CSE 5525: Speech and Language Processing

Instructor: Wei Xu
Course Webpage

https://cocoxu.github.io/courses/5525_spring17.html

CSE 5525: Speech and Language Processing

Fundamentals of natural language processing, automatic speech recognition and speech synthesis; lab projects concentrating on building systems to process written and/or spoken language.

<table>
<thead>
<tr>
<th>Details</th>
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<tbody>
<tr>
<td>Instructor: <strong>Wei Xu</strong></td>
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<tr>
<td>Time: Wednesday and Friday, 12:45PM- 2:05PM (Spring 2017)</td>
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<tr>
<td>Place: <strong>Bolz Hall</strong> 317</td>
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Language, Thought and Artificial Intelligence

- Goal: give computers the ability to think (and speak)
- Long history in computer science
- Turing Test (Alan Turing 1950)
- Loebner Prize
  - Little interest from NLP community...
  - Very simple programs can fool some judges some of the time

TED-ED https://www.youtube.com/watch?v=3wLqsRLyV-c
The Chinese Room (John Searle 1980)
NLP in Science Fiction

Star Trek

2001: A Space Odyssey

I'M SORRY, DAVE.
I'm afraid I can't do that.

Knightrider
Today’s NLP Applications

- Speech Interfaces
- Machine Translation
- Search Engines
- Information Extraction
- Summarization
- ...

Speech Interfaces

What can I help you with?
Speech Interfaces

• Automatic Speech Recognition
  – Audio In, text out
  – State-of-the-art: 0.3% error for digit strings, 5% dictation 50%+ for TV
Speech Interfaces

• Text to Speech
  – Text in Audio Out

https://www.youtube.com/watch?v=QPk8mR6f3jo
你喜欢看电影吗？

do you like watching movies?
My First Car

For years I have been driving an old used car with a lot of mileage, and I hate it. It gets me where I need to go, but I'm tired of fixing leaks and broken parts all the time. It's annoying every time I need to take it to mechanic. Even when they take care of everything, I know I'll just end up going back there in a few weeks. I have finally decided that I am not going to do it anymore. I have decided to buy a new car! Unfortunately, I have a problem. I have no idea what car to get. Do I want something big? Do I want something stylish? Something economical? I have so many choices that I don't even know where to begin.

I am not sure if I will be able to make a decision on my own. I don't have a lot of money, either, so I probably don't have many options. After I did some research, I knew that I would need some expert advice. Eventually, I went to a local dealership to check out some new models. I talked to the saleswoman and listened at she carefully. Her honesty and professionalism were really impressive. She had a lot of vary helpful suggestions and showed myself some safe, affordable choices. After a long discussion I finally decided which one I wanted.
Natural Language Understanding

- Convert words into semantic representation that can be used to query a database

Where can I find Indian food in Clintonville?

1. Mughal Darbar
   - Cuisine: Indian
   - Location: University District
   - Address: 2321 N High St
   - Phone: (614) 477-6065
   - Rating: 4.5 stars (42 reviews)
   - Reservations:
   - Pickup Orders:
Question Answering
Summarization

User reviews:

“**Ash** always makes visitors feel like her personal guests and never disappoints as a hostess.” in 3 reviews

“Great customer service and **delicious food**.” in 2 reviews

“I did opt to eat on their **patio** during the nice summer weather and I would have to say that it was pleasant.” in 7 reviews

Outdoor Seating: Yes
“Yess! Yess! Its official Nintendo announced today that they Will release the Nintendo 3DS in north America march 27 for $250”
“Yess! Yess! Its official Nintendo announced today that they Will release the Nintendo 3DS in north America march 27 for $250”
“Yess! Yess! Its official *Nintendo* announced today that they Will release the *Nintendo 3DS* in north America march 27 for $250”
“Yess! Yess! Its official Nintendo announced today that they Will release the Nintendo 3DS in north America march 27 for $250”

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<tr>
<td>Nintendo</td>
<td>3DS</td>
<td>March 27</td>
<td>$250</td>
<td>North America</td>
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Information Extraction

**Samsung Galaxy S5 Coming to All Major U.S.**

- State of the art is maybe 80%, for single easy fields: 90%+
- Redundancy helps a lot!
- Much of human knowledge is waiting to be harvested from the Web!

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<tr>
<td>Samsung</td>
<td>Galaxy S5</td>
<td>April 11</td>
<td>?</td>
<td>U.S.</td>
</tr>
<tr>
<td>Nintendo</td>
<td>3DS</td>
<td>March 27</td>
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NLP as a Field

• Tasks (each have their own datasets and evaluations)
  – Syntactic Parsing
  – Summarization
  – Machine Translation
  – Information Extraction
  – ...

• Methods
  – Heuristic / Rule-based Approaches (dominated until the 1990s statistical revolution)
  – Probabilistic Graphical Models
  – Neural Networks (deep learning)
  – ...
Topics in CSE 5525

- Text Classification
- Language Modeling
- Hidden Markov Models and Discriminative Sequence Models
- Part of Speech Tagging and Named Entity Recognition
- Parsing
- Speech Recognition
- Machine Translation
- Information Extraction
- Lexical Semantics
- Other topics, time permitting
Why is NLP hard?

• “Any speaker of any human language can produce and understand an infinite number of sentences.”

(Fromkin, Rodman & Hyams. 2011. An Introduction to Language.)

Creativity!
UN wants Yemen’s warring parties to resume talks on Jan 14.

Layers of Linguistic Annotation

Syntax: UN wants Yemen’s warring parties to resume talks on Jan 14.

Morphology: war + ing

Words: UN-wants-Yemen’s-warring-parties-to-resume-talks-on-Jan-14-

UTF8: UN wants Yemen’s warring parties to resume talks on Jan 14.
UN wants Yemen’s warring parties to resume talks on Jan 14.

Syntax:
- (Parts of Speech): UN (NNP) wants (VBZ) Yemen’s (NNS) warring (NNP) parties (NNS) to (TO) resume (VB) talks (NN) on (IN) Jan (NNP) (CD 14)
Layers of Linguistic Annotation

Semantics/Discourse:
- DiplomaticTalks-Event
- **Between:** Yemen’s warring parties
- **Mediator:** UN
- **Date:** 1/14/2016

Syntax:
- (ROOT
  - (S
    - (NP (NNP UN))
    - (VP (VBZ wants)
      - (S
        - (NP (NP (NNP Yemen) (POS 's))
        - (VBG warring) (NNS parties))
      - (TO to)
      - (VP (VB resume)
        - (NP (NNS talks))
        - (PP (IN on)
          - (NP (NNP Jan) (CD 14))))))
  - (.
    - (.
      - (.
        - (.
          - (.
            - (.))))))

 Constituents)
Why is NLP hard?

- Why is it easy for computers to parse Python, but not English?

Ambiguity!
Princess Diana dresses to be auctioned
Ten dresses, including gowns designed by Catherine Walker, Bruce Oldfield and Zandra Rhodes, to go under the hammer

Lauren Cochrane
guardian.co.uk, Friday 15 March 2013 17.26 GMT
Students Cook & Serve Grandparents

On Thursday, September 9, Gorman School hosted the first annual Grandparent’s Day. All Grandparents were invited to a school wide pancake breakfast. Upper grade students served as excellent chefs, as well as taking responsibility for serving the food and the clean up after.
Lexical Ambiguity
Lexical Ambiguity
What will you get out of this class?

• Understanding of a major field of Artificial Intelligence
• Basic machine learning skills
• Ideas that you could transform into a startup company or academic research
• Summer interns?
What to Expect

• Lots of math and programming
• A bit of Linguistics
• Computing Resources:
  – Experiments could take hours to run or debug depending the efficiency and quality of your code. We recommend you start **early** on homework assignments and final project.
Prerequisites

• (CSE 3521 or CSE 5521) and (CSE 5522 or Stat 3460 or Stat 3470)

• Math:
  – Basic Probability
  – Basic Linear Algebra

• Programming
  – Python or ability to learn Python quickly
  – Numpy/Scipy (Python libraries for scientific computing)
  – Linux/Unix (for windows users: https://www.cygwin.com/)
Textbook

• Books
  – Jurfasky and Martin (2\textsuperscript{nd} edition and 3\textsuperscript{rd} edition draft)
  – Some other readings as well
Grading

• Participation (5%)
• Homework Assignments (55%)
  – one written assignment (individual)
  – three programming assignments (individual)
  – market research (individual or group of 2)
• Midterm (20%)
• Final Project (20% group of 3-4)
Homework

• #0 written assignment (simple):
  - Probability & Programming Basics
  - Due next week on January 11th

• Programming assignments (subject to change):
  - #1: Text Classification (Naive Bayes)
  - #2: Tagging (Structured Perceptron)
  - #3: Machine Translation (Word Alignment)
Homework

- Assignments are your individual work.

**Moss**

*A System for Detecting Software Plagiarism*

**UPDATES**

- May 18, 2014 *Community contributions (including a Windows submission GUI from Shane May, thanks!) are now in their own section on this page.*
- May 14, 2014 *And here is a Java version of the submission script. Thanks to Bjoern Zielke!*
- May 2, 2014 *Here is a PHP version of the submission script. Many thanks to Phillip Rehs!*
- June 9, 2011 *There were two outages over the last couple of days that lasted no more than a hour each (I think). I’ve made some changes to the disk management software that should prevent these problems from recurring.*
- April 29, 2011 *There was an outage lasting a few hours today, the first since last summer, but everything is back up.*
- August 1, 2010 *Everything is back to normal.*
- July 27, 2010 *The Moss server is back on line. There may be some more tuning and possibly downtime in the coming weeks, but any outages should be brief. New registrations are not yet working, but people with existing accounts can submit jobs.*
- July 25, 2010 *As many (many!) people have noticed, the Moss server has been down for all of July. Unfortunately the hardware failed while I was away on a trip. I am hopeful it will be back up within a few days.*

**What is Moss?**

Moss (for a Measure Of Software Similarity) is an automatic system for determining the similarity of programs. To date, the main application of Moss has been in detecting plagiarism in programming classes. Since its development in 1994, Moss has been very effective in this role. The algorithm behind moss is a significant improvement over other cheating detection algorithms (at least, over those known to us).
Homework

• **Market Research** on companies that use speech or language technologies.
Homework

- Market Research on companies that use speech or language technologies.
Market Research

- a short ~5 minute video presentation about a company (due on February 3rd)
Midterm

- In class, the week before spring break
- but, not final exam
Final Project (group of 3-4)

• Step 1: form a team and brainstorm 3 ideas

• Step 2: select an idea (talk to the instructor during office hours) and collect your data

• Step 3: conduct analyses of your data

• Step 4: develop a working system

• Step 5: write a 2-4 page report and give an in-class presentation (last class of the semester)
QA and Course Resources

- Carmen (homework submission & grades)
- Piazza (discussion and announcements)
Office Hours

• Instructor’s Office Hours:
  Wednesdays 4:30-5:30pm, Dreese 495

• TA: Wuwei Lan
Guest Lectures and Invited Talks

• January 13th — Zhou Yu (CMU)
• Late Feb or March — Micha Elsner (OSU)
• March 3rd — Ray Mooney (UT Austin)
By next week, please

• Do Homework #0
  - due at the beginning of class on next Wed
  - hand in paper copy
• Sign up Piazza (via Carmen)
• Watch three example video presentations of market research

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<thead>
<tr>
<th>Market Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Example Presentation 1 (Iceland’s Crowdsourced Constitution by Abhishek GAdiraju)</td>
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<tr>
<td>• Example Presentation 2 (Silk Road by Shreshth Khilani)</td>
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<td>• Example Presentation 3 (Kiva: Loans That Change Lives by Morgan Snyder and Tiffany Lu)</td>
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</tbody>
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