Lists as Stacks and Queues

SoftUni Team

Technical Trainers

Software University

SoftUni

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Stacks

LIFO

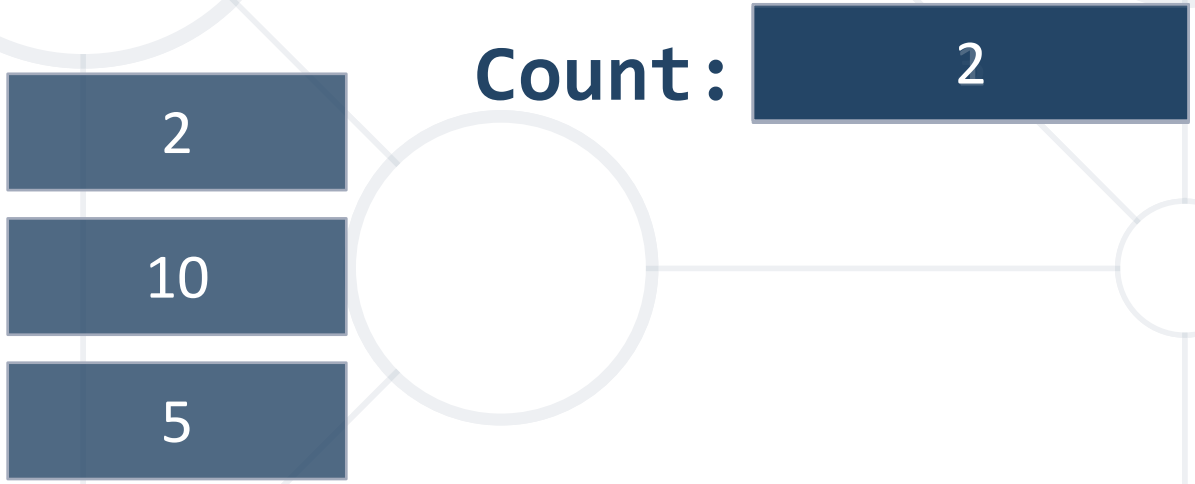
What is a Stack?

- A stack is a **linear** data structure that stores items
- The process of adding data to a stack is referred to as a "**push**"
- **Retrieving** data from a stack is called a "**pop**"
- Elements in a stack are added/removed from the top ("last in, first out") or **LIFO** order

Push to a Stack

Count : 3

Pop from a Stack

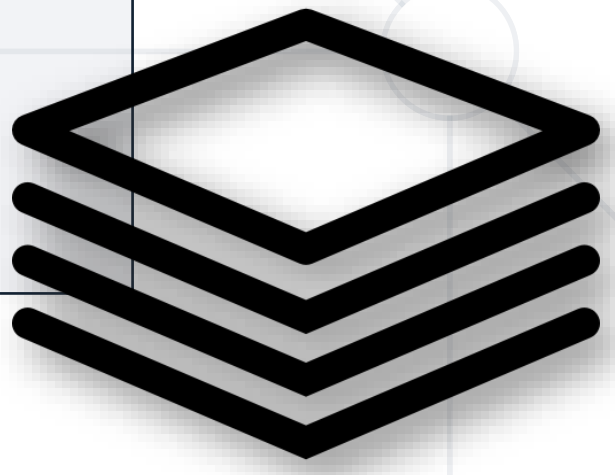


Stacks in Python

- The **list** methods make it very easy to use a list as a **stack**
- To add an item to the top of the stack, use **`append()`**
- To retrieve an item from the top of the stack, use **`pop()`**

Stacks in Python: Example

```
stack = [3, 4, 5]
stack.append(6)
stack.append(7)
print(stack) # [3, 4, 5, 6, 7]
stack.pop()  # 7
print(stack) # [3, 4, 5, 6]
stack.pop()  # 6
stack.pop()  # 5
print(stack) # [3, 4]
```



Problem: Reverse Strings

- Write a program that reads a string, reverses it using stacks and prints the result on the console

```
I love Python
```

```
nohtyP evol I
```

```
Stacks and Queues
```

```
seueuQ dna skcatS
```

Solution: Reverse Strings

```
text = list(input())
stack = []

for i in range(len(text)):
    stack.append(text.pop())

print("".join(stack))
```

Problem: Matching Parentheses

- We are given an algebraic expression with parentheses
- Scan through the string and extract each set of parentheses
- Print the result back on the console

```
1 + (2 - (2 + 3) * 4 / (3 + 1)) * 5
```

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

Solution: Matching Parentheses

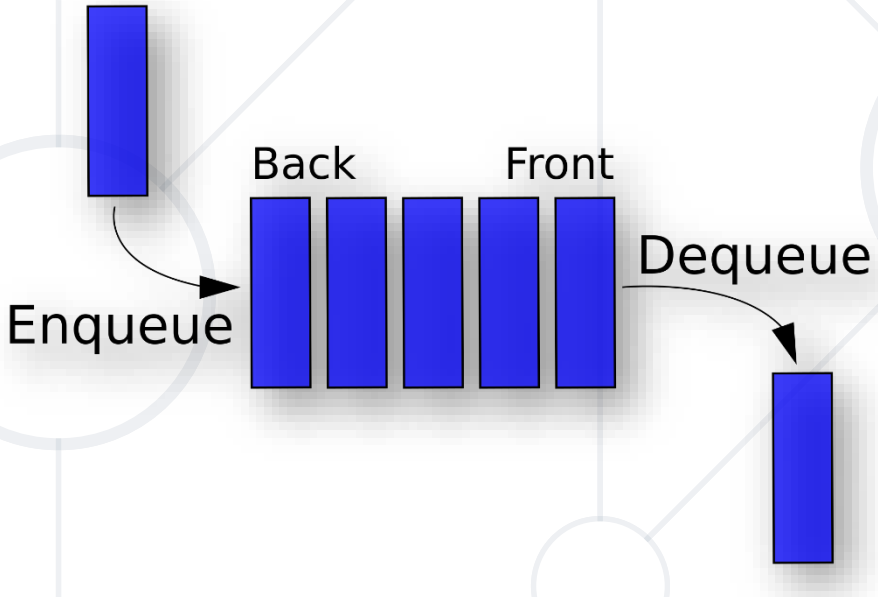
```
text = input()
parentheses = []

for i in range(len(text)):
    if text[i] == "(":
        parentheses.append(i)
    elif text[i] == ")":
        start_index = parentheses.pop()
        print(text[start_index:i + 1])
```

Queues

FIFO

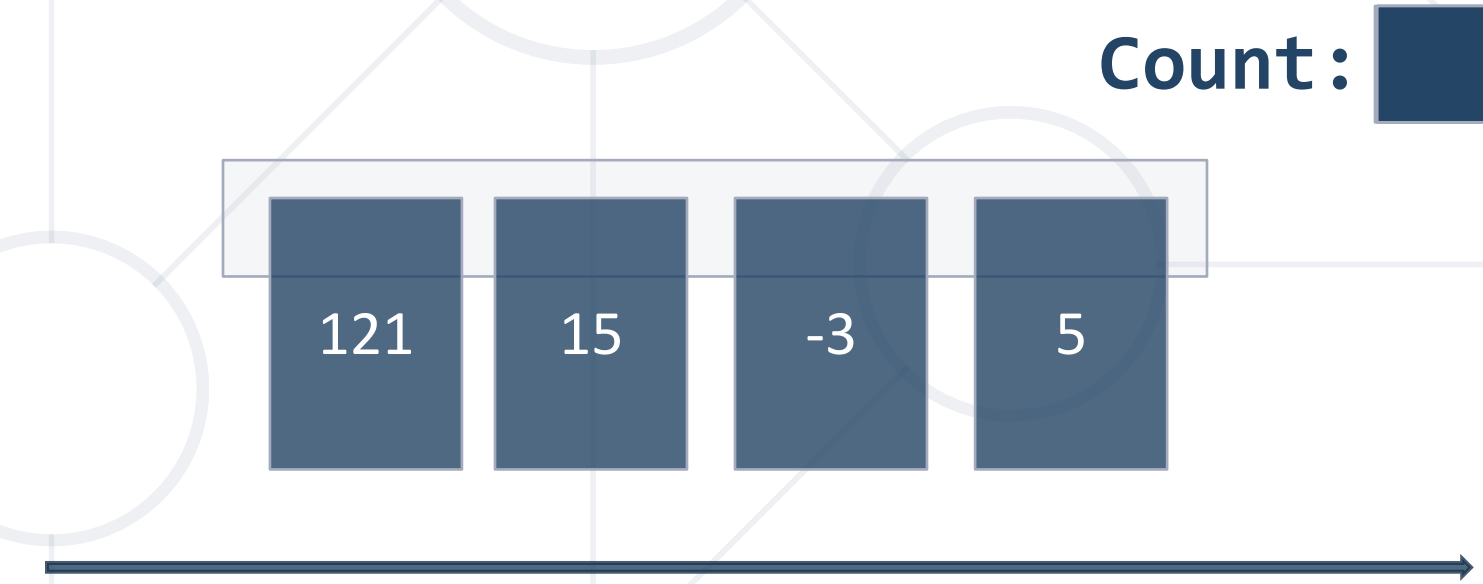
What is a Queue?

- A queue is a **first-in first-out** (FIFO) abstract data type
- We use them when we want things to happen in the **order** that they were **called**



Enqueue

Dequeue



Queues in Python

- It is possible to use a list as a queue, however they are not efficient for this purpose
- Doing inserts or pops from the beginning of a list is **slow**
- That's why we use `collections.deque`
- We use `append()` to add to the queue and `popleft()` to remove from the queue

Queues in Python: Example

```
from collections import deque
queue = deque(["Eric", "John", "Michael"])
queue.append("Terry")           # Terry arrives
queue.append("Graham")          # Graham arrives
queue.popleft()                 # First leaves: 'Eric'
queue.popleft()                 # Second leaves: 'John'
print(queue)                    # ['Michael', 'Terry', 'Graham']
```

Problem: Supermarket

- Read an input with a name and add it to a queue until "**End**"
  - If you receive "**Paid**", print every customer and empty the queue
  - When you receive "**End**" print the remaining people in the format: "**{count} people remaining.**"

```
Anna
Michael
Simone
End
```

```
3 people remaining.
```

Solution: Supermarket

```
from collections import deque
queue = deque()
while True:
    command = input()
    if command == "Paid":
        while len(queue):
            print(queue.popleft())
    elif command == "End":
        print(f"{len(queue)} people remaining.")
        break
    else:
        queue.append(command)
```

Problem: Water Dispenser

- Read the problem description from the Lab Documents and test with the provided inputs

```
2
Peter
Amy
Start
2
refill 1
1
End
```

```
Peter got water
Amy got water
0 liters left
```

Solution: Water Dispenser

```
from collections import deque
queue = deque()
water_quantity = int(input())
name = input()
# add people to queue
command = input()
while command != "End":
    if "refill" in command:
        # increase liters
    else:
        liters = int(command)
        if liters <= water_quantity:
            water_quantity -= liters
            print(f"{queue.popleft()} got water")
        else:
            print(f'{queue.popleft()} must wait')
    command = input()
print(f"{water_quantity} liters left")
```

Summary

- Stack
  - LIFO data structure
- Queue
  - FIFO data structure
- Stack and Queue in Python

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