Day 2: Textual Data, Sampling, and Working with Texts

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Essex Summer School 2012

July 10, 2012
Some key basic concepts

(text) corpus a large and structured set of texts for analysis

word frequency refers to the number of times that words occur in a text or in a corpus of texts

concordance a(n alphabetical) list of the principal words used in a text, with their immediate contexts

lemmas the base form of a word that has the same meaning even when different suffixes (or prefixes) are attached.
<table>
<thead>
<tr>
<th><strong>“key” words</strong></th>
<th>Words selected because of special attributes, meanings, or rates of occurrence</th>
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</thead>
<tbody>
<tr>
<td><strong>stop words</strong></td>
<td>Words that are designated for exclusion from any analysis of a text</td>
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<tr>
<td><strong>readability</strong></td>
<td>provides estimates of the readability of a text based on word length, syllable length, etc.</td>
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<tr>
<td><strong>complexity</strong></td>
<td>A word is considered “complex” if it contains three syllables or more</td>
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</table>
Word frequency as an indicator of substantive content

- Individual word usage tends to be associated with a particular degree of affect, position, etc. without regard to context of word usage
- Atomic words have been found to be far more informative than $n$-grams in this regard (Benoit and Laver 2003, Midwest paper)
- Some approaches focus on occurrence of a word as a binary variable, irrespective of frequency: a binary outcome (e.g. Hopkins and King 2008)
- Other approaches use frequencies: Poisson, multinomial, and related distributions (e.g. Laver, Benoit and Garry 2003)
Word frequency: Zipf’s Law

- Zipf’s law: Given some corpus of natural language utterances, the frequency of any word is inversely proportional to its rank in the frequency table.

- The simplest case of Zipf’s law is a “1/f function”. Given a set of Zipfian distributed frequencies, sorted from most common to least common, the second most common frequency will occur 1/2 as often as the first. The third most common frequency will occur 1/3 as often as the first. The \( n \)th most common frequency will occur 1/\( n \) as often as the first.

- In the English language, the probability of encountering the most common word is given roughly by \( P(r) = 0.1/r \) for up to 1000 or so.

- The assumption is that words and phrases mentioned most often are those reflecting important concerns in every communication.
Word frequency: Zipf’s Law

- Formulaically: if a word occurs \( f \) times and has a rank \( r \) in a list of frequencies, then for all words \( f = \frac{a}{r^b} \) where \( a \) and \( b \) are constants and \( b \) is close to 1.

- So if we log both sides, \( \log(f) = \log(a) - b \log(r) \).

- If we plot \( \log(f) \) against \( \log(r) \) then we should see a straight line with a slope of approximately -1.

[Graph of log10 frequency vs. log10 rank with the equation \( y = -0.9853x + 3.6789 \) and \( R^2 = 0.9902 \).]
Some approaches trim low-frequency words or words that are non-discriminating among texts.

Frequently this is based on a measure of word frequency known as tf-idf: term frequency-inverse document frequency.

Rationale behind filtering out words based on frequency:

- **Substantive:** Non-discriminating words (articles, conjunctions, pronouns, etc.) are non-informative.
- **Practical:** Non-discriminating words may strain computational abilities of particular statistical or computational techniques, esp. those requiring word frequency matrix analysis.
- **Substantive:** Low-frequency words may simply not be worth bothering about.
Word concordances on popular web sites

- Amazon word statistics example http://www.amazon.com/Innovative-Comparative-Methods-Policy-Analysis/dp/0387288287/ref=sr_1_1?ie=UTF8&s=books&qid=1249293340&sr=8-1

Computation of tf-idf

- $tf_{i,j} = \frac{n_{i,j}}{\sum_k n_{k,j}}$
  where $n_{i,j}$ is number of occurrences of term $t_i$ in document $d_j$, $k$ is total number of terms in document $d_j$

- $idf_i = \ln \frac{|D|}{|\{d_j : t_i \in d_j\}|}$
  where
  - $|D|$ is the total number of documents in the set
  - $|\{d_j : t_i \in d_j\}|$ is the number of documents where the term $t_i$ appears (i.e. $n_{i,j} \neq 0$)

- $tf-idf_i = tf_{i,j} \cdot idf_i$
Computation of tf-idf: Example

Example: We have 100 political party manifestos, each with 1000 words. The first document contains 16 instances of the word “environment”; 40 of the manifestos contain the word “environment”.

- The term frequency is $\frac{16}{1000} = 0.016$
- The document frequency is $\frac{100}{40} = 2.5$, or $\ln(2.5) = 0.916$
- The tf-idf will then be $0.016 \times 0.916 = 0.0147$
- If the word had only appeared in 15 of the 100 manifestos, then the tf-idf would be $0.016 \times 0.916 = 0.0147$ (three times higher).
- A high weight in tf-idf is reached by a high term frequency (in the given document) and a low document frequency of the term in the whole collection of documents; hence the weights hence tend to filter out common terms.
Strategies for selecting units of textual analysis

- Words
- $n$-word sequences
- Pages
- Paragraphs
- Themes
- Natural units (a speech, a poem, a manifesto)
- Key: depends on the research design
Sample v. “population”

- Basic Idea: Observed text is a stochastic realization
- Systematic features shape most of observed verbal content
- Non-systematic, random features also shape verbal content

$\mu$: “True” preferences of author
Unobservable and uncertain

$\pi$: Intended message of author given $\mu$ and $M$
Unobservable and uncertain

$T$: Stochastic process of text generation

$M$: Strategic model of politics

$\tau$: Text generated by author given $\pi$ and $T$
Observable and certain
Sampling strategies for selecting texts

- Difference between a sample and a population
- May not be feasible to perform any sampling
- May not be necessary to perform any sampling
- Be wary of sampling that is a feature of the social system: “social bookkeeping”
- Different types of sampling vary from random to purposive
  - random sampling
  - non-random sampling
- Key is to make sure that what is being analyzed is a valid representation of the phenomenon as a whole – a question of research design
Random versus “Constructed” Sampling

- Based on a study by Riffe, Aust and Lacy (1993), who compared sampling from newspaper articles randomly versus “constructed”
- Either randomly sample 7 consecutive days, or between 2–4 consecutive weeks, and compare to “known” quantities
- Study showed that constructed sampling is much more efficient
- Why? Because cyclic variation in newspaper content occurs according to the day of the week – not every day contains equal proportions of different content
Word frequency examples

- Variations use vocabulary diversity analysis (e.g. Labbé et al. 2004)

![Graph showing evolution of vocabulary diversity in General de Gaulle's broadcast speeches (June 1958–April 1969).]

Fig. 8. Evolution of vocabulary diversity in General de Gaulle’s broadcast speeches (June 1958–April 1969).
Word length (defined as number of syllables) can be indicative of genre, if not necessarily authorship (Kelih et. al. 2004)
Practical issues working with texts

File formats  How the electronic text is formatted
Conversion  Converting files from one format to another
Pre-analysis text processing  ▶ Lemmatization refers to the algorithmic process of converting words to their lemma forms.
stemming  the process for reducing inflected (or sometimes derived) words to their stem, base or root form. Different from lemmatization in that stemmers operate on single words without knowledge of the context.
▶ reducing infrequent words
▶ “stop lists” for most frequent words
"Stop" words

as, able, about, above, according, accordingly, across, actually, after, afterwards, again, against, aint, all, allow, allows, almost, alone, along, already, also, although, always, am, among, amongst, an, and, another, any, anybody, anyhow, anyone, anything, anyway, anyways, anywhere, apart, appear, appreciate, appropriate, are, aren't, around, as, aside, ask, asking, associated, at, available, away, awfully, be, became, because, become, becomes, becoming, been, before, beforehand, behind, being, believe, below, beside, besides, best, better, between, beyond, both, brief, but, by, cmon, cs, came, can, cant, cannot, cant, cause, causes, certain, certainly, changes, clearly, co, com, come, comes, concerning, consequently, consider, considering, contain, containing, contains, corresponding, could, couldn't, course, currently, definitely, described, despite, did, didnt, different, do, does, doesnt, doing, dont, done, down, downwards, during, each, edu, eg, eight, either, else, elsewhere, enough, entirely, especially, et, etc, even, ever, everything, everywhere, ex, exactly, example, except, far, few, fifth, first, five, followed, following, follows, for, former, formerly, forth, four, from, further, furthermore, get, gets, getting, given, gives, go, goes, going, gone, got, gotten, greetings, had, hadnt, happens, hardly, has, hasnt, have, havent, having, he, hes, hello, help, hence, her, heres, hereafter, hereby, herein, hereupon, hers, herself, hi, him, himself, his, hither, hopefully, how, howbeit, however, id, ill, im, ive, ie, if, ignored, immediate, in, inasmuch, inc, indeed, indicate, indicated, indicates, inner, insofar, instead, into, inward, is, isnt, it, itd, itll, its, its, itself, just, keep, keeps, kept, know, knows, known, last, lately, later, latter, latterly, least, less, lest, let, lets, like, liked, likely, little, look, looking, looks, ltd, mainly, many, may, maybe, me, mean, meanwhile, merely, might, more, moreover, most, mostly, much, must, my, myself, name, namely, nd, near, nearly, necessary, need, needs, neither, never, nevertheless, new, next, nine, no, nobody, non, none, noone, nor, normally, not, nothing, novel, now, nowhere, obviously, of, off, often, oh, ok, okay, old, on, once, one, ones, only, onto, or, other, others, otherwise, ought, our, ours, ourselves, out, outside, over, overall, own, particular, particularly, per, perhaps, placed, please, plus, possible, presumably, probably, provides, que, quite, qv, rather, rd, re, really, reasonably, regarding, regardless, regards, relatively, respectively, right, said, same, saw, say, saying, says, second, secondly, see, seeing, seem, seemed, seeming, seems, seen, self, selves, sensible, sent, serious, seriously, seven, several, shall, she, should, shouldnt, since, six, so, some, somebody, someone, something, sometime, sometimes, somewhat, somewhere, soon, sor…
Practical issues working with texts

Dataset generation  How to convert text files into “datasets”
MaxQDA/Wordstat take care of this step for us, along with stemming etc.

“Collocations”: bigrams, or trigrams e.g. capital gains tax
Software preview

- QDAMiner/Wordstat
- MaxQDA
- Jfreq
- Yoshikoder
- Stata and Wordscores library
- R and austin library
- Other programs