CS378: Natural Language Processing
Lecture 1: Introduction

Greg Durrett (he/him)

Credit: Stephen Roller
Lecture: Tuesdays and Thursdays 11:00am - 12:15pm in JGB 2.216
  - Recordings available afterwards on LecturesOnline

Course website (including syllabus):

Discussion board: link on the course website

Office hours: see course website, all on Zoom

TAs: Xi Ye and Lokesh Pugalenthi

Office hours start today, and I will stay around after this class 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.
  - Format: in-person to encourage discussion, but all materials are available asynchronously afterwards.

- 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, GCP credits, or Google Colab access will be helpful for the final project though.
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?

Dr. Strange in the Multiverse of Madness
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。

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.
When was Abraham Lincoln born?

<table>
<thead>
<tr>
<th>Name</th>
<th>Birthday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lincoln, Abraham</td>
<td>2/12/1809</td>
</tr>
<tr>
<td>Washington, George</td>
<td>2/22/1732</td>
</tr>
<tr>
<td>Adams, John</td>
<td>10/30/1735</td>
</tr>
</tbody>
</table>

February 12, 1809

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

The park has a total of five visitor centers.
• NLP is about building these pieces! (largely using statistical approaches)

• Lots of this is done end-to-end with neural nets. But analysis is still useful...
How do we represent language?

Labels
- the movie was good
- Beyoncé had one of the best videos of all time (subjective)

Sequences/tags
- PERSON
  - Tom Cruise
- WORK_OF_ART
  - Mission Impossible

Trees
- I eat cake with icing
- \( \lambda x. \text{flight}(x) \land \text{dest}(x) = \text{Miami} \)
- flights to Miami
How do we use these representations?

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

Penn treebank

Collins vs. Charniak parsers

Unsup: topic models, grammar induction

Pretraining

earliest stat MT work at IBM

Ratnaparkhi tagger

Sup: SVMs, CRFs, NER, Sentiment

Semi-sup, structured prediction


1980

1990

2000

2010

2020
Pretraining

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

\[
P(w | \text{I want to go to}) = 0.01 \text{ Hawai‘i}
\]

\[
0.005 \text{ LA}
\]

\[
0.0001 \text{ class}
\]

/ GPT-3: use this model for other purposes

\[
P(w | \text{the acting was horrible, I think the movie was}) = 0.1 \text{ bad}
\]

- 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, …}
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?
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 40% of grade
- 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 (25% of grade), take-home
  - Similar to written homework problems

- Final project (25% of grade)
  - Groups of 1 or 2
  - Standard project: understanding dataset biases
  - 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!
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.

Conduct

YOU BELONG HERE

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The University of Texas at Austin
College of Natural Sciences
Survey

› See Instapoll (you can answer later as well)