# CSSE 220 Day 27

Linked List Implementation
Abstract Data Types
Data-structure-palooza

Checkout *LinkedLists2* project from SVN

# Questions

# Data Structures

- Understanding the engineering trade-offs when storing data

# Data Structures Recap

- Efficient ways to store data based on how we'll use it
- The main theme for the last 1/6 of the course
- So far we've seen `ArrayLists`
  - Fast addition **to end of list**
  - Fast access to any existing position
  - Slow inserts to and deletes from middle of list

# Another List Data Structure

- What if we have to add/remove data from a list frequently?

- `LinkedLists` support this:
  - Fast insertion and removal of elements
    - Once we know where they go
  - Slow access to arbitrary elements

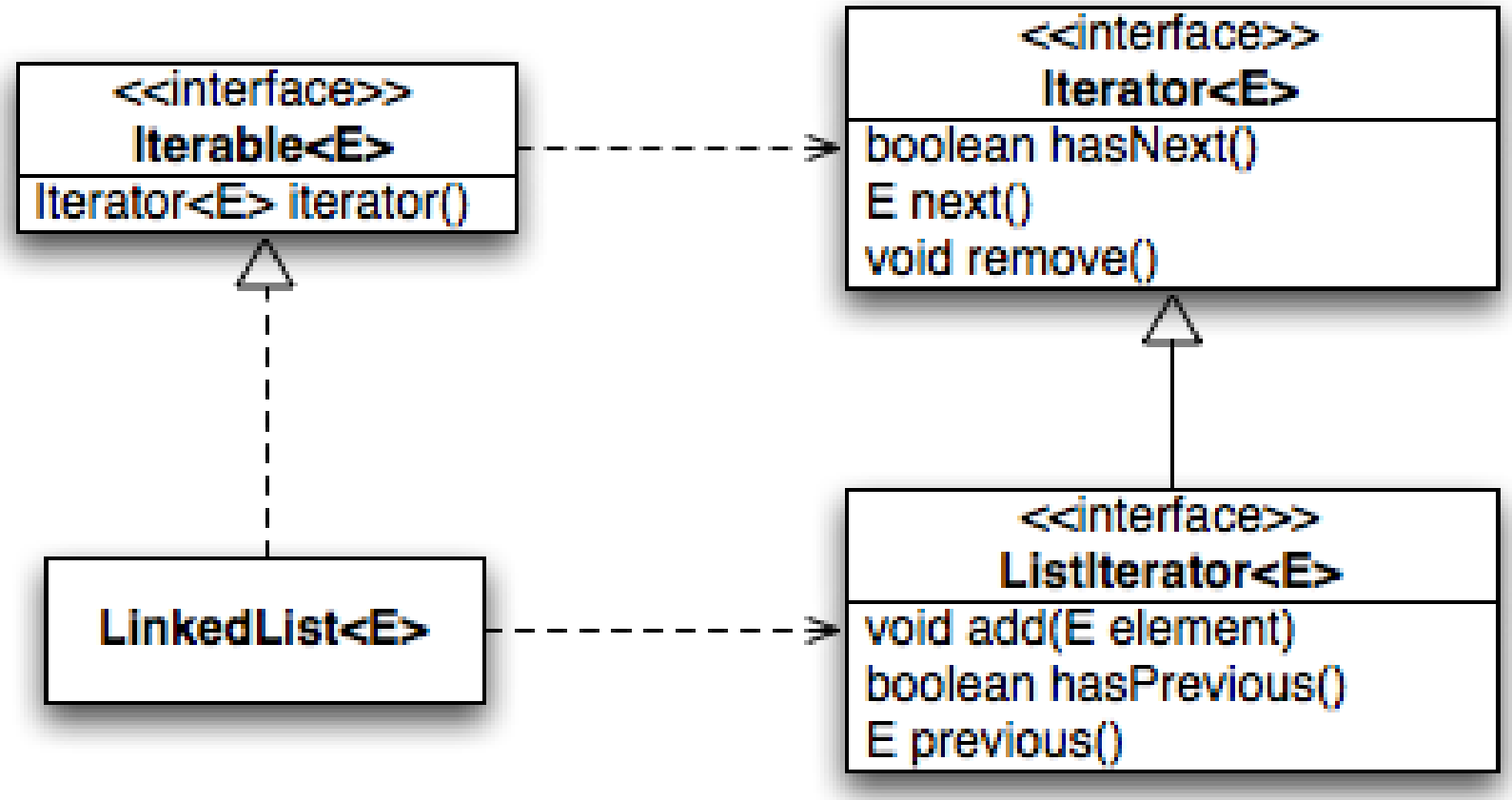
"random access"

# LinkedList<E> Methods

- `void addFirst(E element)`
- `void addLast(E element)`
- `E getFirst()`
- `E getLast()`
- `E removeFirst()`
- `E removeLast()`

- What about accessing the middle of the list?
  - `LinkedList<E> implements Iterable<E>`

# Accessing the Middle of a LinkedList



# An Insider's View

```
for (String s : list) {
  // do something
}
```

```
Iterator<String> iter =
    list.iterator();

while (iter.hasNext()) {
  String s = iter.next();
  // do something
}
```

Enhanced For Loop

What Compiler Generates

# Implementing LinkedList

- A simplified version, with just the essentials
- Won't implement the java.util.List interface
- Will have the usual linked list behavior
  - Fast insertion and removal of elements
    - Once we know where they go
  - Slow random access


PLEASE STAND BY

# Abstract Data Types (ADTs)

- Boil down data types (e.g., lists) to their essential operations
- Choosing a data structure for a project then becomes:
  - Identify the operations needed
  - Identify the abstract data type that most efficient supports those operations
- Goal: that you understand several basic abstract data types and when to use them

# Common ADTs

- Array List
- Linked List
- Stack
- Queue
- Set
- Map

Implementations for all of these are provided by the Java Collections Framework in the **`java.util`** package.

# Array Lists and Linked Lists

| Operations Provided | Array List Efficiency | Linked List Efficiency |
|---|---|---|
| Random access | O(1) | O(n) |
| Add/remove item | O(n) | O(1) |

# Stacks

- A last-in, first-out (LIFO) data structure
- Real-world stacks
  - Plate dispensers in the cafeteria
  - Pancakes!
- Some uses:
  - Tracking paths through a maze
  - Providing "unlimited undo" in an application

| Operations Provided | Efficiency |
|---|---|
| Push item | O(1) |
| Pop item | O(1) |

Implemented by `Stack`, `LinkedList`, and `ArrayDeque` in Java

Q1

# Queues

- A first-in, first-out (FIFO) data structure
- Real-world queues
  - Waiting line at the BMV
  - Character on Star Trek TNG
- Some uses:
  - Scheduling access to shared resource (e.g., printer)

| Operations Provided | Efficiency |
|---|---|
| Enque item | O(1) |
| Dequeue item | O(1) |

Implemented by **`LinkedList`** and **`ArrayDeque`** in Java

Q1

# Sets

- **Unordered** collections **without duplicates**
- Real-world sets
  - Students
  - Collectibles
- Some uses:
  - Quickly checking if an item is in a collection


| Operations | HashSet | TreeSet |
|---|---|---|
| Add/remove item | O(1) | O(lg n) |
| Contains? | O(1) | O(lg n) |

Can hog space

Sorts items!

Q1

# Maps

- Associate keys with values
- Real-world "maps"
  - Students
  - Collectibles
- Some uses:
  - Associating student ID with transcript
  - Associating name with high scores

| Operations | HashMap | TreeMap |
|---|---|---|
| Insert key-value pair | O(1) | O(lg n) |
| Look up value for key | O(1) | O(lg n) |

Can hog space

Sorts items by key!

Q1

# Work Time

- Finish LinkedList or work on Dam Beavers