School of Computer Science

COMP SCI 1103/2103 Algorithm Design & Data Structure

Stacks, Queues and Linked Lists

Stacks - review

- LIFO

- Different implementations
  - Linked list implementation
  - Array implementation

- Both implementations can guarantee O(1) complexity for the basic operations.
  - push
  - pop
  - isEmpty

Applications of stacks

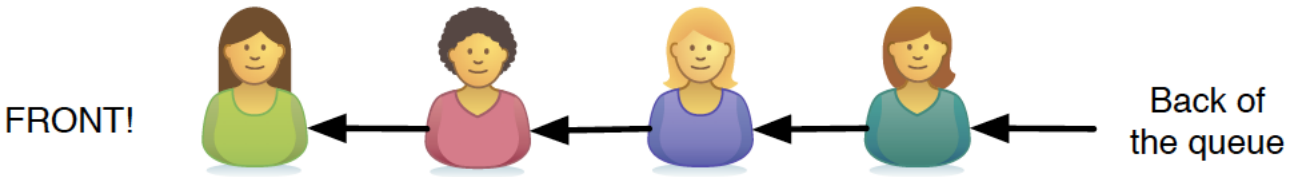
- Tracking function calls
- Postfix Expressions – find the result
  - Put input numbers in stack as you reach them
  - When you reach an operation in input string,
    - If there are less than the number of operands of that operation in stack, then error
    - Else apply the operation on them (top two for example) and push the result in stack
  - When you reach the end of input string,
    - If there are more than one elements in the stack then error
    - Else return the top of the stack
- Balancing Symbols

Balancing brackets pseudocode

```
Create an empty stack
While nextchar!= null
        If nextChar is left bracket
                Push nextChar on stack
        If nextChar is right bracket
                if stack is empty
                    error
                else
                    char= pop stack
                    If nextChar is the right counterpart of char
                            Nothing
                    Else
                            Error
If stack has element(s) left in it
        Error
```

Queue

- A queue is a data structure that retrieves data in the same order in which it was stored.
- You have access to the front of the queue, to remove things, and the back of the queue, to add things.
- This is called First-In/First-Out (FIFO).
- Think about the lineup at a coffee shop. You join the queue from the end of the queue and are served from the front of the queue.



Queue operations

- The operations associated with a queue are:
  - enqueue: add an element to the back of the queue
  - dequeue: remove the front element and return its value
  - isEmpty: return true if the queue is empty, false otherwise

- Any preconditions for dequeue?

Queue implementations

- Queues are very easy to implement in linked lists
  - enqueue: add a node to the end of the queue
    - If the list is initially empty, then both *end* and *front* need an update; otherwise, just the *end* pointer should be updated
  - dequeue: remove the node at the front, returns the value and destroys the old node, updating *front* to point to the new head.
    - Check first if it is empty. Moreover, if the list becomes empty, *end* pointer should also be updated.
  - isEmpty: check to see if *end* or *front* point to NULL.
- Queues can also be implemented using an array
  - A circular array implementation
  - We need to keep size, as well as start and end pointers
- Basic operations take O(1) for both linked list and array

Notes for queues

- Black box
  - Inside, we may have a linked list or an array
  - While the whole chain is contained, the functions that you use in this data structure restrict you to only accessing certain elements.
- This enforces the FIFO semantics of the data structure and this allows you to write your code knowing that this will be enforced.

Suitable abstractions assist programming

- Using the right ADT at the right time enforces correct behavior.
  - It's important that things don't jump the queue.
  - It's important that activation records don't get out of order in the stack.

- Applying an existing, well-understood solution to a problem:
  - Saves you time
  - Lowers the risk of incorrect code
  - Reduces the programmer's burden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