Topic 9
Maps

"He's off the map!"
- Stan (Mark Ruffalo) *Eternal Sunshine of the Spotless Mind*

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Data Structures

- More than arrays and lists
- Write a program to count the frequency of all the words in a file.
- Make a simplification: assume words are anything set off by whitespace

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Performance using ArrayList

<table>
<thead>
<tr>
<th>Title</th>
<th>Size (kb)</th>
<th>Total Words</th>
<th>Distinct Words</th>
<th>Time (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>small sample</td>
<td>0.6</td>
<td>89</td>
<td>25</td>
<td>0.001</td>
</tr>
<tr>
<td>2BR02B</td>
<td>34</td>
<td>5,638</td>
<td>1,975</td>
<td>0.051</td>
</tr>
<tr>
<td>Alice in Wonderland</td>
<td>120</td>
<td>29,460</td>
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<td>0.741</td>
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<tr>
<td>Adventures of Sherlock Holmes</td>
<td>581</td>
<td>107,533</td>
<td>15,213</td>
<td>4.144</td>
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<tr>
<td>2008 CIA Factbook</td>
<td>10,030</td>
<td>1,330,100</td>
<td>74,042</td>
<td>173.000</td>
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</tbody>
</table>

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Order?

- Express change in size as factor of previous file

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O(Total Words * Distinct Words) ??
Clicker Question

- Given 3 minutes for the 2008 CIA Factbook with 1,330,100 total words and 74,042 distinct words, how long for 1,000x total words and 100x distinct words?
  A. an hour
  B. a day
  C. a week
  D. a month
  E. half a year

Why So Slow

- Write a contains method for an array based list

  ```java
  public boolean contains(E target) {
  ```

A Faster Way - Maps

- Also known as:
  - table, search table, dictionary, associative array, or associative container
- A data structure optimized for a very specific kind of search / access
- In a map we access by asking "give me the value associated with this key."
- Recall, in the ArrayList example we did not count the number of occurrences of each word

Keys and Values

- Dictionary Analogy:
  - The key in a dictionary is a word: `foo`
  - The value in a dictionary is the definition:
    `First on the standard list of metasyntactic variables used in syntax examples`
- A key and its associated value form a pair that is stored in a map
- To retrieve a value the key for that value must be supplied
  - A List can be viewed as a Map with integer keys
More on Keys and Values

- Keys must be unique, meaning a given key can only represent one value
  - but one value may be represented by multiple keys
  - like synonyms in the dictionary.
  
  Example:
  - factor: n.See coefficient of $X$
  - factor is a key associated with the same value (definition) as the key coefficient of $X$

The Map Interface in Java

- void clear()
  - Removes all mappings from this map (optional operation).

- boolean containsKey(Object key)
  - Returns true if this map contains a mapping for the specified key.

- boolean containsValue(Object value)
  - Returns true if this map maps one or more keys to the specified value.

- Set<K> keySet()
  - Returns a Set view of the keys contained in this map.

The Map Interface Continued

- V get(Object key)
  - Returns the value to which this map maps the specified key.

- boolean isEmpty()
  - Returns true if this map contains no key-value mappings.

- V put(K key, V value)
  - Associates the specified value with the specified key in this map

The Map Interface Continued

- V remove(Object key)
  - Removes the mapping for this key from this map if it is present

- int size()
  - Returns the number of key-value mappings in this map.

- Collection<V> values()
  - Returns a collection view of the values contained in this map.
### Results with HashMap

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