Natural Language Processing (NLP)

- "Natural" language
  - Languages that people use to communicate
- Ultimate goal
  - To create computational models that perform as well at using natural language as humans do
- Immediate goal
  - To build computer systems that can process text and speech more intelligently

![Diagram of NL input and output]

Information retrieval

- Ad-hoc IR
- Web search

![Diagram of information need, text collection, relevant documents, and IR system]

Query: (articles on) leveraged buyouts

Query: (articles on) leveraged buyouts involving more than 100 million dollars that were attempted but failed during 1986 and 1990

I see what I eat = I eat what I see

[Mad Hatter, Alice in Wonderland]
Question answering (QA)

- Task
  - How many calories are there in a Big Mac?
  - Who is the voice of Miss Piggy?
  - Who was the first American in space?
  - Retrieve not just relevant documents, but return the answer

Machine translation

- one of the first applications envisioned for NLP techniques
  - The spirit is willing, but the flesh is weak.
  - “open”

IBM’s Watson


Dialogue-based systems

- Assistant: Can I help you?
- Customer: I was wondering whether you have any switched brass lampholders.
- Assistant: The brass lampholders are out of stock, but they should be in on Wednesday. The plastic ones are over here...
Why is dealing with NL hard?
Ambiguity!!!! …at all levels of analysis 😞

- Phonetics and phonology
  - Concerns how words are related to the sounds that realize them. Important for speech-based systems.
    » “I scream” vs. “ice cream”
    » “nominal egg”
    » “It’s very hard to recognize speech.” vs. “It’s very hard to wreck a nice beach.”

- Morphology
  - Concerns how words are constructed from morphemes.
    » “unionized”
    ◆ union + ized
    ◆ un + ion + ized

- Syntax
  - Concerns sentence structure
  - Different syntactic structure implies different interpretation
    » Squad helps dog bite victim.
    ◆ [np squad] [vp helps [np dog bite victim]]
    ◆ [np squad] [vp helps [np dog] [inf-clause bite victim]]
  » Helicopter powered by human flies.

- Semantics
  - Concerns what words mean and how these meanings combine to form sentence meanings.
    » Red-hot star to wed astronomer.
    » The once-sagging cloth diaper industry was saved by full dumps.

- Discourse
  - Concerns how the immediately preceding sentences affect the interpretation of the next sentence
    » Jack drank the wine on the table. It was brown and round.
    » Jack saw Sam at the party. He went back to the bar to get another drink.
    » Jack saw Sam at the party. He clearly had drunk too much.

[Adapted from Wilks (1975)]
Why is dealing with NL hard?

Ambiguity!!!! …at all levels of analysis 😒

- Pragmatics
  - Concerns how sentences are used in different situations and how use affects the interpretation of the sentence.

[Hardware store example.]

What topics will we cover?

- Language modeling
- Phonetic analysis
- Morphological analysis
- Lexical semantics and word-sense disambiguation
- Part-of-speech tagging
- Parsing
- Grammar induction
- Semantic analysis
- Pronoun resolution
- Coreference analysis
- NL Generation
- Machine translation
- Dialogue systems
- Information extraction

Reference Material

- Required text book:

- Other useful references:
  - Others listed on course web page...

Prereqs, Coursework, & Grading

- Prerequisites
  - CS 2110.

- Grading
  - 75%: four programming projects with short reports
  - 15%: critiques of selected readings and research papers
  - 9%: participation
    - You’ll be expected to participate in class discussion and class exercises or otherwise demonstrate an interest in the material studied in the course.
  - 1%: course evaluation completion

www.cs.cornell.edu/courses/cs4740/2011sp/