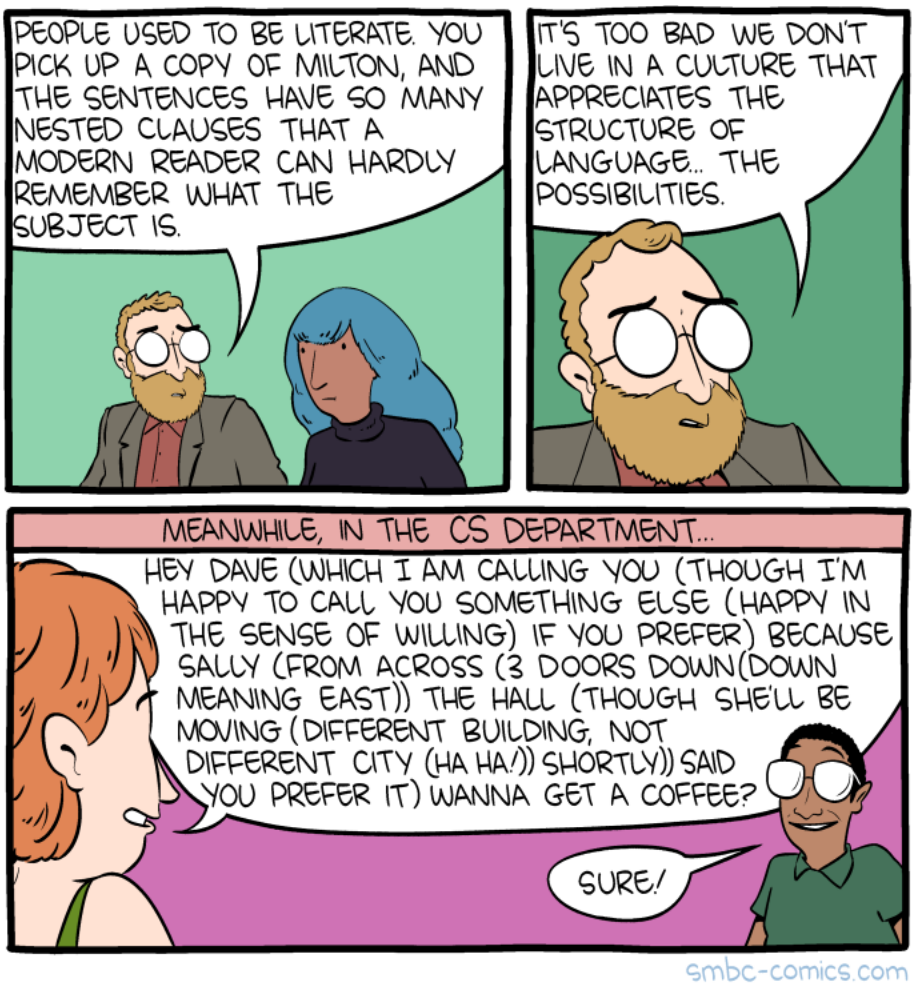
CS159 - Assignment 1
Data Analysis and Regular Expressions

Due: Wednesday, 9/2 @ 11:59pm (your time zone)



`http://www.smbc-comics.com/index.php?db=comics&id=2884`

Regular expressions are one of the more useful tools for many NLP tasks. The goals of this assignment are to familiarize yourself with regular expressions, to play with them in different languages/environments, to get some experience with some useful command-line tools, and to get a feeling for text data analysis.

You will only be handing in a write-up for this assignment, however, it will involve coding and experimentation. You will not hand-in any code, but you are still expected to write the code yourself (we will do group projects soon) and should not be copying material from online, etc. If you have any question about what is appropriate, feel free to come talk to me.

`sed` and `grep`

For this assignment, we'll be using two command-line tools, `grep` and `sed`. If you're using a Mac, these are built-in and can be accessed via terminal. If you're using Windows, I'd recommend installing a Linux emulator like cygwin (`https://www.cygwin.com/`), which has these built-in, though you're also welcome to try and install `sed` and `grep` individually. Another option is to ssh into `little.cs.pomona.edu` (you'll need to VPN into the campus network first) and run the experiments on little. If all else fails, I am willing to allow pairs *just on the `grep/sed` portion of this assignment if you contact me beforehand.*

Before starting, you may find it useful to read the notes section at the end of this handout which discusses `grep` and `sed` as well as review some of the links posted at the end of the regular expression slides posted on the course webpage.

Resources

For some of the problems in this assignment you will be processing real data. These files can all be found at:

`http://www.cs.pomona.edu/classes/cs159/assignments/assignment1_resources.zip`

String matching [10 points]

For all of the following problems you MUST use regular expressions exclusively.

1. Write two Java functions that take as input a `String` and return a `boolean` indicating whether that string is a valid social security number. They should both use a single regular expression to do the entire matching (one per problem) and should not do any additional string processing, etc.

   (a) To start with, we'll define a social security number (SSN) as a number consisting of 9 digits. Optionally, the SSN may be separated into 3 digits, 2 digits and 4 digits by two dashes '-' (note that it must either have 2 dashes or none).

   (b) The first version isn't exactly correct for social security numbers. Currently, the first three digits of the SSN must be less than or equal to 772[1], though the other 6 numbers can

[1] along with a few other restrictions we won't worry about

be any number. Write a second Java function that enforces this additional restriction. For simplicity, you may assume that for this version the user must enter dashes.

Include these two functions in your writeup.

2. For this problem, we're going to be analyzing 100K twitter posts found in `twitter.posts.txt` in the assignment1 resources data.

   Before there was an explicit mechanism to retweet, users would use various notations to indicate a retweet. Write a statement using `grep` that selects all the lines in the file that contain retweets. A retweet is signified by the characters "rt" (all capitalization variants) or the word "Retweet", optionally follow by a colon, optionally followed by some number of spaces, followed by an '@', directly followed by a username (which consist of only alphanumeric characters), and then concluded with either whitespace, a colon, or the end of the string. A retweet must be preceded by a space or be at the beginning of the string, so be careful not to match something like "blurt @bobby".

   The following are examples of valid retweets:
   RT @profkauchak ...
   ... rt @teran471
   blah blah Retweet:@theman blah blah

   Include your `grep` statement in your writeup as well as your answers to the following questions:

   (a) Of the 100K tweets, how many included a retweet? (*Hint:* The `wc` command might be useful for counting.)
   (b) How many used "RT" to denote the retweet? "Rt"? "rt"? "Retweet"?

A quick overview of `grep` can be found at the end of this handout.

String replacement [10 points]

3. HTML processing

   Using `sed`, write one command-line expression, i.e. that you type it all and then press return only once (though you can use multiple `sed` statements chained together with pipes), to do all of the following to an input file:

   - remove all the html tags from the document (an html tag is any text surrounded by '<>' and may contain spaces). Be careful about greedy matching. Both '*' and '+' try and match as much as they can, so if you just use them with say '<.*>', it can match the whole line if the whole line starts and ends with brackets (even though it may be multiple tags). Think about what characters can and, more importantly, can't be inside an html tag.
   - change any sequences of ` ` to spaces

- the title of an html article is enclosed with "<title> ... </title>" tags. Before removing the html tags, identify the title and prepend it with "Title:". For example, if in the file the title was "<title>A Brave New World</title>", then you would replace this sequence with "Title: A Brave New World".

The input file should be called *filename*.

For example, if the the following html was in the filename

```
<html>
<title>This is the best title!</title>
<body>
This <i>test</i> article uses <b>old school</b> formatting
rather than <font color="red">css.</font>
</body>
</html>
```

then the result of running your call would be:

```
Title: This is the best title!

This test article uses old school formatting
rather than css.
```

A quick overview of `sed` can be found at the end of this handout.

4. Write a function in Perl, Python or Java that takes as input a string representing a single word and returns a pig latin version of that word. Any string processing should be done using ONLY the regular expression functionality of the language. To turn a word into pig latin, move any sequence of one or more consonants at the beginning of the word to the end, then, regardless of what letter the word stars with, add 'ay' to the end of it. For example "crouton → outoncray" or "snake → akesnay" or "another" → "anotheray".

Data analysis [30 points]

For this last problem, you will be analyzing a real corpus consisting of two files `normal.txt` and `simple.txt` found in the assignment resources data. Each of these files contains text from Wikipedia articles, `normal.txt` from English Wikipedia and `simple.txt` from Simple English Wikipedia. The files each contain articles on the same 500 topics. The articles are delimited by the `TITLE` descriptor and paragraphs are delimited by blank lines. To answer the questions in this section, you may do it however you'd like; the only thing that matters is the answer.

3. Create a table that has normal Wikipedia in one column and simple Wikipedia in the other column. Include a row for each of the following for each Wikipedia (in this order):

   - `Paragraphs:` How many paragraphs does each data set contain? What is the average number of paragraphs per article?
   - `Sentences:` How many sentences does each data set contain? What is the average number of sentences per article?

     To do this, write a simple sentence segmenter. We will use a fairly simple definition of a sentence. First, split the paragraphs into sentences based on any text that ends with a '?' or '!' or '.' optionally proceeded by quotes. Now, go back through and merge sentences with the following criterion: 1) sentences should not start with a lowercase letter, if one does, merge it with the previous sentence 2) if a sentence ends with a period and the last word is a capitalized word with three or less characters, then merge it with the sentence that follows it.
   - `Words total:` How many words does each data set contain?

     To do this, write a simple word tokenizer. First split the text (not including the titles) into tokens based on whitespace. Then, for each token, as long as it starts or ends with: `" , : ; ' ( ) . ? !` then split that character off as a new token. For example, the token `banana."` would end up as three different tokens since you would continue to split off trailing characters.

     We'll then define a "word" as any token that contains any alphanumeric characters, for example, a period by itself or "()" would not be considered a word.
   - `Words per article:` What is the average number of words per article?
   - `Words per sentence:` What is the average number of words per sentence?
   - `Vocab size:` How many *different* words are there in each of the data sets (i.e what is the vocabulary size)? Count different capitalization variants as different words, i.e. "dog" and "Dog" would count as two different words.
   - **Vocab size2:** What is the vocabulary size if you lowercase all of the words, i.e. "dog" and "Dog" would be considered one word?

4. List one example (you can make it up) where our sentence splitting approach does not do the correct thing.

5. List one example (you can make it up) where our tokenization technique does not do the correct thing.

6. List the top ten most frequent words in each data set with their frequencies. Are there any surprises? Do they differ much?

7. Find two more interesting pieces of data to compare/contrast between these data sets. You will be graded on how creative your analysis is, how difficult the analysis was and how profound your results are. If you need ideas, come talk to me (earlier than later) and we can bounce some ideas around. Extra credit will be given for particularly insightful analysis.

Extra credit [up to 4 points]

In the data analysis work, we implemented fairly basic word tokenizers and sentence segmenters. For extra credit, you may improve one or both of these. If you do, include in your write a) what you did and b) how this changed your results compared to the "original" versions. Extra credit will be awarded based on the quality of the improvements.

When you're done

Submit your writeup in .doc, .pdf or .txt using the course submission mechanism linked on the course web page.

Useful notes

- `grep`

  `grep` is a command line tool that allows you to find lines in a file that match particular regular expressions. Most frequently, `grep` takes two parameters, a double quoted regular expression and a filename. `grep` will then print to the console all lines in the file that match the regular expression (the `-v` flag causes `grep` to return all non-matching lines). For example

  ```
  grep "banana" file
  ```

  would output all lines in the file that contained the string banana, including lines that had other variants like bananas. `grep` does not have the character class shortcuts (like \d, \w, etc.) however, you can make your own using brackets (like [0-9]). `grep` has many other useful features that you can experiment with. I would suggest always using `grep -E`, which has uses the more traditional notation.

  You can find documentation for `grep` online, for example:

  ```
  http://www.panix.com/~elflord/unix/grep.html
  ```

  is pretty good. You can also type `man grep` to get some information. Using `grep -E` does have a few extra useful features, for example it will allow you to use the `\b` character for denoting a boundary (whitespace or the beginning/end).

- `sed`

  `sed` is another command-line program. `sed` is particularly useful for doing string substitutions in a file. Like `grep`, the most common way to use `sed` is to pass it a command in quotes as the first argument and then a filename as the second. The most common way to use `sed` is with the substitution command:

  ```
  sed -E "s/aa/bb/" filename
  ```

  which will substitute *the first* occurrent of "aa" on each line with "bb" and print it out to the console (or you could redirect it to an file using '`>`'). If you want it to substitute all occurrences, use the global flag:

  ```
  sed -E "s/aa/bb/g" filename
  ```

  You can use other standard regular expression techniques with `sed` including things like '.' for matching everything, character classes using '[]', and the use of groups identified by parenthesis in the matching expression and then denoted by '\\1', '\\2', etc. For example:

  ```
  sed -E "s/([dD]ave)/\\1 is great/g" filename
  ```

  would add " is great" after every occurrence of "dave" or "Dave" in a file.

  `sed` will also read input from the console if you don't provide a filename. This features is frequently used to chain sed statements together. For example:

  ```
  sed -E "s/[0-9]+//g" filename | sed -E "s/ +/ /g"
  ```

  which first removes all numbers then pipes/sends the output from that to another `sed` call using '|', which then removes multiple spaces.

For additional information type `man sed` or see resources online, for example http://www.grymoire.com/Unix/Sed.html.