Lecture 10: Iterators

CS 62

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Alexandra Papoutsaki & William Devanny

Friday Quiz

- Sorting, big-O,
- Iterators
- Set up induction

Sorting (in case you forgot)

Selectionsort

- Find largest (smallest) element, put at end (beginning), sort rest
- Complexity: $O(n^2)$
- In-place

Mergesort:

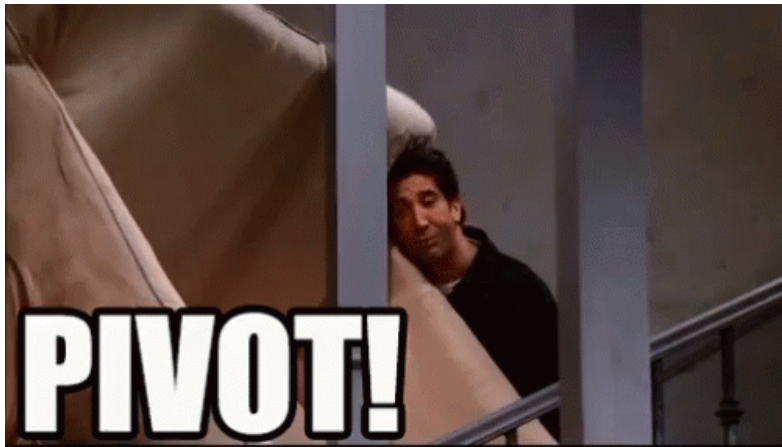
- Divide in half, sort each half, then merge them in order
- Complexity: $O(n \log n)$
- $O(n)$ extra space to merge into

Quicksort (a quick intro)

Divide & conquer

1. Pick a pivot (different techniques: first, last, random, median, etc)
2. Move smaller elements to left of pivot, larger to right
3. Recursively sort each of the smaller lists
4. Make one big list

Complexity: $O(n \log n)$ on average, $O(n^2)$ in worst case



Which one should I use?

You already know the answer… It depends

- If small list then selection/insertion (less overhead)
- If large list and need to always run quickly then merge sort (but needs extra space)
- If large list, need to run fast on average, but being occasional slow is OK, then quick sort.

- https://www.toptal.com/developers/sorting-algorithms/

Collections and Iterators

A `Collection` represents a group of objects known as its elements

Iterator: Object to traverse through a collection

- one element at a time
- Implemented as interface in `Java`

Iterator in Java

```
public interface Iterator<E> {
      //returns true if the iteration has more elements
      boolean hasNext();

      //returns the next element in the iteration
      E next();

      //removes the last element that was returned by next
      void remove(); //optional
}
```

Iterator rules

- `remove` is optional (we won't use it)
- Only allowed to call `remove` once and then must terminate iteration.
- Never change a collection in middle of an iteration
  - Behavior is officially undefined if you do
  - Iterator often copies data structure before iterating, so changes may not appear to original!

Iterator example

```
Iterator listIterator = myList.iterator();
while(listIterator.hasNext()){
     System.out.println(listIterator.next());
}

while(listIterator.hasNext()){
     String elt = listIterator.next();
     System.out.println(elt); }
```

Iterable

Interface which when implemented allows for-each loop

Includes `Iterator<T> iterator()`

- Example: `ArrayList<E>`

See definition and use of of iterator in `ArrayIndexList`.

- Often implemented by inner class.

For-each loop

```
for(String elt: myList){
      System.out.println(elt);
}
```

- Abbreviates previous code
- Fine as long as `myList` has an iterator method
- Called an *active* or *external* iterator.

- Cannot modify the collection

Iterable

- Notice can have two iterators going through list independently!
- Never modify a data structure when iterating through elements as may get unpredictable results
- Most classes in Java collection classes have iterators which are designed to "*fail fast*".
  - Throw an exception if simultaneous access and modification

Java 8

- Read Iterating over collections in Java 8
- `forEach()` method now in collection classes
  - `public void forEach(Consumer action)`
  - *Internal iterator*
- *Description copied from interface Iterable*

Performs the given action for each element of the `Iterable` until all elements have been processed or the action throws an exception. Unless otherwise specified by the implementing class, actions are performed in the order of iteration (if an iteration order is specified). Exceptions thrown by the action are relayed to the caller.

Using forEach()

```
myList.forEach(elt -> {System.out.println(elt);});
```

- No explicit control over iterator
- Similar to for-each loop, but it is a method of data structure
- `Consumer` is an interface with method void `accept(T t)`
- `accept` method has code to be executed
- Most valuable when more than one way to traverse
- May only access effectively final variables from scope

Code

- Method definition:

```
public void forEach(Consumer <? super E> action) {
      for (E elt: this)
            { action.accept(elt);
      }
}
```

- `forEach()` is "default method" of `Iterable` interface.
- Automatically inherited in all classes implementing it.
- See article for restrictions on default methods – can't access instance variables!