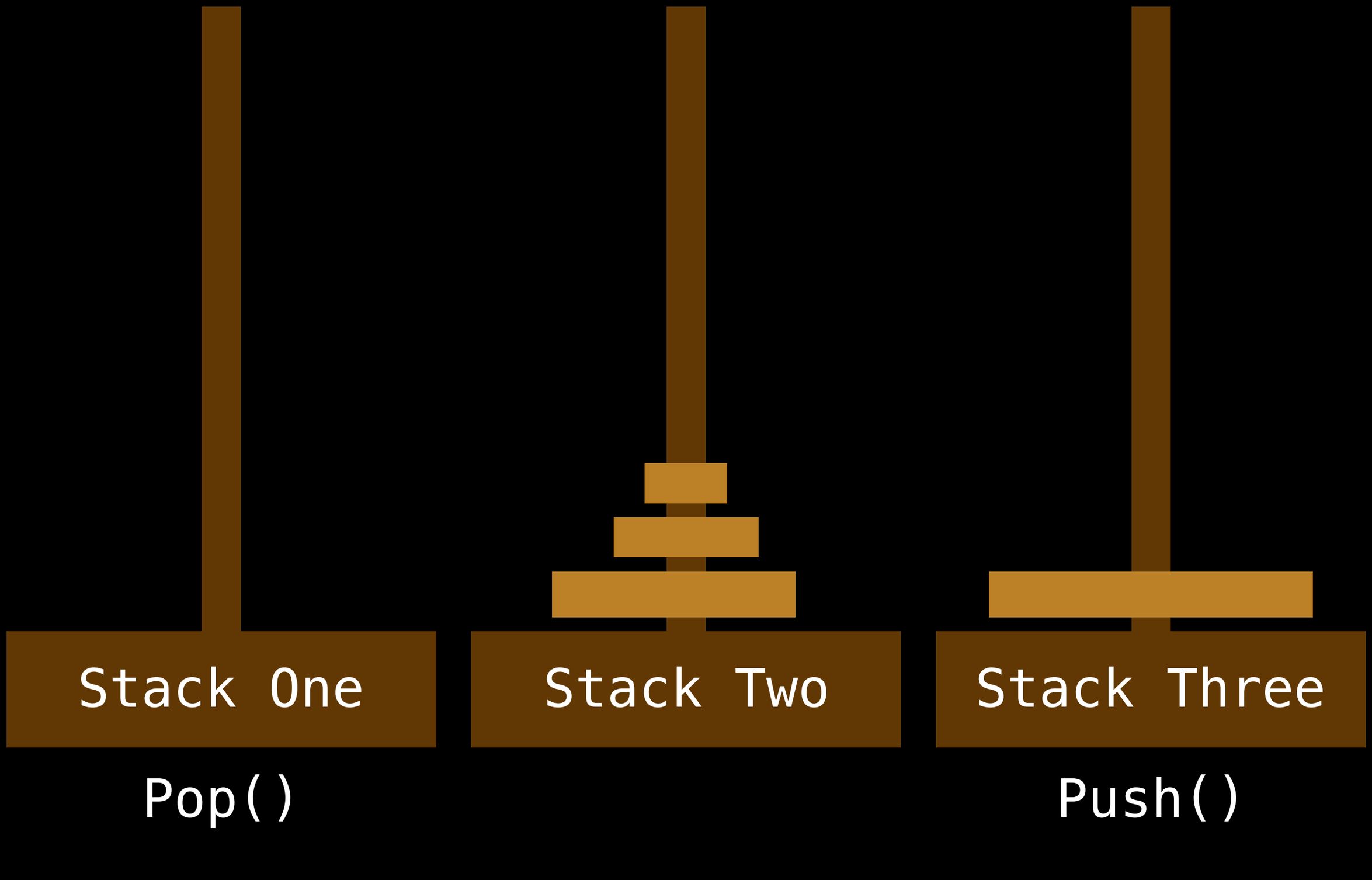
# Tower of Hanoi



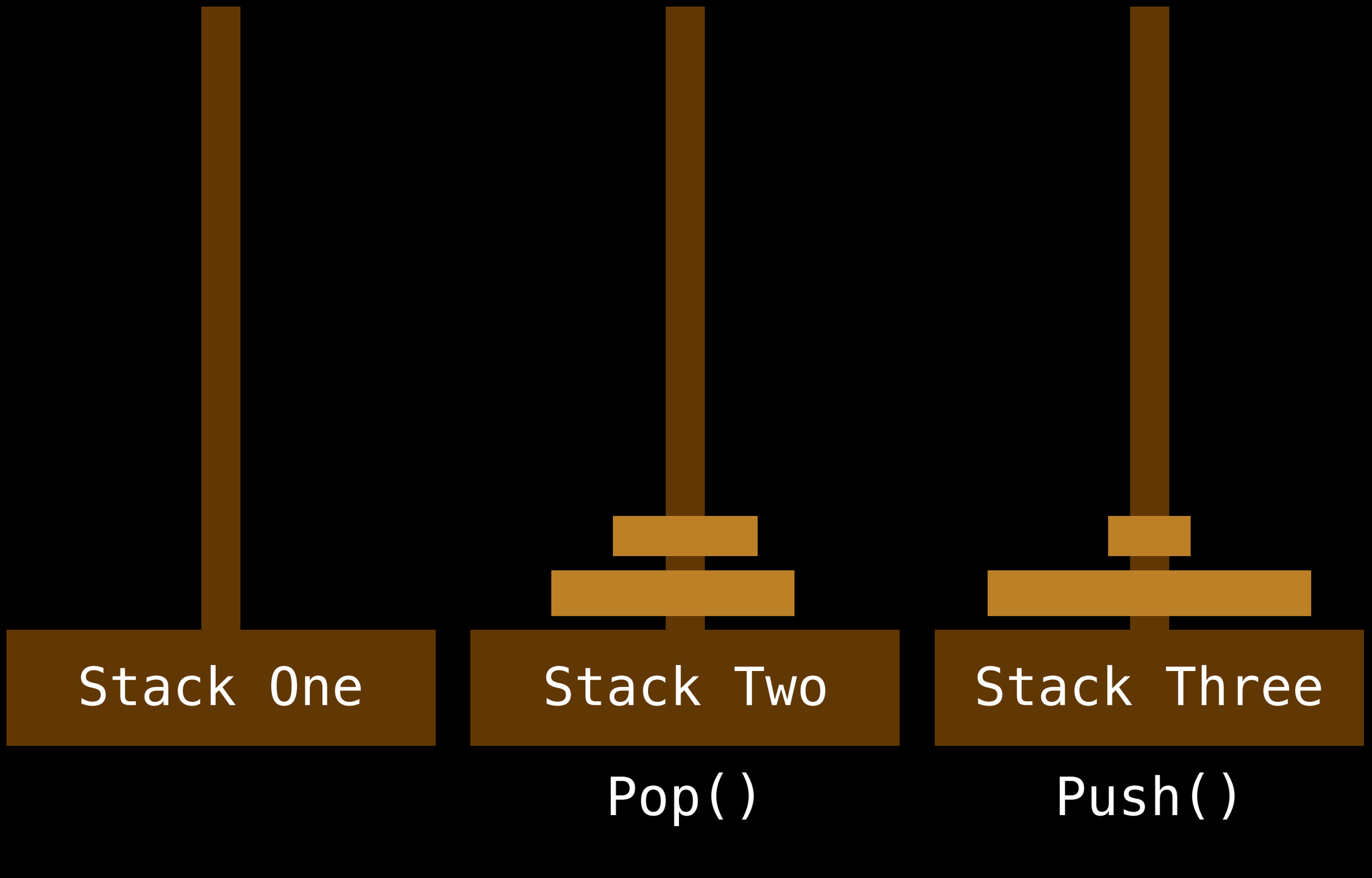
# Tower of Hanoi



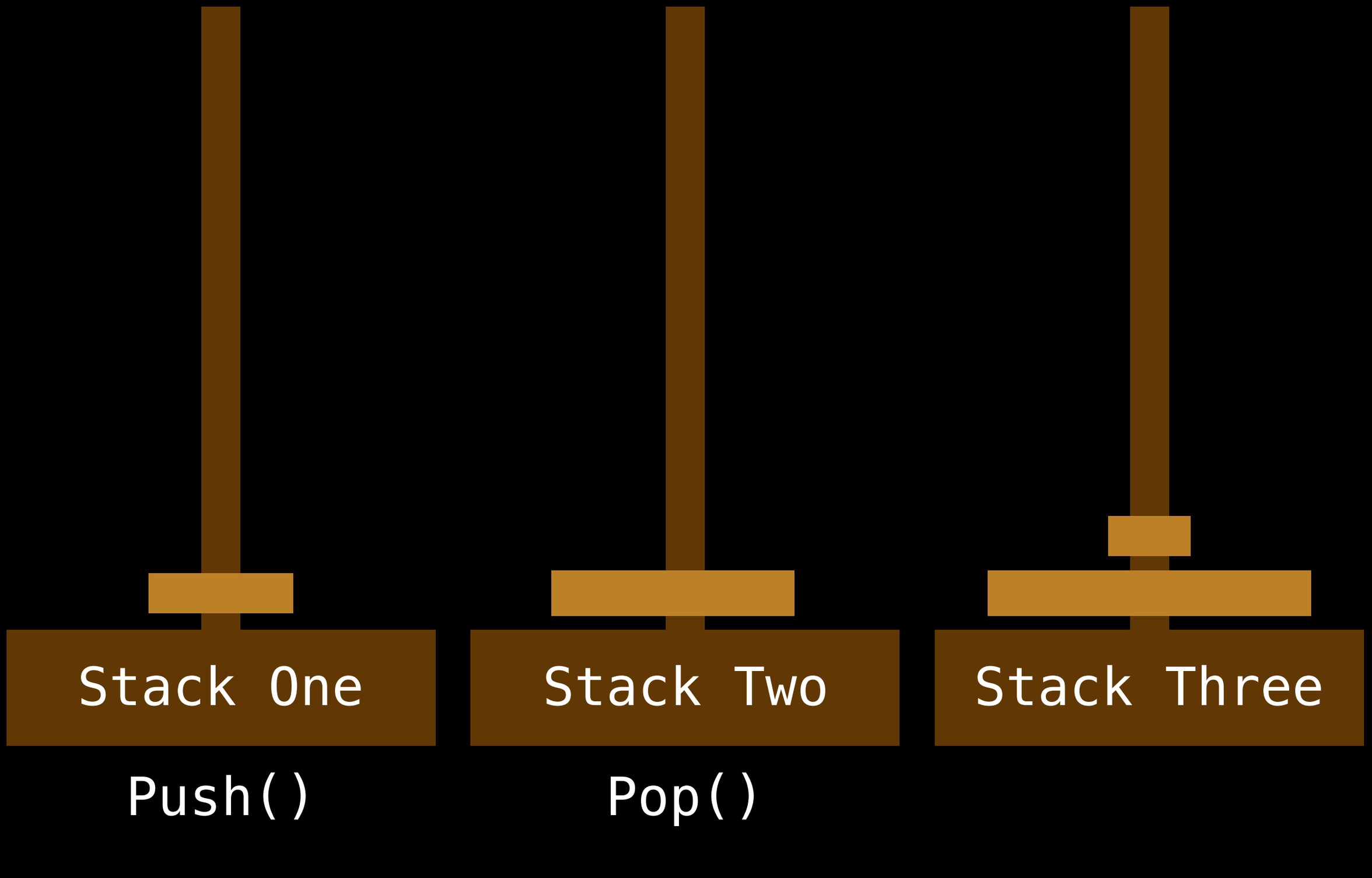
# Tower of Hanoi



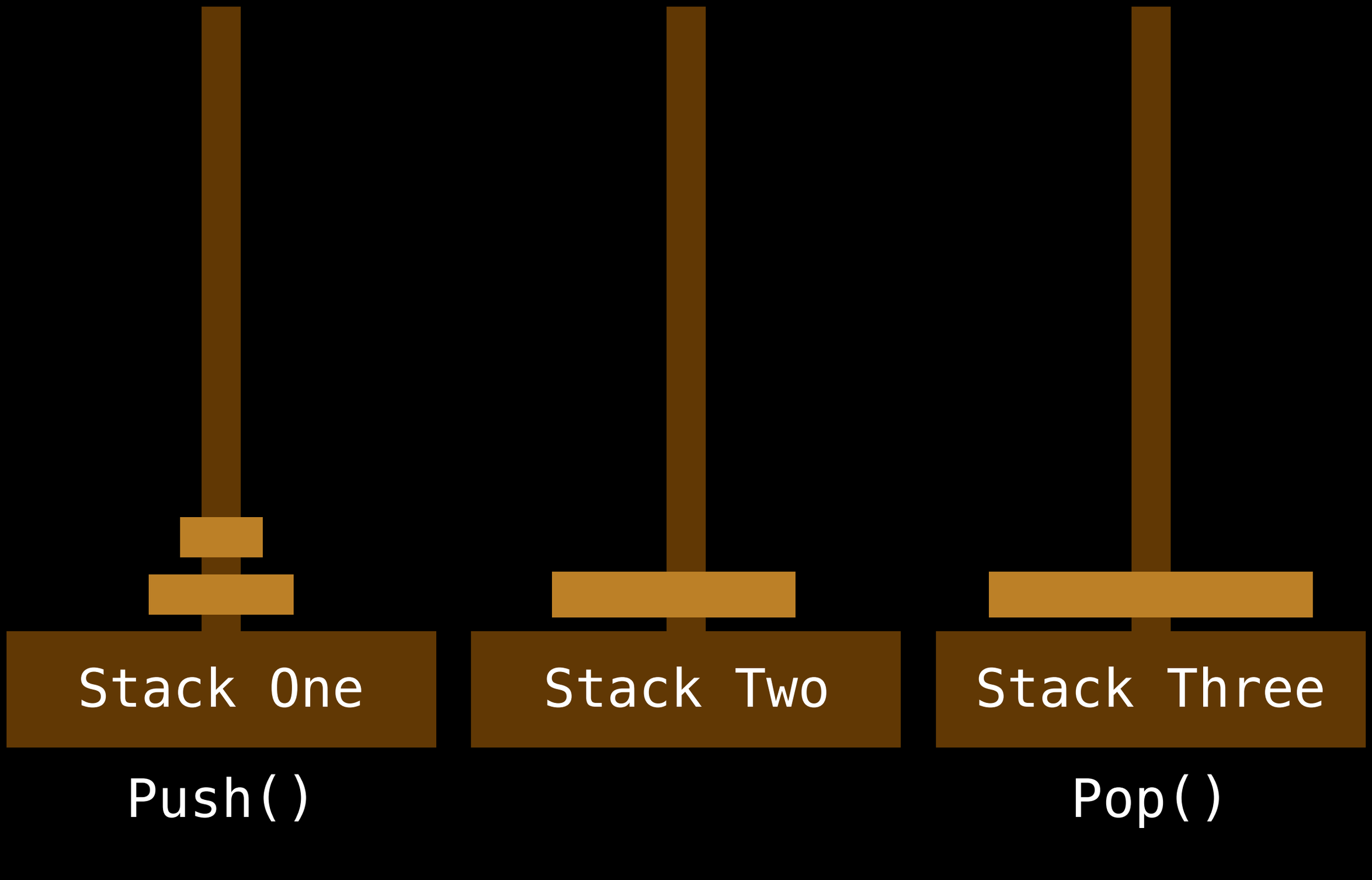
# Tower of Hanoi



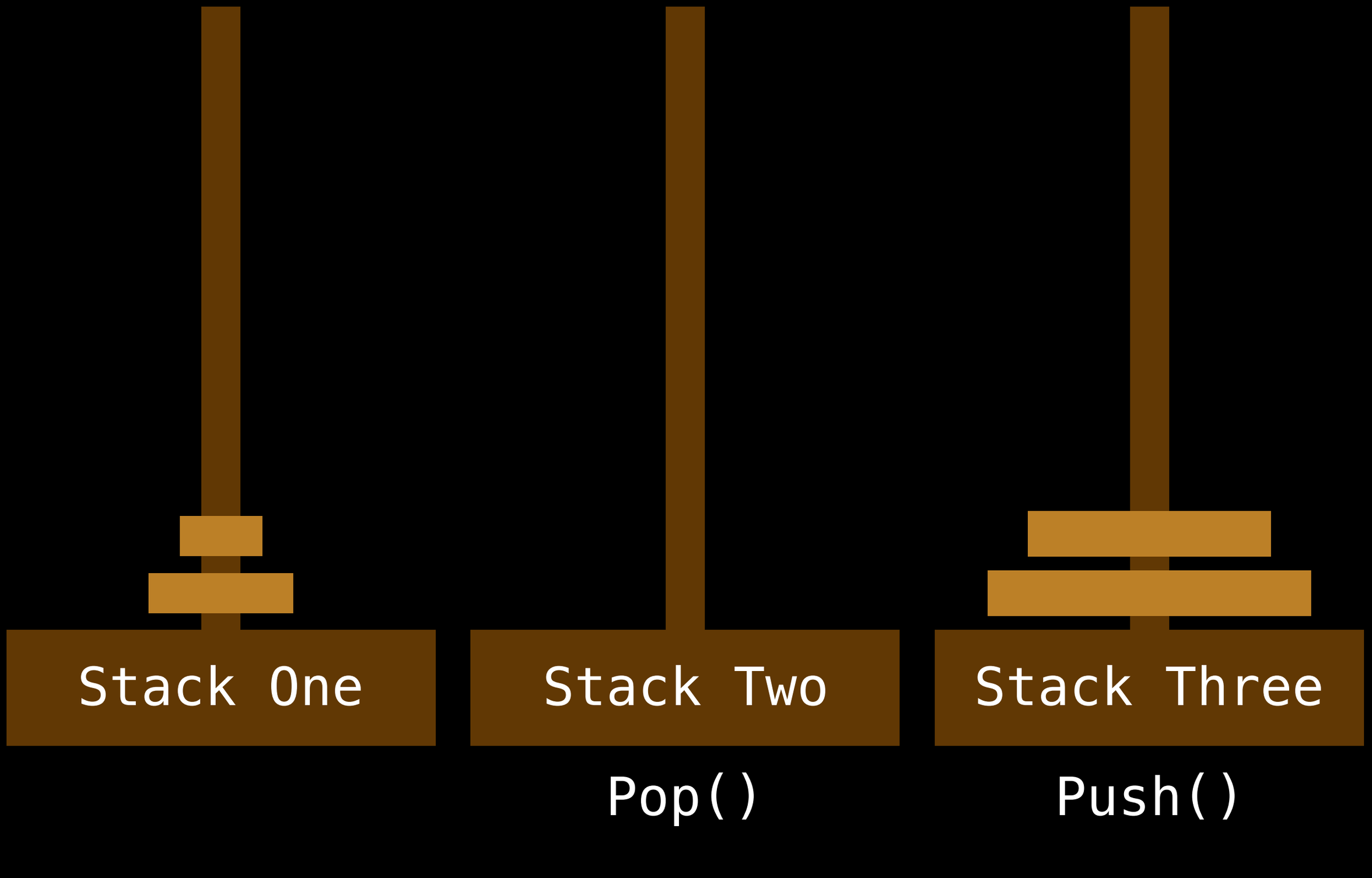
# Tower of Hanoi



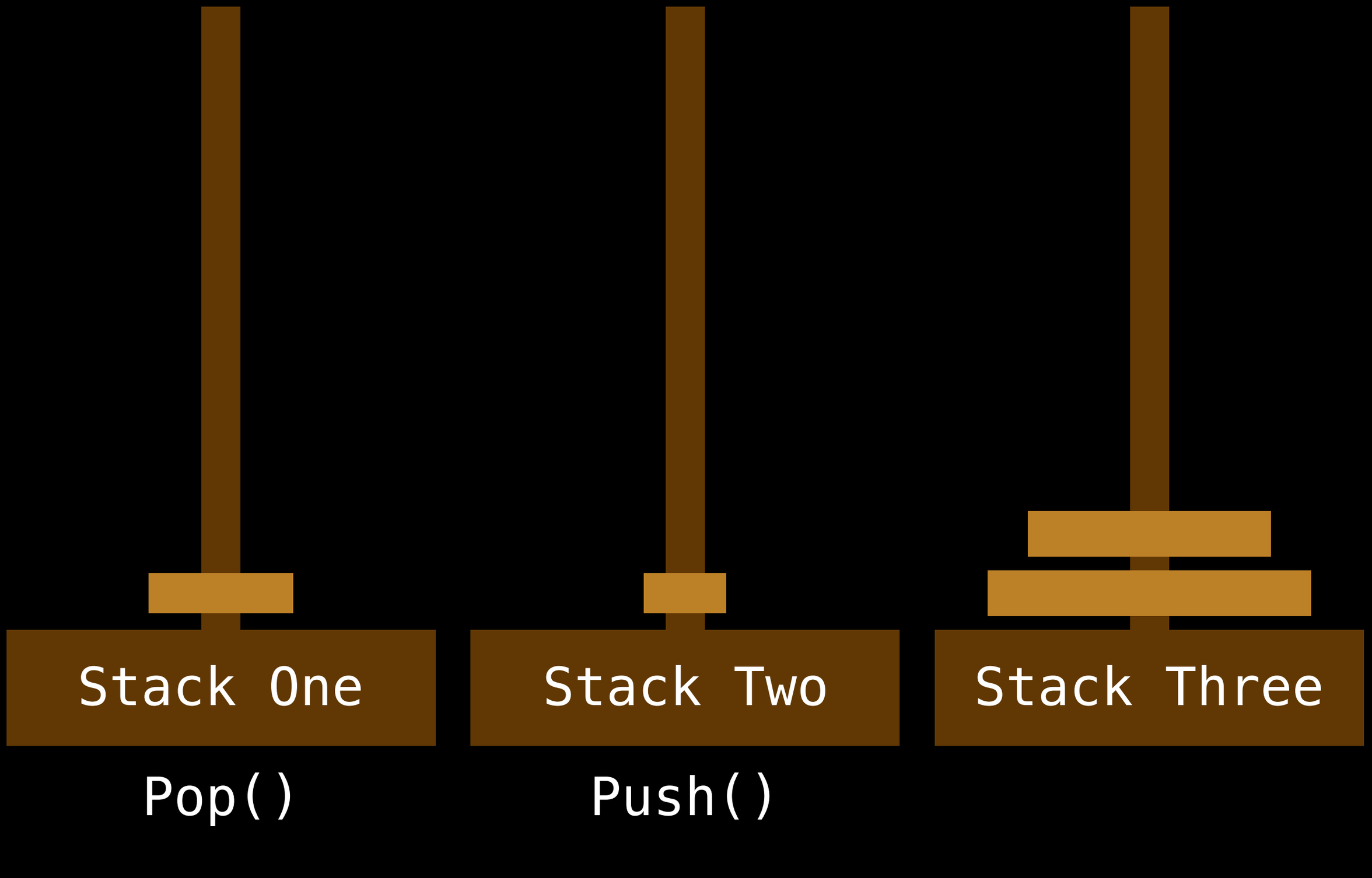
# Tower of Hanoi



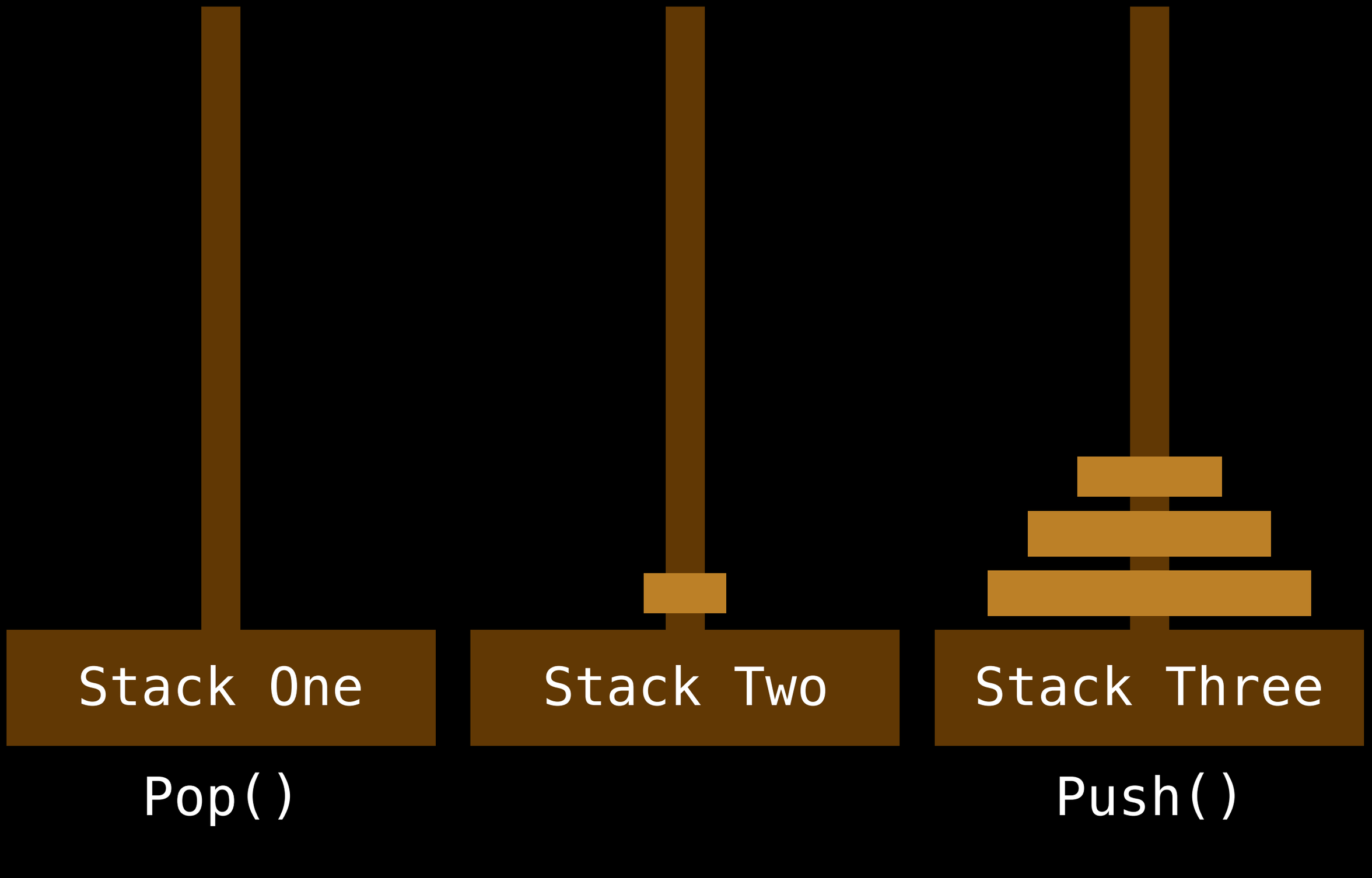
# Tower of Hanoi



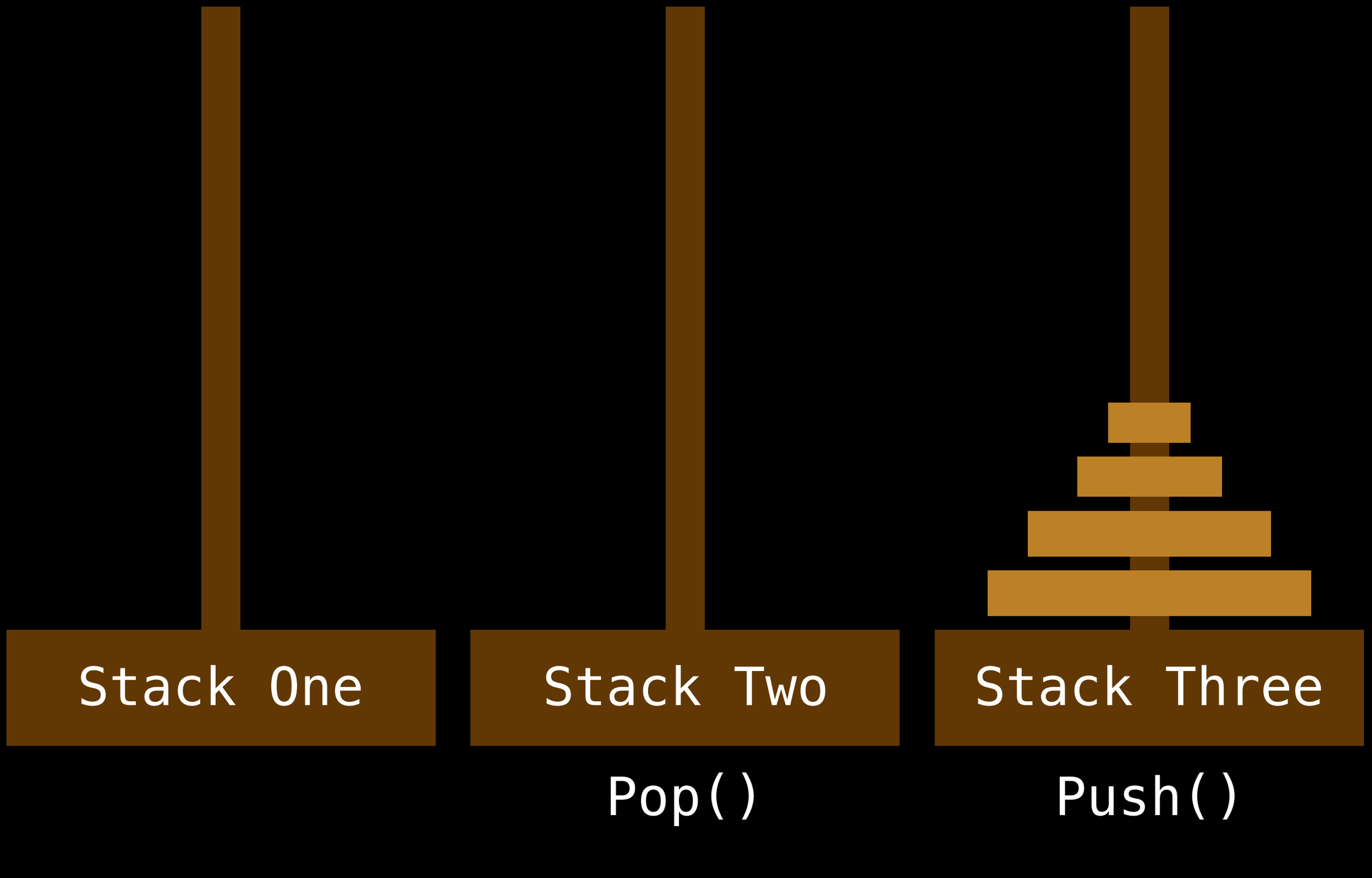
# Tower of Hanoi



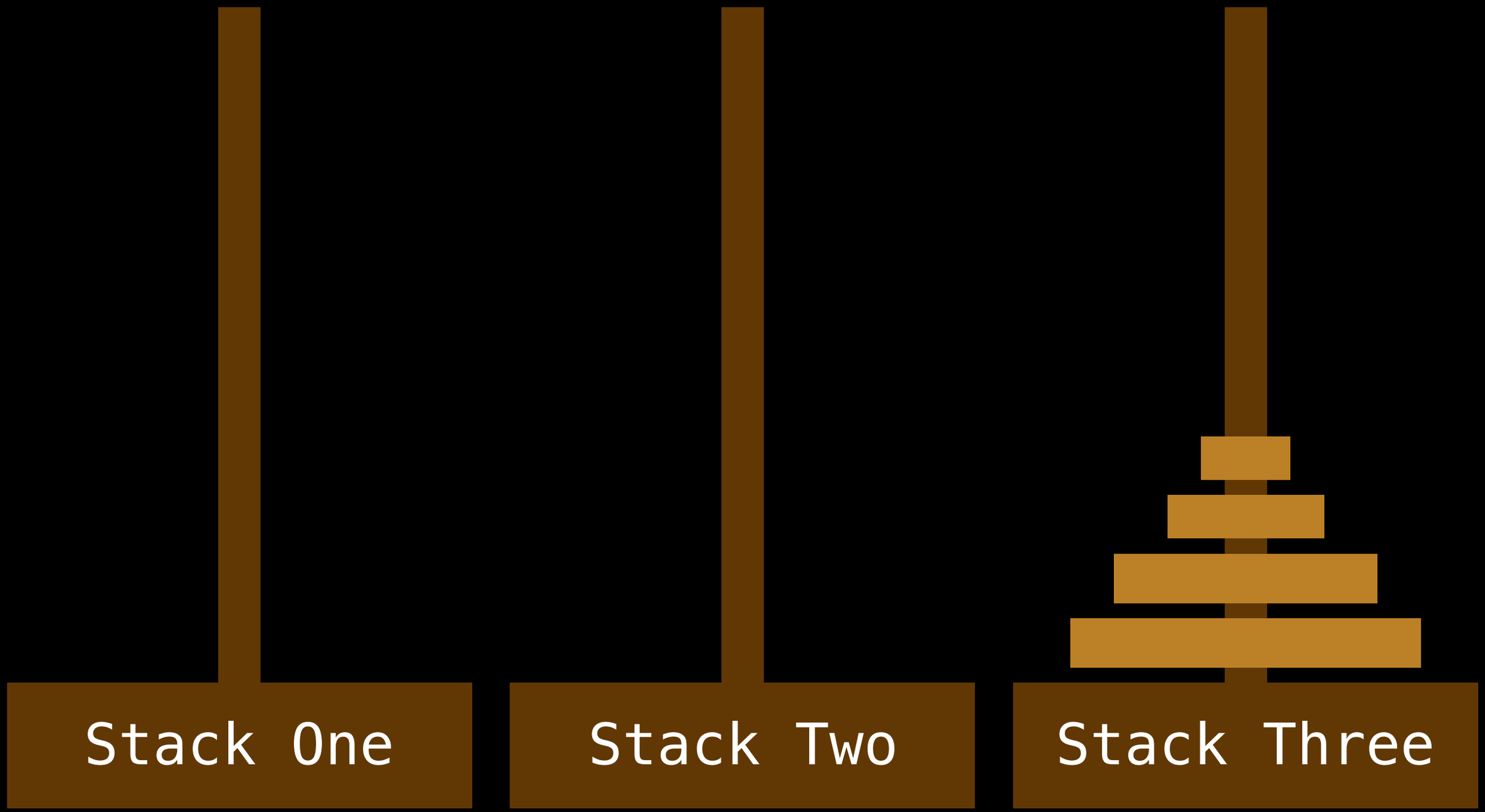
# Tower of Hanoi



# Tower of Hanoi



# Tower of Hanoi



# Stack Operations

William Fiset

# Pushing

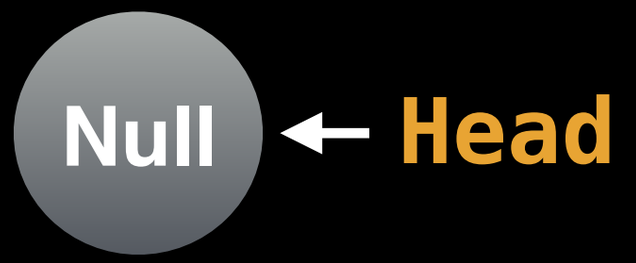
## Instructions

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

# Pushing

## Instructions

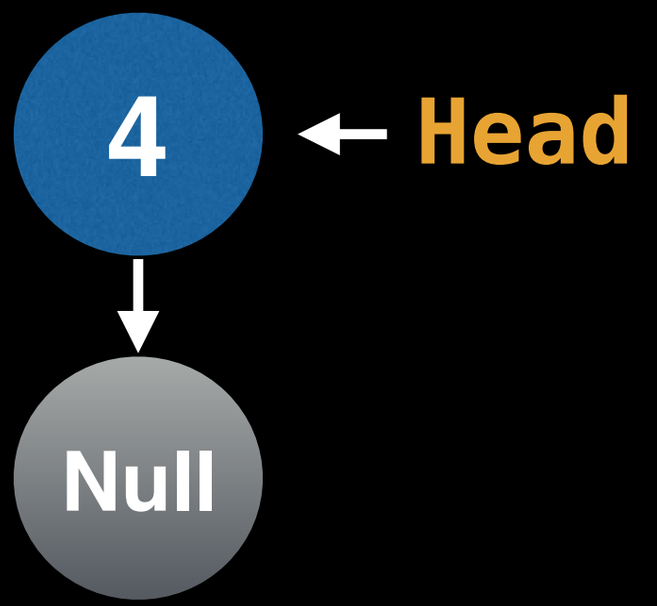
Push(4)
Push(2)
Push(5)
Push(13)



# Pushing

## Instructions

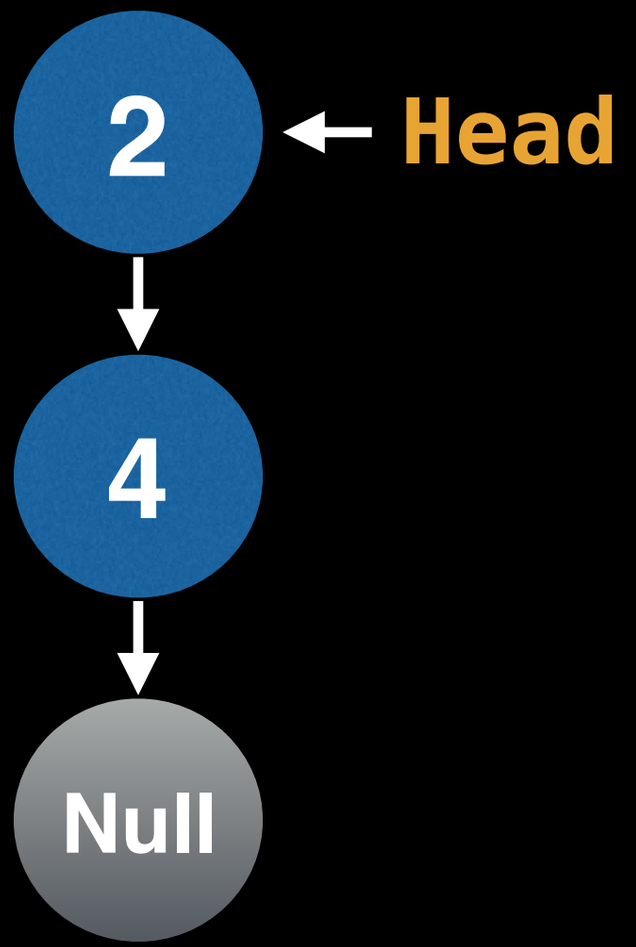
Push(4)
Push(2)
Push(5)
Push(13)



# Pushing

## Instructions

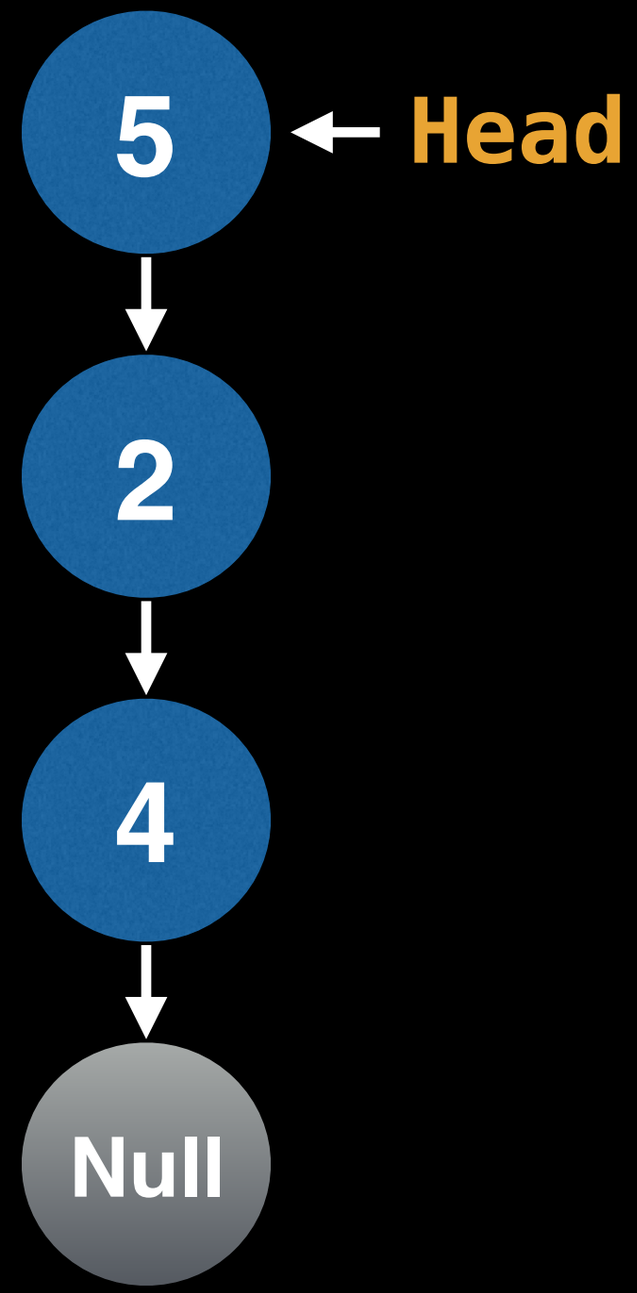
Push(4)
Push(2)
Push(5)
Push(13)



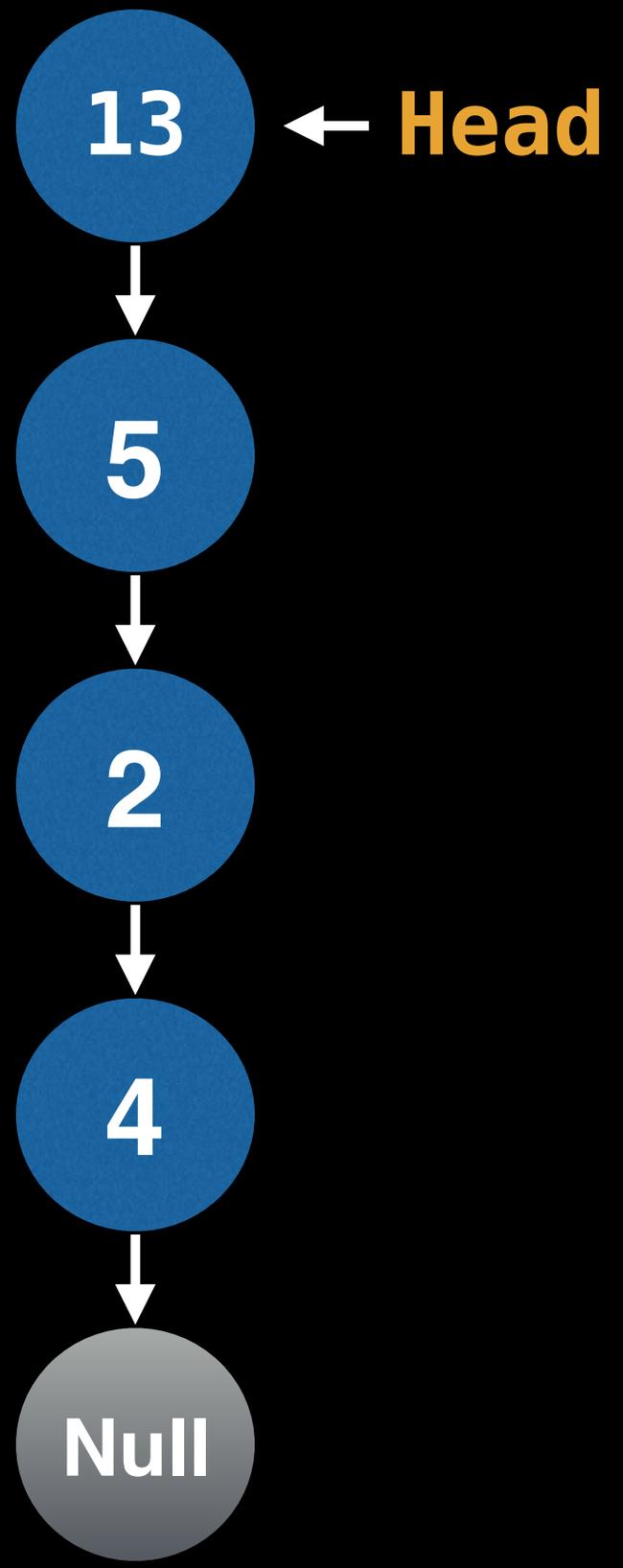
# Pushing

## Instructions

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



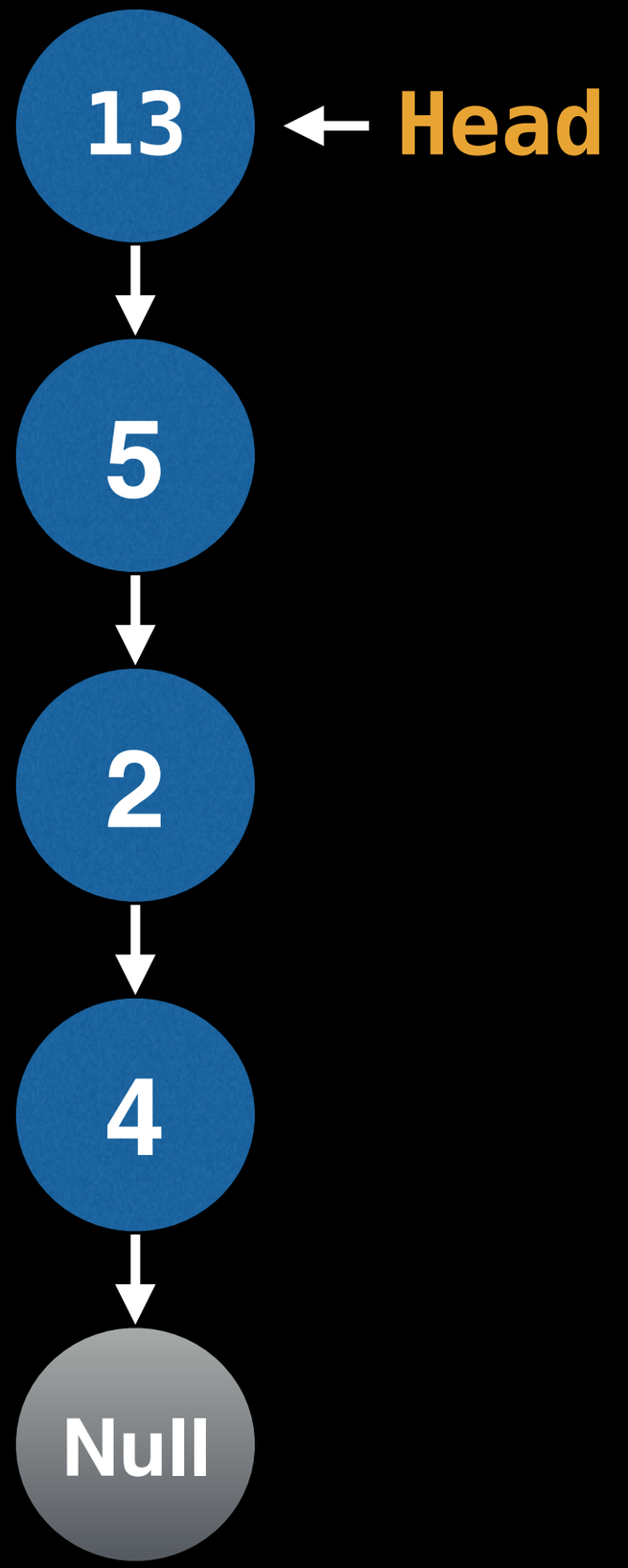
# Pushing




## Instructions

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

# Popping



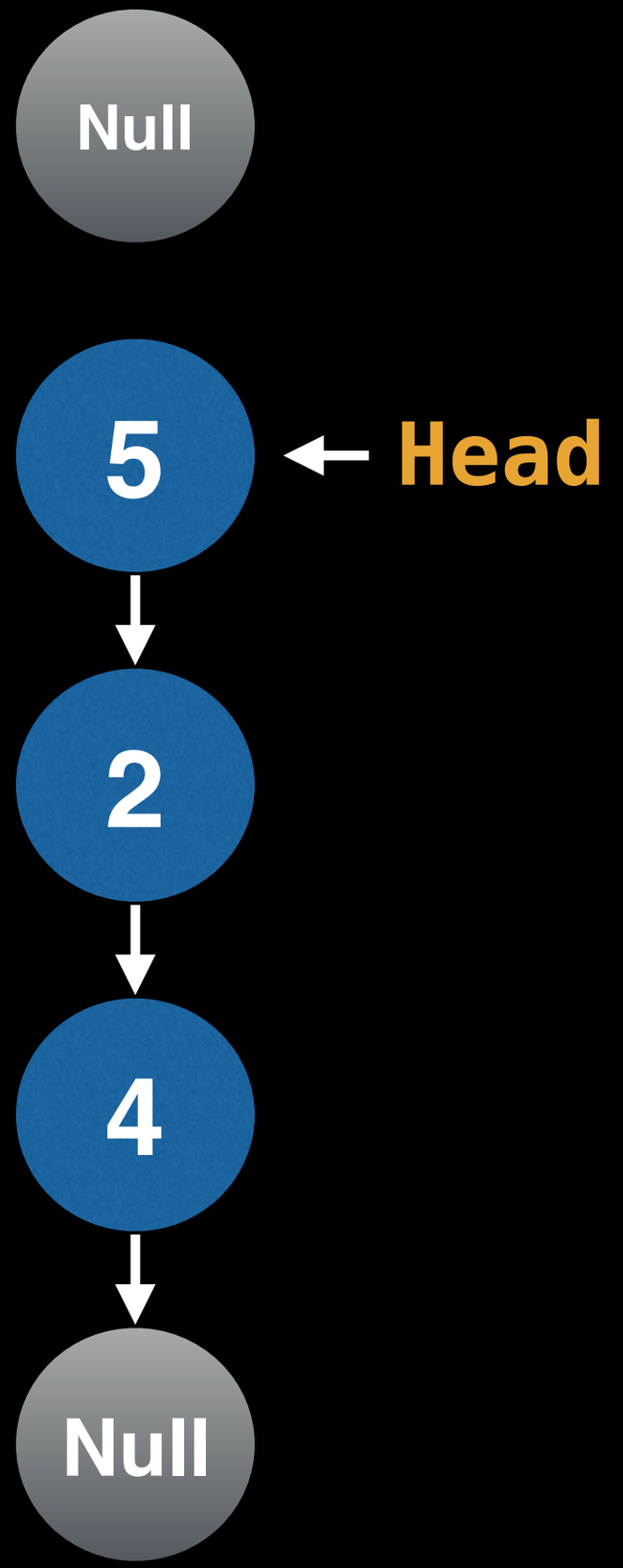

## Instructions

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

# Popping

## Instructions

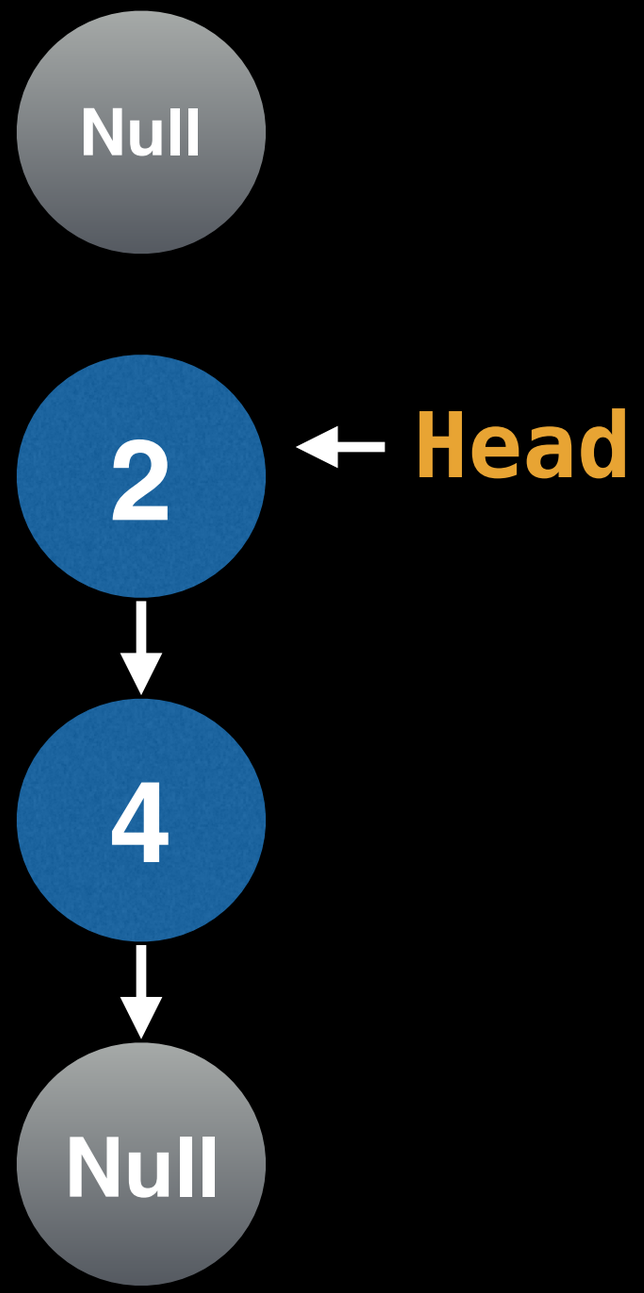
Pop()
Pop()
Pop()
Pop()



# Popping

## Instructions

Pop()
Pop()
Pop()
Pop()



# Popping

## Instructions

Pop()
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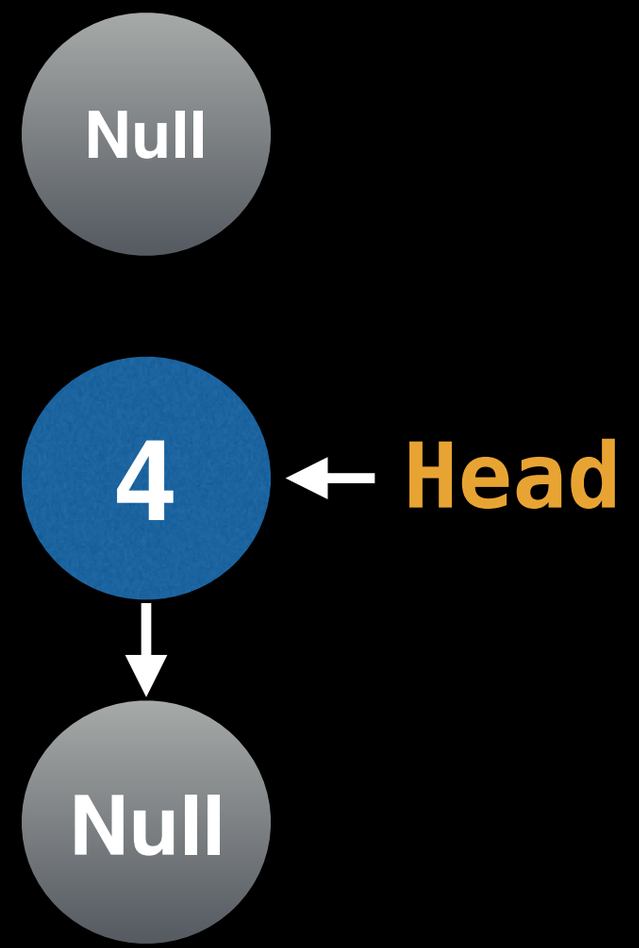
Pop()
Pop()



# Popping

## Instructions

Pop()
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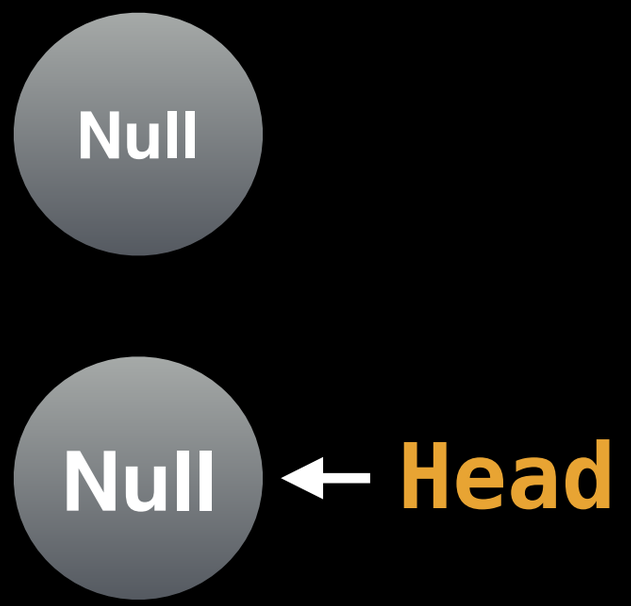
Pop()



# Popping

## Instructions

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