Introduction to NLP

Ruihong Huang
Texas A&M University

Some slides adapted from slides by Dan Jurafsky, Luke Zettlemoyer, Ellen Riloff
• "An Aggie does not lie, cheat, or steal or tolerate those who do." For additional information, please visit: http://aggiehonor.tamu.edu.

• Upon accepting admission to Texas A&M University, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning, and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the TAMU community from the requirements or the processes of the Honor System.
• The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on west campus or call 979-845-1637. For additional information, visit http://disability.tamu.edu.
• Piazza: CSCE 689, NLP
• https://piazza.com/class/isgmuz7h4e36t
• course page:
• http://faculty.cse.tamu.edu/huangrh/Fall16_nlp_foundation_technique.html
• Ten In-Class Quizzes: 20%
• Class participation: 10%
• Four Programming Assignments: 40%
• The Final Project: 30%
• Late Policy: 20% reduction per day. For both programming assignments and the final project.
Programming Assignments

• Code: has to be runnable
• Report: how to run, results and analysis, remaining issues, known bugs.
The Final Project

• By the end of the semester: submit code data and a report.

• Report: 8 pages maximum, describe the problem, approaches and evaluation results.
The final Project

- Solving a mini core research problem you have identified by reading recent research papers from top NLP conferences.
- Developing a nice NLP application system.
Basic Recipe of Forming a Project

• Choose a Topic and do a quick survey
• Prepare data
• Think about evaluation methods
• Start to work on it
Core research problems

• Coreference resolution, discourse
• Semantics
Applications

- Question-Answering
- Sentiment Analysis
- Text Summarization
- Machine Translation
Consider to participate in a SemEval task

What is NLP?

- Fundamental goal: *deep understand of broad language*
  - Not just string processing or keyword matching

- End systems that we want to build:
  - Simple: spelling correction, text categorization…
  - Complex: speech recognition, machine translation, information extraction, sentiment analysis, question answering…
US Cities: Its largest airport is named for a World War II hero; its second largest, for a World War II battle.
Hi Dan, we’ve now scheduled the curriculum meeting.

It will be in Gates 159 tomorrow from 10:00-11:30.

-Chris
Google Knowledge Graph

The Knowledge Graph
Learn more about one of the key breakthroughs behind the future of search.

See it in action
Discover answers to questions you never thought to ask, and explore collections and lists.
Text Summarization

- Condensing documents
  - Single or multiple docs
  - Extractive or synthetic
  - Aggregative or representative

- Very context-dependent!

- An example of analysis with generation

WASHINGTON (CNN) -- President Obama's inaugural address was cooler, more measured and reassuring than that of other presidents making it, perhaps, the right speech for the times.

Some inaugural addresses are known for their soaring, inspirational language. Like John F. Kennedy's in 1961: "Ask not what your country can do for you. Ask what you can do for your country."

Obama's address was less stirring, perhaps, but it was also more candid and down-to-earth.

"Shaping today," the new president said, "we must begin by asking what we can do for our fellow citizens of this country, for each other, for the communities we call home."

"In his first inaugural in 1933, "The only thing we have to fear is fear itself." Or Bill Clinton, who took office during the economic crisis of the early 1990s. "There is nothing wrong with America that cannot be fixed by what is right with America," Clinton declared at his first inaugural.

President Obama renewed his call for a massive plan to stimulate economic growth.

Obama, too, offered reassurance.

"We gather because we have chosen hope over fear, unity of purpose over conflict and discord," Obama said.

Obama's call to unity after decades of political division echoed Abraham Lincoln's first inaugural address in 1861. Even though he delivered it at the onset of a terrible civil war, Lincoln's speech was not a call to battle. It was a call to look beyond the war, toward reconciliation based on what he called "the better angels of our nature."
Machine Translation

• Helping human translators

Enter Source Text:

这 不过 是 一 个 时间 的 问题

Fully automatic

Translation from Stanford’s Phrasal:

This is only a matter of time.
Human-machine Dialogs

“What's the best movie to see this weekend?”

That would probably start an argument. But here’s a list of highly-regarded movies:

- **NORTH BY NORTHWEST**
  - Released July 17, 1959
  - 100%

- **THE TREASURE OF THE SIERRA...**
  - Released January 6, 1948
  - 100%

“Can I help you with?”

“You need to start understanding me Siri.”

“I’ll make a note of that.

“Yeah you better make a note of that.”

Noted:

- Of that
Inter-Disciplinary

**Computer Science:** artificial intelligence, machine learning

**Linguistics:** computational linguistics

**Psychology:** cognitive psychology, psycholinguistics

**Statistics:** probabilistic methods, information theory
Interactions with Linguists (History)

• 70s and 80s: more linguistic focus
  - deeper models, toy domains, rule-based systems

• 90s: empirical revolution
  - robust corpus-based methods, empirical evaluation

• 2000s: richer linguistic representations used in statistical approaches
Outline

- **Bag** of Words: Text classification
- **Sequence** of Words: language modeling, parts of speech tagging
- **Tree** of Words: syntactic parsing, dependency parsing
- **Semantics**: thesaurus, distributed
- **Discourse**, pragmatics
- **Applications**: QA, MT..
Language Technology

making good progress

mostly solved

Spam detection
Let's go to Agra! ✓
Buy V1AGRA ...

Part-of-speech (POS) tagging
ADJ ADJ NOUN VERB
ADV
Colorless green ideas sleep furiously.

Named entity recognition (NER)
PERSON ORG
LOC
Einstein met with UN officials in Princeton.

Sentiment analysis
Best roast chicken in San Francisco! 🌟
The waiter ignored us for 20 minutes. 🙄

Coreference resolution
Carter told Mubarak he shouldn't run again.

Word sense disambiguation (WSD)
I need new batteries for my mouse.

Parsing
I can see Alcatraz from the window!

Machine translation (MT)
第13届上海国际电影节开幕…
The 13th Shanghai International Film Festival...

Information extraction (IE)
You're invited to our dinner party, Friday May 27 at 8:30

still really hard

Question answering (QA)
Q. How effective is ibuprofen in reducing fever in patients with acute febrile illness?

Paraphrase
XYZ acquired ABC yesterday
ABC has been taken over by XYZ

Summarization
The Dow Jones is up
The S&P500 jumped
Housing prices rose
Economy is good

Dialog
Where is Citizen Kane playing in SF?
Castro Theatre at 7:30.
Do you want a ticket?

Party May 27 add
• Ambiguity !!
Ambiguities inherent in Language

- Language is succinct and expressive.
- Human resolve ambiguities naturally.
Syntax: structural ambiguity

Time flies like an arrow.

Metaphor:
Time/NOUN flies/VERB like/PREP an/ART arrow/NOUN

New Fly Species:
Time/NOUN flies/NOUN like/VERB an/ART arrow/NOUN

Stopwatch Imperative:
Time/VERB flies/NOUN like/PREP an/ART arrow/NOUN
Syntax: structural ambiguity (attachment)

- I saw the Grand Canyon flying to New York.
- I watered the plant with yellow leaves.
- I saw the man on the hill with the telescope.
S
  NP
    Det the
    N dog
  VP
    V saw
    NP
      Det a
      N man
      PP
        P in
        NP
          Det the
          N park
But syntax doesn’t tell us much about meaning...

• Colorless green ideas sleep furiously. [Chomsky]

• plastic cat food can cover
Semantics: Lexical Ambiguity

• I walked to the bank ...

  of the river.

  to get money.

• The bug in the room ...

  was planted by spies.

  flew out the window.

• I work for John Hancock ...

  and he is a good boss.

  which is a good company.
Discourse: coreference

A Short Story

President John F. Kennedy was assassinated.

The president was shot yesterday.

Relatives said that John was a good father.

JFK was the youngest president in history.

His family will bury him tomorrow.

Friends of the Massachusetts native will hold a candlelight service in Mr. Kennedy’s home town.
Pragmatics

Rules of Conversation

• Can you tell me what time it is?
• Could I please have the salt?

Speech Acts

• I bet you $50 that the Jazz will win tonight.
  • Will you marry me?
NLP: a branch of AI

- Lack of world knowledge
- Inferences
World Knowledge, Inferences

John went to the diner.

He ordered a steak.

He left a tip and went home.

John wanted to commit suicide.
He got a rope.
• Sparsity!!!
Zipf’s Law

• the frequency of any word is inversely proportional to its rank: \( f = \frac{K}{r} \)

• fat-tail, most words occur only a couple of times

• high lexical diversity -> data sparseness
• Brown Corpus: A balanced corpus of written American English in 1960 (except poetry!), 1 million words.
• the novel: “The Whale”, 44% words: one time
Goals of the class

• Key tasks, algorithms
• Essentially skills to build your system
• (Hopefully) see problems, holes, gaps, start research