CS378: Natural Language Processing
Lecture 1: Introduction

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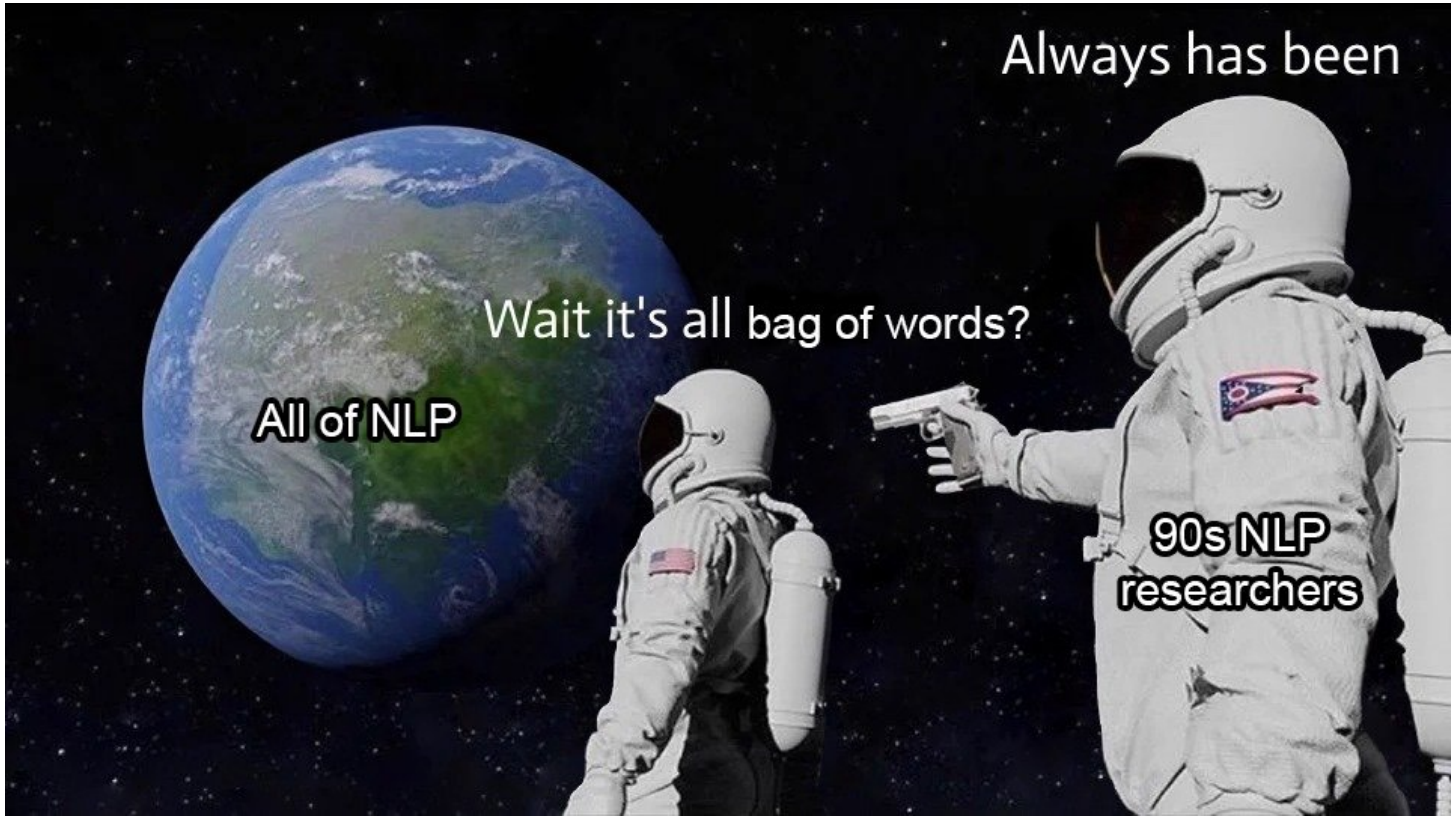


Credit: Stephen Roller

Administrivia

- Lecture: Tuesdays and Thursdays 9:30am - 10:45am
- Course website (including **syllabus**): http://www.cs.utexas.edu/~gdurrett/courses/fa2021/cs378.shtml
- edstem board (~Piazza): link on the course website
- Office hours: see course website. Mix of Zoom (instructor and TAs) and on-campus (TAs). Please come!
- TAs: Kaj Bostrom and Abhilash Potluri (say hi!)
- All office hours start next week, but I will stay around after this class (including on Zoom) if you have questions

Course Requirements

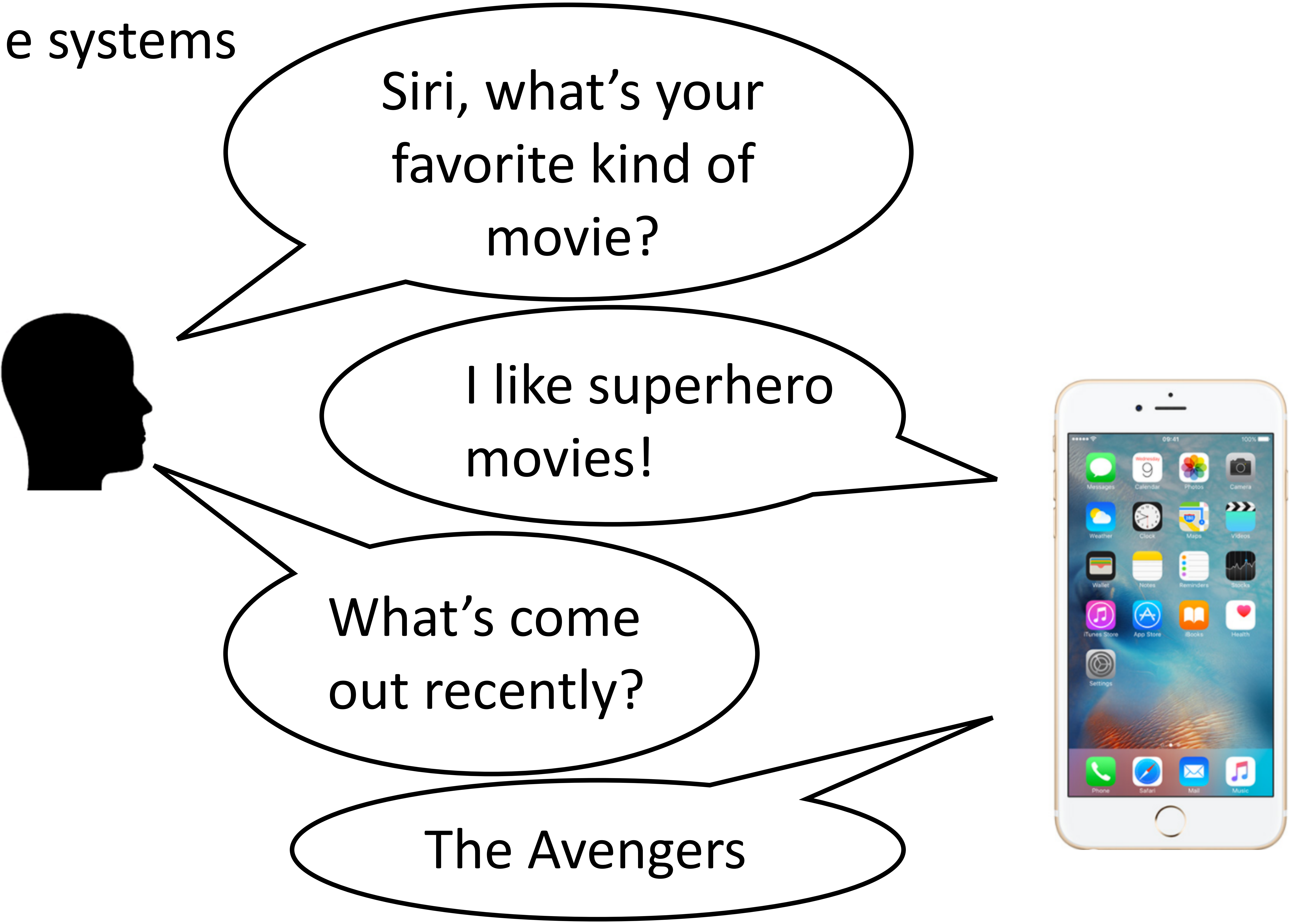
- CS 429
- Recommended: CS 331, familiarity with probability and linear algebra, programming experience in Python
- Helpful: Exposure to AI and machine learning (e.g., CS 342/343/363)
- Assignment 0 is out now (optional):
  - If this seems like it'll be challenging for you, come and talk to me (this is smaller-scale than the other assignments, which are smaller-scale than the final project)

Format and Accessibility

- Lectures will build in time for discussion, in-class exercises, and questions. Additional material is available as videos to watch either before or after lectures
  - We'll do plenty of discussion groups in class. Piazza is also available to find teammates
- Equipment: useful to have a device for lecture to do Instapolls. For homework:
  - Lab machines available via SSH
  - A GPU is **not** required to complete the assignments! Having a GPU or GCP credits could be helpful **if** you want to pursue an independent project

What’s the goal of NLP?

- Be able to solve problems that require deep understanding of text
- Example: dialogue systems



Siri, what’s your favorite kind of movie?

I like superhero movies!

What’s come out recently?

The Avengers

Machine Translation

The Political Bureau of the CPC Central Committee

July 30

hold a meeting

中共中央政治局7月30日召开会议，会议分析研究当前经济形势，部署下半年经济工作。

People’s Daily, August 10, 2020

Translate

The Political Bureau of the CPC Central Committee held a meeting on July 30 to analyze and study the current economic situation and plan economic work in the second half of the year.

Question Answering

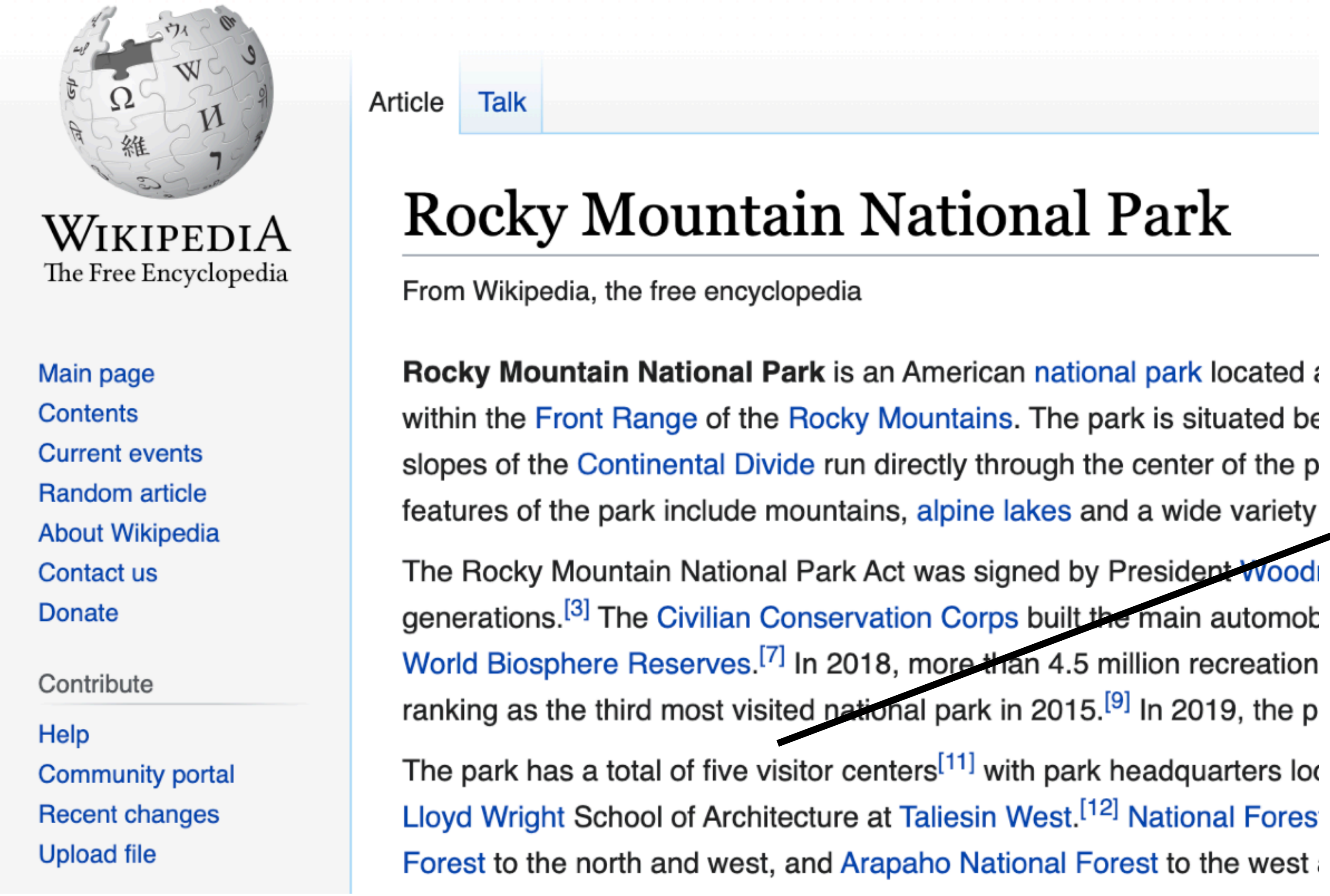
When was Abraham Lincoln born?

map to Birthday field

Name	Birthday
Lincoln, Abraham	2/12/1809
Washington, George	2/22/1732
Adams, John	10/30/1735

→ **February 12, 1809**

How many visitors centers are there in Rocky Mountain National Park?



Rocky Mountain National Park

From Wikipedia, the free encyclopedia

Rocky Mountain National Park is an American national park located
within the Front Range of the Rocky Mountains. The park is situated be
slopes of the Continental Divide run directly through the center of the p
features of the park include mountains, alpine lakes and a wide variety

The Rocky Mountain National Park Act was signed by President Wood
generations.[3] The Civilian Conservation Corps built the main automob
World Biosphere Reserves.[7] In 2018, more than 4.5 million recreation
ranking as the third most visited national park in 2015.[9] In 2019, the p

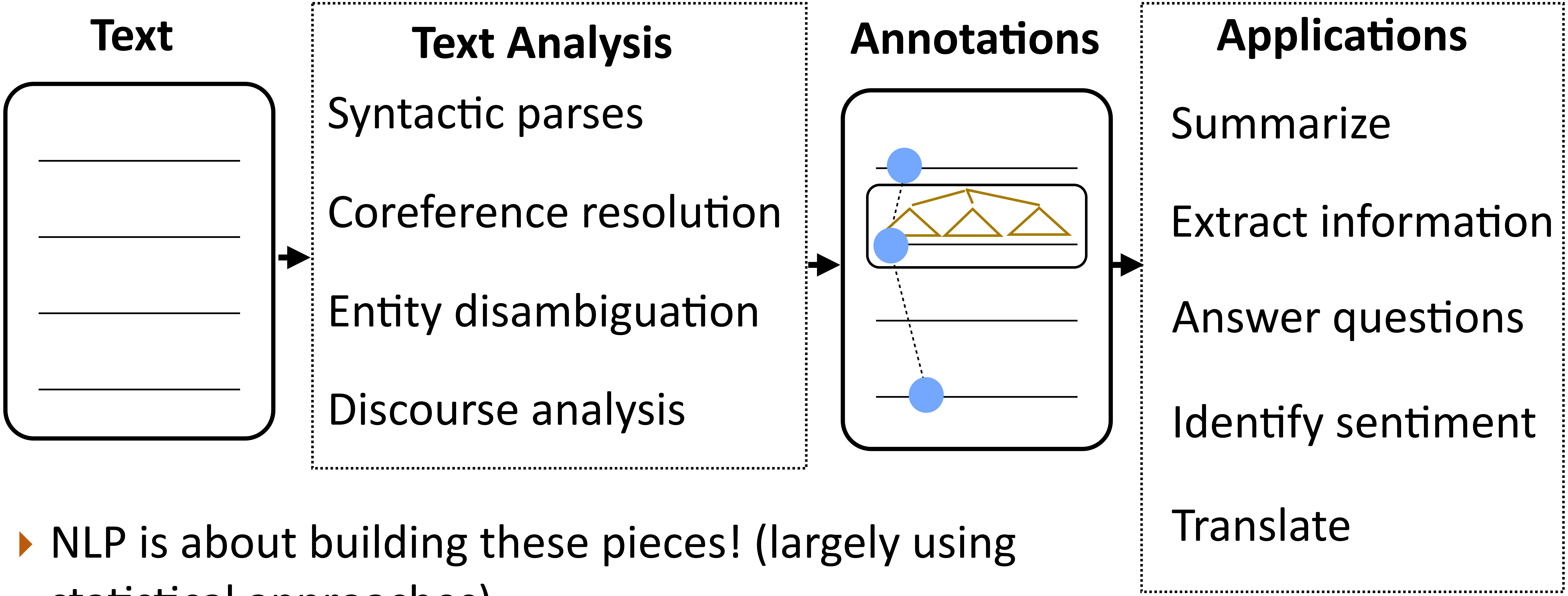
The park has a total of five visitor centers[11] with park headquarters lo
Lloyd Wright School of Architecture at Taliesin West.[12] National Fores
Forest to the north and west, and Arapaho National Forest to the west

The park has a total of five visitor centers

↓

five

NLP Analysis Pipeline



Text

Text Analysis

Syntactic parses

Coreference resolution

Entity disambiguation

Discourse analysis

Annotations

Applications

Summarize

Extract information

Answer questions

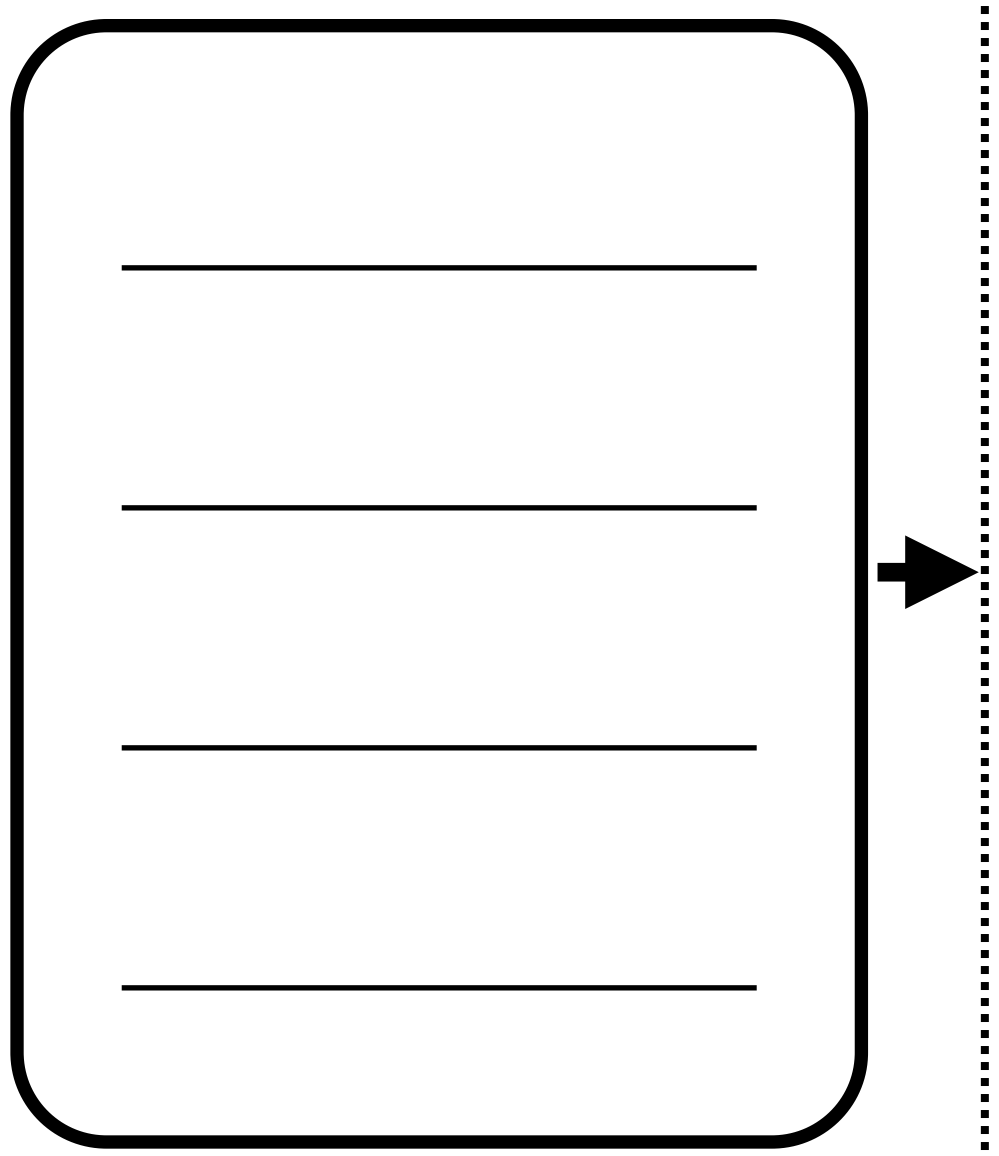
Identify sentiment

Translate

- NLP is about building these pieces! (largely using statistical approaches)

How do we represent language?

Text



Labels

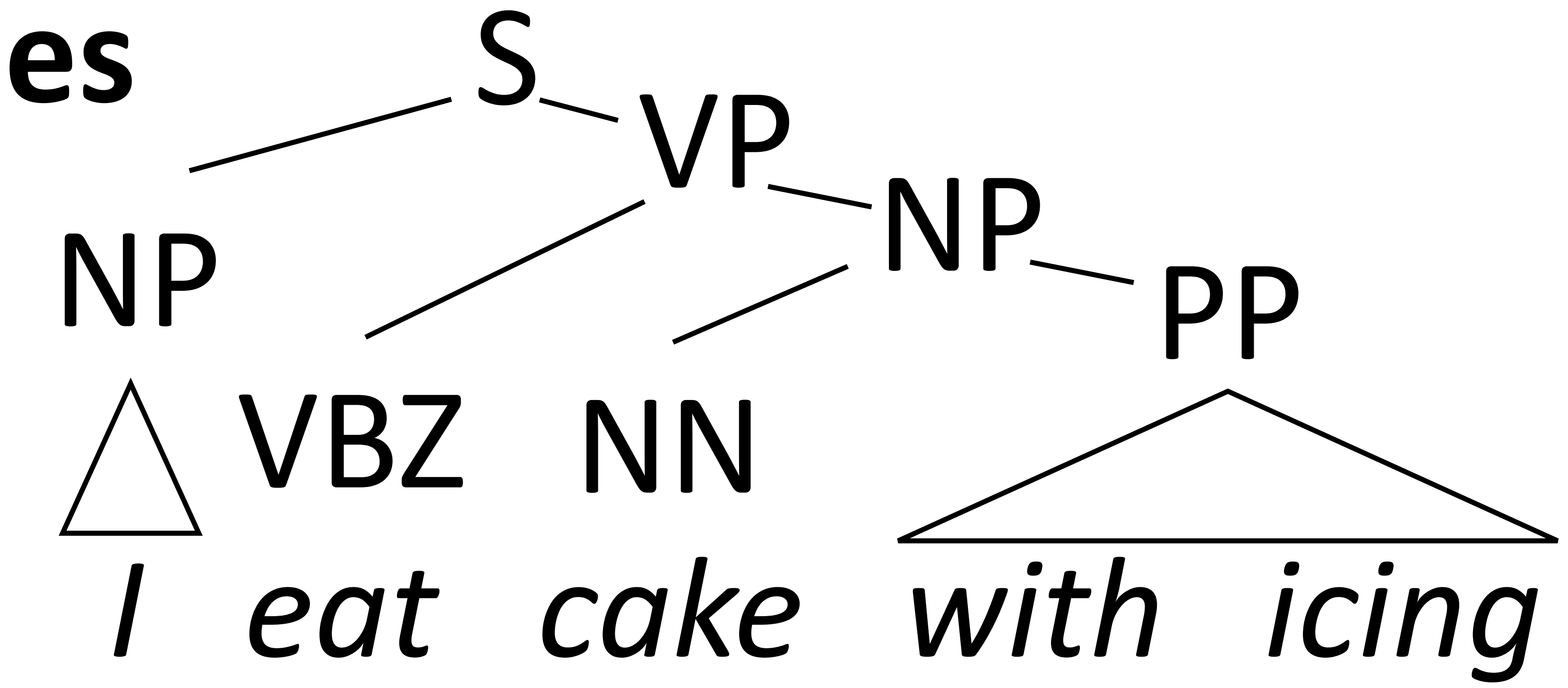
the movie was good +

Beyoncé had one of the best videos of all time **subjective**

Sequences/tags

PERSON *Tom Cruise* *stars in the new* **WORK_OF_ART** *Mission Impossible* *film*

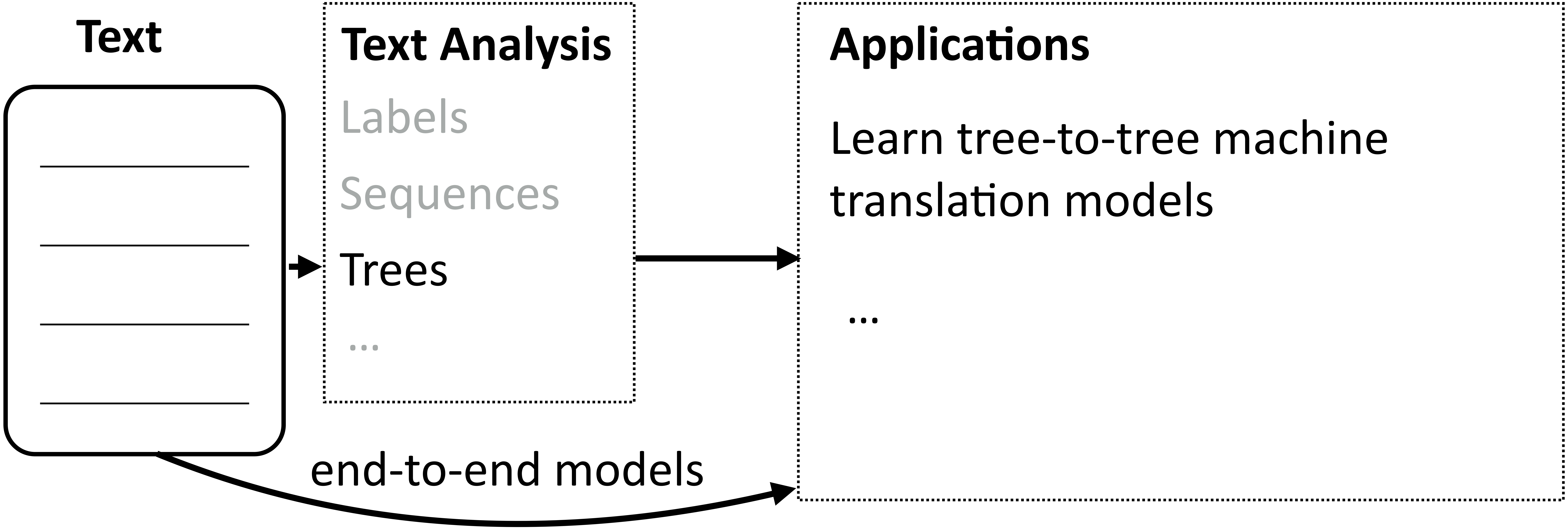
Trees



$\lambda x.\ \mathit{flight}(x) \wedge \mathit{dest}(x)=\mathit{Miami}$

flights to Miami

How do we use these representations?



Text

Text Analysis

Labels

Sequences

Trees

…

Applications

Learn tree-to-tree machine translation models

…

end-to-end models

- Main question: What representations do we need for language? What do we want to know about it? What ambiguities do we need to resolve?

Why is language hard?

(and how can we handle that?)

Language is Ambiguous!

- Hector Levesque (2011): "Winograd schema challenge" (named after Terry Winograd, the creator of SHRDLU)

The city council refused the demonstrators a permit because they advocated violence

The city council refused the demonstrators a permit because they feared violence

The city council refused the demonstrators a permit because they _______ violence

- >5 datasets in the last two years examining this problem and commonsense reasoning
- Referential ambiguity

Language is Ambiguous!

Teacher Strikes Idle Kids

Ban on Nude Dancing on Governor's Desk

Iraqi Head Seeks Arms

- Syntactic and semantic ambiguities: parsing needed to resolve these, but need context to figure out which parse is correct

example credit: Dan Klein

Language is **Really** Ambiguous!

- There aren’t just one or two possibilities which are resolved pragmatically

il fait vraiment beau →

It is really nice out

It’s really nice

The weather is beautiful

It is really beautiful outside

He makes truly beautiful

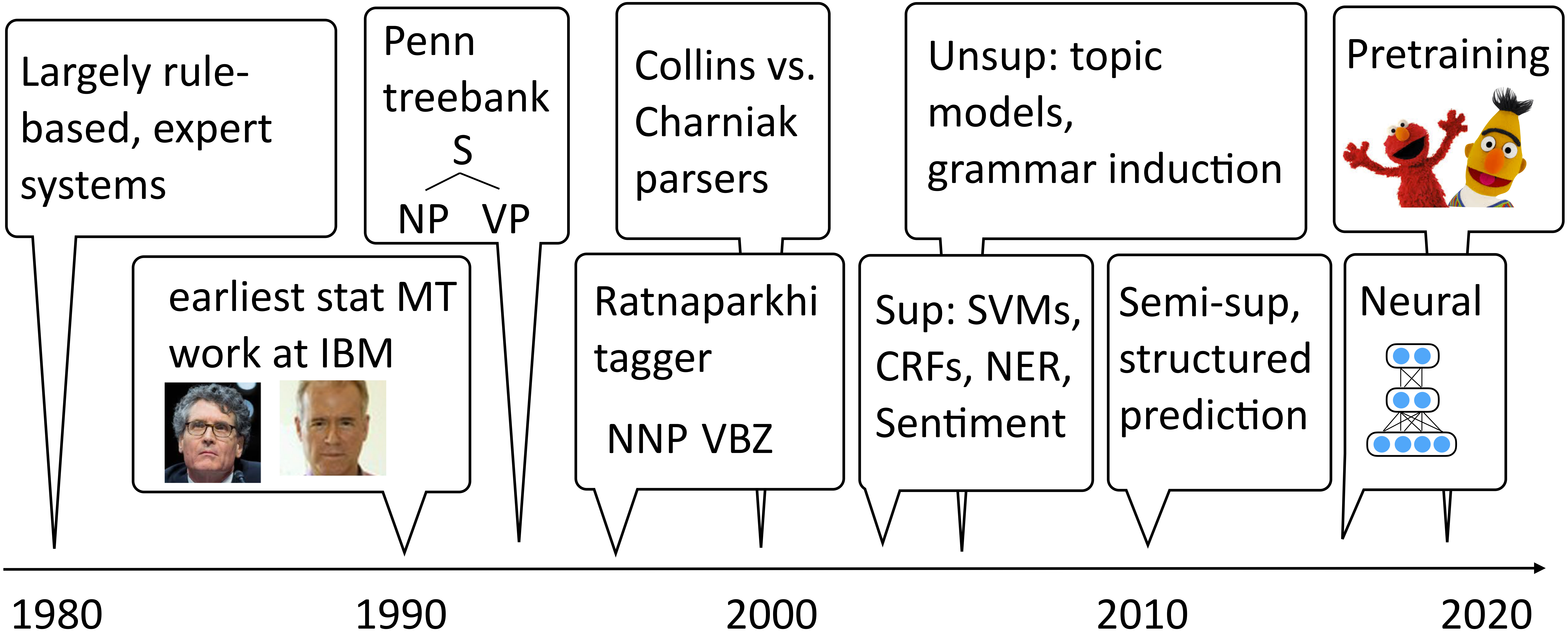
It fact actually handsome

- Combinatorially many possibilities, many you won’t even register as ambiguities, but systems still have to resolve them

What techniques do we use?

(to combine data, knowledge, linguistics, etc.)

A brief history of (modern) NLP



Largely rule-based, expert systems

earliest stat MT work at IBM

Penn treebank

S

NP VP

Collins vs. Charniak parsers

Ratnaparkhi tagger

NNP VBZ

Unsup: topic models, grammar induction

Sup: SVMs, CRFs, NER, Sentiment

Semi-sup, structured prediction

Pretraining

Neural

Pretraining

- Language modeling: predict the next word in a text $P(w_i | w_1, \ldots, w_{i-1})$

P(*w* | I want to go to) = 0.01 Hawai'i

0.005 LA

0.0001 class

: use this model for other purposes

P(*w* | the acting was horrible, I think the movie was) = 0.1 bad

0.001 good

- Model understands some sentiment?

- Train a neural network to do language modeling on massive unlabeled text, fine-tune it to do {tagging, sentiment, question answering, ...}

Peters et al. (2018), Devlin et al. (2019)

Interpretability

- When we have complex models, how do we understand their decisions?

The movie is mediocre, maybe even bad.	Negative 99.8%

The movie is mediocre, maybe even ~~bad~~.	Negative 98.0%
The movie is ~~mediocre~~, maybe even bad.	Negative 98.7%
The movie is ~~mediocre~~, maybe even ~~bad~~.	Positive 63.4%
The movie is ~~mediocre~~, ~~maybe~~ even ~~bad~~.	Positive 74.5%
The ~~movie~~ is mediocre, maybe even ~~bad~~.	Negative 97.9%

The movie is mediocre, maybe even bad.

Wallace, Gardner, Singh
Interpretability Tutorial at EMNLP 2020

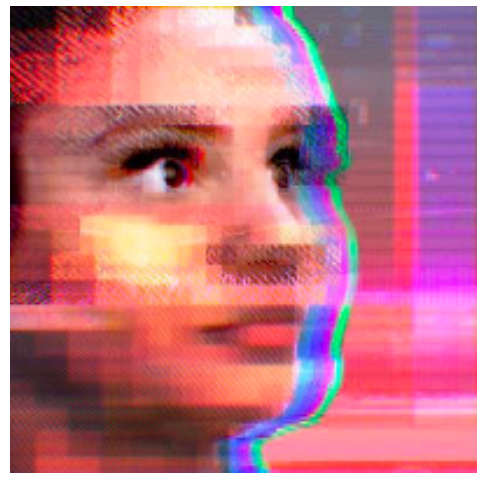
Where are we?

- We have very powerful neural models that can fit lots of datasets
- Data: we need data that is not just correctly labeled, but reflects what we actually want to be able to do
- Users: systems are not useful unless they do something we want
- Language/outreach: who are we building this for? What languages/dialects do they speak?

Social Impact

- NLP systems are increasingly used in the world

…and increasingly we have to reckon with their impact



- This lecture: let’s warm up by thinking about these issues a bit

Social Impact

- Rate your awareness of the social impact of NLP, AI, and machine learning from 1 to 5, where 1 is little awareness and 5 is strong awareness (5 = you feel like you could write a blog post about a current issue).

- Describe one scenario where you think deployment of an NLP system might pose ethical challenges *due to the application* itself (i.e., using NLP to do "bad stuff")

- Describe one scenario where you think deployment of an NLP system might pose ethical challenges due to *unintended* consequences (e.g., unfairness, indirectly causing bad things to happen, etc.).

Outline of the Course

- Classification: linear and neural, word representations (3.5 weeks)
- Text analysis: tagging and parsing (3 weeks) <= takes us to the midterm
- Generation, applications: language modeling, machine translation (3 weeks)
- Question answering, pre-training (2 weeks)
- Applications and miscellaneous (2.5 weeks)
- Goals:
  - Cover fundamental techniques used in NLP
  - Understand how to look at language data and approach linguistic phenomena
  - Cover modern NLP problems encountered in the literature: what are the active research topics in 2020?

Coursework

- Five assignments, worth 45% of grade (A1-4: 10%, A5: 5%)
  - Mix of writing and implementation;
  - Assignment 0 is out now, optional diagnostic
  - ~2 weeks per assignment except for A5
  - 5 “slip days” throughout the semester to turn in assignments 24 hours late
  - Submission on Gradescope

These assignments require understanding the concepts, writing performant code, and thinking about how to debug complex systems. **They are challenging; start early!**

Office hours: please come! However, **the course staff are not here to debug your code!** We **will** help you understand the concepts and come up with debugging strategies!

Coursework

- Midterm (20% of grade), take-home
  - Similar to written homework problems

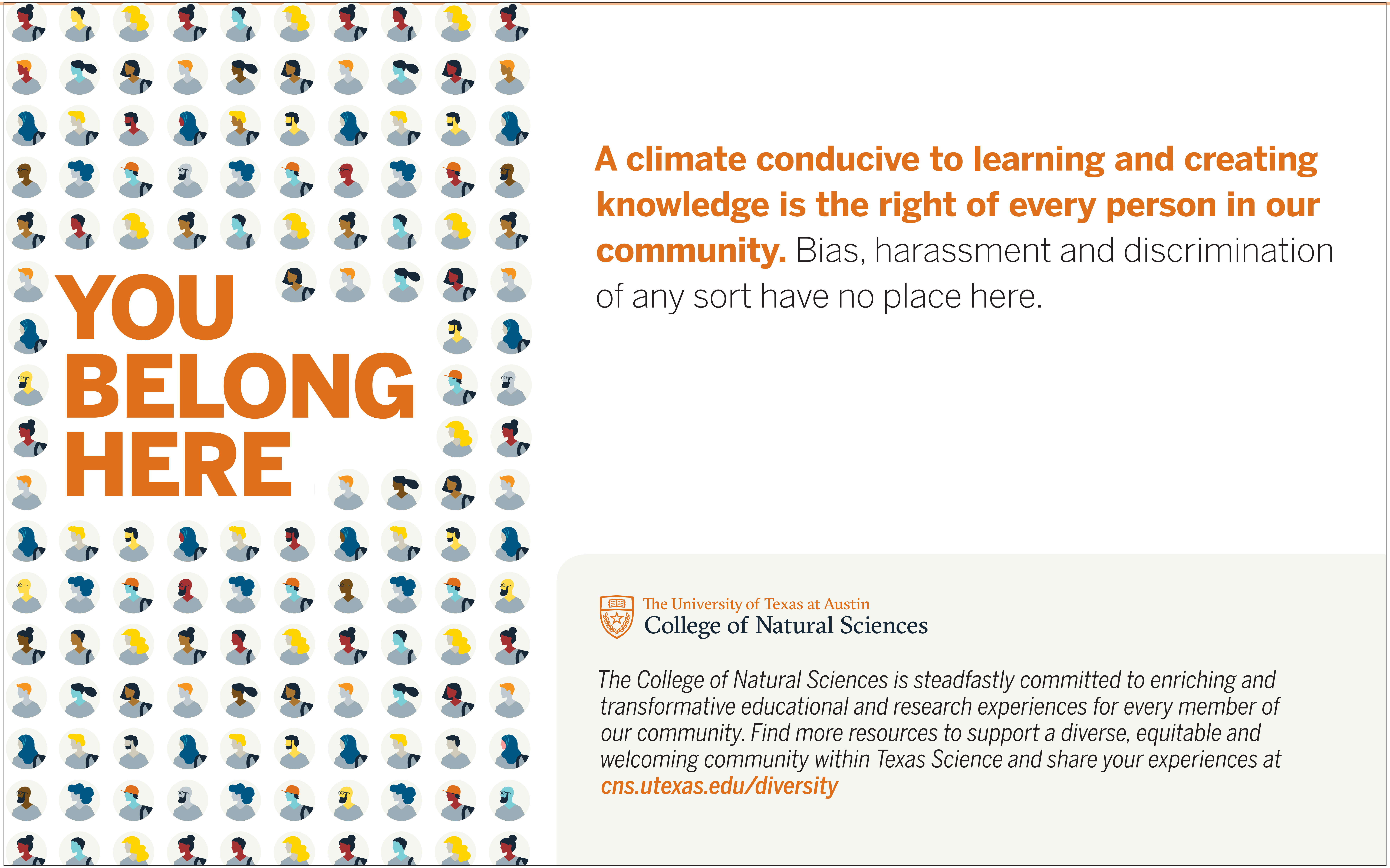
- Final project (25% of grade)
  - Groups of 1 or 2
  - Standard project: neural network models for question answering
  - Independent projects are possible: these must be proposed earlier (to get you thinking early) and will be held to a high standard!

- Social Impact Responses, UT Instapoll (10% of the grade)
  - These will be done online and can be done during or after class

Academic Honesty

- You may work in groups, but your final writeup and code **must be your own**
- Don’t share code with others!

Conduct



YOU BELONG HERE

A climate conducive to learning and creating knowledge is the right of every person in our community. Bias, harassment and discrimination of any sort have no place here.

The University of Texas at Austin
College of Natural Sciences

The College of Natural Sciences is steadfastly committed to enriching and transformative educational and research experiences for every member of our community. Find more resources to support a diverse, equitable and welcoming community within Texas Science and share your experiences at ***cns.utexas.edu/diversity***

Survey

- See Instapoll (you can answer later as well)