CISC 3115 TY3

C27a: Stack and Queue

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Outline

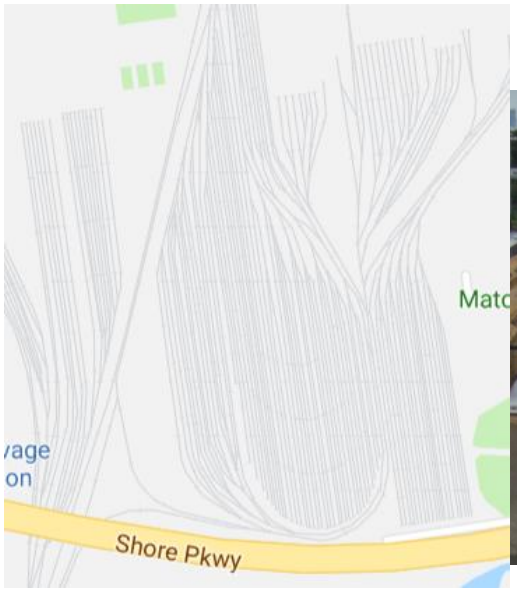
- Discussed
  - Concept of data structure
  - Use data structures
    - List
- To discuss
  - Stack
  - Queue and priority queue
  - Set and map

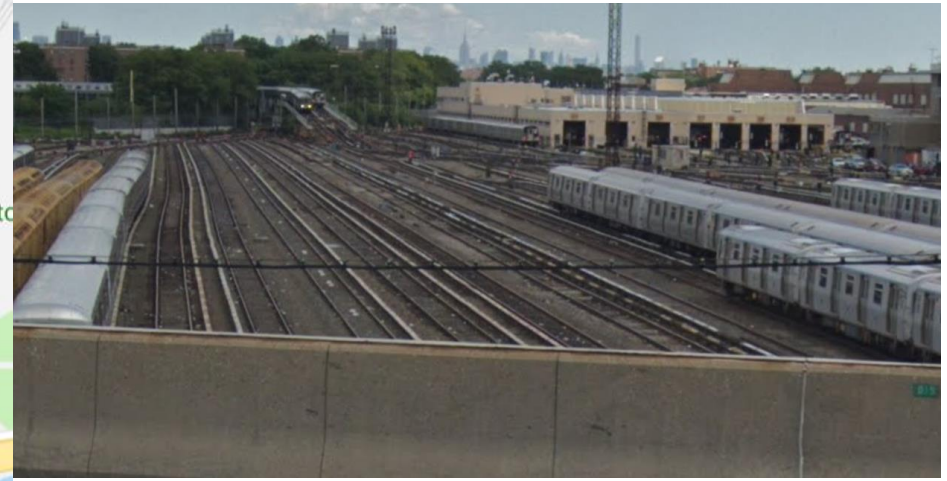
Outline of This Lecture

- Stack
- Queue
- Priority queue

The Stack Data Structure

- A data structure stores data in a last-in, first-out fashion



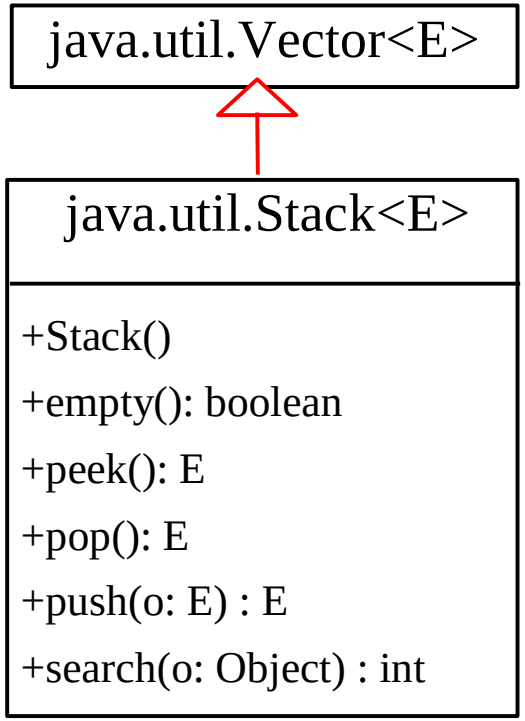


The Stack Class

- An implementation of the stack data structure in Java
- It represents a last-in-first-out stack of objects.
- The elements are accessed only from the top of the stack. (You can only retrieve, insert, or remove an element from the top of the stack.)

The Stack Class

- 5 methods added to Vector to implement a stack



Creates an empty stack.

Returns true if this stack is empty.

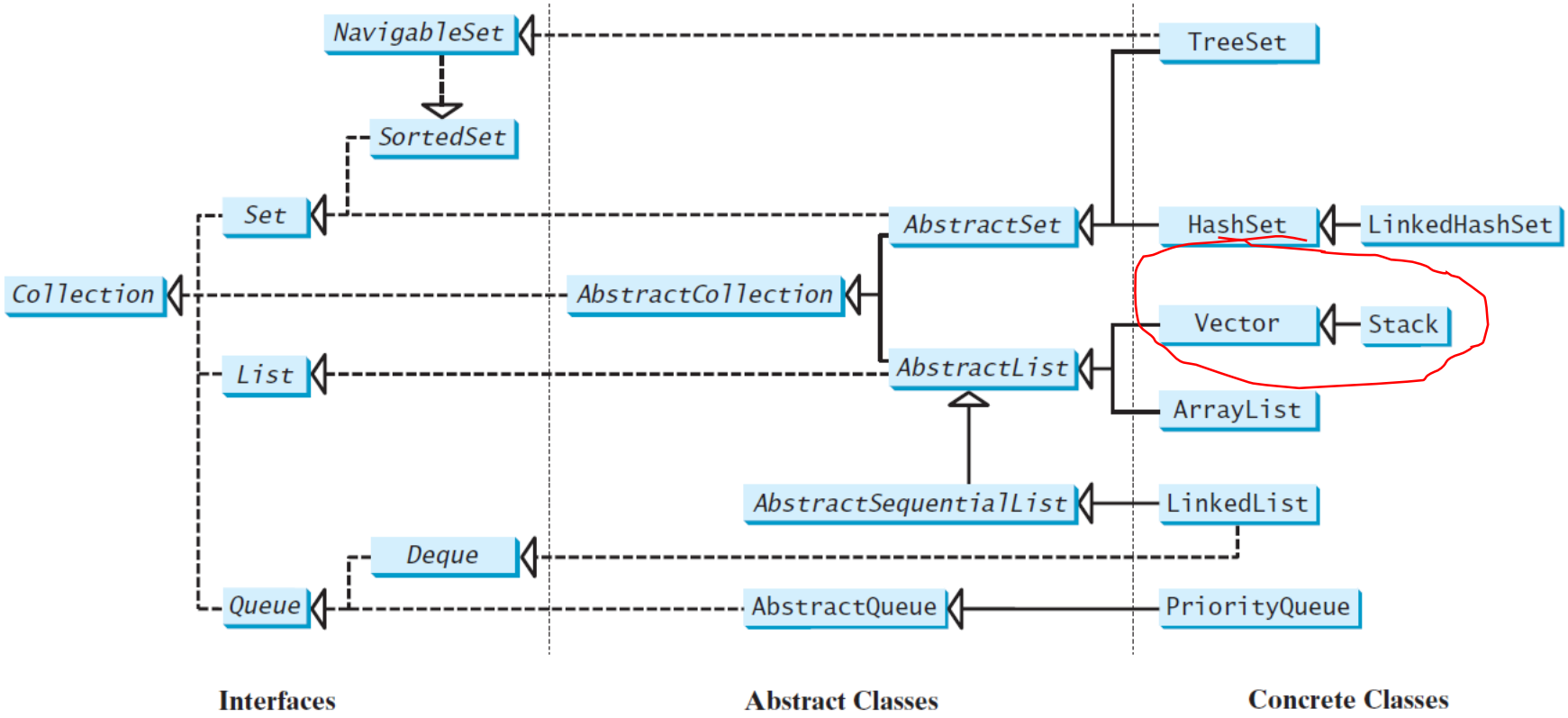
Returns the top element in this stack.

Returns and removes the top element in this stack.

Adds a new element to the top of this stack.

Returns the position of the specified element in this stack.

The Bigger Picture



Vector

- java.util.Vector<E>
  - Like java.util.ArrayList<E>, it implements a growable array of objects.
    - Like an array, it contains components that can be accessed using an integer index.
    - However, the size of a Vector can grow or shrink as needed to accommodate adding and removing items after the Vector has been created.
- How is it different from the ArrayList class?
  - Vector is synchronized, while ArrayList not
  - If a thread-safe implementation is not needed, it is recommended to use ArrayList in place of Vector.

Stack: Example 1

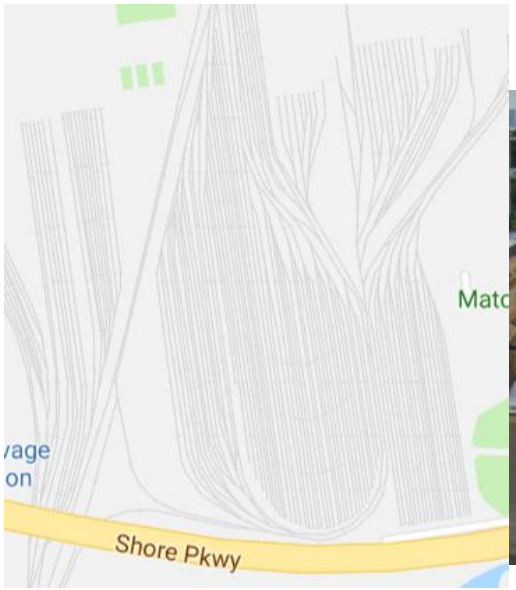
- Problem: we want to implement a calculator that evaluates an expression like (1 + 2) * 3
- Solution: covert the expression (the infix notation) to the postfix notation
  - 1 2 + 3 *
  - Evaluate it using a Stack
    - Scan the expression
    - push 1, push 2, see +, pop 2, pop 1, evaluate 1+2, push 3, push 3, see *, pop 3, pop 3, evaluate 3*3

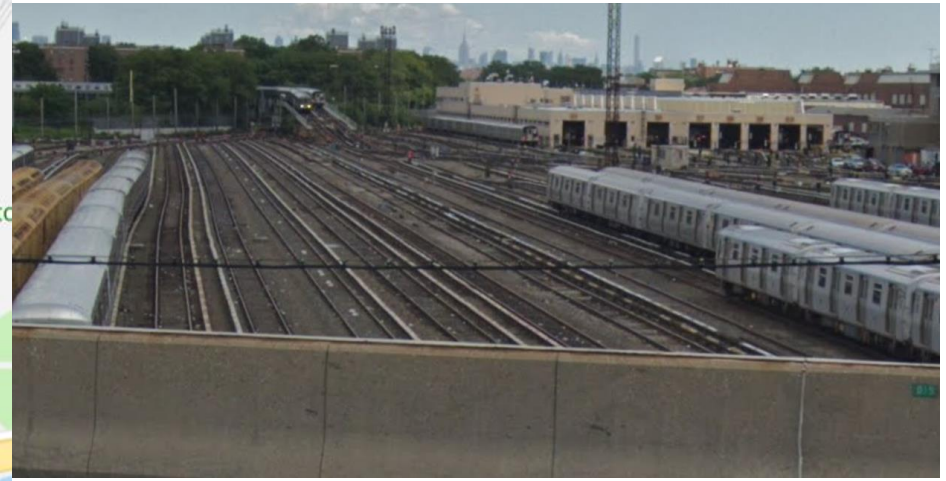
Stack: Example 2

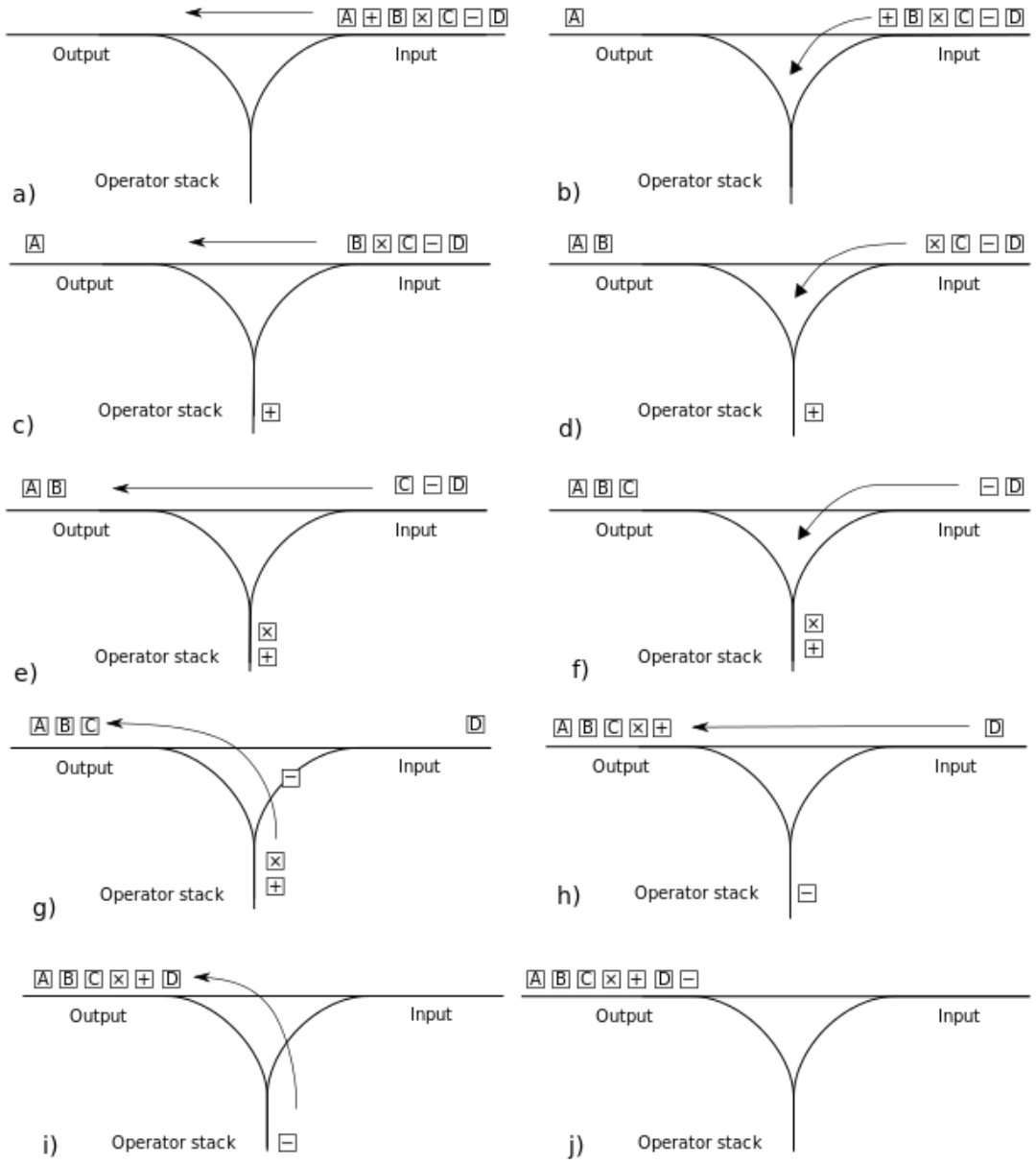
- Problem: we have implemented a calculator that evaluates postfix expression like 1 2 + 3 * using a stack. But were we given infix expressions?
- Solution: covert the expression (the infix notation) to the postfix notation using a sack
- Called the Shunting Yard algorithm
  - Developed by Edsger Dijkstra

Shunting Yard

- One of the MTA's







From https://en.wikipedia.org/wiki/Shunting-yard_algorithm

Questions?

- Concept of stack
- Use stack
- Difference between Java's Vector and ArrayList classes

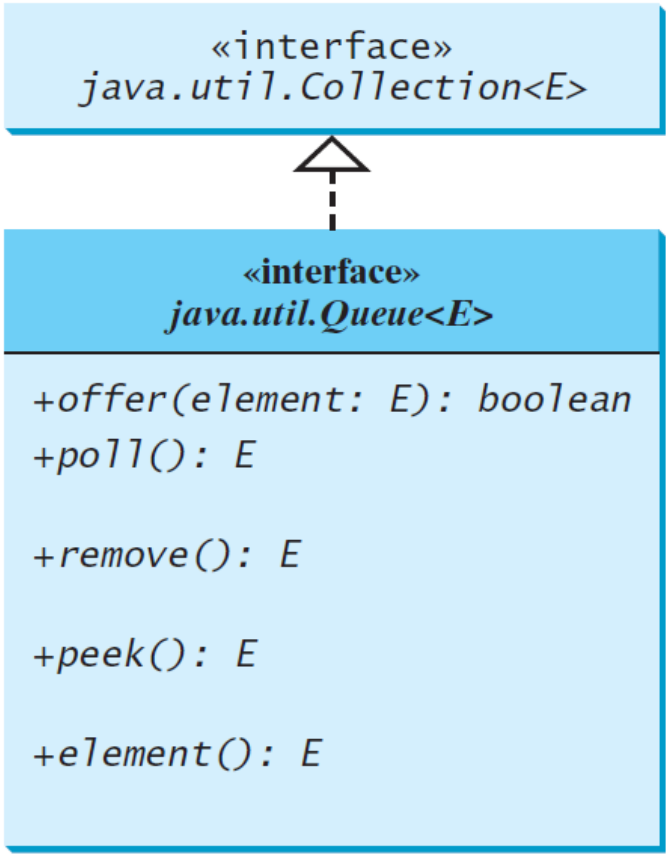
Queue

- A queue is a first-in/first-out data structure.
  - Elements are appended to the end of the queue and are removed from the beginning of the queue.
  - Head and tail of a queue
    - Access/remove from head
    - Add to tail

Priority Queue

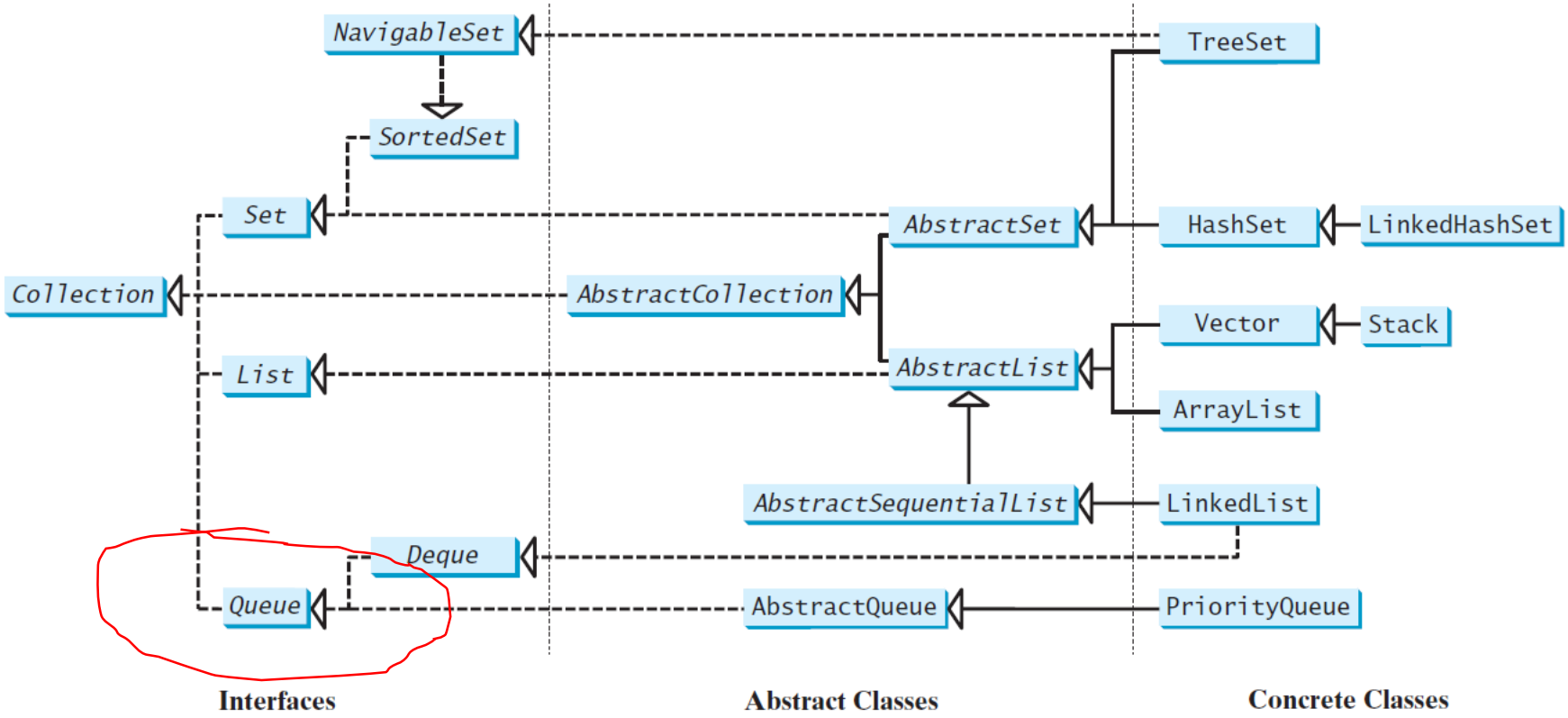
- In a priority queue, elements are assigned priorities.
- When accessing elements, the element with the highest priority is removed first.
- However, among elements with the same priority, the first-in/first-out discipline is applied.

The Queue Interface



Inserts an element into the queue.	
Retrieves and removes the head of this queue, or `null` if this queue is empty.	
Retrieves and removes the head of this queue and throws an exception if this queue is empty.	
Retrieves, but does not remove, the head of this queue, returning `null` if this queue is empty.	
Retrieves, but does not remove, the head of this queue, throws an exception if this queue is empty.	

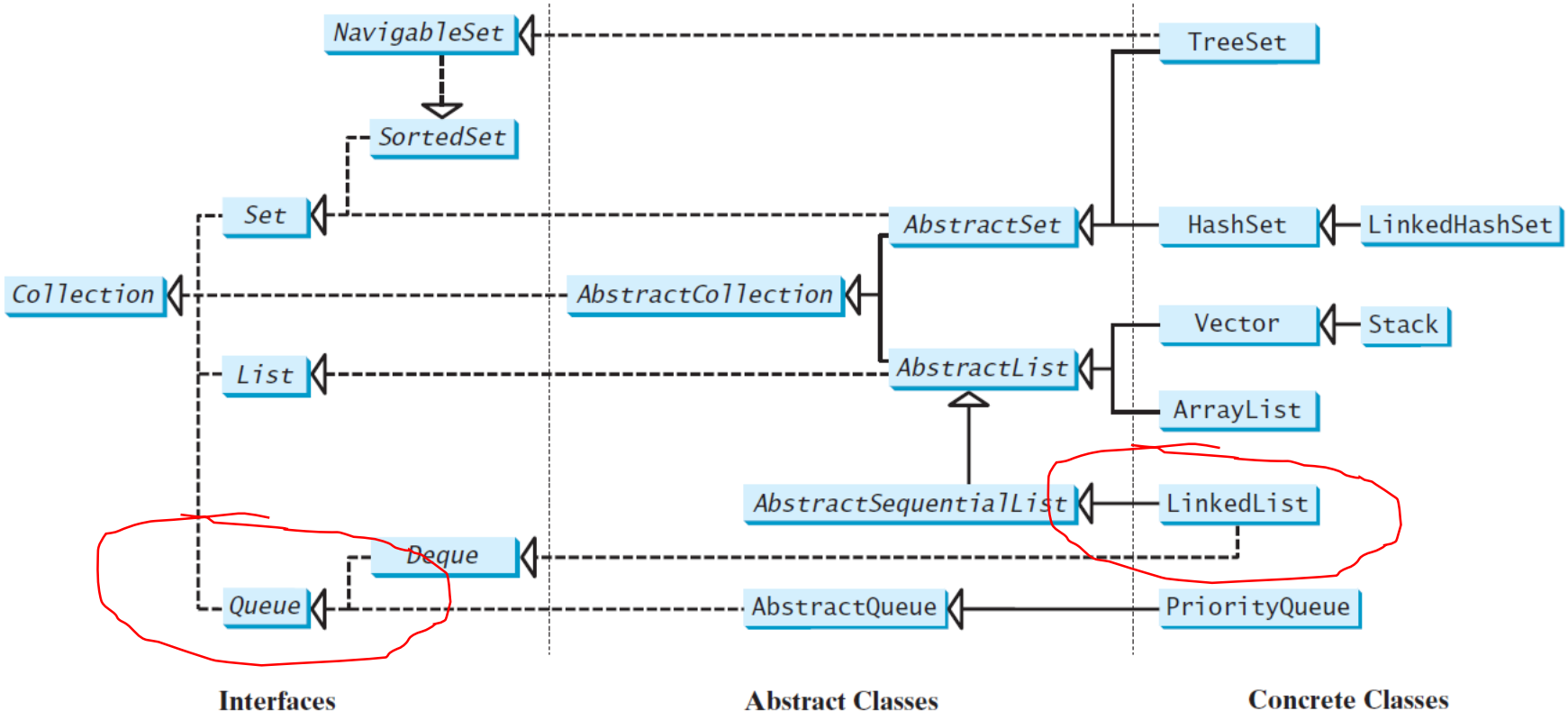
The Bigger Picture



Using the Queue Data Structure: Question?

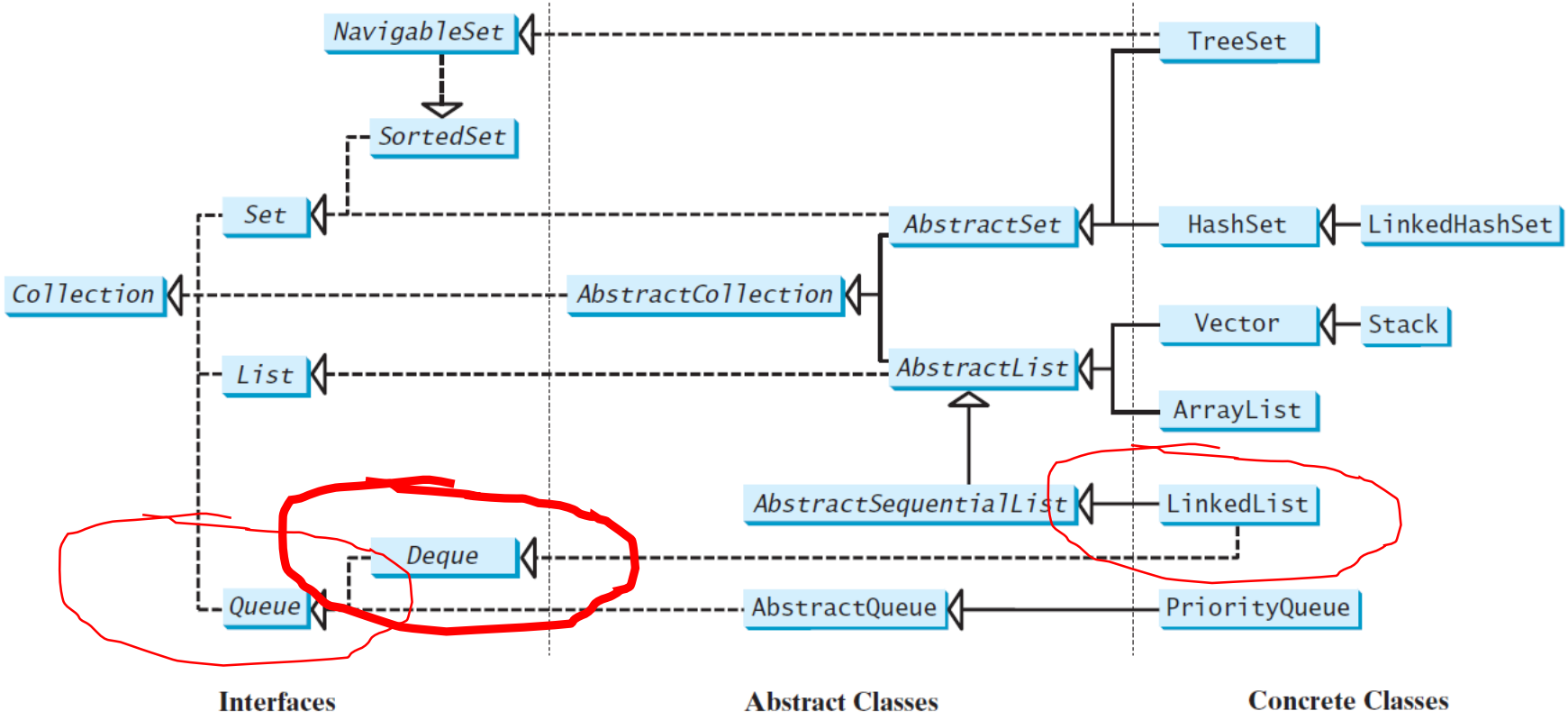
- Wait! The Queue in an interface in Java, how do I use a Queue in my program?

Answer: The Bigger Picture



Using the Queue Data Structure: Question?

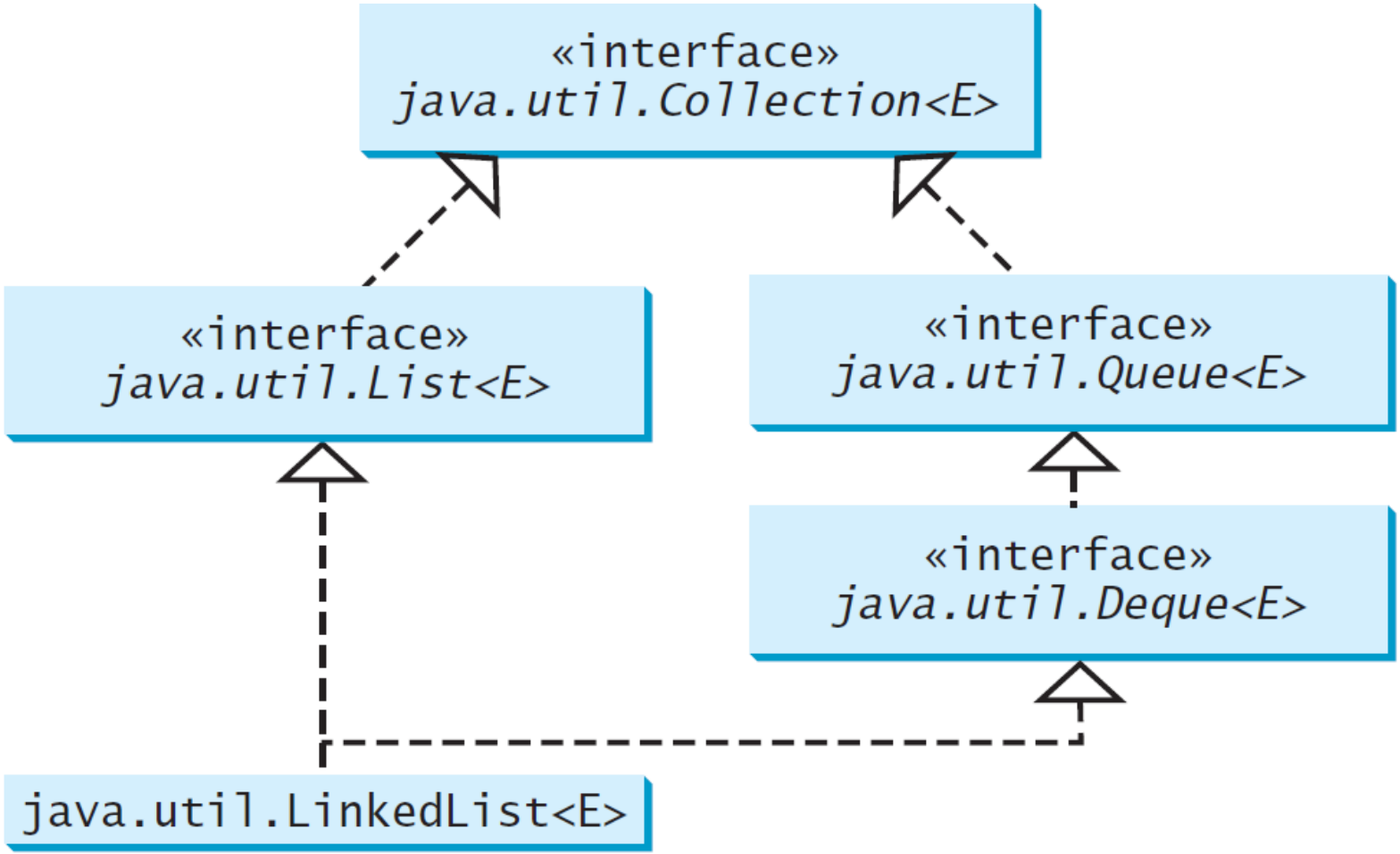
- What is Deque? How do I pronounce it?



Deque

- java.util.Deque
- An interface for "double ended queue", pronounced as "deck"
  - A linear collection that supports element insertion and removal at both ends.

Using LinkedList as Queue

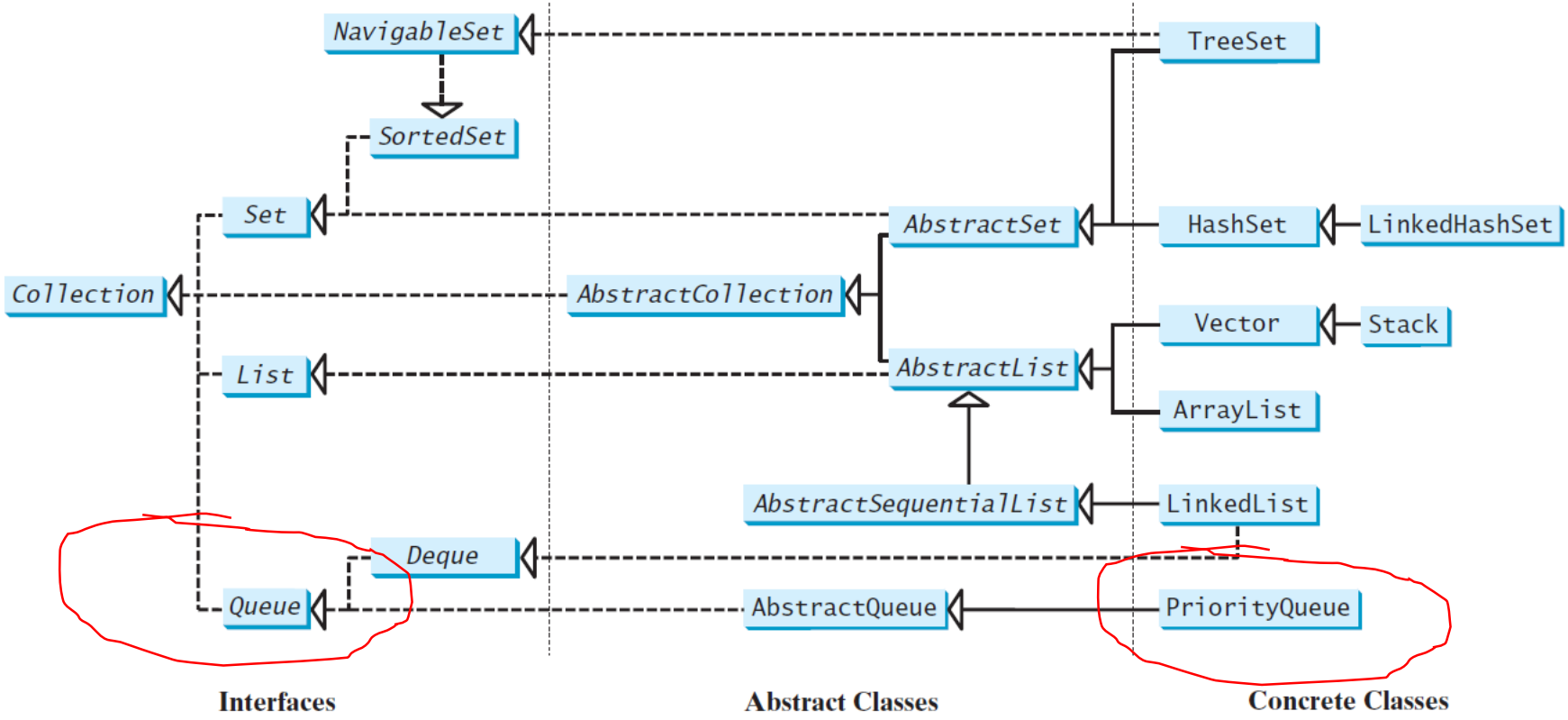


Queue Operations

- Defined in the Queue interface

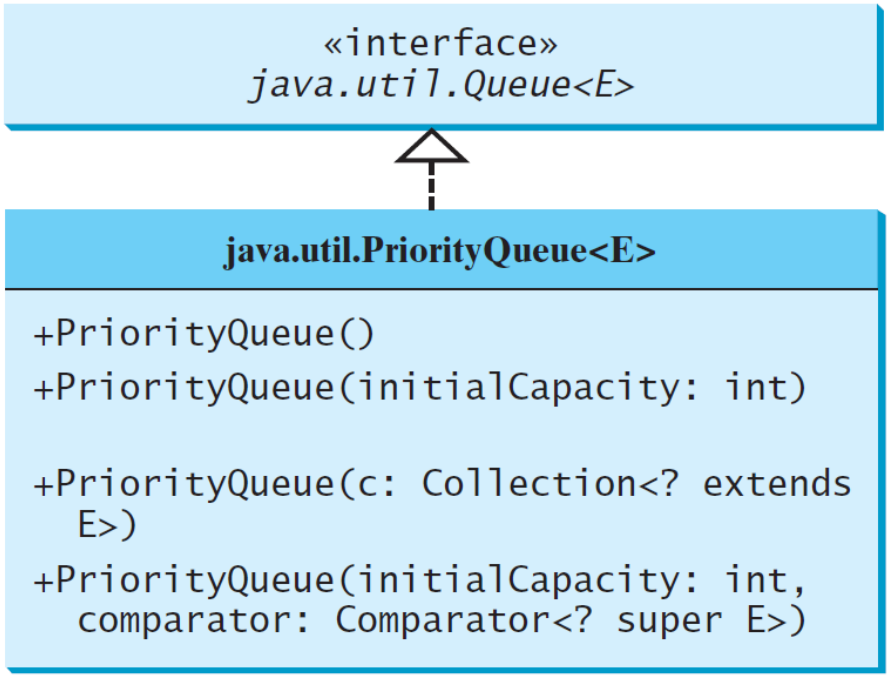
Summary of Queue methods		
	Throws exception	*Returns special value*
Insert	add(e)	offer(e)
Remove	remove()	poll()
Examine	element()	peek()

Priority Queue in Java



The PriorityQueue Class

- Also example Java API documentation for the class and AbstractQueue



+PriorityQueue()	Creates a default priority queue with initial capacity 11.
+PriorityQueue(initialCapacity: int)	Creates a default priority queue with the specified initial capacity.
+PriorityQueue(c: Collection<? extends E>)	Creates a priority queue with the specified collection.
+PriorityQueue(initialCapacity: int, comparator: Comparator<? super E>)	Creates a priority queue with the specified initial capacity and the comparator.

PriorityQueue Basics in Java

- PriorityQueue sorts elements in natural order that realizes the concept of priority
- Sort passengers based seat class
  - [John, 1st class], [Tom, 1st class], [Joan, 1st class], [Emma, 1st class], [Eric, economy], [Erica, economy]
  - They form a queue, however, the 1st class passengers will be served first.

Queue and PriorityQueue: Examples

- Queue basics
- PriorityQueue basics
- Assign seats to passengers in a queue on an airplane

Stack and Queue: Examples in Textbook

- Examine the examples in the textook

Questions?

- Concept of queue and priority queue
- Queue and priority queue in Java
- Use queue and priority queue in your programs