CSSE 220 Day 14

Sorting Algorithms
Algorithm Analysis and Big-O
Searching

Checkout *SortingAndSearching* project from SVN

Exam recap

- Look at a few problems together
  - Computer part, and problems 3, 5, 6.
- Student questions?
- If you think one of your problems was incorrectly graded, talk with me during the work time at the end of class.

- Questions about anything in the course?

What is sorting?

- Let's see…

Why study sorting?

- Shlemiel the Painter

Course Goals for Sorting: You should…

- Be able to describe basic sorting algorithms:
  - Selection sort
  - Insertion sort
  - Merge sort
  - Quicksort
- Know the run-time efficiency of each
- Know the best and worst case inputs for each

Selection Sort

- Basic idea:
  - Think of the list as having a sorted part (at the beginning) and an unsorted part (the rest)
  - Find the smallest value in the unsorted part
  - Move it to the end of the sorted part (making the sorted part bigger and the unsorted part smaller)

Repeat until unsorted part is empty

Profiling Selection Sort

- Profiling: collecting data on the run-time behavior of an algorithm

- How long does selection sort take on:
  - 10,000 elements?
  - 20,000 elements?
  - …
  - 80,000 elements?

Q1

Analyzing Selection Sort

- Analyzing: calculating the performance of an algorithm by studying how it works, typically mathematically
- Typically we want the relative performance as a function of input size

- Example: For an array of length *n*, how many times does `selectionSort()` call `compareTo()`?

Handy Fact
$1 + 2 + \ldots + (n-1) + n = \frac{n(n+1)}{2}$

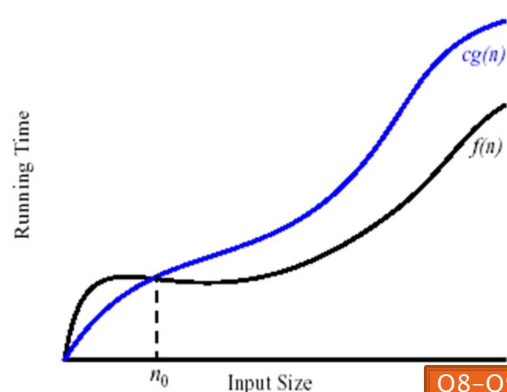
Q2-Q7

Big-Oh Notation

- In analysis of algorithms we care about differences between algorithms on very large inputs
- We say, "selection sort takes on the order of n^2 steps"
- Big-Oh gives a formal definition for "on the order of"

Formally

- We write f(n) = O(g(n)), and say "f is big-Oh of g"
- if there exists positive constants c and n_0 such that
- $0 \leq f(n) \leq c\, g(n)$ for all $n > n_0$
- g is a ceiling on f



Q8–Q9

Another Interesting Comic on Sorting … follow link
http://www.smbc-comics.com/?db=comics&id=1989

Perhaps it's time for a break.

Insertion Sort

- Basic idea:
  - Think of the list as having a sorted part (at the beginning) and an unsorted part (the rest)
  - Get the first value in the unsorted part
  - Insert it into the correct location in the sorted part, moving larger values up to make room

Repeat until unsorted part is empty

Insertion Sort Exercise, Q10-19

- Profile insertion sort
- Analyze insertion sort assuming the inner while loop runs the maximum number of times
- What input causes the worst case behavior? The best case?
- Does the input affect selection sort?

Ask for help if you're stuck!

Q10-Q19

Searching

- Consider:
  - Find Cary Laxer's number in the phone book
  - Find who has the number 232-2527
- Is one task harder than the other? Why?
- For searching unsorted data, what's the worst case number of comparisons we would have to make?

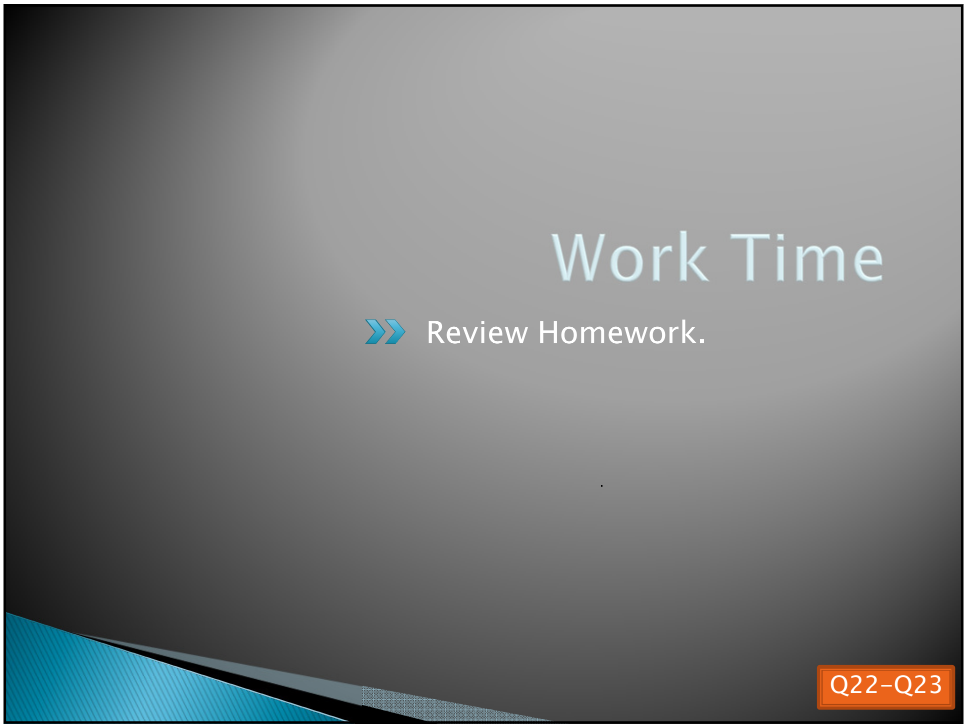
Binary Search of Sorted Data

- A divide and conquer strategy
- Basic idea:
  - Divide the list in half
  - Decide whether result should be in upper or lower half
  - Recursively search that half

Analyzing Binary Search

- What's the best case?
- What's the worst case?
- We use recurrence relations to analyze recursive algorithms:
  - Let T(*n*) count the number of comparisons to search an array of size *n*
  - Examine code to find recursive formula of T(*n*)
  - Solve for *n*

Q20–Q21


Work Time
Review Homework.
Q22-Q23