CS W3134: Data Structures in Java
Lecture #5: Lists, cont’d.
9/21/04
Janak J Parekh

Administrivia

- Homework 1 is out! Who’s read it?
- Let me show you what it should do…
- Textbooks – have you guys been getting them? The bookstore has some 50 copies left…?

Agenda

- Continue lists
“Unordered” lists

- How do we do…
  - Insert()
  - Delete()
  - Find()
  - Display()
  - Sort() (We wait)
- Play with the sample applet
- Operations include New, Fill, Insert, Find, Delete

Ordered lists

- What’s an ordered list?
- How do we do…
  - Insert()? Book page 60 has a clever technique
    - Once you find the “right point”, slide down in a “bottom-up fashion”
  - Find()? Book page 57
    - Binary search
    - Key: play the “number-guessing game”, but as an algorithm. Start in the middle and keep on cutting your search space by half. Let’s look at an example…

Costs

- How much do each of the previous operations cost in the worst case?
  - Most are linear, some are unit
  - Binary search is special – it’s better than linear time
    - Divide the range by half until too small to divide further == # of comparisons needed
    - Reverse: what’s the range that can be covered with $n$ steps? (Book page 63)
      - i.e., $r = 2^s$
      - What’s this expressed as in terms of $s$?
        - $s = \log r$
      - Algorithm grows logarithmically
Formalizing costs

- Terminology differs based on details; we’ll go light
- Time to insert one element is some constant $K$
  - e.g., $T(N) = K$
- Time to search for an element (linearly) is $T(N) = K \times N$
- “Big-Oh Notation”: upper-bound on worst-case time
  - We drop the constant $K$ – for sufficiently large $N$, the constant is unimportant
  - To be precise, we find a function $F(x)$, where $T(x)$ is $O(F(x))$ if $|T(x)| \leq K|F(x)|$ for some $x > c$
  - The idea of doubling your computer’s speed is embedded in $K$
  - $T(N) = O(N)$, for example

Examples of costs

- For lists using arrays?
  - Linear search: $O(N)$
  - Etc.
  - Draw a graph of the comparative costs, page 72
- What are bad about arrays?
  - Slow search in unordered, slow insert in ordered – can we speed both? Yes
  - Fixed size: can we change that? Yes

Sorts

- Applets!
- Bubble (p. 85)
  - Sort pairwise repeatedly
  - Biggest placed each time
- Selection (p. 89)
  - Search for smallest, swap with first
  - Search for smallest, swap with second
- Insertion (p. 95)
  - Take the next one, and put it into the existing sorted subset
- All $O(n^2)$
  - But they’re not the exact same performance
  - Let’s write out a little bit of pseudocode for each
Next Time

- Finish sorting
- Stacks