CS1004: Intro to CS in Java, Spring 2005

Lecture #20: Algorithms, cont'd.

Janak J Parekh
janak@cs.columbia.edu

Administrivia

- HW#4 due now
- Extra credits returned today

Board examples

- Finish Fibonacci numbers
- Array algorithms
  - Search for a number (or an item in general) in a list
  - Find the largest number in a list
  - Sort numbers
- We'll do more in the homework and in the rest of the semester

Algorithm correctness & efficiency

- Define desirable characteristics in an algorithm:
- Correctness
  - Does the algorithm solve the problem it is designed for?
  - Does the algorithm solve the problem correctly?
- Ease of understanding
  - How easy is it to understand or alter an algorithm?
  - Important for program maintenance

Attributes of Algorithms (continued)

- Elegance
  - How clever or sophisticated is an algorithm?
  - Sometimes elegance and ease of understanding work at cross-purposes
- Efficiency
  - How much time and/or space does an algorithm require when executed?
  - Perhaps the most important desirable attribute

Measuring Efficiency

- Analysis of algorithms
  - Study of the efficiency of various algorithms
- Efficiency measured as function relating size of input to time or space used
- For one input size, best case, worst case, and average case behavior must be considered
- The Θ/O notation captures the order of magnitude of the efficiency function
  - Θ ("big-Theta") vs. O ("big-Oh") notation

Order of Magnitude: Order n

- As n grows large, order of magnitude dominates running time, minimizing effect of coefficients and lower-order terms
- All functions that have a linear shape are considered equivalent
- Order of magnitude n
  - Written O(n)
  - Functions vary as a constant times n

Sequential Search, analyzed

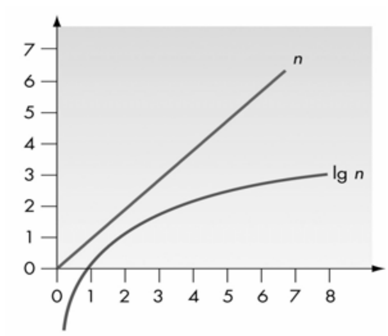
- Comparison of the *NAME* being searched for against a name in the list
  - Central *unit* of work
- For lists with n entries:
  - Best case
    - *NAME* is the first name in the list, 1 comparison
    - O(1)
  - Worst case
    - *NAME* is the last name in the list, or not in list
    - n comparisons, or O(n)
  - Average case
    - Roughly n/2 comparisons, or O(n)

Sequential Search (continued)

- Space efficiency
  - Uses essentially no more memory storage than original input requires
  - Very space-efficient
- But… is there a faster way to search through a list?

Binary Search

- Given ordered data,
  - Search for *NAME* by comparing to middle element
  - If not a match, restrict search to either lower or upper half only
  - Each pass eliminates half the data
- Efficiency
  - Best case
    - 1 comparison: O(1)
  - Worst case
    - lg n comparisons: O(lg n)
    - *What's lg n?*



A Comparison of n and lg n (S/G, pg. 109)

Sorting

- What if we want to sort the numbers in a list?
- There are number of algorithms; book describes selection sort, but we'll also go over bubble sort very quickly.
- Let's begin!

Next time

- Finish working with algorithms (for now)
- Begin OO design