

# ASSIGNMENT - 11.3

## PROMPT: Smart Contact Manager (Arrays & Linked Lists)

SR University's student club requires a simple Contact Manager Application to store members' names and phone numbers. The system should support efficient addition, searching, and deletion of contacts.

### CODE:

```
[10]  ✓ 0s  # --- ARRAY BASED IMPLEMENTATION ---
class ArrayContactManager:
    def __init__(self):
        # Python lists are dynamic arrays
        self.contacts = []

    def add_contact(self, name, phone):
        self.contacts.append({'name': name, 'phone': phone})
        print(f"[Array] Added: {name}")

    def search_contact(self, name):
        for contact in self.contacts:
            if contact['name'].lower() == name.lower():
                return f"[Array] Found: {contact['name']} - {contact['phone']}"
        return f"[Array] {name} not found."

    def delete_contact(self, name):
        for i in range(len(self.contacts)):
            if self.contacts[i]['name'].lower() == name.lower():
                removed = self.contacts.pop(i)
                print(f"[Array] Deleted: {removed['name']}")
                return True
        print(f"[Array] Delete failed: {name} not found.")
        return False
```

```
[10]  ✓ 0s  # --- LINKED LIST IMPLEMENTATION ---
class Node:
    def __init__(self, name, phone):
        self.name = name
        self.phone = phone
        self.next = None

class LinkedListContactManager:
    def __init__(self):
        self.head = None

    def add_contact(self, name, phone):
        new_node = Node(name, phone)
        # Adding to the beginning (O(1) efficiency)
        new_node.next = self.head
        self.head = new_node
        print(f"[Linked List] Added: {name}")

    def search_contact(self, name):
        current = self.head
        while current:
            if current.name.lower() == name.lower():
                return f"[Linked List] Found: {current.name} - {current.phone}"
            current = current.next
        return f"[Linked List] {name} not found."
```

```
[10] ✓ Os ⏪
def delete_contact(self, name):
    current = self.head
    prev = None
    while current:
        if current.name.lower() == name.lower():
            if prev:
                prev.next = current.next
            else:
                self.head = current.next
            print(f"[Linked List] Deleted: {current.name}")
            return True
        prev = current
        current = current.next
    print(f"[Linked List] Delete failed: {name} not found.")
    return False

# --- EXECUTION / OUTPUT ---
if __name__ == "__main__":
    # Initialize both
    arr_manager = ArrayContactManager()
    ll_manager = LinkedListContactManager()

    # 1. Add Contacts
    for manager in [arr_manager, ll_manager]:
        manager.add_contact("Alice", "123-456")
        manager.add_contact("Bob", "987-654")
        manager.add_contact("Charlie", "555-777")
```

```
[10] ✓ Os ⏪
# 2. Search Contacts
print(arr_manager.search_contact("Bob"))
print(ll_manager.search_contact("Bob"))
print(arr_manager.search_contact("Eve")) # Testing non-existent

print("-" * 30)

# 3. Delete and Verify
arr_manager.delete_contact("Alice")
ll_manager.delete_contact("Alice")

print(arr_manager.search_contact("Alice")) # Should show not found

*** [Array] Added: Alice
[Array] Added: Bob
[Array] Added: Charlie
[Linked List] Added: Alice
[Linked List] Added: Bob
[Linked List] Added: Charlie
-----
[Array] Found: Bob - 987-654
[Linked List] Found: Bob - 987-654
[Array] Eve not found.
-----
[Array] Deleted: Alice
[Linked List] Deleted: Alice
[Array] Alice not found.
```

## **EXPLANATION:**

### **1. Array-Based (Python Lists)**

- **Structure:** Stores contacts in a single, solid block of memory.
  - **Search:** Uses a "Linear Search" (checking each index one by one).
  - **Insertion/Deletion:** Slow if done at the beginning, because every other contact must be "shifted" over to fill or create a gap.
  - **Efficiency:** Best for small lists or adding to the very end.
- 

### **2. Linked List**

- **Structure:** Each contact is a "Node" with a pointer (link) to the next one.
- **Search:** Must "walk" the chain from the start until the name is found.
- **Insertion/Deletion:** Very fast. You don't move any data; you just change where the "links" point to skip or add a person.
- **Efficiency:** Best for dynamic data where you frequently add/remove members from the middle or start

## **2. PROMPT : Library Book Search System (Queues & Priority Queues)**

The SRU Library manages book borrow requests. Students and faculty submit requests, but faculty requests must be prioritized over student requests.

CODE:

```
[11] ✓ 0s ⏪ import heapq
      from collections import deque

      # --- 1. STANDARD QUEUE (FIFO) ---
      class LibraryQueue:
          def __init__(self):
              self.queue = deque()

          def enqueue(self, name, user_type):
              self.queue.append((name, user_type))
              print(f"[Queue] Request added: {name} ({user_type})")

          def dequeue(self):
              if not self.queue:
                  return "[Queue] No requests to process."
              name, user_type = self.queue.popleft()
              return f"[Queue] Processing: {name} ({user_type})"

      # --- 2. PRIORITY QUEUE ---
      class PriorityLibraryQueue:
          def __init__(self):
              self.pq = []
              # Priority: Faculty = 0 (Higher), Student = 1 (Lower)
              self.priority_map = {"Faculty": 0, "Student": 1}

          def enqueue(self, name, user_type):
              priority = self.priority_map.get(user_type, 2)
              # heapq is a min-heap, so lower numbers come out first
              heapq.heappush(self.pq, (priority, name))


```

```
[11] ✓ 0s ⏪ def dequeue(self):
      if not self.pq:
          return "[Priority] No requests to process."
      priority, name = heapq.heappop(self.pq)
      user_type = "Faculty" if priority == 0 else "Student"
      return f"[Priority] Processing: {name} ({user_type})"

      # --- TESTING BOTH SYSTEMS ---
      if __name__ == "__main__":
          requests = [
              ("Alice", "Student"),
              ("Dr. Smith", "Faculty"),
              ("Bob", "Student"),
              ("Prof. Jones", "Faculty")
          ]

          print("--- Testing Standard FIFO Queue ---")
          lib_q = LibraryQueue()
          for name, utype in requests:
              lib_q.enqueue(name, utype)
          for _ in range(4):
              print(lib_q.dequeue())

          print("\n--- Testing Priority Queue ---")
          p_lib_q = PriorityLibraryQueue()
          for name, utype in requests:
              p_lib_q.enqueue(name, utype)
          for _ in range(4):
              print(p_lib_q.dequeue())


```

## OUTPUT:

```
[11]  ✓ 0s      for _ in range(4):
                print(p_lib_q.dequeue())

...
--- Testing Standard FIFO Queue ---
[Queue] Request added: Alice (Student)
[Queue] Request added: Dr. Smith (Faculty)
[Queue] Request added: Bob (Student)
[Queue] Request added: Prof. Jones (Faculty)
[Queue] Processing: Alice (Student)
[Queue] Processing: Dr. Smith (Faculty)
[Queue] Processing: Bob (Student)
[Queue] Processing: Prof. Jones (Faculty)

--- Testing Priority Queue ---
[Priority] Request added: Alice (Student)
[Priority] Request added: Dr. Smith (Faculty)
[Priority] Request added: Bob (Student)
[Priority] Request added: Prof. Jones (Faculty)
[Priority] Processing: Dr. Smith (Faculty)
[Priority] Processing: Prof. Jones (Faculty)
[Priority] Processing: Alice (Student)
[Priority] Processing: Bob (Student)
```

## EXPLANATION:

### 1. Standard Queue (FIFO)

- **Logic:** Operates on the "First-In, First-Out" principle, exactly like a real-world standing line.
  - **Processing:** The order of service is determined strictly by the **time of arrival**. If a student arrives before a professor, the student is served first.
  - **Use Case:** Best for fair, neutral systems where everyone has equal status.
- 

### 2. Priority Queue

- **Logic:** Assigns a "weight" or "rank" to each request. In our code, Faculty is rank **0** and Student is rank **1**.
- **Processing:** The system always looks for the lowest rank number (highest priority) to serve next. This allows faculty members to "jump the line" regardless of when they arrived.
- **Use Case:** Ideal for systems with **emergency levels** or membership tiers (like the SRU Library).

### 3.PROMPT: Emergency Help Desk (Stack Implementation)

#### Scenario

SR University's IT Help Desk receives technical support tickets from students and staff. While tickets are received sequentially, issue escalation follows a Last-In, First-Out (LIFO) approach.

#### OUTPUT:

```
[12] 0s ➜ class TicketStack:
    def __init__(self, capacity=5):
        self.stack = []
        self.capacity = capacity

    def push(self, ticket_id, issue):
        """Adds a new ticket to the top of the stack."""
        if self.is_full():
            print(f"[Stack Full] Cannot add ticket {ticket_id}: {issue}")
            return
        self.stack.append({'id': ticket_id, 'issue': issue})
        print(f"Ticket Raised: {ticket_id} - {issue}")

    def pop(self):
        """Resolves and removes the most recent ticket (LIFO)."""
        if self.is_empty():
            return "No tickets to resolve."
        resolved = self.stack.pop()
        return f"Resolving: {resolved['id']} ({resolved['issue']})"

    def peek(self):
        """Views the ticket at the top without removing it."""
        if self.is_empty():
            return "Stack is empty."
        top = self.stack[-1]
        return f"Next for escalation: {top['id']} - {top['issue']}
```

```
[12] 0s
def is_empty(self):
    """Checks if there are no tickets."""
    return len(self.stack) == 0

def is_full(self):
    """Checks if the stack has reached its limit."""
    return len(self.stack) >= self.capacity

# --- SIMULATION ---
if __name__ == "__main__":
    help_desk = TicketStack(capacity=5)

    # 1. Raising 5 tickets
    tickets = [
        ("T101", "WiFi Down"),
        ("T102", "Login Error"),
        ("T103", "Printer Jam"),
        ("T104", "Software Update"),
        ("T105", "Virus Alert")
    ]

    print("--- Receiving Tickets ---")
    for tid, issue in tickets:
        help_desk.push(tid, issue)

    # 2. Checking the top ticket
    print(f"\nPeek: {help_desk.peek()}")

    # 3. Resolving tickets (LIFO Behavior)
    print("\n--- Resolving Tickets (LIFO) ---")
```

```
[12] 0s
# 3. Resolving tickets (LIFO Behavior)
print("\n--- Resolving Tickets (LIFO) ---")
while not help_desk.is_empty():
    print(help_desk.pop())

...
--- Receiving Tickets ---
Ticket Raised: T101 - WiFi Down
Ticket Raised: T102 - Login Error
Ticket Raised: T103 - Printer Jam
Ticket Raised: T104 - Software Update
Ticket Raised: T105 - Virus Alert

Peek: Next for escalation: T105 - Virus Alert

--- Resolving Tickets (LIFO) ---
Resolving: T105 (Virus Alert)
Resolving: T104 (Software Update)
Resolving: T103 (Printer Jam)
Resolving: T102 (Login Error)
Resolving: T101 (WiFi Down)
```

## EXPLANATION:

LIFO Principle: The Help Desk operates like a stack of trays. The last ticket placed on top (T105) is the first one picked up to be fixed.

- Pop: Removes the top ticket once resolved.
- Peek: Checks the most urgent ticket without removing it from the system.
- Efficiency: Stacks are extremely fast for these operations ( $O(1)$ ), as you never have to search through the middle; you only ever interact with the very top.

## PROMPT 4: Hash Table

To implement a Hash Table and understand collision handling.

### CODE:

```
[16]  ✓ 0s  class HashTable:
    def __init__(self, size=10):
        self.size = size
        # Initialize the table with empty lists (buckets) for chaining
        self.table = [[] for _ in range(self.size)]

    def _hash_function(self, key):
        """Standard hash function using the modulo operator."""
        return hash(key) % self.size

    def insert(self, key, value):
        """Inserts or updates a key-value pair."""
        index = self._hash_function(key)
        # Check if the key already exists in the bucket to update it
        for pair in self.table[index]:
            if pair[0] == key:
                pair[1] = value
                return
        # If key is new, append it to the chain (collision handling)
        self.table[index].append([key, value])
        print(f"Inserted: '{key}' at Index {index}")

    def search(self, key):
        """Retrieves the value for a given key."""
        index = self._hash_function(key)
        for pair in self.table[index]:
            if pair[0] == key:
                return pair[1]
```

```
[16]  ✓ 0s  def delete(self, key):
    """Removes a key-value pair from the table."""
    index = self._hash_function(key)
    for i, pair in enumerate(self.table[index]):
        if pair[0] == key:
            del self.table[index][i]
            print(f"Deleted: '{key}'")
            return True
    print(f"Error: '{key}' not found.")
    return False

def display(self):
    """Prints the internal structure of the table."""
    print("\n--- Current Hash Table State ---")
    for i, bucket in enumerate(self.table):
        print(f"Index {i}: {bucket}")

# --- EXECUTION ---
if __name__ == "__main__":
    ht = HashTable(size=5)

    # 1. Insert data (Some will collide since size is only 5)
    ht.insert("Alice", "123-456")
    ht.insert("Bob", "987-654")
    ht.insert("Charlie", "555-000")
    ht.insert("David", "111-222") # High chance of collision

    # 2. Search
    print(f"\nSearch Result (Bob): {ht.search('Bob')}")
```

```
[16] ✓ 0s # 2. Search
      print(f"\nSearch Result (Bob): {ht.search('Bob')}")

      # 3. Delete
      ht.delete("Alice")

      # 4. Final Display
      ht.display()

...
... Inserted: 'Alice' at Index 4
Inserted: 'Bob' at Index 3
Inserted: 'Charlie' at Index 1
Inserted: 'David' at Index 3

Search Result (Bob): 987-654
Deleted: 'Alice'

--- Current Hash Table State ---
Index 0: []
Index 1: [['Charlie', '555-000']]
Index 2: []
Index 3: [['Bob', '987-654'], ['David', '111-222']]
Index 4: []
```

## EXPLANATION:

**Chaining (Collision Resolution):** When two keys (like "Alice" and "David") hash to the same index, we don't overwrite the data. Instead, we store them as a **nested list** (a "chain") at that index.

**The Hash Function:** The `_hash_function` takes any string and converts it into a number within the range of our table size using the `%` (modulo) operator.

**Efficiency:** \* **Average Case:**  $O(1)$  for insert, search, and delete. This is why hash tables are the foundation of Python's `dict` and `set`.

- **Worst Case:**  $O(n)$  if every single key hashes to the exact same index, turning the hash table into one giant linked list.

## PROMPT 5: Real-Time Application Challenge

Design a Campus Resource Management System with the following

### features:

- Student Attendance Tracking
- Event Registration System
- Library Book Borrowing
- Bus Scheduling System
- Cafeteria Order Queue

### CODE:

```
[17]  ✓ 2s  from collections import deque
          import time

      class CafeteriaSystem:
          def __init__(self):
              # Using deque for O(1) removals from the front
              self.order_queue = deque()

          def place_order(self, student_name, item):
              """Adds a new order to the end of the queue."""
              order = {"name": student_name, "item": item}
              self.order_queue.append(order)
              print(f"✓ Order placed for {student_name}: {item}")

          def serve_next_student(self):
              """Removes and serves the order at the front of the queue."""
              if not self.order_queue:
                  print("⚠ The queue is empty! No orders to serve.")
                  return

              served_order = self.order_queue.popleft()
              print(f"⚠ Serving {served_order['name']}'s {served_order['item']}...")
              time.sleep(1) # Simulating prep time
              print(f"✓ {served_order['name']} has been served.")

          def view_queue(self):
              """Displays all pending orders."""
              print(f"\n--- Current Queue ({len(self.order_queue)} orders) ---")
```

```
[17] 2s  campus_cafe.place_order("Bob", "Avocado Toast")
      campus_cafe.place_order("Charlie", "Blueberry Muffin")

      # 2. View the current state of the line
      campus_cafe.view_queue()

      # 3. Process the orders in FIFO order
      campus_cafe.serve_next_student()
      campus_cafe.serve_next_student()

      # 4. Final check of the queue
      campus_cafe.view_queue()

...
... ✓ Order placed for Alice: Iced Latte
✓ Order placed for Bob: Avocado Toast
✓ Order placed for Charlie: Blueberry Muffin

--- Current Queue (3 orders) ---
1. Alice - Iced Latte
2. Bob - Avocado Toast
3. Charlie - Blueberry Muffin
-----
─ ┌─ Serving Alice's Iced Latte...
─ ┌─ Alice has been served.
─ ┌─ Serving Bob's Avocado Toast...
─ ┌─ Bob has been served.

--- Current Queue (1 orders) ---
1. Charlie - Blueberry Muffin
-----
```

## EXPLANATION:

This system is designed to handle high-traffic campus operations by prioritizing data integrity and processing speed. By matching specific real-world tasks to optimized data structures, we ensure the software remains responsive even during peak hours, like class transitions or lunch breaks.

## Logic Breakdown

- Efficiency: Using structures like Hash Maps for attendance and Queues for the cafeteria ensures that as the student body grows, the system's response time remains nearly instantaneous (constant time complexity).
- Reliability: The use of Sets for event registration prevents "double-booking" errors at the data level, reducing the need for complex manual checks.
- Flow Control: The FIFO (First-In, First-Out) logic implemented in the cafeteria code ensures a fair, chronological service order, which is the standard requirement for any physical or digital waiting line.