Using DiaCollo for Historical Research

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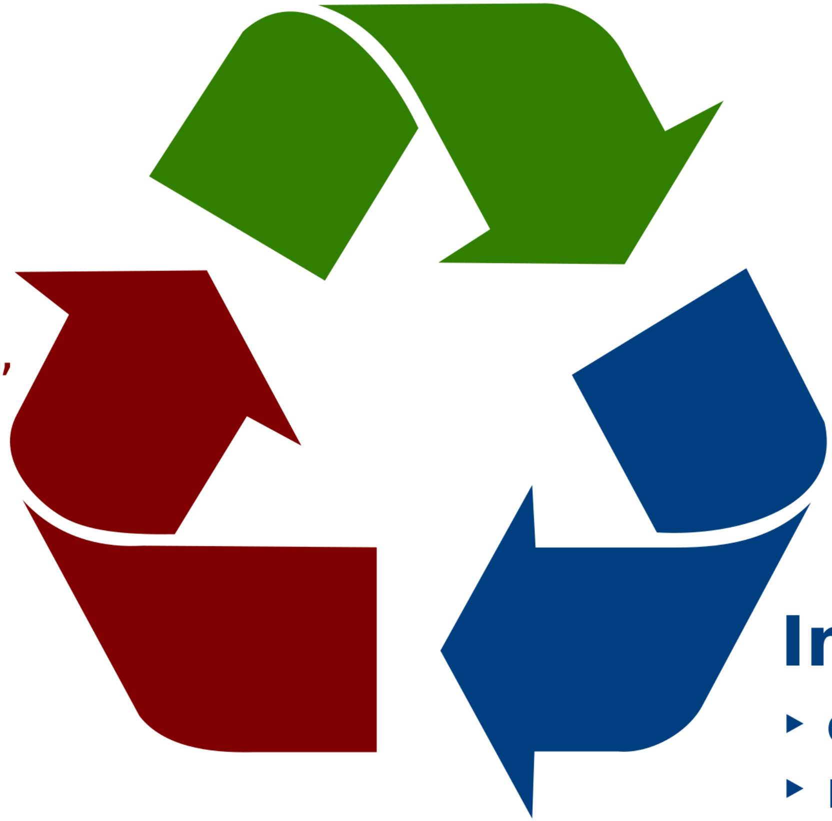
Overview

- Collaborative software development
- Corpora & collocations
- DiaCollo: diachronic collocation profiling
- Use case: Education policy in *Die Grenzboten*
- Summary & conclusion

Software Development Cycle

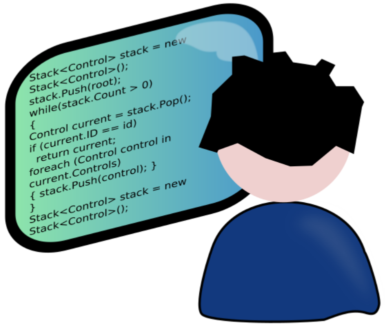
Planning

- identify desiderata & bugs
- sketch next steps



Evaluation

- testing “in the wild”
- user feedback



```
Stack<Control> stack = new
Stack<Control>();
stack.Push(root);
while(stack.Count > 0)
{
Control current = stack.Pop();
if (current.ID == id)
  return current;
foreach (Control control in
current.Controls)
{ stack.Push(control); }
}
Stack<Control> stack = new
Stack<Control>();
```

Implementation

- coding & documentation
- release & deployment

Corpora & Collocations

Diachronic Text Corpora

- heterogeneous with respect to to ***date of origin***
- should expose temporal effects of e.g. ***semantic shift***, ***discourse trends***
- problematic for conventional NLP tools (which assume **homogeneity**)

Collocation Profiling

(Church & Hanks 1990; Manning & Schütze 1999; Evert 2005)

> *"You shall know a word by the company it keeps"* — J. R. Firth

- **prompt** user for target **collocant** term(s) of interest (w_1)
- **lookup** all candidate **collocates** (w_2) co-occurring with w_1
- **rank** candidates by association score
  - score function $\varphi(f_1, f_2, f_{12}, N)$ approximates **relevance** of w_2 to w_1
  - "chance" co-occurrences with high-frequency w_2 should be **filtered out**!
  - statistical method $\rightsquigarrow$ requires **large data sample**

Diachronic Collocation Profiling

The Problem: (temporal) heterogeneity

- conventional collocation extractors assume **corpus homogeneity**
- co-occurrence frequencies are computed only for **word-pairs** (w_1, w_2)
- influence of **occurrence date** (and other document properties) is irrevocably lost

A Solution (sketch)

- represent terms as n-tuples of independent attributes, **including occurrence date**
- partition corpus **on-the-fly** into **user-specified intervals** (“date slices”, “epochs”)
- collect independent epoch-wise profiles into final result set

Advantages

- full support for diachronic axis
- variable query-level granularity
- flexible attribute selection
- multiple association scores

Drawbacks

- sparse data requires larger corpora
- computationally expensive
- large index size
- no syntactic relations (yet)

DiaCollo: Development

Planning & Evaluation

- in collaboration with DWDS lexicographers & CLARIN-D historians

Implementation

- Perl+PDL API, CLI, client/server
  - RESTful D* **web-service** + GUI
- various output & visualization formats, e.g.
  - TSV, JSON , HTML, Highcharts, d3-cloud, . . .
- **batteries not included**
  - tokenization, annotation, full-text search, . . .
- **garbage in ⇝ garbage out**
  - "messy" corpora ⇝ unsatisfying results

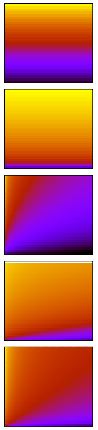
Deployment

- successfully applied to 70 distinct curated corpora at the BBAW, including:
  - Royal Society *Philosophical Transactions* (1665–1869, 9.8K documents, 35M tokens)
  - *Deutsches Textarchiv* (1600–1900, 3.6K documents, 205M tokens)
  - *DWDS Zeitungen* (1946–2019, 16M documents, 6.3G tokens)

DiaCollo: Scoring & Comparison Functions

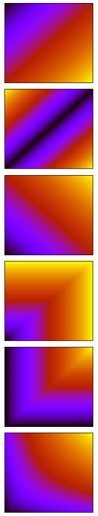
Selected Score Functions

f	raw collocation frequency	$= f_{12}$
lf	collocation log-frequency	$= \log_2(f_{12} + \varepsilon)$
mi	pointwise MI × log-frequency	$\approx \log_2 \frac{f_{12} \times N}{f_1 \times f_2} \times \log_2 f_{12}$
ll	log-likelihood (Dunning 1993)	$\approx \mathrm{sgn}(f_{12} \vert f_1, f_2) \times \log \frac{\mathrm{L}(H_0)}{\mathrm{L}(H_1)}$
ld	log-Dice coefficient (Rychlý 2008)	$\approx 14 + \log_2 \frac{2 \times f_{12}}{f_1 + f_2}$



Selected Diff Operations

diff	raw score difference	$= s_\mathrm{a} - s_\mathrm{b}$
adiff	absolute score difference	$= \lvert s_\mathrm{a} - s_\mathrm{b} \rvert$
avg	arithmetic average	$= \frac{s_\mathrm{a} + s_\mathrm{b}}{2}$
max	maximum	$= \max\{s_\mathrm{a}, s_\mathrm{b}\}$
min	minimum	$= \min\{s_\mathrm{a}, s_\mathrm{b}\}$
havg	harmonic average	$\approx \frac{2 s_\mathrm{a} s_\mathrm{b}}{s_\mathrm{a} + s_\mathrm{b}}$



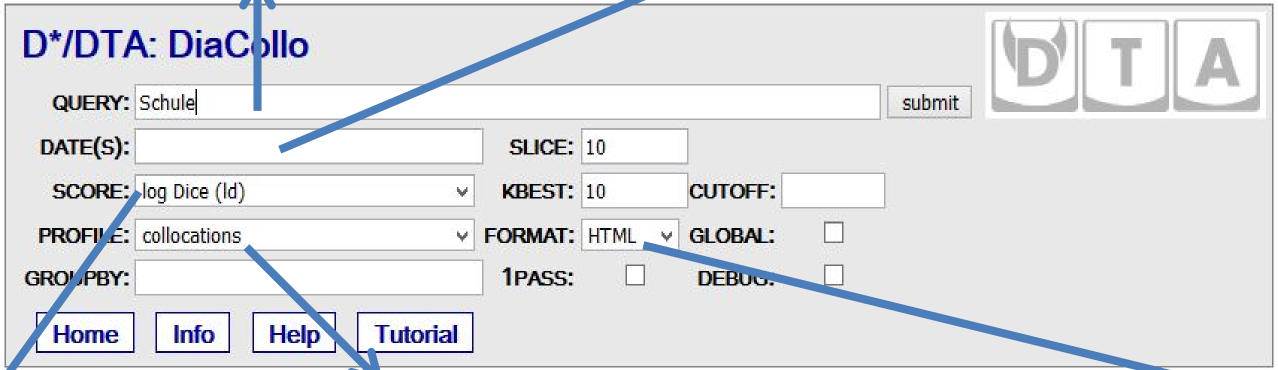
CLARIN-D

Use Case: Education Policy in *Die Grenzboten*

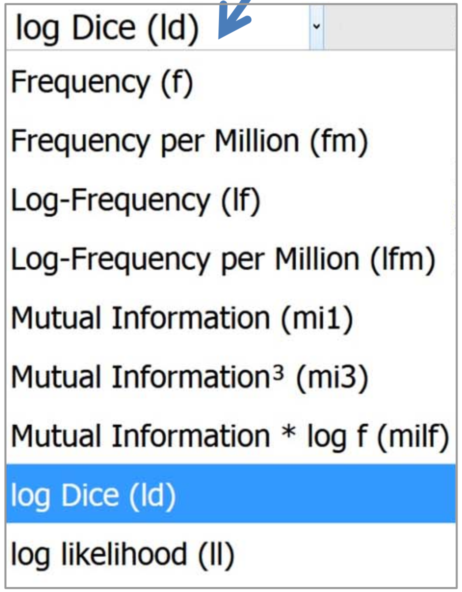
‘*Schule*’: DiaCollo Query (DTA)

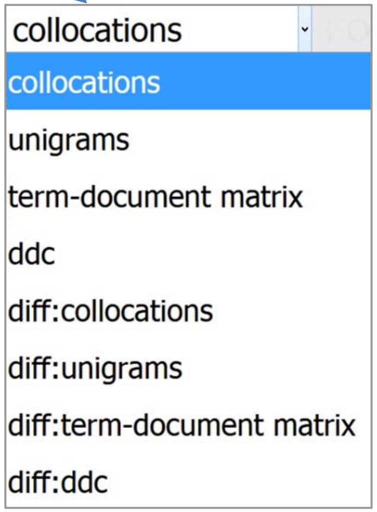
Target as:
LEMMA(s), e.g. Maske
/REGEX/ , e.g. /^Masken.*$/
DDC QUERY

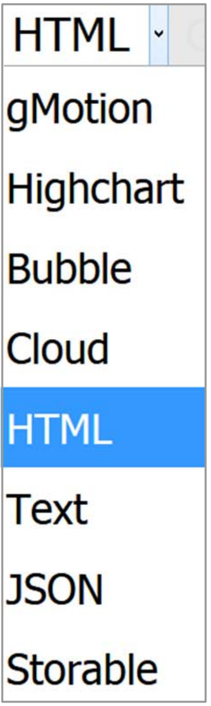
Target date(s):
DATE(s), e.g. 1900:1999 or *:* or 1900:*
/REGEX/, e.g. /^18[345]/


D*/DTA: DiaCollo

QUERY: Schule
DATE(S):
SLICE: 10
SCORE: log Dice (ld)
KBEST: 10
CUTOFF:
PROFILE: collocations
FORMAT: HTML
GLOBAL: □
GROUPBY:
1PASS: □
DEBUG: □

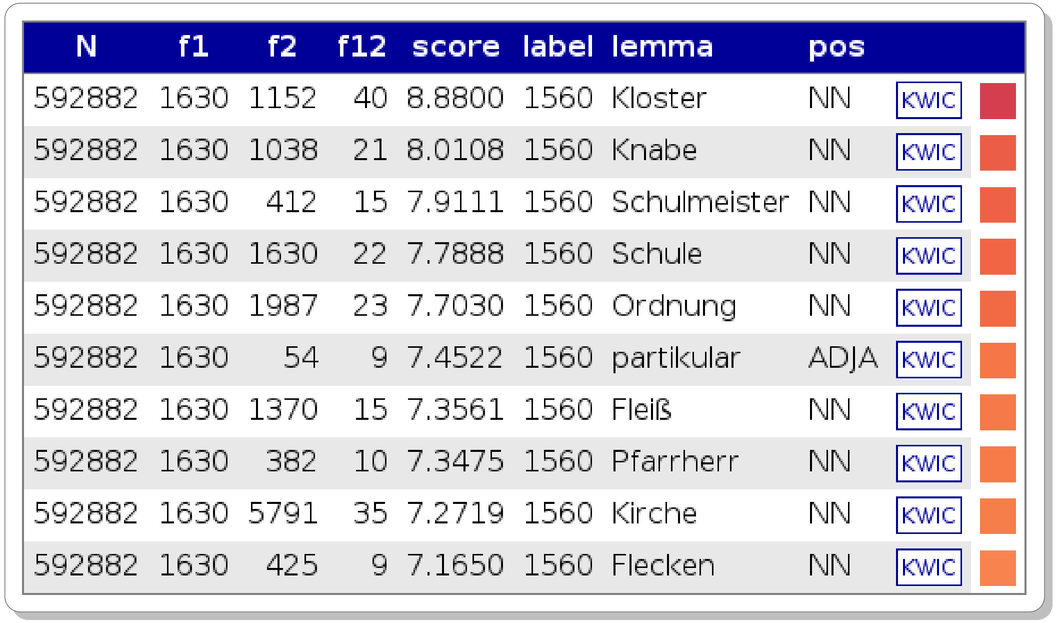

log Dice (ld)
Frequency (f)
Frequency per Million (fm)
Log-Frequency (lf)
Log-Frequency per Million (lfm)
Mutual Information (mi1)
Mutual Information³ (mi3)
Mutual Information * log f (milf)
log Dice (ld)
log likelihood (ll)





'*Schule*': DiaCollo Collocates (DTA: HTML)

1560–1569

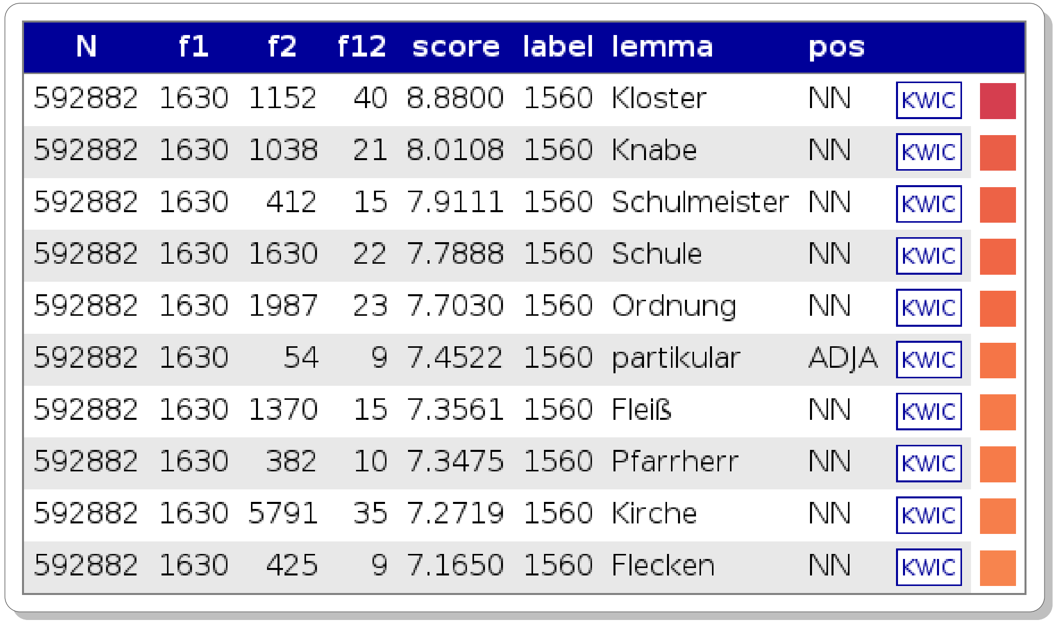


N	f1	f2	f12	score	label	lemma	pos		
592882	1630	1152	40	8.8800	1560	Kloster	NN	KWIC	🟥
592882	1630	1038	21	8.0108	1560	Knabe	NN	KWIC	🟧
592882	1630	412	15	7.9111	1560	Schulmeister	NN	KWIC	🟧
592882	1630	1630	22	7.7888	1560	Schule	NN	KWIC	🟧
592882	1630	1987	23	7.7030	1560	Ordnung	NN	KWIC	🟧
592882	1630	54	9	7.4522	1560	partikular	ADJA	KWIC	🟧
592882	1630	1370	15	7.3561	1560	Fleiß	NN	KWIC	🟧
592882	1630	382	10	7.3475	1560	Pfarrherr	NN	KWIC	🟧
592882	1630	5791	35	7.2719	1560	Kirche	NN	KWIC	🟧
592882	1630	425	9	7.1650	1560	Flecken	NN	KWIC	🟧

- association with religious institutions
  - *Kloster* ("cloister")
  - *Pfarrherr* ("pastor")
  - *Kirche* ("church")

‘*Schule*’: DiaCollo Collocates (DTA: HTML)

1560–1569



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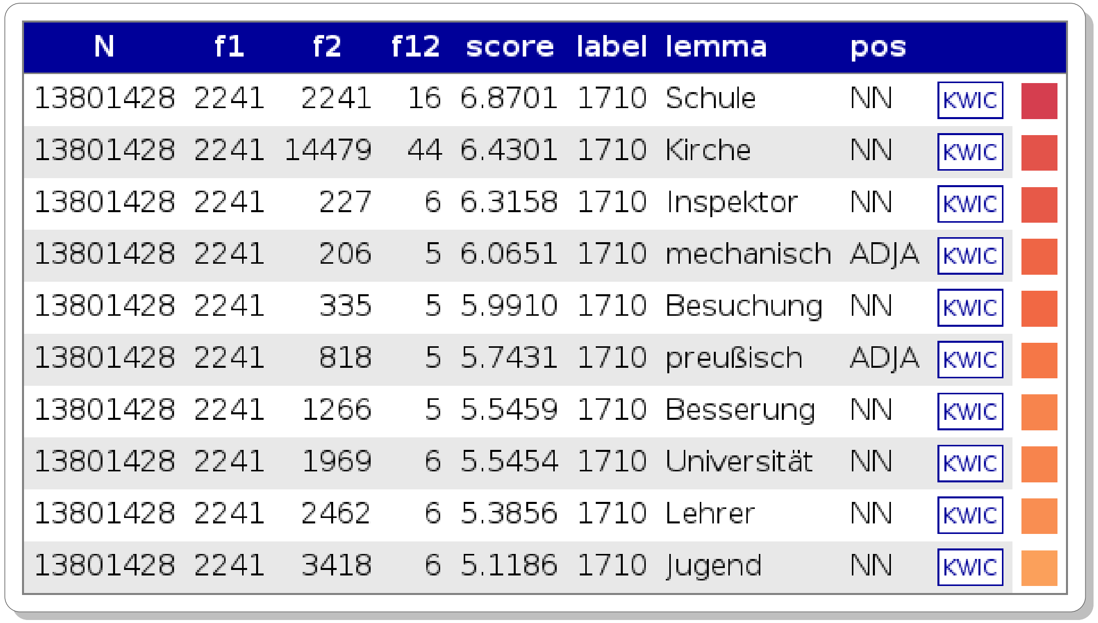
592882	1630	1370	15	7.3561	1560	Fleiß	NN	KWIC	🟧
592882	1630	382	10	7.3475	1560	Pfarrherr	NN	KWIC	🟧
592882	1630	5791	35	7.2719	1560	Kirche	NN	KWIC	🟧
592882	1630	425	9	7.1650	1560	Flecken	NN	KWIC	🟧

1710–1719



N	f1	f2	f12	score	label	lemma	pos		
13801428	2241	2241	16	6.8701	1710	Schule	NN	KWIC	🟥
13801428	2241	14479	44	6.4301	1710	Kirche	NN	KWIC	🟥
13801428	2241	227	6	6.3158	1710	Inspektor	NN	KWIC	🟥
13801428	2241	206	5	6.0651	1710	mechanisch	ADJA	KWIC	🟧
13801428	2241	335	5	5.9910	1710	Besuchung	NN	KWIC	🟧
13801428	2241	818	5	5.7431	1710	preußisch	ADJA	KWIC	🟧
13801428	2241	1266	5	5.5459	1710	Besserung	NN	KWIC	🟧
13801428	2241	1969	6	5.5454	1710	Universität	NN	KWIC	🟧
13801428	2241	2462	6	5.3856	1710	Lehrer	NN	KWIC	🟧
13801428	2241	3418	6	5.1186	1710	Jugend	NN	KWIC	🟧

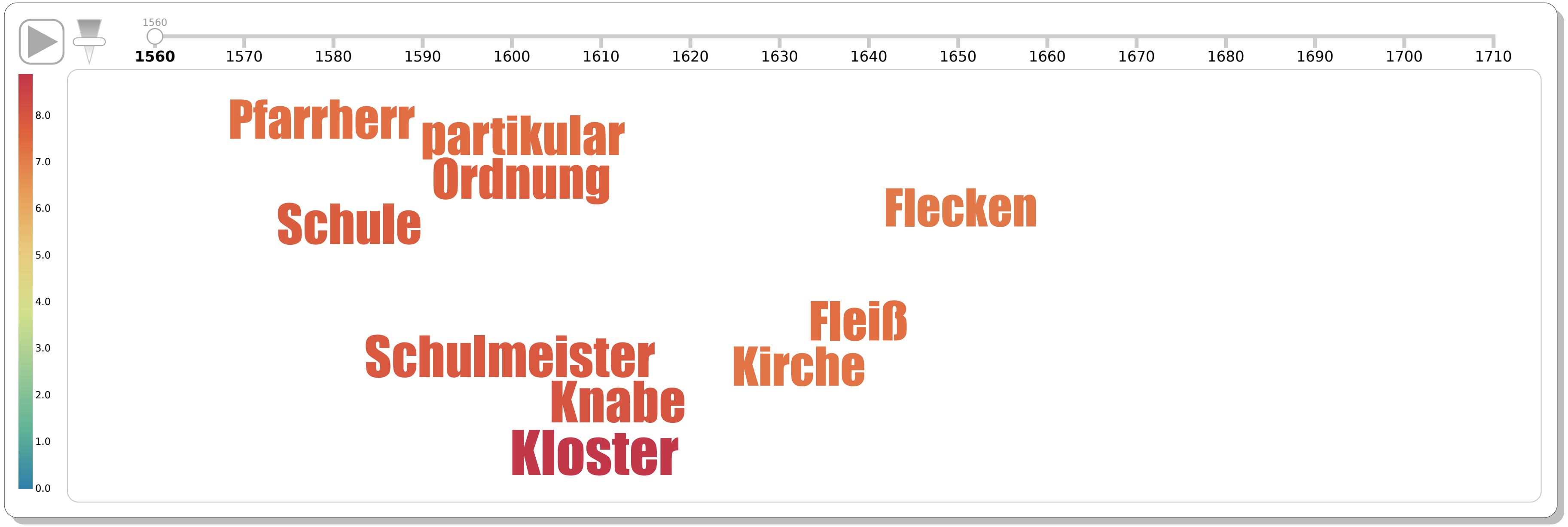
- association with religious institutions
  - *Kloster* (“cloister”)
  - *Pfarrherr* (“pastor”)
  - *Kirche* (“church”)

- stronger secular associations
  - *Inspektor* (“inspector”)
  - *preußisch* (“prussian”)
  - *Universität* (“university”)
- trend continues as time progresses

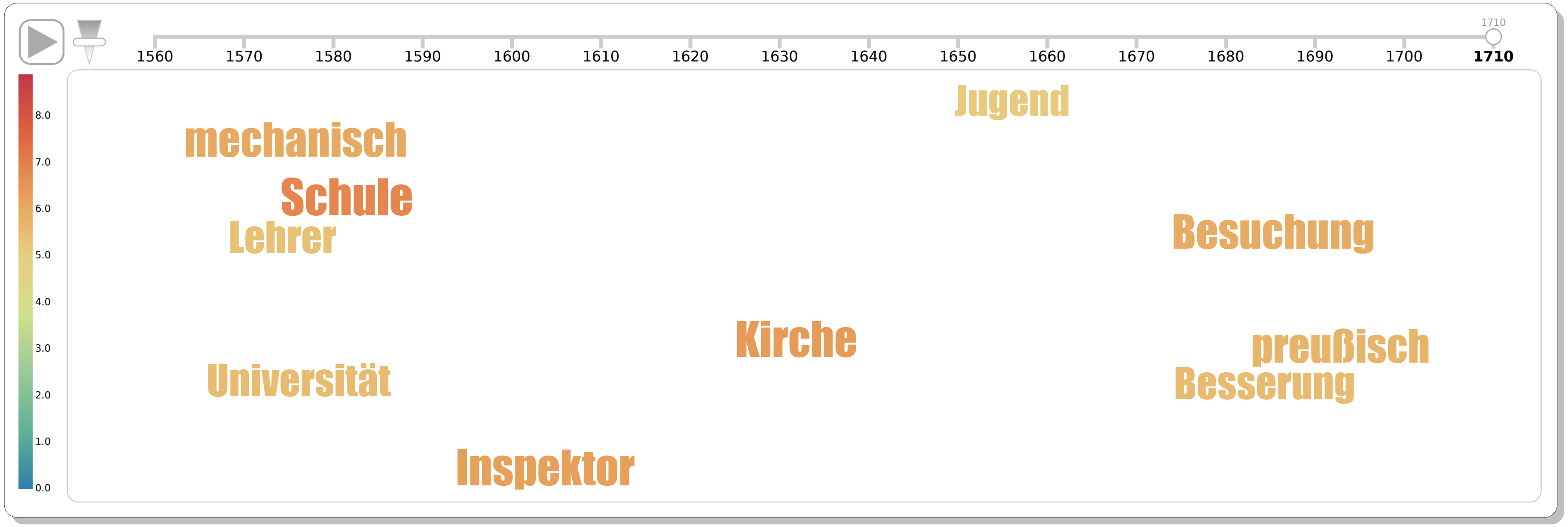
‘*Schule*’: DiaCollo Collocates (DTA: lemma-cloud)

CLARIN-D

1560s:



1710s:



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Die Grenzboten Corpus

Die Grenzboten 67. 2. 1908
Die Grenzboten 63. 4. 1904
Grenzboten 52. 3. 1893
Grenzboten 52. 4. 1893
Die Grenzboten 65. 2. 1906

Image: SuUB Bremen

http://brema.suub.uni-bremen.de/grenzboten
http://www.deutschestextarchiv.de/doku/textquellen#grenzboten

- *Die Grenzboten* (“the messengers from the border(s)”) was a bi-weekly national-liberal German language periodical published 1841–1922
- covered a wide range of politics, literature, and the arts throughout the ‘long’ nineteenth Century
- 270 volumes (ca. 187,000 pages) digitized, OCR’ed, and structured by the SuUB Bremen in the context of a DFG-Project
  - integrated into the corpus research infrastructure of the *Deutsches Textarchiv* at the BBAW CLARIN Service Center

Are *Die Grenzboten* concerned with education?

Step 1: query corpus vocabulary database (LexDB)

- identify relevant terms in the corpus, e.g. *Schule* (“school”), 1840–1899
  - . . . in the *Deutsches Textarchiv*: 101.52 per million tokens
  - . . . in *Die Grenzboten* : **237.29** per million tokens

Step 2: query DiaCollo

- identify strong collocates for *Schule* (“school”)
- identify possible debates in the corpus via query results
- close reading in the texts via “keyword-in-context” (KWIC) hyperlinks

Education Policy & Religion

Collocate ‘*Kirche*’ (“church”)

- persistently prominent throughout the entire *Grenzboten* corpus
- 1850s–1880s: *konfessionell* (“confessional”)
- 1890s–1910s: *Religionsunterricht* (“religious education”)

Refining the Search

- restrict to attributive adjective collocates (`GROUPBY: l,p=ADJA`)

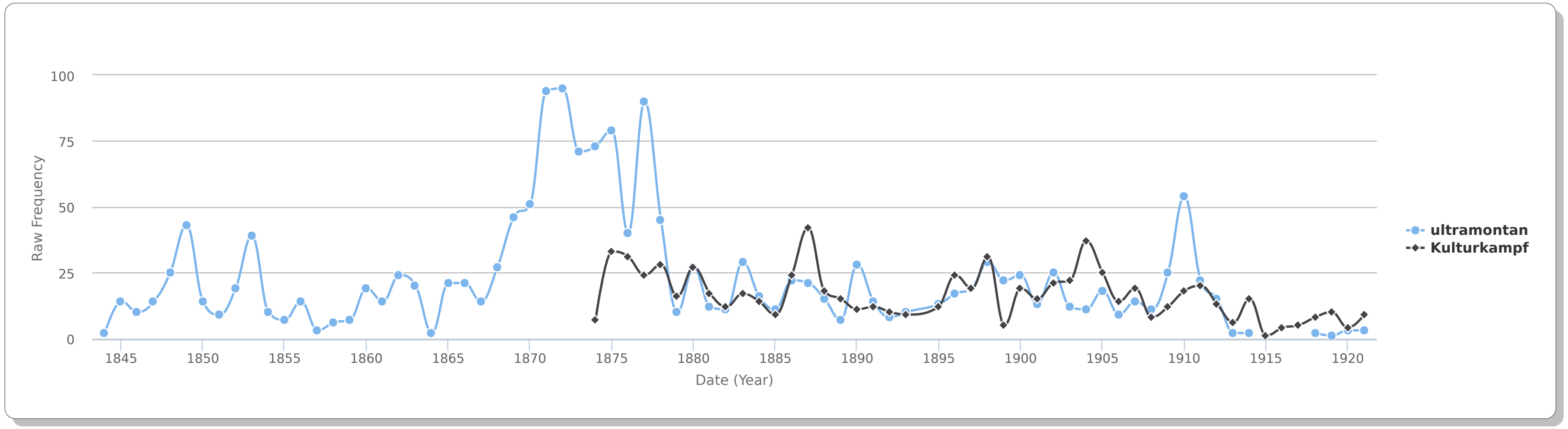
protestantisch	(“protestant”)	1860s
katholisch	(“Catholic”)	1860s-1870s
evangelisch	(“Protestant, Evangelical”)	1860s-1870s
konfessionell	(“confessional”)	1860s-1880s
kirchlich	(“churchly”)	1870s

- collocates related to church & religious confession peak in the 1860s–1870s
- also prominent: *öffentlich* (“public”; 1840s, 1870s–1900s)
  - KWIC ⇝ stance of publicly funded schools w.r.t. church influence in education

Education Policy: *Kulturkampf*

Kulturkampf ("cultural struggle")

- rights & influences of state (Prussia) vs. church (Pope Pius IX)
- *ultramontan* ("ultramontane") ⇝ staunch supporters of the Catholic Church



Refining the Search: GermaNet thesaurus + paragraph search window

(Hamp & Feldweg 1997; Henrich & Hinrichs 2010)

- corpus hits show evidence for anti-Catholic opinions in debates on education
  - who should be in charge of education and curricula?
  - how to deal with different religious denominations in schools?

Upshot

- some important aspects of debate are **not** apparent from initial naïve DiaCollo queries
- informed curiosity & focused investigation leads to very satisfying results

Summary & Conclusion

Collaborative Development

- cyclic process ⇝ *feedback loop*
- elusive common ground ⇝ *terminology, research methodology*

DiaCollo

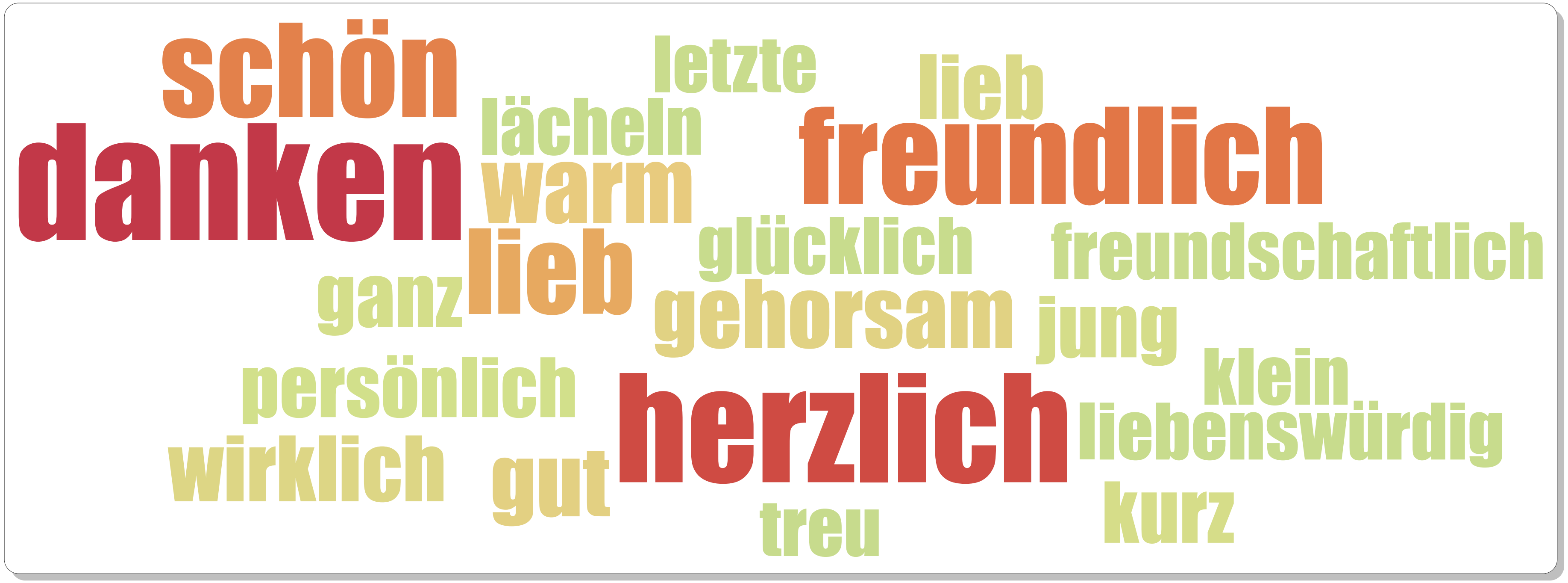
- diachronic text corpora ⇝ *semantic shift, discourse trends*
- conventional tools ⇝ *implicit assumptions of homogeneity*
- diachronic profiling ⇝ *date-dependent lexemes*

. . . as a tool for historical research

- fluent “blended”/“scalable” reading ⇝ *distant ↔ close reading*
- digital corpora (sources) ⇝ *quantity, quality, legal issues*

CLARIN-D

— The End —



Thank you for listening!

http://kaskade.dwds.de/~jurish/diacollo

http://metacpan.org/release/DiaColloDB

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