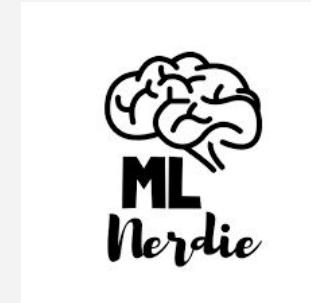




# Research for beginners: NLP edition

- Vaibhav Kumars x2, Ashima Suvarna

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asuvarna31@gmail.com



# About MLNerdie Delhi

To join: [delhi@mlnerdie.com](mailto:delhi@mlnerdie.com)

# About Women Who Code Delhi

To join: [delhi@womenwhocode.com](mailto:delhi@womenwhocode.com)

# What is research ?

It may be different from what you think



# What is research ?

- Research = Solve problems that have no known solution by anyone in the world.
- Research ≠ Learning from books, papers, news reports, professors ... Anything that can be learned, by definition, is not research.
- "Searching online" is not research.

\*Taken from [purdue.edu](http://purdue.edu)

A dark, atmospheric background showing a man in a blue shirt and dark pants pushing a massive, dark boulder up a steep, rocky mountain slope. The scene is set at night or in low light, with dramatic shadows and highlights on the rocks.

# Research is hard

What is your ‘**why**’ ?

# Problem statement

How to begin ?

# Finding interesting problem statements.

1. Slow-paced
2. Fast-paced



# Finding interesting problem statements.

1. Slow-paced
- Take challenging electives/stepping into unknown.



# Finding interesting problem statements.

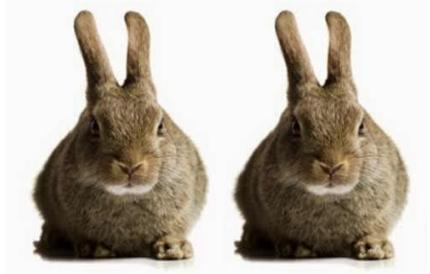
## 1. Slow-paced

- Take challenging electives/stepping into unknown.
- Reading existing papers. [[blog](#)]



# Finding interesting problem statements.

- 2. Fast-paced
- Kaggle competitions.



# Finding interesting problem statements.

## 2. Fast-paced

- Kaggle competitions.
- Approaching professors.
  - At your own university.

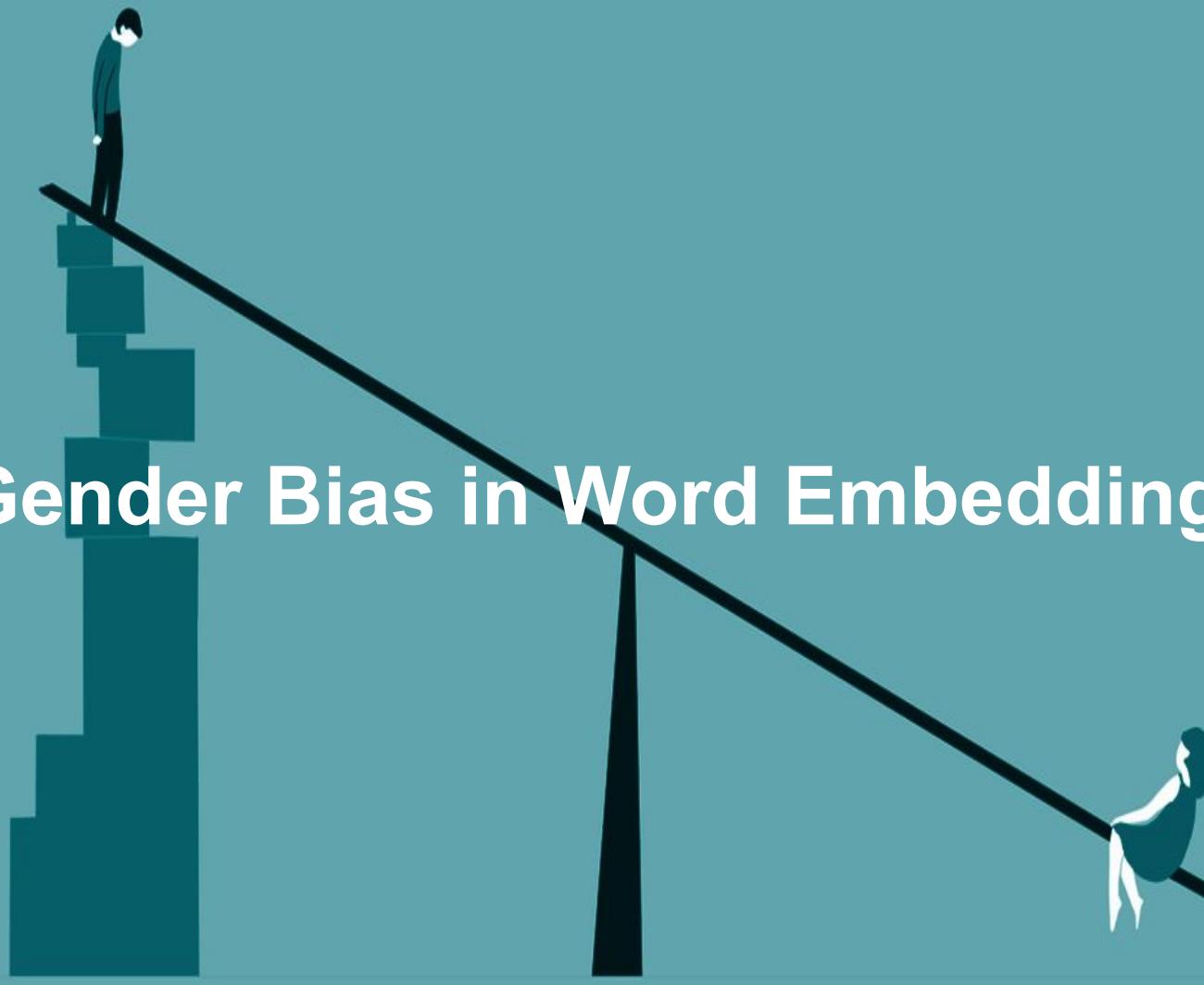


# Finding interesting problem statements.

## 2. Fast-paced

- Kaggle competitions.
- Approaching professors.
  - At your own university.
  - External place.





# Gender Bias in Word Embeddings.



# 1. How would a computer understand words?

- NLP = Natural Language Processing
- We need a system through which the computer can understand natural language
- Do computers understand numbers?
- What is the idea of numbers?
- BUT
- How do humans understand words?
- What is the idea of words?

View notebook at: [shorturl.at/nQT59](http://shorturl.at/nQT59)

## 2. The Distributional Hypothesis

“You shall know a word by the company it keeps” - (Firth, 1957)

Delhi, Mumbai, Rajasthan, Mizoram, Arunachal pradesh

Mother, Father, Sister, Brother

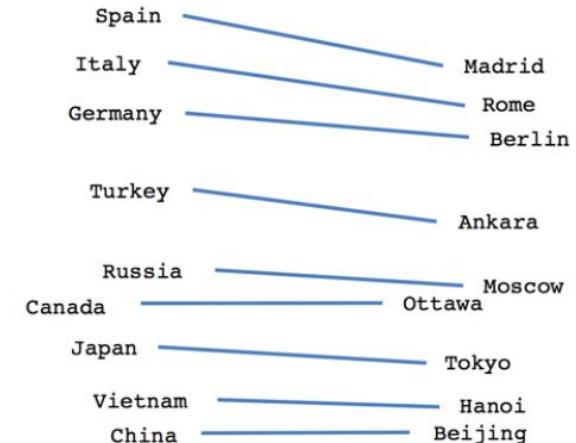
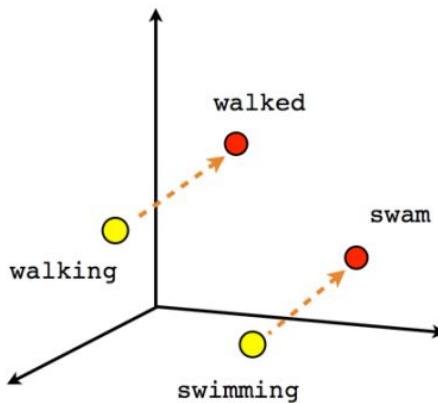
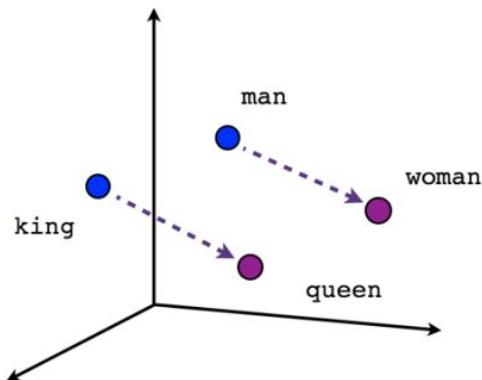
Dog, Cat, Hamster, Parrot, Centipede

### 3. Word vectors!

- Represent each word by an n-dimensional vector of floats
- n is usually 300
- 300 dimensions!
- How to view relationship between words in 300 dimensions? How to imagine 300 dimensions?

"To deal with hyper-planes in a 14-dimensional space, visualize a 3-D space and say 'fourteen' to yourself very loudly. Everyone does it." – Geoffrey Hinton

# 4. Word vectors are amazing!



## 5. Word vectors are really amazing!

Gender: brother - boy + girl = sister

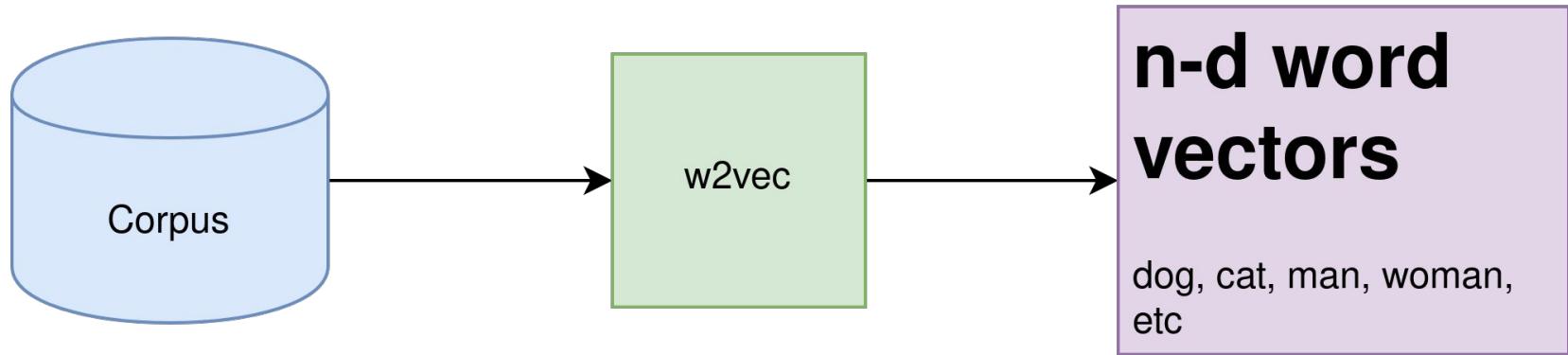
Capital: india - delhi + berlin = germany

Philosophy: Life - death + white = black

## 6. The arcane art of creating word vectors - word2vec

- The word2vec algorithm!
- All hail Tomas Mikolov! (Mikolov, Sutskever et al. 2013)
- A system trained to predict a word from its context or vice versa
- W2vec trains a two-layer neural network on a huge text database (corpus)

## 7. The w2vec algorithm



\*n is usually 300

# 8. One-hot encoding

Aback = [1, 0, 0, 0, 0, 0, 0, ..., 0]

Based = [0, 1, 0, 0, 0, 0, 0, ..., 0]

Cute = [0, 0, 1, 0, 0, 0, 0, ..., 0]

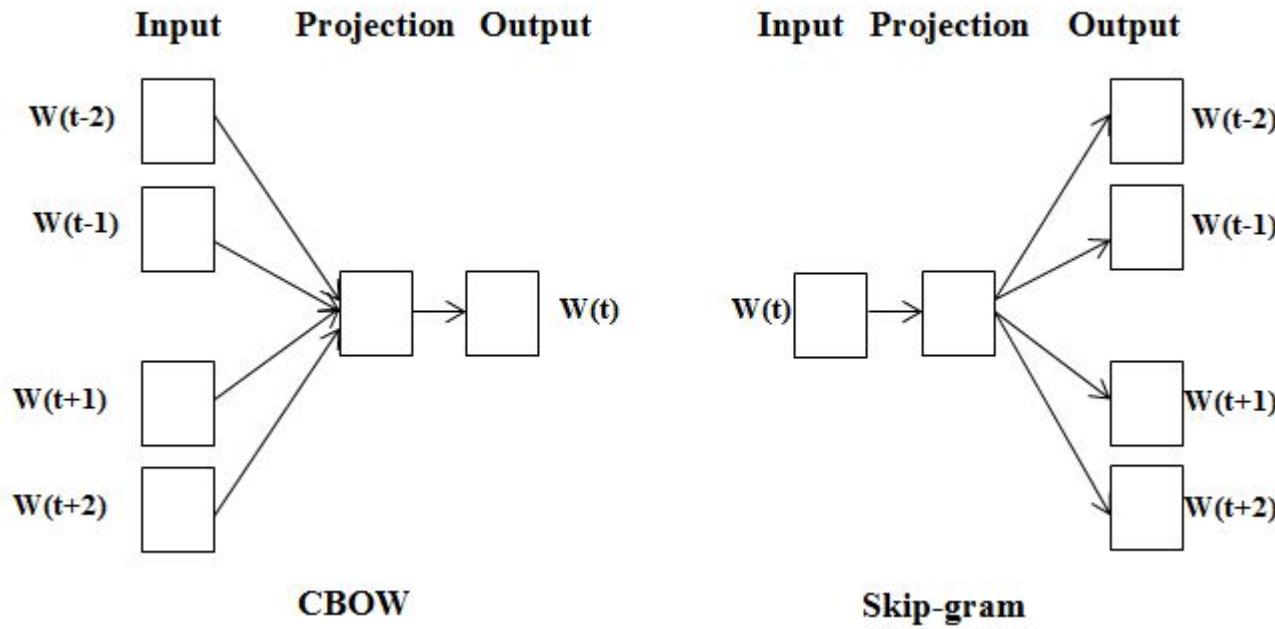
...

Zebra = [0, 0, 0, 0, 0, 0, 0, ..., 1]

Problems with this:

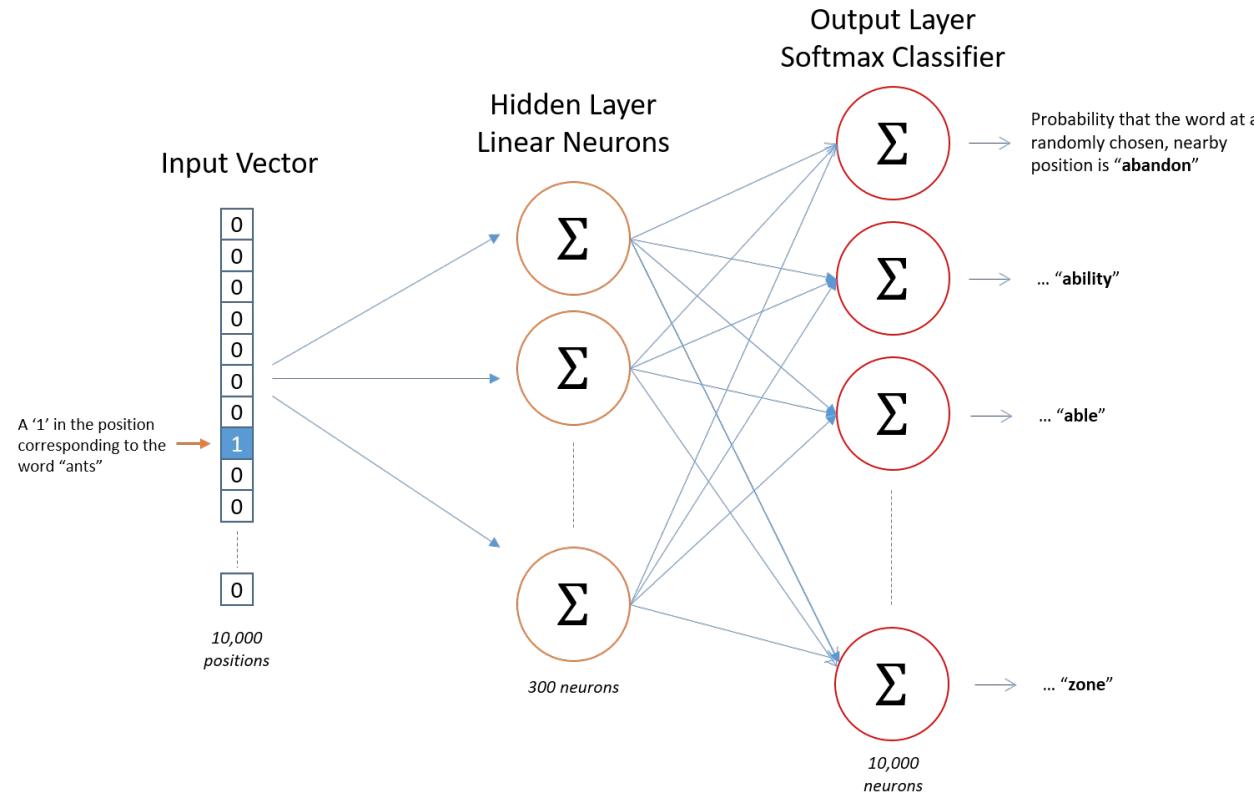
- Dimension of each vector = #Words in the corpus = HUGE!
- Vectors for words “close” to each other aren’t “close” to each other

## 9. Skip gram and continuous bag of words (CBOW)



\*Taken from “Efficient Estimation of Word Representations in Vector Space”, 2013

# 10. The w2vec neural net

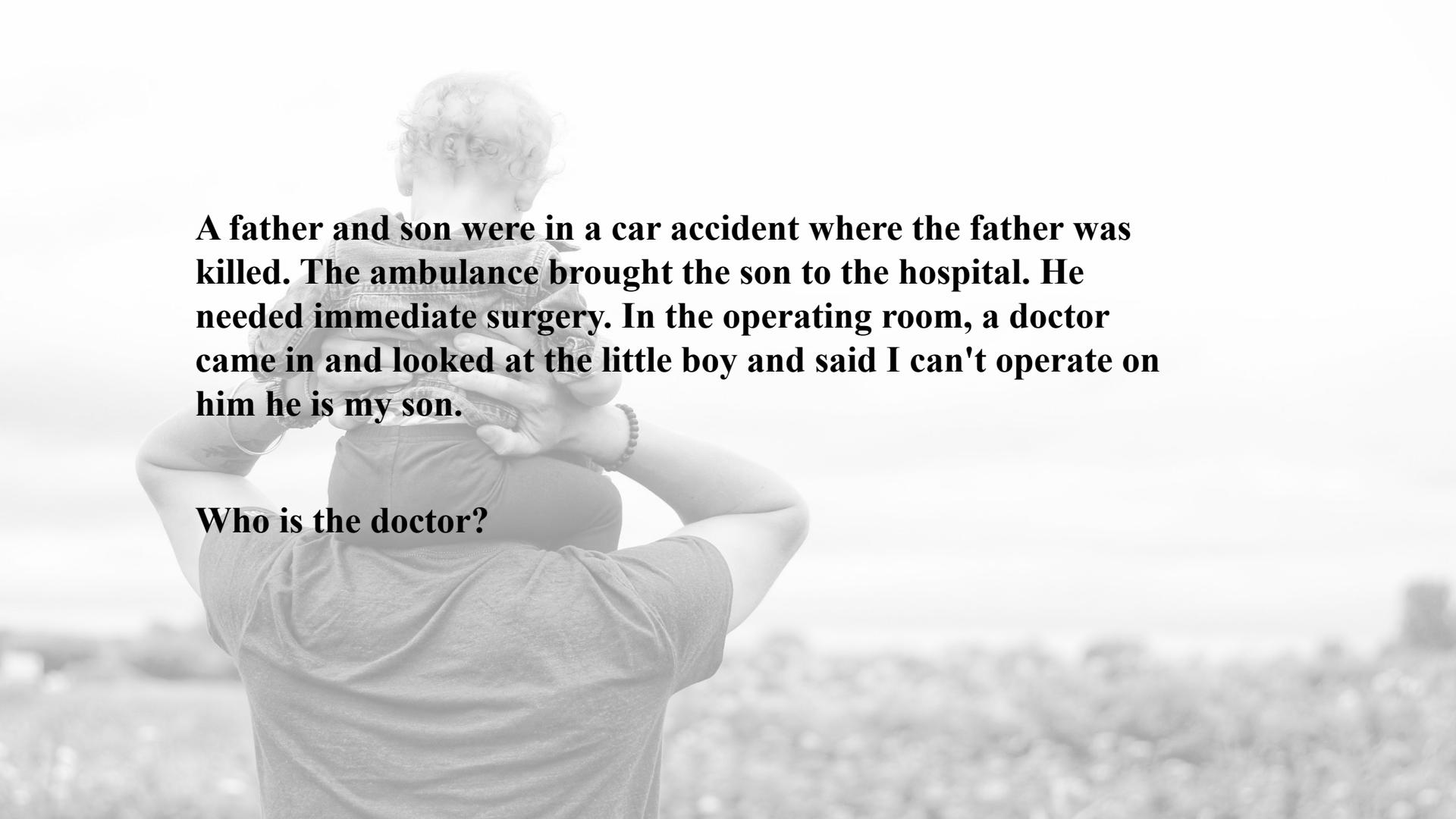


The first set of weights here are the word embeddings

# 11. Word embeddings are very useful!

Almost every NLP problem requires the use of word embeddings

- Natural language translation
- Coreference resolution
- Text summarization
- Chatbots
- Search queries
- Text similarity
- And many more!



**A father and son were in a car accident where the father was killed. The ambulance brought the son to the hospital. He needed immediate surgery. In the operating room, a doctor came in and looked at the little boy and said I can't operate on him he is my son.**

**Who is the doctor?**

Are word embeddings ethical? Just? Unbiased?  
Indifferent to gender or race?

Spoiler: They are not !!

# Bias in embeddings - Occupations

## Extreme *she* occupations

- |                 |                       |                        |
|-----------------|-----------------------|------------------------|
| 1. homemaker    | 2. nurse              | 3. receptionist        |
| 4. librarian    | 5. socialite          | 6. hairdresser         |
| 7. nanny        | 8. bookkeeper         | 9. stylist             |
| 10. housekeeper | 11. interior designer | 12. guidance counselor |

## Extreme *he* occupations

- |                |                   |                |
|----------------|-------------------|----------------|
| 1. maestro     | 2. skipper        | 3. protege     |
| 4. philosopher | 5. captain        | 6. architect   |
| 7. financier   | 8. warrior        | 9. broadcaster |
| 10. magician   | 11. fighter pilot | 12. boss       |

\*Source: Man is to Computer Programmer as Woman is to Homemaker?Debiasing Word Embeddings  
(Tolga et al. 2016)

# Bias in embeddings - Analogies

sewing-carpentry  
nurse-surgeon  
blond-burly  
giggle-chuckle  
sassy-snappy  
volleyball-football

## Gender stereotype *she-he* analogies.

register-nurse-physician  
interior designer-architect  
feminism-conservatism  
vocalist-guitarist  
diva-superstar  
cupcakes-pizzas

housewife-shopkeeper  
softball-baseball  
cosmetics-pharmaceuticals  
petite-lanky  
charming-affable  
hairdresser-barber

queen-king  
waitress-waiter

## Gender appropriate *she-he* analogies.

sister-brother  
ovarian cancer-prostate cancer

mother-father  
convent-monastery

\*Source: Man is to Computer Programmer as Woman is to Homemaker?Debiasing Word Embeddings  
(Tolga et al. 2016)

# Bias in translation



english to french

All Shopping Books News Images More Settings Tools

About 8,64,00,00,000 results (0.54 seconds)

English	↔	French
The tall nurse	X	La grande infirmière

Open in Google Translate Feedback

english to french

All Shopping Books News Images More Settings Tools

About 8,64,00,00,000 results (0.54 seconds)

English	↔	French
The tall doctor	X	Le grand docteur

Open in Google Translate Feedback

"As French makes a distinction between "masculine and feminine objects", people use **le** for masculine things/persons and **la** for feminine things/persons." -  
[http://www.frenchtutorial.com/en/learn-french/basics/le\\_la\\_les](http://www.frenchtutorial.com/en/learn-french/basics/le_la_les)

# Bias in coreference resolution

The physician hired the secretary because he was overwhelmed with clients.

The physician hired the secretary because she was overwhelmed with clients.

The physician hired the secretary because she was highly recommended.

The physician hired the secretary because he was highly recommended.

(Zhao et al., NAACL, 2018)



# Literature Review

## Collecting and analyzing



# SURVEY PAPER !

Blessing in disguise.



# Literature review - collecting papers.

- Reading references from the initial papers.

## 1 Introduction

Word embedding models have been designed for representing the meaning of words in a vector space. These models have become a fundamental NLP technique and have been widely used in various applications. However, prior studies show that such models learned from human-generated corpora are often prone to exhibit social biases, such as gender stereotypes (Bolukbasi et al., 2016; Caliskan et al., 2017). For example, the word “programmer” is neutral to gender by its definition, but an embedding model trained on a news corpus associates “programmer” closer with “male” than “female”.

\*Source: Learning Gender-Neutral Word Embeddings (Zhao et al. 2019)

# Literature review - collecting papers.

- Reading references from the initial papers.
- Identify the seminal papers.

Man is to computer programmer as woman is to homemaker? debiasing **word embeddings**

[PDF] nips.cc

T Bolukbasi, KW Chang, JY Zou... - Advances in neural ... , 2016 - papers.nips.cc

... in a small way debiased **word embeddings** can hopefully contribute to reducing **gender bias** in society ... In specific applications, one might argue that **gender biases** in the **embedding** (eg computer ... statistics and that, in these special cases, the original biased **embeddings** could be ...

☆ 99 Cited by 625 Related articles All 13 versions »

# Literature review - collecting papers.

- Reading references from the initial papers.
- Identify the seminal papers.
- **Analyze the citees\***.

Man is to computer programmer as woman is to homemaker? debiasing word embeddings

Search within citing articles

Grad-cam: Visual explanations from deep networks via gradient-based localization

[RR Selvaraju, M Cogswell, A Das... - Proceedings of the ...](#), 2017 - openaccess.thecvf.com

We propose a technique for producing 'visual explanations' for decisions from a large class of Convolutional Neural Network (CNN)-based models, making them more transparent. Our approach-Gradient-weighted Class Activation Mapping (Grad-CAM), uses the gradients of ...

 99 Cited by 1543 Related articles All 10 versions 

Semantics derived automatically from language corpora contain human-like biases

[A Caliskan, JJ Bryson, A Narayanan - Science, 2017 - science.sciencemag.org](#)

Machine learning is a means to derive artificial intelligence by discovering patterns in existing data. Here, we show that applying machine learning to ordinary human language results in human-like semantic biases. We replicated a spectrum of known biases, as ...

 99 Cited by 585 Related articles All 24 versions 

\*Source: <https://scholar.google.co.in/>

# Literature review - collecting papers.

- Reading references from the initial papers.
- Identify the seminal papers.
- Analyze the citees\*.
- Use keyword search.

"gender bias in word embeddings"

About 52 results (0.06 sec)

[Lipstick on a pig: Debiasing methods cover up systematic gender biases in word embeddings but do not remove them](#) [\[PDF\]](#) [arxiv.org](#)

[H.Gonen, Y.Goldberg](#) - arXiv preprint arXiv:1903.03862, 2019 - arxiv.org  
... participation data. Recently, some work has been done to reduce the **gender bias in word embeddings**, both as a post-processing step (Bolukbasi et al., 2016b) and as part of the training procedure (Zhao et al., 2018). Both works ...

[☆ 99](#) Cited by 53 Related articles All 9 versions [»](#)

[Learning gender-neutral word embeddings](#) [\[PDF\]](#) [arxiv.org](#)

[J.Zhao, Y.Zhou, Z.Li, W.Wang, KW.Chang](#) - arXiv preprint arXiv ..., 2018 - arxiv.org  
... Coreference Resolution Finally, we investigate how the **gender bias in word embeddings** affects a downstream application, such as coreference resolution. Coreference resolution aims at clustering the denotative noun phrases referring to the same entity in the given text ...

[☆ 99](#) Cited by 57 Related articles All 8 versions [»](#)

\*Source: <https://scholar.google.co.in/>

# Literature review - analyzing papers.

- What question or problem is the author addressing?
- What are the key concepts and how are they defined?
- What are the results and conclusions of the study?
- What are the strengths and weaknesses of the research?

Dissect each line and question yourself about everything that you read.

# Man is to Computer Programmer as Woman is to Homemaker? Debiasing Word Embeddings

Given a collection of words  $\mathbf{W}$ : what words to debias ?

1. **Gender neutral.**
2. **Gender specific.**

**Main Idea :** “We will use the gender specific words to learn a gender subspace in the embedding, and our debiasing algorithm removes the bias only from the gender neutral words while respecting the definitions of these gender specific words”.

# Types of biases

Nurse is close to both man and woman, however, more close to woman, this results in a bias.

**Pairs of gender-specific words:** {man,woman},{he,she}.

**Direct bias:** Direct bias results when there is an association between a gender-neutral word and gender-pair. Example nurse and {man,woman}.

**Indirect bias:** The relative order of gender neutral words is also disturbed due to biases. For example. the words bookkeeper and receptionist are much closer to softball than football, this is due to female association of the former words.

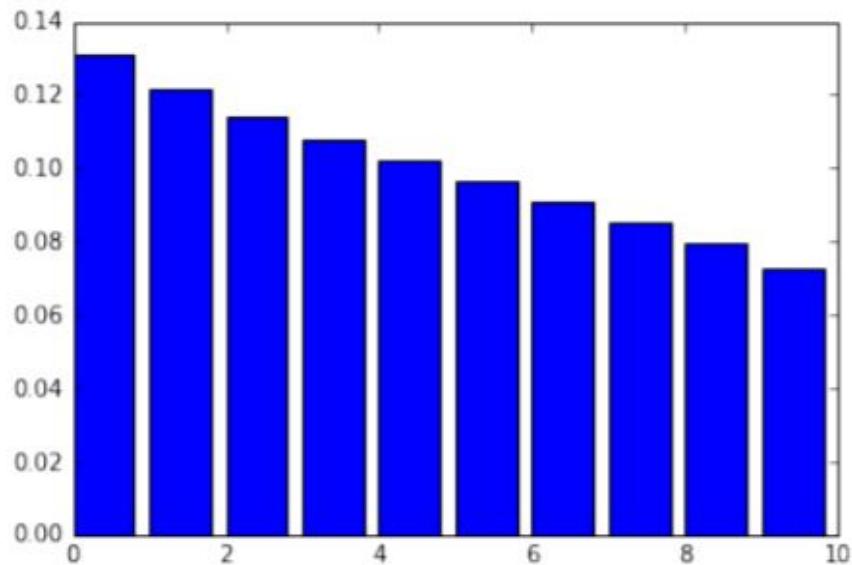
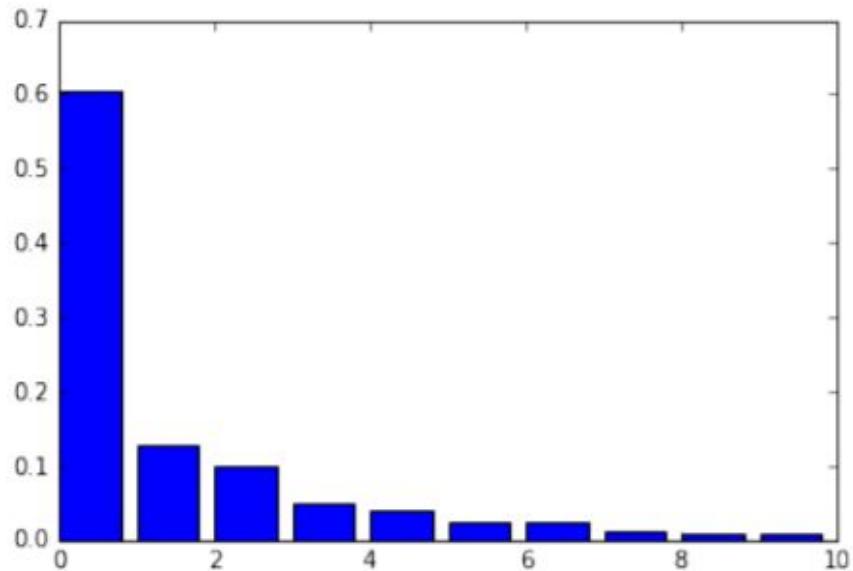
# Gender subspace

It is a subset (also called the subspace) of the embedding space that is responsible for capturing the gender information.

Define Quantitatively ?

Gender pairs: {he,she},{grandfather,grandmother} and so on.. 10 such pairs.

Subspace: Take such gender pair differences and compute the principle components. The first PC captures the gender subspace.



**Left:** the percentage of variance explained in the PCA of these vector differences. The top component explains significantly more variance than any other. **Right:** for comparison, the corresponding percentages for random unit vectors (figure created by averaging over 1,000 draws of ten random unit vectors in 300 dimensions)

# Direct bias

N : set of gender neutral words.

G: gender direction(or subspace) as determined earlier.

$$\text{DirectBias}_c = \frac{1}{|N|} \sum_{w \in N} |\cos(\vec{w}, g)|^c$$

where c is a parameter that determines how strictly we measure bias.

# Indirect - bias

We can identify the contribution of the gender-subspace in determining the similarities of any two words.

For any given word w:

$$w = \underline{w_g} + \underline{w_{\perp}},$$

Indirect bias wrt to a word v is defined as :

$$\beta(w, v) = \left( w \cdot v - \frac{\underline{w_{\perp}} \cdot \underline{v_{\perp}}}{\|\underline{w_{\perp}}\|_2 \|\underline{v_{\perp}}\|_2} \right) / w \cdot v.$$



# Debiasing methods

Hard debiasing and soft debiasing

# Hard-debias

Consists of two parts, for each gender-neutral word, we do:

**Neutralize:** Ensure that for any gender neutral word, the component on the gender-subspace is zero.

**Equalize:** perfectly equalizes sets of words outside the subspace and thereby enforces the property that any neutral word is equidistant to all words in each equality set.

Example: {grandmother, grandfather},{guy, gal} are x2 equality sets and babysit is processed.

# Soft debias

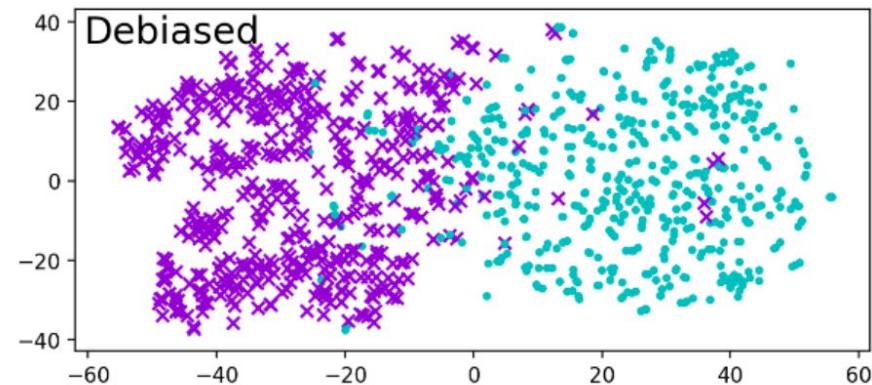
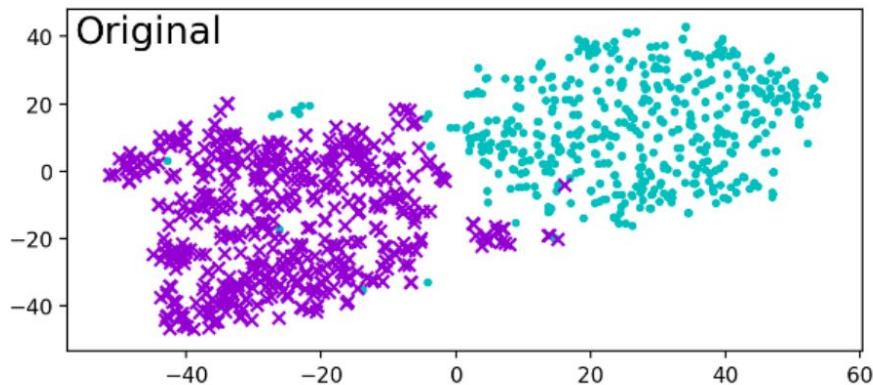
Soft debiasing can be viewed as a linear transformation that seeks to preserve pairwise inner products between all the word vectors while minimizing the projection of the gender neutral words onto the gender subspace.

YOU MADE IT !!

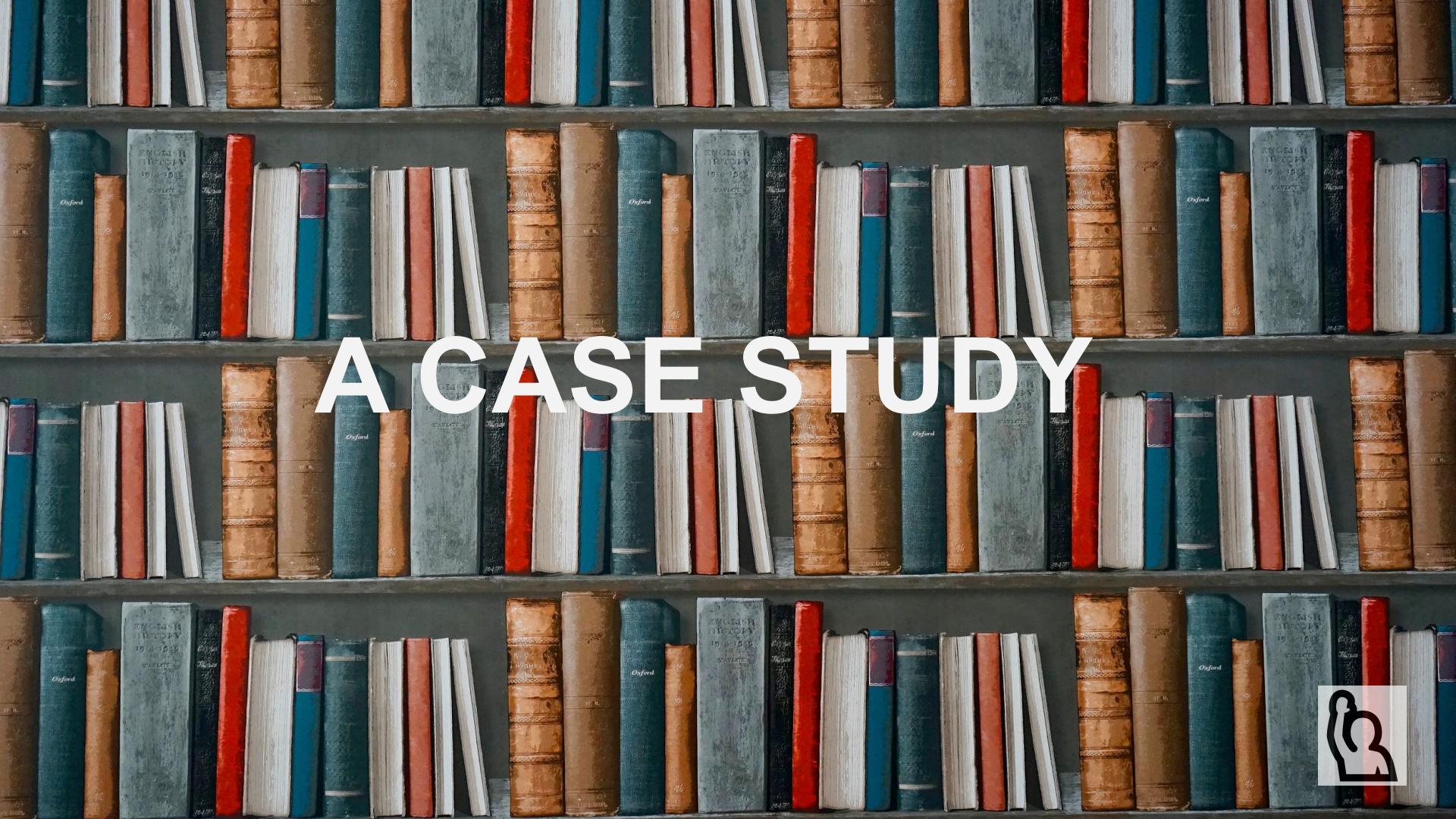


# Lipstick on a pig

- Current debiasing methods do not debias word embeddings, they just hide it.
- Gender information is preserved in terms of clusters
- “Male” words cluster together, so do “female” words



\*Source: Lipstick on a Pig:Debiasing Methods Cover up Systematic Gender Biases in Word Embeddings But do not Remove Them (Gonen et al. 2019)



# A CASE STUDY



# **Handling Gender Biases in E-Commerce Product Specifications**

In this work, we explore the presence and degree of gender bias in product descriptions featured on e-commerce websites.

Using the knowledge obtained in analysis, we recommend methods to debias the product description, using a product feature level text selection scheme, sourced by customer reviews.

# THE PROBLEM STATEMENT



Click image to open expanded view

KitchenAid KSM150PSWH Artisan Series 5-Qt. Stand Mixer with Pouring Shield - White  
by KitchenAid

★★★★★ 5 customer reviews | 8,907 customer reviews | 1000+ answered questions

Amazon's Choice for "kitchen aid artisan 5 qt stand mixer"

Price: \$279.00

Get \$50 off instantly: Pay \$229.00 upon approval for the Amazon Rewards Visa Card.

Color: White

10-speed slide control ranges from a very fast whip to a very slow stir  
Includes Flat Beater, Dough Hook and Wire Whip  
Power Hub for Additional Attachments. 14.1 inches depth, 13.9 inches height and 8.7 inches width  
Unique Mixing Action. Power Cord Length : 4.0  
Assembled with Pride in Greenville, Ohio  
Choose from all the color options to find the one that best matches your style and personality.  
The power hub turns your stand mixer into a culinary center with more than 15 optional attachments available.

Show more

Share [Email](#) [Facebook](#) [Twitter](#) [Pinterest](#) 20K+ Shares

\$279.00

This item does not ship to India. Please check other sellers who may ship internationally. Learn more

In Stock. Ships from and sold by Amazon.com.

Qty: 1

Add to Cart Turn on 1-Click ordering for this browser

Deliver to India Add to List Add to Wedding Registry

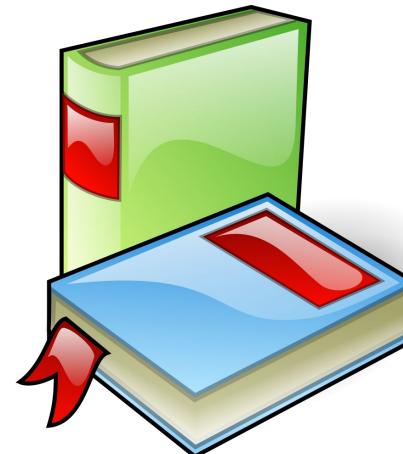
Sellers on Amazon

Buy \$79.05 new (7) from \$179.99 + \$32.74 shipping

Gender icons: a woman and a man standing side-by-side.

# Literature Review

- Fairness in Data Distribution and Model Learning
- Fairness in Representation Learning
- Gender Bias Detection and Removal (Debiasing)
- Novelty of this work (Innovation)



# Developing An Approach

## Step 1: Explore your Dataset

- Understand what kind of data you need
- See how you will procure it
- Pre & Post processing

5 of 5 people found the following review helpful:

 **excellent resource** May 30, 2014

By Kimberly Palmer

Format: Kindle Edition

I'm a big fan of Nick Loper and this is just the latest example in the useful information he offers folks -anyone looking to launch some kind of online business can learn from him and be more productive along the way

Comment | Was this review helpful to you?

KitchenAid KSM150PSWH Artisan Series 5-Qt. Stand Mixer with Pouring Shield - White by KitchenAid

 8,907 customer reviews | 1000+ answered questions

Amazon's Choice for "kitchen aid artisan 5 qt stand mixer"

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- Unique Mixing Action. Power Cord Length : 4.0
- Assembled with Pride in Greenville, Ohio
- Choose from all the color options to find the one that best matches your style and personality.
- The power hub turns your stand mixer into a culinary center with more than 15 optional attachments available.

 Show more

Compare with similar items

Used & new (7) from \$179.99 + \$32.74 shipping

Buy this product as Certified Refurbished and save \$79.05.

 KitchenAid RRK150WH 5 Qt. Artisan Series - White (Certified Refu... 

# Developing An Approach

## Step 1: Explore your Dataset

- Understand what kind of data you need
- See how you will procure it
- Pre & Post processing

# Developing An Approach

## Step 1: Explore your Dataset

- Understand what kind of data you need
- See how you will procure it
- Pre & Post processing

### Corpus Creation

- Reviewer Gender Identification
  - Master list of names
  - Classification with SVM
- Gender-Specific Corpus Creation

# Developing An Approach

## Step 2: Implement your algorithm

### Identify and Quantify Gender Bias

- Aspect (Feature) Identification in Product Description
- Gender-to-Feature Association (Affinity) Scoring
- Gender Bias Quantification



Proposed  
Framework

### Debiasing

- Candidate Feature Extraction
- Debiasing Prowess Computation
- Feature-Oriented Objective Text Extraction from Reviews



Extractive  
Debiasing

# Developing An Approach

Step 3: Analysing your algorithm

## Qualitative Analysis

Good for problem domains involving user preferences

Not good for optimization or system dynamic algorithms

Eg: User Study, Preference Analysis, A/B Testing

# Developing An Approach

## Step 3: Analysing your algorithm

# Qualitative Analysis



# Developing An Approach

Step 3: Analysing your algorithm

## Quantitative Analysis

Assessing the correctness of a predictive or classification algorithm

Accuracy : No. of Correctly Classified Instances

Precision: True positives / False positives + True positives

Recall : number of positive class predictions made out of all positive examples in the dataset.

# Results? Wha...What ?

You can report results like this:

Image with Caption Generated	Top 3 Best Quotes	Similarity (in %)	Evaluation +ve	-ve
	<p>Change is the watchword of progression. When we tire of well-worn ways, we seek for new. This restless craving in the souls of men spurs them to climb, and to seek the mountain view.</p>	77.3		
a man is standing on a hill	<p>Men trip not on mountains, they stumble on stones.</p>	74.1	87	13
	<p>Most of life is routine-dull and grubby, but routine is the mountain that keeps a man going. If you wait for inspiration you'll be standing on the corner after the parade is a mile down the street.</p>	73.9		
	<p>But Hopes are Shy Birds flying at a great distance seldom reached by the best of Guns.</p>	75.2		
a bird is flying through the trees	<p>Perfect as the wing of a bird may be, it will never enable the bird to fly if unsupported by the air. Facts are the air of science. Without them a man of science can never rise.</p>	73.9	81	19
	<p>It may be hard for an egg to turn into a bird: it would be a jolly sight harder for it to learn to fly while remaining an egg. We are like eggs at present. And you cannot go on indefinitely being just an ordinary, decent egg. We must be hatched or go bad.</p>	72.8		

# Results? Wha...What ?

You can report results like this:

Product	Current Product Description	New Sentences
KitchenAid Mixer	<ul style="list-style-type: none"><li>0-speed slide control ranges from a very fast whip to a very slow stir</li><li>Includes Flat Beater , Dough Hook and Wire Whip</li><li>Power Hub for Additional Attachments. 14.1 inches depth ,13.9 inches height and 8.7 inches width</li><li>Unique Mixing Action . Power Cord Length : 4.0</li><li>Assembled with Pride in Greenville, Ohio</li><li>Choose from all the color options to find the one that best matches your style and personality</li><li>The power hub turns your stand mixer into a culinary center with more than 15 optional attachments available.</li></ul>	<ul style="list-style-type: none"><li>KitchenAid is a dependable , high quality brand .</li><li>It is easy to use and handle .</li><li>The color may fade at times</li></ul>
M-Audio SP-2	<ul style="list-style-type: none"><li>Classic-style sustain pedal for use with any electronic keyboard</li><li>Designed to work and feel just like acoustic piano's sustain pedal</li><li>Slip-resistant rubber bottom grips the floor while you play</li><li>High-quality chrome foot pedal with expressive half-pedal capabilities</li><li>Includes 6-foot cable with 1/4-inch jack. 1-year warranty</li></ul>	<ul style="list-style-type: none"><li>It holds a good sustain and is reasonably priced</li><li>Use this sustain pedal as a hands-free transmitter switch</li></ul>

# How to Write a Paper !!

Starting with what you know best is sensible !

# Sort your figures and tables like:

problem into our space of solution. This completes the debiasing (bias removal / controlling) process.

## 5 Experiments

**5.1 Dataset Description** We crawled user reviews and product description for randomly selected products from the Amazon.com e-retail website. The crawled dataset consisted of user reviews from 1994–2014 across randomized product categories pertaining to one product at a time. For each product, the dataset has product ID, e-retail description as featured on the website and the set of reviews received by it, wherein each review consists of username (name of the person who has written the review), review text, rating and time of review. In total, we collated around 142.4 million user reviews posted by around 10 million users across 20 product categories.

**5.2 Results and Observations** We carry out the bias identification and debiasing as illustrated earlier in the paper. The results of bias detection and debiasing are presented on Ta-



Figure 3: Product Description of a KitchenAid Mixer

**6.1 Nature of Product Descriptions** The product descriptions typically contain mention of features, aesthetic and other capabilities of the product. An example product description is presented in Figure 3.

# How to Write a Paper !!

Starting with what you know best is sensible !

**Compile your results (tables or graphs)**

**Write experiment:**

Put the language used, the frameworks used, the hyperparameters tuned

Include data preprocessing in this section

# How to Write a Paper !!

Starting with what you know best is sensible !

Now, write Discussion and Conclusion

*" In this work, we proposed a methodology to identify and quantify gender biases in e-commerce product descriptions. Using product feature ontologies and the features (aspects) present in the product description, we determine the dimensions (features) to control such biases. We debias by selecting instance fragments from product reviews provided by users of the lesser-represented gender, covering features missing from the given product descriptions. "*

# How to Write a Paper !!

Starting with what you know best is sensible !

Now, write the **Introduction** in agreement with your conclusion and problem statement

Then, **Related Work**

And, finally the **abstract**

# Publish

Where to submit ?

# Terminologies:

**peer review ?**



**Single blind**

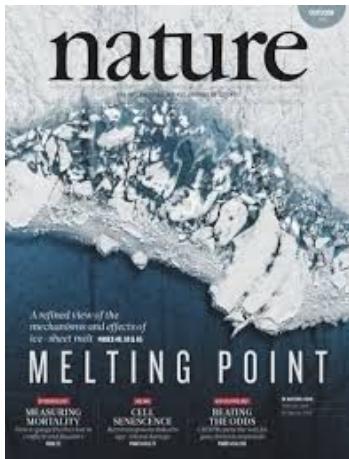


**Double blind**



# Journals

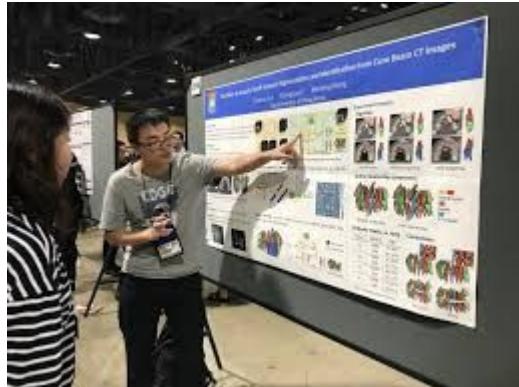
- Periodical publication focussed on a certain discipline
- Written
- Flexible review period
- Longer and detailed



Nature Journal

# Conferences

- Researchers gather to discuss research in a field
- Written + Oral
- Pre-defined review period
- Short and concise with limited pages (**RANDOM !!!**)



Poster Presentation



Paper Presentation

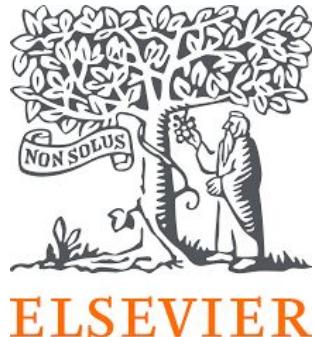
# Selecting conferences

1. Peer reviewed are always valued !.
2. Check the indexing(coming up) and the rank of the conference from [here](#).
3. Strive for workshops, special tracks and student abstracts.



# Selecting Journals

1. Indexing : Reflection of its quality. Eg SCI, SCI-E, Scopus.
2. Impact factor : proxy for the relative importance of a journal within its field.



# Resources

<http://www.wikicfp.com/cfp/>

[https://www.aclweb.org/portal/acl\\_sponsored\\_events](https://www.aclweb.org/portal/acl_sponsored_events)

<https://mjl.clarivate.com/home>