

# Parts of Speech

(slides from Alan Black and possibly others at CMU)

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- My cat who lives dangerously no longer has nine lives.

- My cat who **lives** dangerously no longer has nine **lives**.

• My cat who **lives** dangerously no longer has nine **lives**.

• lives: verb /l ih v z/

• lives: noun /l ay v z/

# Part-of-Speech Tagging Task

- Input: a sequence of word tokens  $\mathbf{w}$
- Output: a sequence of part-of-speech tags  $\mathbf{t}$ , one per word

# Example

Charlie	Brown	received	a	valentine	.

# Example

Charlie	Brown	received	a	valentine	.
proper noun	proper noun	verb	determiner	noun	punctuation

# Example

Charlie	Brown	received	a	valentine	.
proper noun	proper noun	verb	determiner	noun	punctuation
name, first name, person name, ...	name, last name, person name,	past tense, transitive	indefinite, singular	singular, count	end-of- sentence, period



# How do we know the class?

- Substitution test

- The ADJ cat sat on the mat

- The blue NOUN sat on the NOUN

- The blue cat VERB on the mat

- The blue cat sat PREP the mat

# What are the Classes?

- Nouns, Verbs, Adjectives ...
  - Lots of different values (open class)
- Pronouns
  - I, you, she, her, myself, ...
- Determiners
  - The, a, this, that, some, ...
- Prepositions
  - By, at, from, as, against, below, ...
- Conjunctions
  - And, or, neither, but, ...
- Modal auxiliaries
  - Will, may, could, can, ...
- Some classes are well defined, some open

# Broad POS categories

open classes

nouns

verbs

adjectives

adverbs

closed classes

prepositions

particles

determiners

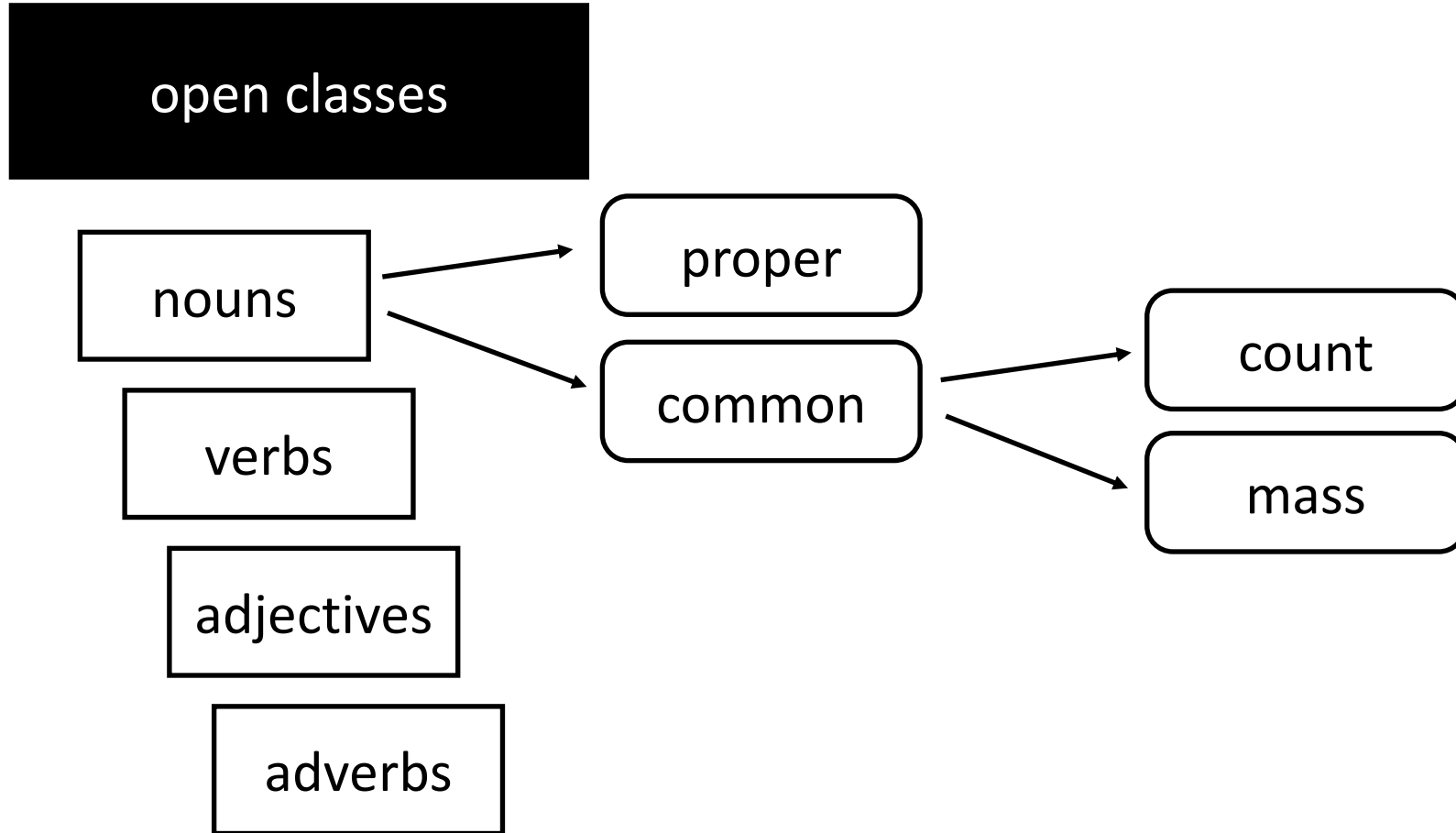
numerals

pronouns

conjunctions

auxiliary verbs

# More Fine-Grained Classes



# More Fine-Grained Classes

open classes

nouns

verbs

adjectives

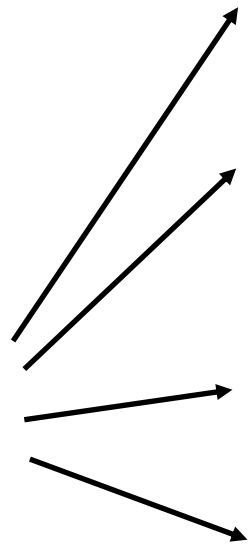
adverbs

directional

degree

manner

temporal



What POS?

I feared that my pet  
raccoon was ill  
so I took him to the vet.

That fear turned out to  
be unfounded.

# Hard Cases

- I will call up my friend
- I will call my friend up
- I will call my friend up in the treehouse
- Gerunds
  - I like walking
  - I like apples
  - His walking kept him fit
  - His apples kept him fit

# Maybe?

- Interjections
- Negatives
- Politeness markers
- Greetings
- Existential *there*
- Emoticon
- URL
- Hashtag



# Some PTB Data (POS Tags)

IN In DT an NNP Oct. CD 19 NN review IN of `` `` DT The NN Misanthrope " " IN at NNP  
Chicago POS 's NNP Goodman NNP Theatre -LRB- -LRB- `` `` VBN Revitalized NNS Classics

VBP Take DT the NN Stage IN in NNP Windy NNP City , , " " NN Leisure CC & NNS Arts -RRB-  
-RRB- , , DT the NN role IN of NNP Celimene , , VBN played IN by NNP Kim NNP Cattrall , ,  
VBD was RB mistakenly VBN attributed TO to NNP Christina NNP Haag . .

NNP Ms. NNP Haag VBZ plays NNP Elianti . .

NNP Rolls-Royce NNP Motor NNPS Cars NNP Inc. VBD said PRP it VBZ expects PRP\$ its NNP  
U.S. NNS sales TO to VB remain JJ steady IN at IN about CD 1,200 NNS cars IN in CD 1990 . .

DT The NN luxury NN auto NN maker JJ last NN year VBD sold CD 1,214 NNS cars IN in DT  
the NNP U.S.

*NN.\* → kinds of nouns; VB.\* → kinds of verbs; DT → determiner; ...  
(You don't have to memorize the Penn Treebank tags)*

# How bad is ambiguity?

7 down  
6 that  
6 set  
6 put  
6 open  
6 hurt  
6 cut  
6 bet  
6 back  
5 vs.  
5 the  
5 spread  
5 split  
5 say  
5 's  
5 run  
5 repurchase  
5 read  
5 present  
5 out  
5 many  
5 less  
5 left  
5 Japanese  
5 in  
5 hit  
5 if

317 down RB  
200 down RP  
138 down IN  
10 down JJ  
1 down VBP  
1 down RBR  
1 down NN

# “Down”

## “gold” tag is correct

CD One CD hundred CC and CD ninety CD two JJ former NNS greats , , JJ near NNS greats , , RB hardly NNS knowns CC and NNS unknowns VBP begin DT a JJ 72-game , , JJ three-month NN season IN in NN spring-training NNS stadiums RB up CC and RB down NNP Florida

PRP He MD will VB keep DT the NN ball RP down , , VB move PRP it RB around IN As DT the NN judge VBD marched IN down DT the JJ center NN aisle IN in PRP\$ his VBG flowing JJ black NN robe , , PRP he VBD was VBN heralded IN by DT a NN trumpet NN fanfare

JJ Other NNP Senators VBP want TO to VB lower DT the JJ down NNS payments VBN required IN on JJ FHA-insured NNS loans

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NNP Texas NNP Instruments , , WDT which VBD had VBN reported NNP Friday IN that JJ third-quarter NNS earnings VBD fell RBR more IN than CD 30 NN % IN from DT the JJ year-ago NN level , , VBD went RBR down CD 2 CD 1\8 TO to CD 33 IN on CD 1.1 CD million NNS shares

IN Because NNS hurricanes MD can VB change NN course RB rapidly , , DT the NN company VBZ sends NNS employees NN home CC and NNS shuts VBP down NNS operations IN in NNS stages : -- DT the RBR closer DT a NN storm VBZ gets , , DT the RBR more JJ complete DT the NN shutdown

NNP Jaguar POS 's JJ American NN depository NNS receipts VBD were IN up CD 3\8 NN yesterday IN in DT a NN down NN market , , VBG closing IN at CD 10 CD 3\8

“gold” tag is actually incorrect (an annotator screwed up!)

# “Japanese”

## “gold” tag is correct

RB Meanwhile , , JJ Japanese NNS bankers VBD said PRP they VBD were RB still JJ hesitant IN about VBG accepting NNP Citicorp POS 's JJS latest NN proposal CC And DT the NNPS Japanese VBP are JJ likely TO to VB keep RB close IN on NNP Conner POS 's NNS heels DT The NN issue VBZ is RB further VBN complicated IN because IN although DT the NNS organizations VBP represent JJ Korean NNS residents , , DT those NNS residents VBD were RB largely VBN born CC and VBN raised IN in NNP Japan CC and JJ many VBP speak RB only NNP Japanese

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CC And DT the NNP Japanese VBP make RB far JJR more NNS suggestions : -- CD 2,472 IN per CD 100 JJ eligible NNS employees CC vs. RB only CD 13 IN per CD 100 NNS employees IN in DT the (...)  
DT The NNS Japanese VBP are IN in DT the JJ early NN stage RB right RB now , , VBD said NNP Thomas NNP Kenney , , DT a JJ onetime NN media NN adviser IN for NNP First NNP Boston NNP Corp. WP who VBD was RB recently VBN appointed NN president IN of NNP Reader POS 's NNP Digest NNP Association POS 's JJ new NNP Magazine NNP Publishing NNP Group  
IN In CD 1991 , , DT the NNS Soviets MD will VB take DT a JJ Japanese NN journalist IN into NN space , , DT the JJ first NN Japanese TO to VB go IN into NN orbit

“gold” tag is actually incorrect (an annotator screwed up!)

# How do we do this

- Pick the most frequent tag
  - Gives about 90% accuracy
- Look at the context
  - Preceding (and succeeding) words

# Evaluating a POS tagger

On held-out data we can quantify:

how the tagger is doing **overall**

- **Accuracy** = the % of tokens for which the predicted label matched the gold label:  
$$\frac{\#(\text{pred}=\text{gold})}{\#(\text{tokens})}$$

how the tagger is doing **for a particular tag** (say, **VERB**)—different error types

- **false positives** (**VERB** predicted, should have been something else)  
$$\#(\text{pred}=\text{V}, \text{gold}\neq\text{V})$$
- **false negatives** (should have predicted **VERB**, actually predicted something else)  
$$\#(\text{pred}\neq\text{V}, \text{gold}=\text{V})$$
- **true positives** (correctly predicted **VERB**!)  
$$\#(\text{pred}=\text{gold}=\text{V})$$
- *true negatives: Tokens that don't involve **VERB** at all—not relevant to our question*

# Precision and Recall

To measure relative performance with respect to a particular tag (say, **VERB**)

- **Precision** = % of **VERB** predictions that were correct
- **Recall** = % of actual **VERB** tokens that were correctly tagged

☞ *Same numerator, different denominators!*

☞ *Rewrite in terms of error categories?*

To combine these into one score we typically use **F<sub>1</sub> score** = harmonic mean, computed as

- $2 * \text{Precision} * \text{Recall} / (\text{Precision} + \text{Recall})$
- $= 2 * \text{TP} / (2 * \text{TP} + \text{FP} + \text{FN})$   
(a version of the Sørensen-Dice coefficient)

# Example

British	Left	Waffles	On	Falkland	Islands
NOUN	NOUN	VERB	PREP	PROPN	PROPN
NOUN	VERB	NOUN	PREP	PROPN	NOUN

- Accuracy?
- Count of each error type for NOUN (TP, TN, FP, FN)?
- Precision, Recall,  $F_1$  of NOUN?