Regular expressions[1]

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[1] With materials used from "Speech and Language Processing" (2nd ed.), D. Jurafsky and J. H. Martin. 2007.

Introduction

- Course:
  - Victor Kitov
  - Anna Potapenko
  - Murat Apishev
- Lectures+seminars
  - python+scikit-learn+numpy+matplotlib+...
  - linguistic packages: NLTK, pymorphy2, gensim, ...

Recommended materials

- Books:
  - Speech and Language Processing (3rd ed. draft), D. Jurafsky and J. H. Martin.
  - Speech and Language Processing (2nd ed.), D. Jurafsky and J. H. Martin. 2007.
- Video-lectures:
  - D. Jurafsky & C. Manning: Natural Language Processing.
- Resourses:
  - Resource catalog for NLP

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Overview of text mining tasks

- Clustering
  - identify news about the same event
  - identify books on similar subject
- Topic modelling: probabilistic co-clustering of documents and terms.
- Classification
  - classify news into different categories: politics, sports, arts, etc.
  - assign documents to authors
    - are two documents written by the same person?
  - assign documents to genres:
    - survey, scientific article, remark, textbook, etc.

Overview of text mining tasks

- Coreference resolution - identify expressions in a text referring to the same person or thing
  - The **music** was so loud that **it** couldn't be enjoyed.
  - Despite **her** difficulty, **Wilma** came to understand the point.
  - **Carol** told **Bob** to attend the party. **They** arrived together.
  - **Some of our colleagues** are going to be supportive. **These kinds of people** will earn our gratitude.
- Named entity recognition
  - locate and classify named entities in text into pre-defined categories
    - people names, organizations, locations, times, quantities, monetary values, percentages
  - Jim bought 300 shares of Acme Corp. in 2006. ->
  - **[Jim]** *(Person)* bought 300 shares of **[Acme Corp.]** *(Organization)* in **[2006]** *(Time)*.

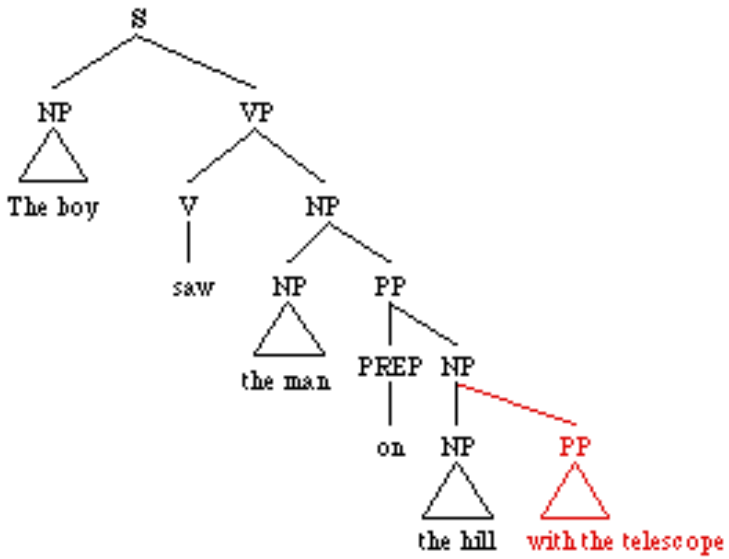
Overview of text mining tasks

- Sentiment analysis (also known as opinion mining) - extract subjective attitudes from the text.
  - classify content into subjective (opinions) and objective (facts).
  - identify overall polarity
    - positive/negative or grade.
    - e.g.: negative movie review, rating 7 out of 10.
  - identify aspects-based attitude
    - extract individual aspects of entity
    - evaluate opinion about each aspect
    - e.g.: some cell phone review => design-excellent, battery-poor, ...
- Part-of-speech tagging

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

Overview of text mining tasks

- Syntactic parsing



- Automatic translation
  - Je ne l'ai pas mangé depuis six jours ->
  - I have not eaten it for six days.

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Regular expressions

- re - python package for working with regular expressions.

Simple match

RE	Example Patterns Matched
/woodchucks/	"interesting links to woodchucks and lemurs"
/a/	"Mary Ann stopped by Mona's"
/!/	"You've left the burglar behind again!" said Nori

- Case sensitive: /Woodchucks/ will not match woodchucks

Match any symbol from set

RE	Match	Example Patterns
/[wW]oodchuck/	Woodchuck or woodchuck	"Woodchuck"
/[abc]/	'a', 'b', *or* 'c'	"In uomini, in soldati"
/[1234567890]/	any digit	"plenty of 7 to 5"

Regular expressions

- match any digit: /[1234567890]/
- match any uppercase letter: /[ABCDEFGHIJKLMNOPQRSTUVWXYZ]/

Shorter ways

RE	Match	Example Patterns Matched
/[A-Z]/	an upper case letter	"we should call it 'Drenched Blossoms' "
/[a-z]/	a lower case letter	"my beans were impatient to be hoed!"
/[0-9]/	a single digit	"Chapter 1: Down the Rabbit Hole"

- range: /b-g/
  - matches b, c, d, e, f, g.

Matching except set of characters

RE	Match (single characters)	Example Patterns Matched
/[^A-Z]/	not an upper case letter	"Oyfn pripetchik"
/[^Ss]/	neither 'S' nor 's'	"I have no exquisite reason for't"
/[^\.]/	not a period	"our resident Djinn"
/[e^]/	either 'e' or '^'	"look up ^ now"
/a^b/	the pattern 'a^b'	"look up a^ b now"

Different number of occurences

p? matches pattern p or empty string.

None or single occurence

RE	Match	Example Patterns Matched
/woodchucks?/	woodchuck or woodchucks	"woodchuck"
/colou?r/	color or colour	"colour"

- p* matches 0 or more occurences of p:
  - [], [p],[pp],[ppp],...
- p+ matches 1 or more occurences:
  - [p],[pp],[ppp],...
- Recognizing sheep language: baa!, baaa!, baaaa!, ...
  - /baaa*!/
- /cat|dog/ will match [...cat...] or [...dog...].

Anchors

^ - start of string

- /^**The**/ - will match «the» only at the start of the string
- [The red brown fox]

$ - end of string

- /.***bushes$**/ - will match «bushes» only at the start of the string
- [Fox jumped into the **bushes**.]

\b matches word boundary

- a word is sequence of letters,digits and underscore
- /\b**the**\b/ matches [in **the** trees]
- /\b**the**\b/ doesn't match [other].

Other

- Special operators:

RE	Expansion	Match	Examples
\d	[0-9]	any digit	Party␣of␣5
\D	[^0-9]	any non-digit	Blue␣moon
\w	[a-zA-Z0-9_]	any alphanumeric/underscore	Daiyu
\W	[^\w]	a non-alphanumeric	!!!!
\s	[␣\r\t\n\f]	whitespace (space, tab)	
\S	[^\s]	Non-whitespace	in␣Concord

Counts to match

RE	Match
*	zero or more occurrences of the previous char or expression
+	one or more occurrences of the previous char or expression
?	exactly zero or one occurrence of the previous char or expression
{n}	*n* occurrences of the previous char or expression
{n,m}	from *n* to *m* occurrences of the previous char or expression
{n,}	at least *n* occurrences of the previous char or expression

Matching reserved symbols

RE	Match	Example Patterns Matched
*	an asterisk "*"	"K*A*P*L*A*N"
\.	a period "."	"Dr. Livingston, I presume"
\?	a question mark	"Why don't they come and lend a hand?"
\n	a newline	
\t	a tab	

Substitutions

- /the (.*)er they were, the \1er they will be/
  - will match «The bigger they were, the bigger they will be»
  - will NOT match «The bigger they were, the faster they will be»

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Collocations

- Collocations are words that too frequently co-appear in text.
- Examples: New York, fast food, vice president, stock exchange, real estate, deja vu...

Collocations extraction: t-test

- t-test for checking co-occurence of $w_i w_j$:
  - define $x = \mathbb{I}[w_i w_j]$
  - $\overline{x} = \frac{\#[w_i w_j]}{N}$, where N is text length
  - test statistic:

$$\frac{\overline{x} - \mu}{\sqrt{s^2/N}} \to Student(N-1) \to Normal(0,1) \text{ for } N \to \infty$$

  - where $\mu = p(w_i)p(w_j) = \frac{\#[w_i]}{N}\frac{\#[w_j]}{N}$ - expected co-occurence, given independence assumption.
  - $s^2 = \overline{x}(1-\overline{x})$ - sample variance.
  - to be a collocation test statistic should be large.

Collocations extraction: PMI

- Pointwise mutual information:

$$PMI(w_i w_j) = \frac{p(w_i w_j)}{p(w_i)p(w_j)}$$

Collocations extraction: χ^2 Person test

χ^2 Pearson test for independence:

$$\begin{aligned} TS &= N\frac{[p(w_i w_j) - p(w_i)p(w_j)]^2}{p(w_i)p(w_j)} + N\frac{[p(w_i \overline{w}_j) - p(w_i)p(\overline{w}_j)]^2}{p(w_i)p(\overline{w}_j)} \\ &+ N\frac{[p(\overline{w}_i w_j) - p(\overline{w}_i)p(w_j)]^2}{p(\overline{w}_i)p(w_j)} + N\frac{[p(\overline{w}_i \overline{w}_j) - p(\overline{w}_i)p(\overline{w}_j)]^2}{p(\overline{w}_i)p(\overline{w}_j)} \end{aligned}$$

$$TS \approx N\frac{[p(w_i w_j) - p(w_i)p(w_j)]^2}{p(w_i)p(w_j)}$$

$$TS \sim \chi^2(1)$$

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Tokenization

- Tokenization: division of text into tokens:
  - Foxes are small-to-medium-sized, omnivorous mammals. Foxes are slightly smaller than a medium-size domestic dog.
  - [Foxes] [are] [small]-[to]-[medium]-[sized], [omnivorous] [mammals]. [Foxes] [are] [slightly] [smaller] [than] [a] [medium]-[size] [domestic] [dog].
- Break dashed words? [medium]-[size] or [medium-size]?
- Count or not punctuation?
  - may reveal emotions - e.g. for sentiment analysis
  - useful for splitting into sentences , phrases=>text understanding.
  - useful for writer identification

Utterance

- Count or not utterance?
  «I do uh main- mainly business data processing»
  - types of utterances:
  - fillers: uh, um, e-mmm
  - fragments: like *[main-]*
  - may reveal emotions - e.g. for sentiment analysis
    - have different meaning, like uh, um.
  - useful in text processing-utterance begin new clause, idea.
  - useful for speaker identification

Stop words, capitalization

- Remove stop words?
  - and or not but,....
  - stop-words are corpus and task dependent
    - e.g. corpus of requests to city mayor - his name will be in all documents.
- Leave capitalization?
  - e.g. convert They->they?
  - capitalization is informative for, e.g., POS-tagging and named entity recognition.
  - for document classification, topic modelling - mostly not important.
  - may loose original meaning, like after US->us.

Standardization

- Standardize words or not?
  - stemming
    - remove variable endings with fixed rules
  - lemmatization
    - replace wordform with lemma
    - using dictionary
    - we look for wrods with

Stemming

- Most popular stemmer - Porter stemmer
- Stemmer as a cascade of determenistic rules, such as:

$$\text{ATIONAL} \rightarrow \text{ATE} \quad \text{(e.g., relational} \rightarrow$$
$$\text{ING} \rightarrow \varepsilon \quad \text{if stem contains vow}$$
$$\text{SSES} \rightarrow \text{SS} \quad \text{(e.g., grasses} \rightarrow \text{gra}$$

Still makes errors of:

- overgeneralization:
  - organization->organ
  - policy->police
- undergeneralization:
  - analysis->analyzes
  - European->Europe

Segmentation

- We can segement not into words, but into larger strings
  - collect phraze statistics
  - detect authorship, plagiate
- Segment into sequences of symbols
  - Man on a roof -> ma, an,n_,_o,on...
  - detect statistics of syllables, identifying language
    - e.g. classify recipes to countries of origin.
    - risotto, spaghetti,

Sentence segmentation

- Sentence segmentation
  - natural unit of analysis for
    - POS tagging, syntactic analysis.
  - [!], [?] unambiguosly identify sentance end
  - [.] - not necessarily:
    - Mr.Johnson travelled to central office of Microsoft Inc. in the U.S.A.
    - we need to build a classifier on segmented corpus.
    - using dictionary of abbreviations may help.