



UNIVERSITY of  
RWANDA

**NAMES: DUFITIMANA Olivier**

**Student number: 224005582**

**BIT YEAR TWO**

**BIT-DATA STRUCTURE EXERCISES – NUMBER 2**

Data structure is defined as the way the data is organized, managed, and stored so that it can be accessed and modified efficiently. Just like how books are arranged in a library. Data structure helps computer easy to store and process data quickly.

**PARTS I- STACK**

**A. Basics**

A1: Push/Pop (LIFO) in a Payment App: in the mtn MOMO app when you fill payment details step-by-step, pressing back removes the last step: this shows nature of a stack because the most recent action (the last step added) is the first to be “popped” off the stack. A stack is a Last-In, First-Out (LIFO) data structure, where the last item added is the first one to be removed. This principle can be seen in various real-world situations.

A2: Pop (Undo) in a Learning Platform: Navigating course modules in UR Canvas and pressing the back button to “undo” the last step is similar to a pop operation on a stack. Each new module view is “pushed” onto a stack, and the back button “pops” the top item, returning the user to the previous view.

**B. Application**

A3: Enabling an “Undo” Function: A stack can enable an undo function for correcting mistakes in an application like BK Mobile Banking. Each transaction or action a user performs is pushed

onto a stack. To undo a mistake, the application simply pops the most recent action from the top of the stack, effectively reversing it.

A4: Balanced Parentheses Check: Stacks are used to ensure forms are correctly balanced, as seen in Irembo registration forms. An opening bracket or a data entry field is pushed onto the stack, and when its matching closing bracket or field is found, it is popped. If the stack is empty at the end, the form is balanced; otherwise, it is not.

### **C. Logical**

#### Stack-Based Logical and Advanced Concepts

A5: Sequence of Push and Pop: Consider a student's tasks on a stack: Push("CBE notes"), Push("Math revision"), Push("Debate"), Pop(), Push("Group assignment"). The last task added, "Group assignment," is at the top of the stack and is the next to be removed.

A6: Undo with Multiple Pops: If a student undoes three recent actions during an ICT exam, the last three items are popped from the stack. The remaining items on the stack are the answers that were recorded before the three most recent ones.

### **D. Advanced thinking**

A7: Pop to Backtrack: In a Rwanda Air booking form, a stack can enable a user to go back step-by-step. Each step a user takes is pushed onto a stack. When they press the back button, the last step is popped, and the system returns to the state of the previous item on the stack.

A8. Push words, then pop to verse: To reverse the proverb "Umwana ni umutware," each word is pushed onto a stack in the order it appears. The words are then popped one by one. Since a stack is LIFO, the last word pushed ("umutware") is the first to be popped, resulting in the reversed proverb: "Umutware ni Umwana".

A9. DFS using a stack: A stack is better suited for a deep search (DFS) of a library's shelves than a queue. A stack's LIFO nature means it prioritizes exploring one path or branch as deeply as possible before backtracking. A queue, which is First-In, First-Out (FIFO), would be better for a breadth-first search, where all items at one level are explored before moving to the next level.

A10. Push/pop for Navigation: A feature using stacks for transaction navigation in an app like BK Mobile could be a "Go Back to Previous State" button. When a user navigates from a transaction list to view a specific transaction, the list state is pushed onto a stack. If they view another transaction, that state is also pushed. The "Go Back" button would pop the current state, returning the user to the previous screen.

## **PARTS II-QUEUE**

### **Introduction to Queues**

A queue is a First-In, First-Out (FIFO) data structure, where the first item added is the first one to be removed. This is like a line of people waiting for service.

#### **A. Basics**

A1. Enqueue (add at rear), Dequeue (remove from front): At a restaurant in Kigali, customers are served in the order they arrive. This is a perfect example of FIFO behavior, as the first person in line is the first person to be served. In a queue, an item is added at the rear (end) of the line, which is called an enqueue operation, and an item is removed from the front of the line, which is a dequeue operation.

A2. Dequeue (next items leaves first.): A YouTube playlist, where the next video plays automatically, is also an example of a dequeue operation, as the video at the front of the playlist is the next to be removed and played.

### **Queue-Based Applications and Concepts**

#### **B. Application**

A3. Enqueue (job submission): The line of people waiting to pay taxes at RRA offices is a real-life example of a queue. Each person is enqueued as they arrive and dequeued when they are served. A4. Queue management:

Improving Customer Service: Queues improve customer service at places like MTN/Airtel service centers by ensuring that SIM replacement requests are processed in the order they are received. This provides a fair and predictable system, reducing waiting time uncertainty and perceived unfairness.

#### **C. Logical**

A5. Sequence of Enqueue/Dequeue: In a sequence of bank operations: Enqueue("Alice"), Enqueue("Eric"), Enqueue("Chantal"), Dequeue (), Enqueue("Jean"). After Alice is dequeued, Eric is at the front of the queue.

A6. FIFO message handling

Fairness in Handling Applications: A queue ensures fairness in handling RSSB pension applications by processing them strictly in the order of arrival. This guarantees that no application can jump the line, promoting a fair and transparent system.

## **D. Advanced thinking**

### **A7. Different Queue Types:**

**Linear Queue:** A line of people at a wedding buffet is a linear queue. They move in a straight line from the start to the end of the line.

**Circular Queue:** Buses looping at Nyabugogo bus station can be modeled as a circular queue. When a bus leaves, the empty space can be filled by another bus, creating a continuous loop of service.

**Deque:** A bus allows boarding from both the front and rear, which is an example of a double-ended queue (deque). Items can be added or removed from both ends.

### **A8. Enqueue orders, dequeue when ready**

**Modeling Restaurant Orders:** A queue can model a restaurant's order process by using an enqueue operation for each customer's food order and a dequeue operation when the food is ready and the customer is called.

**A9. Priority Queue:** At CHUK hospital, emergencies are treated as a priority queue because they are served immediately, regardless of their arrival time. Unlike a normal queue, a priority queue processes items based on their urgency or importance, not just their arrival order.

**A10. Enqueue /dequeue Matching System :** Queues can fairly match drivers and students in a taxi app. Drivers waiting for a passenger are enqueued in the order they become available. When a student requests a ride, the driver at the front of the queue is dequeued and matched with the student.