NDARIHORANYE Thierry

Reg No 224008249

BIT

Year 2

Data structure and Algorithms

A. <u>STACKS</u>

A stack is a linear data structure that follows the Last-In-First-Out (LIFO) principle. In the MTN MoMo app, when you fill payment details step-by-step, pressing back removes the last step *182*1*1*number*amount*Pin#.

Think of it like a stack of pancakes - you can only add or remove pancakes from the top.

In the MTN MoMo app, each step in the payment process is added to a stack. When you press back, the most recent step (the last one added) is removed first, demonstrating the Last-In-First-Out (LIFO) principle of stacks. .

A stack is a data structure that can hold many elements, and the last element added is the first one to be removed.

Like a pile of pancakes, the pancakes are both added and removed from the top. So when removing a pancake, it will always be the last pancake you added. This way of organizing elements is called LIFO: Last In First Out.

Basic operations we can do on a stack are:

- **Push:** Adds a new element on the stack.
- **Pop:** Removes and returns the top element from the stack.
- **Peek:** Returns the top (last) element on the stack.
- **Is Empty:** Checks if the stack is empty.
- **Size:** Finds the number of elements in the stack.

Reasons to implement stacks using lists/arrays:

- ✓ **Memory Efficient:** Array elements do not hold the next elements address like linked list nodes do.
- ✓ **Easier to implement and understand:** Using arrays to implement stacks require less code than using linked lists, and for this reason it is typically easier to understand as well.

LogicalOperation: Push and Pop sequence. student records tasks in a stack: Push("CBE notes"), Push("Math revision"),Push("Debate"), Pop(), Push("Group assignment") After the sequence, the top of the stack is "Group assignment.

Operation: Undo with multiple Pops. During ICT exams, a student undoes 3 recent actions, After undoing three actions, the remaining answers are the ones that were added to the stack before the last three actions.

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B. Queues

A queue is a linear data structure that follows the First-In-First-Out (FIFO) principle.

Think of a queue as people standing in line in a supermarket. The first person to stand in line is also the first who can pay and leave the supermarket.

Enqueue (add at rear), Dequeue (remove from front). At a restaurant in Kigali, customers are served in order. Customers are served in the order they arrive, demonstrating the First-In-First-Out (FIFO) principle of queues.

Operation: Dequeue (next item leaves first). In a YouTube playlist, the next video plays automatically. The next video is played in the order it was added to the playlist, similar to the dequeue operation where the first item added is the first to be removed.

Application, Operation: Enqueue (job submission).At RRA offices, people waiting to pay taxes form a line. People are served in the order they arrive, following the FIFO principle of queues.

Enqueue management: In MTN/Airtel service centers, SIM replacement requests are processed in order. Queues ensure that requests are handled in the order they are received, promoting fairness and efficiency in customer service.

Logical

Operation: Sequence of Enqueue/Dequeue.In Equity Bank, operations are:Enqueue(“Alice”), Enqueue(“Eric”), Enqueue(“Chantal”), Dequeue(), Enqueue(“Jean”) After the sequence, "Eric" is at the front of the queue.

Operation: FIFO message handling, By processing applications in the order they are received, queues ensure that each applicant is treated fairly and without bias. RSSB pension applications are handled by arrival order.

Operation: Enqueue/Dequeue matching system. In a moto/e-bike taxi app, riders wait for passengers. Riders are enqueued as they request a ride, and passengers are dequeued and matched with the next available rider, ensuring a fair and orderly matching process.

Addition information

- **Enqueue:** Adds a new element to the queue.
- **Dequeue:** Removes and returns the first (front) element from the queue.
- **Peek:** Returns the first element in the queue.
- **Is Empty:** Checks if the queue is empty.
- **Size:** Finds the number of elements in the queue.

References:

"Introduction to Algorithms" by Thomas H. Cormen

"Data Structures and Algorithms in Python" by Michael T. Goodrich

GeeksforGeeks: Stack and Queue implementations in various programming languages.