UNIVERSITY of RWANDA

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SCHOOL OF BUSINESS AND ECONOMICS

DEPARTMENT OF BUSINESS INFORMATION AND TECHNOLOGY

MODULE: DATA STRUCTURE AND ALGORITHMS

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Assignment 1

STACK (Understanding Through Real-Life Applications)

Stacks are linear data structures that follow the **Last In, First Out (LIFO)** principle. Think of a stack like a pile of plates: the last plate placed on top is the first one you remove.

A. Basics

1. **Push/Pop (LIFO) MTN MoMo App**
   - **Concept**: In LIFO, the last item added is the first removed.
   - **Example**: When filling payment details step-by-step in MTN MoMo, pressing "Back" removes the most recent step.
   - **Q1** *How does this show the LIFO nature of stacks?*
   - **Answer**: This mirrors LIFO because the last action (e.g., entering amount) is undone first, just like popping the top of a stack.
2. **Pop (Undo) UR Canvas**
   - **Concept**: Pop removes the top item, often used for undo operations.
   - **Example**: Navigating course modules and pressing "Back" undoes the last navigation.
   - **Q2** *Why is this action similar to popping from a stack?*
   - **Answer**: It's like popping from a stack because each navigation step is added to the top, and undoing removes the most recent one.

B. Application

3. **Push (Add to Stack) BK Mobile Banking**
   - **Concept**: Each transaction is pushed onto the stack.

Q3 *How could a stack enable the undo function when correcting mistakes?*

Answer: To undo a mistake, the app could pop recent transactions from the stack, allowing users to reverse actions step-by-step.

4. **Balanced Parentheses Check Irembo Forms**
   - **Concept**: Push opening brackets, pop when matching closing brackets appear.
   - **Q4** *How can stacks ensure forms are correctly balanced?*
   - **Answer**: Stacks help ensure that every opening field (like a bracket) has a matching closing field, preventing mismatched or incomplete forms.

C. Logical Thinking

5. **Push and Pop Sequence; Student Tasks**

- **Sequence**: Push ("CBE notes"), Push ("Math revision"), Push("Debate"), Pop (), Push ("Group assignment")
- **Q5** *Which task is next (top of stack)?*
- **Answer**: After popping "Debate", the top becomes "Math revision". Then "Group assignment" is pushed, making it the new top.

  Top of stack: "Group assignment"

6. **Undo with Multiple Pops; ICT Exams**

- **Scenario**: Undoing 3 actions means popping 3 items.
- **Q6** *Which answers remain in the stack after undoing?*
- **Answer**: The earlier actions remain untouched. If the stack had 5 actions, only the last 3 are removed.

  Remaining: First 2 actions

D. Advanced Thinking

7. **Pop to Backtrack; RwandAir Booking**

- **Concept**: Each form step is pushed; going back pops the last step.
- **Q7** *How does a stack enable this retracing process?*
- **Answer**: Stacks allow retracing by popping each step, returning to the previous one in reverse order of entry.

8. **Reverse Words "Umwana ni umutware"**

- **Algorithm**:
  - Push each word: "Umwana", "ni", "umutware"
  - Pop each word: "umutware", "ni", "Umwana"

Q8 *Show how a stack algorithm reverses the proverb.*
Answer: Reversed proverb: **"umutware ni Umwana"**

9. **DFS with Stack; Kigali Public Library**

- **Concept**: Depth-First Search (DFS) explores deeply before backtracking.
- **Q9** *Why does a stack suit this case better than a queue?*
- **Answer**: A stack suits DFS because it allows diving into one shelf deeply, then backtracking step-by-step, unlike a queue which explores broadly.

10. **Navigation with Push/Pop; BK Mobile App**

- **Feature Suggestion**:

  - Each transaction viewed is pushed onto a stack.
  - Pressing "Back" pops the last viewed transaction.
  - Users can retrace their navigation history efficiently.
- **Q10** *Suggest a feature using stacks for transaction navigation.*
- **Answer**: This stack-based navigation lets users revisit previous transactions in reverse order, enhancing usability.

QUEUE; (Real-Life Applications of FIFO Logic)

Queues follow the **First In, First Out (FIFO)** principle: the first item added is the first one removed. Eg; a line at a bank or restaurant; people are served in the order they arrive.

A. Basics

1. **Enqueue/Dequeue; Kigali Restaurant**

- **Concept**: Enqueue adds to the rear, Dequeue removes from the front.
- **Q1** *How does this show FIFO behavior?*
- **Answer**: Customers are served in the order they arrive, showing FIFO behavior; the first customer to enter is the first to be served.

2. **Dequeue; YouTube Playlist**

- **Concept**: The next item in line is played automatically.
- **Q2** *Why is this like a dequeue operation?*
- **Answer**: This is like a dequeue because the first video in the playlist is removed (played) before the next one, just like removing the front item in a queue.

B. Application

3. **Enqueue; RRA Tax Line**

- **Q3** *How is this a real-life queue?*
- **Answer**: People waiting to pay taxes form a queue. Each person joins at the rear and is served in order; a classic real-life queue.

4. **Queue Management; MTN/Airtel Service Centers**

- **Q4** *How do queues improve customer service?*
- **Answer**: Requests are handled in arrival order, reducing confusion and ensuring fairness. Queues improve customer service by organizing flow and minimizing wait-time disputes.

C. Logical Thinking

5. **Sequence; Equity Bank**

- **Operations**: Enqueue("Alice"), Enqueue("Eric"), Enqueue("Chantal"), Dequeue(), Enqueue("Jean")
- **Q5** *Who is at the front now?*
- **Answer**: After dequeuing "Alice", the front becomes "Eric".
  Front of queue: Eric

6. **FIFO Message Handling; RSSB Applications**

- **Q6** *Explain how a queue ensures fairness.*
- **Answer**: Applications are processed in the order they arrive, ensuring fairness. No one skips ahead; everyone is treated equally based on submission time.

D. Advanced Thinking

7. **Queue Types in Rwandan Life**

- **Linear Queue**: People at a wedding buffet; they move forward one by one.
- **Circular Queue**: Buses at Nyabugogo loop through stops and return to the start.
- **Deque (Double-Ended Queue)**: Boarding a bus from either front or rear; passengers can enter or exit from both ends.
- **Q7** *Explain how each map to real Rwandan life*
- **Answer**: These examples show how different queue types manage flow and access in daily life.

8. **Order Processing; Kigali Restaurant**

- **Q8** *How can queues model this process?*
- **Answer**: Customers place orders (enqueue), and when food is ready, they're called (dequeue). This models a queue where service is based on order time.

9. **Priority Queue; CHUK Hospital**

- **Q9** *Why is this a priority queue, not a normal queue?*
- **Answer**: Emergencies are treated first, regardless of arrival time. This overrides FIFO; urgent cases jump the line, making it a **priority queue**.

10. **Matching System; Moto/E-bike Taxi App**

- **Q10** *How would queues fairly match drivers and students?*
- **Answer**: Riders (drivers) and passengers (students) are matched in order. When a student requests a ride, the first available driver in the queue is assigned. This ensures fairness and efficiency — no driver or student is skipped unless priority rules apply.