Amirkabir University of Technology
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Natural Language Processing

Lecture 17: Text Preprocessing

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Variations of Corpora

- Language: 7097 languages in the world
- Variety, like African American Language varieties.
  - AAE Twitter posts might include forms like "iont" (I don't)

- Code switching, e.g., Spanish/English, Hindi/English:

  S/E: Por primera vez veo a @username actually being hateful! It was beautiful:)

  [For the first time I get to see @username actually being hateful! it was beautiful:)]

  H/E: dost tha or ra- hega ... dont wory ... but dherya rakhe

  [“he was and will remain a friend ... don’t worry ... but have faith”]

- Genre: newswire, fiction, scientific articles, Wikipedia
- Author Demographics: writer's age, gender, ethnicity, SES

Outline

- **Tokenization**
- Normalization
- Lemmatization
- Stemming
- Stopword Removal

Space-based Tokenization

- A very simple way to tokenize
  - For languages that use space characters between words
    - Arabic, Cyrillic, Greek, Latin, etc., based writing systems
  - Segment off a token between instances of spaces

- Unix tools for space-based tokenization
  - The "tr" command
  - Inspired by Ken Church's UNIX for Poets
  - Given a text file, output the word tokens and their frequencies

More Counting

- Merging upper and lower case

```
tr 'A-Z' 'a-z' < shakes.txt | tr -sc 'A-Za-z' '\n' | sort | uniq -c
```

- Sorting the counts

```
tr 'A-Z' 'a-z' < shakes.txt | tr -sc 'A-Za-z' '\n' | sort | uniq -c | sort -n -r
```

```
  23243 the
  22225 i
  18618 and
  16339 to
  15687 of
  12780 a
  12163 you
  10839 my
  10005 in
   8954 d
```

What happened here?

Issues in Tokenization

- Can't just blindly remove punctuation:
  - m.p.h., Ph.D., AT&T, cap’n
  - prices ($45.55)
  - dates (01/02/06)
  - URLs (http://www.stanford.edu)
  - hashtags (#nlproc)
  - email addresses (someone@cs.colorado.edu)
- Clitic: a word that doesn't stand on its own
  - "are" in we're, French "je" in j'ai, "le" in l'honneur
- When should multiword expressions (MWE) be words?
  - New York, rock ’n’ roll

Tokenization in NLTK

Bird, Loper and Klein (2009), *Natural Language Processing with Python*. O'Reilly

```
>>> text = 'That U.S.A. poster-print costs $12.40...'
>>> pattern = r'''(?x)    # set flag to allow verbose regexps
...     ([A-Z]\.)+        # abbreviations, e.g. U.S.A.
...   | \w+(-\w+)*        # words with optional internal hyphens
...   | \$?\d+(\.\d+)?%?  # currency and percentages, e.g. $12.40, 82%
...   | \.\.\.            # ellipsis
...   | [][.,;"'?():-_`]  # these are separate tokens; includes ], [
... '''
>>> nltk.regexp_tokenize(text, pattern)
['That', 'U.S.A.', 'poster-print', 'costs', '$12.40', '...']
```

Tokenization in Languages without Spaces

- Many languages (like Chinese, Japanese, Thai) don't use spaces to separate words!

- How do we decide where the token boundaries should be?

How to do word tokenization in Chinese?

姚明进入总决赛 “Yao Ming reaches the finals”

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姚明进入总决赛 “Yao Ming reaches the finals”

- 3 words?

姚明　　进入　　总决赛

YaoMing reaches finals

How to do word tokenization in Chinese?

姚明进入总决赛 “Yao Ming reaches the finals”

- 3 words?

姚明　　进入　　总决赛
YaoMing reaches finals

- 5 words?

姚　　明　　进入　　总　　决赛
Yao　Ming　reaches　overall　finals

- 7 characters? (don't use words at all):

姚　明　　进　　入　　总　　决　　赛
Yao Ming enter enter overall decision game

Sentence Segmentation

- !, ? mostly unambiguous but **period** "." is very ambiguous
  - Sentence boundary
  - Abbreviations like Inc. or Dr.
  - Numbers like .02% or 4.3

- Common algorithm: Tokenize first: use rules or ML to classify a period as either (a) part of the word or (b) a sentence-boundary.
  - An abbreviation dictionary can help

- Sentence segmentation can then often be done by rules based on this tokenization.

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Word Normalization

- Putting words/tokens in a standard format
  - U.S.A. or USA
  - uhhuh or uh-huh
  - Fed or fed
  - am, is, be, are

Case Folding

- Applications like IR: reduce all letters to lower case
  - Since users tend to use lower case
  - Possible exception: upper case in mid-sentence?
    - e.g., ***General Motors***
    - ***Fed*** vs. ***fed***
    - ***SAIL*** vs. ***sail***

- For sentiment analysis, MT, Information extraction
  - Case is helpful (***US*** versus ***us*** is important)

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Lemmatization

- Represent all words as their lemma, their shared root
  = dictionary headword form:
  - *am, are, is* → *be*
  - *car, cars, car's, cars'* → *car*
  - Spanish quiero (‘I want’), quieres (‘you want’)

    → querer ‘want'
  - *He is reading detective stories*

    → *He be read detective story*

Lemmatization is done by Morphological Parsing

- Morphemes:
  - The small meaningful units that make up words
  - **Stems**: The core meaning-bearing units
  - **Affixes**: Parts that adhere to stems, often with grammatical functions

- Morphological Parsers:
  - Parse *cats* into two morphemes *cat* and *s*
  - Parse Spanish *amaren* ('if in the future they would love') into morpheme *amar* 'to love', and the morphological features *3PL* and *future subjunctive*.

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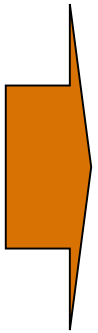
Stemming

- Reduce terms to stems, chopping off affixes crudely

This was not the map we found in Billy Bones's chest, but an accurate copy, complete in all things-names and heights and soundings-with the single exception of the red crosses and the written notes.



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Porter Stemmer

- Based on a series of rewrite rules run in series
  - A cascade, in which output of each pass fed to next pass
- Some sample rules:

$$\begin{aligned} \text{ATIONAL} &\rightarrow \text{ATE} \quad \text{(e.g., relational} \rightarrow \text{relate)} \\ \text{ING} &\rightarrow \epsilon \quad \text{if stem contains vowel (e.g., motoring} \rightarrow \text{motor)} \\ \text{SSES} &\rightarrow \text{SS} \quad \text{(e.g., grasses} \rightarrow \text{grass)} \end{aligned}$$

Dealing with complex morphology

- Dealing with complex morphology is necessary for many languages
- e.g., the Turkish word:
  - Uygarlastiramadiklarimizdanmissinizcasina
  - `(behaving) as if you are among those whom we could not civilize'
  - Uygar `civilized' + las `become'
    + tir `cause' + ama `not able'
    + dik `past' + lar 'plural'
    + imiz 'p1pl' + dan 'abl'
    + mis 'past' + siniz '2pl' + casina 'as if'

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Stopwords

- Many of the most frequently used words in English are likely to be useless for text mining
- These words are called *Stopwords*
  - Examples: the, of, and, to, an, is, that, …
  - Typically text contains about 400 to 500 such words
  - For an application, an additional domain specific stopwords list may be constructed

Stopword Removal

- Why should we remove stopwords?
  - Reduce data set size
  - Stopwords account for 20-30% of total word count
  - Improve effectivity of text mining methods
  - Stopwords may confuse the mining algorithm

- Challenges
  - *to be or not to be*

Further Reading

- Speech and Language Processing (3rd ed. draft)
  - Chapter 2