CS 124/LINGUIST 180
From Languages to Information

DAN JURAFSKY
PROFESSOR OF COMPUTER SCIENCE
PROFESSOR OF LINGUISTICS
STANFORD UNIVERSITY
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INTRODUCTION AND COURSE OVERVIEW

From Languages to Information

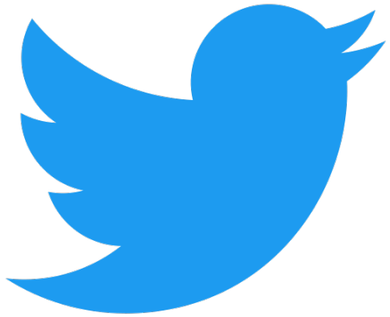
Automatically extracting meaning and structure from:

- Human language (news, social media, etc.)
- Social networks

Interacting with humans via language

- Dialog systems/Chatbots
- Question Answering
- Recommendation Systems

Commercial World



Social World

Disaster Relief

Helping teachers in the classroom

Improve Police-Community relations via Body-Cameras

Training Mental Health Counselers

1. Extracting information from language

Information Retrieval

6,586,013,574 web searches every day (by one estimate)

Text-based information retrieval is likely the most frequently used piece of software in the world

How does it work? Can you build an IR engine?

Programming Assignment 3: Search!

Text Classification: Disaster Response

Haiti Earthquake 2010

Classifying SMS messages

Mwen thomassin 32 nan pyron mwen ta renmen jwen yon ti dlo gras a dieu bo lakay mwen anfom se sel dlo nou bezwen

I am in Thomassin number 32, in the area named Pyron. I would like to have some water. Thank God we are fine, but we desperately need water.

Programming Assignment 2: Triage!

Extracting Sentiment and Social Meaning

Lots of meaning is in **connotation**

> "connotation: an idea or feeling that a word invokes in addition to its literal or primary meaning."

Extracting connotation is generally called **sentiment analysis**

Programming Assignment 2: Sentiment

A (fictional) application of sentiment analysis for toxicity intervention that shows how hard it can be!

Sentiment in Restaurant Reviews

Dan Jurafsky, Victor Chahuneau, Bryan R. Routledge, and Noah A. Smith. 2014. Narrative framing of consumer sentiment in online restaurant reviews. First Monday 19:4

900,000 Yelp reviews online

A very bad (one-star) review:

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 ...

What is the language of bad reviews?

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 ...

Other narratives with this language

A genre using:

Past tense, we/us, negative, people narratives

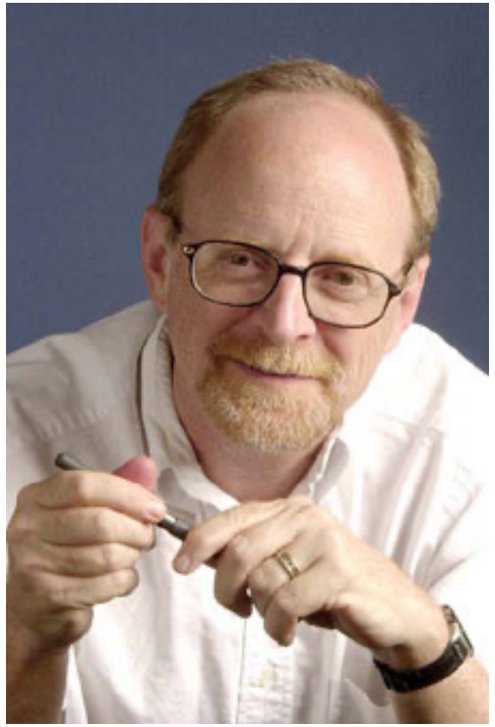
Texts written by **people suffering trauma**

- James Pennebaker lab at UT Austin
- Past tense is used for "distancing"
- Use of “we”: seeking solace in community

1-star reviews are trauma narratives!

The lesson of reviews:

It’s all about personal interaction



What about positive reviews? Sex, Drugs, and Dessert

addicted to pepper shooters

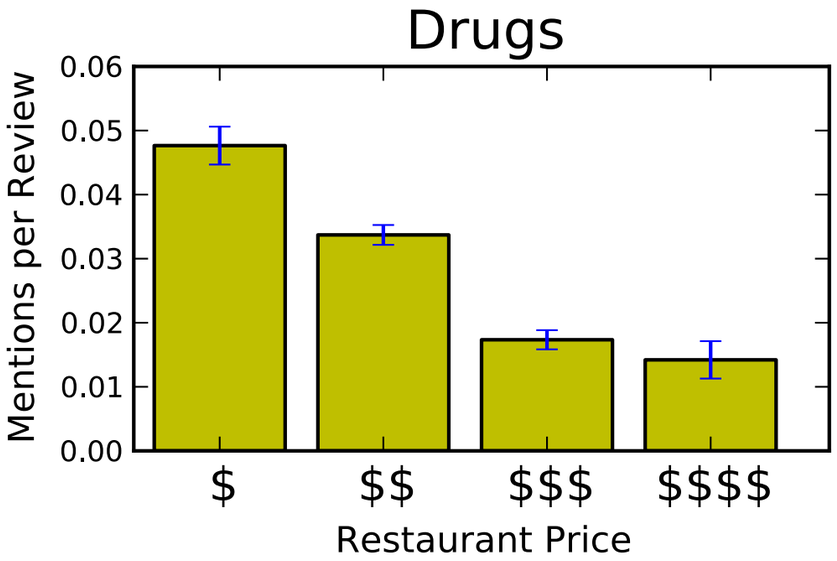
garlic noodles… my *drug of* choice

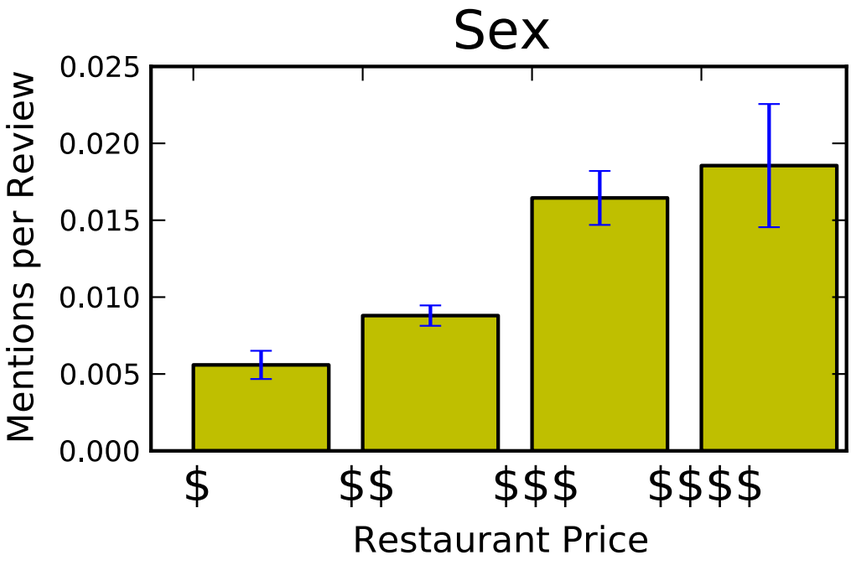
the fries are *like crack*

orgasmic pastry

sexy food

seductively seared fois gras





Computational Biology: Comparing Sequences

```
AGGCTATCACCTGACCTCCAGGCCGATGCCC
TAGCTATCACGACCGCGGTCGATTTGCCCGAC

-AGGCTATCACCTGACCTCCAGGCCGA--TGCCC---
 | |  | | | | | | |  | | | | x |  | |  | | |  | | | | |
TAG-CTATCAC--GACCGC--GGTCGATTTGCCCGAC
```

Sequence comparison is key to

- Finding genes
- Determining function
- Uncovering evolutionary processes

This is also how spell checkers work!

We'll learn: edit distance algorithms (Quiz 1)

Social Networks

The network formed by your friends or other relations offline or online

- Can we compute properties of these networks?
- Extract information from them?

- **We'll learn: Network algorithms (Quiz 9)**

Help improve Police-Community Interaction (week 9)

Problems:

- A flood of viral videos show inappropriate officer use of force
- Black Americans report more negative interactions with police

Could natural language processing help?

- Quantify police-community interactions using body-worn cameras?
- Help develop officer training?
- Reduce the chances of violence?
- I'll talk about work with Prof. Jennifer Eberhardt

2. Interacting with humans via language

Personal Assistants

Siri

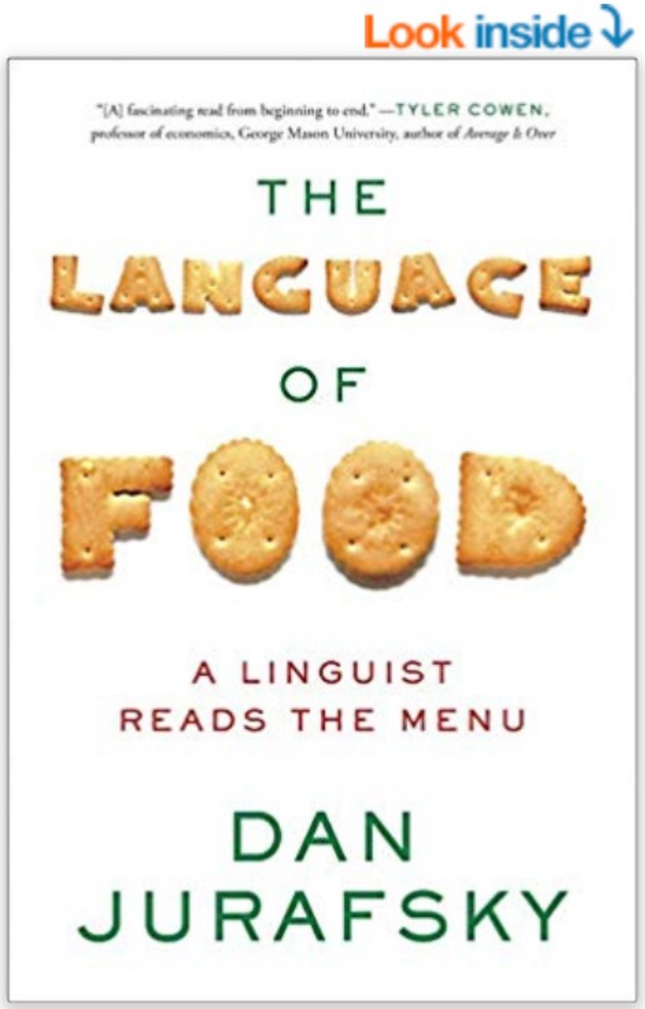
amazon alexa

Google Now

PA 7 Chatbot!

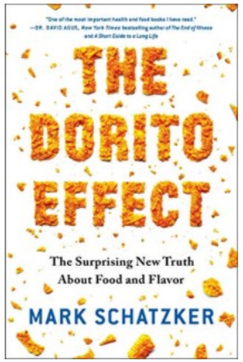
Recommendation Engines: The Good

If you bought….

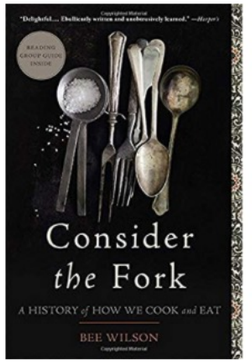


Customers who bought this item also bought

First Bite: How We Learn to Eat
› Bee Wilson
4.5 out of 5 stars 46
Paperback
$11.37 prime



The Dorito Effect: The Surprising New Truth About Food and Flavor
› Mark Schatzker
4.5 out of 5 stars 193
Paperback
$9.48 prime



Consider the Fork: A History of How We Cook and Eat
› Bee Wilson
4.0 out of 5 stars 253
Paperback
$15.65 prime

Cuisine and Empire: Cooking in World History (California Studies in…
› Rachel Laudan
4.0 out of 5 stars 35
Paperback
$16.20 prime

PA 7 and Quiz 8

The dark side: YouTube Radicalization

ChatGPT: Large language models

What makes language interpretation hard?

Ambiguity

Resolving ambiguity is hard

Ambiguity

There are at least half a dozen meanings of this sentence:

`The chef made her duck`

Go here and type (and vote for) some definitions

https://pollev.com/danjurafsky451

Ambiguity

The chef made her duck

The cook cooked waterfowl for a different woman X (person using "she/her" pronouns) to eat

The cook cooked waterfowl belonging to X

The cook cooked waterfowl belonging to the cook

The cook created the (plaster?) waterfowl that X owns

The cook caused X to quickly lower X's head or body

The cook uncovered the true identity of the cook's spy waterfowl

The cook waved their magic wand and turned X into undifferentiated waterfowl

The chef made her duck

The chef caused X to quickly lower her head or body

Part of speech: “duck” can be a Noun or Verb

The chef cooked waterfowl for X (or belonging to X)

Part of speech:

“her” is possessive pronoun (“of her”)

“her” is dative pronoun (“for her”)

The chef cooked waterfowl belonging to the chef (vs to X)

Coreference

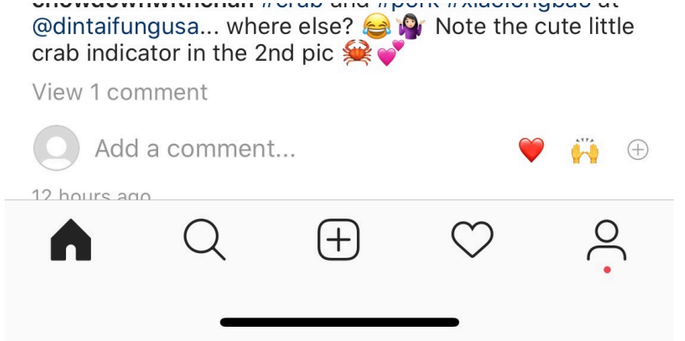
“her” can refer to X or to the Chef

The chef made the (plaster) duck statue X (or the chef) owns

Word Meaning : “make” can mean “create” or “cook”

More difficulties: Non-standard language, emojis, hashtags, names

chowdownwithchan #crab and #pork #xiaolongbao at @dintaifungusa... where else? 😂🤷‍♀️ Note the cute little crab indicator in the 2nd pic 🦀💕

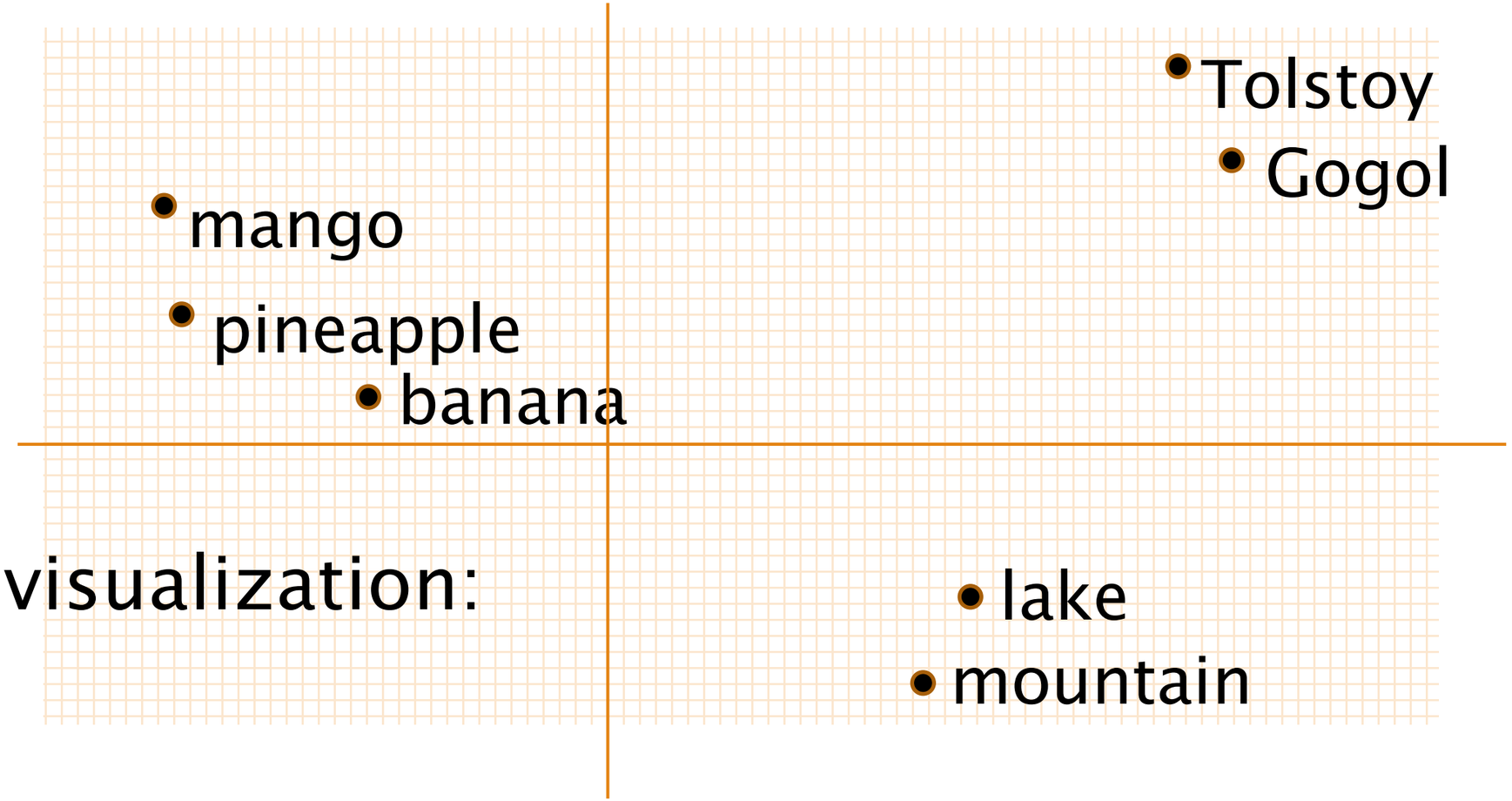


Models and Tools

- Regular Expressions
- Edit distance and alignment
- Neural word embeddings
- Machine Learning classifiers
  - Naive Bayes
  - Logistic Regression
  - Neural Networks
- Neural Language Models aka "Foundation Models"
- Network algorithms
  - PageRank
- Recommendation algorithms
  - Collaborative filtering
- Linguistic tools
  - Sentiment lexicons
  - Emotion lexicons
- The GUS chatbot architecture (Siri, Alexa)
- Neural chatbots (ChatGPT)

Core of modern NLP: Neural "word embeddings"

A word's meaning is a point in (say) 300-dimensional space



A 2-D visualization:

Problem: Embeddings reflect cultural bias!

Bolukbasi, Tolga, Kai-Wei Chang, James Y. Zou, Venkatesh Saligrama, and Adam T. Kalai. 2016. "Man is to computer programmer as woman is to homemaker? Debiasing word embeddings." In *NeurIPS 2016*, pp. 4349-4357.

Ask “Paris : France :: Tokyo : x”

- x = Japan

Ask “father : doctor :: mother : x”

- x = nurse

Ask “man : computer programmer :: woman : x”

- x = homemaker

What can we do about this problem? Week 5!

Logistics: Instructor

Instructor: Dan Jurafsky (he/him)

Professor in CS and Linguistics

My office hours:

- Tuesday after class 4:30-5:50
- Margaret Jacks Hall 117

*How to pronounce my name

Picture by Ross Petukhov

Course Staff

Dan Jurafsky
Professor

Deveshi Buch
Head TA

Amelie Byun
Course Manager

John Cho
Course Coordinator

Course Assistants

Niki Agrawal

Jason Ah Chuen

Naomi Eigbe

Amelia Hardy

David Lim

Alexis Lowber

Dwight Moore

John Nguyen

Tolu Oyeniyi

Samantha Silverstein

Anooshree Sengupta

Alisa Wang

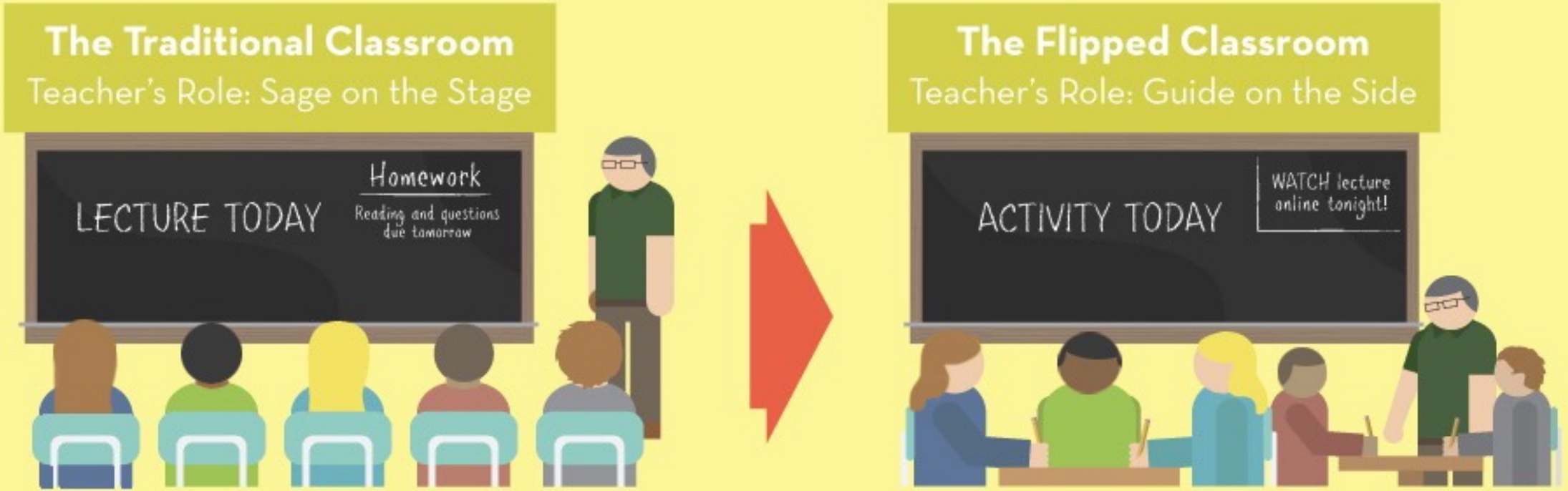
Michelle Xu

Evidence Based Pedagogy!

WHAT IS THE FLIPPED CLASSROOM?

The flipped classroom inverts traditional teaching methods, delivering instruction online outside of class and moving "homework" into the classroom.

THE INVERSION



From (defunct) www.knewton.com/flipped-classroom/

Why the flipped classroom (1)

Mastery learning: Learn until you master

Benjamin Bloom, 1968

Bloom's mastery learning

Personalized, **goal-driven practice**, driven by **feedback**

1. Watch (and re-watch) lectures at your own pace and learn when it's best for you
2. Videos have embedded miniquizzes. If you get it wrong, it gives you feedback about why you misunderstood.
3. You have **infinite** chances at each weekly Tuesday Quiz, so you can go back to the lecture and retake them.
4. With programming assignments you can see your performance on the training and dev set to see what you might be doing wrong on the test set!

Why the videos have embedded quizzes: “summative” vs “formative” assessment

Summative assessment

- Final exams/midterms: goal is grading

Formative assessment

- Along the way: goal is for **you** to find out what you don’t know so you can learn

Why the flipped classroom (2)

Attention span: everyone spaces out during long lectures

- Middendorf and Kalish, 1995, Johnstone and Percival 1976, Burns 1985

"the class started 1:00. The student sitting in front of me took copious notes until 1:20. Then he just nodded off… motionless, with eyes shut for about a minute and a half, pen still poised. Then he awoke and continued his rapid note-taking as if he hadn't missed a beat."

Student remembered only the first 15-20 minutes

Why the flipped classroom (3)

Active learning: Be in charge of your learning

- Most important: programming assignments
- Active learning ("constructivism"), learning by doing

Collaborative learning: Learn from each other

- Use class time for group problem-solving
- "Small group active learning"
- You must do PA6 in groups

cs124: Flipped classroom

1. **Prerecorded video lectures on video:**
   - About ~90 minutes/week of video lectures
   - Some people watch it speeded up
2. **Live sessions:**
   - 2 required lectures
   - 5 required in-class group works (“active learning”)
     - Group Work #1 next Tuesday is **required live**
     - Group works #2, #3, #4, #5 are recommended to be done live, but if you miss class that day, make sure you still do it at home; the material will be on the midterms

Logistics More Specifically

Online Video Lectures w/embedded non-graded questions (watch before class)

20 pages of reading a week (up to you when to read)

Weekly online Quizzes (Tue of following week)

7 Python homeworks (mostly due Fri of following week)

Two midterms during class time (but we will have alternate times on both days)

- Feb 16
- Mar 16

Learning Goals

At the end of this course, you will be able to:

Learning goals

Write efficient regular expressions to solve any kind of text-based extraction task

Learning goals

Apply the edit distance algorithm to all sorts of text sequence problems

Learning goals

Build a supervised classifier to solve problems like sentiment classification

Learning goals

Build a neural network and train it using stochastic gradient descent

Learning goals

Build a search engine

Learning goals

Build a recommendation engine

Learning goals

Build a computational model of word meaning (using lexicons and neural word embeddings)

Learning goals

Build a chatbot

Learning goals

Understand and implement PageRank and other social network functions

Learning goals

Understand neural language models and be able to reason both about what they can do, and also their social implications

This class is the undergrad intro to:

Win 2023: cs224N Natural Language Processing w/Deep Learning (Manning)

Win 2023: cs246 Mining Massive Data Sets (Leskovec)

Spr 2023: cs222U Natural Language Understanding (Potts)

Win 2023: cs224C: NLP for Computational Social Science (Yang)

Spr 2023: cs346 Ethical and Social Issues in NLP (Jurafsky)

Spr 2023: cs 224??: Human-Centered NLP

Aut 2023: cs224W Machine Learning with Graphs

Aut 2023: cs221 Artificial Intelligence

? cs224S Spoken Language Processing

? cs276 Information Retrieval and Web Search

Should I take 124 or 224X?

CS124 is designed for sophomores or juniors

- It's gentle (I explain everything) and broad (covering many topics, not just NLP but also recommendation engines, IR, social networks)
- Mastery learning, quizzes and programming homeworks
- No research project, but a fun chatbot final homework

CS224N and 224U are deeper, more focused, grad courses

- They assume you are familiar with machine learning and will jump right into optimization and do advanced stuff
- Learning via research: novel research projects as a large component

CS224?? (Human Center NLP) and CS346 (Social and Ethical Issues in NLP) require that you have already had 224N or 224U

CS224C is a different topic: Computational Social Science

(You should of course take all of them!!)

Syllabus

cs124.stanford.edu

Where do I find all the programming assignments and quizzes and readings?

Everything is on the webpage cs124.stanford.edu

Except the videos which are on canvas!

In other words:

- Lectures slides: webpage
- Group work instructions: webpage
- Tutorial information: webpage
- Programming assignments: webpage (points to git where they live)
- Weekly quizzes: webpage (points to gradescope where they live)
- Practice midterms: webpage
- Midterms: gradescope
- Videos: canvas

Coming up this week: Thursday

Optional tutorial on jupyter notebooks and PA0, getting ready for PA1

Come to class **with your laptops** and we'll go through PA0 together!

This tutorial will be led by amazing head TA Deveshi Buch!!! But I and many other CAs will be there!

Action Items Before Thursdays class!

1) Read the syllabus webpage at cs124.stanford.edu

2) Look at PA0 (you can find it from the webpage)

3) Watch Canvas Videos on "PA0 Mac Setup" (or "PA0 Windows Setup")

Coming up next week (Tuesday)

"Unix for poets":

grep

sort

Key UNIX tools for dealing with text files and regular expressions.

Action Items Before Tuesday's class!

1) Watch the "week 1" videos on Canvas before class (even earlier, since the quiz is also due Tuesday)

3) Download this file to your laptop

http://cs124.stanford.edu/nyt_200811.txt

4) If you don't know UNIX yet (haven't had cs107):

- For people using a Windows 10 machine, if you don't have Ubuntu on your machine:
  - Watch the first 9 minutes of Bryan's lovely pa0 video about how to download and install Ubuntu:
  - https://canvas.stanford.edu/courses/144170/modules/items/981067
- Watch Chris Gregg's excellent UNIX videos here: Logging in, first 7 File System, and first 8 useful commands

  https://web.stanford.edu/class/archive/cs/cs107/cs107.1186/unixref/

PA1: Spam Lord!

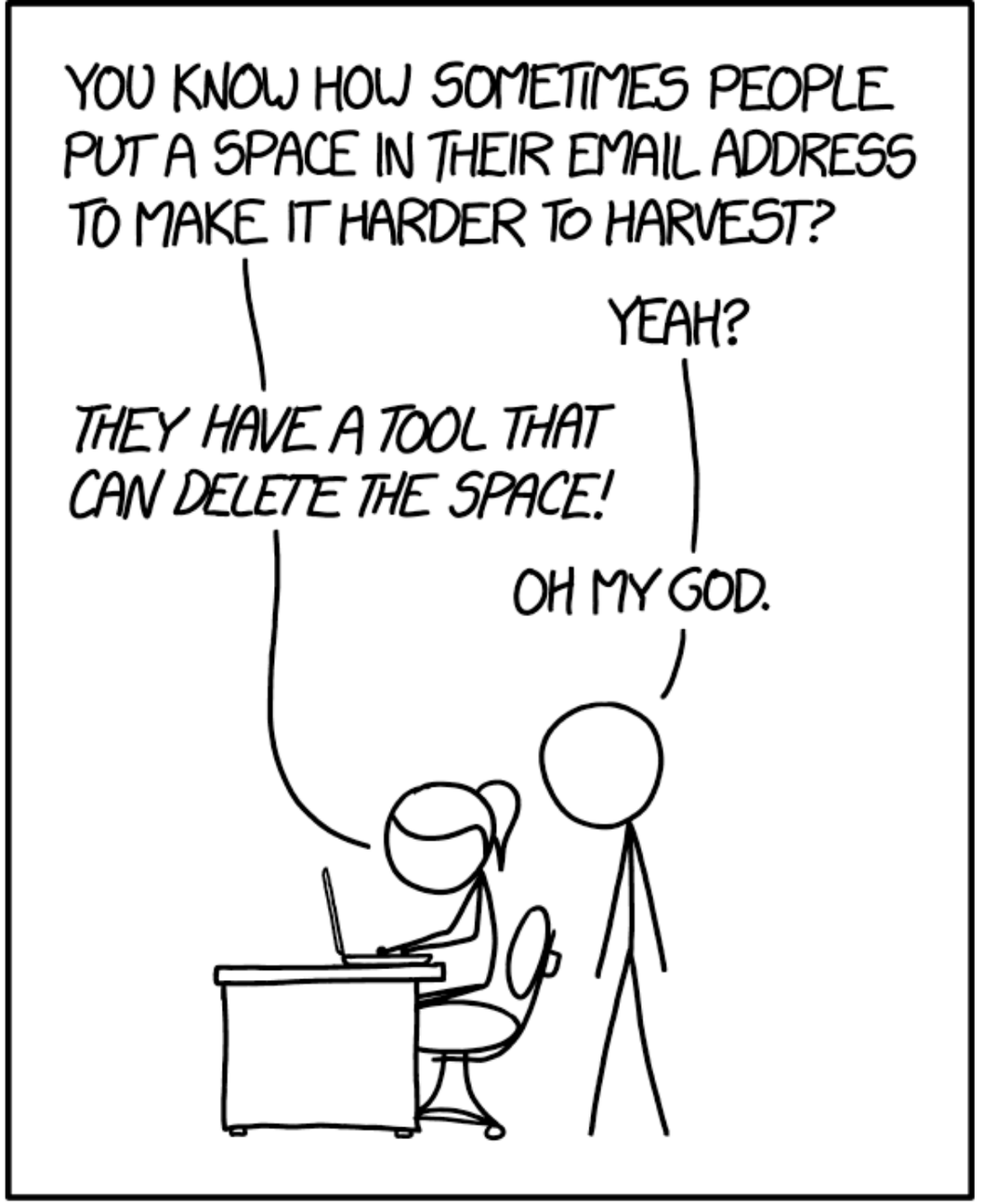
Write regular expressions to spread evil* throughout the galaxy!

By extracting email addresses and phone numbers from the web!

```
jur a fs ky at st anford dot e d u
```

Goes live Friday 5pm!

*Just kidding; don't be evil



LESS-DRAMATIC REVELATIONS FROM THE CIA HACKING DUMP