19CSE 111: Foundations of Data Structures

Lecture 5:Queues

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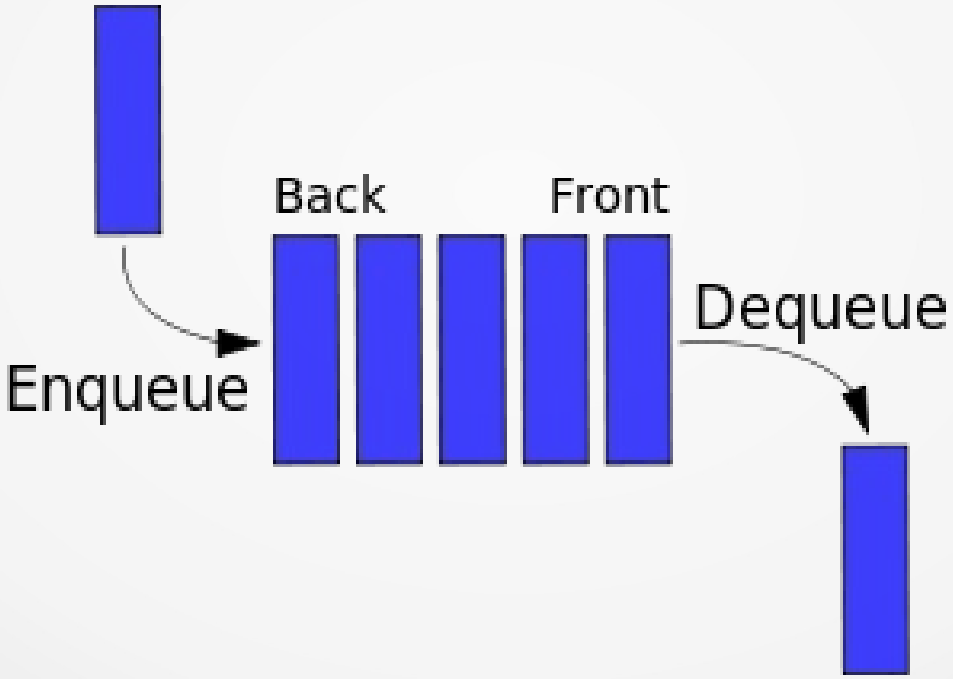
Queues

- It is a first-in-first-out abstract data type
- Applications in Real World
  - Transportation
  - Operations Research
  - Acts as buffer in many applications

Queues: An Overview

- Element that is inserted first is removed first
  - Insertions at the rear of the queue and deletions at the front of the queue



http://upload.wikimedia.org/wikipedia/commons/thumb/5/52/Data_Queue.svg/300px-Data_Queue.svg.png

Queue ADT: Main Operations

- enqueue(o)
  - Inserts an object o at the end of the queue
  - Input: object; Output: None
- dequeue()
  - Removes and returns the first element in the queue
  - Input: none; Output: object
  - Error occurs if queue is empty

Other Queue Operations

- size()
  - Returns the number of objects in the queue
- isEmpty()
  - Returns a Boolean indicating if the queue is empty
- front()
  - Return first element of the queue without removing it. Error occurs if queue is empty
  - Input: None; Output: Object

Queue Exceptions

- Some operations may cause an error causing an exceptions
- Exceptions in the Queue ADT
  - QueueEmptyException
    - dequeu() and front() cannot be performed if the queue is empty
  - QueueFullException
    - Occurs when the queue has a maximum size limit ie implemented with an array
    - enqueue(o) cannot occur when the queue is full

Queue Example

Operation	Output	Queue Contents
enqueue(5)	-	(5)
enqueue(3)	-	(5,3)
enqueue(7)	-	(5,3,7)
dequeue()	5	(3,7)
size()	2	(3,7)
enqueue(4)	-	(3,7,4)
dequeue()	3	(7,4)
dequeue()	7	(4)
size()	1	(4)
dequeue()	4	()
dequeue()	“error”	()

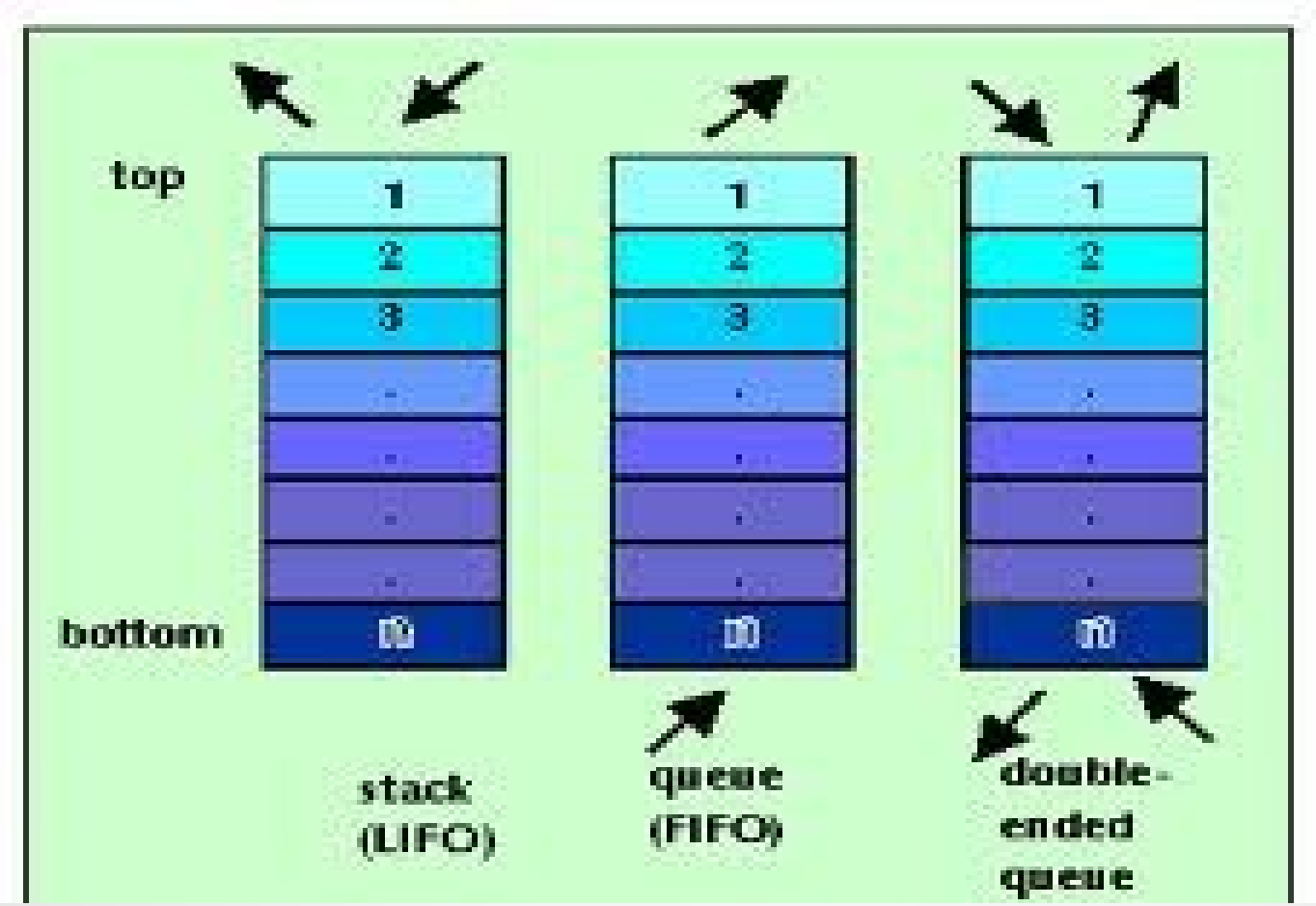
Exercise

- Describe the output of the following series of queue operations
  - enqueue(5),enqueue(3), dequeue(), enqueue(2), enqueue(8), dequeue(), dequeue(), isEmpty(), enqueue(9), enqueue(1), size(), dequeue(), enqueue(7), enqueue(6), front(), dequeue(), dequeue(), enqueue(4), dequeue(), dequeue()
- Show how to implement a queue using two stacks. Analyze the running time of the queue operations.

Exercises

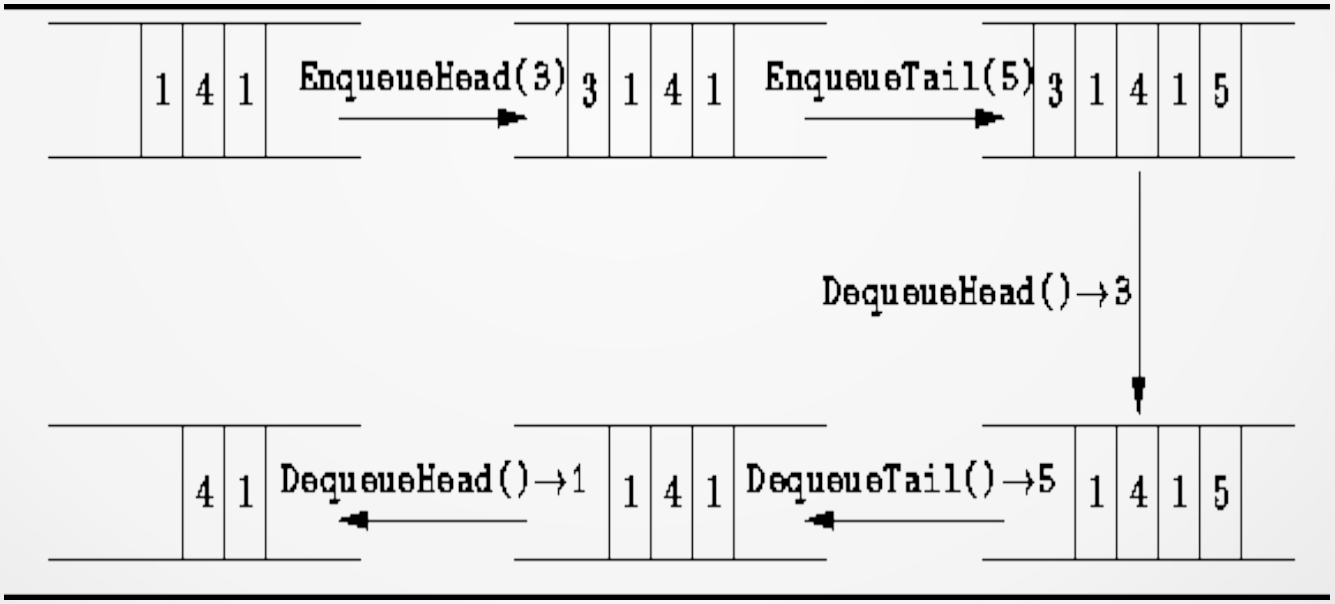
- Reverse the order of elements in a stack S using one additional queue
- Using additional non-array variables, order all elements on a queue using
  - Two additional queues
  - One additional queue

Double-Ended Queue



Double-Ended Queues

- It is a queue like data structure that supports insertion and deletion at both ends
  - Front and rear of the queue
- Also known as deque



http://www.brpreiss.com/books/opus4/html/img751.gif

Deque Abstract Data Type

- insertFirst(*o*)
  - Insert a new object *o* at the beginning of D
  - Input: Object; Output: None
- insertLast(*o*)
  - Insert a new object *o* at the end of D
  - Input: Object; Output: None
- RemoveFirst()
  - Remove the first object of D. Error occurs if D is empty
  - Input: None; Output: None
- RemoveLast()
  - Remove the last object of D. Error occurs if D is empty
  - Input: None; Output: None

Additional Deque functions

- first()
  - Return first object of D; error occurs if D is empty
  - Input: None; Output: Object
- last()
  - Return last object of D; error occurs if D is empty
  - Input: None; Output: Object
- size()
  - Returns the number of objects in D
- isEmpty()
  - Returns a Boolean indicating if D is empty