CS1004: Intro to CS in Java, Spring 2005

Lecture #19: Algorithms, cont'd.

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Administrivia

- HW#4 due on Tuesday
- I'm behind on my email/homework fixes… I should be caught up by Tuesday

Board examples

- Palindrome checker (see book for code)
- Print out the first *n* Fibonacci numbers
- Search for a number (or an item in general) in a list
- Find the largest number in a list
- Sort numbers
- Other examples in the books

Strategy

- General process:
  - Identify the main classes/data involved
  - Try to do one or two steps by hand
  - Generalize and write out the algorithm
- Let's begin, on the board
- We'll then talk about how to *characterize* the resulting algorithms we get

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 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 Θ(n)
  - Functions vary as a constant times n

Sequential Search, analyzed

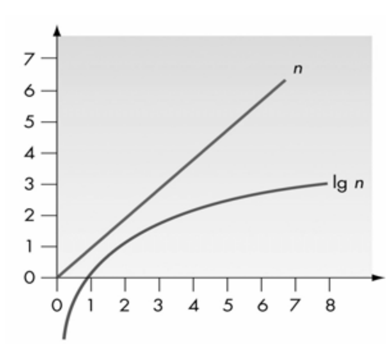
- Comparison of the *NAME* being searched for against a name in the list
  - Central *unit* of work
- For lists with n entries:
  - Best case
    - *NAME* is the first name in the list, 1 comparison
    - Θ(1)
  - Worst case
    - *NAME* is the last name in the list, or not in list
    - n comparisons,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



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

- Continue working with algorithms