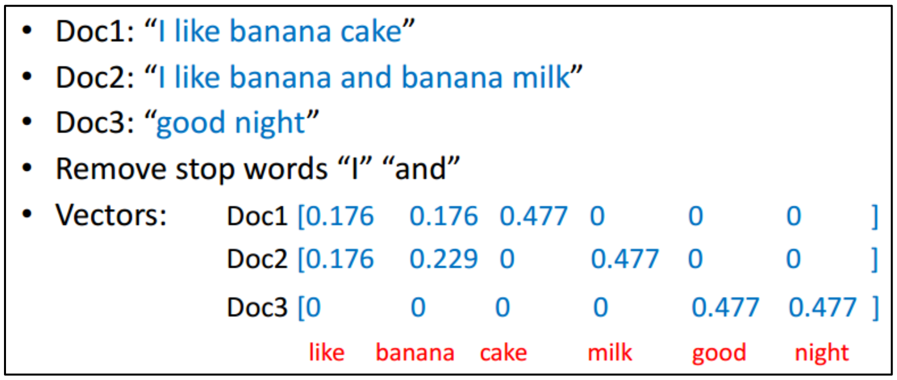
CS5344 Lab 2

AY2021/2022 Semester 2

Write a Spark program that finds the top-10 most relevant documents given a query comprising of set of keywords and identify the most relevant sentence in these documents to the query. This is an individual lab assignment.

A *document* can be modelled as a vector of words (or terms). Each entry in the vector is a **TF-IDF** value that reflects how important a word is to a document in a collection, computed as **TF-IDF = log (1 +TF) * log (N/DF)** where N is total number of documents, TF is the count of the word in a document, and DF is the count of documents having the word. Figure 1 shows a simple example.



- Doc1: "I like banana cake"
- Doc2: "I like banana and banana milk"
- Doc3: "good night"
- Remove stop words "I" "and"
- Vectors:

	like	banana	cake	milk	good	night
Doc1	0.176	0.176	0.477	0	0	0
Doc2	0.176	0.229	0	0.477	0	0
Doc3	0	0	0	0	0.477	0.477

Figure 1. Example of representing documents as vectors.

A *query* can also be represented as a vector where each entry represents a word with a value 1 if the word is in the query, and 0 otherwise. We can compute a *relevance score* for each document *d* to a query *q* based on the based on the cosine similarity of their corresponding vectors V_1 and V_2 and rank the documents with respect to a query:

$$\textbf{relevance (q, d)} = cosine(\overrightarrow{V_1}, \overrightarrow{V_2}) = \frac{\overrightarrow{V_1} \cdot \overrightarrow{V_2}}{||\overrightarrow{V_1}|| \times ||\overrightarrow{V_2}||}$$

Algorithm.

Step 1. Compute term frequency (TF) of every word in a document.
This is similar to the Word Count program in Lab 1.

Step 2. Compute TF-IDF of every word w.r.t a document.
Use key-value pair RDD and the groupByKey() API for this step.

Step 3. Compute normalized TF-IDF of every word w.r.t. a document.

If the TF-IDF value of *word1* in *doc1* is t_1 and the sum of squares of the TF-IDF of all the words in *doc1* is S, then the normalized TF-IDF value of *word1* is $\frac{t_1}{\sqrt{S}}$.

Step 4. Compute the relevance of each document w.r.t a query.

Step 5. Sort and get top-10 documents.

Step 6. For each of the top-10 document, compute the relevance of each sentence w.r.t the query. A sentence is delimited by a full-stop.

Step 7. Output the most relevant sentence for each of the top-10 document.

Input: (a) set of documents (in "datafiles" folder),
(b) set of keywords for a query (in *query.txt*)
(c) stopwords to remove (in *stopwords.txt*).

Output: One line per document in the following format:
<docID> <document relevance score> <relevant sentence> <sentence relevance score>

The output should be sorted in descending order of the relevance of the documents to the query.

Deliverables: Zip your executable Spark program(s) with documentation in the code, the output files, and upload it to the Lab2 folder in Luminus. The zipped folder should be named as Student ID_Lab2.

Important Notes:

- Your code should be executable either on the virtual machine configuration given in Lab 1 or on stand-alone Spark configuration.
- Specify the python version you use in your program.
- For data preprocessing, all words should be transformed to lowercase.
- The logarithm for TFIDF is log10.