



Justin Trudeau   
@JustinTrudeau

 Following ▾

To those fleeing persecution, terror & war,  
Canadians will welcome you, regardless of your  
faith. Diversity is our strength #WelcomeToCanada

---

RETWEETS LIKES  
**165,284** **256,250**

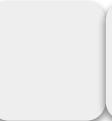
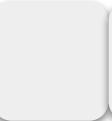
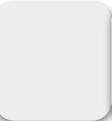
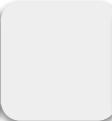
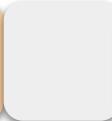
12:20 PM - 28 Jan 2017

# CS 106S Week 2

## Sentiment Analysis and Refugee Tweets

[cs106s.stanford.edu](http://cs106s.stanford.edu), Autumn 2024

# Welcome to Week 2 of Class!





# The Map For Today

- 1 sentiment analysis overview
- 2 JavaScript objects – beautiful, complex
- 3 project: refugee sentiment on Twitter
- 4 implementation & check-off form!

# Natural Language Processing

Gemini

Claude

Large Language Models



Sentiment Analysis



The cutest  
cat ever!  
#Pumpkin

Image Captioning

English  $\leftrightarrow$  Chinese (Simplified)

I choose you Pikachu

我选择你皮卡丘

Wǒ xuǎnzé nǐ píkāqū

Language Translation

Work of Art

My Hero Academia is an acclaimed Japanese manga series by Nationality Kōhei Horikoshi Person

Named Entity Recognition

And a lot more!

Hello. How are you feeling today?  
Eliza

I'm struggling  
You

Do you enjoy being struggling?  
Eliza

\*surprised pikachu face\*  
You

Let's change focus a bit... Tell me about your family.  
Eliza

Chatbots (e.g., 1960s ELIZA)



Speech Recognition

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# Today: Sentiment Analysis

sen·ti·ment a·nal·y·sis

*noun*

the process of computationally identifying and categorizing opinions expressed in a piece of text, especially in order to determine whether the writer's attitude towards a particular topic, product, etc., is positive, negative, or neutral.

"companies have key lessons to learn about harnessing the power of social media and sentiment analysis"

Google Search / Oxford Languages

# Today: Sentiment Analysis

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Google Search / Oxford Languages



# Sentiment Analysis Out There

## Google Product Search



HP Officejet 6500A Plus e-All-in-One Color Ink-jet - Fax / copier / printer / scanner

\$89 online, \$100 nearby ★★★★ 377 reviews

September 2010 - Printer - HP - Inkjet - Office - Copier - Color - Scanner - Fax - 250 sh

### Reviews

Summary - Based on 377 reviews



What people are saying

- |                  |  |  |
|------------------|--|--|
| ease of use      |  | "This was very easy to setup to four computers." |
| value            |  | "Appreciate good quality at a fair price."       |
| setup            |  | "Overall pretty easy setup."                     |
| customer service |  | "I DO like honest tech support people."          |
| size             |  | "Pretty Paper weight."                           |
| mode             |  | "Photos were fair on the high quality mode."     |



Barry Pierce

596 reviews

8,474 followers

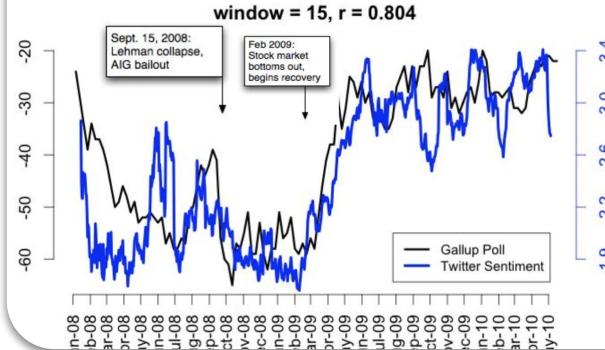


May 11, 2022

Otessa Moshfegh seems to be completely incapable of producing works that aren't masterpieces.

## Twitter sentiment versus Gallup Poll of Consumer Confidence

Brendan O'Connor, Ramnath Balasubramanyan, Bryan R. Routledge, and Noah A. Smith. 2010. From Tweets to Polls: Linking Text Sentiment to Public Opinion Time Series. In ICWSM-2010



# How can we tell sentiment?

- ❑ look at a piece of text
- ❑ extrapolate “features” in the text
  - ❑ common features:
    - ❑ is a **word** positive or negative?

awesome

terrible

spectacular

unbelievable

- ❑ is a **phrase** positive or negative?

terribly awesome

not good

what in the world was that

- ❑ classify the piece as positive or negative



## Examples!



### Positive or negative movie review?



- unbelievably disappointing



- Full of zany characters and richly applied satire, and some great plot twists



- this is the greatest screwball comedy ever filmed



- It was pathetic. The worst part about it was the boxing scenes.

**What words tell you each review is positive or negative? What words are kind of ambivalent?**



## Examples!



### Positive or negative movie review?

- unbelievably disappointing
- Full of zany characters and richly applied satire, and some great plot twists
- this is the greatest screwball comedy ever filmed
- It was pathetic. The worst part about it was the boxing scenes.

What words tell you each review is positive or negative? What words are kind of ambivalent?



# A Bit More Challenging



“how does wes anderson sleep at night knowing his best movie was the cat in the hat directed by bo welch”



“this cured my depression and brought it back full force in the span of 2 hours”



“over 75% of this movie is just memes”



“lost my mind everytime he started singing (so the whole movie)”



# Linguistics of Restaurant Reviews

## Negative Reviews

The bartender... absolutely horrible... we waited 10 min before we even got her attention... and then we had to wait 45 - FORTY FIVE! - minutes for our entrees... stalk the waitress to get the cheque... she didn't make eye contact or even break her stride to wait for a response ...

Negative sentiment language

horrible awful terrible bad disgusting

Past narratives about people

waited, didn't, was

he, she, his, her,

manager, customer, waitress, waiter

Frequent mentions of **we** and **us**

... **we** were ignored until **we** flagged down a waiter to get **our** waitress ...

## Positive Reviews

What about positive reviews?

Sex, Drugs, and Dessert

*addicted to pepper shooters*

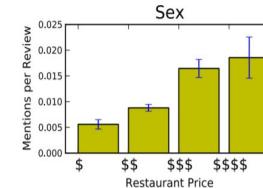
*garlic noodles... my drug of choice*

*the fries are like crack*

*orgasmic pastry*

*sexy food*

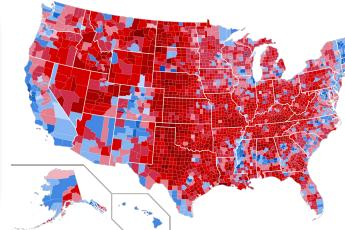
*seductively seared fois gras*



Prof. Dan Jurafsky.  
Check out more [here](#)!

# Uses of Sentiment Analysis

- ★ **movie reviews:** what does the public think of a movie?
- ★ **products:** what do people think of the new iPhone?
- ★ **public sentiment:** reaction to news? current events?
- ★ **politics:** what do people think of x issue?
- ★ **prediction:** what will the outcome of an election be based on social media data (and polling ofc)?

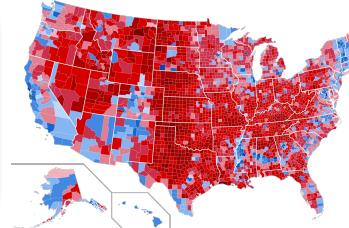


Windows 8

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# Uses of Sentiment Analysis

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# In Recent News

US elections 2024

## 'They're eating the cats': Trump rambles falsely about immigrants in debate

Ex-president's repetition of unsubstantiated claims prompts ABC moderator to fact-check him on air

- [Fact check: Harris and Trump's debate claims at a glance](#)
- [Harris-Trump debate: key takeaways](#)

Alice Herman

Tue 10 Sep 2024 22.28 EDT

Share



The Guardian, 2024

Benjamin Yan, CS106S 2024

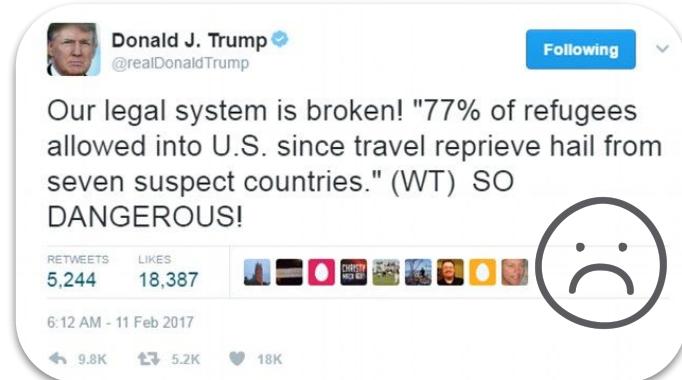
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# In-Class Project

**Build a sentiment classifier  
for refugee tweets.**

Can we classify tweets as  
**pro** or **anti**-refugee?

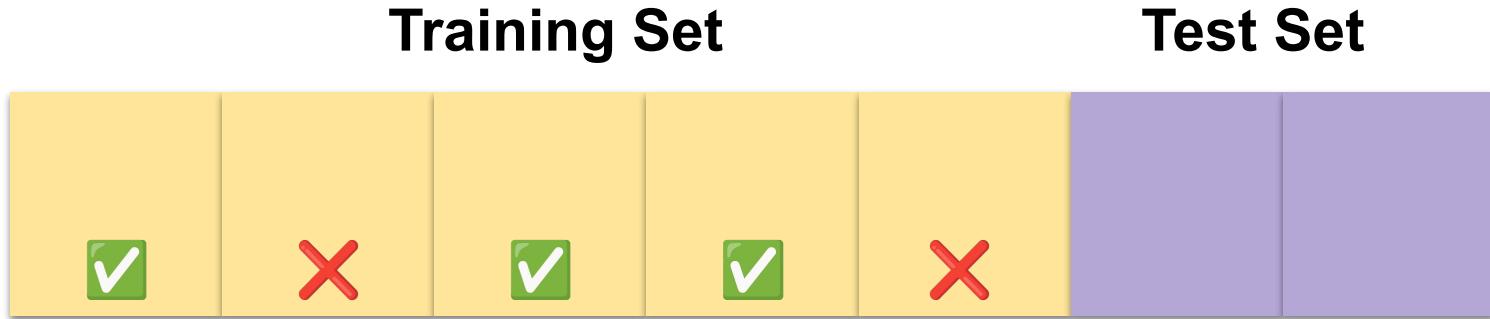
Why Twitter? 



# Motivation / Why?

- ❑ **Bots & automated tools that detect hateful tweets** and respond with educational resources
  - ❑ Sway public opinion, combat misinformation
- ❑ **Understanding general opinion** in the US
  - ❑ 2024 – Presidential Election Year, alongside critical Senate and House races in battleground states
  - ❑ Geo-tagging of tweets for mapping sentiment

# Training & Testing Splits



We use this to train/tune the model i.e.  
learn the sentiment of each word

We use this to evaluate the  
model's performance

- Machine learning tasks require abundant human-labeled data
- Our data is in **trainTweets.js** and **testTweets.js**, **content warning**

# 'Key' Approach

- ❑ give each word a value
- ❑ represents **how pro/anti-refugee sentiment** it is
- ❑ determine how pro/anti-refugee a given word is from the training set
- ❑ **ultimate goal to create wordMap**
- ❑ training will be the process of making wordMap



# wordMap

**wordMap[word] =**

(# of times the  
word appears in  
positive tweets)

(# of times the  
word appears in  
negative tweets)

Tweets within the **training set**

# Review of Objects / Dictionaries / Maps

In Python (CS 106A/X)

```
phonebook = dict()  
phonebook ["Mary"] =  
3141592653
```

In C++ (CS106B)

```
Map<string, int> phonebook;  
phonebook ["Mary"] =  
3141592653;
```

In Java (AP CSA)

```
HashMap<String, Integer> phonebook =  
new HashMap<String, Integer>();
```

# JavaScript Objects

```
let cat = {  
    "Name": "Whiskers",  
    "legs": 4,  
    "tails": 1,  
    "Enemies": ["Water", "Dogs"]  
};
```

- In JavaScript, **objects** store data which you can access through their **properties**

# JavaScript Objects

```
let album = {  
    "name": "Brat",  
    "artist": "Charli XCX"  
};
```

brat and it's  
the same but  
there's three  
more songs  
so it's not

```
let name = album.name;  
let name = album["name"];
```

album.name = "Brat extended"; // can change

# Other Object Functions

```
let album = {  
    "name": "Brat",  
    "artist": "Charli XCX"  
};
```

brat and it's  
the same but  
there's three  
more songs  
so it's not

```
album.hasOwnProperty("name")  
"name" in album
```

// true  
// true

```
album["topHit"] = "Apple"  
album.topHit = "Apple"
```

# Creating wordMap

1. iterate through each training tweet
2. get tweet's classification
3. for each word in the tweet
  - a. stem the word //var stemmedWord = stemmer(word);
  - b. if tweet is anti-refugee, -1 to word's score in wordMap
  - c. if pro-refugee, add +1 to word's Score

+1

+1

+1

+1

Example: “We love refugees #refugees”

Positive (+1)

# Creating wordMap

```
var wordMap = {  
    "we": 1,  
    "love": 1,  
    "refugees": 1,  
    "#refugees": 1,  
    ...  
}
```

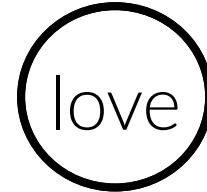
# Stemming

loved

loves

loving

lovely



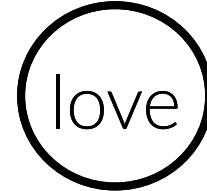
# Stemming

loved

loves

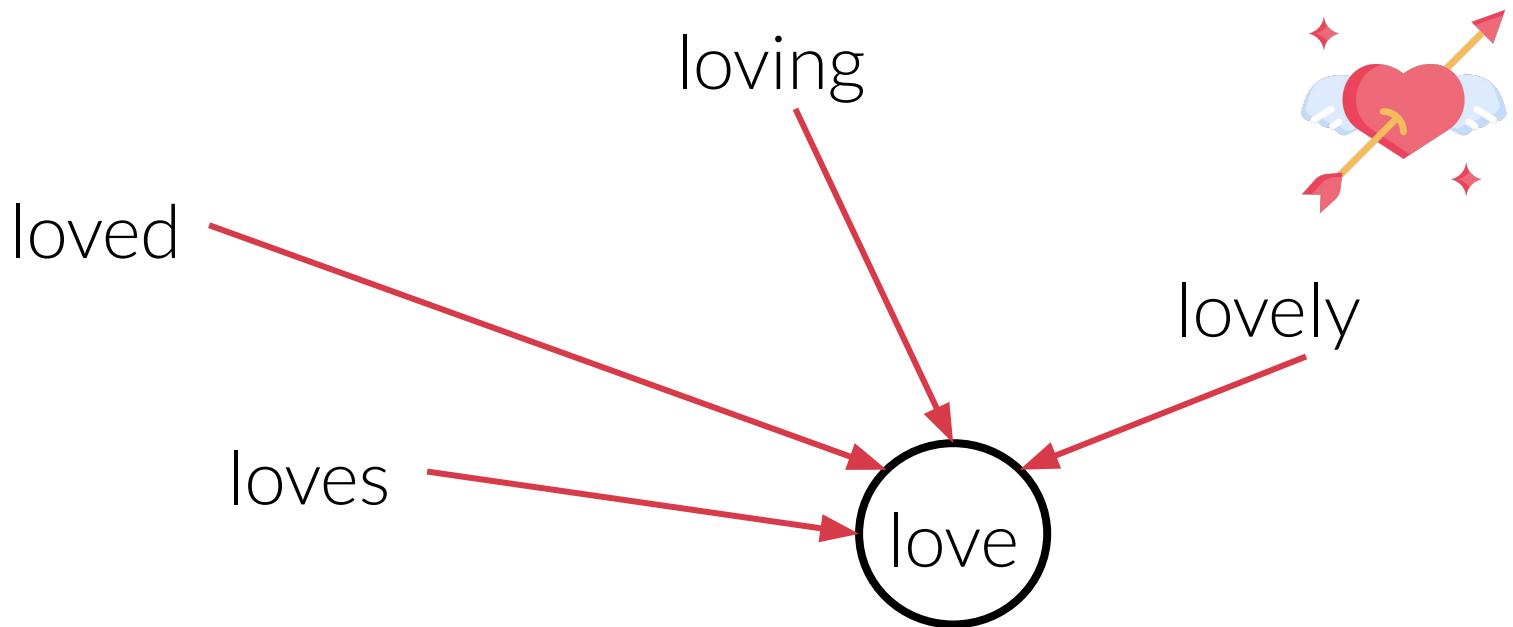
loving

lovely



All of these words are inflections of the word “love.”

# Stemming



```
let stemmedWord = stemmer(word);
```

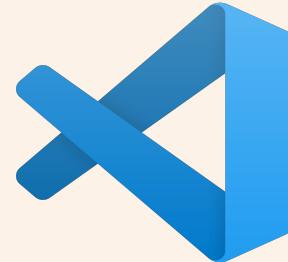
# Moving on to the Starter Code!

# Review: Software Needed



install Chrome

Getting  
Set Up



install VS Code  
(or an editor of your  
choice)

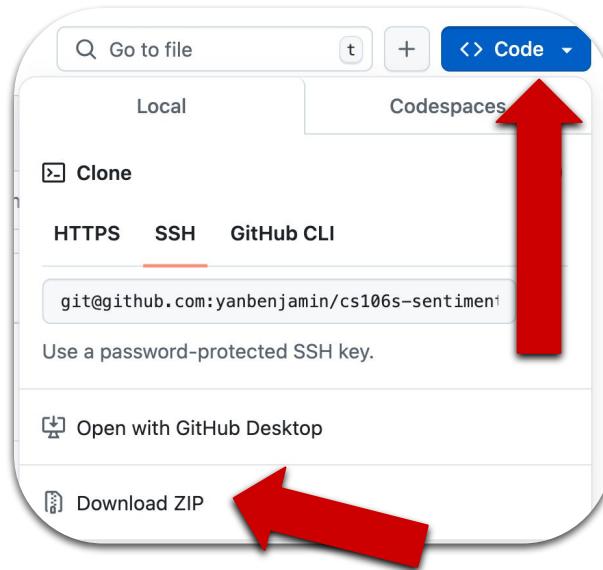
# Getting Set Up (Downloading Code)



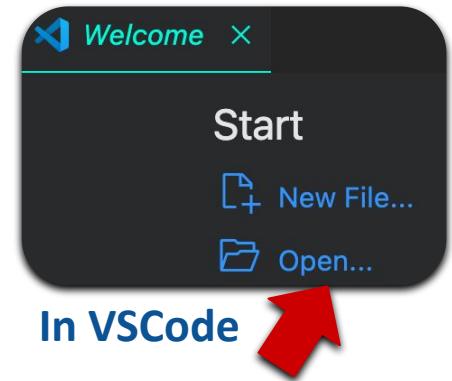
- 1 Navigate to Week 2 of the Schedule section of [cs106s.stanford.edu](https://cs106s.stanford.edu)

Also, at this link:

<https://github.com/yanbenjamin/cs106s-sentiment>

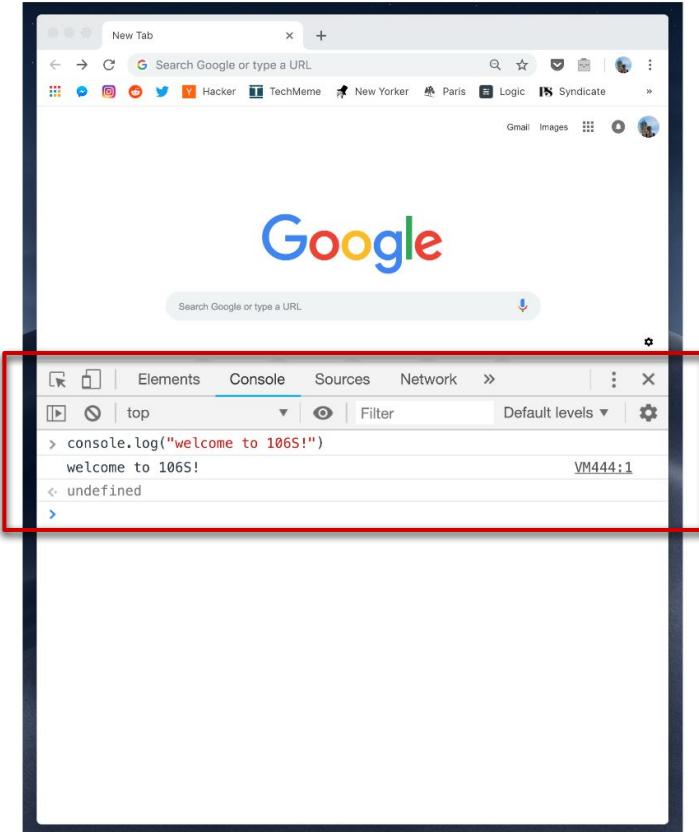


- 2 Click the bright “Code” button, then click “Download ZIP”



- 3 Unzip the download (clicking .zip file should do the trick) and open the folder / files in your editor

# Review: Using Browser to Code



1. Open **index.html** in Chrome
  2. On Mac: Press **cmd**—**option**—**j**  
On Windows: Press **ctrl**—**shift**—**j**
- Don't let go of the previous key while pressing the next.
- Here, **in the console that pops up**, we can input and run JavaScript code!

# Classifying Test Tweets

1. initialize a variable to store our “score” of the tweet.
2. for each word in the tweet:
  - a. stem the word
  - b. if word is in wordMap, add its score to our variable
3. once we go through all words in a tweet, classify!
  - a. if score is  $> 0$ , classify as pro-refugee (1)
  - b. if score is  $< 0$ , classify as anti-refugee (-1)

# Classifying Test Tweets

```
var wordMap = {  
    "hate": -5,  
    "love": +4,  
    "all": +1,  
    "refugees": +1,  
    "#refugees": +1,  
    ...  
}
```

“Don’t hate. Love all refugees”

#refugees – Positive

$$\text{score} = -5 + 4 + 1 + 1 + 1 = +2$$

category = positive (+1)

# That's the JavaScript model – let's code it up!

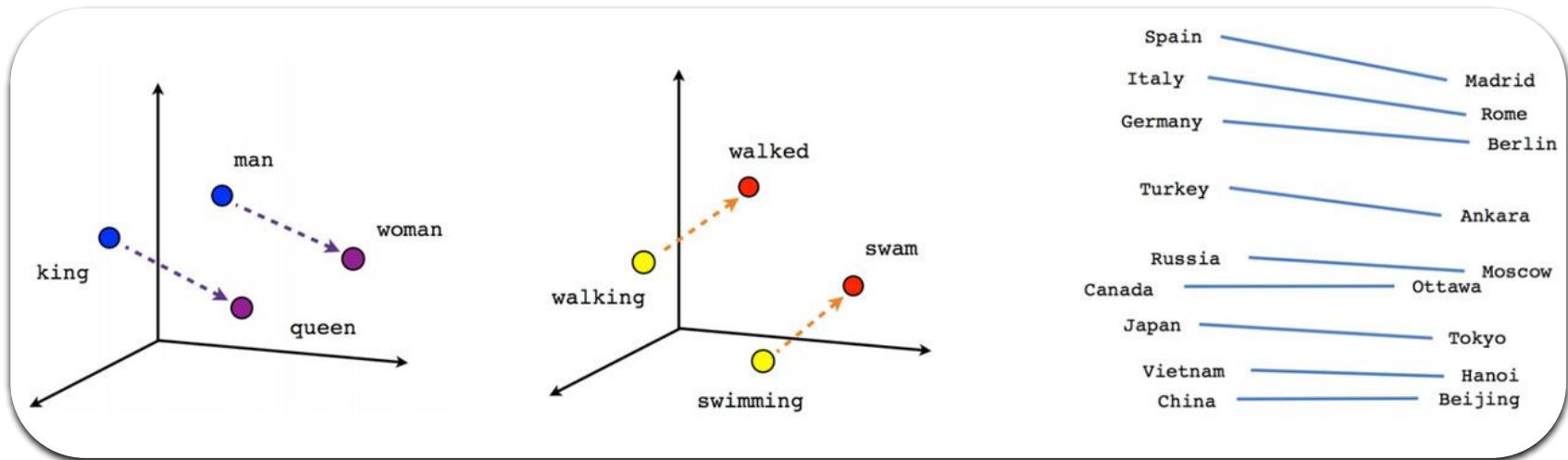
# Model Pitfalls

- Negation
  - Use a phrase-based algorithm like bigrams?
  - Can lead to more problems: **overfitting** (doesn't generalize well to new data)
- No weighting
  - Should “**the**” really be treated the same way we treat “**love**” or “**hate**”?

# Far From a Solved Problem

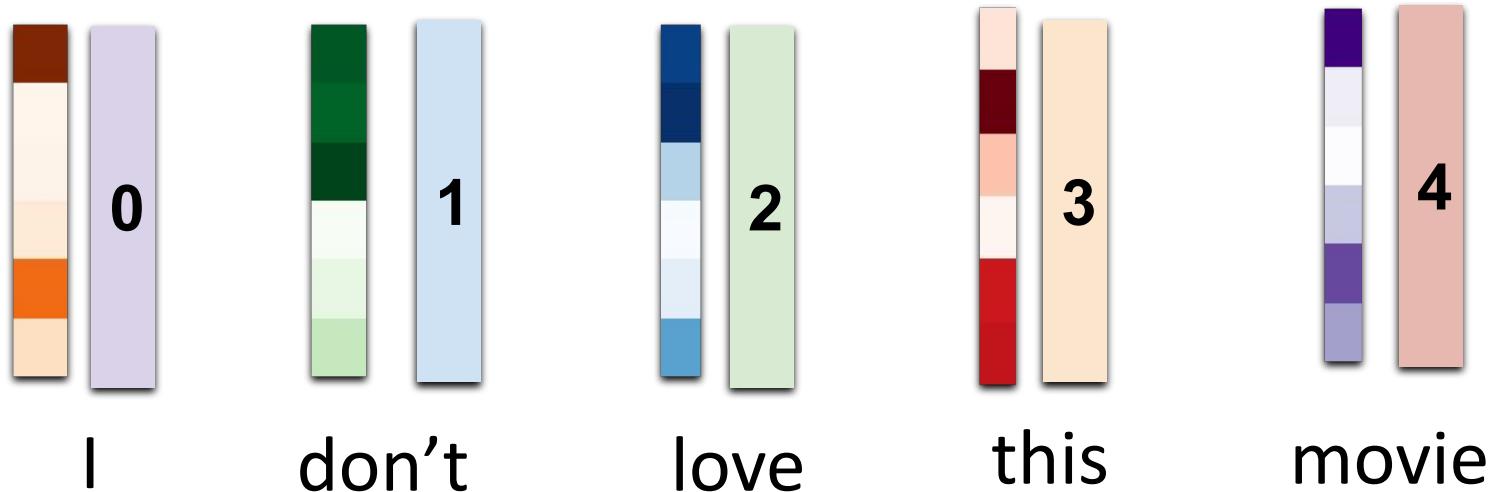
1. There was an earthquake in California.
2. The team failed to complete the challenge. (We win/lose!)
3. They said it would be great.
4. They said it would be great, and they were right.
5. They said it would be great, and they were wrong.
6. The party fat-cats are sipping their expensive imported wines.
7. Oh, you're terrible!
8. Here's to ya, ya bastard!
9. Of 2001, "Many consider the masterpiece bewildering, boring, slow-moving or annoying, . . ."
10. long-suffering fans, bittersweet memories, hilariously embarrassing moments, . . .

# Glimpse of Modern ML approaches: word2Vec (word vectors)



# Glimpse of Modern ML approaches: LLM embedding layers

- Generally a sum of a word + position embeddings





# Topical Classes @ Stanford

**CS 124:** From Languages  
to Information (Jurafsky)

**CS 224N:** Natural  
Language Processing  
with Deep Learning

**CS 224C:** NLP for  
Computational Social  
Science

**CS 152:** Trust & Safety



# Google Earth Engine Sign-Up for Next Week!

- ❖ Need to request access to Google Earth Engine (GEE) for **Week 3's lesson!**
- ❖ May take some time to be approved—**try to do this by end of today!**

- 1 Open an Incognito Window in Chrome      **ctrl** / **cmd** + **shift** + **n**
- 2 Go to [signup.earthengine.google.com](https://signup.earthengine.google.com), log in with your **Stanford email**
- 3 **Do not click Create a Google Cloud Project.** There's a tiny link below to the **SIGNUP FORM**—you'll want to click that.
- 4 Fill out the form:
  - ❖ **Affiliation/Institution:** **Stanford University**
  - ❖ **Institution Type:** **Academia**
  - ❖ “*What would you like to accomplish with Earth Engine?*” → **Required to participate in a class for Stanford CS 106S (<https://cs106s.stanford.edu>)**
  - ❖ **DON'T TICK** “I am interested in commercial use of Earth Engine”!
- 5 Submit!

Scripts Docs Assets

Filter scripts...

NEW ▾

Owner (16)

Writer

Reader

Examples

Image

Image Collection

Feature Collection

Charts

Arrays

Primitive

Cloud Masking

Landsat457 Surface Reflectance

Landsat8 Surface Reflectance

Landsat8 TOA Reflectance QA Band

MODIS Surface Reflectance QA Band

Sentinel2

Sentinel2

Get Link

Save

Run

Reset

Inspector Console Tasks

Use print(...) to write to this console.

```
1 // This example uses the Sentinel-2 QA band to cloud mask
2 // the collection. The Sentinel-2 cloud flags are less
3 // selective, so the collection is also pre-filtered by the
4 // CLOUDY_PIXEL_PERCENTAGE flag, to use only relatively
5 // cloud-free granule.
6
7 // Function to mask clouds using the Sentinel-2 QA band.
8 function maskS2clouds(image) {
9   var qa = image.select('QA60')
10
11  // Bits 10 and 11 are clouds and cirrus, respectively.
12  var cloudBitMask = 1 << 10;
13  var cirrusBitMask = 1 << 11;
14
15  // Both flags should be set to zero, indicating clear conditions
16  var mask = qa.bitwiseAnd(cloudBitMask).eq(0).and(
17    qa.bitwiseAnd(cirrusBitMask).eq(0))
18
19  // Return the masked and scaled data, without the QA band
20  return image.updateMask(mask).divide(10000)
21    .select("B,*")
22    .copyProperties(image, ["system:time_start"])
```



# Check-Off Form!

Another **brief check-off form** (< 5 min to complete) for checking attendance!

For today, click the “Check-Off Form” link in the **Week 2** section of [cs106s.stanford.edu](https://cs106s.stanford.edu).



<https://tinyurl.com/cs106s-aut24-w2-checkoff> (case sensitive!)



# Have an awesome weekend!