ASSIGNMENT-11.1

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BATCH:36

Task Description #1 – Stack Implementation

Task: Use AI to generate a Stack class with push, pop, peek, and is_empty methods.

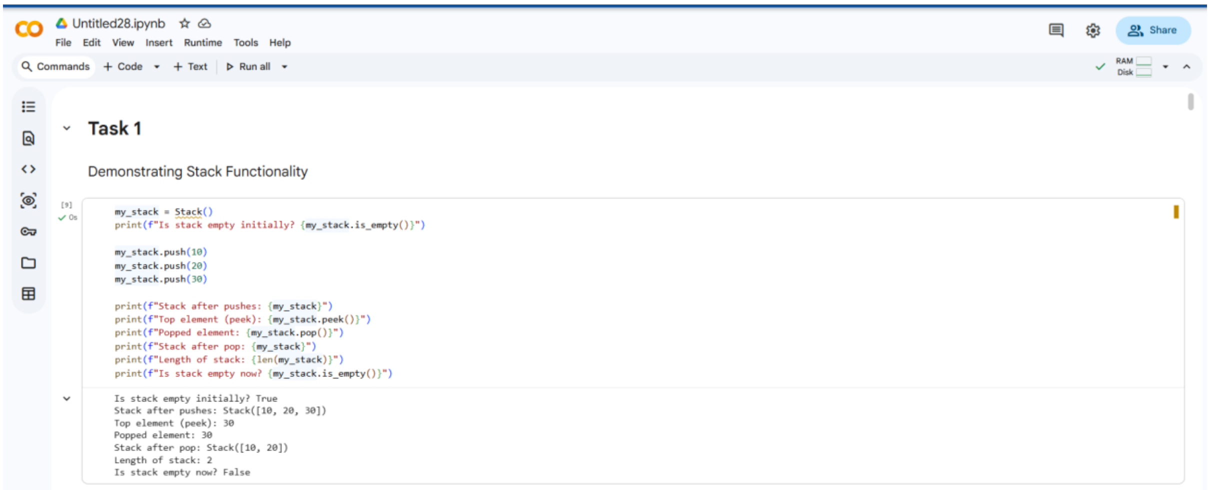
Sample Input Code:

class Stack:

pass

Expected Output:

• A functional stack implementation with all required methods and docstrings.



EXPLANATION:

A stack follows the principle LIFO (Last In, First Out).

The last element inserted is the first one removed.

We use a Python list (self.items) to store elements.

Task Description #2 – Queue Implementation

Task: Use AI to implement a Queue using Python lists.

Sample Input Code:

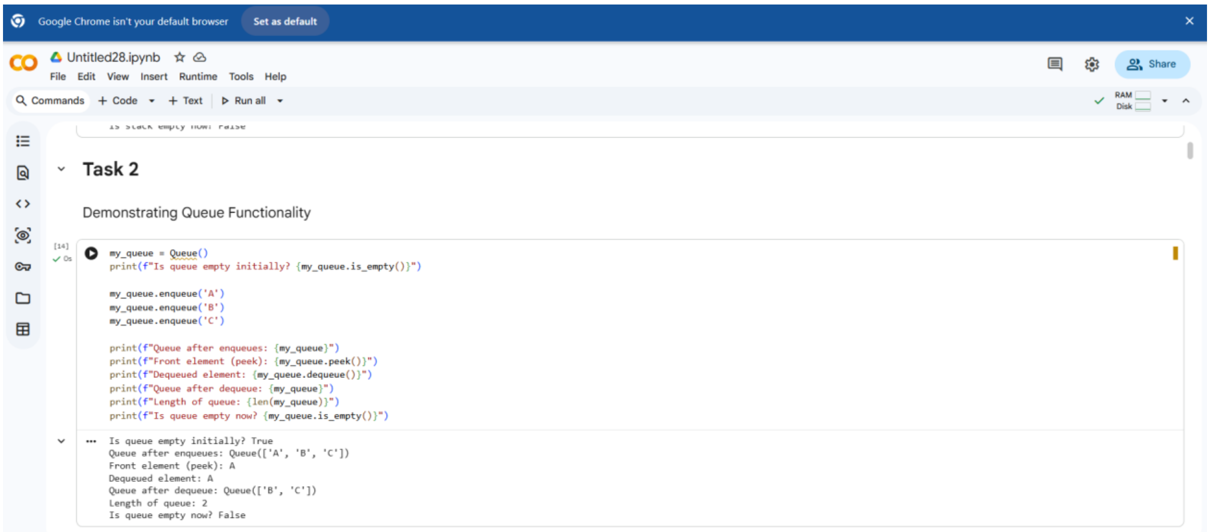
class Queue:

pass

Expected Output:

• FIFO-based queue class with enqueue, dequeue, peek, and size

methods.



EXPLANATION:

A queue works on the principle FIFO (First In, First Out).

The first element inserted is the first one removed.

We use a Python list called self.items to store elements.

Task Description #3 – Linked List

Task: Use AI to generate a Singly Linked List with insert and display

methods.

Sample Input Code:

class Node:

pass

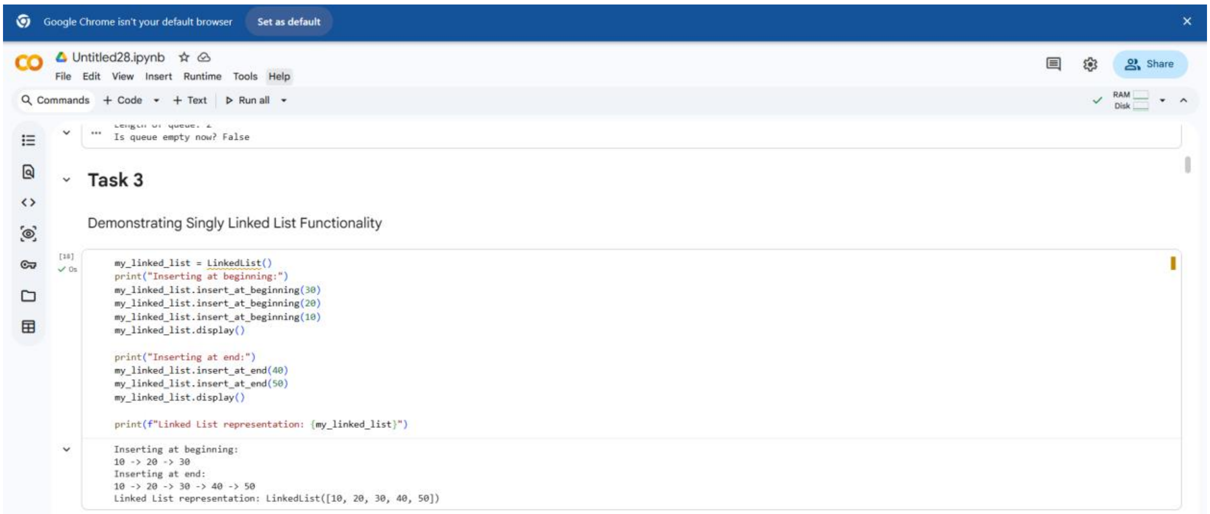
class LinkedList:

pass

Expected Output:

• A working linked list implementation with clear method

Documentation.



EXPLANATION (Linked List):

A singly linked list is a collection of nodes where:

Each node stores data

And a reference to the next node

☐insert(data)

Creates a new node

Traverses to the last node

Task Description #4 – Binary Search Tree (BST)

Task: Use AI to create a BST with insert and in-order traversal methods.

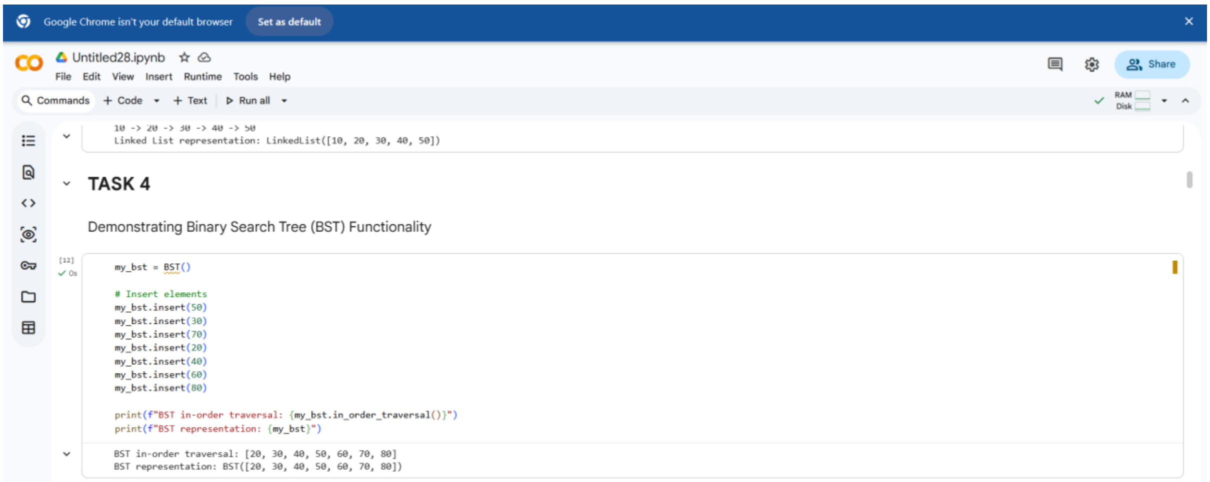
Sample Input Code:

class BST:

pass

Expected Output:

• BST implementation with recursive insert and traversal methods.



EXPLANATION:

A Binary Search Tree (BST) stores values such that:

Left child contains smaller values

Right child contains larger values

Insert (recursive):

If the tree is empty, the first value becomes the root.

Otherwise, compare the value with the current node:

Go left if smaller

Go right if larger

Repeat this process recursively until an empty spot is found and insert there.

In-order traversal:

Visits nodes in the order: Left → Root → Right. This prints the elements in sorted order. So, the BST keeps data ordered and allows efficient insertion and sorted traversal.

Task Description #5 – Hash Table

Task: Use AI to implement a hash table with basic insert, search, and

delete methods.

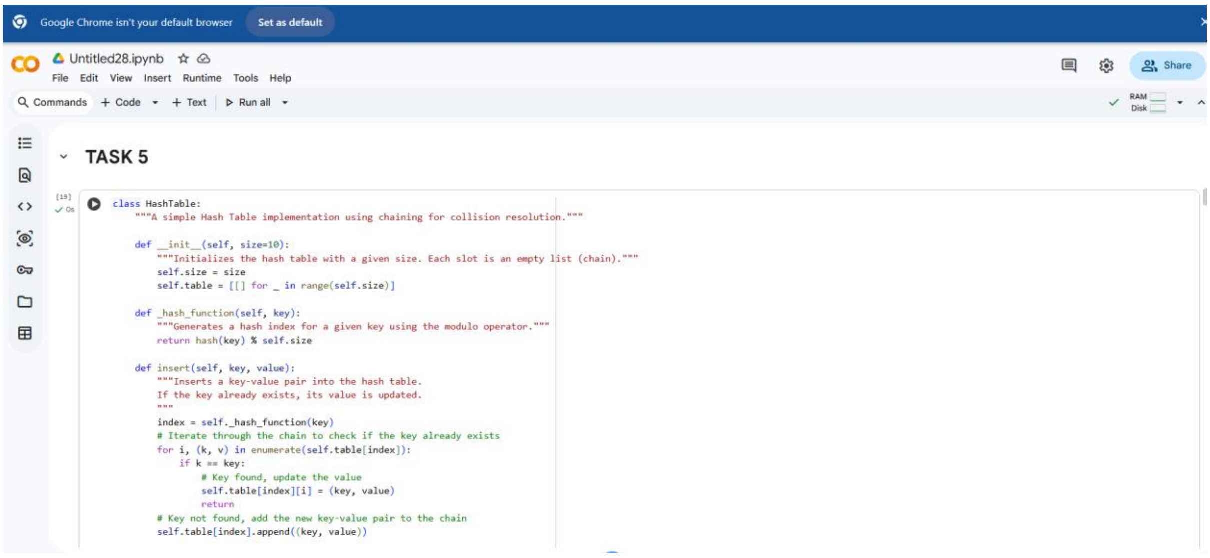
Sample Input Code:

class HashTable:

pass

Expected Output:

• Collision handling using chaining, with well-commented methods.



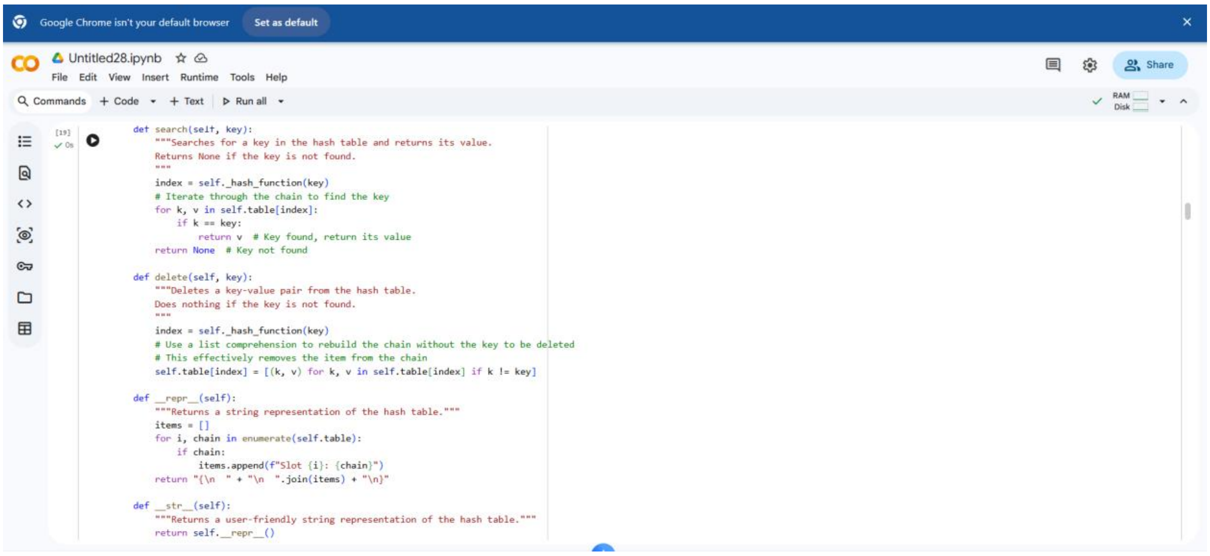
TASK 5

```
class HashTable:
    """A simple Hash Table implementation using chaining for collision resolution."""

    def __init__(self, size=10):
        """Initializes the hash table with a given size. Each slot is an empty list (chain)."""
        self.size = size
        self.table = [[] for _ in range(self.size)]

    def _hash_function(self, key):
        """Generates a hash index for a given key using the modulo operator."""
        return hash(key) % self.size

    def insert(self, key, value):
        """Inserts a key-value pair into the hash table.
        If the key already exists, its value is updated.
        """
        index = self._hash_function(key)
        # Iterate through the chain to check if the key already exists
        for i, (k, v) in enumerate(self.table[index]):
            if k == key:
                # Key found, update the value
                self.table[index][i] = (key, value)
                return
        # Key not found, add the new key-value pair to the chain
        self.table[index].append((key, value))
```



```
    def search(self, key):
        """Searches for a key in the hash table and returns its value.
        Returns None if the key is not found.
        """
        index = self._hash_function(key)
        # Iterate through the chain to find the key
        for k, v in self.table[index]:
            if k == key:
                return v  # Key found, return its value
        return None  # Key not found

    def delete(self, key):
        """Deletes a key-value pair from the hash table.
        Does nothing if the key is not found.
        """
        index = self._hash_function(key)
        # Use a list comprehension to rebuild the chain without the key to be deleted
        # This effectively removes the item from the chain
        self.table[index] = [(k, v) for k, v in self.table[index] if k != key]

    def __repr__(self):
        """Returns a string representation of the hash table."""
        items = []
        for i, chain in enumerate(self.table):
            if chain:
                items.append(f"Slot {i}: {chain}")
        return "{\n  " + "\n  ".join(items) + "\n}"

    def __str__(self):
        """Returns a user-friendly string representation of the hash table."""
        return self.__repr__()
```

EXPLANATION:

A hash table stores data using a key-value pair.

A hash function converts the key into an index.

Task Description #6 – Graph Representation

Task: Use AI to implement a graph using an adjacency list.

Sample Input Code:

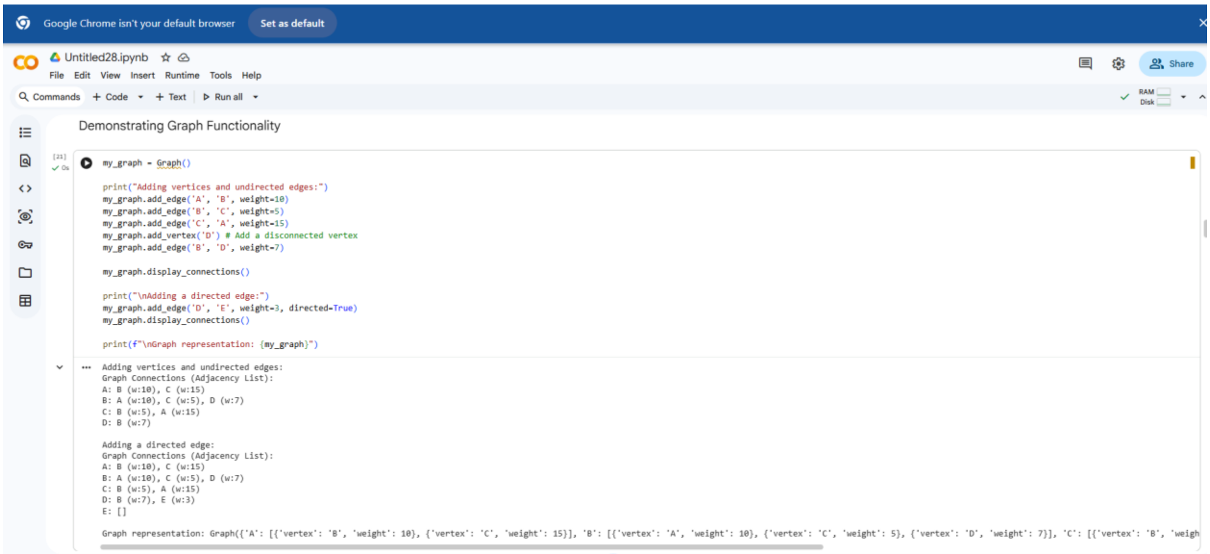
class Graph:

pass

Expected Output:

• Graph with methods to add vertices, add edges, and display

Connections.



EXPLANATION:

A graph consists of:

Vertices (nodes)

Edges (connections)

Using an adjacency list, each vertex stores a list of its connected vertices.

Task Description #7 – Priority Queue

Task: Use AI to implement a priority queue using Python's heapq module.

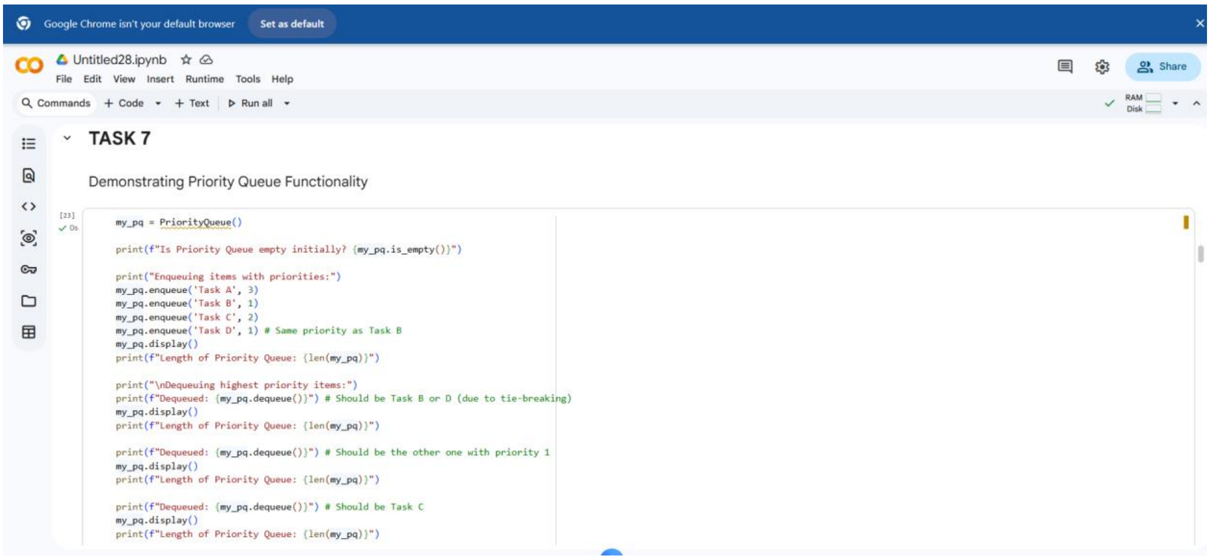
Sample Input Code:

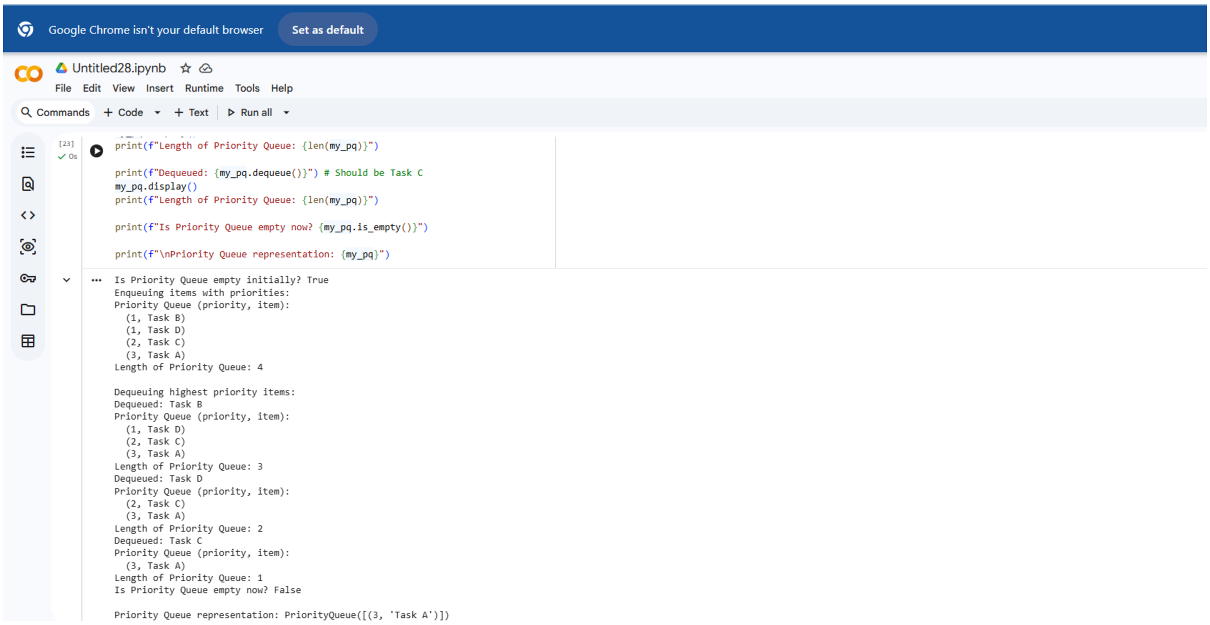
class PriorityQueue:

pass

Expected Output:

• Implementation with enqueue (priority), dequeue (highest priority), and display methods.





EXPLANATION:

A priority queue stores elements with a priority value.

The element with the highest priority is removed first.

Python’s heapq provides a min-heap, so to get highest priority first, we:

Store priority as negative value.

This makes larger priorities come out first.

Task Description #8 – Deque

Task: Use AI to implement a double-ended queue using

collections.deque.

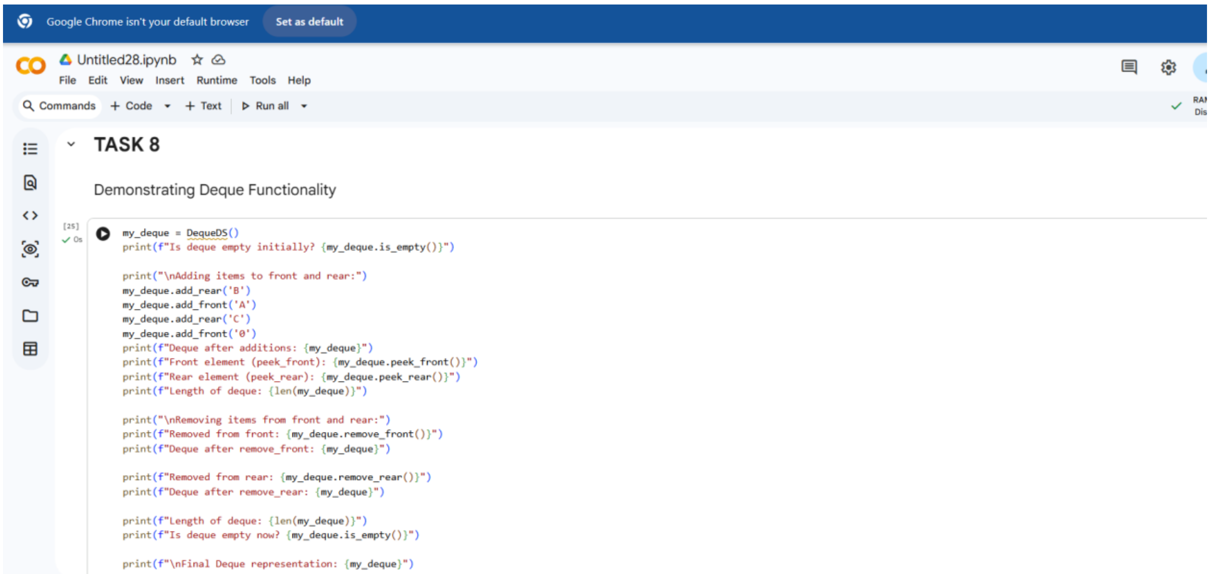
Sample Input Code:

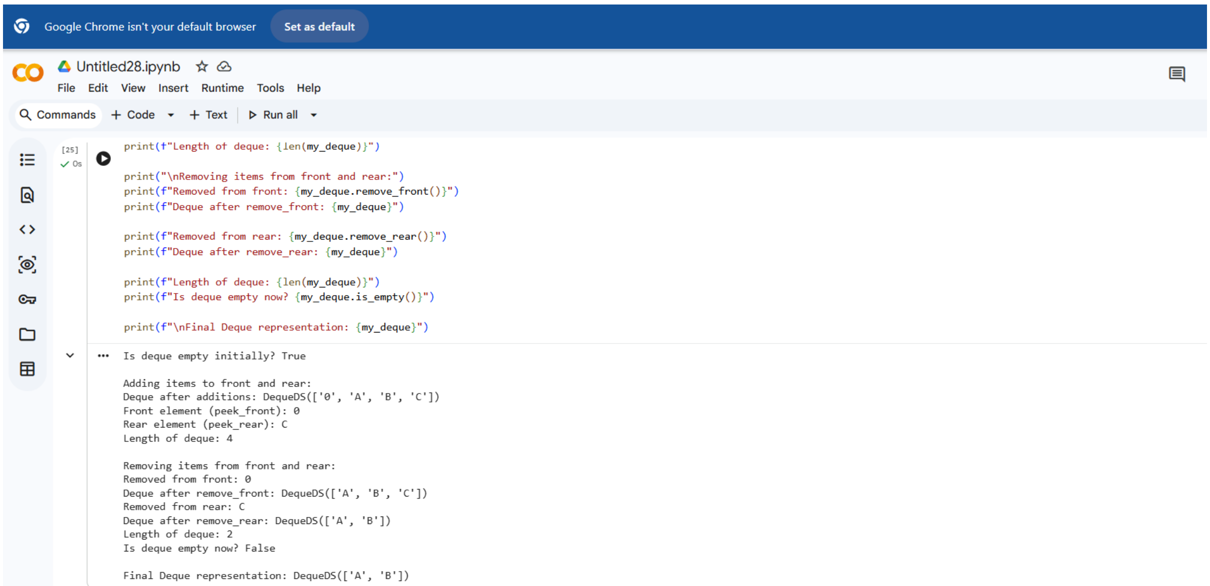
class DequeDS:

pass

Expected Output:

• Insert and remove from both ends with docstrings.





EXPLANATION:

A Deque (Double-Ended Queue) allows:

Insertion at front and rear

Deletion from front and rear

It is more flexible than a normal queue.

Using collections.deque:

appendleft() → insert front

append() → insert rear

popleft() → remove front

pop() → remove rear

All operations are O(1) (efficient).

Task Description #9 Real-Time Application Challenge – Choose the Right Data Structure

Scenario:

Your college wants to develop a Campus Resource Management System that handles:

1. Student Attendance Tracking – Daily log of students entering/exiting the campus.
2. Event Registration System – Manage participants in events with quick search and removal.
3. Library Book Borrowing – Keep track of available books and their due dates.
4. Bus Scheduling System – Maintain bus routes and stop connections.
5. Cafeteria Order Queue – Serve students in the order they arrive.

Student Task:

• For each feature, select the most appropriate data structure from the list below:

o Stack

o Queue

o Priority Queue

o Linked List

o Binary Search Tree (BST)

o Graph

o Hash Table

o Deque

• Justify your choice in 2–3 sentences per feature.

• Implement one selected feature as a working Python program with AI-assisted code generation.

Expected Output:

• A table mapping feature → chosen data structure → justification.

• A functional Python program implementing the chosen feature with comments and docstrings.

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I'll start by generating the table for **Feature-Data Structure Mapping and Justification**.

```
%%write_and_execute_cell
# Feature-Data Structure Mapping and Justification

print("### Campus Feature to Data Structure Mapping")
print("Below is a table outlining common campus features, the most suitable data structure for each, and a brief justification fo
print("\n| Campus Feature               | Data Structure       | Justification
print("|-----------------------------|---------------------|------------------------------------------------------------
print("| Cafeteria Order Queue        | Queue               | Orders are processed in a First-In, First-Out (FIFO) manner. A Que
print("| Student Management System    | Hash Table          | Enables quick insertion, deletion, and retrieval of student recorc
print("| Course Enrollment System     | Graph               | Course prerequisites and dependencies can be effectively modeled a
print("| Campus Navigation (Shortest Path) | Graph              | The campus layout (buildings, paths) can be represented as a gra
print("| Book Lending System (Library)| Binary Search Tree   | Books can be stored and retrieved efficiently by unique identifier
print("| Event Scheduling (Priority)  | Priority Queue      | Events often have different levels of urgency or importance. A Pri
print("| Undo/Redo Functionality      | Stack               | Actions are added and removed in a Last-In, First-Out (LIFO) manne
print("| Recent Activity Feed         | Deque               | New activities are added to one end, and older activities can be e
```

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```python
class CafeteriaOrderQueue:
    """Simulates a cafeteria order queue using the Queue data structure."""

    def __init__(self):
        self.order_queue = Queue()
        print("Cafeteria Order Queue initialized.")

    def place_order(self, order_details):
        """Adds a new order to the queue."""
        print(f"Placing order: {order_details}")
        self.order_queue.enqueue(order_details)
        self.display_queue_status()

    def fulfill_order(self):
        """Removes and returns the next order to be fulfilled."""
        if not self.order_queue.is_empty():
            fulfilled_order = self.order_queue.dequeue()
            print(f"Fulfilling order: {fulfilled_order}")
            self.display_queue_status()
            return fulfilled_order
        else:
            print("No orders in the queue to fulfill.")
            return None

    def display_queue_status(self):
        """Prints the current status of the order queue."""
        print(f"Current orders in queue (length {len(self.order_queue)}): {self.order_queue}")
        if not self.order_queue.is_empty():
            print(f"Next order to be fulfilled: {self.order_queue.peek()}")
        print("----------------------------------------")

# --- Simulation of Cafeteria Order Process ---
print("\n--- Simulating Cafeteria Order Process ---")
my_cafeteria = CafeteriaOrderQueue()
```

```python
my_cafeteria = CafeteriaOrderQueue()

# Students placing orders
my_cafeteria.place_order("Student A - Pizza with Coke")
my_cafeteria.place_order("Student B - Burger with Fries")
my_cafeteria.place_order("Student C - Salad with Water")
my_cafeteria.place_order("Student D - Pasta")

# Cafeteria fulfilling orders
print("\n--- Fulfilling Orders ---")
my_cafeteria.fulfill_order()
my_cafeteria.fulfill_order()

# Another student places an order while others are being served
my_cafeteria.place_order("Student E - Sandwich")

my_cafeteria.fulfill_order()
my_cafeteria.fulfill_order()
my_cafeteria.fulfill_order()

# Try to fulfill an order when the queue is empty
my_cafeteria.fulfill_order()
```

```
--- Simulating Cafeteria Order Process ---
Cafeteria Order Queue initialized.
Placing order: Student A - Pizza with Coke
Current orders in queue (length 1): Queue(['Student A - Pizza with Coke'])
Next order to be fulfilled: Student A - Pizza with Coke
----------------------------------------
Placing order: Student B - Burger with Fries
Current orders in queue (length 2): Queue(['Student A - Pizza with Coke', 'Student B - Burger with Fries'])
Next order to be fulfilled: Student A - Pizza with Coke
----------------------------------------
Placing order: Student C - Salad with Water
```

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```
Placing order: Student B - Burger with Fries
Current orders in queue (length 2): Queue(['Student A - Pizza with Coke', 'Student B - Burger with Fries'])
Next order to be fulfilled: Student A - Pizza with Coke
----------------------------------------
Placing order: Student C - Salad with Water
Current orders in queue (length 3): Queue(['Student A - Pizza with Coke', 'Student B - Burger with Fries', 'Student C - Salad with Water'])
Next order to be fulfilled: Student A - Pizza with Coke
----------------------------------------
Placing order: Student D - Pasta
Current orders in queue (length 4): Queue(['Student A - Pizza with Coke', 'Student B - Burger with Fries', 'Student C - Salad with Water', 'Student D - Pasta'])
Next order to be fulfilled: Student A - Pizza with Coke
----------------------------------------

--- Fulfilling Orders ---
Fulfilling order: Student A - Pizza with Coke
Current orders in queue (length 3): Queue(['Student B - Burger with Fries', 'Student C - Salad with Water', 'Student D - Pasta'])
Next order to be fulfilled: Student B - Burger with Fries
----------------------------------------
Fulfilling order: Student B - Burger with Fries
Current orders in queue (length 2): Queue(['Student C - Salad with Water', 'Student D - Pasta'])
Next order to be fulfilled: Student C - Salad with Water
----------------------------------------
Placing order: Student E - Sandwich
Current orders in queue (length 3): Queue(['Student C - Salad with Water', 'Student D - Pasta', 'Student E - Sandwich'])
Next order to be fulfilled: Student C - Salad with Water
----------------------------------------
Fulfilling order: Student C - Salad with Water
Current orders in queue (length 2): Queue(['Student D - Pasta', 'Student E - Sandwich'])
Next order to be fulfilled: Student D - Pasta
----------------------------------------
Fulfilling order: Student D - Pasta
Current orders in queue (length 1): Queue(['Student E - Sandwich'])
Next order to be fulfilled: Student E - Sandwich
----------------------------------------
Fulfilling order: Student E - Sandwich
Current orders in queue (length 0): Queue([])
----------------------------------------
No orders in the queue to fulfill.
```

EXPLANATION:

The cafeteria system uses a Queue because it follows the First In, First Out (FIFO) rule.

Students who arrive first are served first.

The program supports adding orders, serving orders, and displaying pending orders.

Task Description #10: Smart E-Commerce Platform – Data Structure Challenge

An e-commerce company wants to build a Smart Online Shopping System with:

1. Shopping Cart Management – Add and remove products

dynamically.

2. Order Processing System – Orders processed in the order they are placed.

3. Top-Selling Products Tracker – Products ranked by sales count.

4. Product Search Engine – Fast lookup of products using product ID.

5. Delivery Route Planning – Connect warehouses and delivery locations.

Student Task:

• For each feature, select the most appropriate data structure from the list below:

o Stack

o Queue

o Priority Queue

o Linked List

o Binary Search Tree (BST)

o Graph

o Hash Table

o Deque

• Justify your choice in 2–3 sentences per feature.

• Implement one selected feature as a working Python program with AI-assisted code generation.

Expected Output:

• A table mapping feature → chosen data structure → justification.

• A functional Python program implementing the chosen feature with comments and docstrings.

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```python
class OrderProcessingSystem:
    """Simulates an order processing system using the Queue data structure."""

    def __init__(self):
        self.order_queue = Queue()
        print("Order Processing System initialized.")

    def place_order(self, order_details):
        """Adds a new order to the queue."""
        print(f"Placing order: {order_details}")
        self.order_queue.enqueue(order_details)
        self.display_queue_status()

    def process_order(self):
        """Removes and returns the next order to be processed."""
        if not self.order_queue.is_empty():
            processed_order = self.order_queue.dequeue()
            print(f"Processing order: {processed_order}")
            self.display_queue_status()
            return processed_order
        else:
            print("No orders in the queue to process.")
            return None

    def display_queue_status(self):
        """Prints the current status of the order queue."""
        print(f"Current orders in queue (length {len(self.order_queue)}): {self.order_queue}")
        if not self.order_queue.is_empty():
            print(f"Next order to be processed: {self.order_queue.peek()}")
        print("----------------------------------------")

print("OrderProcessingSystem class defined.")
```

```
OrderProcessingSystem class defined.
```

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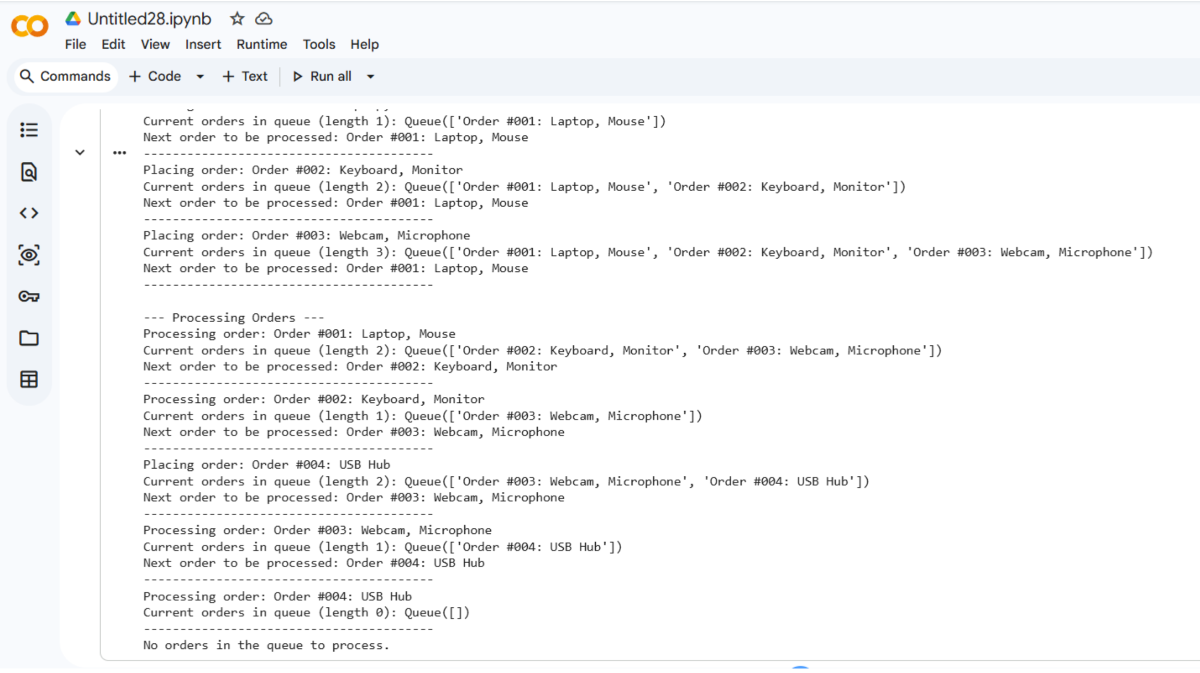
```python
print("\n--- Simulating Order Processing System ---")
my_order_system = OrderProcessingSystem()

# Simulate customers placing orders
my_order_system.place_order("Order #001: Laptop, Mouse")
my_order_system.place_order("Order #002: Keyboard, Monitor")
my_order_system.place_order("Order #003: Webcam, Microphone")

# Simulate processing some orders
print("\n--- Processing Orders ---")
my_order_system.process_order()
my_order_system.process_order()

# Another order comes in while others are being processed
my_order_system.place_order("Order #004: USB Hub")

my_order_system.process_order()
my_order_system.process_order()

# Attempt to process an order when the queue is empty
my_order_system.process_order()
```

```
--- Simulating Order Processing System ---
Order Processing System initialized.
Placing order: Order #001: Laptop, Mouse
Current orders in queue (length 1): Queue(['Order #001: Laptop, Mouse'])
Next order to be processed: Order #001: Laptop, Mouse
----------------------------------------
Placing order: Order #002: Keyboard, Monitor
```




```
Current orders in queue (length 1): Queue(['Order #001: Laptop, Mouse'])
Next order to be processed: Order #001: Laptop, Mouse
----------------------------------------
Placing order: Order #002: Keyboard, Monitor
Current orders in queue (length 2): Queue(['Order #001: Laptop, Mouse', 'Order #002: Keyboard, Monitor'])
Next order to be processed: Order #001: Laptop, Mouse
----------------------------------------
Placing order: Order #003: Webcam, Microphone
Current orders in queue (length 3): Queue(['Order #001: Laptop, Mouse', 'Order #002: Keyboard, Monitor', 'Order #003: Webcam, Microphone'])
Next order to be processed: Order #001: Laptop, Mouse
----------------------------------------

--- Processing Orders ---
Processing order: Order #001: Laptop, Mouse
Current orders in queue (length 2): Queue(['Order #002: Keyboard, Monitor', 'Order #003: Webcam, Microphone'])
Next order to be processed: Order #002: Keyboard, Monitor
----------------------------------------
Processing order: Order #002: Keyboard, Monitor
Current orders in queue (length 1): Queue(['Order #003: Webcam, Microphone'])
Next order to be processed: Order #003: Webcam, Microphone
----------------------------------------
Placing order: Order #004: USB Hub
Current orders in queue (length 2): Queue(['Order #003: Webcam, Microphone', 'Order #004: USB Hub'])
Next order to be processed: Order #003: Webcam, Microphone
----------------------------------------
Processing order: Order #003: Webcam, Microphone
Current orders in queue (length 1): Queue(['Order #004: USB Hub'])
Next order to be processed: Order #004: USB Hub
----------------------------------------
Processing order: Order #004: USB Hub
Current orders in queue (length 0): Queue([])
----------------------------------------
No orders in the queue to process.
```

EXPLANATION:

The product search system uses a Hash Table because product IDs can be used as keys for instant lookup.

Insertion, search, and deletion operations are very fast (average O(1)).

This makes it suitable for large-scale e-commerce platforms with thousands of products.