http://www.geekosystem.com/google-conversation/

NLP LINGUISTICS 101

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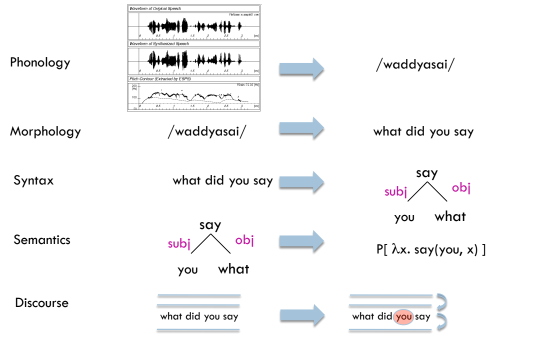
CS457 – Fall 2011

some slides adapted from Ray Mooney

Admin

- □ Assignment 2

Simplified View of Linguistics



Morphology

- What is morphology?
  - study of the internal structure of words
    - morph-ology word-s jump-ing
- Why might this be useful for NLP?
  - generalization (runs, running, runner are related)
  - additional information (it's plural, past tense, etc)
  - allows us to handle words we've never seen before
    - smoothing?

New words

- AP newswire stories from Feb 1988 – Dec 30, 1988
  - 300K unique words
- New words seen on Dec 31
  - compounds: prenatal-care, publicly-funded, channel-switching, …
  - New words:
    - dumbbells, groveled, fuzzier, oxidized, ex-presidency, puppetry, boulderlike, over-emphasized, antiprejudice

Morphology basics

- Words are built up from morphemes
  - stems (base/main part of the word)
  - affixes
    - prefixes
      - precedes the stem
    - suffixes
      - follows the stem
    - infixes
      - inserted inside the stem
    - circumfixes
      - surrounds the stem
  - Examples?

Morpheme examples

- prefix
  - circum- (circumnavigate)
  - dis- (dislike)
  - mis- (misunderstood)
  - com-, de-, dis-, in-, re-, post-, trans-, …
- suffix
  - -able (movable)
  - -ance (resistance)
  - -ly (quickly)
  - -tion, -ness, -ate, -ful, …

Morpheme examples

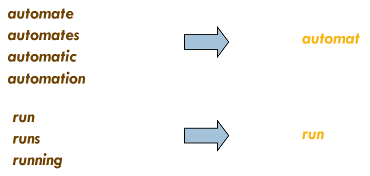
- infix
  - -fucking- (cinder-fucking-rella)
  - more common in other languages
- circumfix
  - doesn't really happen in English
  - a- -ing
    - a-running
    - a-jumping

Agglutinative: Finnish

talo 'the-house'	kaup-pa 'the-shop'
talo-ni 'my house'	kaup-pa-ni 'my shop'
talo-ssa 'in the-house'	kaup-a-ssa 'in the-shop'
talo-ssa-ni 'in my house'	kaup-a-ssa-ni 'in my shop'
talo-i-ssa 'in the-houses'	kaup-o-i-ssa 'in the-shops'
talo-i-ssa-ni 'in my houses'	kaup-o-i-ssa-ni 'in my shops'

Stemming (baby lemmatization)

- Reduce a word to the main morpheme



Stemming example

This is a poorly constructed example using the Porter stemmer.

This is a poorli construct example us the Porter stemmer.

http://maya.cs.depaul.edu/~classes/ds575/porter.html
(or you can download versions online)

Porter's algorithm (1980)

- Most common algorithm for stemming English
  - Results suggest it's at least as good as other stemming options
- Multiple sequential phases of reductions using rules, e.g.
  - sses → ss
  - ies → i
  - ational → ate
  - tional → tion
- http://tartarus.org/~martin/PorterStemmer/

What is Syntax?

- Study of structure of language
- Examine the rules of how words interact and go together
- Rules governing grammaticality
- I will give you one perspective
  - no single correct theory of syntax
  - still an active field of research in linguistics
  - we will often use it as a tool/stepping stone for other applications

Structure in language

The man ____ all the way home.

what are some examples of words that can/can't go here?

Structure in language

The man ____ all the way home.

why can't some words go here?

Structure in language

The man flew all the way home.

- Language is bound by a set of rules
- It's not clear exactly the form of these rules, however, people can generally recognize them
- This is syntax!

Syntax != Semantics

Colorless green ideas sleep furiously.

- Syntax is only concerned with how words interact from a grammatical standpoint, not semantically

Parts of speech

What are parts of speech (think 3rd grade)?

Parts of speech

Parts of speech are constructed by grouping words that function similarly:

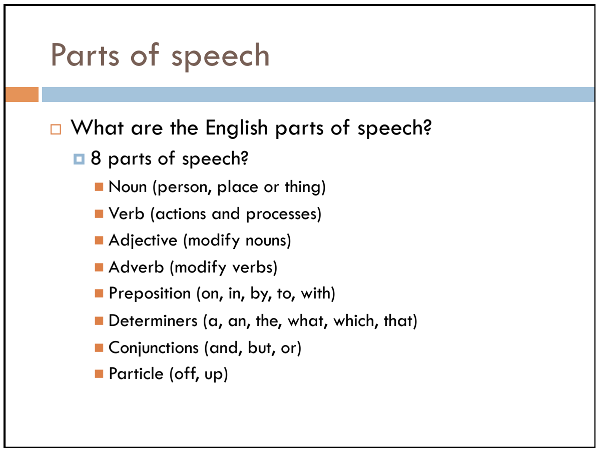
- with respect to the words that can occur nearby
- and by their morphological properties

The man ____ all the way home.

ran
forgave
ate
drove
drank
hid
learned
hurt

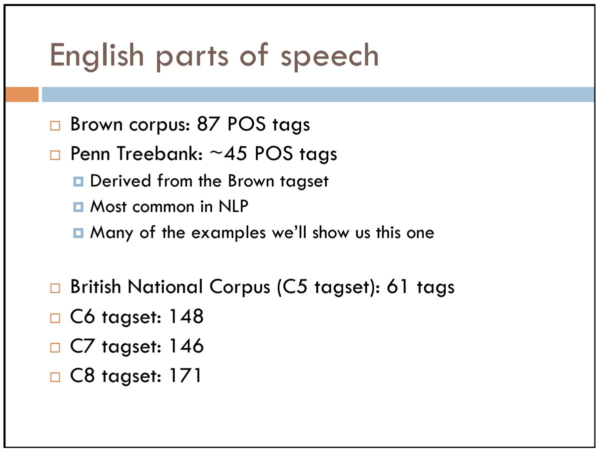
integrated
programmed
shot
shouted
sat
slept
understood
voted

washed
warned
walked
spoke
succeeded
survived
read
recorded



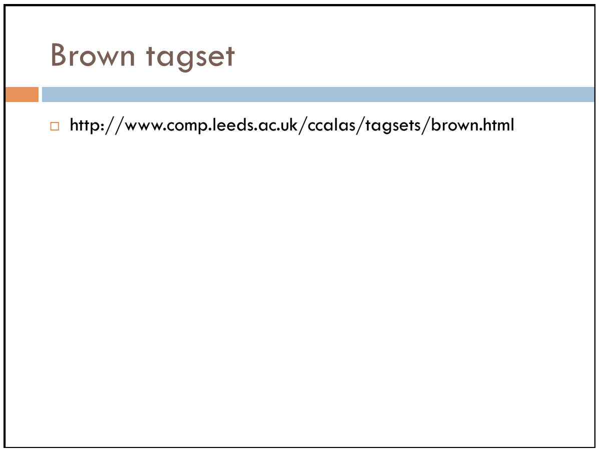
Parts of speech

- What are the English parts of speech?
  - 8 parts of speech?
    - Noun (person, place or thing)
    - Verb (actions and processes)
    - Adjective (modify nouns)
    - Adverb (modify verbs)
    - Preposition (on, in, by, to, with)
    - Determiners (a, an, the, what, which, that)
    - Conjunctions (and, but, or)
    - Particle (off, up)



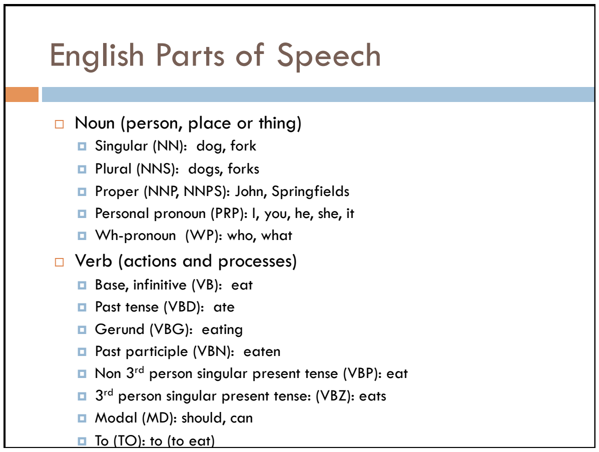
English parts of speech

- Brown corpus: 87 POS tags
- Penn Treebank: ~45 POS tags
  - Derived from the Brown tagset
  - Most common in NLP
  - Many of the examples we'll show us this one
- British National Corpus (C5 tagset): 61 tags
- C6 tagset: 148
- C7 tagset: 146
- C8 tagset: 171



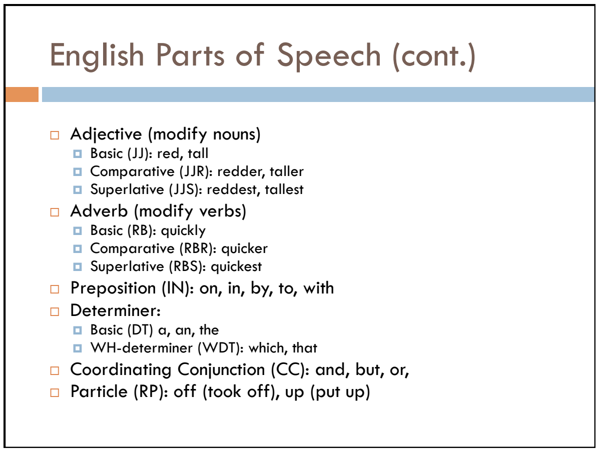
Brown tagset

- http://www.comp.leeds.ac.uk/ccalas/tagsets/brown.html



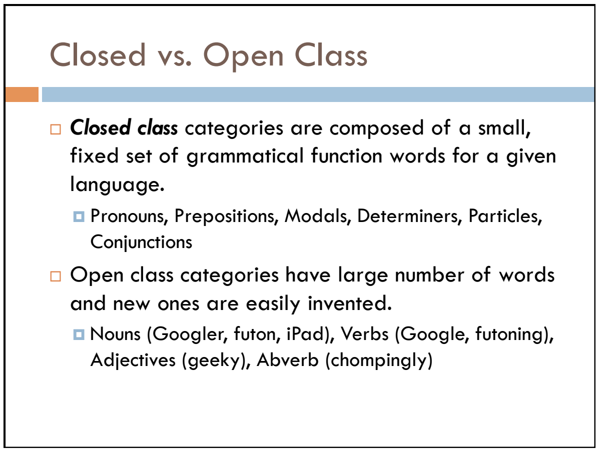
English Parts of Speech

- Noun (person, place or thing)
  - Singular (NN): dog, fork
  - Plural (NNS): dogs, forks
  - Proper (NNP, NNPS): John, Springfields
  - Personal pronoun (PRP): I, you, he, she, it
  - Wh-pronoun (WP): who, what
- Verb (actions and processes)
  - Base, infinitive (VB): eat
  - Past tense (VBD): ate
  - Gerund (VBG): eating
  - Past participle (VBN): eaten
  - Non 3rd person singular present tense (VBP): eat
  - 3rd person singular present tense: (VBZ): eats
  - Modal (MD): should, can
  - To (TO): to (to eat)



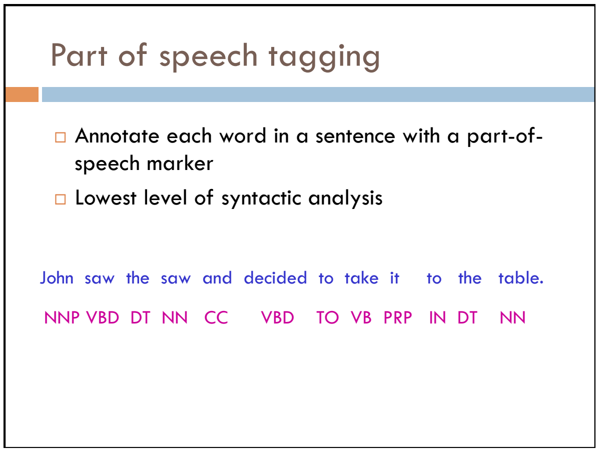
English Parts of Speech (cont.)

- Adjective (modify nouns)
  - Basic (JJ): red, tall
  - Comparative (JJR): redder, taller
  - Superlative (JJS): reddest, tallest
- Adverb (modify verbs)
  - Basic (RB): quickly
  - Comparative (RBR): quicker
  - Superlative (RBS): quickest
- Preposition (IN): on, in, by, to, with
- Determiner:
  - Basic (DT) a, an, the
  - WH-determiner (WDT): which, that
- Coordinating Conjunction (CC): and, but, or,
- Particle (RP): off (took off), up (put up)



Closed vs. Open Class

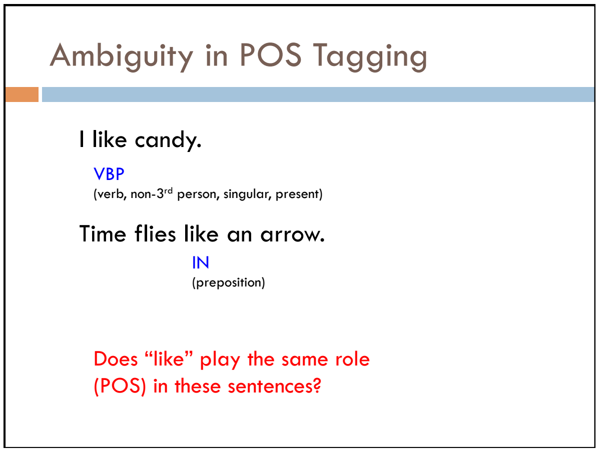
- ***Closed class*** categories are composed of a small, fixed set of grammatical function words for a given language.
  - Pronouns, Prepositions, Modals, Determiners, Particles, Conjunctions
- Open class categories have large number of words and new ones are easily invented.
  - Nouns (Googler, futon, iPad), Verbs (Google, futoning), Adjectives (geeky), Abverb (chompingly)



Part of speech tagging

- Annotate each word in a sentence with a part-of-speech marker
- Lowest level of syntactic analysis

John	saw	the	saw	and	decided	to	take	it	to	the	table.
NNP	VBD	DT	NN	CC	VBD	TO	VB	PRP	IN	DT	NN



Ambiguity in POS Tagging

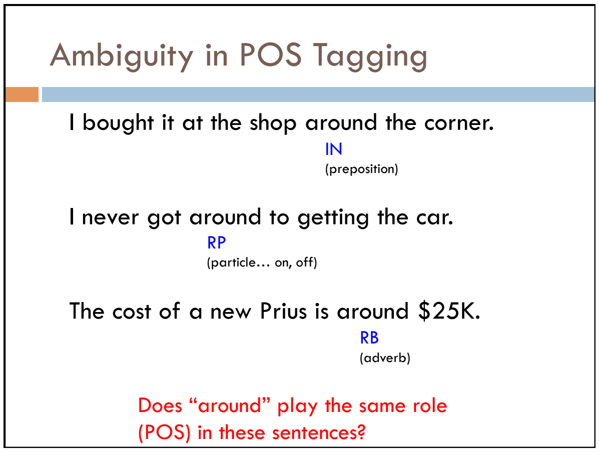
I like candy.

VBP
(verb, non-3rd person, singular, present)

Time flies like an arrow.

IN
(preposition)

Does "like" play the same role (POS) in these sentences?



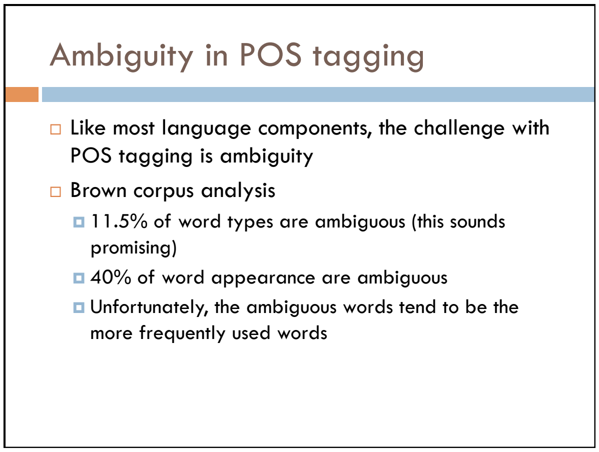
Ambiguity in POS Tagging

I bought it at the shop around the corner.
IN
(preposition)

I never got around to getting the car.
RP
(particle… on, off)

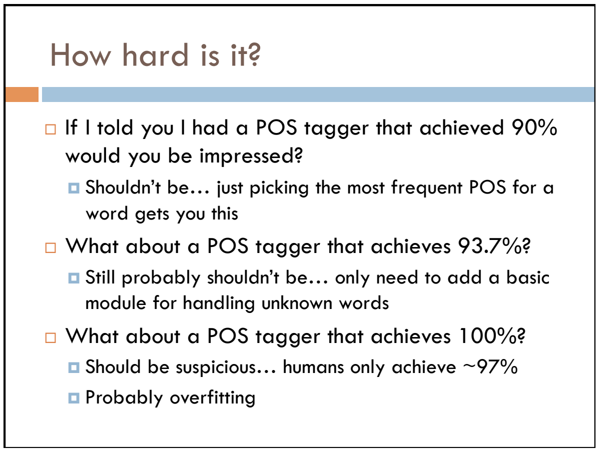
The cost of a new Prius is around $25K.
RB
(adverb)

Does "around" play the same role (POS) in these sentences?



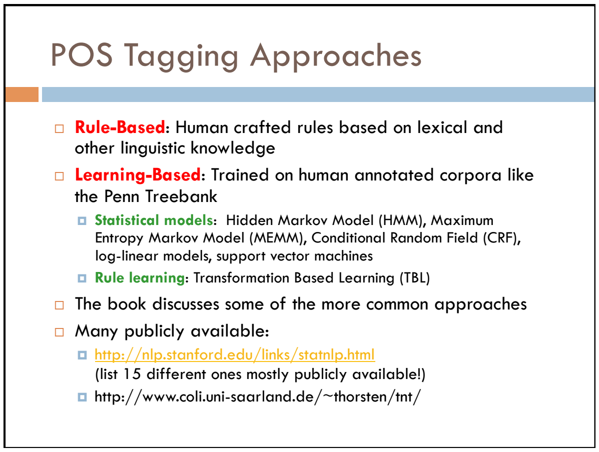
Ambiguity in POS tagging

- Like most language components, the challenge with POS tagging is ambiguity
- Brown corpus analysis
  - 11.5% of word types are ambiguous (this sounds promising)
  - 40% of word appearance are ambiguous
  - Unfortunately, the ambiguous words tend to be the more frequently used words



How hard is it?

- If I told you I had a POS tagger that achieved 90% would you be impressed?
  - Shouldn't be… just picking the most frequent POS for a word gets you this
- What about a POS tagger that achieves 93.7%?
  - Still probably shouldn't be… only need to add a basic module for handling unknown words
- What about a POS tagger that achieves 100%?
  - Should be suspicious… humans only achieve ~97%
  - Probably overfitting



POS Tagging Approaches

- **Rule-Based**: Human crafted rules based on lexical and other linguistic knowledge
- **Learning-Based**: Trained on human annotated corpora like the Penn Treebank
  - **Statistical models**: Hidden Markov Model (HMM), Maximum Entropy Markov Model (MEMM), Conditional Random Field (CRF), log-linear models, support vector machines
  - **Rule learning**: Transformation Based Learning (TBL)
- The book discusses some of the more common approaches
- Many publicly available:
  - http://nlp.stanford.edu/links/statnlp.html (list 15 different ones mostly publicly available!)
  - http://www.coli.uni-saarland.de/~thorsten/tnt/