

## 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/cacml12.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) (<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/) (<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/) (<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 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?
- .00-.19 “very weak” correlation
  - .20-.39 “weak” correlation
  - .40-.59 “moderate” correlation
  - .60-.79 “strong” correlation
  - .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).

Complete and answer the following:

- 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).
- For age, which subgroup has the largest representation? Which subgroup has the least representation?
- For gender, which subgroup has the largest representation? Which subgroup has the least representation?
- For race, which subgroup has the largest representation? Which subgroup has the least representation?
- Recreate a table of the age group, gender, and race distributions of subjects based on the UTK dataset subgroups. Please see the table below as an example - inspired by the one discussed in the lecture.

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\\_UnconstrainedAgeGenderRaceEstimation\\_MSUTechReport2014.pdf](http://biometrics.cse.msu.edu/Publications/Face/HanJain_UnconstrainedAgeGenderRaceEstimation_MSUTechReport2014.pdf)

- 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.

Turn in a report (in PDF format) documenting your outputs in each Step. The report should follow the JDF format. Jupyter notebook (ipynb files) submission is optional, but a final PDF document per JDF format is required. The file name for submission is GTuserName\_Assignment\_4, for example, Joyner03\_Assignment\_4. Reports that are not neat and well organized will receive up to a 10-point deduction. All charts, graphs, and tables should be generated in Python or Excel, or any other suitable software application, else appropriate points will be deducted, which could be the maximum.