Solving Problems: Anagrams/Jumbles

- How do humans solve puzzles like that at [www.jumble.com](http://www.jumble.com)
  - Is it important to get computers to solve similar puzzles? Reasons?
  - Should computers mimic humans in puzzle-solving, game playing, etc.? Lessons from chess?

- nelir, nelri, neilr, neirl, nerli, neril, nleir, nleri, nlier, nlire, nlrei, nlrie, nielr, nierl, niler, nilre, nirel, ... lenir, lenri, leirn, leinr, leirn, lerni, lerin, liner
  - What’s the problem here?
Brute force? SillyAnagrams.java

```java
public String[] allAnagrams(String s) {
    int anaCount = factorial(s.length());
    Set anagrams = new TreeSet();
    ArrayList list = new ArrayList();
    for (int k=0; k < s.length(); k++) {
        list.add(s.substring(k, k+1));
    }
    while (anagrams.size() != anaCount) {
        Collections.shuffle(list);
        anagrams.add(listToString(list));
    }
    return (String[]) anagrams.toArray(new String[0]);
}
```
Quantifying brute force for anagrams

- All anagrams of "compute" takes average of 1 second over 20 trials. How long will "computer" take? Why?
  - What is worst case time?
  - What is best case time?

- We’re willing to do some pre-processing to make the time to find anagrams quicker
  - Often find that some initialization/up-front time or cost (investment?) saves in the long run
  - What properties do words share that are anagrams?
Toward a faster anagram finder

- Words that are anagrams have the same letters; use a letter fingerprint or signature/histogram to help find anagrams
  - Count how many times each letter occurs:
    - “teacher” 1 0 1 0 2 0 0 1 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0
    - “cheater” 1 0 1 0 2 0 0 1 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0

- Store words, but use fingerprint for comparison when searching for an anagram
  - How to compare fingerprints using .equals()
  - How to compare fingerprints using .compareTo()

- How do we make client programmers unaware of fingerprints? Should we do this?
Another anagram method

- Instead of fingerprint/histogram idea, use sorted form of word
  - “gable” and “bagel” both yield “abegl”
  - Anagrams share same sorted form

- Similarities/differences to histogram/fingerprint idea?
  - Both use canonical or normal/normalized form
  - Normalized form used for comparison, but not for printing
  - When should this normal form be created?

- When is one method preferred over the other?
  - Big words, little words? Different alphabets? DNA vs English?
We’ll use an adapter or wrapper class called \texttt{Anaword} instead of \texttt{String}

- Clients can treat Anaword objects like strings, but the objects are better suited for finding anagrams than strings.
- The Anaword for “bear” prints as “bear” but compares to other Anaword objects as $11001000000000000100000000$

In Java change behavior with \texttt{.toString()} and \texttt{.equals()}

- No overloaded operators as in C++
  - Exception is $+$, this works for strings, but can't change it.
- When string needed, automatically call \texttt{toString()}.
Understandable, extensible?

- The code does things simply, but isn't very OO. Why is simple sometimes better? Why is it worse?

```java
void printAll(Anaword[] list, Anaword target) {
    System.out.print("anagrams of "+target+: ");

    for(int k=0; k < list.length; k++){
        if (target.equals(list[k])) {
            System.out.print(list[k]);
        }
    }
    System.out.println();
}
```
Find all anagrams in dictionary

- If we sort the dictionary what will happen to the anagrams?
  - capitol optical topical
  - danger gander garden ranged
  - lameness maleness nameless salesmen

- How can we overload \texttt{.equals()}
  - Look at "danger" or 1001101000000100010….

- How can we sort with Collections.sort or Arrays.sort
  - Elements sorted must be \texttt{comparable}/sortable
  - Must \texttt{implement} the java.lang.Comparable \texttt{interface}
    - Return negative, zero, positive number depending on less than, equal to, or greater than
    - What is method signature?
Anaword objects with options

- **Can we use different canonical forms in different contexts?**
  - Could have Anaword, FingerPrintAnaword, SortAnaword
  - What possible issues arise? What behavior is different in subclasses?
    - If there’s no difference in behavior, don’t have subclasses

- **Alternative, make canonical/normalize method a class**
  - Turn a function/idea into a class, then let the class vary to encapsulate different methods
  - Normalization done at construction time or later
  - Where is normalizer object created? When?
Anagram: Using Normalizers

- How can we normalize an Anaword object differently?
  - Call normalize explicitly on all Anaword objects
  - Have Anaword objects normalize themselves
  - Advantages? Disadvantages?

- If Anaword objects normalize themselves, how can we experiment with different normalization techniques?
  - Cut and paste. Problems? Versions? Saved code?
  - What about using save-as and several .java files?
  - What about deciding at runtime on normalization?

- We need inheritance!
Normalizer hierarchy

- **Anaword objects normalize themselves**
  - Where does the normalizer come from?
    - Passed in at construction time
    - Obtained from normalizer factory
    - Other approaches?

- How is Normalizer used?

- **Normalizer is conceptually an interface**
  - Different implementations of the interface have different behavior (guts) but same skin (sort of)