Project Documentation: Data Structures GUI Application

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Introduction

This project is a graphical user interface (GUI) application designed to demonstrate various data structures and their operations, including arrays, stacks, queues, circular queues, and linked lists. The application allows users to interact with each data structure through dedicated frames for managing and visualizing operations. The application is developed using swings and windows builder plugin.

Project Structure

The project comprises multiple JFrame classes, each representing a different data structure and its functionalities:

- Main JFrame
- Array Operations JFrame
- Stack Operations JFrame
- Queue Operations JFrame
- Circular Queue Operations JFrame
- Linked List Operations JFrame

1. Main JFrame

Purpose: Serves as the entry point for the application, providing navigation to other data structure operations.

UI Components:

Buttons:

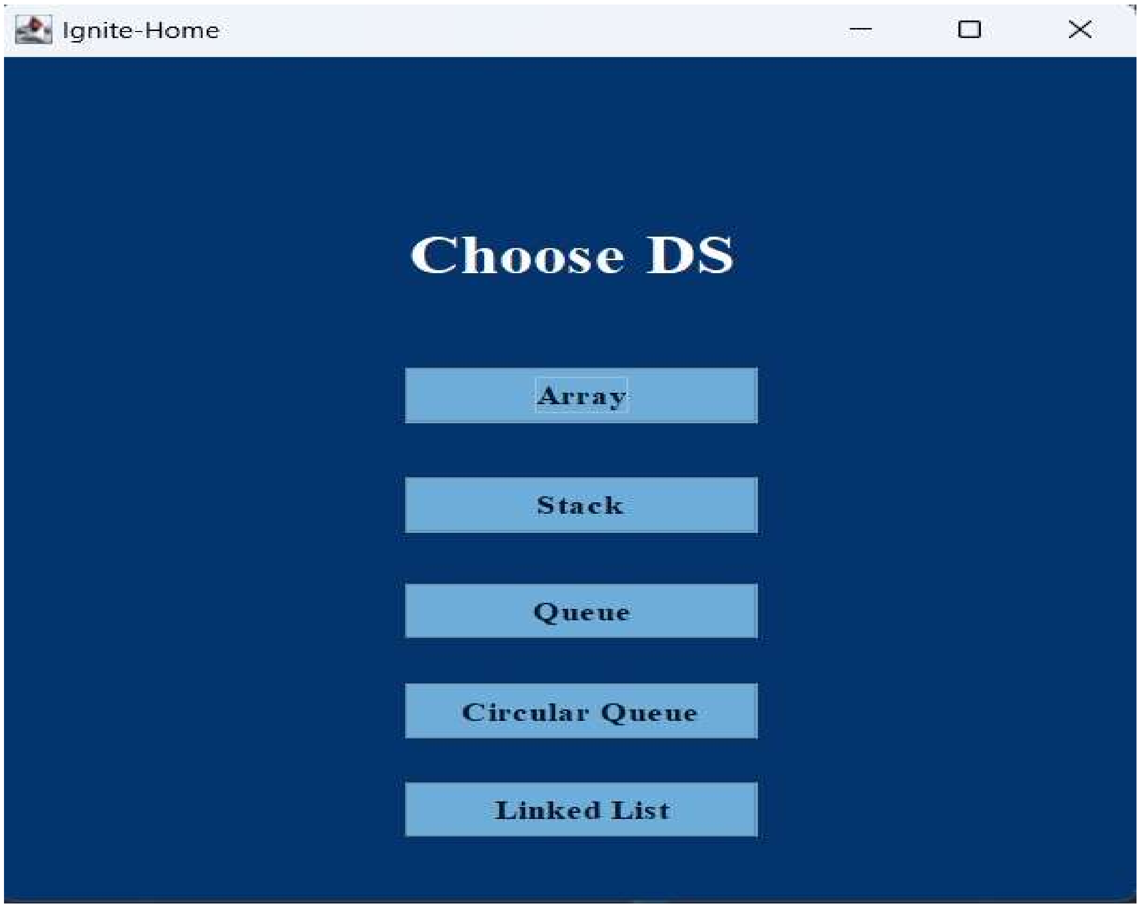
Array: Navigates to the Array Operations JFrame.

Stack: Navigates to the Stack Operations JFrame.

Queue: Navigates to the Queue Operations JFrame.

Circular Queue: Navigates to the Circular Queue Operations JFrame.

Linked List: Navigates to the Linked List Operations JFrame.



Functionality: Each button redirects the user to its corresponding data structure's JFrame, allowing users to explore various data structure operations.

2. Array Operations JFrame

Purpose: Manages an array to perform various operations such as setting its size, inserting elements, deleting elements, and displaying the array contents.

UI Components:

Input Fields:

textSize: A text field for entering the size of the array.

textElement: A text field for entering the value to be inserted into the array.

textDelete: A text field for entering the index of the element to be deleted from the array.

textPosition: A text field for specifying the position at which to insert a new element.

Buttons:

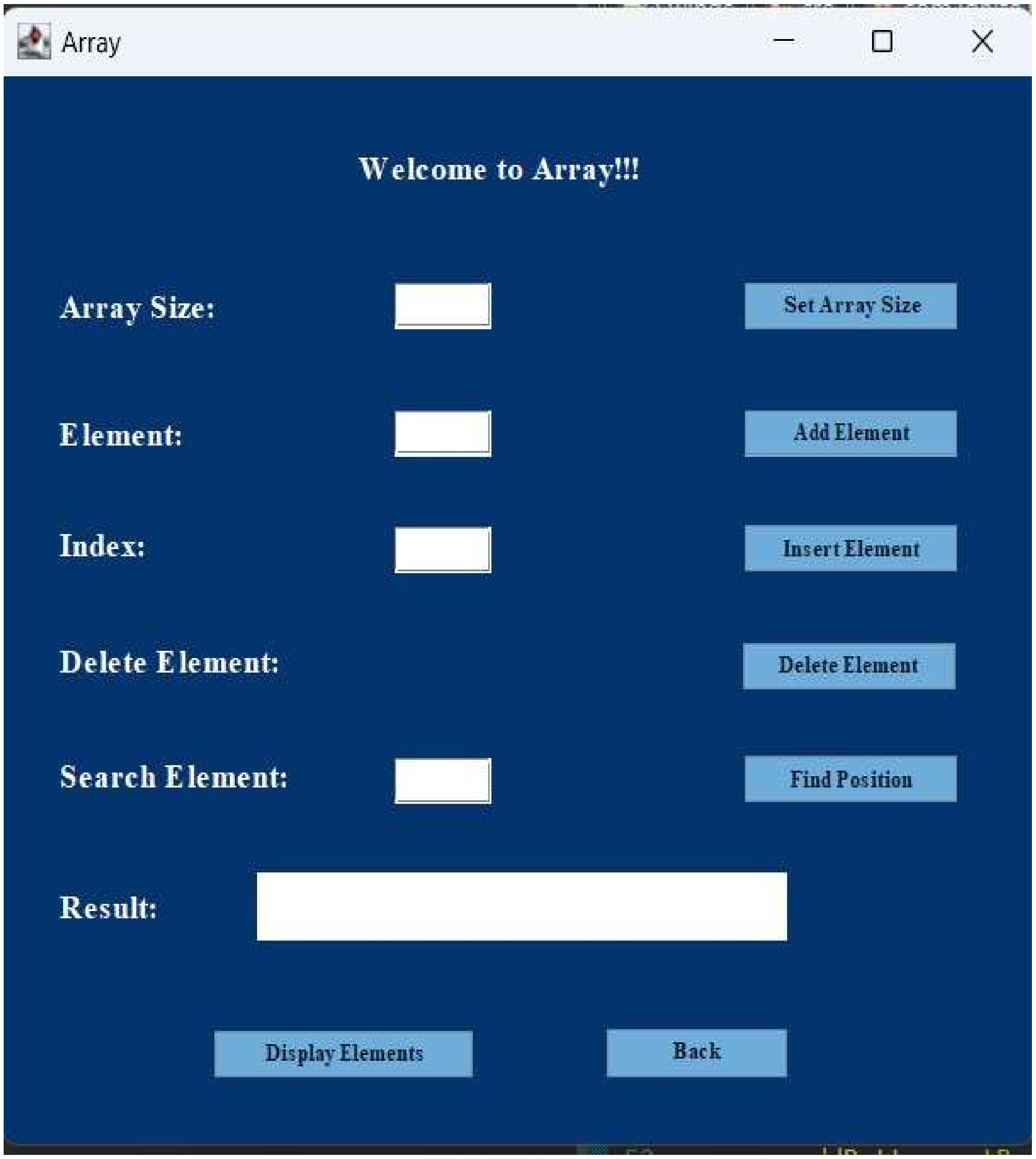
Set Size: Initializes the array with the specified size.

Insert: Adds an element at a specified position in the array.

Delete: Removes an element from a specified index.

Display: Displays all elements in the array.

Back: Returns to the Main JFrame.



Functionality:

Set Size: The user inputs the desired size of the array in the textSize field. Clicking this button initializes the array with the specified size and sets the current size to zero.

Insert: The user can enter a value in the textElement field and specify the position in the textPosition field. When this button is clicked, the application adds the element at the specified index, shifting subsequent elements if necessary. If the array is full or if the position is invalid, an error message is displayed.

Delete: By entering an index in the textDelete field, the user can remove an element from that index in the array. The application will check for valid index values and provide feedback if the index is out of bounds. Upon deletion, the elements are shifted left to fill the gap.

Display: Clicking this button presents all elements in the array in a readable format. If the array is empty, a corresponding message is displayed to inform the user.

3. Stack Operations JFrame

Purpose: Implements a stack data structure to manage a collection of elements in a last-in, first-out (LIFO) manner.

UI Components:

Text Field:

textElement: For entering values to add to the stack.

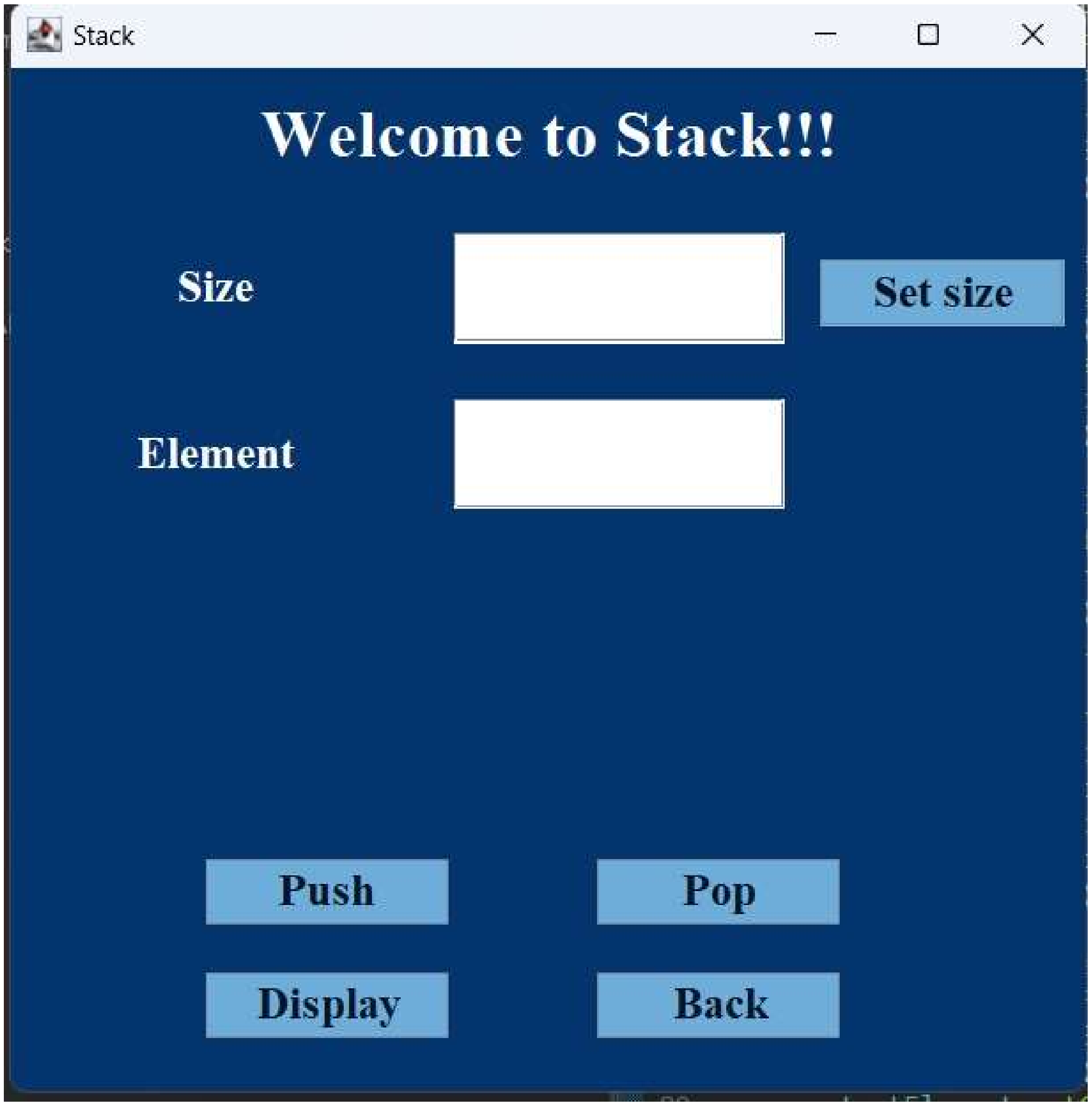
Buttons:

Push: Adds an element to the top of the stack.

Pop: Removes the top element from the stack.

Display: Lists all elements in the stack.

Back: Returns to the Main JFrame.



Functionality:

Push: Inserts an element onto the top of the stack.

Pop: Removes and returns the top element from the stack.

Display: Shows all elements in the stack from top to bottom.

Boundary and Error Handling: Checks for empty stack conditions before pop operations and provides feedback on successful operations.

4. Queue Operations JFrame

Purpose: Implements a queue data structure to manage a collection of elements in a first-in, first-out (FIFO) manner.

UI Components:

Text Field:

textElement: For entering values to add to the queue.

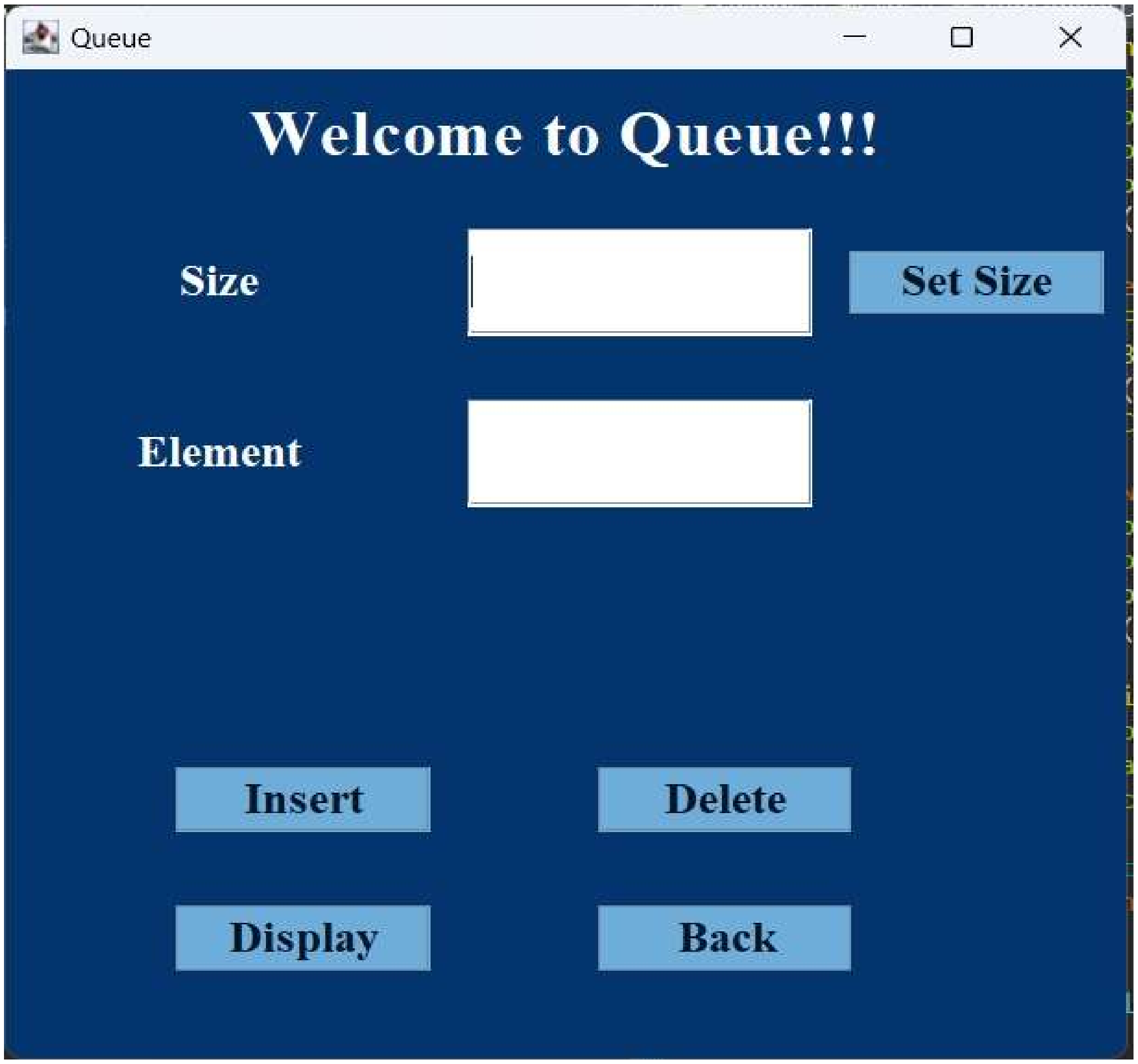
Buttons:

Enqueue: Adds an element to the rear of the queue.

Dequeue: Removes an element from the front of the queue.

Display: Lists all elements in the queue.

Back: Returns to the Main JFrame.



Functionality:

Enqueue: Inserts an element at the rear of the queue.

Dequeue: Removes and returns the front element from the queue.

Display: Shows all elements in the queue from front to rear.

Boundary and Error Handling: Ensures that dequeue operations cannot occur on an empty queue and notifies the user accordingly.

5. Circular Queue Operations JFrame

Purpose: Manages a circular queue, which utilizes a fixed-size array in a circular manner to optimize space.

UI Components:

Text Field:

textSize: For setting the size of the circular queue.

textElement: For entering values to add to the circular queue.

Buttons:

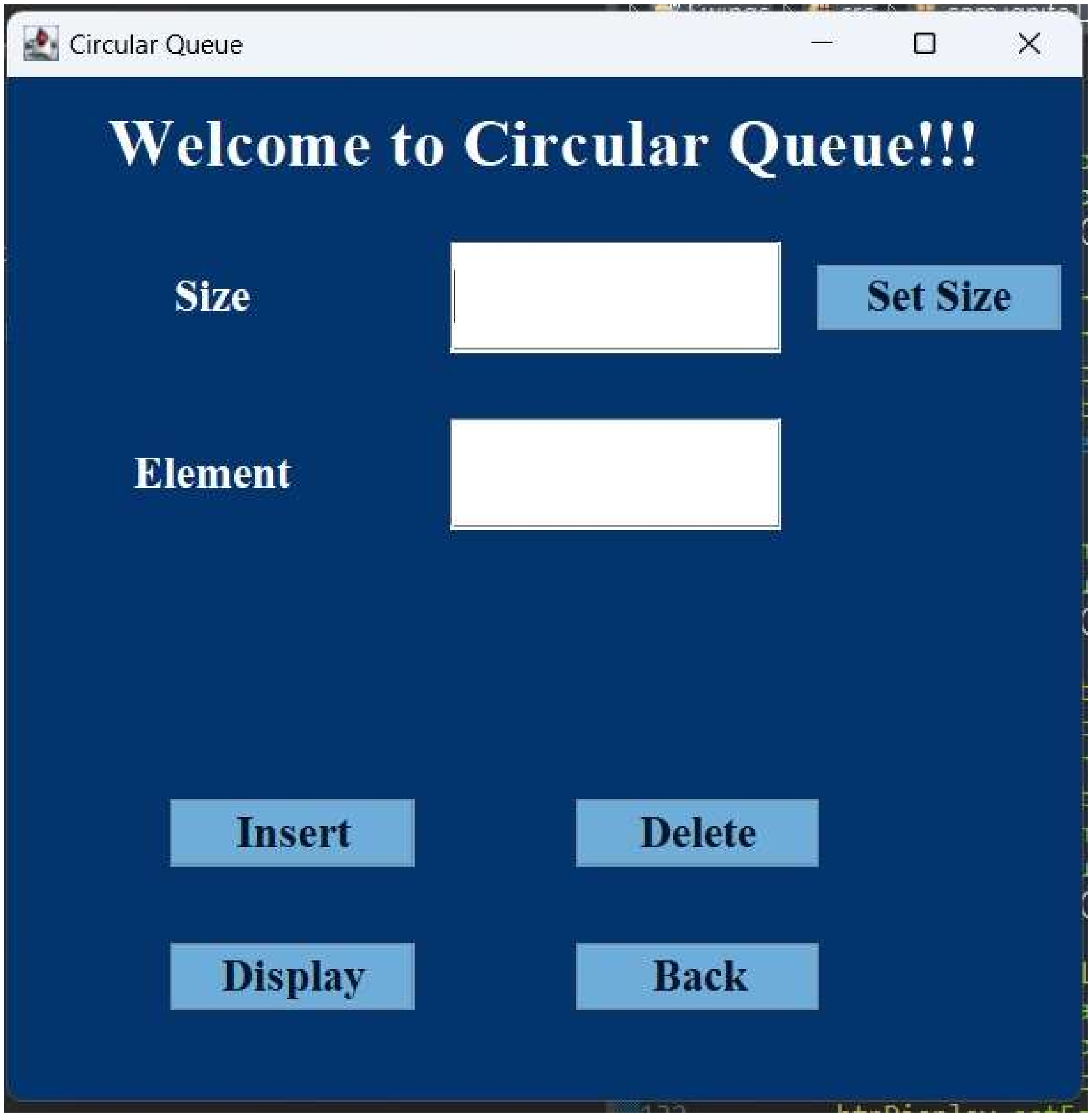
Set Size: Initializes the circular queue with the specified size.

Insert: Adds an element to the queue.

Delete: Removes an element from the queue.

Display: Lists all elements in the circular queue.

Back: Returns to the Main JFrame.



Functionality:

Set Size: Configures the circular queue size.

Insert: Adds an element at the rear, wrapping around if necessary.

Delete: Removes an element from the front of the queue.

Display: Shows all elements in the circular queue.

Boundary and Error Handling: Prevents insertion into a full queue and deletion from an empty queue, providing relevant feedback.

6. Linked List Operations JFrame

Purpose: Manages a singly linked list, allowing operations for inserting, deleting, and displaying nodes.

UI Components:

Text Field:

textElement: For entering values to add to the list.

Buttons:

Insert at Start: Adds a node at the beginning of the list.

Insert at End: Adds a node at the end of the list.

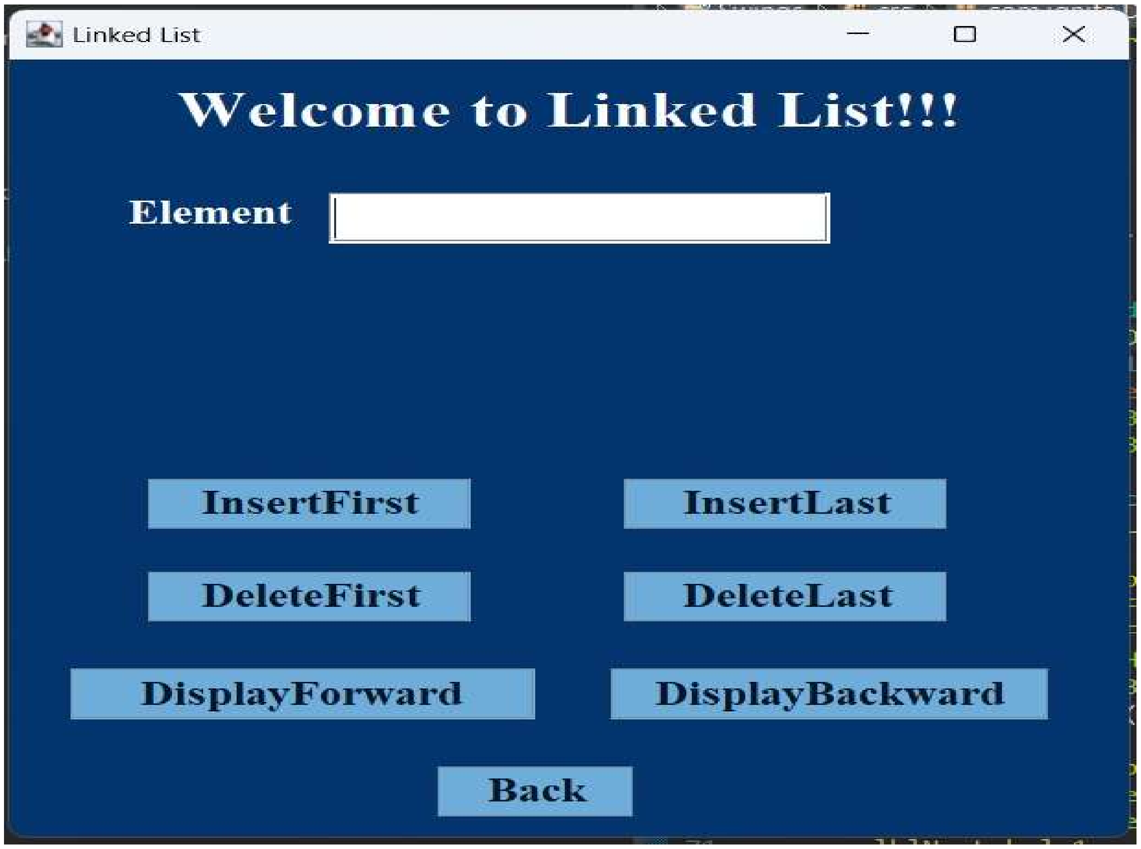
Delete from Start: Removes the node at the beginning of the list.

Delete from End: Removes the node at the end of the list.

Search: Finds and returns the position of a specific value in the linked list.

Display: Lists all nodes in the linked list in order.

Back: Returns to the Main JFrame.



Functionality:

Insert at Start: Adds a node to the head of the list.

Insert at End: Adds a node to the tail of the list.

Delete from Start: Removes the head node.

Delete from End: Removes the last node.

Search: Locates a specified value in the linked list.

Display: Shows all nodes from the start to the end of the list.

Boundary and Error Handling: Provides alerts for operations on an empty list and ensures correct feedback for all operations.

Application Workflow

Launch the Application:

Run the main dashboard (IgniteDS JFrame), which displays buttons to select each data structure.

Choose a Data Structure:

Select any data structure by clicking its corresponding button, which opens a dedicated JFrame for that structure.

Set Initial Parameters:

For each data structure, initialize it by setting its size (for stack, queue, and array) or simply start performing operations.

Perform Operations:

Execute operations like insert, delete, display, and search based on the chosen data structure.

Return to Main Dashboard:

Use the Back button in any JFrame to return to the main IgniteDS dashboard and switch to another data structure as needed.

Technical Implementation Details

Core Data Structures and Functional Logic

Array:

Basic array structure with methods for insertion, deletion, search, and display.

Stack:

Implements stack operations using an array, with boundary checks for overflow and underflow.

Queue:

Implements queue operations using an array, with boundary checks for overflow and underflow.

Circular Queue:

Uses modular arithmetic for circular indexing, making it efficient in fixed-size arrays.

Linked List:

Each node contains two pointers (next and previous) for bi-directional traversal, facilitating both front and end operations.

Error Handling and Boundary Conditions

Each structure includes validations:

Array: Checks for index bounds during insert, delete, and search operations.

Stack: Checks for full and empty stack conditions.

Circular Queue: Validates full and empty queue states before enqueue and dequeue.

Linked Lists: Ensures lists are not empty before deletion and checks for successful insertion.

Design and UI

Color Theme: Consistent use of colors across the interface to differentiate sections and improve readability.

Font and Button Design: Fonts and button sizes are maintained for uniformity and clear identification.

Messages and Notifications: Informative labels provide feedback after each operation, helping users understand the results and any errors.

Possible Future Enhancements

Additional Data Structures: Expand with binary trees, hash tables, or other advanced structures.

Dynamic Resizing: Implement dynamic resizing for array and circular queue when capacity limits are reached.

Graphical Visualization: Add animations or visual cues to represent stack growth, queue wrap-around, or node links in linked lists.