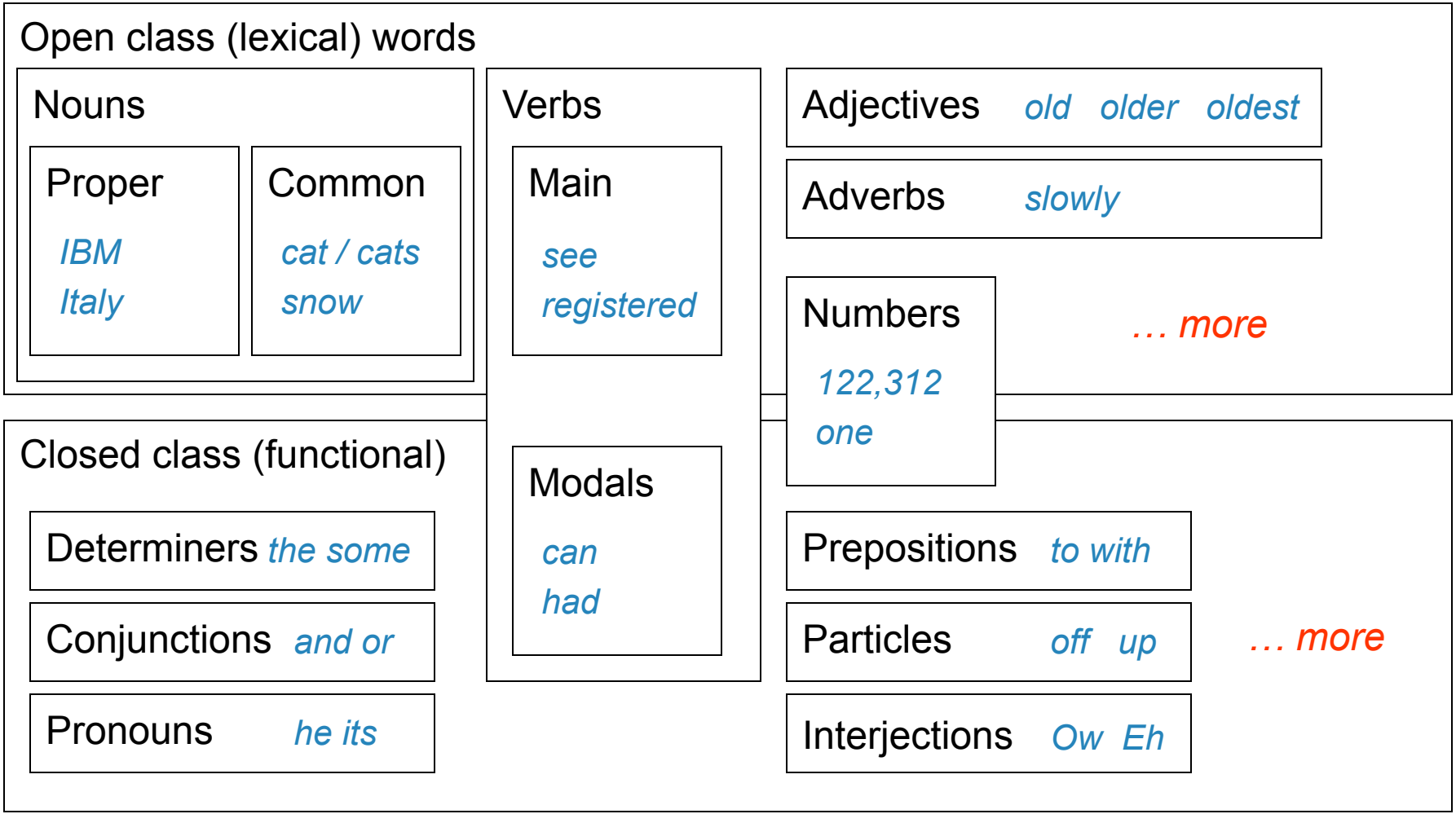
Part-of-speech tagging

A simple but useful form of linguistic analysis

Many slides adapted from slides by Chris Manning

Parts of Speech

- Perhaps starting with Aristotle in the West (384–322 BCE), there was the idea of having parts of speech
  - a.k.a lexical categories, word classes, “tags”, POS
- It comes from Dionysius Thrax of Alexandria (c. 100 BCE) the idea that is still with us that there are 8 parts of speech
  - But actually his 8 aren’t exactly the ones we are taught today
    - Thrax: noun, verb, article, adverb, preposition, conjunction, participle, pronoun
    - School grammar: noun, verb, adjective, adverb, preposition, conjunction, pronoun, interjection


Open class (lexical) words
Nouns
Proper
IBM
Italy
Common
cat / cats
snow
Verbs
Main
see
registered
Adjectives old older oldest
Adverbs slowly
Numbers
122,312
one
… more
Closed class (functional)
Modals
can
had
Determiners the some
Conjunctions and or
Pronouns he its
Prepositions to with
Particles off up
Interjections Ow Eh
… more

Open vs. Closed classes

- Open vs. Closed classes
  - Closed:
    - determiners: ***a, an, the***
    - pronouns: ***she, he, I***
    - prepositions: ***on, under, over, near, by, …***
    - Why “closed”?
  - Open:
    - Nouns, Verbs, Adjectives, Adverbs.

POS Tagging

- Words often have more than one POS: *back*
  - The *back* door = JJ
  - On my *back* = NN
  - Win the voters *back* = RB
  - Promised to *back* the bill = VB
- The POS tagging problem is to determine the POS tag for a particular instance of a word.

POS Tagging

https://www.ling.upenn.edu/courses/Fall_2003/ling001/penn_treebank_pos.html

- Input: Plays well with others
- Ambiguity: NNS/VBZ UH/JJ/NN/RB IN NNS
- Output: Plays/VBZ well/RB with/IN others/NNS
- Uses:
  - Text-to-speech (how do we pronounce “lead”?)
  - Can write regexps like (Det) Adj* N+ over the output for phrases, etc.
  - As input to or to speed up a full parser
  - If you know the tag, you can back off to it in other tasks

Penn Treebank POS tags

POS tagging performance

- How many tags are correct? (Tag accuracy)
  - About 97% currently
  - But baseline is already 90%
    - Baseline is performance of stupidest possible method
      - Tag every word with its most frequent tag
      - Tag unknown words as nouns
  - Partly easy because
    - Many words are unambiguous
    - You get points for them (*the*, *a*, etc.) and for punctuation marks!

Deciding on the correct part of speech can be difficult even for people

- Mrs/NNP Shaefer/NNP never/RB got/VBD around/RP to/TO joining/VBG

particle

- All/DT we/PRP gotta/VBN do/VB is/VBZ go/VB around/IN the/DT corner/NN

- Chateau/NNP Petrus/NNP costs/VBZ around/RB 250/CD

How difficult is POS tagging?

- About 11% of the word types in the Brown corpus are ambiguous with regard to part of speech
- But they tend to be very common words. E.g., *that*
  - I know *that* he is honest = IN Prepsition or Subordinating conjunction
  - Yes, *that* play was nice = DT
  - You can't go *that* far = RB
- 40% of the word tokens are ambiguous

Part-of-speech tagging

A simple but useful form of linguistic analysis

Part-of-speech tagging revisited

A simple but useful form of linguistic analysis

Sources of information

- What are the main sources of information for POS tagging?
  - Knowledge of neighboring words
    - Bill saw that man yesterday
    - NNP NN DT NN NN
    - VB VB(D) IN VB NN
  - Knowledge of word probabilities
    - *man* is rarely used as a verb….
- The latter proves the most useful, but the former also helps

More and Better Features → Feature-based tagger

- Can do surprisingly well just looking at a word by itself:
  - Word: the: the → DT
  - Lowercased word: Importantly: importantly → RB
  - Prefixes: unfathomable: un- → JJ
  - Suffixes: Importantly: -ly → RB
  - Capitalization: Meridian: CAP → NNP
  - Word shapes: 35-year: d-x → JJ
- Then build a maxent (or whatever) model to predict tag
  - Maxent P(t|w): 93.7% overall / 82.6% unknown

How to improve supervised results?

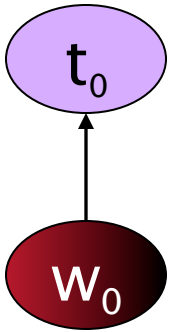
- Build better features!

  - We could fix this with a feature that looked at the next word

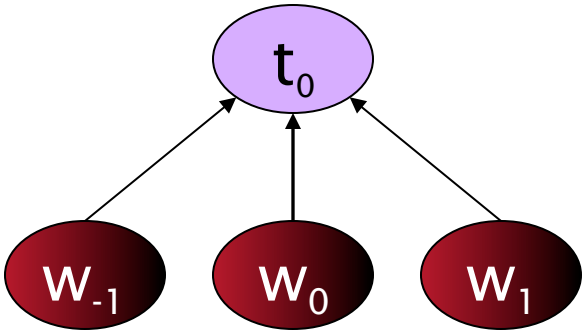
  - We could fix this by linking capitalized words to their lowercase versions

Tagging Without Sequence Information

Baseline



Three Words



Model	Features	Token	Unknown
Baseline	56,805	**93.69%**	82.61%
3Words	239,767	**96.57%**	86.78%

Using words only in a straight classifier works as well as a basic (HMM or discriminative) sequence model!!

Overview: POS Tagging Accuracies

- Rough accuracies:
  - Most freq tag: ~90% / ~50%
  - Maxent P(t|w): 93.7% / 82.6%
  - Trigram HMM: ~95% / ~55%
  - MEMM tagger: 96.9% / 86.9%
  - TnT (HMM++): (smoothing, suf,..) 96.2% / 86.0%
  - Bidirectional dependencies: 97.2% / 90.0%
  - Upper bound: ~98% (human agreement)

Most errors on unknown words

Summary of POS Tagging

For tagging, the change from generative (HMM) to discriminative (ME) model **does not by itself** result in great improvement

One profits from models for specifying dependence on **overlapping features of the observation** such as spelling, suffix analysis, etc.

An MEMM allows integration of rich features of the observations and considers dependence with the previous word's tag, but can suffer strongly from assuming independence from following observations; this effect can be relieved by adding dependence on following words.

This additional power (of the CRF, Structured Perceptron models) has been shown to result in improvements in accuracy

The **higher accuracy** of discriminative models comes at the price of **much slower training**

Part-of-speech tagging revisited

A simple but useful form of linguistic analysis