Corpus Linguistics (L415/L615)
Statistics for Corpus Linguistics

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Statistics for Corpus Linguistics

We will more or less follow the presentation in Gries (2009) ... with some pointers from Stephanie Dickinson

▶ Point of emphasis: learning to quantitatively think about one’s data

General breakdown at looking at distributional data:

▶ Frequencies of occurrence of linguistic elements
  ▶ Frequency lists
  ▶ Dispersion statistics
▶ Frequencies of co-occurrence (cf. collocations)

We’ll also break things down into:

▶ Descriptive statistics
▶ Inferential statistics: evaluate data from significance perspective
Observed frequencies

**Observed absolute frequencies:** basic counts

- e.g., in spoken part of ICE-GB, *give* occurs 297 times, *bring* occurs 128 times
- e.g., in written part of ICE-GB, *give* occurs 144 times, *bring* occurs 69 times

Sometimes logarithms are taken, to create a linear distribution

**Observed relative frequencies:** adjust for size of corpora, e.g., frequencies per 1,000,000 words:

- Spoken: 637,682 words, Written: 423,581 words
- *give*: 465.75 words/million (spoken), 339.96 words/million (written)
- *bring*: 200.73 words/million (spoken), 162.90 words/million (written)
Proportions & Relative frequency ratio

**Proportions** (relative frequencies) are often used for hypothesis testing.

**Relative frequency ratio**: the quotient of the relative frequencies of a word in two corpora, e.g.:

- *source* appears 14 times in Perl corpus of 6,065 words
- *source* appears 1 times in Python corpus of 5,596 words

Proportions: \[ \frac{14}{6065} = 0.00231 \] and \[ \frac{1}{5596} = 0.000179 \]

Relative frequency ratio: \[ \frac{14}{6065} \div \frac{1}{5596} = 12.92 \]
Entrop
Zero frequencies

Problem: zero frequencies for things which may be possible

- Smoothing/discounting techniques can adjust for this, e.g., Good-Turing smoothing
Consider the following 3-part “corpus”:

q w w e e e r | q r r t t t t | q y y y y y y

Overall relative frequency of y: 28.57% (6/21)

- Range from 0% to 85.71%
- q: relative frequency is 14.29% across all subcorpora

One can measure degree of **dispersion** ($DP_{norm}$)

- Reporting standard deviations can also help
Co-occurrence

We have already talked about collocations, so we’ll just mention a few pointers for consideration:

▶ Use type frequencies in addition to token frequencies?
▶ Use a window-based approach?
▶ Use collocations of more than two words?
▶ Use discontinuous $n$-grams?
Q: How to compare the relationship between two variables?

- Examine a **scatter plot**
- Calculate a **correlation coefficient**
  - e.g., Pearson’s $r$, Kendall’s $\tau$
  - Generally: 0: no correlation, 1: strong positive correlation, −1: strong negative correlation

For more than two variables, **linear modeling** could be helpful

- Simplest linear models require interval-scaled variables
- Typically: build comprehensive model & remove non-significant predictors in stepwise fashion
Cross-Tabulations

Tests such as **Pearson’s chi-squared** can show how observed frequencies (and percents) compare between groups/conditions

Cross-tabulation of two variables (corpus & verb form):

<table>
<thead>
<tr>
<th></th>
<th>LOB</th>
<th>FLOB</th>
<th>BROWN</th>
<th>FROWN</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>pres perf</strong></td>
<td>4,196</td>
<td>4,073</td>
<td>3,538</td>
<td>3,499</td>
<td>15,306</td>
</tr>
<tr>
<td></td>
<td>10.5%</td>
<td>10.4%</td>
<td>8.7%</td>
<td>8.8%</td>
<td>9.6%</td>
</tr>
<tr>
<td><strong>simp past</strong></td>
<td>35,821</td>
<td>35,276</td>
<td>37,223</td>
<td>36,250</td>
<td>144,470</td>
</tr>
<tr>
<td></td>
<td>89.5%</td>
<td>89.9%</td>
<td>91.3%</td>
<td>91.2%</td>
<td>90.4%</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>40,017</td>
<td>39,349</td>
<td>40,761</td>
<td>39,749</td>
<td>159,876</td>
</tr>
</tbody>
</table>

Relationship between tenses & corpus parts

\(\chi^2 = 130.8; \ df = 3; \ p < 0.001\), but ...
Thinking about data

Is the pattern really about variety/dialect?

- British (LOB, FLOB) corpora feature more present perfects than American (Brown, Frown) corpora

Instead of **TENSE × CORPUS:**

- We might want: **TENSE × VARIETY × TIME**
  - LOB, Brown < FLOB, Frown

Simple way: slice up the table on previous slide

- Alternative: generalized models (see paper)
Generalized linear models

Generalized linear model predicting the probability of a binary variable

- In what conditions (**variety**, **time**) are you relatively more likely to have pres. perf.?

<table>
<thead>
<tr>
<th>Variety</th>
<th>Time</th>
<th>DV Tense</th>
<th>Freq.</th>
</tr>
</thead>
<tbody>
<tr>
<td>BrE</td>
<td>early</td>
<td>pres perf (1)</td>
<td>4,196</td>
</tr>
<tr>
<td>BrE</td>
<td>early</td>
<td>simp past (0)</td>
<td>35,821</td>
</tr>
<tr>
<td>BrE</td>
<td>late</td>
<td>pres perf (1)</td>
<td>4,073</td>
</tr>
<tr>
<td>BrE</td>
<td>late</td>
<td>simp past (0)</td>
<td>35,276</td>
</tr>
<tr>
<td>AmE</td>
<td>early</td>
<td>pres perf (1)</td>
<td>3,538</td>
</tr>
<tr>
<td>AmE</td>
<td>early</td>
<td>simp past (0)</td>
<td>37,223</td>
</tr>
<tr>
<td>AmE</td>
<td>late</td>
<td>pres perf (1)</td>
<td>3,499</td>
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<td>AmE</td>
<td>late</td>
<td>simp past (0)</td>
<td>36,250</td>
</tr>
</tbody>
</table>
Gries list a few hints (in section 3.3) that are worth remembering:

- Plot your data
  - e.g., A linear correlation may actually be curvilinear
- Look at effect size
  - It’s not all about significance (which tends to happen with large corpora)
- Look at pairwise comparisons
  - Significance doesn’t mean that all pairs significantly differ from each other
In addition to testing hypotheses, one can use statistical techniques to generate hypotheses

- e.g., hierarchical agglomerative cluster analysis
  - This produces tree diagrams which are relatively easily interpretable
  - $n$ objects clustered into $m < n$ groups: large within-group similarity, small between-group similarity
  - clustered on the basis of $x$ characteristics (features)

- Example: clustering Russian verbs meaning ‘to try’
Number of clusters

Clustering varies by:

- Technique (e.g., more even-size or elongated clusters?)
- Similarity measurement (e.g., distance? curvature?)
- Number of clusters (often user-specified)