This week (Chapter 2):

- Abstract data types (**Today**)
- Data Structures (Wednesday and Friday)
- Programming practices (Friday)

Today:

- Recent exercises and quiz questions
- Definition *abstract data type*, especially in contrast with *data structure*
- The "canonical" ADTs
- Start data structures (time permitting)

```
public class SimpleLinkedList<E> implements Iterable<E> {
    private class Node {
        E datum;
        Node next;
        Node(E datum, Node next) {
            this.datum = datum;
            this.next = next;
        }
    }

    private Node head;
    private Node tail;
    private int size;

    public void set(int index, E element) {
        checkIndex(index);
        Node current = head;
        for (int i = 0; i < index; i++) current = current.next;
        current.datum = element;
    }
    // ...
}
```

Class invariant for `SimpleLinkedList`:

(a) `head` = `null` iff `tail` = `null` iff `size` = 0.

(b) If `tail` ≠ `null` then `tail.next` = `null`.

(c) If `head` ≠ `null` then `tail` is reached by following `size` − 1 `next` links from `head`.

1.17 State and prove a loop invariant for the loop of `set()`. The loop invariant should capture the meaning of the variables `current` and `head`.

1.18 Argue that `set()` preserves the class invariant.

```
public class DataSet {
    private int sum, n, min, max;
    public DataSet(int initialVal) {
        min = max = sum = initialVal;
        n = 1;
    }
    public void add(int x) {
        sum += x;
        n++;
        if (x < min) min = x;
        if (x > max) max = x;
    }
    private double ave() { return ((double) sum) / n;}
    private int range() { return max - min; }
}
```

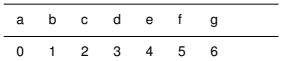
	Best case	Worst case	Expected case
Bounded linear search			
Binary search			
Quick sort			

An abstract data type (ADT) is a data type whose representation is hidden from the client. Implementing an ADT as a Java class is not very different from implementing a function library as a set of static methods. The primary difference is that we associate data with the function implementations and we hide the representation of the data from the client. When using an ADT, we focus on the operations specified in the API and pay no attention to the data representation; when implementing an ADT, we focus on the data, then implement operations on that data.

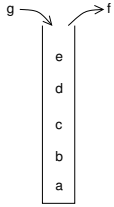
[Sedgewick and Wayne, *Algorithms*, Pg 64; also cf pg 84]

The "canonical ADTs":

- **List.** Linear collection with sequential and random access.
- **Stack.** Linear collection with LIFO access.
- **Queue.** Linear collection with FIFO access.
- **Set.** Unordered collection with binary membership.
- **Bag.** Unordered collection with enumerated membership.
- **Map.** Unordered collection of associations between keys and values.

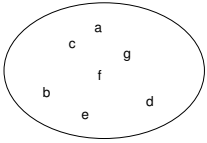


List

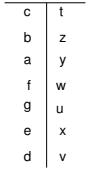


Stack

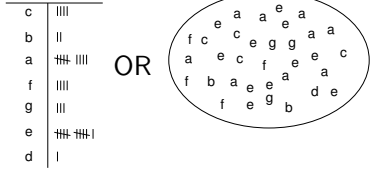
Queue



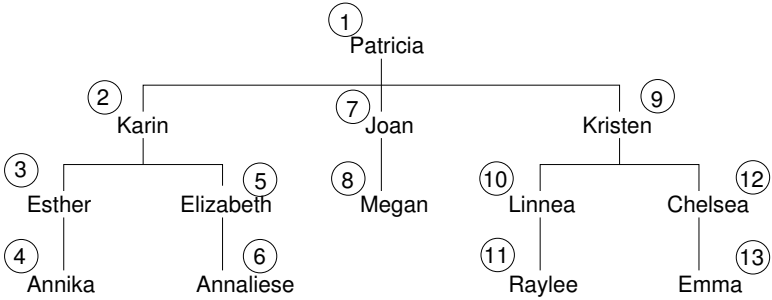
Set



Map



Bag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Joan
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Kristen
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Esther
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Elizabeth
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Megan
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Linnea
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Chelsea
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Annika
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Annaliese
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Raylee
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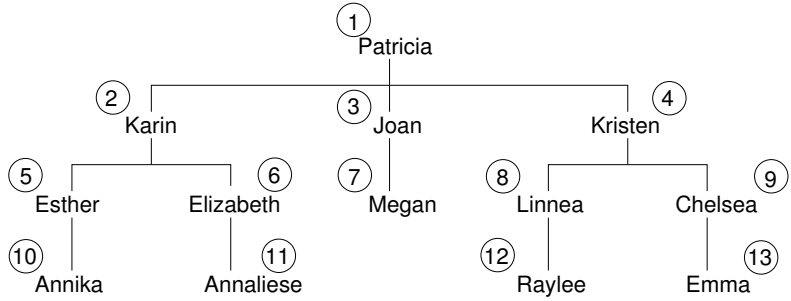
Emma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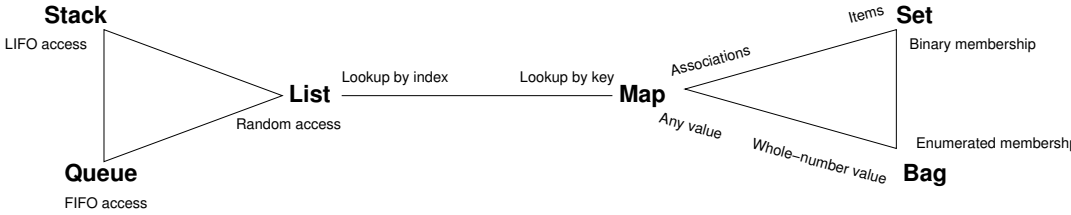
Stack
LIFO access
Queue
FIFO access
List
Random access
Lookup by index
Lookup by key
Map
Associations
Any value
Whole−number value
Items
Set
Binary membership
Enumerated membershp
Bag

The four basic ways to implement an ADT:

- Use an array
- Use a linked structure
- Use an "advanced" data structure, varying and/or hybridizing linked structures and arrays
- Adapt an existing implementation of another ADT.

Coming up:

Due Tues, Jan 24: (end of day)
Finish reading Section 2.1
Do Ex 1.11
Take ADT quiz

Due Fri, Jan 27:
Read Section 2.(2, 4, & 5)
Take data structures quiz

Also:
Do "basic data structures" practice problems (by Mon, Jan 30)
Do **"Implementing ADTs"** *project (suggested by Wed, Feb 1)*