Data Structure Summary

A data structure is an implementation of an [abstract] interface.

- List
- Queue
- Stack
- Deque [double ended queue]
- Unordered Set [set]
- Sorted Set
- Map [set of key-value pairs]
- Sorted Map [sorted set of key-value pairs (kvp)]

Access and Modifification Characteristics

	get/set	**add/remove**
Arrays	$O(1)$	$O(1 + \min(i, n-i))$
LinkedList	$O(1 + \min(i, n-i))$	$O(1)$*
Skiplist	$O(\log n)$	$O(\log n)$

*given a pointer to the location, else traversal is necessary

Set

Efficient for contains().

SortedSet

Efficient for find().

- Does a successor search [closest value ≥ to value]

Maps

Efficient for contains() [kvp]

SortedMap

Efficient for find() [kvp]

Array-based

Efficient for read / write. Expensive insertion / deletion.

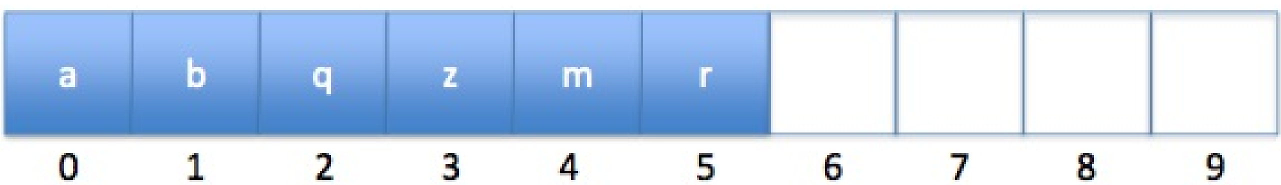
ArrayList / ArrayStack

Efficient access anywhere. Efficient insertion / deletion at back [think stack].

- Implements **List** interface with an array
- superceded by ArrayDeque
- **get(), set() in O(1)**
- **add(), remove() in O(1 + n-i)**
- **resize is O(n)** [amortized]

// for $m \geq 1$ add() / remove() calls, resize() will copy at most $2m$

// the amortized cost of resize() for m calls is $2m/m = O(1)$



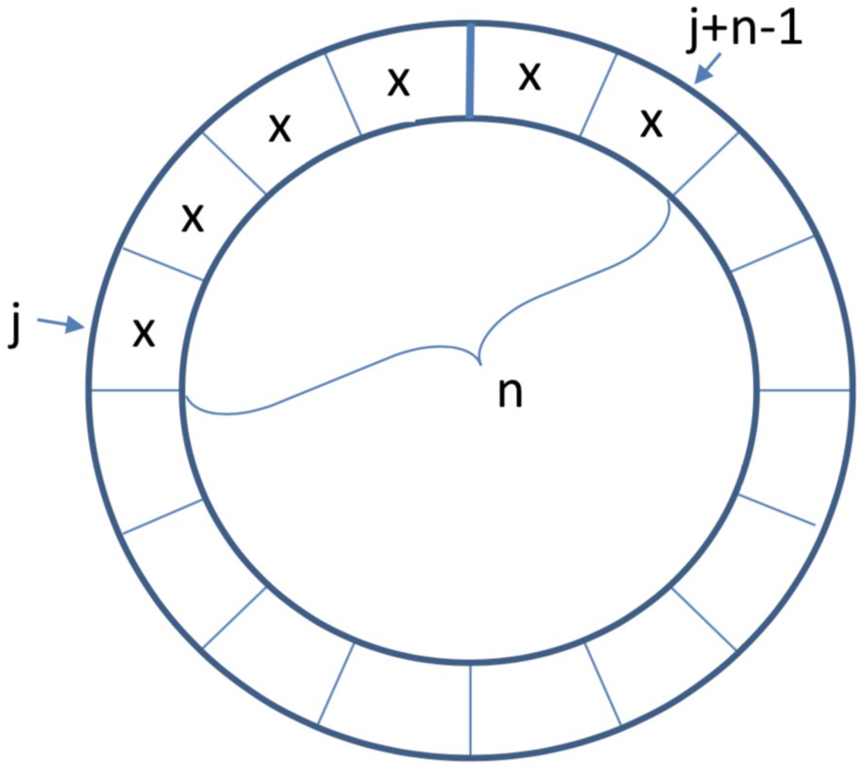
ArrayQueue / ArrayDeque

Efficient access anywhere. Efficient insertion / deletion at front and back [think deque].

- Implements **List** interface with an array
- **get(), set() in O(1)**

- **add(), remove() in O(1 + min(i, n−i))**
- **resize is O(n)** [amortized]

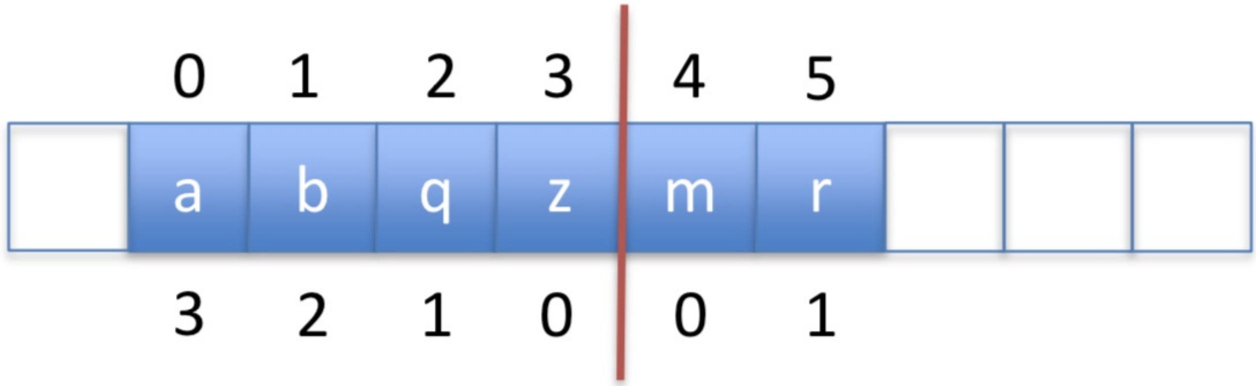
// since ArrayQueue only supports addLast() and removeFirst(), these are O(1)



DualArrayDeque

Efficient access anywhere. Efficient insertion / deletion at front and back [think deque].

- Implements **List** interface
- Uses two **ArrayStacks** front-to-front
- May be rebalanced if one array is much larger than the other
- **get(), set() in O(1)**
- **add(), remove() in O(1 + min(i, n−i))**

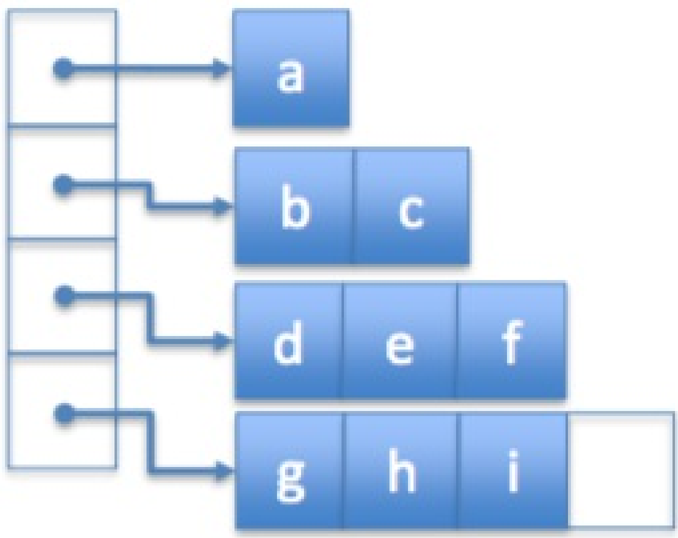


RootishArrayStack

List of Lists, of increasing size. Efficient space [sqrt(n) wasted space. Efficient access anywhere. Efficient insertion / deletion at back.

- Implements the **List** interface using multiple backing arrays
- Reduces 'wasted space' [unused space]
- At most: *sqrt(n)* unused array locations
- Good for space efficiency
- **get(), set() in O(1)**
- **add(), remove() in O(1 + n−i)**

// m ≥ 1 add() / remove() calls, results on O(m) time on resize()



Linked Lists

Efficient insertion / deletion. Expensive access.

Singly Linked List [SLList]

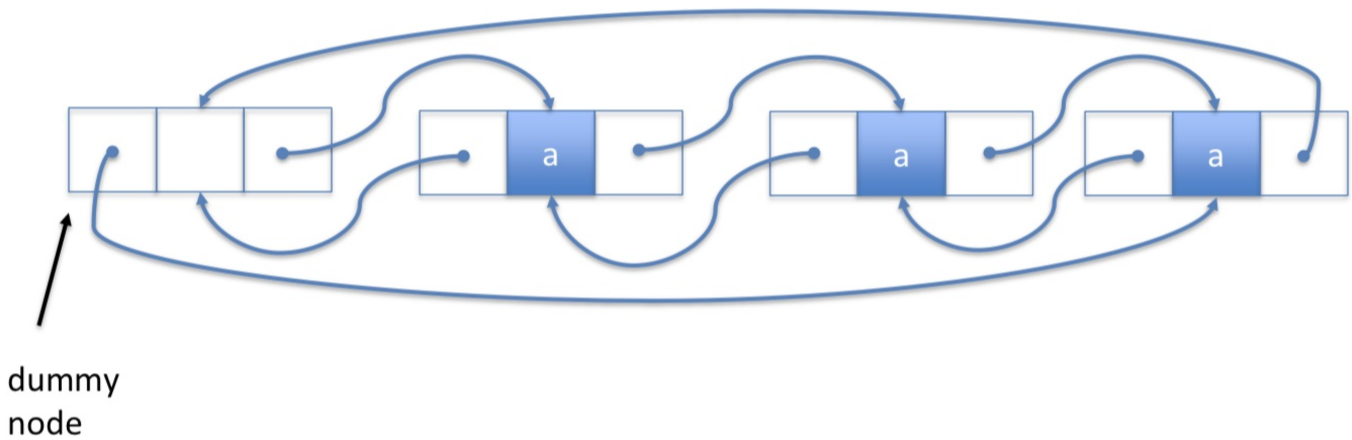
Nodes with pointer to next node. Efficient insertion / deletion. Expensive access.

- Implements the Stack and Queue **interfaces**.
- **get(), set() in O(1 + i)**
- **add(), remove() in O(1)**

Doubly Linked List [DLList]

Nodes with pointers to previous and next nodes. Efficient insertion / deletion. Expensive access.

- Implements the Stack and Queue **interfaces**.
- **get(), set() in O(1 + min(i, n−i))**
- **add(), remove() in O(1 + min(i, n−i))**



SELList [Space-Efficient Linked List]

Nodes with pointers to previous and next nodes. Values stored as blocks in each node. [you can skip data] Efficient insertion / deletion. Expensive access.

- Implements the **List** interfaces

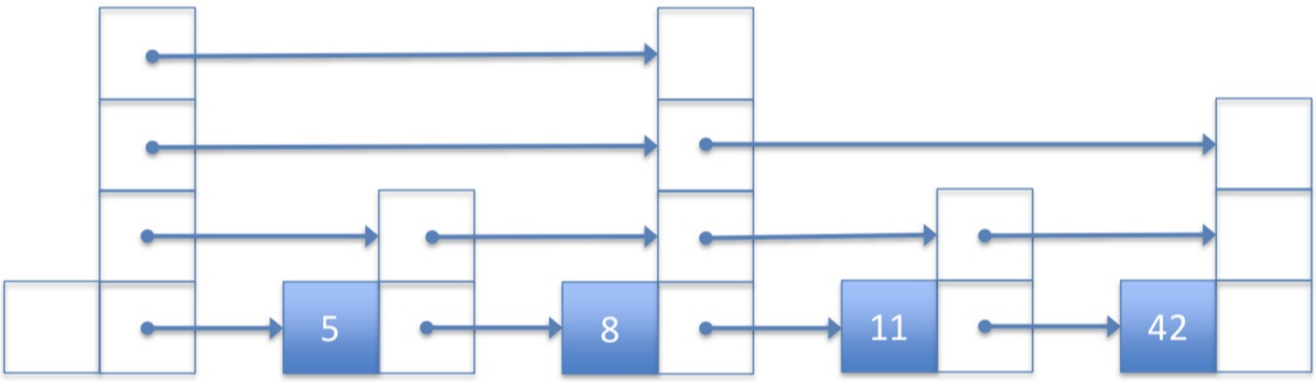
- wasted space: { n + O(b + n/b) }
- **get(), set() in O(1 + min(i, n−i)/*b*)**
- **add(), remove() in O(1 + min(i, n−i)/*b*)**

// m ≥ 1 add() / remove() calls, results in O(b•m) time on resize()

SkipLists

SLL with additional skipping pointers. Randomly generated structure. Allows for faster searches.

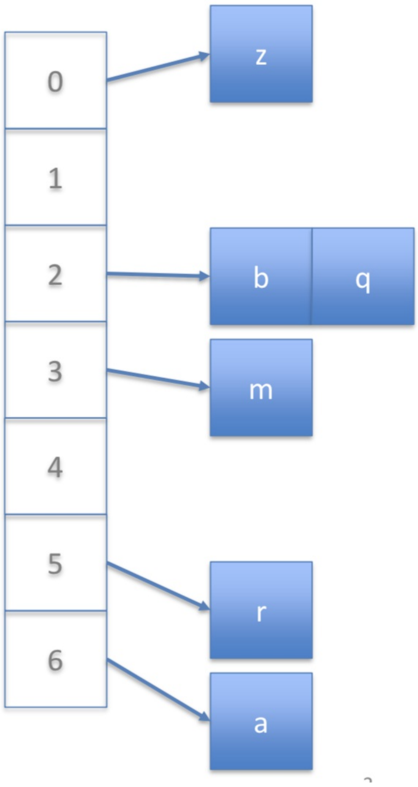
- Implements the **SortedSet** interface
- Successor search: **find(x) will return smallest value ≥ x**
- **get(), set() in O(log n)**
- **add(), remove() in O(log n)**



After Midterm

HashTable

- Unordered sets with fast access
- Associative array
    - Index elements into a range of int
    - for non-integer elements, use hashCode()



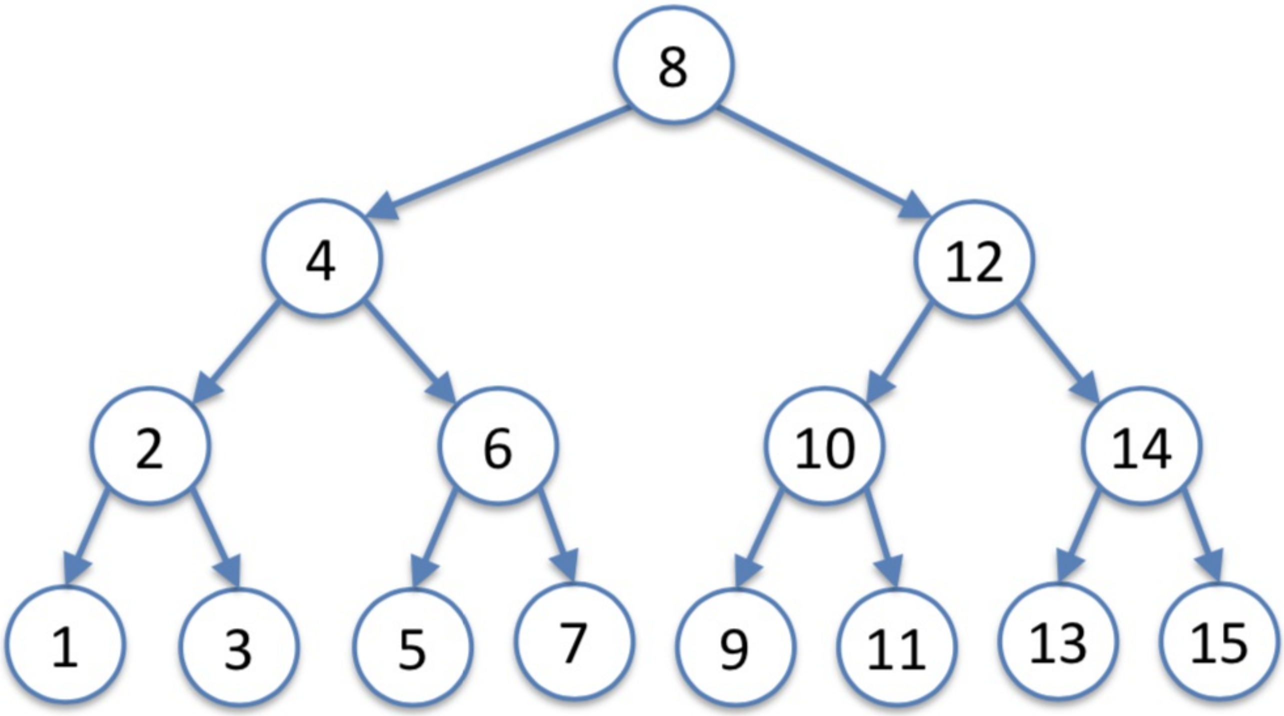
ChainedHashTable

- Implements the **USet** interface
- **find(), add(), remove() in O(n_i)**
    - where *n_i* is based of size of list at index

// m ≥ 1 add() / remove() calls, results in O(m) time on resize()

Binary Tree

- Nodes with up to two child nodes



BinarySearchTree

- Implements the **SSet** interface
- **find(), add(), remove() in O(n)**

Random Binary Search Trees

Balanced trees are statistically more likely

- Implements the **SSet** interface
- **contructed in O(n•log(n))**
- **add(), remove() in O(n)**
- **find()) in O(log n)**

// search path is at most 2•log(n) + O(1)

Treaps

Has an extra priority:
Parent priority should be less than child priority.
This has the property of bounding the height of the tree.

- Implements the **SSet** interface

- Priorities are randomly applied
- **contructed in O(n•log(n))**
- **find(),add(), remove() in O(log n)**