Language Processing with Perl and Prolog

Chapter 7: Part-of-Speech Tagging Using Rules

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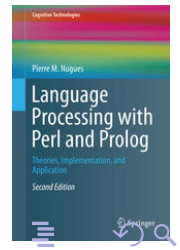
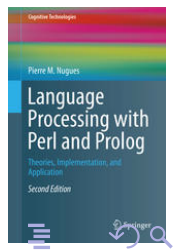


The Parts of Speech

The parts of speech (POS) are classes that correspond to the lexical – or word – categories
Plato made a distinction between the verb and the noun.
After him, the word categories further evolved and grew in number until Dionysus Thrax formulated and fixed them.
Aelius Donatus popularized the list of the eight parts of speech: noun, pronoun, verb, participle, conjunction, adverb, preposition, and interjection.
Grammarians have adopted these POS for most European languages although they are somewhat arbitrary



Part-of-speech Annotation

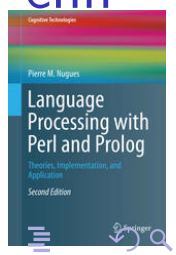
Sentence:

That round table might collapse

Annotation:

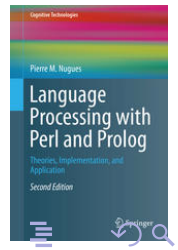
Words	Parts of speech	POS tags
that	Determiner	DT
round	Adjective	JJ
table	Noun	NN
might	Modal verb	MD
collapse	Verb	VB

The automatic annotation uses predefined POS tagsets such as the Penn Treebank tagset for English



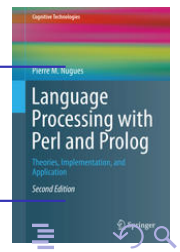
Word Ambiguity

	English	French	German
Part of speech	*can* modal	*le* article	*der* article
	can noun	*le* pronoun	*der* pronoun
Semantic	*great* big	*grand* big	*groß*
	great notable	*grand* notable	*groß*



POS Tagging

Words	Possible tags	Example of use
that	Subordinating conjunction	*That he can swim is good*
	Determiner	*That white table*
	Adverb	*It is not that easy*
	Pronoun	*That is the table*
	Relative pronoun	*The table that collapsed*
round	Verb	*Round up the usual suspects*
	Preposition	*Turn round the corner*
	Noun	*A big round*
	Adjective	*A round box*
	Adverb	*He went round*
table	Noun	*That white table*
	Verb	*I table that*
might	Noun	*The might of the wind*
	Modal verb	*She might come*
collapse	Noun	*The collapse of the empire*
	Verb	*The empire can collapse*



Part-of-Speech Ambiguity in Swedish

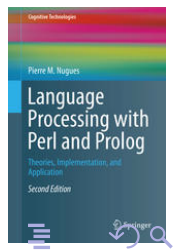
The word *som* in the *Norstedts svenska ordbok*, 1999, has three entries:

1. *Om jag vore lika vacker som du, skulle jag vara lycklig.* (konjunktion)
2. *Bilen som jag köpte i fjol.* (pronomen)
3. *Som jag har saknat dig.* (adverb)

The part-of-speech difference can be significant:

Swedish. Compare the pronunciation of *vaken*, adjective, as in *Han är aldrig vaken innan klockan sju* and *vaken*, noun, as in *Vi fiskade i vaken i sjön*

English. Compare *object* in *I object to violence*, verb, or *I could see an object*, noun.



Simple Grammatical Constraints are not Satisfying

Although, it makes no sense,

I see a bird

can be tagged as:

*I/**noun** see/**noun** a/**noun** bird/**noun***

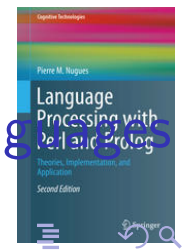
Because sequences of four nouns are possible in English as in:

city school committee meeting.

The disambiguation methods are based on

- Handcrafted rules
- Automatically learned rules
- Statistical methods

Currently disambiguation accuracy is greater than 95% for many languages



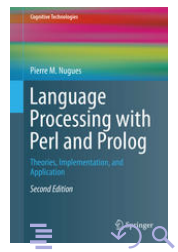
POS Annotation with Rules

The phrase *The can rusted* has two readings
Let's suppose that *can*/modal is more frequent than *can*/noun in our corpus

First step: Assign the most likely POS
The/art *can*/modal *rusted*/verb

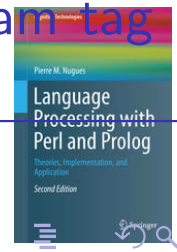
Second step: Apply rules
Change the tag from modal to noun if one of the two previous words is an article
The/art *can*/noun *rusted*/verb

This is the idea of Brill's tagger.



Rule Templates

Rules	Explanation
`alter(A, B, prevtag(C))`	Change A to B if preceding tag is C
`alter(A, B, nexttag(C))`	Change A to B if the following tag is C
`alter(A, B, prev2tag(C))`	Change A to B if tag two before is C
`alter(A, B, next2tag(C))`	Change A to B if tag two after is C
`alter(A, B, prev1or2tag(C))`	Change A to B if one of the two preceding tags is C
`alter(A, B, next1or2tag(C))`	Change A to B if one of the two following tags is C
`alter(A, B, surroundingtag(C, D))`	Change A to B if surrounding tags are C and D
`alter(A, B, nextbigram(C, D))`	Change A to B if next bigram tag is C D
`alter(A, B, prevbigram(C, D))`	Change A to B if previous bigram tag is C D



Learning Rules Automatically

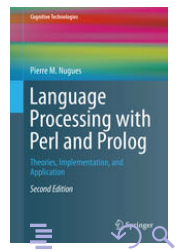
Compare the hand-annotation of the reference corpus with the automatic one

Automatic tagging	Hand annotation: gold standard
The/art *can*/modal *rusted*/verb	*The*/art *can*/noun *rusted*/verb

For each error instantiate the templates
Rules correcting the error

```
alter(modal, noun, prevtag(art)).
alter(modal, noun, prev1or2tag(art)).
alter(modal, noun, nexttag(verb))
alter(modal, noun, surroundingtag(art, verb))
```

Rules introduce good and bad transformations
Select the rule that has the greatest error reduction and apply it



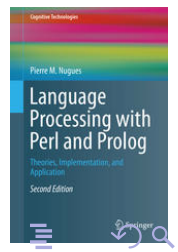
Part-of-Speech Ambiguity in Swedish

The Swedish word *den* can be a determiner or a pronoun.
It corresponds to two entries in the *Nordstedts svenska ordbok* (1999, page 187):

- **den** artikel . . . som här antas vara känd . . . : ***den*** *nya bilen*
- **den** pron. personen eller företeelsen som är omtalad i sammanhanget . . . : *Var har du köpt kameran? Jag har fått* ***den*** *i present.*

Frequency information:

```
egrep -i "den  dt" talbanken.txt | wc -l
     820
egrep -i "den  pn" talbanken.txt | wc -l
     256
```



Ambiguity Resolution in Swedish: The Baseline

Let us suppose that *den* is the only word to tag in the corpus and that it has two possible parts of speech: dt and pn.
Using the most frequent part of speech produces the annotations:

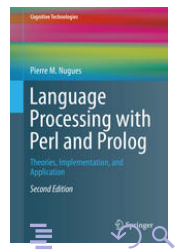
Den	nya	läroplanen	innebär	också	...
dt	jj	nn	vb_fin	ab	

Jag	har	fått	den	i	present
pn	vb_fin	vb	dt	pp	nn

If the POS tagger is restricted to *den*, out of 820 + 256 = 1076 POS assignments,

$$\frac{820}{1076} = 76\%$$

are correct.



Ambiguity Resolution in Swedish: The Rule Templates

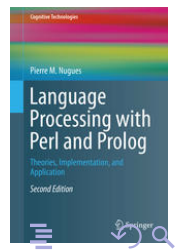
Let us use two rules templates `alter(A, B, prev(C))` and `alter(A, B, next(C))` and instantiate them with the error on *Jag har fått den i present*.

Jag	har	fått	den	i	present
pn	vb_fin	**vb**	(dt → pn)	**pp**	nn

It yields:

1. Change `dt` to `pn` if previous POS tag is `vb`: `alter(dt, pn, prev(vb))`
2. Change `dt` to `pn` if next POS tag is `pp`: `alter(dt, pn, next(pp))`

Both rules produce a correct annotation on the training example.

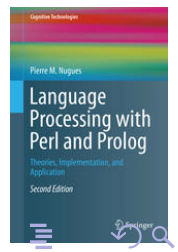


Ambiguity Resolution in Swedish: Selecting the Rules

Let us apply the two rules to all the occurrences of *den* in the corpus and ignore all the other words:

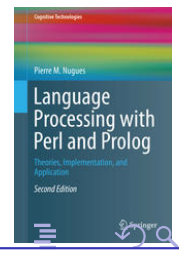
- The first rule corrects 15 wrong annotations of *den* and introduces 59 mistakes: $15 - 59 = -44$
- The second rule corrects 20 wrong annotations and introduces 5 mistakes: $20 - 5 = +\mathbf{5}$

The training step of Brill's tagger selects the most efficient rule, here `alter(dt, pn, next(pp))`.
Of course, this step is applied to all the ambiguous words and not only *den*.
We iterate the procedure until the error rate is below a certain threshold.



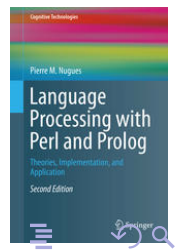
Brill's Learning Algorithm

St.	Operation	Input	Output
1.	Annotate each word of the corpus with its most likely part of speech	*Corpus*	*AnnotatedCorpus(1)*
2.	Compare pairwise the part of speech of each word of the *AnnotationReference* and *AnnotatedCorpus(i)*	*AnnotationReference* *AnnotatedCorpus(i)*	List of errors
3.	For each error, instantiate the rule templates to correct the error	List of errors	List of tentative rules
4.	For each instantiated rule, compute on *AnnotatedCorpus(i)* the number of good transformations minus the number of bad transformations the rule yields	*AnnotatedCorpus(i)* Tentative rules	Scored tentative rules



Brill's Learning Algorithm

St.	Operation	Input	Output
5.	Select the rule that has the greatest error reduction and append it to the ordered list of transformations	Tentative rules	*Rule(i)*
6.	Apply *Rule(i)* to *Annotated-Corpus(i)*	*AnnotatedCorpus(i)* *Rule(i)*	*AnnotatedCorpus(i+1)*
7.	If number of errors is under predefined threshold, end the algorithm else go to step 2.	–	List of rules

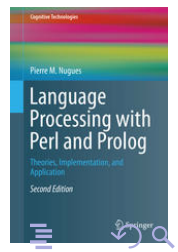


First Brill's Rules

#	Change From	To	Condition
1	NN	VB	Previous tag is TO
2	VBP	VB	One of the previous three tags is MD
3	NN	VB	One of the previous two tags is MD
4	VB	NN	One of the previous two tags is DT
5	VBD	VBN	One of the previous three tags is VBZ

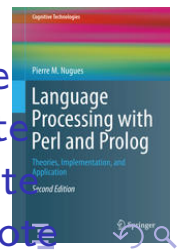
In the table, rules consider parts of speech only. This is the normal case and they are called unlexicalized.
Rules can also consider word values and they are called lexicalized.

Change From	To	Condition
IN	RB	The word two positions to the right is *as*



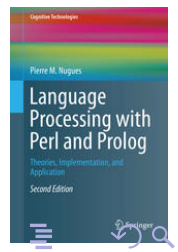
Standard POS Tagsets: The Penn Treebank

1.	CC	Coordinating conjunction	25.	TO	*to*
2.	CD	Cardinal number	26.	UH	Interjection
3.	DT	Determiner	27.	VB	Verb, base form
4.	EX	Existential *there*	28.	VBD	Verb, past tense
5.	FW	Foreign word	29.	VBG	Verb, gerund/present participle
6.	IN	Preposition/sub. conjunction	30.	VBN	Verb, past participle
7.	JJ	Adjective	31.	VBP	Verb, non-third pers. sing. pres.
8	JJR	Adjective, comparative	32.	VBZ	Verb, third-pers. sing. present
9.	JJS	Adjective, superlative	33.	WDT	*wh*-determiner
10.	LS	List item marker	34.	WP	*wh*-pronoun
11.	MD	Modal	35.	WP$	Possessive *wh*-pronoun
12.	NN	Noun, singular or mass	36.	WRB	*wh*-adverb
13.	NNS	Noun, plural	37.	#	Pound sign
14.	NNP	Proper noun, singular	38.	$	Dollar sign
15.	NNPS	Proper noun, plural	39.	.	Sentence final punctuation
16.	PDT	Predeterminer	40.	,	Comma
17.	POS	Possessive ending	41.	:	Colon, semicolon
18.	PRP	Personal pronoun	42.	(	Left bracket character
19.	PRP$	Possessive pronoun	43.	)	Right bracket character
20.	RB	Adverb	44.	"	Straight double quote
21.	RBR	Adverb, comparative	45.	‘	Left open single quote
22.	RBS	Adverb, superlative	46.	“	Left open double quote
23.	RP	Particle	47.	’	Right close single quote
24.	SYM	Symbol	48.	”	Right close double quote



An Example of Tagged Text from the Penn Treebank

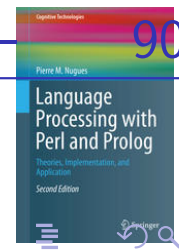
Battle-tested/JJ Japanese/JJ industrial/JJ managers/NNS here/RB always/RB buck/VBP up/RP nervous/JJ newcomers/NNS with/IN the/DT tale/ NN of/IN the/DT first/JJ of/IN their/PP$ countrymen/NNS to/TO visit/VB Mexico/NNP ,/, a/DT boatload/NN of/IN samurai/FW warriors/NNS blown/VBN ashore/RB 375/CD years/NNS ago/RB ./. “/“ From/IN the/DT beginning/NN ,/, it/PRP took/VBD a/DT man/NN with/IN extraordinary/JJ qualities/NNS to/TO succeed/VB in/IN Mexico/NNP ”/” says/VBZ Kimihide/NNP Takimura/NNP ,/, president/NN of/IN the/DT Mitsui/NNP group/NN ’s/POS Kensetsu/NNP Engineering/NNP Inc./NNP unit/NN ./.



Measuring Quality: The Confusion Matrix

From Franz (1996, p. 124)

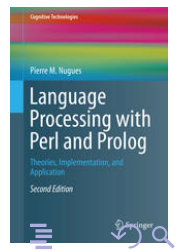
↓Correct	Tagger → DT	IN	JJ	NN	RB	RP	VB	VBD	VBG	VBN
DT	99.4	0.3	–	–	0.3	–	–	–	–	–
IN	0.4	97.5	–	–	1.5	0.5	–	–	–	–
JJ	–	0.1	93.9	1.8	0.9	–	0.1	0.1	0.4	1.5
NN	–	–	2.2	95.5	–	–	0.2	–	0.4	–
RB	0.2	2.4	2.2	0.6	93.2	1.2	–	–	–	–
RP	–	24.7	–	1.1	12.6	61.5	–	–	–	–
VB	–	–	0.3	1.4	–	–	96.0	–	–	0.2
VBD	–	–	0.3	–	–	–	–	94.6	–	4.8
VBG	–	–	2.5	4.4	–	–	–	–	93.0	–
VBN	–	–	4.6	–	–	–	–	4.3	–	90.6



Recognizing Parts of Speech

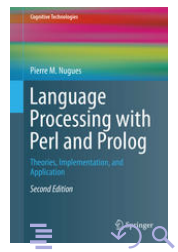
Parts of speech denomination is comparable in Western European languages and roughly corresponds
They follow Donatus' teaching
(`http://htl2.linguist.jussieu.fr:8080/CGL/text.jsp?id=T28`)
If you are not sure, look up in a dictionary
Two common mistakes in the labs:

- Confusion between noun and the Swedish word *namn*.
  - A common noun, or more simply a noun, corresponds to *substantiv*
  - Proper noun, or name, (or proper name) corresponds to *namn* or *egennamn*.
- Possessive pronouns like *my*, *your*, *his*, *her*, ... are not real pronouns. They should be called possessive adjectives or determiners.



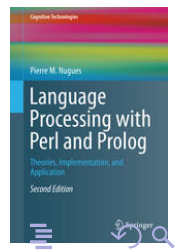
Multext and Google's Universal POS tagset

Part of speech	Multext	Universal POS
Noun	N	Noun
Verb	V	Verb
Adjective	A	Adj
Pronoun	P	Pron
Determiner	D	Det
Adverb	R	Adv
Adposition (Preposition)	S	Adp
Conjunction	C	Conj
Numeral	M	Num
Interjection	I	-
Residual	X	X
Particle	-	Prt
Ponctuation mark	-	.



Attributes for Nouns (Multext)

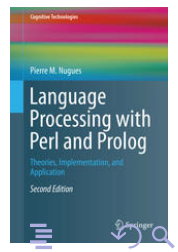
Position	Attribute	Value	Code
1	Type	Common	c
		Proper	p
2	Gender	Masculine	m
		Feminine	f
		Neuter	n
3	Number	Singular	s
		Plural	p
4	Case	Nominative	n
		Genitive	g
		Dative	d
		Accusative	a



Annotation for Swedish: Tokens

Bilen framför justitieministern svängde fram och tillbaka över vägen så att hon blev rädd.
'The car in front of the Justice Minister swung back and forth and she was frightened.'

```
<tokens>
  <token id="1">Bilen</token>
  <token id="2">framför</token>
  <token id="3">justitieministern</token>
  <token id="4">svängde</token>
  <token id="5">fram</token>
  <token id="6">och</token>
  <token id="7">tillbaka</token>
  <token id="8">över</token>
  <token id="9">vägen</token>
  <token id="10">så</token>
  <token id="11">att</token>
  <token id="12">hon</token>
  <token id="13">blev</token>
  <token id="14">rädd</token>
  <token id="15">.</token>
</tokens>
```



Parts of Speech for Swedish

```
<taglemmas>
  <taglemma id="1" tag="nn.utr.sin.def.nom" lemma="bil"/>
  <taglemma id="2" tag="pp" lemma="framför"/>
  <taglemma id="3" tag="nn.utr.sin.def.nom" lemma="justitieminister"
  <taglemma id="4" tag="vb.prt.akt" lemma="svänga"/>
  <taglemma id="5" tag="ab" lemma="fram"/>
  <taglemma id="6" tag="kn" lemma="och"/>
  <taglemma id="7" tag="ab" lemma="tillbaka"/>
  <taglemma id="8" tag="pp" lemma="över"/>
  <taglemma id="9" tag="nn.utr.sin.def.nom" lemma="väg"/>
  <taglemma id="10" tag="ab" lemma="så"/>
  <taglemma id="11" tag="sn" lemma="att"/>
  <taglemma id="12" tag="pn.utr.sin.def.sub" lemma="hon"/>
  <taglemma id="13" tag="vb.prt.akt.kop" lemma="bli"/>
  <taglemma id="14" tag="jj.pos.utr.sin.ind.nom" lemma="rädd"/>
  <taglemma id="15" tag="mad" lemma="."/>
</taglemmas>
```