CSCI 136: Data Structures and Advanced Programming
Lecture 14
Sorting, part 2
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Topics
• Bubble sort
• How do we sort data of any type?

Your to-dos
1. Lab 5 (solo lab), due Tuesday 3/15 by 10pm.
2. Read before Fri: Bailey, Ch 6.5-6.6.

Announcements
3. No class: Fri, March 18.
Study tip

Grades are important, but they are **not the most important thing** in life.

A few things to keep in mind.

Quizzes are for **practice**.

Labs are for **practice**.

You can **resubmit** labs.

You can **resubmit** the midterm.

Just do your best.

Sorting algorithm

A **sorting algorithm** is a **procedure** for transforming an unordered set of data into an ordered sequence.

A **comparison sorting algorithm** takes as input a set $S$ and a binary relation $<$ that defines an **ordering** on $S$. 
Bubble sort

Bubble sort is an in-place sorting algorithm in which the largest element “bubbles up” during each pass. Bubble sort makes \( n-1 \) passes through the data, performing pairwise comparisons of elements using \(<\). During a pass, if bubble sort finds two elements out of order, it swaps them.

Bubble sort maintains the invariant (an always-true logical rule) that the rightmost \( n \)-numSorted elements are sorted.

I.e., bubble sort builds a sorted order to the right.

Bubble sort algorithm

```java
public static void bubbleSort(int data[], int n)
// pre: 0 <= n <= data.length
// post: values in data[0..n-1] in ascending order
{
    int numSorted = 0; // number of values in order
    int index; // general index
    while (numSorted < n)
    {
        // bubble a large element to higher array index
        for (index = 1; index < n-numSorted; index++)
        {
            if (data[index-1] > data[index])
                swap(data, index-1, index);
        }
        // at least one more value in place
        numSorted++;
    }
}
```

Bubble sort complexity

Bubble sort is an \( O(n^2) \) sorting algorithm in the worst case. The naive algorithm is also \( O(n^2) \) in the best case. With a small modification, bubble sort is \( O(n) \) in the best case (i.e., where the array is already sorted).

Bubble sort’s performance is bad enough that there are few practical uses for it (other than for teaching!).
What if…

… you wanted to sort arbitrary objects?

What’s problematic with our bubble sort implementation?

Recap & Next Class

**Today:**

• More sorting algorithms
• Sorting arbitrary data

**Next class:**

• Comparators
• More sorts