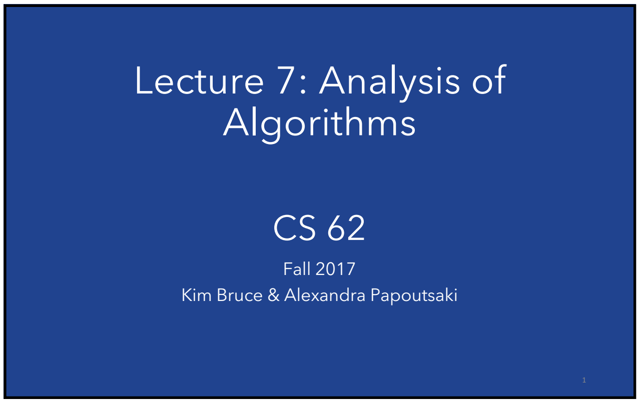
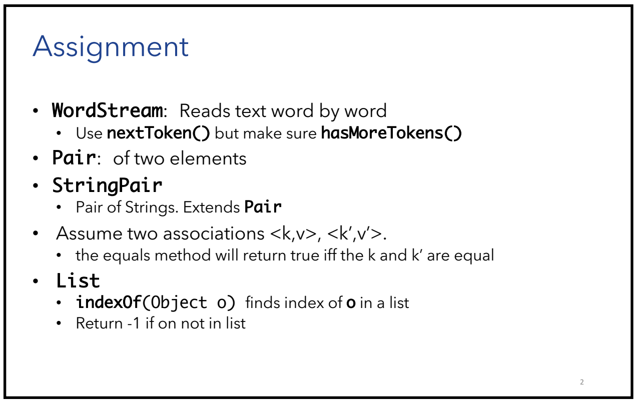


Lecture 7: Analysis of Algorithms

CS 62

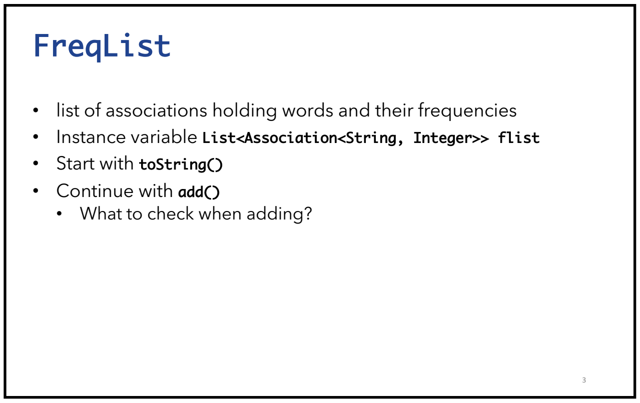
Fall 2017

Kim Bruce & Alexandra Papoutsaki



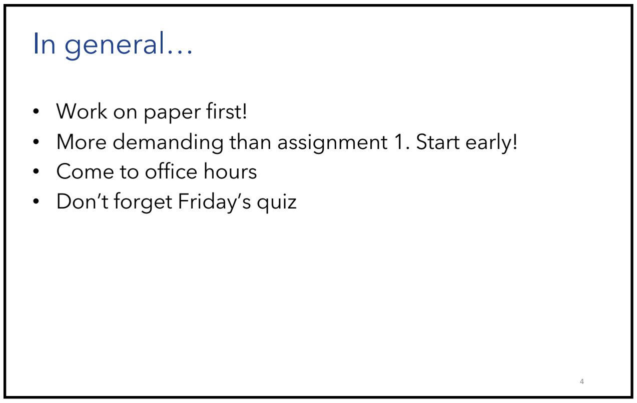
Assignment

- `WordStream`: Reads text word by word
  - Use **`nextToken()`** but make sure **`hasMoreTokens()`**
- `Pair`: of two elements
- `StringPair`
  - Pair of Strings. Extends **`Pair`**
- Assume two associations <k,v>, <k',v'>.
  - the equals method will return true iff the k and k' are equal
- `List`
  - `indexOf(Object o)` finds index of **`o`** in a list
  - Return -1 if on not in list



`FreqList`

- list of associations holding words and their frequencies
- Instance variable **`List<Association<String, Integer>> flist`**
- Start with **`toString()`**
- Continue with **`add()`**
  - What to check when adding?



In general…

- Work on paper first!
- More demanding than assignment 1. Start early!
- Come to office hours
- Don't forget Friday's quiz

Order of Magnitude

- Definition: We say that $g(n)$ is $O(f(n))$ if there exist two constants C and k such that
  $$|g(n)| <= C\ |f(n)|, for\ all\ n > k.$$
- Used to measure time and space complexity of algorithms on data structures of size n.
- Examples:
  - $2n + 1$ is $O(n)$
  - $n^3 - n^2 + 83$ is $O(n$^$3)$
  - $2^n + n^2$ is $O(2$^$n)$
- Most common are:
  - $O(1)$ - for any constant
  - $O(\log n), O(n), O(n \log n), O(n^2), \ldots, O(2^n)$

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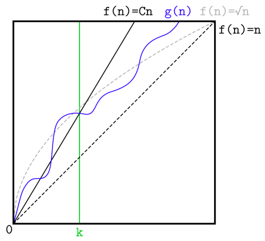
Complexity



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Complexity

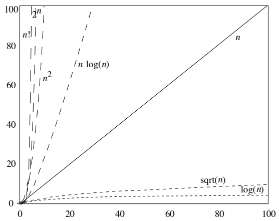

Figure 5.3 Long-range trends of common curves. Compare with Figure 5.2.

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Comparing Orders of Magnitude

- Suppose have ops w/complexities given & problem of size n taking time t.
- How long if increase size of problem?

Problem Size:	*10 n*	*100n*	*1000n*
O(log n)	3+t	7 + t	10+ t
O(n)	10 t	100 t	1000 t
O(n log n)	> 10 t	> 100 t	> 1000 t
O(n^2)	100 t	10,000 t	1,000,000 t
O(2^n)	~ t^{10}	~ t^{100}	~ t^{1000}

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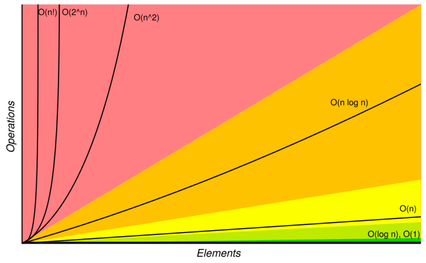
Rule of thumb



Adding to **ArrayList**

- Suppose n elements in **ArrayList** and add 1.
- If space:
  - Add to end is $O(1)$
  - Add to beginning is $O(n)$
- If not space:
  - What is cost of **ensureCapacity**?
  - $O(n)$ because n elements in array

EnsureCapacity

- What if only increase in size by 1 each time?
  - Adding n elements one at a time to end
    - Total cost of copying over arrays: $1 + 2 + 3 + \cdots + (n - 1)\ =\ n(n-1)/2$
    - Total cost of $O(n^2)$
  - Average cost of each is $O(n)$
- What if double in size each time?
  - Suppose add $n\ =\ 2^m$ new **elts** to end
    - Total cost of copying over arrays: $1 + 2 + 4 + \cdots + n/2\ =\ n - 1, O(n)$
    - Average cost of $O(1)$, but “lumpy”

ArrayList Operations

- Worst case:
  - $O(1)$: **size, isEmpty, get, set**
  - $O(n)$: **remove, add**
- Add to end is on average $O(1)$