

# HG2052

## Language, Technology and the Internet

### Lang Identification/Normalization

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Lecture 9

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# Language Identification

# What is Language Identification?

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- Given a document and a list of possible languages, in what language was the document written? (e.g. English, German, Japanese, Uyghur, ...)
- Orthography? (i.e., does the language have an agreed written form?)
- A solved problem?

## An Example

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What is the language of the following document:

*Seperti diberitakan, Selasa, Megawati optimistis memenangi sengketa pilpres. Sementara itu, Yudhoyono dalam ceramah di kediamannya di Cikeas, Senin malam, menyatakan, tuduhan kecurangan merupakan pencemaran nama baik.*

## A Second Example

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What is the language of the following document:

*Revolution is à la mode at the moment in the country, where the joie de vivre of the citizens was once again plunged into chaos after a third coup d'état in as many years. Although the leading general is by no means an enfant terrible per se, the fledgling economy still stands to be jettisoned down la poubelle.*

## Another Example

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What is the language of the following document:

*Så sitter du åter på handlar'ns trapp och gråter så övergivet.*

## Yet Another Example

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What is the language of the following document:

*Nag hmo kuv mus tom khw.*

## A Harder Example

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What is the language of the following document:

```
11100000101110111001000011110000010111  
0111001010001110000010111011100100110
```



# Why do we want Language Identification?

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- There's more than English out there!
  - circa 2002,  $> 30\%$  of the Web was not in English, a number which is continuously growing
  - only  $\sim 6\%$  of world's population are native English speakers
  - $< 30\%$  of world's population are competent in English
  - Non-Anglophone communities are rapidly becoming connected

# Why Language Identification?

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- Language identification provides us with the means to automatically “discover” web data to convert into a corpus over which to learn linguistic (lexical) properties
- Also research on:
  - mining interlinear text (e.g. ODIN)
  - cleaning web text (e.g. CLEANVAL)

# Basic Approaches

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- Linguistically-grounded methods
- Similarity-based categorisation and classification
- Feature-based and kernel-based methods

# Don't Websites Declare the Language and Encoding?

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- These are frequently:
  - not there
  - wrong (e.g. S-JIS, EUC-JP, UTF-8)
- Remember: users are competent “scrollers”, but “above the fold” real estate still a premium

# Early Attempts: Diacritics

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- Intuition: a language has a certain set of “special characters”
- e.g. French vs. English:
  - Once we see one of à, é, ô... we know the document is in French
  - Unless we're talking about a résumé, or a prêt-à-porter fashion show, or...
- Choose a set of “special characters” for each language, and search the document for them
- Advantages:
  - cheap analysis: characters appear, or not
- Disadvantages:
  - overlapping diacritic sets
  - short documents may not contain diacritics
  - only sensible for European languages
  - assumes we know the document encoding

# Early Attempts: Discriminating Character $n$ -grams

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- Intuition: certain languages have certain strings which only/frequently occur in that language
  - English: “ery ”
  - French: “eux ”
  - Italian: “cchi”
  - Serbo-Croat: “lj”
- But note, *zucchini*, *killjoy*...
- Advantages:
  - cheap analysis: sequence appears, or not
- Disadvantages:
  - sequences may occur in multiple languages
  - short documents may not contain given sequence
  - only sensible for alphabet languages

# Early Attempts: Stop Word Lists

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- Intuition: common words in one language do not occur in another language (e.g., Johnson, 1993)
  - List stop words, e.g.
    - \* English: *the, a, of, in, by, for*...
    - \* French: *le, la, les, de, un, une, à, en*...
    - \* German: *ein, das, der, die, in, im*...
  - Document has stop words from one language
- Advantages:
  - cheap analysis: words in document  $\times$  words in list
- Disadvantages:
  - overlap of stop word sets
  - short documents may not contain stop words
  - only sensible for European languages (?)

# Statistical Language ID

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- Intuition: **Distribution** of character  $n$ -grams is constant across documents in the same language
- Variety of methods:
  - Compare  $n$ -gram ranking
  - Compare Bayesian probability of distribution
  - Compare entropy of distribution
- Advantages:
  - language model is independent (?) of document
- Disadvantages:
  - potentially much training data is required
  - classification can be slow
  - domain effects
  - encoding issues make task absurd (or very easy!)



## One Example: $n$ -gram Ranking

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- For each language in the classification (training) set:
  - Find the frequency of all 1-grams ( $A, B, C, \dots$ ), 2-grams ( $AA, AB, AC, \dots BA, BB, BC, \dots$ , etc.) in the training data
  - Rank each  $n$ -gram from most frequent to least frequent (resolve ties)

- 
- To classify a document (test set):
    - Find the frequency of all 1-grams, 2-grams, etc. in the document
    - Rank each  $n$ -gram from most frequent to least frequent
    - For each  $n$ -gram in the test document:
      - \* Calculate the “out-of-place” distance between the rank in the test document and the rank in the training language
      - \* Include (pre-computed) “out-of-range” rank for  $n$ -grams not found in training set
    - Sum the distances for each  $n$ -gram to a given language to estimate a “language distance”
    - Predict the language that has the least distance to the test document (resolve ties)

# *N*-gram Ranking: Example

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- Training data (1-grams only):
  - English:  $\_ , e , t , o , n , i \dots$
  - Welsh:  $\_ , a , d , y , e , n \dots$
  - Vietnamese:  $\_ , n , h , t , i , c \dots$
  
- Test document: *knowing, having, going*
  - $g(1) , n(2) \times 4$
  - $i(3) \times 3$
  - $\_(4) , o(5) \times 2$
  - $\dots$

---

➤ English:

➤  $|1 - 7| + |2 - 5| + |3 - 6| + |4 - 1| + |5 - 4|$

➤  $= 16$

➤ Welsh:

➤  $|1 - 7| + |2 - 6| + |3 - 7| + |4 - 1| + |5 - 7|$

➤  $= 19$

➤ Vietnamese:

➤  $|1 - 7| + |2 - 2| + |3 - 5| + |4 - 1| + |5 - 7|$

➤  $= 13$

➤ → Vietnamese! ...hmm...

## Feature-based methods

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(Semi-)automatically construct a list of discriminating features (c.f. linguistically grounded methods)

- Monte Carlo sampling of distribution features
- Document similarity using information measures
- Kernel methods

Top performers, but require a level of statistical proficiency beyond this subject!

# Encoding Detection

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- Intuition: the encoding of a document determines its language
  - If the document is encoded in S-JIS, it is in Japanese
  - GJK → Chinese
  - ISO 8859-1 → ???
- One-document, one-encoding much better than one-document, one-language
- Advantages
  - deals with a wide set of languages
  - often need to know encoding anyway
  - relatively small number of encodings (~100?)
- Disadvantages
  - encoding often does not uniquely identify language
  - especially with Unicode

## So, how do they do?

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- Most methods report  $\sim 100\%$  accuracy (or precision/recall)
- A solved problem?

# What's the Problem?

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- Diverse training/test/classification sets between reported results:
- Classification sets contain as few as three languages
  - There are many more languages to be dealt with
  - Obfuscatory impact of many languages is unclear
- Training data can be  $> 1\text{MB}$ 
  - May not be able to find 1MB of training data for many languages
  - Restricts some algorithms to common languages
- Test string can be  $> 10\text{KB}$ 
  - Documents may be **much** smaller than 10KB
  - Impact of performance on small test samples is unclear



# Open Issues

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- How well do existing techniques support language identification for languages which form the bulk of the more than 7000 languages identified in the Ethnologue?

- Can we treat LangID as an open-class classification problem?

$$\arg \max_{c \in C} lm(c, D) \text{ vs. } \arg \max_{c \in C \cup C'} lm(c, D)$$

- What is the performance of the variety of LangID systems in environments where the amount of gold standard data for training is small (e.g. 50/100/250 words or 50/100/250 characters)?

- Can we move away from a one-to-one view of LangID to a one-to-many view?

- finer granularity (e.g. sentence, paragraph, section)
- in quantitative terms (e.g. a document is 95% English, 3% French and 2% Italian)

- Can we move away from accuracy/precision-style evaluation criteria to produce something more representative of reality?

- 
- gradated judgements for source language
  - gradated judgements for resource type
  - possibly micro-level markup of the location of different languages in the document

# Summary

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- What is language identification?
- Why is language identification important?
- What issues arise in language identification?
- What methods are used?
- Why isn't language identification a solved problem?

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# Language Normalization

# How You See the Web

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**Korp's lover planned 'murder pack', court told**

 [Jesse Hogan 5:39pm] Tania Herman allegedly compiled a list of items in preparation for the attempted murder of Maria Korp. [more](#)

♦ Herman confessed to me: brother

**New laws outlaw bride trafficking**

[4:50pm] Tough new laws could see people who traffic young Australian girls overseas for forced marriages jailed for up to 25 years. [more](#)

**Qantas staff to testify in Corby case**

[6:52pm] Two Qantas employees arrive in Bali to testify at Schapelle Corby's reopened trial tomorrow. [more](#)

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 [7:18pm] Saddam Hussein's legal team boycott proceedings until a man they say attacked him at a hearing is brought to justice. [more](#)

**ADF's top lawyer has Hicks commission in sights**

[6:09pm] The Australian Defence Force's chief lawyer expresses concerns about the US military commission set up to try David Hicks. [more](#)

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 NASA plans to send an astronaut out to repair the shuttle.

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Korp's lover planned 'murder pack', court told

Tania Herman [Jesse Hogan 5:39pm] Tania Herman allegedly compiled a list of items in preparation for the attempted murder of Maria Korp. more
* Herman confessed to me: brother

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* Terrorist trials: Vote now

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* Bush appoints Bolton to UN
* US teens caught with dismembered body
-- press space for next page --
Arrow keys: Up and Down to move. Right to follow a link; Left to go back.
H)elp O)ptions P)rint G)o M)ain screen Q)uit /=search [delete]=history list
```

# Document Types and Parsing

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- Documents come in an ever-increasing range of formats (HTML, PDF, PS, MSWord, Excel, ...)
  - need for robust means to detect document type (resilient to faulty MIME type, metadata, etc)
- Need to be able to extract out basic “semantic” content into common format (text) to index/carry out pre-processing over
- Need to be able to identify the source language(s) of a given document, and its character encoding

# Metadata

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- Most document types contain metadata of some description:

```
<head>
  <title>CSLI LinGO Lab</title>
  <META HTTP-EQUIV="Content-Type" CONTENT="text/html; charset=iso-8859-1">
  <meta http-equiv="Content-Style-Type" content="text/css">
  <meta name="keywords" content="linguistic grammars online,
  LinGO, computational linguistics,
  head-driven phrase structure grammar, hpsg, natural language processing,
  parsing, generation, augmentative and alternative communication, aac,
  LinGO Redwoods, multiword expressions, MWE, grammar matrix">
  <meta name="description" content="This page provides information about
  the CSLI Linguistic Grammars Online (LinGO) Lab at Stanford
  University.">
```

- Should we also extract out this data, or is metadata too unreliable to consider using?



# What is Our Document “Unit”?

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- What is the appropriate granularity of document “unit”:
  - an email message?
  - an email message with attachments?
  - an email message with a zip attachment containing multiple documents?
  - an HTML document containing multiple languages?
  - multiple HTML documents encapsulated in frames?
  - a single post in a web user forum “thread”?
  - a single page in a web user forum “thread”?
  - a multi-page web user forum “thread”?

# Tokenisation

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➤ **Tokens** are the atomic text elements that we wish to index and use as our units in pre-processing

➤ **Tokenisation** is the process of converting a text into tokens, e.g.:

Tim Berners-Lee's ad hoc pre-processing policy from '92

↓

Tim Berners Lee ad-hoc preprocessing policy from 92

➤ It is vital that we are **consistent** in tokenising all documents and queries equivalently (why?)

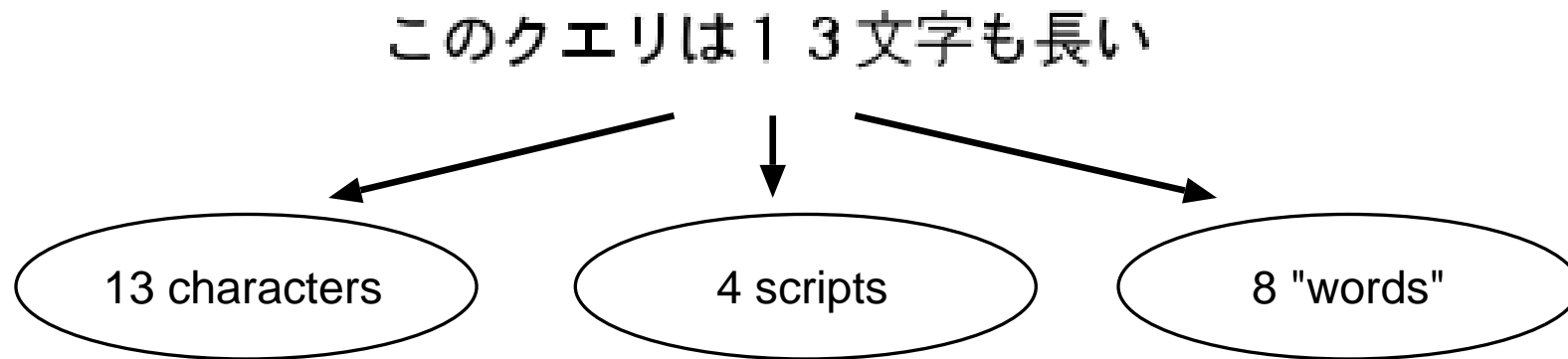
# Issues in English Tokenisation

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- Hyphenation
  - Berners-Lee = one token or two (Berners Lee)
  - tradeoff vs. trade-off vs. trade off
- Possessives (Berners-Lee's = Berners-Lee?)
- Multiword units (Tailem Bend = Tailem-Bend?)
- The document context will often aid us in making these decisions, but we don't have this luxury with queries AND we need to have a consistent policy for all documents and queries

# Tokenisation in Non-segmenting Languages

- What is a “word” in a language such as Thai, Japanese or Chinese?



- How to deal with segmentation ambiguity?

東京都に住んでいます。

ไปทานเหล้า

東京都 = 東京都 *higashi kyoutou* “East Kyoto”  
or 東京 都 *toukyou-to* “Tokyo city”

# Granularity of Tokenisation

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- What is the appropriate granularity to index over:
  - sub-characters??
  - characters/character  $n$ -grams? (not as silly as it sounds)
  - words/word  $n$ -grams (phrases)?
  - some combination of all of these?
- Is it possible to come up with a policy which can be applied consistently across languages (which co-exist within a single “locale”)?:
  - `raison d'être` = `raison detre`?
  - `resume` = `résumé`?

# Token Normalisation

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- Tokens are generally further normalised by:
  - normalising numbers, character case, punctuation, etc.
  - eliminating “stopwords”
  - stemming/lemmatisation
  - expanding the token set with synonyms, homonyms, etc.

# Number Normalisation

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## ➤ Dates

7/10/2006 vs. 10/7/2006 vs. Oct 7, 2006 ...  
2000AD vs 1421 AH vs 2543 (Buddhist) vs Heisei 12 ...

## ➤ Amounts

\$700K vs \$700,000 vs 0.7 million dollars vs ...  
128.250.37.80 vs. www.cs.mu.oz.au vs. www

## ➤ Often indexed as metadata, separate to text tokens

## ➤ Occurrences of left-to-right text (e.g. dollar amounts) in right-to-left languages like Hebrew and Arabic

# Normalising Case and Punctuation

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- The general policy is to reduce all letters to lower case, although this is not always a good idea:
  - SAP vs. sap
  - MoD vs. mod vs. MOD
  - Cardinal Sin vs. cardinal sin
- Punctuation normalisation must be carried out in a language specific fashion in order to accommodate the idiosyncracies of different languages/domains (e.g. x.id vs. xid)
- Punctuation indicating sentence boundaries generally ignored



# Stop Words

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- **Stop word** = word which tends to occur with high frequency across all documents and is semantically bleached or promiscuous

English stop words: of, the, a, to, not, and, or, ...

- The general policy for classification is to strip all stop words from documents

to be or not to be → be

- Stop word lists specific to individual languages (complications with short queries)
- Removing stop words has the spinoff advantage of (moderate) index compression

## Discussion

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- How might you go about (semi-)automatically identifying stop words in a novel language/domain?

# Stemming/lemmatisation

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- Basic flavours of word **morphology**:
  - **inflectional morphology**: word-class preserving alternations in word form for a given lexeme (cf. *I am, you are, she is, it can be*)
  - **derivational morphology**: description of the process by which a given lexeme is derived from a second lexeme, generally from a different word class (e.g. *a+symmetry+ic → asymmetric, act+ive+ist → activist*)
- **Stemming** is the process of stripping away affixes to leave the **stem** of the word (often a nonce-word, e.g. *producer → produc*)

- 
- **Lemmatisation** is the process of recovering the base lexeme of a given word (e.g. *dogs are mammals* → *dog be mammal*)
  - Obvious “benefits” of stemming and lemmatisation in normalisation:
    - index compression
    - removal of superficial divergences in word form
    - particularly salient when working with languages with rich morphology (e.g. Turkish, Spanish, Inuit)
  - Some controversy over whether stemming/lemmatisation hurts or helps in web mining applications; greatest impact over short documents

# Porter Stemmer

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- Most popular English stemmer currently in use, based on **suffix** stripping only

- Implemented as cascaded set of rewrite rules, e.g.:

`sses → ss`

`ies → i`

`ational → ate`

`tional → tion`

- Optionally constrain the algorithm to produce a dictionary-listed stem at each step
- See [www.tartarus.org/~martin/PorterStemmer/](http://www.tartarus.org/~martin/PorterStemmer/) for an implementation in your programming language of choice

# Decompounding

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- In European languages such as German, Dutch and Swedish, compound words are generally single words (e.g. *solar cell* = *zonnecel*; cf. *bath tub*)
- **Decompounding** is the process of splitting a compound word (esp. noun) up into its component tokens (e.g. *zonnecel* → *zon cel*)
  - generally performed recursively, by way of searching for a concatenation of words which can compound (note: not simply a question of segmentation)
- Decompounding has been shown to have considerable impact in web search applications

# Backwards Transliteration

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- Languages such as Japanese and Chinese borrow heavily from languages such as English (e.g. names, technical terminology) through the process of **transliteration** (e.g. *computer* → *konpyūta*)
- Due to lack of normalisation of the transliteration process, there are commonly multiple transliteration alternatives for a given word (e.g. *konpyūta* vs. *konpyūtā*; *bodī* vs. *badī*)
- Possibilities for normalisation by mapping transliterated words back onto their source language equivalents (**back transliteration**)

# Expansion

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- Expansion involves abstracting away from a text by way of synonyms and/or homonyms, usually in the form of hand-constructed equivalences:
  - *car* = *automobile*
  - *normalisation* = *normalization*
  - *your* = *you're*
- In practice, this often takes the form of cross-indexing, in indexing any document containing *car* as also containing *automobile*, and vice versa



# Summary

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- What is tokenisation, and why is it important?
- What complications are there when tokenising over non-segmenting languages?
- What forms of token normalisation are commonly employed over English?
- What is stemming/lemmatisation?
- What other forms of token normalisation are there for non-English languages?
- Do you think the gain from normalisation outweighs the noise introduced?

# Acknowledgments

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- Many slides from Tim Baldwin's *Web as Data* (Melbourne University 433-352)
- Excellent introduction to Information Retrieval, including web searching: Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, *Introduction to Information Retrieval*, Cambridge University Press. 2008.  
<http://nlp.stanford.edu/IR-book/information-retrieval-book.html>  
*Determining the vocabulary of terms* deals with tokenization/normalization