Day 3: Descriptive statistical methods for textual analysis

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Day 3 Basic Outline

- Exploring texts
- Presenting overall text statistics
- Quantifying the complexity of texts
- Quantifying lexical diversity
- Summarizing and presenting results
- Graphical methods
- Demonstration with inaugural speeches
- Work through Exercise 2

Key Words in Context

KWIC *Key words in context* Refers to the most common format for concordance lines. A KWIC index is formed by sorting and aligning the words within an article title to allow each word (except the stop words) in titles to be searchable alphabetically in the index.

lime (14)

79[C.10]	4	/Which was builded of **lime** and sand;/Until they came to
247A.6	4	/That was well biggit with **lime** and stane.
303A.1	2	bower,/Well built wi **lime** and stane,/And Willie came
247A.9	2	/That was well biggit wi **lime** and stane,/Nor has he stoln
305A.2	1	a castell biggit with **lime** and stane,/O gin it stands not
305A.71	2	is my awin,/I biggit it wi **lime** and stane;/The Tinnies and
79[C.10]	6	/Which was builded with **lime** and stone.
305A.30	1	a prittie castell of **lime** and stone,/O gif it stands not
108.15	2	/W*hi*ch was made both of **lime** and stone,/Shee tooke him by
175A.33	2	castle then,/Was made of **lime** and stone;/The vttermost
178[H.2]	2	near by,/Well built with **lime** and stone;/There is a lady
178F.18	2	built with stone and **lime**!/But far mair pittie on Lady
178G.35	2	was biggit wi stane and **lime**!/But far mair pity o Lady
2D.16	1	big a cart o stane and **lime**,/Gar Robin Redbreast trail it

Another KWIC Example (Seale et al (2006)

Table 3
Example of Keyword in Context (KWIC) and associated word clusters display

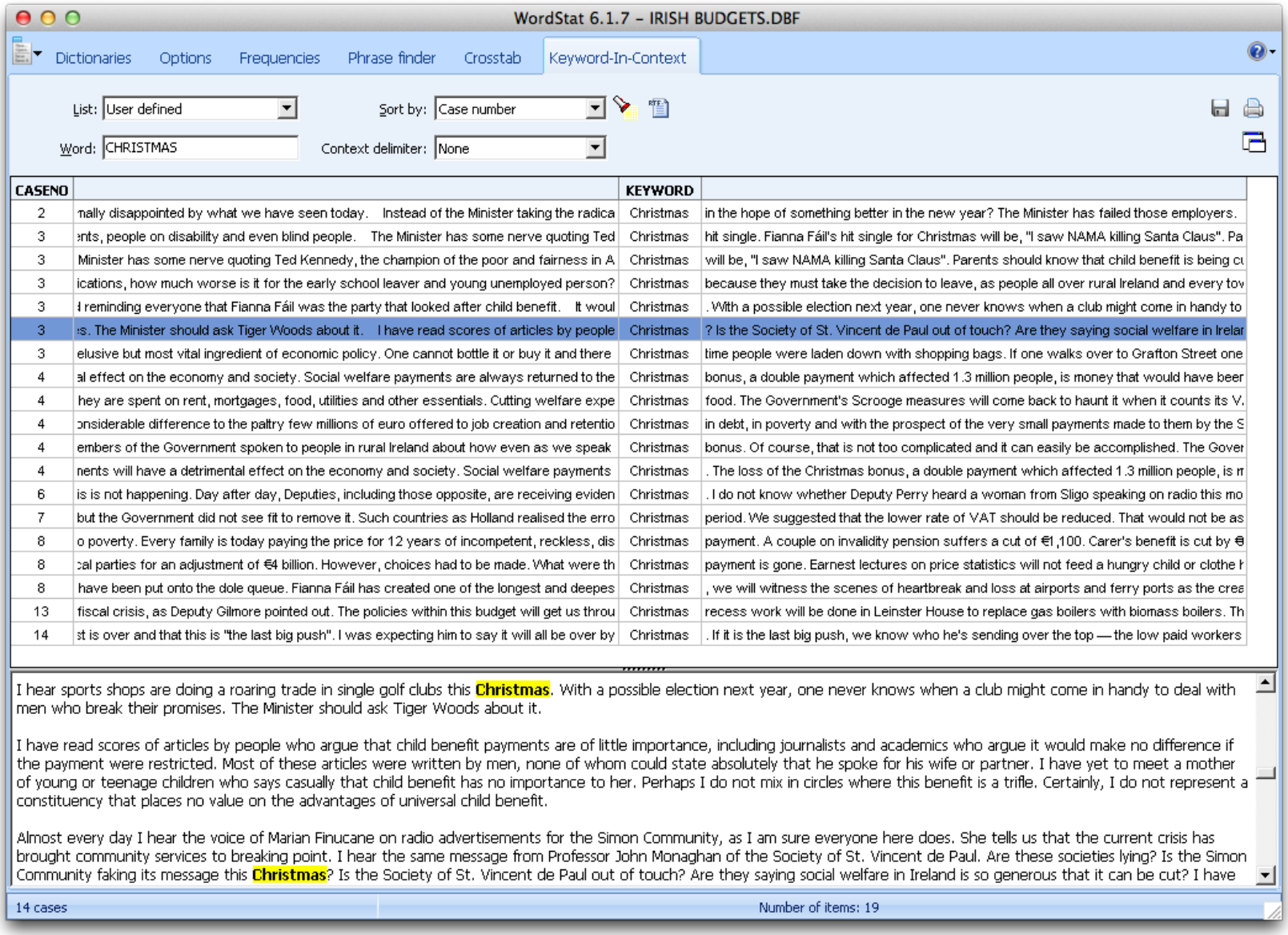
Extracts from Keyword in Context (KWIC) list for the word 'scan'

An MRI **scan** then indicated it had spread slightly
Fortunately, the MRI **scan** didn't show any involvement of the lymph nodes
3 very worrying weeks later, a bone **scan** also showed up clear.
The bone **scan** is to check whether or not the cancer has spread to the bones.
The bone **scan** is done using a type of X-ray machine.
The results were terrific, CT **scan** and pelvic X-ray looked good
Your next step appears to be to await the result of the **scan** and I wish you well there.
I should go and have an MRI **scan** and a bone **scan**

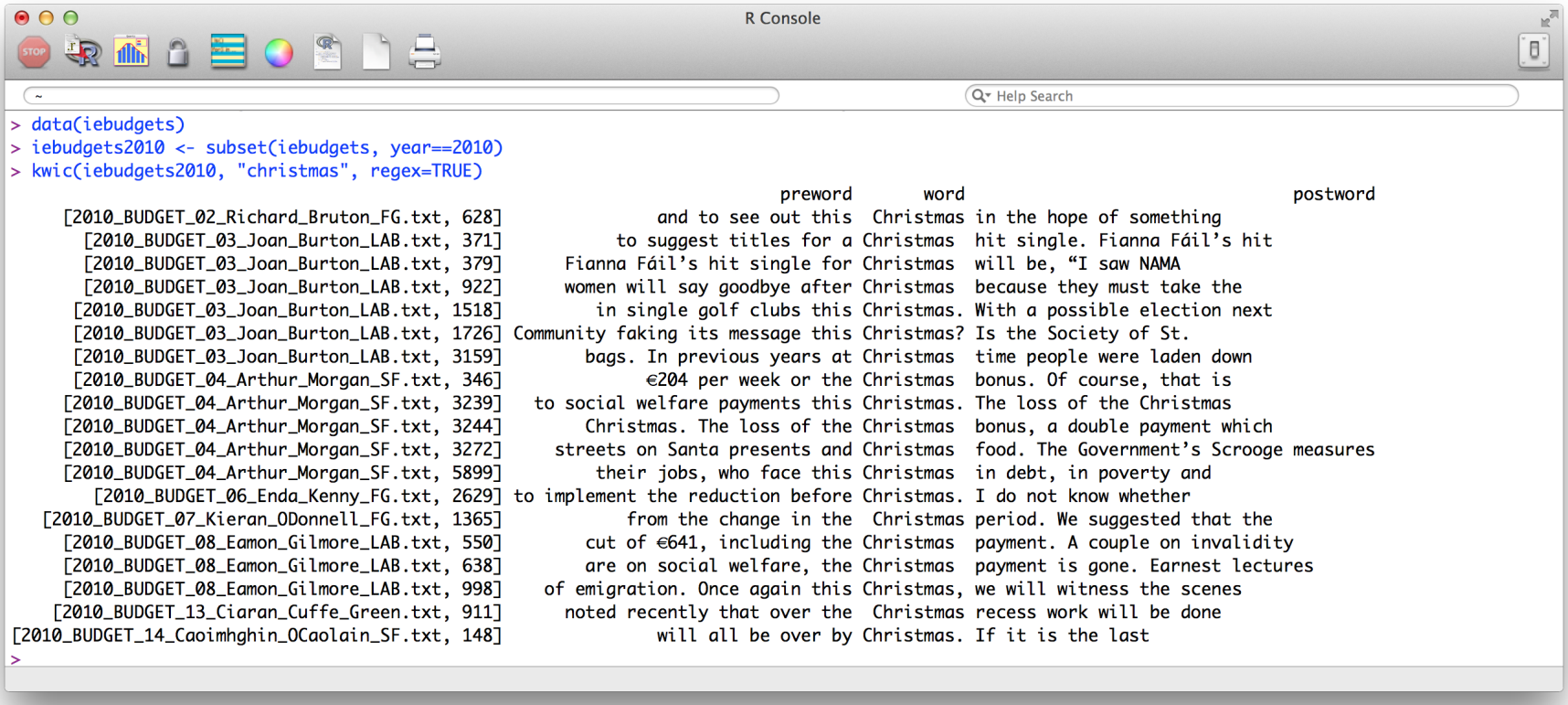
Three-word clusters most frequently associated with keyword 'scan'

N	Cluster	Freq
1	A bone scan	28
2	Bone scan and	25
3	An MRI scan	18
4	My bone scan	15
5	The MRI scan	15
6	The bone scan	14
7	MRI scan and	12
8	And Mri scan	9
9	Scan and MRI	9

Another KWIC Example: Irish Budget Speeches



Irish Budget Speeches KIWC in quanteda




```
> data(iebudgets)
> iebudgets2010 <- subset(iebudgets, year==2010)
> kwic(iebudgets2010, "christmas", regex=TRUE)
                                                      preword      word                                  postword
    [2010_BUDGET_02_Richard_Bruton_FG.txt, 628]             and to see out this  Christmas in the hope of something
      [2010_BUDGET_03_Joan_Burton_LAB.txt, 371]          to suggest titles for a Christmas  hit single. Fianna Fáil's hit
      [2010_BUDGET_03_Joan_Burton_LAB.txt, 379]      Fianna Fáil's hit single for Christmas  will be, "I saw NAMA
      [2010_BUDGET_03_Joan_Burton_LAB.txt, 922]      women will say goodbye after Christmas  because they must take the
     [2010_BUDGET_03_Joan_Burton_LAB.txt, 1518]        in single golf clubs this Christmas. With a possible election next
     [2010_BUDGET_03_Joan_Burton_LAB.txt, 1726] Community faking its message this Christmas? Is the Society of St.
     [2010_BUDGET_03_Joan_Burton_LAB.txt, 3159]       bags. In previous years at Christmas  time people were laden down
     [2010_BUDGET_04_Arthur_Morgan_SF.txt, 346]            €204 per week or the Christmas  bonus. Of course, that is
    [2010_BUDGET_04_Arthur_Morgan_SF.txt, 3239]   to social welfare payments this Christmas. The loss of the Christmas
    [2010_BUDGET_04_Arthur_Morgan_SF.txt, 3244]      Christmas. The loss of the Christmas  bonus, a double payment which
    [2010_BUDGET_04_Arthur_Morgan_SF.txt, 3272]    streets on Santa presents and Christmas  food. The Government's Scrooge measures
    [2010_BUDGET_04_Arthur_Morgan_SF.txt, 5899]       their jobs, who face this Christmas  in debt, in poverty and
       [2010_BUDGET_06_Enda_Kenny_FG.txt, 2629] to implement the reduction before Christmas. I do not know whether
   [2010_BUDGET_07_Kieran_ODonnell_FG.txt, 1365]           from the change in the  Christmas period. We suggested that the
     [2010_BUDGET_08_Eamon_Gilmore_LAB.txt, 550]       cut of €641, including the Christmas  payment. A couple on invalidity
     [2010_BUDGET_08_Eamon_Gilmore_LAB.txt, 638]       are on social welfare, the Christmas  payment is gone. Earnest lectures
     [2010_BUDGET_08_Eamon_Gilmore_LAB.txt, 998]   of emigration. Once again this Christmas, we will witness the scenes
    [2010_BUDGET_13_Ciaran_Cuffe_Green.txt, 911]     noted recently that over the  Christmas recess work will be done
[2010_BUDGET_14_Caoimhghin_OCaolain_SF.txt, 148]             will all be over by Christmas. If it is the last
>
```

Simple descriptive table about texts: Example

Speaker	Party	Tokens	Types
Brian Cowen	FF	5,842	1,466
Brian Lenihan	FF	7,737	1,644
Ciaran Cuffe	Green	1,141	421
John Gormley (Edited)	Green	919	361
John Gormley (Full)	Green	2,998	868
Eamon Ryan	Green	1,513	481
Richard Bruton	FG	4,043	947
Enda Kenny	FG	3,863	1,055
Kieran ODonnell	FG	2,054	609
Joan Burton	LAB	5,728	1,471
Eamon Gilmore	LAB	3,780	1,082
Michael Higgins	LAB	1,139	437
Ruairi Quinn	LAB	1,182	413
Arthur Morgan	SF	6,448	1,452
Caoimhghin O'Caolain	SF	3,629	1,035
All Texts		49,019	4,840
Min		919	361
Max		7,737	1,644
Median		3,704	991
Hapaxes with Gormley Edited		67	
Hapaxes with Gormley Full Speech		69	

Basic descriptive summaries of text

Readability statistics Use a combination of syllables and sentence length to indicate "readability" in terms of complexity

Vocabulary diversity (At its simplest) involves measuring a *type-to-token ratio* (TTR) where unique words are types and the total words are tokens

Word (relative) frequency

Theme (relative) frequency

Length in characters, words, lines, sentences, paragraphs, pages, sections, chapters, etc.

Flesch-Kincaid readability index

- F-K is a modification of the original Flesch Reading Ease Index:

$$206.835 - 1.015\left(\frac{\text{total words}}{\text{total sentences}}\right) - 84.6\left(\frac{\text{total syllables}}{\text{total words}}\right)$$

  Interpretation: 0-30: university level; 60-70: understandable by 13-15 year olds; and 90-100 easily understood by an 11-year old student.

- Flesch-Kincaid rescales to the US educational grade levels (1–12):

$$0.39\left(\frac{\text{total words}}{\text{total sentences}}\right) + 11.8\left(\frac{\text{total syllables}}{\text{total words}}\right) - 15.59$$

Gunning fog index

- Measures the readability in terms of the years of formal education required for a person to easily understand the text on first reading
- Usually taken on a sample of around 100 words, not omitting any sentences or words
- Formula:

$$0.4 \left[\left(\frac{\text{total words}}{\text{total sentences}} \right) + 100 \left(\frac{\text{complex words}}{\text{total words}} \right) \right]$$

where complex words are defined as those having three or more syllables, not including proper nouns (for example, Ljubljana), familiar jargon or compound words, or counting common suffixes such as -es, -ed, or -ing as a syllable

Scales and Indexes

- Involves characterizing the coded text units using additional quantification
- Examples

  Category frequencies Coded category frequency measures, such as the proportion of times "economy" is mentioned in a speech, or the proportion of mentions of the environment

  Type/token measures Frequency tabulations of token types and their frequencies

  Range/variance Here we might be interested in the total number or the spread or variance of categories used in particular documents or by particular speakers
- May also involve scales or indexes constructed from summary information

Summarizing: Scale Example

- A very simple example comes from the CMP, using PER110 "European Union: Positive Mentions" and PER108 "European Union: Negative Mentions"
- The overall pro- versus anti- EU-ness can be assessed as PER110 - PER108. Theoretical range is $[-100, 100]$.
- A more complicated example is the CMP's famous "rile" index, which adds 26 categories of the "right" and subtracts from this the sum of 13 categories of the "left".

Lexical Diversity

- Basic measure is the TTR: Type-to-Token ratio
- Problem: This is very sensitive to overall document length, as shorter texts may exhibit fewer word repetitions
- Special problem: length may relate to the introdution of additional subjects, which will also increase richness

Lexical Diversity: Alternatives to TTRs

TTR $\frac{\text{total types}}{\text{total tokens}}$

Guiraud $\frac{\text{total types}}{\sqrt{\text{total tokens}}}$

D (Malvern et al 2004) Randomly sample a fixed number of tokens and count those

MTLD the mean length of sequential word strings in a text that maintain a given TTR value (McCarthy and Jarvis, 2010) – fixes the TTR at 0.72 and counts the length of the text required to achieve it

Vocabulary Diversity Example

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

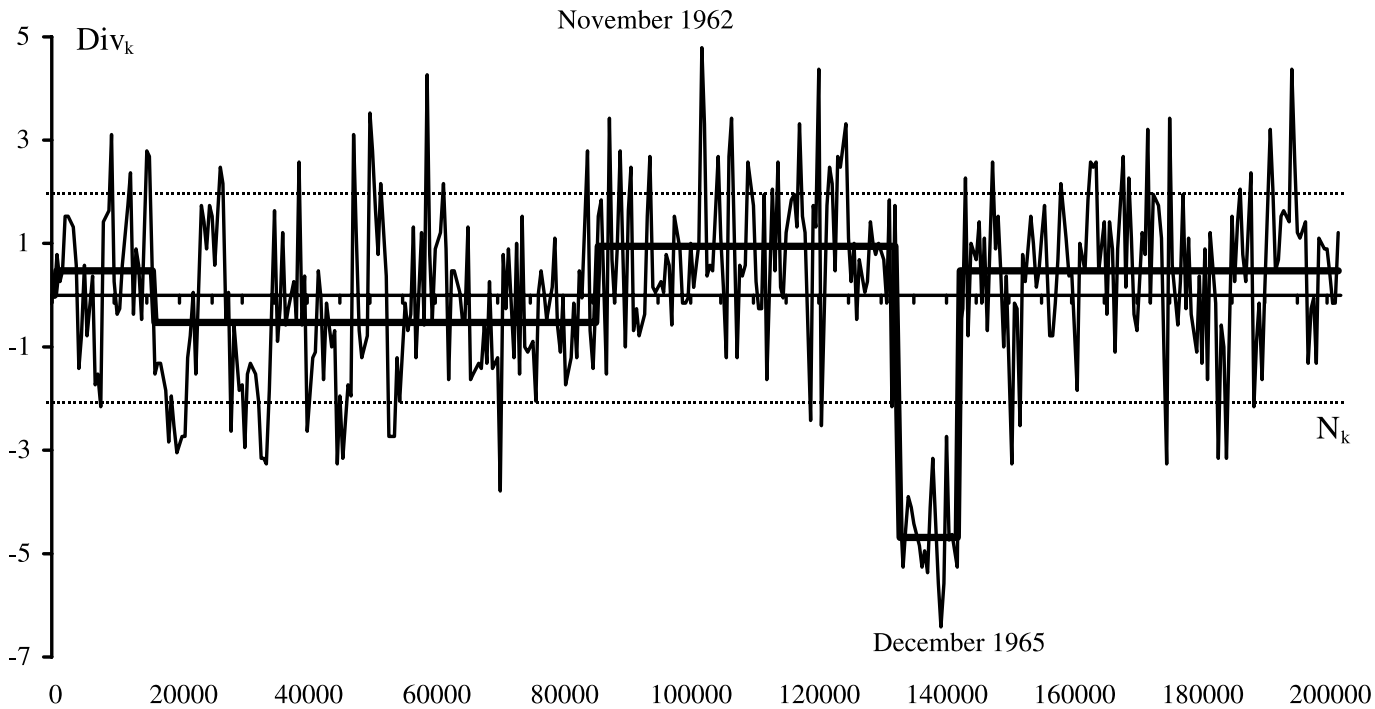


Fig. 8. Evolution of vocabulary diversity in General de Gaulle's broadcast speeches (June 1958–April 1969).

Inference and Reporting

- This involves drawing conclusions from the research, and these conclusions will depend on the *validity* established by the research design
- Reporting means communicating the results in a clear and relevant fashion. (This can be challenging – see for instance the Schonhardt-Bailey article.)
- No iron-clad rules here – use your discretion as applied to a particular case

Summarizing: Example

Democratic	Republican
iraq	consent
administration	ask
year	unanimous
health	bill
families	committee
program	senate
care	30
debt	2006
women	border
veterans	senator
help	vote
americans	law
country	hearing
children	authorized
new	further
education	states
funding	proceed
workers	order
programs	session
disaster	time

Top 20 Democratic and Republican words from the 2006 US Senate (source: Nicholas Beauchamp 2008)

LIWC Example

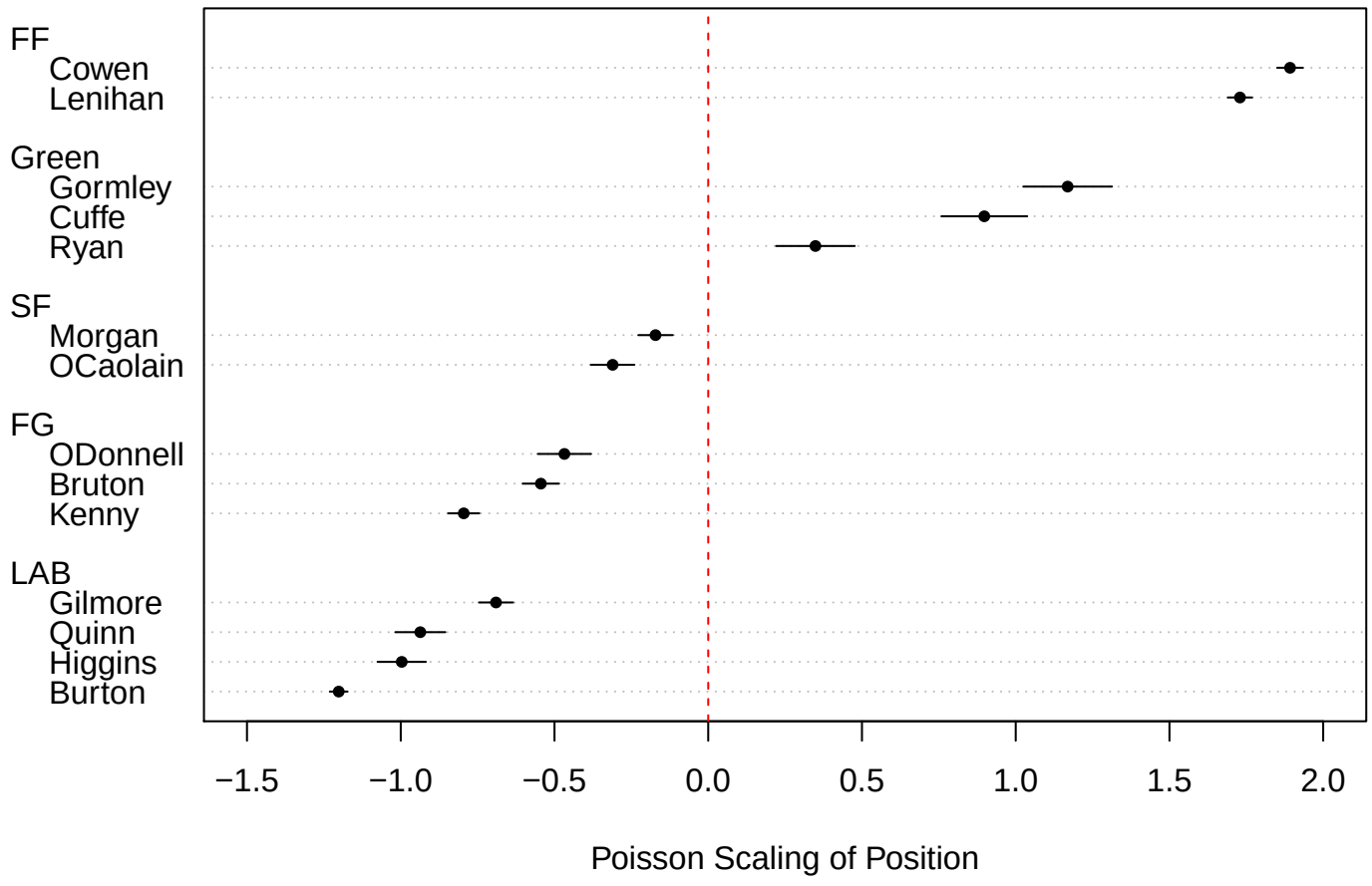
- From an application of the Linguistic Inquiry and Word Count dictionary to texts by Al Zawahiri and Bin Laden, benchmarked against a general corpus

	Bin Ladin (1988 to 2006) N = 28	Zawahiri (2003 to 2006) N = 15	Controls N = 17	p (two-tailed)
Word Count	2511.5	1996.4	4767.5	
Big words (greater than 6 letters)	21.2a	23.6b	21.1a	.05
Pronouns	9.15ab	9.83b	8.16a	.09
I (e.g. I, me, my)	0.61	0.90	0.83	
We (e.g. we, our, us)	1.94	1.79	1.95	
You (e.g. you, your, yours)	1.73	1.69	0.87	
He/she (e.g. he, hers, they)	1.42	1.42	1.37	
They (e.g., they, them)	2.17a	2.29a	1.43b	.03
Prepositions	14.8	14.7	15.0	
Articles (e.g. a, an, the)	9.07	8.53	9.19	
Exclusive Words (but, exclude)	2.72	2.62	3.17	
Affect	5.13a	5.12a	3.91b	.01
Positive emotion (happy, joy, love)	2.57a	2.83a	2.03b	.01
Negative emotion (awful, cry, hate)	2.52a	2.28ab	1.87b	.03
Anger words (hate, kill)	1.49a	1.32a	0.89b	.01
Cognitive Mechanisms	4.43	4.56	4.86	
Time (clock, hour)	2.40b	1.89a	2.69b	.01
Past tense verbs	2.21a	1.63a	2.94b	.01
Social Processes	11.4a	10.7ab	9.29b	.04
Humans (e.g. child, people, selves)	0.95ab	0.52a	1.12b	.05
Family (mother, father)	0.46ab	0.52a	0.25b	.08
Content				
Death (e.g. dead, killing, murder)	0.55	0.47	0.64	
Achievement	0.94	0.89	0.81	
Money (e.g. buy, economy, wealth)	0.34	0.38	0.58	
Religion (e.g. faith, Jew, sacred)	2.41	1.84	1.89	

Note. Numbers are mean percentages of total words per text file. Statistical tests are between Bin Ladin, Zawahiri, and Controls. Documents whose source indicates "Both" (n=3) or "Unknown" (n=2) were excluded due to their small sample sizes.

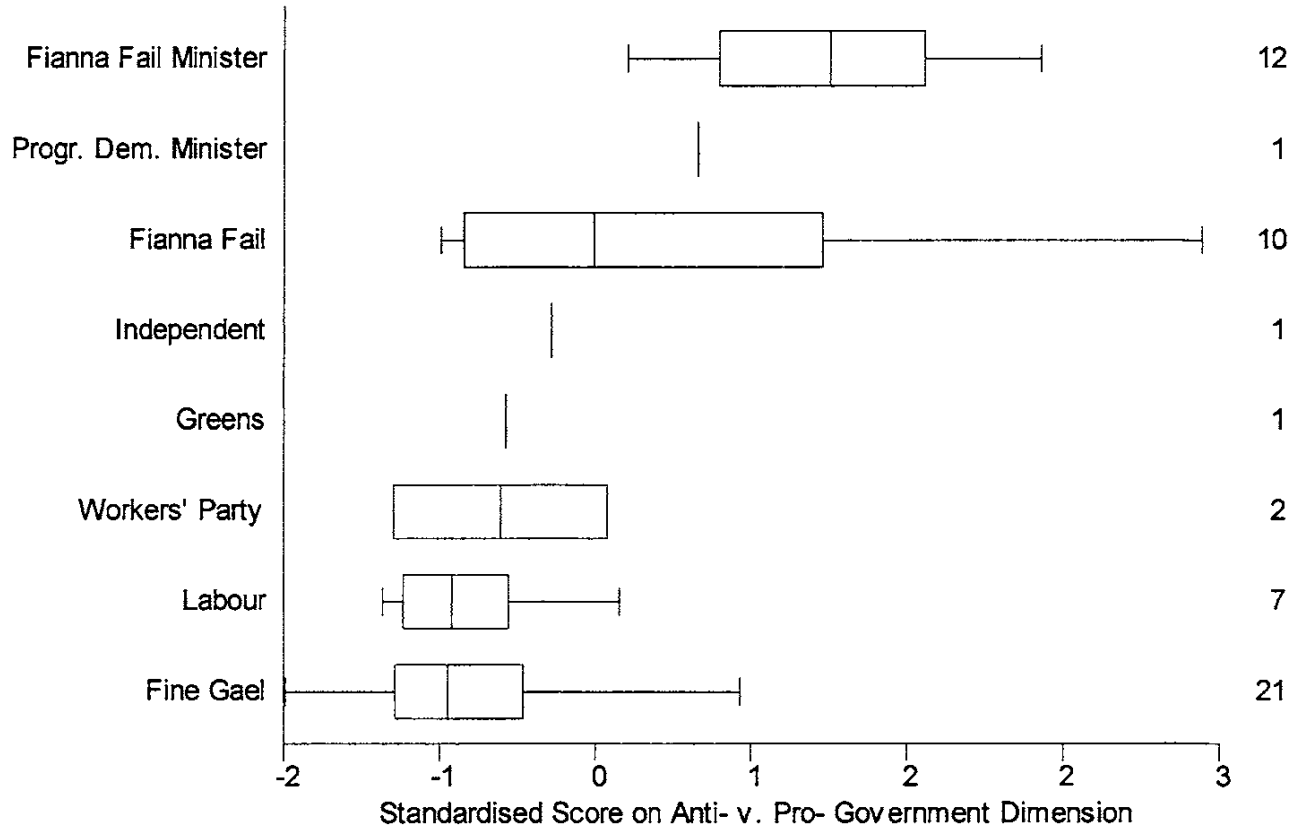
Graphical Methods: Example

- From a uni-dimensional scaling model from a term-document matrix (Poisson scaling)



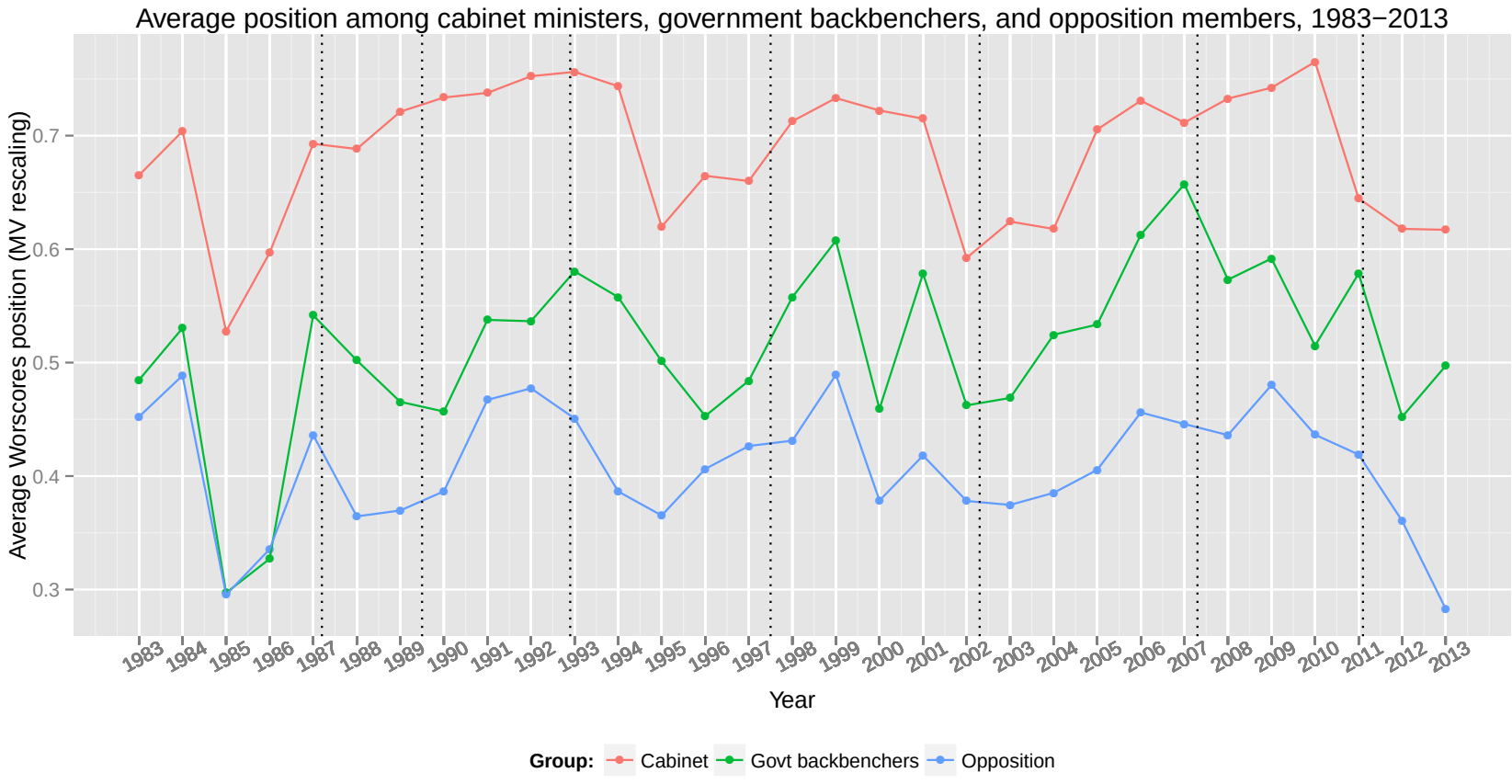
No confidence debate speeches (Wordscores)

FIGURE 3. Box Plot of Standardized Scores of Speakers in 1991 Confidence Debate on "Pro- versus Antigovernment" Dimension, by Category of Legislator



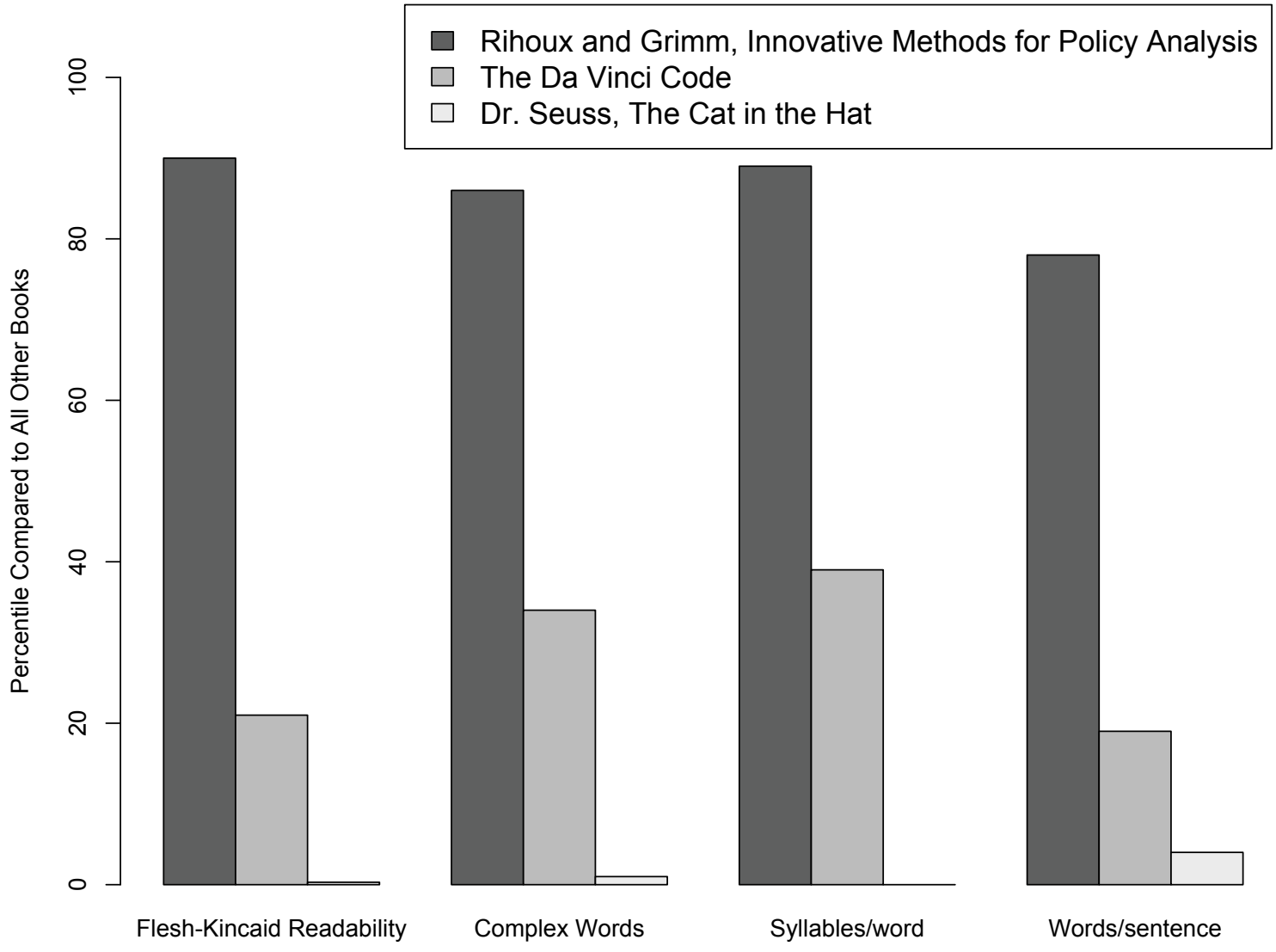
(from Benoit and Laver, *Irish Political Studies* 2002)

Government v. Opposition in yearly budget debates



(from Herzog and Benoit EPSA 2013)

Comparing Texts on the Basis of Quantitative Information



Applied to political texts

Bush's second inaugural address:

freedom America
liberty nation American country world
time free citizen hope history people day human right
seen ideal work unite justice cause government move choice
tyranny live act life accept defend duty generation great question honor
states president fire character force power fellow enemy century witness excuse
soul God division task define advance speak institution independence society serve

Obama's inaugural address:

nation America people
work generation world common
time seek spirit day American peace crisis hard
greater meet men remain job power moment women
father endure government short hour life hope freedom carried
journey forward force prosperity courage man question future friend
service age history God oath understand ideal pass economy care
promise children Earth stand demand purpose faith hand found interest

Obama's Inaugural Speech in Wordle