

AI ASSISTED CODING

LAB-11.2

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BATCH:03

TASK-01:

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

Sample Input Code:

```
class Stack:
```

```
    pass
```

PROMPT:

Generate a python stack class using push ,pop, is empty.

CODE:

```
11.2.1.py x 11.2.2.py 11.2.3.py 11.2.4.py 11.2.5.py 11.2.6.py 11.2.7.py 11.2.8.py 11.2.9.py 11.2.10.py
11.2.1.py > Stack > __init__
1 from typing import Any, List
2
3 class Stack:
4     """
5     A simple implementation of a Stack data structure.
6     """
7     def __init__(self) -> None:
8         """
9         Initializes an empty stack.
10        """
11        self._items: List[Any] = []
12
13    def is_empty(self) -> bool:
14        """
15        Checks if the stack is empty.
16
17        Returns:
18        | bool: True if the stack is empty, False otherwise.
19        """
20        return not self._items
21
22    def push(self, item: Any) -> None:
23        """
24        Adds an item to the top of the stack.
25
26        Args:
27        | item (Any): The item to be added to the stack.
28        """
29        self._items.append(item)
30
31    def pop(self) -> Any:
32        """
33        Removes and returns the item at the top of the stack.
34
35        Raises:
36        | IndexError: If the stack is empty.
37
38        Returns:
39        | Any: The item at the top of the stack.
40        """
41        if self.is_empty():
42            raise IndexError("pop from an empty stack")
43        return self._items.pop()
44
45    def peek(self) -> Any:
46        """
47        Returns the item at the top of the stack without removing it.
48
49        """
```

```

    Raises:
        IndexError: If the stack is empty.

    Returns:
        Any: The item at the top of the stack.
    """
    if self.is_empty():
        raise IndexError("peek from an empty stack")
    return self._items[-1]

def __str__(self) -> str:
    """
    Returns a string representation of the stack.
    """
    return str(self._items)

def __len__(self) -> int:
    """
    Returns the number of items in the stack.
    """
    return len(self._items)

# --- Example Usage ---
if __name__ == "__main__":
    print("Creating a new stack...")
    s = Stack()

    print(f"Is the stack empty? {s.is_empty()}") # Expected: True

    print("\nPushing items: 10, 20, 30")
    s.push(10)
    s.push(20)
    s.push(30)

    print(f"Current stack: {s}")
    print(f"Stack size: {len(s)}")
    print(f"Is the stack empty? {s.is_empty()}") # Expected: False

    print(f"\nPeeking at the top item: {s.peak()}") # Expected: 30
    print(f"Current stack after peek: {s}")

    print(f"\nPopping an item: {s.pop()}") # Expected: 30
    print(f"Current stack after pop: {s}")

    print(f"Popping another item: {s.pop()}") # Expected: 20
    print(f"Current stack: {s}")

    print("\nPopping the last item...")
    s.pop()
    print(f"Is the stack empty now? {s.is_empty()}") # Expected: True

```

OUTPUT:

```

PS C:\Users\ramch\OneDrive\Desktop\ai> & C:/Users/ramch/AppData/Local/Programs/Python/Python312/python.exe c:/Users/ramch/OneDrive/Desktop/ai/11.2.1.py
Creating a new stack...
Is the stack empty? True

Pushing items: 10, 20, 30
Current stack: [10, 20, 30]
Stack size: 3
Is the stack empty? False

Peeking at the top item: 30
Current stack after peek: [10, 20, 30]

Popping an item: 30
Current stack after pop: [10, 20]
Popping another item: 20
Current stack: [10]

Popping the last item...
Is the stack empty now? True
PS C:\Users\ramch\OneDrive\Desktop\ai>

```

OBSERVATION:

The AI generated the code in an efficient way according to the prompt as it developed the stack class.

TASK-02:

Use AI to implement a Queue using Python lists.

Sample Input Code:

```
class Queue:  
    pass
```

PROMPT:

Generate a python code to implement the queue in data structures

CODE:

```

1122.py / ~
1  from typing import Any, List
2
3  class Queue:
4      """
5      A simple implementation of a Queue data structure using a Python list.
6      Note: For performance-critical applications, collections.deque is preferred.
7      """
8      def __init__(self) -> None:
9          """
10         Initializes an empty queue.
11         """
12         self._items: List[Any] = []
13
14     def is_empty(self) -> bool:
15         """
16         Checks if the queue is empty.
17
18         Returns:
19             bool: True if the queue is empty, False otherwise.
20         """
21         return not self._items
22
23     def enqueue(self, item: Any) -> None:
24         """
25         Adds an item to the back (end) of the queue.
26
27         Args:
28             item (Any): The item to be added to the queue.
29         """
30         self._items.append(item)
31
32     def dequeue(self) -> Any:
33         """
34         Removes and returns the item from the front of the queue.
35
36         Raises:
37             IndexError: If the queue is empty.
38
39         Returns:
40             Any: The item at the front of the queue.
41         """
42         if self.is_empty():
43             raise IndexError("dequeue from an empty queue")
44         return self._items.pop(0)
45
46     def peek(self) -> Any:
47         """
48         Returns the item at the front of the queue without removing it.
49
50         Raises:
51             IndexError: If the queue is empty.
52
53         Returns:
54             Any: The item at the front of the queue.
55         """
56         if self.is_empty():
57             raise IndexError("peek from an empty queue")
58         return self._items[0]

```

```

3  class Queue:
4      return self._items[0]
5
6  def __str__(self) -> str:
7      """
8      Returns a string representation of the queue.
9      """
10     return str(self._items)
11
12 def __len__(self) -> int:
13     """
14     Returns the number of items in the queue.
15     """
16     return len(self._items)
17
18 # --- Example Usage ---
19 if __name__ == "__main__":
20     print("Creating a new queue...")
21     q = Queue()
22
23     print(f"Is the queue empty? {q.is_empty()}") # Expected: True
24
25     print("\nEnqueueing items: 'A', 'B', 'C'")
26     q.enqueue('A')
27     q.enqueue('B')
28     q.enqueue('C')
29
30     print(f"Current queue: {q}")
31     print(f"Queue size: {len(q)}")
32     print(f"Is the queue empty? {q.is_empty()}") # Expected: False
33
34     print(f"\nPeeking at the front item: {q.peek()}") # Expected: 'A'
35     print(f"Current queue after peek: {q}")
36
37     print(f"\nDequeueing an item: {q.dequeue()}") # Expected: 'A'
38     print(f"Current queue after dequeue: {q}")
39
40     print(f"\nDequeueing another item: {q.dequeue()}") # Expected: 'B'
41     print(f"Current queue: {q}")
42
43     print("\nDequeueing the last item...")
44     q.dequeue()
45     print(f"Is the queue empty now? {q.is_empty()}") # Expected: True

```

OUTPUT:

```
PS C:\Users\ranch\OneDrive\Desktop\ai> & C:/Users/ranch/AppData/Local/Programs/Python/Python312/python.exe c:/Users/ranch/OneDrive/Desktop/ai/11.2.2.py
Creating a new queue...
Is the queue empty? True

Enqueuing items: 'A', 'B', 'C'
Current queue: ['A', 'B', 'C']
Queue size: 3
Is the queue empty? False

Peeking at the front item: A
Current queue after peek: ['A', 'B', 'C']

Dequeuing an item: A
Current queue after dequeue: ['B', 'C']
Dequeuing another item: B
Current queue: ['C']

Dequeuing the last item...
Is the queue empty now? True
PS C:\Users\ranch\OneDrive\Desktop\ai>
```

OBSERVATION:

The code generated by AI is more accurate about the queue in data structures and it also passed all the test cases.

TASK-03:

Use AI to generate a Singly Linked List with insert and display methods.

Sample Input Code:

```
class Node:
```

```
pass
```

```
class LinkedList:
```

```
pass
```

PROMPT:

Generate a python code of singly linked list with insert and display methods.

CODE:

```
1123.py > _
1 from typing import Any, Optional
2
3 class Node:
4     """
5     An object for storing a single node of a linked list.
6     Models two attributes: data and the link to the next node in the list.
7     """
8     def __init__(self, data: Any, next_node: Optional['Node'] = None):
9         """
10         Initializes a Node.
11
12         Args:
13             data (Any): The data to be stored in the node.
14             next_node (Optional['Node']): The next node in the list. Defaults to None.
15         """
16         self.data = data
17         self.next = next_node
18
19 class LinkedList:
20     """
21     A simple implementation of a Singly Linked List.
22     """
23     def __init__(self):
24         """
25         Initializes an empty linked list.
26         """
27         self.head: Optional[Node] = None
28
29     def is_empty(self) -> bool:
30         """
31         Checks if the linked list is empty.
32
33         Returns:
34             bool: True if the list is empty, False otherwise.
35         """
36         return self.head is None
37
38     def insert(self, data: Any) -> None:
39         """
40         Inserts a new node with the given data at the end of the list.
41
42         Args:
43             data (Any): The data for the new node.
44         """
45         new_node = Node(data)
46         # If the list is empty, the new node becomes the head.
47         if self.is_empty():
48             self.head = new_node
49             return
50
51         # Otherwise, traverse to the end of the list.
52         last_node = self.head
53         while last_node.next:
54             last_node = last_node.next
55
56         # Set the next pointer of the last node to the new node.
57         last_node.next = new_node
58
59 0
```

```

19 class LinkedList:
20
21     def display(self) -> None:
22         """
23         Traverses the linked list and prints the data of each node.
24         """
25         if self.is_empty():
26             print("Linked list is empty.")
27             return
28
29         current = self.head
30         nodes = []
31         while current:
32             nodes.append(str(current.data))
33             current = current.next
34         print(" -> ".join(nodes))
35
36 # --- Example Usage ---
37 if __name__ == "__main__":
38     print("Creating a new linked list...")
39     ll = LinkedList()
40
41     print("Is the list empty?", ll.is_empty()) # Expected: True
42     ll.display() # Expected: Linked list is empty.
43
44     print("\nInserting elements: 10, 20, 30")
45     ll.insert(10)
46     ll.insert(20)
47     ll.insert(30)
48
49     print("Is the list empty?", ll.is_empty()) # Expected: False
50
51     print("\nDisplaying the list:")
52     ll.display() # Expected: 10 -> 20 -> 30
53
54     print("\nInserting another element: 40")
55     ll.insert(40)
56
57     print("Displaying the final list:")
58     ll.display() # Expected: 10 -> 20 -> 30 -> 40
59

```

OUTPUT:


```
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
PS C:\Users\ramch\OneDrive\Desktop\ai> & C:\Users\ramch\AppData\Local\Programs\Python\Python312\python.exe c:\Users\ramch\OneDrive\Desktop\ai\11.2.3.py
Creating a new linked list...
Is the list empty? True
Linked list is empty.

Inserting elements: 10, 20, 30
Is the list empty? False

Displaying the list:
10 -> 20 -> 30

Inserting another element: 40
Displaying the final list:
10 -> 20 -> 30 -> 40
PS C:\Users\ramch\OneDrive\Desktop\ai>
```

OBSERVATION:

The code generated by the AI is used to perform the operations in the data structures like singly linked list performing insert and delete operations accurately.

TASK-04:

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

Sample Input Code:

```
class BST:
```

```
pass
```

PROMPT:

Generate a python code which creates a BST with insert and in-order methods.

CODE:

```
11.2.4.py > Node > __init__
1 from typing import Any, Optional, Generator
2 class Node:
3     """
4     An object for storing a single node of a Binary Search Tree.
5     Models three attributes: the node's value, and pointers to the
6     left and right children.
7     """
8     def __init__(self, value: Any):
9         """
10        Initializes a Node.
11        Args:
12        | value (Any): The value to be stored in the node.
13        """
14        self.value = value
15        self.left: Optional['Node'] = None
16        self.right: Optional['Node'] = None
17 class BST:
18     """
19     A simple implementation of a Binary Search Tree (BST).
20     """
21     def __init__(self):
22         """
23         Initializes an empty BST.
24         """
25         self.root: Optional[Node] = None
26     def insert(self, value: Any) -> None:
27         """
28         Inserts a new value into the BST, maintaining the BST property.
29
30         Args:
31         | value (Any): The value to insert into the tree.
32         """
33         if self.root is None:
34             self.root = Node(value)
35         else:
36             self._insert_recursive(self.root, value)
37     def _insert_recursive(self, current_node: Node, value: Any) -> Node:
38         """
39         A private helper method to recursively find the correct position
40         and insert the new node.
41
42         Args:
43         | current_node (Node): The node to start the search from.
44         | value (Any): The value to insert.
45
46         Returns:
47         | Node: The (potentially new) root of the subtree.
48         """
49         if value < current_node.value:
50             if current_node.left is None:
51                 current_node.left = Node(value)
52             else:
53                 self._insert_recursive(current_node.left, value)
54         elif value > current_node.value:
55             if current_node.right is None:
56                 current_node.right = Node(value)
57             else:
58                 self._insert_recursive(current_node.right, value)
```

```
11.2.4.py > Node > _init_
17 class BST:
18     def __init__(self):
19         self.root = None
20
21     def insert_recursive(self, current_node: Node, value: Any) -> Node:
22         """
23         Inserts a new node into the tree.
24         If the value is already in the tree, it does nothing.
25         """
26         # If value == current_node.value, we do nothing (no duplicates).
27         return current_node
28
29     def inorder_traversal(self) -> None:
30         """
31         Performs an in-order traversal of the tree and prints the values.
32         In-order traversal visits nodes in ascending order.
33         """
34         print("In-order Traversal:", end=" ")
35         nodes = list(self._inorder_generator(self.root))
36         print(" -> ".join(map(str, nodes)))
37
38     def _inorder_generator(self, current_node: Optional[Node]) -> Generator[Any, None, None]:
39         """
40         A private generator for recursively performing in-order traversal.
41         It yields nodes in the order: left subtree, root, right subtree.
42
43         Args:
44             current_node (Optional[Node]): The node to start traversal from.
45         """
46         if current_node:
47             yield from self._inorder_generator(current_node.left)
48             yield current_node.value
49             yield from self._inorder_generator(current_node.right)
50
51 # --- Example Usage ---
52 if __name__ == "__main__":
53     print("Creating a new Binary Search Tree...")
54     bst = BST()
55
56     # The order of insertion matters for the tree's shape.
57     print("Inserting values: 50, 30, 70, 20, 40, 60, 80")
58     values_to_insert = [50, 30, 70, 20, 40, 60, 80]
59     for val in values_to_insert:
60         bst.insert(val)
61
62     # The resulting tree structure will be:
63     #      50
64     #     / \
65     #    30  70
66     #   / \  / \
67     #  20 40 60 80
68
69     # In-order traversal should print the nodes in sorted order.
70     bst.inorder_traversal() # Expected: 20 -> 30 -> 40 -> 50 -> 60 -> 70 -> 80
71
72     print("\nInserting a new value: 55")
73     bst.insert(55)
74     bst.inorder_traversal() # Expected: 20 -> 30 -> 40 -> 50 -> 55 -> 60 -> 70 -> 80
75
76     print("\nAttempting to insert a duplicate value: 40")
77     bst.insert(40) # This should not change the tree
78     bst.inorder_traversal() # Expected: 20 -> 30 -> 40 -> 50 -> 55 -> 60 -> 70 -> 80
79
80 # --- End of Example Usage ---
```

OUTPUT:

```
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
PS C:\Users\ramch\OneDrive\Desktop\ai> & C:/Users/ramch/AppData/Local/Programs/Python/Python312/python.exe c:/Users/ramch/OneDrive/Desktop/ai/11.2.4.py
Creating a new Binary Search Tree...
Inserting values: 50, 30, 70, 20, 40, 60, 80
In-order Traversal: 20 -> 30 -> 40 -> 50 -> 60 -> 70 -> 80

Inserting a new value: 55
In-order Traversal: 20 -> 30 -> 40 -> 50 -> 55 -> 60 -> 70 -> 80

Attempting to insert a duplicate value: 40
In-order Traversal: 20 -> 30 -> 40 -> 50 -> 55 -> 60 -> 70 -> 80
PS C:\Users\ramch\OneDrive\Desktop\ai>
```

OBSERVATION:

The BST in data structures with insertion and in-order traversal methods are generated in python which are more helpful and in an efficient way to understand.

TASK-05:

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

methods.

Sample Input Code:

```
class HashTable:
```

```
pass
```

PROMPT:

Generate a python code which helps to implement the hashtable with basic insert and delete methods.

CODE:

```

1125py> _
1 from typing import Any, List, Tuple, Optional
2
3 class HashTable:
4     """
5     A simple implementation of a Hash Table using chaining for collision resolution.
6     """
7     def __init__(self, size: int = 101):
8         """
9         Initializes the hash table.
10
11         Args:
12             size (int): The number of buckets in the hash table. A prime number
13                        is often recommended to help distribute keys more uniformly.
14         """
15         if size < 1:
16             raise ValueError("Hash table size must be a positive integer.")
17         self.size = size
18         # Initialize the table with empty lists (chains) for each bucket
19         self.table: List[List[Tuple[Any, Any]]] = [[] for _ in range(self.size)]
20
21     def _hash(self, key: Any) -> int:
22         """
23         A private method to compute the hash of a key and map it to a bucket index.
24         This uses Python's built-in hash() and the modulo operator.
25
26         Args:
27             key (Any): The key to hash.
28
29         Returns:
30             int: The index of the bucket for the given key.
31         """
32         return hash(key) % self.size
33
34     def insert(self, key: Any, value: Any) -> None:
35         """
36         Inserts a key-value pair into the hash table.
37         If the key already exists, its value is updated.
38
39         Args:
40             key (Any): The key to insert.
41             value (Any): The value associated with the key.
42         """
43         index = self._hash(key)
44         bucket = self.table[index]
45
46         # Check if the key already exists in the bucket (chain)
47         for i, (existing_key, _) in enumerate(bucket):
48             if existing_key == key:
49                 # Key found, update the value and return
50                 bucket[i] = (key, value)
51                 return
52
53         # Key not found, append the new key-value pair to the chain
54         bucket.append((key, value))
55
56     def search(self, key: Any) -> Optional[Any]:
57         """
58         Searches for a key in the hash table and returns its value.

```

```

3 class HashTable:
56 def search(self, key: Any) -> Optional[Any]:
59
60     Args:
61         key (Any): The key to search for.
62
63     Returns:
64         Optional[Any]: The value associated with the key if found, otherwise None.
65     """
66     index = self._hash(key)
67     bucket = self.table[index]
68
69     # Traverse the chain in the bucket
70     for existing_key, value in bucket:
71         if existing_key == key:
72             return value # Key found, return its value
73
74     return None # Key not found
75
76 def delete(self, key: Any) -> bool:
77     """
78     Deletes a key-value pair from the hash table.
79
80     Args:
81         key (Any): The key to delete.
82
83     Returns:
84         bool: True if the key was found and deleted, False otherwise.
85     """
86     index = self._hash(key)
87     bucket = self.table[index]
88
89     # Find the key in the chain and remove it
90     for i, (existing_key, _) in enumerate(bucket):
91         if existing_key == key:
92             bucket.pop(i)
93             return True # Deletion successful
94
95     return False # Key was not found
96
97 def __str__(self) -> str:
98     """
99     Returns a string representation of the hash table's contents.
100     """
101     elements = []
102     for i, bucket in enumerate(self.table):
103         if bucket:
104             elements.append(f"Bucket {i}: {bucket}")
105     return "\n".join(elements) if elements else "HashTable is empty."
106
107 # --- Example Usage ---
108 if __name__ == "__main__":
109     print("Creating a new hash table of size 10...")
110     ht = HashTable(10)
111
112     print("\n--- Inserting Elements ---")
113     ht.insert("name", "Alice")
114     ht.insert("age", 30)

```

```

111
112     print("\n--- Inserting Elements ---")
113     ht.insert("name", "Alice")
114     ht.insert("age", 30)
115     ht.insert("city", "New York")
116     ht.insert(99, "is a number") # Keys can be different types
117     ht.insert("name", "Bob") # This will update the value for the key "name"
118
119     print("Current Hash Table state:")
120     print(ht)
121
122     print("\n--- Searching for Elements ---")
123     print(f"Search for 'name': {ht.search('name')}}") # Expected: Bob
124     print(f"Search for 'age': {ht.search('age')}}") # Expected: 30
125     print(f"Search for 'country': {ht.search('country')}}") # Expected: None
126
127     print("\n--- Deleting Elements ---")
128     print(f"Deleting 'age'... Success: {ht.delete('age')}}")
129     print(f"Deleting 'country'... Success: {ht.delete('country')}}")
130
131     print("\nFinal Hash Table state:")
132     print(ht)
133
134     print(f"\nSearching for 'age' again: {ht.search('age')}}") # Expected: None
135

```

OUTPUT:

```

PS C:\Users\ramch\OneDrive\Desktop\ai> & C:/Users/ramch/AppData/Local/Programs/Python/Python312/python.exe c:/Users/ramch/OneDrive/Desktop/ai/11.2.5.py
Creating a new hash table of size 10...

--- Inserting Elements ---
Current Hash Table state:
Bucket 0: [('name', 'Bob')]
Bucket 1: [('age', 30), ('city', 'New York')]
Bucket 9: [(99, 'is a number')]

--- Searching for Elements ---
Search for 'name': Bob
Search for 'age': 30
Search for 'country': None

--- Deleting Elements ---
Deleting 'age'... Success: True
Deleting 'country'... Success: False

Final Hash Table state:
Bucket 0: [('name', 'Bob')]
Bucket 1: [('city', 'New York')]
Bucket 9: [(99, 'is a number')]

Searching for 'age' again: None
PS C:\Users\ramch\OneDrive\Desktop\ai>

```

OBSERVATION:

AI generated the code of data structures topic hashtable with basic insert, search and delete which aids us to understand the hashtable using the programming language like python.

TASK-06:

Use AI to implement a graph using an adjacency list.

Sample Input Code:

```
class Graph:
```

```
pass
```

PROMPT:

Generate a python code which implements the graph using an adjacency list in data structures.

CODE:

```
1126py> _
1 from typing import Any, Dict, List, Set
2
3 class Graph:
4     """
5     A simple implementation of an undirected graph using an adjacency list.
6     """
7     def __init__(self):
8         """
9         Initializes an empty graph.
10        The adjacency list is represented as a dictionary where keys are
11        vertices and values are lists of their adjacent vertices.
12        """
13        self.adj_list: Dict[Any, List[Any]] = {}
14
15    def add_vertex(self, vertex: Any) -> bool:
16        """
17        Adds a vertex to the graph.
18
19        Args:
20            vertex (Any): The vertex to be added. Must be a hashable type.
21
22        Returns:
23            bool: True if the vertex was added, False if it already exists.
24        """
25        if vertex not in self.adj_list:
26            self.adj_list[vertex] = []
27            return True
28        return False
29
30    def add_edge(self, v1: Any, v2: Any) -> bool:
31        """
32        Adds an undirected edge between two vertices.
33        If the vertices do not exist, they are created first.
34
35        Args:
36            v1 (Any): The first vertex.
37            v2 (Any): The second vertex.
38
39        Returns:
40            bool: True if the edge was added, False if it already existed.
41        """
42        # Ensure both vertices exist in the graph
43        self.add_vertex(v1)
44        self.add_vertex(v2)
45
46        # Add the edge for an undirected graph
47        if v2 not in self.adj_list[v1]:
48            self.adj_list[v1].append(v2)
49        if v1 not in self.adj_list[v2]:
50            self.adj_list[v2].append(v1)
51        return True
52
53    def display(self) -> None:
54        """
55        Prints the adjacency list representation of the graph.
56        """
57        if not self.adj_list:
58            print("Graph is empty.")
59
60
```

```
11.2.1.py 11.2.2.py 11.2.3.py 11.2.4.py 11.2.5.py 11.2.6.py X 11.2.7.py 11.2.8.py 11.2.9.py 11.2.10.py
11.2.6.py > _
3 class Graph:
53     def display(self) -> None:
58         print("Graph is empty.")
59         return
60         for vertex in self.adj_list:
61             print(f"{vertex}: {self.adj_list[vertex]}")
62
63     def get_vertices(self) -> List[Any]:
64         """
65         Returns a list of all vertices in the graph.
66         """
67         return list(self.adj_list.keys())
68
69     def get_edges(self) -> List[tuple[Any, Any]]:
70         """
71         Returns a list of all edges in the graph.
72         """
73         edges = set()
74         for vertex, neighbors in self.adj_list.items():
75             for neighbor in neighbors:
76                 # To avoid duplicate edges like (A, B) and (B, A)
77                 if vertex < neighbor:
78                     edges.add((vertex, neighbor))
79         return list(edges)
80
81 # --- Example Usage ---
82 if __name__ == "__main__":
83     print("Creating a new graph...")
84     g = Graph()
85
86     print("\n--- Adding Vertices ---")
87     g.add_vertex("A")
88     g.add_vertex("B")
89     g.add_vertex("C")
90     print("Graph after adding vertices:")
91     g.display()
92
93     print("\n--- Adding Edges ---")
94     g.add_edge("A", "B")
95     g.add_edge("B", "C")
96     g.add_edge("C", "A")
97     # Adding an edge with a new vertex
98     g.add_edge("A", "D")
99     print("Graph after adding edges:")
100    g.display()
101
102    print("\n--- Retrieving Vertices and Edges ---")
103    print("Vertices:", g.get_vertices())
104    print("Edges:", g.get_edges())
105
106    print("\n--- Adding a duplicate edge (A, B) ---")
107    success = g.add_edge("A", "B")
108    print(f"Was the edge added? {success}") # Expected: False
109    print("Graph state remains the same:")
110    g.display()
111
```

OUTPUT:

```
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
PS C:\Users\ranch\OneDrive\Desktop\ai> & C:\Users\ranch\AppData\Local\Programs\Python\Python312\python.exe c:\Users\ranch\OneDrive\Desktop\ai\11.2.6.py
Creating a new graph...

--- Adding Vertices ---
Graph after adding vertices:
A: []
B: []
C: []

--- Adding Edges ---
Graph after adding edges:
A: ['B', 'C', 'D']
B: ['A', 'C']
C: ['B', 'A']
D: ['A']

--- Retrieving Vertices and Edges ---
Vertices: ['A', 'B', 'C', 'D']
Edges: [('A', 'C'), ('A', 'B'), ('B', 'C'), ('A', 'D')]

--- Adding a duplicate edge (A, B) ---
Was the edge added? False
Graph state remains the same:
A: ['B', 'C', 'D']
B: ['A', 'C']
C: ['B', 'A']
D: ['A']
PS C:\Users\ranch\OneDrive\Desktop\ai>
```


OBSERVATION:

Implementation of graph with the adjacency list is generated by the AI which makes us know about the graph in an efficient way and easy to understand.

TASK-07:

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

Sample Input Code:

```
class PriorityQueue:  
    pass
```

PROMPT:

Write a python code which implement the priority queue using the heapq module.

CODE:

```

11.2.1.py 11.2.2.py 11.2.3.py 11.2.4.py 11.2.5.py 11.2.6.py 11.2.7.py X 11.2.8.py 11.2.9.py 11.2.10.py
11.2.7.py > ...
1 import heapq
2 from typing import Any, List, Tuple
3
4 class PriorityQueue:
5     """
6     A simple implementation of a Priority Queue using Python's heapq module.
7     Lower numbers indicate higher priority.
8     """
9     def __init__(self):
10         """
11         Initializes an empty priority queue.
12         """
13         self._heap: List[Tuple[int, Any]] = []
14
15     def push(self, item: Any, priority: int) -> None:
16         """
17         Adds an item to the queue with an associated priority.
18
19         Args:
20             item (Any): The item to be stored in the queue.
21             priority (int): The priority of the item. Lower numbers are higher priority.
22         """
23         # heapq is a min-heap, so it naturally keeps the item with the
24         # smallest priority value at the front.
25         heapq.heappush(self._heap, (priority, item))
26
27     def pop(self) -> Any:
28         """
29         Removes and returns the item with the highest priority (lowest number).
30
31         Raises:
32             IndexError: If the priority queue is empty.
33
34         Returns:
35             Any: The item with the highest priority.
36         """
37         if self.is_empty():
38             raise IndexError("pop from an empty priority queue")
39         # heappop removes and returns the smallest item from the heap.
40         # We return only the item (index 1), not its priority (index 0).
41         return heapq.heappop(self._heap)[1]
42
43     def peek(self) -> Any:
44         """
45         Returns the item with the highest priority without removing it.
46
47         Raises:
48             IndexError: If the priority queue is empty.
49
50         Returns:
51             Any: The item with the highest priority.
52         """
53         if self.is_empty():
54             raise IndexError("peek from an empty priority queue")
55         # The highest priority item is always at the root of the heap (index 0).
56         return self._heap[0][1]
57
58     def is_empty(self) -> bool:

```

```

4 class PriorityQueue:
58     def is_empty(self) -> bool:
60         """
61         Checks if the priority queue is empty.
62
63         Returns:
64             bool: True if the queue is empty, False otherwise.
65         """
66         return not self._heap
67
68     def __len__(self) -> int:
69         """
70         Returns the number of items in the priority queue.
71         """
72         return len(self._heap)
73
74     def __str__(self) -> str:
75         """
76         Returns a string representation of the priority queue's heap.
77         Note: The list representation is not necessarily sorted.
78         """
79         return str(self._heap)
80
81 # --- Example Usage ---
82 if __name__ == "__main__":
83     pq = PriorityQueue()
84     print(f"Is the queue empty? {pq.is_empty()}") # Expected: True
85
86     print("\nPushing tasks with priorities...")
87     # (item, priority)
88     pq.push("Task: Write report", 3)
89     pq.push("Task: Answer urgent email", 1) # Highest priority
90     pq.push("Task: Go to meeting", 2)
91     pq.push("Task: Get coffee", 4) # Lowest priority
92
93     print(f"Current queue size: {len(pq)}")
94     print(f"Internal heap representation: {pq}")
95     print(f"Is the queue empty? {pq.is_empty()}") # Expected: False
96
97     print(f"\nHighest priority task (peek): {pq.peek()}") # Expected: Task: Answer urgent email
98
99     print("\nProcessing tasks in order of priority:")
100     while not pq.is_empty():
101         task = pq.pop()
102         print(f" - Popped: {task}")
103
104     print(f"\nIs the queue empty now? {pq.is_empty()}") # Expected: True

```

OUTPUT:



```
PS C:\Users\ramch\OneDrive\Desktop\ai> & C:/Users/ramch/AppData/Local/Programs/Python/Python312/python.exe c:/Users/ramch/OneDrive/Desktop/ai/11.2.7.py
Is the queue empty? True

Pushing tasks with priorities...
Current queue size: 4
Internal heap representation: [(1, 'Task: Answer urgent email'), (3, 'Task: Write report'), (2, 'Task: Go to meeting'), (4, 'Task: Get coffee')]
Is the queue empty? False

Highest priority task (peek): Task: Answer urgent email

Processing tasks in order of priority:
- Popped: Task: Answer urgent email
- Popped: Task: Go to meeting
- Popped: Task: Write report
- Popped: Task: Get coffee

Is the queue empty now? True
PS C:\Users\ramch\OneDrive\Desktop\ai>
```

OBSERVATION:

The priority queue is generated using the `heapq` module of python which implements them accurately.

TASK-08:

Use AI to implement a double-ended queue using `collections.deque`.

Sample Input Code:

```
class DequeDS:
    pass
```

PROMPT:

Write a python code to implement the double-ended queue using `collections .deque`

CODE:

```

112.8.py > ...
1  from collections import deque
2  from typing import Any, Optional
3
4  class DequeDS:
5      """
6      A wrapper class for Python's collections.deque to provide a clear
7      and explicit double-ended queue interface.
8      """
9
10     def __init__(self):
11         """
12         Initializes an empty deque.
13         """
14         self._deque = deque()
15
16     def add_first(self, item: Any) -> None:
17         """
18         Adds an item to the front of the deque.
19
20         Args:
21             item (Any): The item to be added.
22         """
23         self._deque.appendleft(item)
24
25     def add_last(self, item: Any) -> None:
26         """
27         Adds an item to the back of the deque.
28
29         Args:
30             item (Any): The item to be added.
31         """
32         self._deque.append(item)
33
34     def remove_first(self) -> Any:
35         """
36         Removes and returns the item from the front of the deque.
37
38         Raises:
39             IndexError: If the deque is empty.
40
41         Returns:
42             Any: The item from the front.
43         """
44         if self.is_empty():
45             raise IndexError("remove_first from an empty deque")
46         return self._deque.popleft()
47
48     def remove_last(self) -> Any:
49         """
50         Removes and returns the item from the back of the deque.
51
52         Raises:
53             IndexError: If the deque is empty.
54
55         Returns:
56             Any: The item from the back.
57         """
58         if self.is_empty():
59             raise IndexError("remove_last from an empty deque")

```

```

112.8.py > ...
4  class DequeDS:
59     return self._deque.pop()
60
61     def peek_first(self) -> Any:
62         """
63         Returns the item at the front of the deque without removing it.
64
65         Raises:
66             IndexError: If the deque is empty.
67
68         Returns:
69             Any: The item at the front.
70         """
71         if self.is_empty():
72             raise IndexError("peek_first from an empty deque")
73         return self._deque[0]
74
75     def peek_last(self) -> Any:
76         """
77         Returns the item at the back of the deque without removing it.
78
79         Raises:
80             IndexError: If the deque is empty.
81
82         Returns:
83             Any: The item at the back.
84         """
85         if self.is_empty():
86             raise IndexError("peek_last from an empty deque")
87         return self._deque[-1]
88
89     def is_empty(self) -> bool:
90         """
91         Checks if the deque is empty.
92
93         Returns:
94             bool: True if the deque is empty, False otherwise.
95         """
96         return len(self._deque) == 0
97
98     def __len__(self) -> int:
99         """
100         Returns the number of items in the deque.
101         """
102         return len(self._deque)
103
104     def __str__(self) -> str:
105         """
106         Returns a string representation of the deque.
107         """
108         return f"DequeDS({list(self._deque)})"
109
110 # --- Example Usage ---
111 if __name__ == "__main__":
112     d = DequeDS()
113     print(f"Is deque empty? {d.is_empty()}") # Expected: True
114
115     print("\nAdding 'B' and 'C' to the back...")

```

```

112 d = DequeDS()
113 print(f"Is deque empty? {d.is_empty()}") # Expected: True
114
115 print("\nAdding 'B' and 'C' to the back...")
116 d.add_last("B")
117 d.add_last("C")
118 print(d) # Expected: DequeDS(['B', 'C'])
119
120 print("\nAdding 'A' to the front...")
121 d.add_first("A")
122 print(d) # Expected: DequeDS(['A', 'B', 'C'])
123
124 print(f"\nSize of deque: {len(d)}") # Expected: 3
125 print(f"Peek first: {d.peek_first()}") # Expected: A
126 print(f"Peek last: {d.peek_last()}") # Expected: C
127
128 print("\nRemoving from the back...")
129 item = d.remove_last()
130 print(f"Removed '{item}'. Current deque: {d}") # Expected: DequeDS(['A', 'B'])
131
132 print("\nRemoving from the front...")
133 item = d.remove_first()
134 print(f"Removed '{item}'. Current deque: {d}") # Expected: DequeDS(['B'])
135
136 print("\nClearing the deque...")
137 d.remove_first()
138 print(f"Is deque empty? {d.is_empty()}") # Expected: True
139

```

OUTPUT:

```

PS C:\Users\ramch\OneDrive\Desktop\ai> & C:\Users\ramch\AppData\Local\Programs\Python\Python312\python.exe c:/Users/ramch/OneDrive/Desktop/ai/11.2.8.py
Is deque empty? True

Adding 'B' and 'C' to the back...
DequeDS(['B', 'C'])

Adding 'A' to the front...
DequeDS(['A', 'B', 'C'])

Size of deque: 3
Peek first: A
Peek last: C

Removing from the back...
Removed 'C'. Current deque: DequeDS(['A', 'B'])

Removing from the front...
Removed 'A'. Current deque: DequeDS(['B'])

Clearing the deque...
Is deque empty? True
PS C:\Users\ramch\OneDrive\Desktop\ai>

```

OBSERVATION:

The code generated by the AI of data structures topic of double-ended queue with the help of python to easily understand the topic accurately.

TASK-09:

Use AI to generate a comparison table of different data structures (stack, queue, linked list, etc.) including time complexities.

Sample Input Code:

No code, prompt AI for a data structure comparison table

PROMPT:

Generate a comparative table of different data structures including time complexities .

TABLE:

| Data Structure Time Complexity Comparison | | | | | | | |
|---|-----------------------|-------------------|--------------------|----------------------|-------------------|---------------------|---|
| Data Structure | Access (by index/key) | Search (by value) | Insertion (at end) | Insertion (at start) | Deletion (at end) | Deletion (at start) | Notes |
| Python List (Array) | $O(1)$ | $O(n)$ | $O(1)$ | $O(n)$ | $O(1)$ | $O(n)$ | Insertion/deletion at the start is slow because all other elements must be shifted. |
| Stack (using List) | $O(n)$ | $O(n)$ | $O(1)$ | N/A | $O(1)$ | N/A | Operations are only on the "top" (end of the list). Accessing arbitrary elements is not a standard stack operation. |
| Queue (using List) | $O(n)$ | $O(n)$ | $O(1)$ | N/A | N/A | $O(n)$ | <code>deque</code> (from the start) is inefficient. <code>collections.deque</code> is highly preferred. |
| Queue (using deque) | $O(n)$ | $O(n)$ | $O(1)$ | N/A | N/A | $O(1)$ | <code>collections.deque</code> is optimized for fast appends and pops from both ends. |
| Singly Linked List | $O(n)$ | $O(n)$ | $O(n)$ | $O(1)$ | $O(n)$ | $O(1)$ | Insertion/deletion at the start is fast. Finding the end requires traversing the whole list. |
| Doubly Linked List | $O(n)$ | $O(n)$ | $O(1)$ | $O(1)$ | $O(1)$ | $O(1)$ | Faster end-of-list operations than a singly linked list because it can be tracked. Uses more memory per node. |
| Hash Table (Dict) | $O(1)$ | $O(1)$ | $O(1)$ | $O(1)$ | $O(1)$ | $O(1)$ | Average case is $O(1)$. Worst case (due to hash collisions) can be $O(n)$. |
| Binary Search Tree | $O(\log n)$ | $O(\log n)$ | $O(\log n)$ | $O(\log n)$ | $O(\log n)$ | $O(\log n)$ | Assumes the tree is balanced. In the worst case (an unbalanced tree), it degrades to $O(n)$. |

TASK-10:

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.

PROMPT:

Generate the python code according to the given above details.

CODE:

```
11.2.10py > ~
1 from typing import Any, Dict, Optional
2
3 class EventRegistration:
4     """
5     Manages participant registration for an event using a hash table.
6     This provides fast lookups, additions, and removals of participants.
7     """
8     def __init__(self, event_name: str):
9         """
10        Initializes the registration system for a specific event.
11
12        Args:
13            event_name (str): The name of the event.
14        """
15        self.event_name = event_name
16        # The hash table (dictionary) to store participants.
17        # Key: student_id, Value: student_name
18        self._participants: Dict[int, str] = {}
19        print(f"Event Registration System for '{self.event_name}' is now open!")
20
21    def register_participant(self, student_id: int, student_name: str) -> bool:
22        """
23        Registers a new participant for the event.
24
25        Args:
26            student_id (int): The unique ID of the student.
27            student_name (str): The name of the student.
28
29        Returns:
30            bool: True if registration was successful, False if the student
31                  is already registered.
32        """
33        if student_id in self._participants:
34            print(f"-> Error: Student (student_name) (ID: (student_id)) is already registered.")
35            return False
36
37        self._participants[student_id] = student_name
38        print(f"-> Success: (student_name) (ID: (student_id)) has been registered.")
39        return True
40
41    def remove_participant(self, student_id: int) -> bool:
42        """
43        Removes a participant from the event.
44
45        Args:
46            student_id (int): The ID of the student to remove.
47
48        Returns:
49            bool: True if the student was found and removed, False otherwise.
50        """
51        if student_id in self._participants:
52            student_name = self._participants.pop(student_id)
53            print(f"-> Success: (student_name) (ID: (student_id)) has been removed.")
54            return True
55
56        print(f"-> Error: Student with ID (student_id) not found.")
57        return False
58
59
```



```

57 # Create a registration system
58
59 def find_participant(self, student_id: int) -> Optional[str]:
60     """
61     Searches for a participant by their student ID.
62
63     Args:
64         student_id (int): The ID of the student to find.
65
66     Returns:
67         Optional[str]: The name of the student if found, otherwise None.
68     """
69     return self._participants.get(student_id)
70
71 def display_participants(self) -> None:
72     """
73     Displays a list of all registered participants.
74
75     """
76     print(f"\n--- Registered Participants for '{self.event_name}' ---")
77     if not self._participants:
78         print("No participants are currently registered.")
79     else:
80         for student_id, student_name in self._participants.items():
81             print(f"  ID: {student_id}, Name: {student_name}")
82             print("-----")
83
84 # --- Example Usage ---
85 if __name__ == "__main__":
86     # Create a registration system for a "CodeFest 2024" event
87     codefest_event = EventRegistration("CodeFest 2024")
88
89     print("\n--- Registering Participants ---")
90     codefest_event.register_participant(101, "Alice")
91     codefest_event.register_participant(102, "Bob")
92     codefest_event.register_participant(103, "Charlie")
93
94     # Attempt to register a duplicate
95     codefest_event.register_participant(101, "Alice")
96
97     codefest_event.display_participants()
98
99     print("\n--- Searching for a Participant ---")
100     student_id_to_find = 102
101     student_name = codefest_event.find_participant(student_id_to_find)
102     if student_name:
103         print(f"Found participant with ID {student_id_to_find}: {student_name}")
104     else:
105         print(f"Participant with ID {student_id_to_find} not found.")
106
107     print("\n--- Removing a Participant ---")
108     codefest_event.remove_participant(103) # Successful removal
109     codefest_event.remove_participant(999) # Failed removal (not found)
110
111     codefest_event.display_participants()
112

```

OUTPUT:

```

PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS
PS C:\Users\ranch\OneDrive\Desktop\ai> & C:\Users\ranch\AppData\Local\Programs\Python\Python312\python.exe c:\Users\ranch\OneDrive\Desktop\ai\11.2.10.py
Event Registration System for 'CodeFest 2024' is now open!

--- Registering Participants ---
-> Success: Alice (ID: 101) has been registered.
-> Success: Bob (ID: 102) has been registered.
-> Success: Charlie (ID: 103) has been registered.
-> Error: Student Alice (ID: 101) is already registered.

--- Registered Participants for 'CodeFest 2024' ---
  ID: 101, Name: Alice
  ID: 102, Name: Bob
  ID: 103, Name: Charlie
-----

--- Searching for a Participant ---
Found participant with ID 102: Bob

--- Removing a Participant ---
-> Success: Charlie (ID: 103) has been removed.
-> Error: Student with ID 999 not found.

--- Registered Participants for 'CodeFest 2024' ---
  ID: 101, Name: Alice
  ID: 102, Name: Bob
-----
PS C:\Users\ranch\OneDrive\Desktop\ai>

```

TABLE:

| Data Structure Selection and Justification | | |
|--|--------------------------|--|
| Here is a table that maps each system feature to the most suitable data structure and provides a justification for the choice. | | |
| Feature | Chosen Data Structure | Justification |
| 1. Student Attendance Tracking | Stack | A stack is ideal for tracking entries and exits. When a student enters, their ID is pushed onto the stack; when they exit, their ID is popped. This Last-In, First-Out (LIFO) model naturally represents the most recent students on campus and can quickly show who is currently inside. |
| 2. Event Registration System | Hash Table | A hash table (like a Python dictionary) is perfect for managing event participants. It allows for extremely fast $O(1)$ average-time lookups, insertions, and removals using a unique student ID as the key. This efficiency is crucial for quickly checking if a student is registered or for managing a large list of attendees. |
| 3. Library Book Borrowing | Binary Search Tree (BST) | A BST, keyed on book titles or ISBNs, is a great choice for managing available books. It keeps the books in a sorted order, allowing for efficient $O(\log n)$ searching. This is much faster than a linear scan when the library has thousands of books. |
| 4. Bus Scheduling System | Graph | A graph is the most natural way to model a bus network. Each bus stop can be represented as a vertex, and the routes between stops can be represented as edges. This structure allows for solving complex problems like finding the shortest path between two stops or identifying all possible routes. |
| 5. Cafeteria Order Queue | Queue | A queue is the perfect data structure for this task as it follows the First-In, First-Out (FIFO) principle. Students are served in the exact order they arrive, just like a real-world line. This ensures fairness and is the most intuitive way to manage an order system. |

OBSERVATION:

The AI generated the code in an efficient way according to the details given in which it include all the data structures concepts to make all easily understand . As the task contains much more information it should be handled in an efficient way.