Indian Institute of Technology Kharagpur
Department of Computer Science & Engineering

CS60075
Natural Language Processing
Autumn 2020

Module 4: Part 2
Introduction to POS Tagging

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Building a computer that 'understands' text: The NLP pipeline

Tokenization/Segmentation

- Split text into words and sentences
  - Task: what is the most likely segmentation /tokenization?

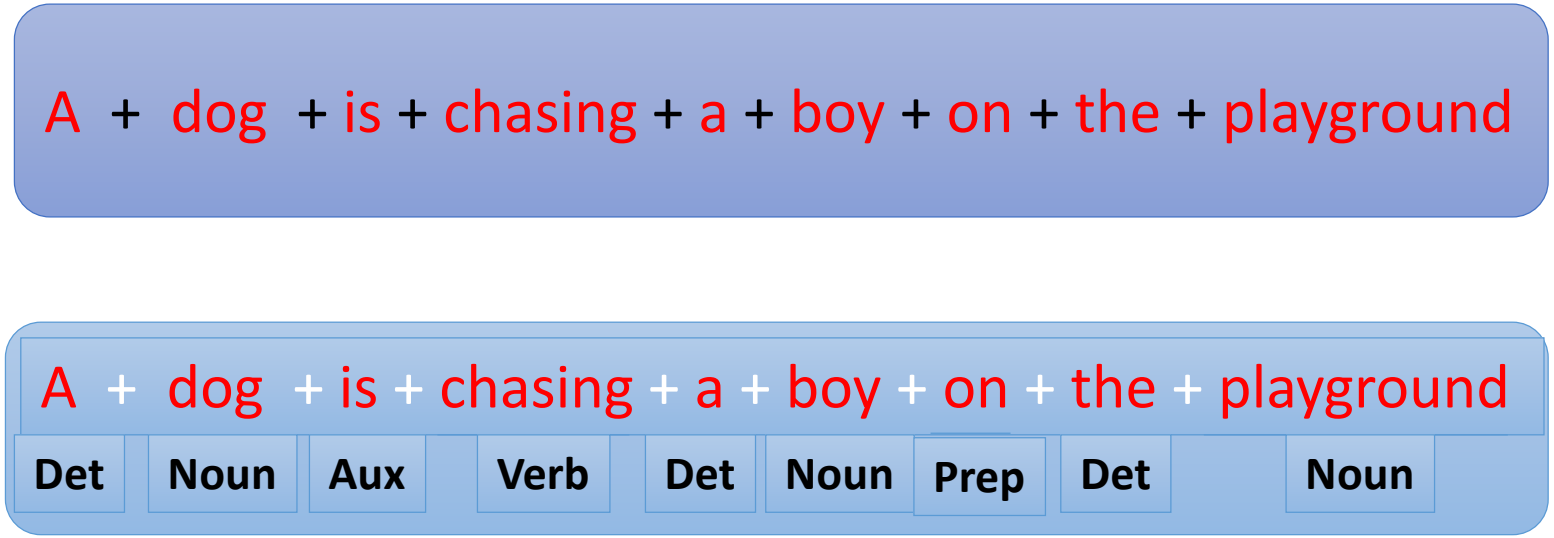
There was an earthquake near D.C. I've even felt it in Philadelphia, New York, etc.

There + was + an + earthquake + near + D.C.

I + ve + even + felt + it + in + Philadelphia, + New + York, + etc.

Part-of-Speech tagging

- Marking up a word in a text (corpus) as corresponding to a particular part of speech
  - Task: what is the most likely tag sequence



Named entity recognition

- Determine text mapping to proper names
  - Task: what is the most likely mapping

Its initial Board of Visitors included U.S. Presidents Thomas Jefferson, James Madison, and James Monroe.

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Organization, Location, Person

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.

- Aristotle (384–322 BCE): the idea of having parts of speech a.k.a lexical categories, word classes, “tags”, POS
- Dionysius Thrax of Alexandria (c. 100 BCE) : 8 parts of speech
  - noun, verb, article, adverb, preposition, conjunction, participle, pronoun

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)

Brown corpus: 87 POS tags

Penn Treebank: ~45 POS tags

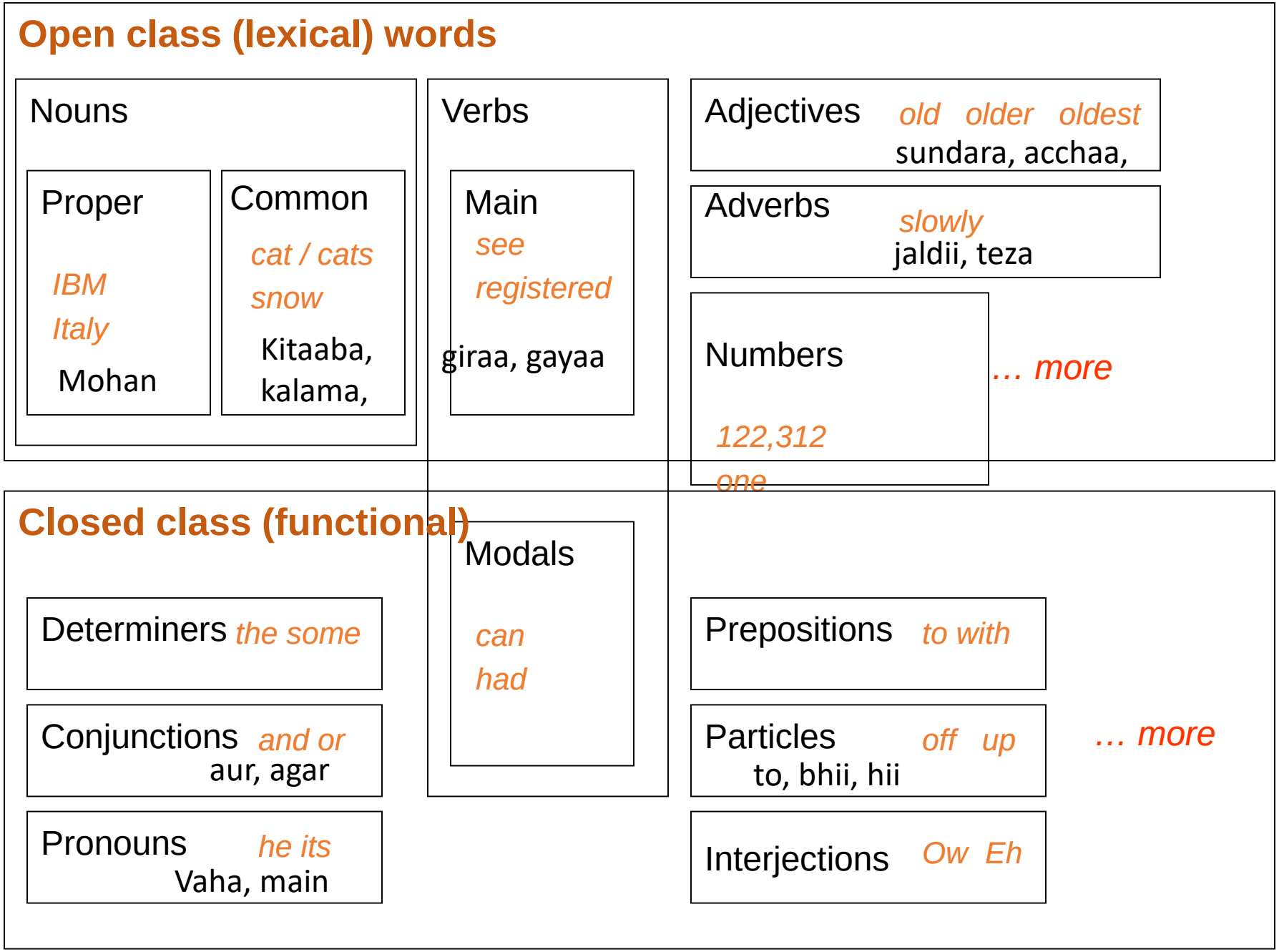
Open vs. Closed classes

- 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.

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, textlish), Verbs (Google), Adjectives (geeky), Abverb (chompingly)


I LIKE TO VERB WORDS.
WHAT?
I TAKE NOUNS AND ADJECTIVES AND USE THEM AS VERBS. REMEMBER WHEN "ACCESS" WAS A THING? NOW IT'S SOMETHING YOU DO. IT GOT VERBED.
VERBING WEIRDS LANGUAGE.
MAYBE WE CAN EVENTUALLY MAKE LANGUAGE A COMPLETE IMPEDIMENT TO UNDERSTANDING.


Open class (lexical) words
Nouns
Proper
IBM
Italy
Mohan
Common
cat / cats
snow
Kitaaba,
kalama,
Verbs
Main
see
registered
giraa, gayaa
Adjectives
old older oldest
sundara, acchaa,
Adverbs
slowly
jaldii, teza
Numbers
122,312
one
… more
Closed class (functional)
Modals
can
had
Determiners the some
Conjunctions and or
aur, agar
Pronouns he its
Vaha, main
Prepositions to with
Particles off up
to, bhii, hii
Interjections Ow Eh
… more

Part Of Speech Tagging

- Annotate each word in a sentence with a part-of-speech marker.

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

UDEP POS tags

Open class words	Closed class words	Other
ADJ	ADP	PUNCT
ADV	AUX	SYM
INTJ	CCONJ	X
NOUN	DET	
PROPN	NUM	
VERB	PART	
	PRON	
	SCONJ	

Ambiguity in POS Tagging

- "Like" can be a verb or a preposition
  - I like/VBP candy.
  - Time flies like/IN an arrow.
- "Around" can be a preposition, particle, or adverb
  - I bought it at the shop around/IN the corner.
  - I never got around/RP to getting a car.
  - A new Prius costs around/RB $25K.

- What is the POS for "back"?
  - The *back* door
  - On my *back*
  - Win the voters *back*
  - Promised to *back* the bill

POS Tagging task

- Input: **the lead paint is unsafe**
- Output: **the/Det lead/N paint/N is/V unsafe/Adj**
- • Uses:
  - text-to-speech (how do we pronounce “lead”?)
  - can differentiate word senses that involve part of speech differences (what is the meaning of “interest”)
  - can write regexps like Det Adj* N* over the output (for filtering collocations)
  - preprocessing for parser

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!), but…
- 40% of word appearances are ambiguous
- Unfortunately, the ambiguous words tend to be the more frequently used words

Constituency

Parts of speech can be thought of as the lowest level of syntactic information

Groups *words* together into categories

_____ likes to eat candy.

What can/can’t go here?

Constituency

_____ likes to eat candy.

nouns

Dinesh
Dr Roy
Professor Das

determiner nouns

The man
The boy
The cat

pronouns

He
She

determiner nouns +

The man that I saw
The boy with the blue pants
The cat in the hat

Constituency

Words in languages tend to form into functional groups (parts of speech)

Groups of words (aka phrases) can also be grouped into functional groups

- often some relation to parts of speech
- though, more complex interactions

These phrase groups are called constituents

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)
  - **Rule learning**: Transformation Based Learning (TBL)
  - **Neural networks**: Recurrent networks like Long Short Term Memory (LSTMs)