AI, Ethics, and Society

Homework Project #4

Readings:
- Chapter 7: Weapons of Math Destruction (Sweating Bullets: On the Job)
- "A Few Useful Things to Know about Machine Learning" by Pedro Domingos
  https://homes.cs.washington.edu/~pedrod/papers/cacm12.pdf

In this assignment, you'll apply AI/ML algorithms related to two applications – word embeddings and facial recognition.

Task Set #1: Here you will use distributional vectors trained using Google's deep learning Word2vec system.

1. Familiarize yourself with the original paper on word2vec - Mikolov et al. (2013) (http://papers.nips.cc/paper/5021-distributed-representations-of-words-and-phrases-and-their-compositionality.pdf). To learn more about the system and how to train your own vectors, you can find more information here (https://code.google.com/archive/p/word2vec). To learn about the python wrapper around Word2vec, you can find more information here (https://rare-technologies.com/word2vec-tutorial/)
2. Install Gensim (Example: pip install gensim. | pip install --upgrade gensim)
3. Download the provided reducedvector.bin file on Canvas which is a a pre-trained Word2vec model based on the Google News dataset (https://code.google.com/archive/p/word2vec/)
   ```
   from gensim.models import Word2Vec
   import gensim.models
   import nltk
   newmodel = gensim.models.KeyedVectors.load_word2vec_format(<path to
   reducedvector.bin>, binary=True)
   ```

4. We can compute similarity measures associated with words within the model. For example, to find different measures of similarity based on the data in the Word2vec model, we can use:
   ```
   # Find the five nearest neighbors to the word man
   newmodel.most_similar('man', topn=5)

   # Compute a measure of similarity between woman and man
   newmodel.similarity('woman', 'man')
   ```

5. To complete analogies like man is to woman as king is to ??, we can use:
   ```
   newmodel.most_similar(positive=['king', 'woman'], negative=['man'], topn=1)
   ```

Q1: We will use the target words - *man* and *woman*. Use the pre-trained word2vec model to rank the following 15 words from the most similar to the least similar to each target word. For each word-target word pair, provide the similarity score. Provide your results in table format.

        wife
        husband
        child
        queen
        king
        man

woman
birth
doctor
nurse
teacher
professor
engineer
scientist
president

Q2: The Bigger Analogy Test Set (BATS) Word analogy task has been one of the standard benchmarks for word embeddings since 2013 (https://vecto.space/projects/BATS/). A) Select any file from the downloaded dataset (BATS_3.0.zip). For each row in your selected file, choose a target word from the row and provide the measure of similarity between your target word and the other words on the row (Remember to document the file used). B) Think of three words that identify membership in one of the protected classes (choose only one class): race, color, religion, or national origin. For each row in your selected BATS_3.0 file, compute the similarity between your target word and each of your three words. Indicate when there are noticeable differences in the similarity scores based on membership in the protected class. Provide your results in table format.

Q3: Sentences:
king is to throne as judge is to ____?
giant is to dwarf as genius is to ____?
college is to dean as jail is to ____?
arc is to circle as line is to ____?
French is to France as Dutch is to ____?
man is to woman as king is to ____?
water is to ice as liquid is to ____?
bad is to good as sad is to ____?
nurse is to hospital as teacher is to ____?
usa is to pizza as japan is to ____?
human is to house as dog is to ____?
grass is to green as sky is to ____?
video is to cassette as computer is to ____?
universe is to planet as house is to ____?
poverty is to wealth as sickness is to ____?

a. Complete the above sentences with your own word analogies. Use the Word2Vec model to find the similarity measure between your pair of words. Provide your results.

Example:
man is to woman as king is to _queen__?
newmodel.similarity('king', 'queen') -> 0.5685571

b. Use the Word2Vec model to find the word analogy and corresponding similarity score. Provide your results.

Example:

man is to woman as king is to ___?
newmodel.most_similar(positive=['king', 'woman'], negative=['man'], topn=1) -> queen, 0.711

c. Lastly, compute and print the correlation between the vector of similarity scores from your analogies versus the Word2Vec analogy-generated similarity scores. What is the strength of the correlation?
   o .00-.19 "very weak" correlation
   o .20-.39 "weak" correlation
   o .40-.59 "moderate" correlation
   o .60-.79 "strong" correlation
   o .80-1.0 "very strong" correlation

Task Set #2: For this part of the assignment, we will work with the UTK dataset (UTKface_cropped.tar.gz) available on Canvas and based on the original UTKFace dataset (https://susanqq.github.io/UTKFace/)

Q1: Each image in the dataset has a unique value representing age, gender, and race based on the following legend:
- age: indicates the age of the person in the picture and can range from 0 to 116.
- gender: indicates the gender of the person and is either 0 (male) or 1 (female).
- race: indicates the race of the person and can from 0 to 4, denoting White, Black, Asian, Indian, and Others (like Hispanic, Latino, Middle Eastern).

Compute and document the frequency of images associated with each subgroup for age (subdivide based on - (0-20), (21,40), (41,60), (61,80), (81, 116)), gender (0,1), and race (0 to 4). Which subgroup in each age, gender, and race category has the largest representation? Which subgroup in each age, gender, and race category has the least representation? Recreate a table of the age group, gender, and race distributions of subjects based on the UTK dataset subgroups (inspired by the one discussed in the lecture and reposted below). Based on what you've learned so far, if an algorithm is trained based on this dataset, which group(s) will be impacted the most? Explain why.

Age group	0–20	21–40	41–60	61+	Total
Female	1, 248	1, 685	1, 011	165	4, 109
Male	1, 427	2, 501	5, 021	2, 641	11, 590
Black	40	532	354	219	1, 145
White	1, 497	3, 368	5, 140	2, 368	12, 373
Asian	1, 126	284	537	219	2, 166
Unknown	12	2	1	0	15
Total	2, 675	4, 186	6, 032	2, 806	15, 699

http://biometrics.cse.msu.edu/Publications/Face/HanJain_UnconstrainedAge GenderRaceEstimation_MSUTechReport2014.pdf

Turn in a report (in PDF format) documenting your outputs. **Please note that, if desired, you may submit a jupyter notebook (.ipynb) for the assignment submission.** If choosing this option, you need to make sure you have clearly printed/displayed all outputs necessary for receiving credit (as you would for a PDF submission) before submitting. This means that the jupyter notebooks must be run before your submission. Credit would not be awarded for just submitting the codes in the notebook and not displaying the output. Note that you can still submit the assignment as a PDF - jupyter notebook is optional and is intended to ease logistics. In this case, submission should be just one **.ipynb** file.