Data Structures

- Abstract Data Type (ADT)
  - A collection of data and a set of operations that can be performed on the data
  - Abstract – operations are defined, but how to implement these operations are not

Some Simple ADTs

- List
- Queue
- Stack
- Tree
- ...
- Just look under `java.util` package

Why Do We Study Data Structures?

- Common to all languages, not just Java
- Building blocks for more complex algorithms
- Programming techniques
- Complexity analysis and performance tradeoffs

List

- beef
- beer
- biscuits
- broccoli
- ...

- A ordered collection of objects

List Operations

- Insert
- Remove
- Get
- Search
- Clear
- Size
- Output
The List Interface

- http://sun.calstatela.edu/~cysun/www/teaching/cs203/extras/List.java

Array Implementation

```java
public class ArrayList implements List {
    private Object elements[];
    ...
}
```

Performance Concerns of ArrayList

- Which operations are efficient??
- Which are not??
- How much space are we wasting??
- What can we do about it??

Linked List

```java
class ListNode {
    Object data;
    ListNode next;
    ...
}
```

Implementation Considerations

- How do we insert at the front of the list??
- How do we remove the first element of the list??
- How do we remove the last element of the list??
Performance Concerns of LinkedList

// assume list is a linked list of Integers
int sum = 0
for (int i = 0; i < list.size(); ++i)
    sum += (Integer) list.get(i);

What wrong with this code??

Iterator

◆ Iterates though each element of a collection ...
◆ ... without exposing the internal of the collection class

The Iterator Interface

public interface Iterator {
    public boolean hasNext();
    public Object next();
}

ListIterator Interface

public interface ListIterator extends Iterator {
    public boolean hasPrevious();
    public Object previous();
}

ListIterator Operations

ListIterator it = list.iterator();
    it.hasNext();  // false
    it.next();    // "beef"
    it.next();    // "beer"
    it.previous(); // "beef"
    it.next();    // "beer"
**LinkedInListIterator**

- An iterator class for LinkedList

**Refactoring List Classes**

- List
  - implements iterator()
  - extends AbstractList
  - extends LinkedList
- Iterator
  - extends ListIterator
  - implements iterator()
- AbstractList
  - extends ArrayList
  - extends LinkedList
- ArrayList
  - ListIterator
  - LinkedList
  - ListNode
  - LinkedListIterator