Assignment 1: Linear Algebra and Probability

Submission: Tuesday Febrary 20th
Maximum 2 students per group

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Machine Learning - 2018-I
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1. Do the tutorial "Kaggle Python Tutorial on Machine Learning" (`https://www.datacamp.com/courses/kaggle-python-tutorial-on-machine-learning`). Complete the 3 chapters and include a screenshot showing the 100% completion of each chapter, as well as a screenshot of the submission to Kaggle.

2. Let $D = \{d_1, \ldots, d_n\}$ be a set of documents and $T = \{t_1, \ldots, t_m\}$ a set of terms (words). Let $TD = (TD_{i,j})_{i=1\ldots m, j=1\ldots n}$ be a matrix such that $TD_{i,j}$ corresponds to the number of times the term t_i appears in the document d_j. Also, let l_i be the length, number of characters, of term t_i, and let $L = (l_1, \ldots, l_m)$ be a column vector. Finally, assume a process where a document d_j is randomly chosen with uniform probability and then a term t_i, present in d_j, is randomly chosen with a probability proportional to the frequency of t_i in d_j.

   For all the following expressions you must provide:

   - a mathematical expression to calculate it that includes TD, L, constants (scalars, vectors or matrices) and linear algebra operations
   - a expression in Numpy (http://www.scipy.org) that, when evaluated, generates the requested matrix, vector or scalar (the expression must be a linear algebra expression that does not involve control structures such as for, while etc.)
   - the result of evaluating the expression, assuming:

$$TD = \begin{bmatrix} 2 & 3 & 0 & 3 & 7 \\ 0 & 5 & 5 & 0 & 3 \\ 5 & 0 & 7 & 3 & 3 \\ 3 & 1 & 0 & 9 & 9 \\ 0 & 0 & 7 & 1 & 3 \\ 6 & 9 & 4 & 6 & 0 \end{bmatrix} \quad L = \begin{bmatrix} 5 \\ 2 \\ 3 \\ 6 \\ 4 \\ 3 \end{bmatrix}$$

   (a) Matrix $P(T, D)$ (each position of the matrix, $P(T, D)_{i,j}$, corresponds to the joint probability of term t_i and document d_j, $P(t_i, d_j)$)

   (b) Matrix $P(T|D)$

   (c) Matrix $P(D|T)$

   (d) Vector $P(D)$

   (e) Vector $P(T)$

(f) $E[l]$ (the expected value of the random variable l corresponding to the length of a randomly chosen term)

(g) $\mathrm{Var}(l)$ (the variance of l)

3. The assignment must be submitted as a Jupyter notebook through the following Dropbox file request, before midnight of the deadline date. The notebook along with the screenshots must be put in a compressed file (using zip) with name `ml-assign1-unalusername.`zip, where `unalusername` is the user name assigned by the university of one of the members of the group.