Special Topics: Natural Language Processing Introduction

Adam Meyers

New York University

2016

Outline

- Grades, Exams, Policies, etc.
- Text Books and Suggested Reading
- A Survey of the Students
- Defining the Field
- CL Applications
- Types of Text Analysis used in CL
- A Practice Manual Annotation Task
- Summary and Syllabus
- Homework No. 1

Grades, Homework, Exams, Final Projects

- Grade Breakdown:
  - ¼ Homework + ¼ Midterm Exam + ¼ Final Exam + ¼ Final Project
- Homework
  - 8 to 10 Homeworks
  - Submit Homework through NYUClasses
- Final Project
  - Sample Topics Available by February 29
  - Final Project Proposal Due April 11
    - counts as 1 homework
  - Student Presentations May 2 & 4: 3 minute talk + 1 minute for questions
  - Final Written Version Due May 9
  - Special Rules for Group projects

Succeeding in This Class

- Experiment and Ask Questions
  - Work out examples from readings on paper
  - Try out and modify NLTK programs
    - break them, read the error messages, fix your bugs, repeat
- Homework: The point of the homework is to work out stuff. If you have trouble, try to state clearly what you do not understand, so the grader can answer questions and/or send me your questions by email and I can go over them in class.
  - You can get credit for getting right answers or clearly stating problems and identifying source of your confusion – you could uncover a valid criticism of the assignment and/or a more general problem in the field
- Midterm and Final: I will provide practice tests
- Final project: Do in stages: (1) Proposal; (2) Baseline System; (3) Final System

Policies

- Late Homework
  - Natural Consequence: You could fall behind, leading to lower marks on exams and the final project.
  - **If** HW is time sensitive, (e.g., I need to release answer key before next class), late HW gets no credit
  - **Else if** HW handed in before end of term
    - Late HW is graded late (at the grader's discretion, see natural consequences)
    - No official score penalty, unless grader does not have time to grade it, e.g., if you hand it in at the end of the term and the grader is busy grading other stuff.
- Missing Homework
  - Given N homeworks, I include the top N-1 homeworks in your grade, so N-1 As and 1 F is still an A average
- Intellectual Integrity (context dependent):
  - http://www.cs.nyu.edu/webapps/content/academic/undergrad/academic_integrity
  - Usually, you may discuss HW with anyone, but your work should be your own.
    - If it is a problem, you should be prepared to solve it on your own after you submit your answer
    - If it is creative, 2 students should not have the same answers
    - Special Cases, e.g., experiments, where we test to see if people get same answer independently
  - Midterm/Final – no help, other than explaining instructions or fixing errors in the phrasing of questions
  - Final Project
    - research = your own (but you can get “normal” advice)
    - other people can help with experiments, e.g., annotation
    - multi-person projects are OK if **each person's contribution is clear enough for grading purposes**

Basic Info: CSCI-UA.0480-011 Spring 2016

- Website: http://cs.nyu.edu/courses/spring16/CSCI-UA.0480-011/
- Class Room: WWH 102
- Schedule: Monday and Wednesday 11:00AM—12:15AM
  - No Classes:
    - February 15 (President's Day)
    - March 14 & 16 (Spring Break)
  - Exams:
    - Midterm: Wednesday, March 9, 2016
    - Final: Monday, May 16, 10:00AM—11:50AM
- My office: 719 Broadway, Rm 702
- Office Hours: Monday: 1:30-3PM or Thursday: 10:30-12PM or by appointment
- My Email: meyers@cs.nyu.edu
- My Phone Number: 212-998-3482

Text Books

- SPEECH and LANGUAGE PROCESSING **2nd Edition**
  - By Daniel Jurafsky and James H. Martin
  - http://www.cs.colorado.edu/~martin/slp.html
  - Overview of the Field, explanations of techniques, algorithms, etc.
- Natural Language Processing with Python
  - By Steven Bird, Ewan Klein, and Edward Loper
  - http://www.nltk.org/book (look at the rest of the website also)
  - Book is available on line (or you can purchase it)
    - Online version may be more up-to-date then the paper version
  - Now available for both Python 2 and Python 3
    - Paper Version = Python 2
    - Electronic Version (with Python 3) being revised by authors
  - Downloadable open source programs to try out various computational linguistics tools and inspect their code

More Stuff to Read/Download, etc.

- Look at projects currently going on at NYU:
  - The Proteus website: http://nlp.cs.nyu.edu/
  - My website: http://nlp.cs.nyu.edu/people/meyers.html
    - GLARF: processing tool written in Common Lisp (for linux, but will soon be available for MAC)
    - NomBank: annotation project
    - COMLEX, NOMLEX: lexicon projects
- Other useful links (I will put more on a website):
  - Previous NLP Classes that I taught
    - http://cs.nyu.edu/courses/spring12/CSCI-GA.2590-001/
    - http://nlp.cs.nyu.edu/meyers/montclair-class/
  - Association for Computational Linguistics: http://aclweb.org/

Some Pointers for Installing NLTK on your own Machine

- **Linux:** NLTK is easy to install in **linux**
- **Apple:** it is possible, but to get all the bells and whistles, you may have to register as a developer and go through a little bit of pain
- **Windows:** There may be some limitations (last I checked), but most things relevant to this class will work.
  - I have not tested it, but Cygwin or AndLinux might be better for running NLTK

Computer Background Survey

- OS experience
  - UNIX experience?
    - Linux, Solaris, Using the Command line in Apple
    - Windows: Cygwin, Andlinux, …
  - How many people mostly use Windows?
    - Some UNIX platform is recommended
- Programming Languages – which languages do people use?
  - Python
  - Java
  - C
  - Any variety of LISP: Common LISP, emacs LISP
  - Shell scripts
- UNIX utilities and script languages
  - grep
  - shell scripts, sed, awk

Linguistics Background Survey

- Syntax:
  - Descriptive Linguistics, e.g., comprehensive grammar of English
  - Chomskyan Linguistics?
  - Non-Chomskyan Frameworks
    - LFG, HPSG, Categorial Grammar, Dependency Grammar, Systemic Grammar, Other
- Phonetics, Phonology
  - Acoustics, Articulatory, Phonetics, Phonology, Intonation
- Discourse, Pragmatics
- Psycho-Linguistics
- Lexicography
- Historical
- Any Other Area

Role of Linguistic Theory in Computational Linguistics

- Framework = Language for Expressing Theory
- Theory = Set of Statements in Framework
- Different Theories/Frameworks are typically designed with different interests/biases/etc.
  - Chomskian Linguistics: Meta Grammar for all languages, set of primatives,
- Computational Linguistics is Applied Field of Study
  - Theories/Frameworks are important to the extent to which they help make a successful application
  - **Choice of theory/framework is secondary. Systems often designed to handle multiple theories/frameworks**
    - It may simply depend on who writes the answer key
  - **Descriptive Adequacy is more important than Explanatory Adequacy**
- Frameworks that are popular in CL: Statistics-based Analysis (various), Dependency Grammar, Penn Treebank (based on 1980s Chomskian Linguistics), PropBank/Nombank (~ Relational Grammar), Frame Semantics (based on FrameNet), ...
- Only Broad Coverage Grammars are suitable, e.g., old theories with descriptive track records
- Proviso: there is a small niche within CL, in which researchers implement new theories

Defining Computational Linguistics

- AKA, Natural Language Processing (NLP), Language Engineering, ...
- Definition: Study of how to solve problems involving the interpretation and generation of human language text and speech
- Properties
  - As with applied science: the proof is in the pudding
  - Sometimes at odds with theoretical linguistics
    - Need not model human abilities and human methods
    - Need not correspond to published linguistic theories
    - But sometimes draws on one or both
  - Broad and changing domain influenced by available funding

CL Applications: Slide 1

- Machine translation
  - Methods are not at all based on how humans translate
  - Effective for gisting text, generating 1st draft translations, but not for high-level translation
  - Works better for “controlled languages” – technical manuals (Microsoft, Catterpiller, etc.)
  - ex: Systran: http://www.systransoft.com/ , Google: http://www.google.com/language_tools?hl=en
- Spoken Language
  - dictation (IBM ViaVoice, Dragon Naturally Speaking)
  - Telephone-based customer support (phone mazes)
- Information Retrieval (not like in the movie ***Brazil***)
  - Web Searches (mostly statistics)

CL Applications Slide 2

- Information Extraction
  - Dealtime, Google Products, Monster.com (job search)
  - Some open source tools:

    https://opennlp.apache.org/

    http://alias-i.com/lingpipe/
  - NYU
    - Some tools on website
      - http://nlp.cs.nyu.edu/projects/index.shtml#t-r-i
      - http://cs.nyu.edu/grishman/jet/jet.html
      - http://nlp.cs.nyu.edu/ice/
      - http://nlp.cs.nyu.edu/termolator/
    - Example from disease domain http://nlp.cs.nyu.edu/info-extr/biomedical-snapshot.jpg
- Question Answering
  - ask.com, Wolfram Alpha, MIT start: http://start.csail.mit.edu/
- Summarization: http://newsblaster.cs.columbia.edu/
- Spelling/Grammar Checking, etc. https://languagetool.org/

Types of Analysis

- Phonetics/Phonology: speech recognition and speech synthesis (not in this class)
  - **We will focus on text analysis**
  - Text does not represent some phonological features
  - Text has punctuation
- Syntactic/Semantic: sentence splitting, tokenization, pos tagging, chunking, parsing, predicate/argument structure, sense disambiguation
- Discourse: anaphora, discourse argument structure, sentiment analysis
- Other: multi-lingual processing (including MT), summarization, IE, etc.

Lowest Level Syntactic Processing (text)

- Tokenization and Segmenation
  - Given a sentence, determine the words or word-like units that it consists of:
    - ***They announced in unison, “We don't agree with each other.”***
    - Tokenization: ***They | announced | in | unison | , | “| We | do | n't | agree | with | each | other | . |”***
      - Controversial parts: ***n't***, ***each other***
  - NLTK command: ***nltk.word_tokenize('this is a sentence')***
- Part of Speech Tagging (modified PTB)
  - Apply a set of part of speech tags to a set of tokens
    - ***They***/PRP ***announced***/VBD ***in***/IN ***unison***/NN **,**/PU **“**/PU ***We***/PRP ***do***/VBP ***n't***/RB ***agree***/VB ***with***/IN ***each***/DT ***other***/JJ **.**/PU **”**/PU
  - NLTK command: ***nltk.pos_tag(tokens)***

Low Level Syntactic Processing

- Named Entity Tagging (with a little semantics)
  - Mark boundaries of names of type PERSON, ORGANIZATION, FACILITY, GPE, LOCATION, …
  - <ENAMEX TYPE=”PERSON”> Adam Meyers</ENAMEX> works for <ENAMEX TYPE=”ORGANIZATION”>New York University</ENAMEX>
  - test_sentence = 'Adam Meyers works for New York University.'
  - NLTK command: ***nltk.chunk.ne_chunk(nltk.pos_tag(nltk.word_tokenize(test_sentence)***
- Chunking -
  - mark verb groups and/or noun groups, convenient approximations of syntactic units (questionable theoretically).
  - [$_{\textbf{NG}}$ ***The book***] ***with*** [$_{\textit{NG}}$ **the *blue cover***] [$_{\text{V}\textit{G}}$***was falling off]*** [$_{\textit{NG}}$ ***the shelf***]**.**
  - NLTK:
    - sentence = 'The book with the blue cover was falling off the shelf.'
    - chunks = r"""

      ```
      NG: {(<DT|JJ|NN>)*(<NN|NNS>)}
      VG: {<MD|VB|VBD|VBN|VBZ|VBP|VBG>*<VB|VBD|VBN|VBZ|VBP|VBG><RP>?}
      """
      ```

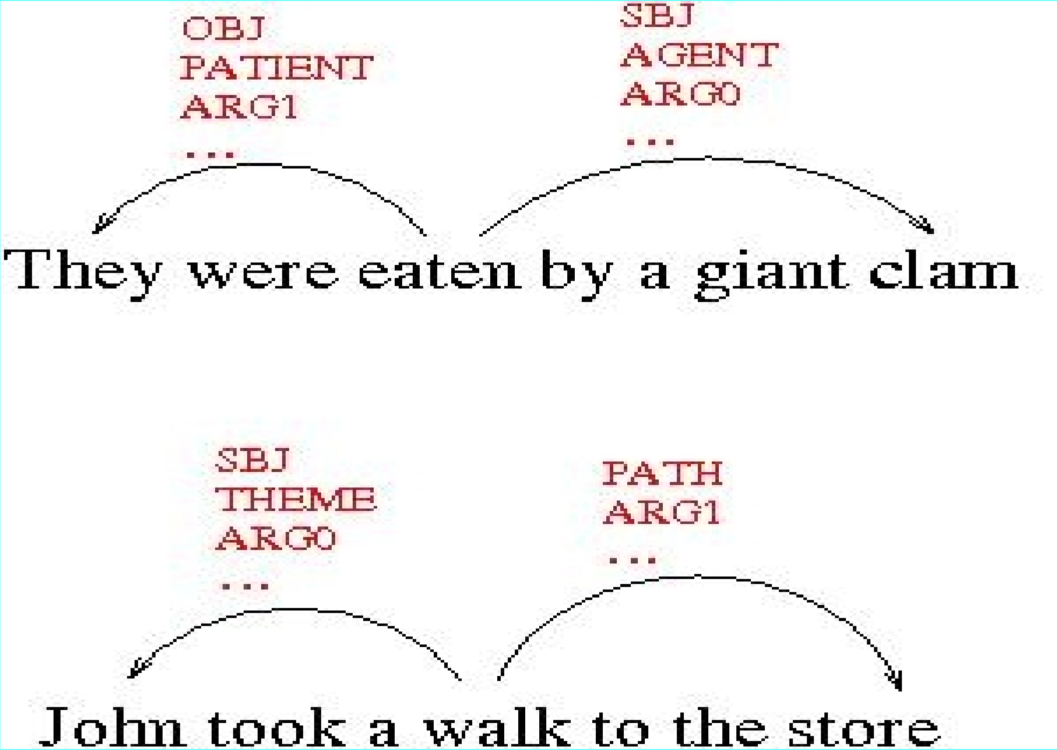
    - chunks_grammar = nltk.RegexpParser(chunks)
    - chunks_grammar.parse(nltk.pos_tag(nltk.word_tokenize(sentence)))

Parsing

- (S (NP (DT the) (NN book))
  (VP (VBZ is)
  (PP (IN on)
  (NP (DT the) (NN shelf)))))

Predicate/Argument Structure

- For thousands of years, linguists have employed systems to characterize predictable paraphrases, e.g., Pāṇini, a Sanskrit linguist from the 4rth Century BC
- In 21st Century CL, semantic role labeling is popular



OBJ
PATIENT
ARG1
...
SBJ
AGENT
ARG0
...
They were eaten by a giant clam
SBJ
THEME
ARG0
...
PATH
ARG1
...
John took a walk to the store

WordNet Noun entry for *table*

1. (52) table, tabular array -- (a set of data arranged in rows and columns; "see table 1")

2. (25) table -- (a piece of furniture having a smooth flat top that is usually supported by one or more vertical legs; "it was a sturdy table")

3. (5) table -- (a piece of furniture with tableware for a meal laid out on it; "I reserved a table at my favorite restaurant")

4. mesa, table -- (flat tableland with steep edges; "the tribe was relatively safe on the mesa but they had to descend into the valley for water")

5. table -- (a company of people assembled at a table for a meal or game; "he entertained the whole table with his witty remarks")

6. board, table -- (food or meals in general; "she sets a fine table"; "room and board")

Sense Disambiguation

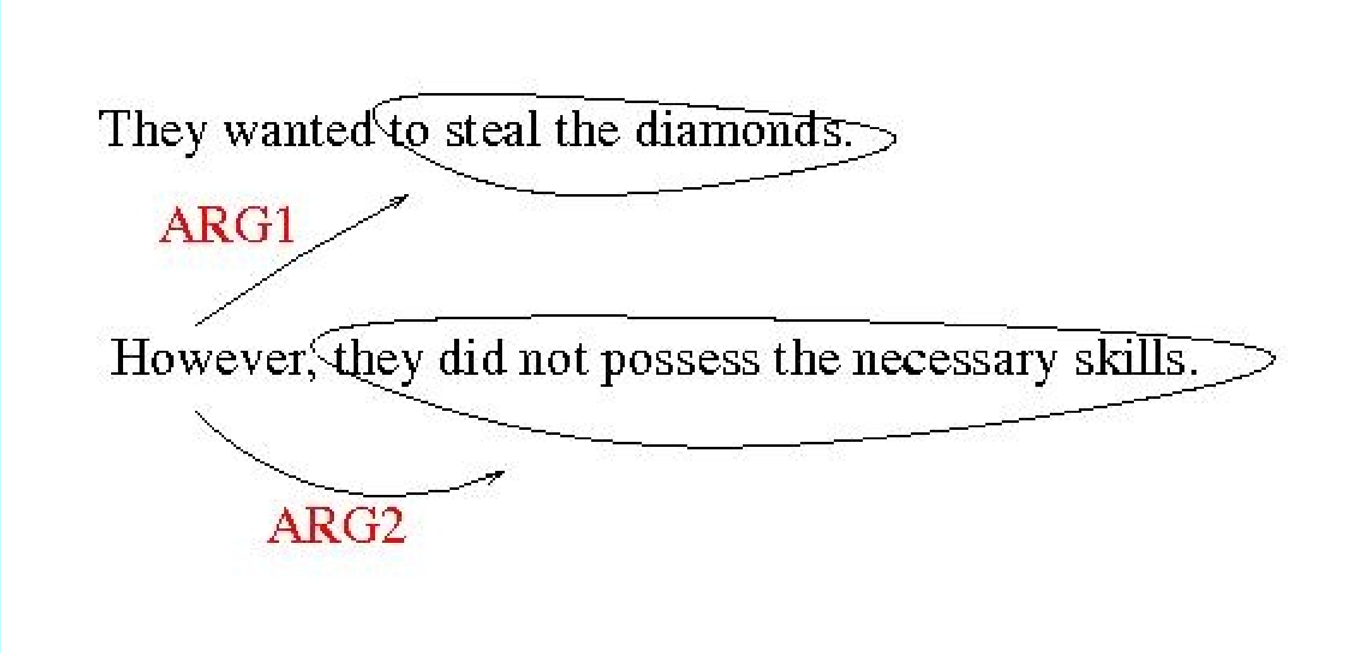
- For interesting characterizations of word senses (and relation between senses), use WordNet (online or download it)
  - wordnet.princeton.edu/
- 2 obviously distinct senses of ***bank***
  - *They took money out of the **bank**.*
  - *The water flooded over the **bank** of the river.*
- Difficult sense disambiguation
  - Senses 2, 3 and 5 on the next slide are arguably not distinct
  - Lexicographers are acutely aware of the merging vs. splitting problem of enumerating senses
  - CL systems usually collapse some WordNet distinctions

Anaphora

- Coreference
  - Though **Big Blue** won the contract, this official is suspicious of **IBM**.
  - **Mary** could not believe what **she** heard.
- Other Varieties
  - John ate **a sandwich** and Mary ate **one** also.
  - **The amusement park** is very dangerous. **The gate** has sharp edges. **The rides** have not been inspected for years.
  - **This book** is valuable, but **the other book** is not.

Discourse Argument Structure

- Adverbs, Subordinate/Coordinate Conjunctions, among other words link clauses



They wanted to steal the diamonds.

However, they did not possess the necessary skills.

Role of Manual Annotation

- Used to create, test and fine-tune task definitions/guidelines.
  - For a task to be well-defined, several annotators must agree on classification most of the time.
  - If humans cannot agree, it is unlikely that a computer can do the task at all
  - Popular, but imperfect measurement of agreement:
    - $Kappa = \frac{Percent(Actual\ Agreement) - Prob(Chance\ Agreement)}{1 - Prob(Chance\ Agreement)}$
- Used to create answer keys to score system output
  - One set of measures are: recall, precision and f-score
  - $Recall = \frac{|Correct|}{|Answer\ Key|}$ $Precision = \frac{|Correct|}{|System\ Output|}$ $F - Score = \frac{1}{\frac{1}{2} * (\frac{1}{Precision} + \frac{1}{Recall})}$

Manual Annotation in Supervised Statistical ML

- Divide the corpus into sub-corpora
  - A training corpus is used to acquire statistical patterns
  - A test corpus is used to measure system performance
  - A development corpus is similar to a test corpus
    - Systems are “tuned” to get better results on the dev corpus
    - Test corpora are only used infrequently to insure accuracy/fairness
      - The system should not be tuned to get better results
- More annotated text often yield better results
- Different genres may have different properties
  - Systems can “train” separately on different genres
  - Systems can “train” on one diverse corpus

Sample Annotation

- *The 23 **patients** who completed 4 or more weeks of **medication** showed **significant improvement** on all **depression scales** and in **quality** of life.*

Change	Degree	Attribute	Theme	Cause
improvement	significant	depression scales	23 patients	medication
improvement	significant	quality	23 patients	medication

A Sample Annotation Task

- Hypothesis: changes in attributes may provide a useful way to summarize biological/medical documents
- Annotation (All items must be in the same sentence):
  - 1 signal indicating increase/decrease/change
  - 1 Noun plus adjective/noun left modifiers indicating the attribute that changed
    - Why no determiner?
    - Why no right modifiers?
  - Optional Arguments (Always mark if found)
    - Degree (how much it changed)
    - Cause
    - THEME (possessor of the attribute)

Specifications: No Right Modifiers

- “no right modifiers” for Attribute
  - “23 patients who completed 4 or more weeks of medication” vs “23 patients”
  - “quality of life” vs “quality”
- Why might we want to modify the specifications to include right modifiers?
- Why might we not want to do so?
- What are some alternatives?

Annotation Experiment

- I am handing out 2 short sample biology and/or medical texts
- Please take a few minutes to annotate all instances of changing attributes that you can find.
- I will compare the results and discuss some annotation specification issues

Summary

- Computational Linguistics is an applied discipline with an increasingly large inventory of applications.
- A wide variety of levels of analysis are used to implement these applications.
  - Many, but not all of these levels are derived from or inspired by theoretical linguistics
- One popular paradigm for producing an analysis automatically involves manually annotating text

Syllabus: Subset of these Topics

- Introduction (today)
- Formal Languages and Transducers
- Corpus Annotation
- Natural Language Syntax and Parsing
- POS Tagging and Hidden Markov Models
- Named Entities and Machine Learning
- Lexical Semantics and Semantic Role Labeling
- Information Extraction: Entities, Relations, Events, Time
- Anaphora: Coreference and Similar Phenomena
- Feature Structures and Representing Multiple Phenomena
- Machine Translation

Homework and Readings

- Jurafsky and Martin, Chapter 1
- NLTK Book – Install NLTK, read Chapter 1 and follow along with their examples.
- Do the following Annotation Task
  - Download about 200 words of text from Wikipedia or News (save as .txt file)
  - In a text editor, add “/JJ” after each adjective
    - Text editors = emacs, vi, ex, notepad, WordPad, ...
      - Windows Users: NotePad is bad for reading non-Windows txt files
- Initially use these Specifications for identifying adjectives
  - An adjective must be able to fill in the blanks
    - The ___ noun ... --- occur between “the” and a noun
    - The noun is ____ . --- a single word following “the” + noun and preceding the end of sentence marker (period)
  - An adjective CANNOT (comfortably) fill the following blank
    - The ___ is --- be the subject of “is”
    - ___s --- become a plural
- Modify specifications to produce a better result. Better = (a) corresponds to some external definition of adjective (e.g., a list of adjectives); and (b) can be applied consistently to the text. Explain your modifications and produce new annotation based on your specifications.

Optional Independent Work

- Get ahead in NLTK book
  - Run NLTK programs
  - Look at source code, copy files and edit copies: add slight modifications and run
- Analyze the results
  - What do you think about part of speech tags?
- Look at the full Penn Treebank Part of Speech tagset defined in: https://www.ling.upenn.edu/courses/Fall_2003/ling001/penn_treebank_pos.html
  - Try to apply these POS tags to a small sample of text from a website
  - Find some difficulties in applying the tagset and ask questions about them in class.