UNIVERSITY OF RWANDA
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Module of Data structure and algorithm

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STACK

A. Basics

1. The MTN MoMo app shows the LIFO (Last-In, First-Out) nature of stacks because the last step of the payment process is the first one removed when you press the back button.
2. The **back** action in UR Canvas is similar to popping from a stack because it removes the most recently viewed modules, which is at the top of the history stack.

B. Application

3. A stack can enable an undo function by pushing each completed action into the stack. When you need to correct a mistake, the pop operation removes the last action effectively undoing it.

4. Stacks can ensure forms are correctly balanced by using a matching system. An opening bracket is pushed into the stack and when a matching closing bracket is found the item is popped, A balanced form will have an empty stack at the end.

C. Logical

5. After the given sequence, the task at the top of the stack is "Group assignment". The sequence is:

Push("CBE notes")

Push("Math revision")

Push("Debate")

Pop()

Push("Group assignment")

6. The specific answers remaining in the stack depend on the full sequence, but the last three answers that were added to the stack are the ones that are removed when the student undoes 3 recent actions.

D. Advanced Thinking

7. A stack enables this retracing by pushing each step of the form onto the stack. To go back, the application pops the current step, revealing the previous step now at the top of the stack.

8. The algorithm reverses the proverb **Umwana ni umutware** by pushing each word into a stack in order:

Push("Umwana")

Push("ni")

Push("umutware")

When the words are then popped, they come off in reverse order: **umutware ni Umwana**.

9. A stack is better for a deep search (Depth-First Search or DFS) because it allows the student to explore one shelf (path) completely before backtracking (popping) to explore another. A queue would check every shelf at a given depth before moving deeper.

Q10: A feature using stacks could be a "transaction filter undo" button. Each time a filter is applied (e.g., "by date," "by type"), it's pushed onto a stack. The user can then pop off the last applied filter to undo it, one by one.

QUEUE

A. Basics

1. The restaurant service shows FIFO (First-In, First-Out) behavior because customers are served in the exact order they arrive and join the line.

2. This is like a dequeue operation because the next video in the playlist (the one at the front of the queue) is automatically removed and played.

B. Application

3. The line of people at RRA offices is a real-life queue. New people enqueue at the end, and the person at the front is the first to be dequeued (served).

4. Queues improve customer service by ensuring that requests are processed in a fair and orderly FIFO manner, preventing customers from being skipped or having to wait for a random length of time.

C. Logical

5. After the operations, Eric is at the front of the queue. The sequence is:
Enqueue("Alice")

Enqueue("Eric")

Enqueue("Chantal")

Dequeue()

(removes Alice)

Enqueue("Jean").

The remaining queue is **"Eric," "Chantal," "Jean."**

6. A queue ensures fairness in RSSB applications by processing them based on their arrival time. The FIFO principle guarantees that the earliest application submitted will be processed first, preventing any unfair skipping or prioritization.

D. Advanced Thinking

7. A Linear queue is like people in a wedding buffet line; they join at the back and are served at the front.

A Circular queue is like buses at Nyabugogo; they loop around, so the back of the line can connect to the front.

A Dequeue (double-ended queue) is like a bus where passengers can get on or off from both the front and the rear.

8. Queues can model this process by enqueuing customer orders as they are placed. The food is prepared in that order, and the customer is called when their order is dequeued and ready.

9. This is a priority queue because patients are not served in the order of their arrival. Emergencies are given a higher priority and jump to the front of the line, which is the defining characteristic of a priority queue.

10. Queues can be used to fairly match riders and passengers by using two queues: one for waiting moto/e-bike drivers and one for waiting students. The system would dequeue the first available driver and the first available student, creating a fair FIFO matching system.