Stacks and Queues

CS 206 - Introduction to Data Structures

Assignment 4 - due Thursday 2/28

1 Tasks

Before we start, it is important to note that you are not allowed to change the given Stack.java, ArrayStack.java, Queue.java, and Deque.java.

Part 1. Copy ArrayStack.java and Stack.java from ~dxu/handouts/cs206/code/lec09. Copy Queue.java from ~dxu/handouts/cs206/code/lec10. Write a class called TwoStacksQueue that implements the Queue interface as follows. Your class will store two ArrayStack objects as instance variables but no other. A TwoStacksQueue object is a Queue and should behave as a Queue (FIFO). Since you are using two stacks to simulate a Queue, it will certainly not be the most efficient implementation of a Queue and that’s ok - just as long as you know that and can analyze the runtime appropriately in the README - see below. There should not be any other array/ArrayList/linked list used within your implementation. Override toString for TwoStacksQueue to return a String that contains the contents of the current Queue in the following format (element1, element2, ..., elementn).

Your README should provide a discussion on the design of your data structure, in particular how you implemented enqueue and dequeue operations. In addition, you should provide a worse-case big-O analysis of each of these operations.

Part 2. Implement the Deque ADT (double-ended queue where we can insert and delete at both ends) with an array used in a circular fashion. Copy Deque.java from ~dxu/handouts/cs206/code/lec10, which specifies the the Deque interface that you must implement. Name your class ArrayDeque. Override toString for ArrayDeque to return a String that contains the contents of the current Deque in the following format (element1, element2, ..., elementn).
Study how we implemented the Queue ADT using a circular array for reference. You should find the discussion in Section 6.3 of your textbook helpful as well.

**Part 3.** Implement a new stack data structure (call it `NewStack`), storing integers, that supports the operations `push`, `pop` and an additional operation `minElement`, which returns the smallest element currently in the stack. All operations should run in $O(1)$ worst case time - note that this means no loops of any kind. Explain how your data structure works in your README and justify the $O(1)$. It is acceptable to write a non-generic `NewStack` that only stores integers and doesn’t implement the `Stack` interface. Override `toString` for `NewStack` to return a `String` that contains the contents of the current stack in the following format `(element1, element2, ..., elementn).

**Part 4.** Write a driver program `Main.java` that tests all the methods you have implemented in your `TwoStacksQueue`, `ArrayDeque`, `NewStack` implementations in above parts. You should include enough tests to clearly demonstrate that your implementation works.

## 2 Electronic Submissions

1. **README:** The usual plain text file `README`
   - **Your name:**
   - **How to compile:** Leave empty if it’s just `javac Main.java`
   - **How to run it:** Leave empty if it’s just `java Main`
   - **Known Bugs and Limitations:** List any known bugs, deficiencies, or limitations with respect to the project specifications. Documented bugs will receive less deduction versus uncaught ones.
   - **Write-up:** Contents as discussed above for Part 1 and 3

2. **Source files:** all `.java` files
3. **Data files used:** none

**DO NOT INCLUDE:** Please delete all executable bytecode (.class) files prior to submission.

To submit, store everything (README and source files) in a directory called `A4`. Then follow the directions here: https://systems.cs.brynmawr.edu/Submit_assignments