# CSE 142

Sorting



## Outline for Today

- Review
  - Sequential vs Binary Searcy
  - Arrays
- Maintaining an Ordered List
  - Sorting



## Linear vs Binary Search

- Recall work needed to search a list of *n* items
  - Linear search ~ *n*
  - Binary search ~ log *n*
- For all but small lists, binary search is much, much, much faster
  - For *n* = 1,000, log *n* ~ 10
  - For *n* = 1,000,000, log *n* ~ 20
- But we can only do binary search if the list is in order: *sorted*
- Today's problem: how do we put a list in order?



## Sorting

- In everyday life, sorting often means "placing in categories"
  - Sorting socks, sorting laundry
  - Sorting a catch of fish
  - Sorting the sheep from the goats

- In computer applications, sorting means "placing in linear order"
  - Alphabetizing a list of names
  - Listing bank account owners in order of balance size
- Like searching, sorting is generally applied to a single collection

## Design Your Sorting Algorithm Here



## A Sorted StringList

- **Choices**
  - **Keep list sorted at all times**
    Need to make adjustments in add method
  - **Sort list before searching if not done already**
    Need check in contains (search) method to sort if not currently sorted
- **In either case, order of items in list is no longer order in which added**
  - **But that's presumably ok – if we want really fast searches, this is a tradeoff worth making**
  - **Terminology: this is a *multiset* or *bag* of strings**
    /** Unordered collection of Strings, possibly with duplicate elements */
    public class StringBag { … }



## Maintaining a Sorted List

- **Nothing in the client interface changes**
  - **Except we can no longer allow client to insert arbitrary strings in the middle of the list**
- **Implementation now relies on list being sorted, so it's crucial that we record this information in a comment**

```
// instance variables
private String[ ] strings;      // Strings in this StringList are stored in
private int       numStrings;   //    strings[0] through strings[numStrings-1],
                                //    and the strings are stored in ascending
                                //    order:  strings[0] <= strings[1] <= ...
                                //    <= strings[numStrings-1]
```



## Method add

- **Only method from original StringList that needs to be changed (true?)**

```
/** Add str to this StringBag.  Return true if successful, otherwise return false */
public boolean add(String str) {
    if (this.numStrings == this.strings.length) {
       return false;
    }
    // find correct location to place str
    …
    // shift larger elements one position to the right
    …
    // place str in correct location
    …
    numStrings++;
    return true;
}
```

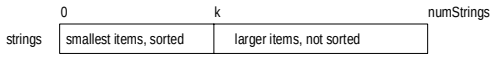
## Modified method add

- Picture:
- Implementation details: exercise



## Selection Sort

- Sort elements in unordered list
- Idea: At each step, pick smallest element in not-yet-sorted part of array and move it to the front
- Picture




- Detailed step (repeat until sorted)
  - Find smallest item in strings[k]..strings[numStrings-1]
  - Swap that item with item in strings[k]
  - Increase k and repeat



## Code For Selection Sort



## Code for Finding Minimum Element

## Test

- Invent some data, check the code



## Embedding in a String Collection Class

- Our original StringList class can be changed to sort the list as needed to allow binary search for contains
  - Add an instance variable to record whether the list is sorted
  - In method add, set this variable to false
  - In method contain, call the sort method if this variable is false, then do a binary search after the sort finishes
  - In method sort, set the variable to true after sorting



## Conclusion

- Performance Tradeoffs
  - Sorting is relatively expensive
  - Pays off if searches are frequent and clustered together compared to additions to the list
- Can either maintain list in sorted order at all times (expensive add operation) or sort when needed (potentially expensive lookup)
- For both algorithms, the diagrams give the key ideas
  - The code is relatively straightforward from there