Computational Linguistics 1

CMSC/LING 723, LBSC 744

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Lecture 7: 22 September 2011
Happy First Day of Fall!

Agenda

- HW2 – assigned today, due next Thursday (9/29)
- Questions, comments, concerns?
- Part-of-speech Tagging

Part-of-speech (POS) Tagging

- "Classes" of words
- 8 parts of speech: noun, verb, pronoun, preposition, adverb, conjunction, participle, article
  - Verbs are actions
  - Adjectives are properties
  - Nouns are things
- Mad Libs??

Why do POS tagging?

- One of the most basic NLP tasks
  - Nicely illustrates principles of statistical NLP
- Useful for higher-level analysis
  - Needed for syntactic analysis
  - Needed for semantic analysis
- Sample applications that require POS tagging
  - Machine translation
  - Information extraction
  - Lots more…

Why is it hard?

- Not only a lexical problem
  - Remember ambiguity?
- Better modeled as sequence labeling problem
  - Need to take into account context!

How do we define POS?

- By meaning
  - Verbs are actions
  - Adjectives are properties
  - Nouns are things
- By the syntactic environment
  - What occurs nearby?
  - What does it act as?
- By what morphological processes affect it
  - What affixes does it take?
- Combination of the above

Unreliable! Think back to the comic!

Parts of Speech

- Open class
  - Impossible to completely enumerate
  - New words continuously being invented, borrowed, etc.
- Closed class
  - Closed, fixed membership
  - Reasonably easy to enumerate
  - Generally, short function words that "structure" sentences

Open Class POS

- Four major open classes in English
  - Nouns
  - Verbs
  - Adjectives
  - Adverbs
- All languages have nouns and verbs... but may not have the other two

Nouns

- Open class
  - New inventions all the time: muggle, webinar, ...
- Semantics:
  - Generally, words for people, places, things
  - But not always (bandwidth, energy, ...)
- Syntactic environment:
  - Occurring with determiners
  - Pluralizable, possessivizable
- Other characteristics:
  - Mass vs. count nouns

Verbs

- Open class
  - New inventions all the time: google, tweet, ...
- Semantics:
  - Generally, denote actions, processes, etc.
- Syntactic environment:
  - Intransitive, transitive, ditransitive
  - Alternations
- Other characteristics:
  - Main vs. auxiliary verbs
  - Gerunds (verbs behaving like nouns)
  - Participles (verbs behaving like adjectives)

Adjectives and Adverbs

- Adjectives
  - Generally modify nouns, e.g., *tall* girl
- Adverbs
  - A semantic and formal potpourri…
  - Sometimes modify verbs, e.g., sang *beautifully*
  - Sometimes modify adjectives, e.g., *extremely* hot

Closed Class POS

- Prepositions
  - In English, occurring before noun phrases
  - Specifying some type of relation (spatial, temporal, …)
  - Examples: *on* the shelf, *before* noon
- Particles
  - Resembles a preposition, but used with a verb ("phrasal verbs")
  - Examples: find *out*, turn *over*, go *on*

Particle vs. Prepositions

He came *by* the office in a hurry	(by = preposition)
He came *by* his fortune honestly	(by = particle)
We ran *up* the phone bill	(up = particle)
We ran *up* the small hill	(up = preposition)
He lived *down* the block	(down = preposition)
He never lived *down* the nicknames	(down = particle)

More Closed Class POS

- Determiners
  - Establish reference for a noun
  - Examples: *a*, *an*, *the* (articles), *that*, *this*, *many*, *such*, …
- Pronouns
  - Refer to person or entities: *he*, *she*, *it*
  - Possessive pronouns: *his*, *her*, *its*
  - Wh-pronouns: *what*, *who*

Closed Class POS: Conjunctions

- Coordinating conjunctions
  - Join two elements of "equal status"
  - Examples: cats *and* dogs, salad *or* soup
- Subordinating conjunctions
  - Join two elements of "unequal status"
  - Examples: We'll leave *after* you finish eating. *While* I was waiting in line, I saw my friend.
  - Complementizers are a special case: I think *that* you should finish your assignment

POS Tagging: What's the task?

- Process of assigning part-of-speech tags to words
- But what tags are we going to assign?
  - Coarse grained: noun, verb, adjective, adverb, …
  - Fine grained: {proper, common} noun
  - Even finer-grained: {proper, common} noun ± animate

What's the tradeoff?

- Important issues to remember
  - Choice of tags encodes certain distinctions/non-distinctions
  - Tagsets will differ across languages!
- For English, Penn Treebank is the most common tagset

Penn Treebank Tagset: 45 Tags

Tag	Description	Example	Tag	Description	Example
CC	coordin. conjunction	*and, but, or*	SYM	symbol	*+,%, &*
CD	cardinal number	*one, two, three*	TO	"to"	*to*
DT	determiner	*a, the*	UH	interjection	*ah, oops*
EX	existential 'there'	*there*	VB	verb, base form	*eat*
FW	foreign word	*mea culpa*	VBD	verb, past tense	*ate*
IN	preposition/sub-conj	*of, in, by*	VBG	verb, gerund	*eating*
JJ	adjective	*yellow*	VBN	verb, past participle	*eaten*
JJR	adj., comparative	*bigger*	VBP	verb, non-3sg pres	*eat*
JJS	adj., superlative	*wildest*	VBZ	verb, 3sg pres	*eats*
LS	list item marker	*1, 2, One*	WDT	wh-determiner	*which, that*
MD	modal	*can, should*	WP	wh-pronoun	*what, who*
NN	noun, sing. or mass	*llama*	WP$	possessive wh-	*whose*
NNS	noun, plural	*llamas*	WRB	wh-adverb	*how, where*
NNP	proper noun, singular	*IBM*	$	dollar sign	$
NNPS	proper noun, plural	*Carolinas*	#	pound sign	#
PDT	predeterminer	*all, both*	"	left quote	‘ or “
POS	possessive ending	*'s*	"	right quote	’ or ”
PRP	personal pronoun	*I, you, he*	(	left parenthesis	[, (, {, <
PRP$	possessive pronoun	*your, one's*	)	right parenthesis	],), }, >
RB	adverb	*quickly, never*	,	comma	,
RBR	adverb, comparative	*faster*	.	sentence-final punc	. ! ?
RBS	adverb, superlative	*fastest*	:	mid-sentence punc	: ; ... – -
RP	particle	*up, off*			

Why is POS tagging hard?

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Why is it hard?*

		87-tag Original Brown	45-tag Treebank Brown
Unambiguous (1 tag)		**44,019**	**38,857**
Ambiguous (2–7 tags)		**5,490**	**8844**
Details:	2 tags	4,967	6,731
	3 tags	411	1621
	4 tags	91	357
	5 tags	17	90
	6 tags	2 (*well*, *beat*)	32
	7 tags	2 (*still*, *down*)	6 (*well*, *set*, *round*, *open*, *fit*, *down*)
	8 tags		4 (*'s*, *half*, *back*, *a*)
	9 tags		3 (*that*, *more*, *in*)

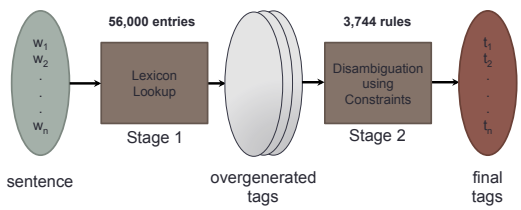
Automatic POS Tagging

- Rule-based POS tagging
- Transformation-based learning for POS tagging
- Hidden Markov Models (next week)
- Maximum Entropy Models (CMSC 773)
- Conditional Random Fields (CMSC 773)

Rule-Based POS Tagging

- Dates back to the 1960's
- Combination of lexicon + hand crafted rules
  - Example: EngCG (English Constraint Grammar)

EngCG Architecture



EngCG: Sample Lexical Entries

Word	POS	Additional POS features
smaller	ADJ	COMPARATIVE
fast	ADV	SUPERLATIVE
that	DET	CENTRAL DEMONSTRATIVE SG
all	DET	PREDETERMINER SG/PL QUANTIFIER
dog's	N	GENITIVE SG
furniture	N	NOMINATIVE SG NOINDEFDETERMINER
one-third	NUM	SG
she	PRON	PERSONAL FEMININE NOMINATIVE SG3
show	V	PRESENT -SG3 VFIN
show	N	NOMINATIVE SG
shown	PCP2	SVOO SVO SV
occurred	PCP2	SV
occurred	V	PAST VFIN SV

EngCG: Constraint Rule Application

Example Sentence: *Newman had originally practiced that ...*

Newman	**NEWMAN N NOM SG PROPER**
had	**HAVE <SVO> V PAST VFIN**
	HAVE <SVO> PCP2
originally	**ORIGINAL ADV**
practiced	PRACTICE <SVO> <SV> V PAST VFIN
	PRACTICE <SVO> <SV> PCP2
that	~~ADV~~
	PRON DEM SG
	DET CENTRAL DEM SG
	CS

overgenerated tags

```
ADVERBIAL-THAT Rule
Given input: that
if
    (+1 A/ADV/QUANT);
    (+2 SENT-LIM);
    (NOT -1 SVOC/A);
then eliminate non-ADV tags
else eliminate ADV tag
```

disambiguation constraint

I thought that you... (subordinating conjunction)
That day was nice. (determiner)
You can go that far. (adverb)

EngCG: Evaluation

- Accuracy ~96%*
- A lot of effort to write the rules and create the lexicon
  - Try debugging interaction between thousands of rules!
  - Recall discussion from the first lecture?
- Assume we had a corpus *annotated* with POS tags
  - Can we *learn* POS tagging automatically?

Supervised Machine Learning

- Start with annotated corpus
  - Desired input/output behavior
- Training phase:
  - Represent the training data in some manner
  - Apply learning algorithm to produce a system (tagger)
- Testing phase:
  - Apply system to unseen test data
  - Evaluate output

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