Technologies for Reusing Text from the Web

The Oral Exam of

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To Obtain the Academic Degree of

Dr. rer. nat.

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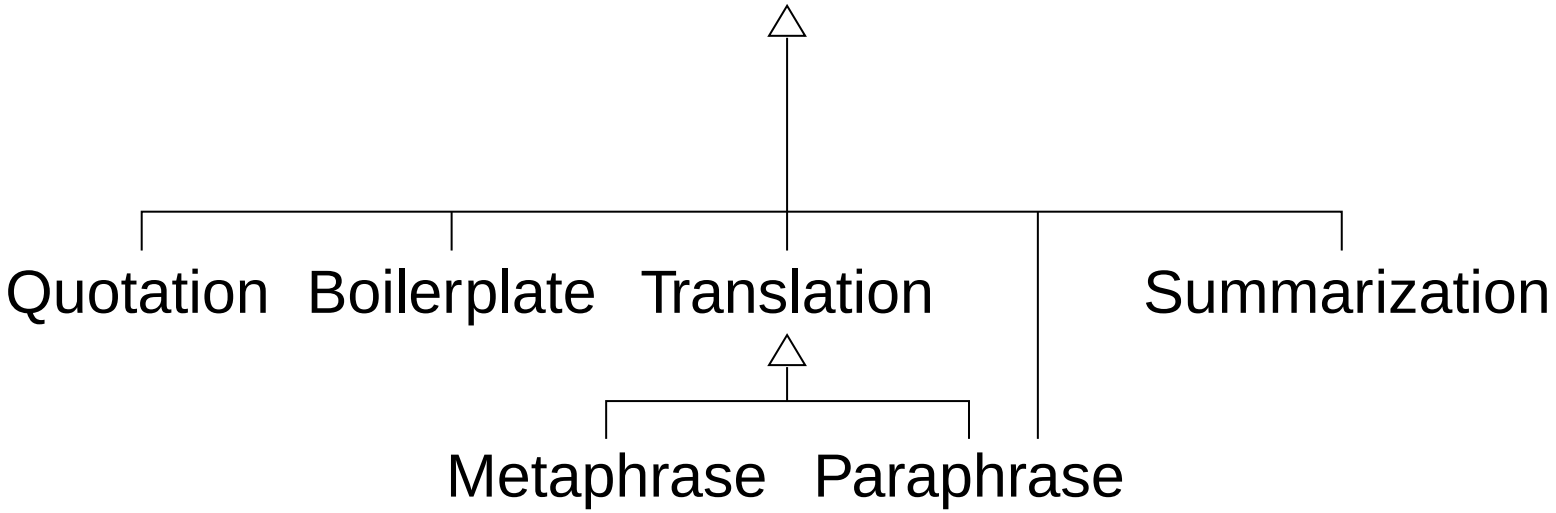

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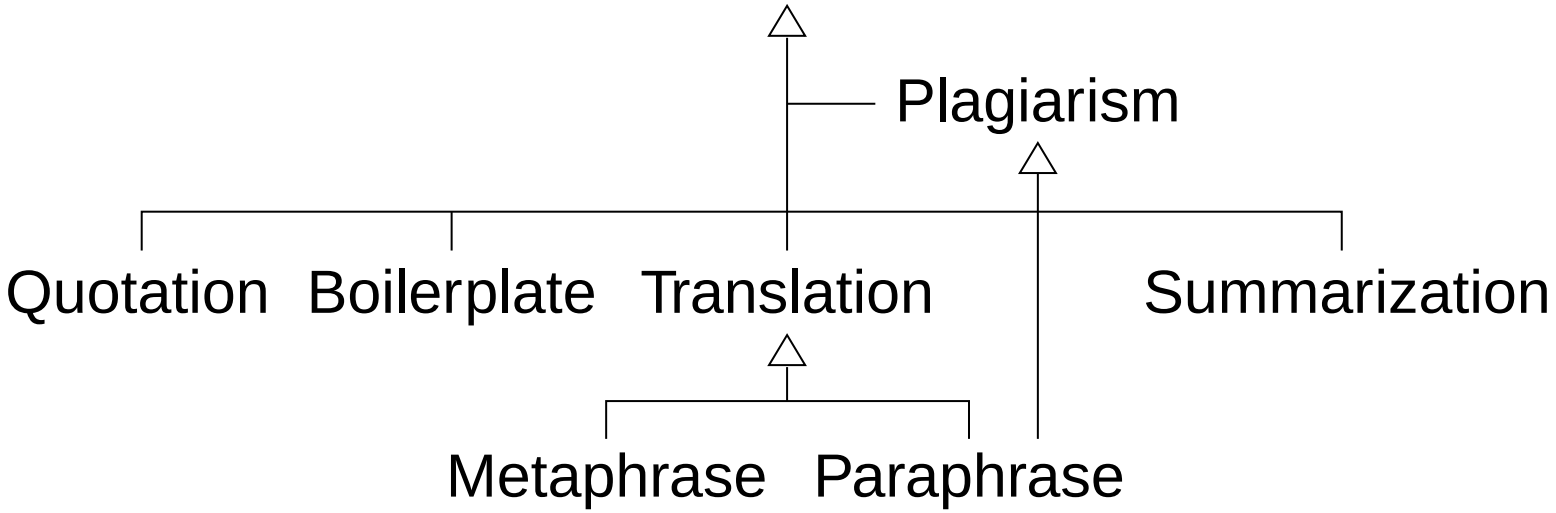

Contributions of Technologies for Reusing Text from the Web

1. Models & Algorithms
   - Unifying fingerprinting framework
   - Cross-language ESA
   - Comment cross-media similarity
   - Query segmentation algorithms

2. Surveys
   - Fingerprinting
   - Plagiarism detection
   - Web comment retrieval
   - Query segmentation

3. Evaluation Resources
   - Wikipedia as near-duplicate corpus
   - Wikipedia as cross-language corpus
   - 3 measures for plagiarism detection
   - 3 plagiarism corpora
   - Query segmentation corpus

4. Comparative Evaluations
   - 5 fingerprint algorithms
   - 3 cross-language models
   - 32 plagiarism detectors within 3 PAN evaluation competitions
   - 8 query segmentation algorithms

5. Tools
   - Netspeak
   - Picapica
   - OpinionCloud
   - Altools lib

Detecting Cross-Language Text Reuse

Measuring Cross-language Similarity

Alan Turing was conceived at Chatrapur, Orissa, India. His father was a member of the Indian Civil Service. He and his wife wanted Alan to be brought up in England, so they returned to Maida Vale, London, where Alan Turing was born on 23 June 1912. He had an elder brother, John. His father's civil service commission was still active, and during Turing's childhood years his parents travelled between Hastings, England and India, leaving their two sons to stay with a retired Army couple. Very early in life, Turing showed signs of the genius he was to later prominently display.

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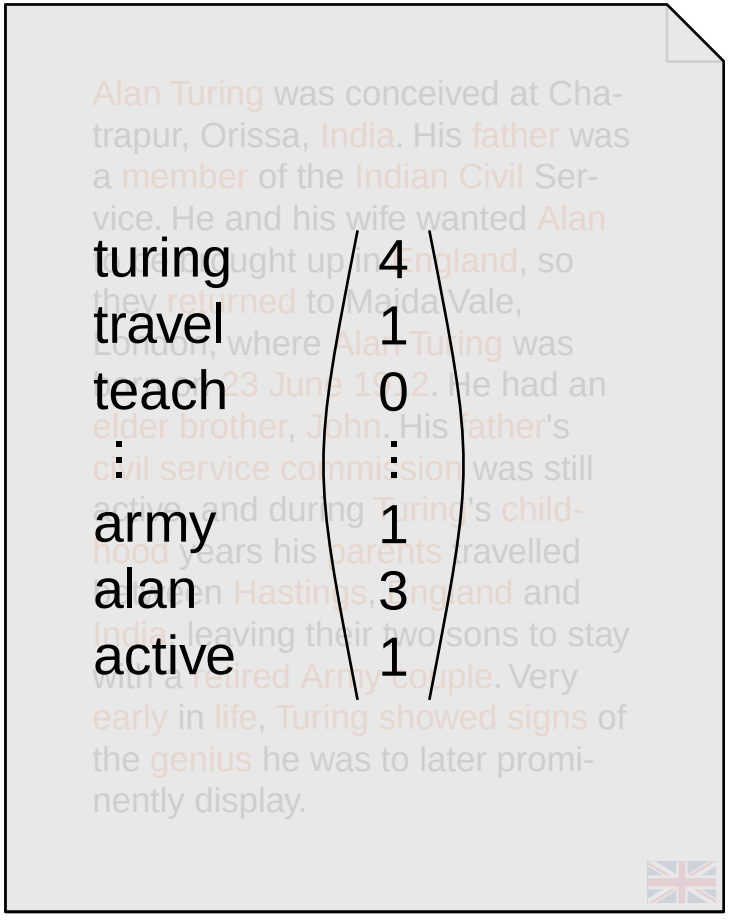

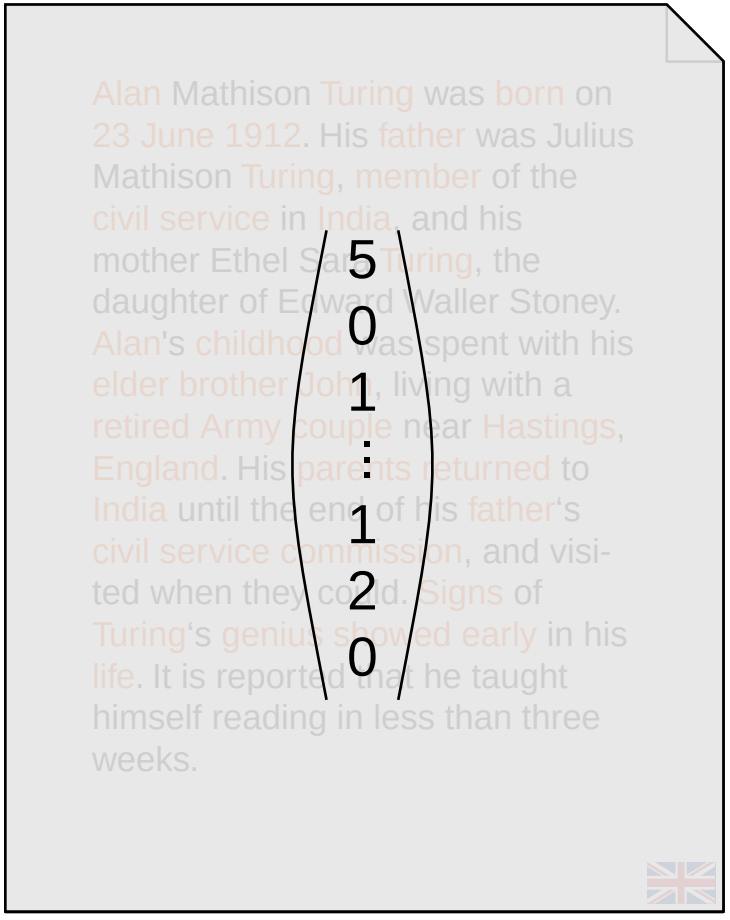

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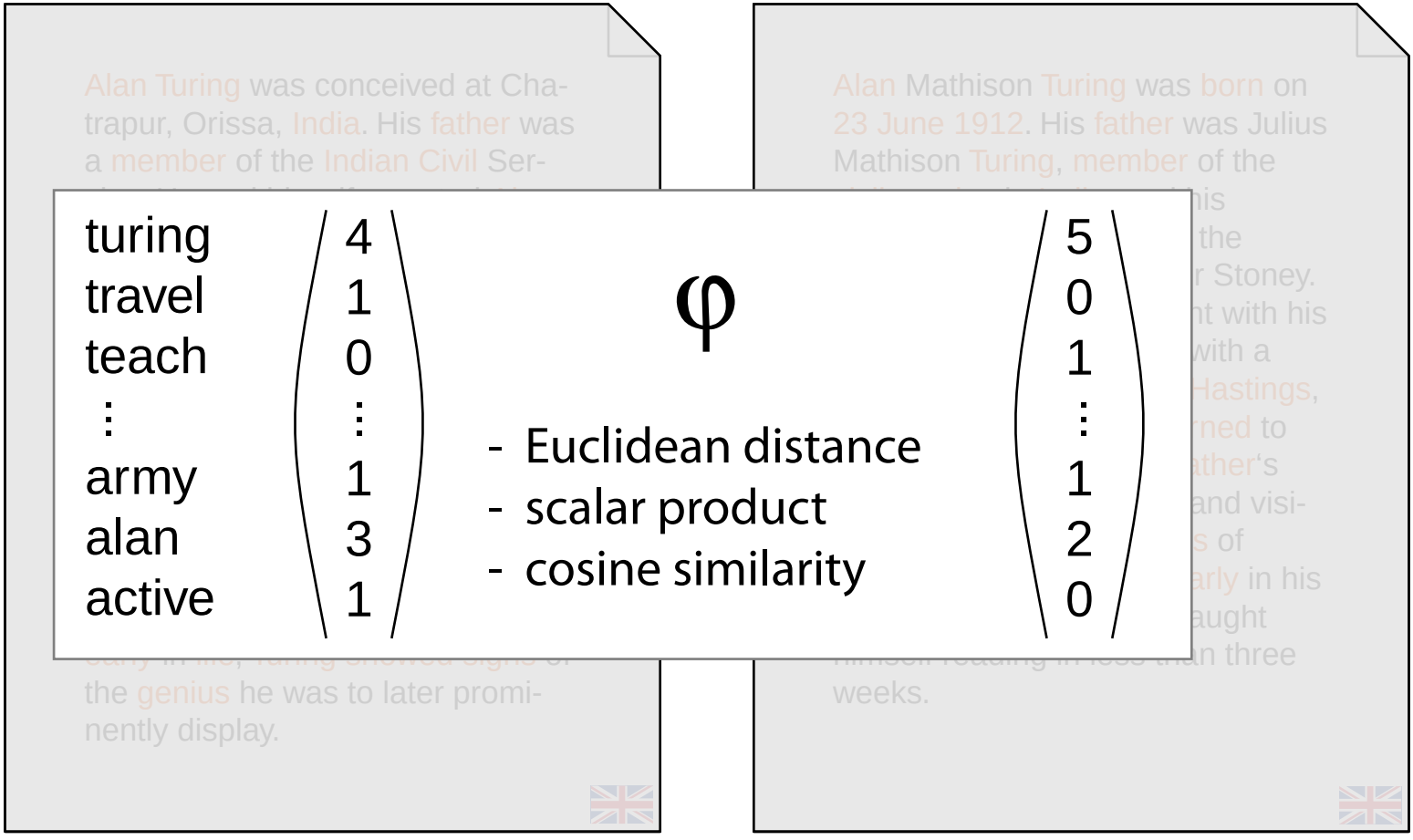

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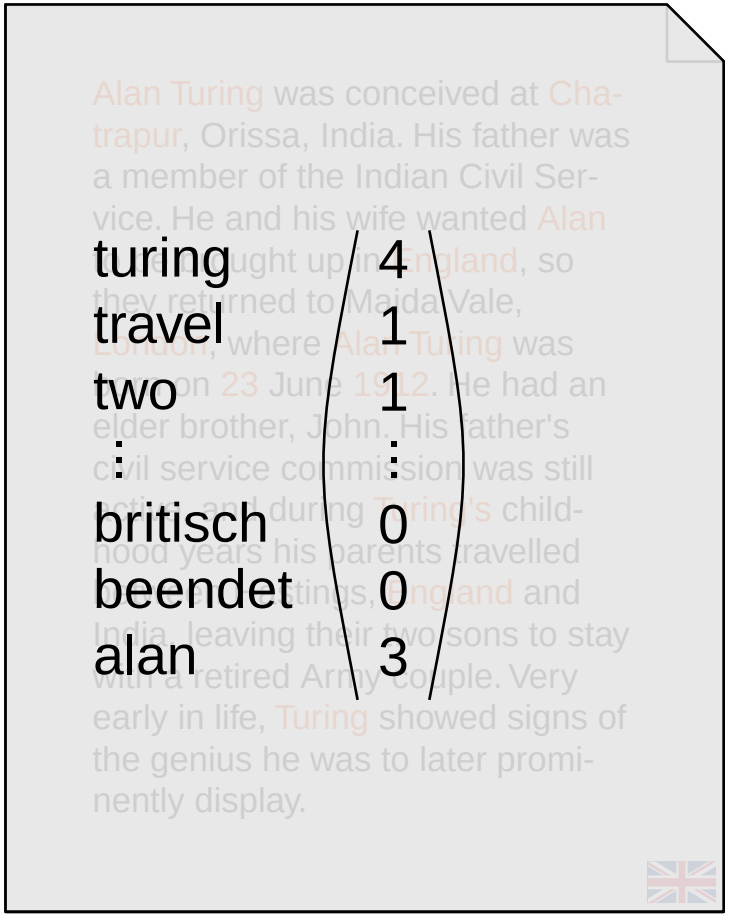

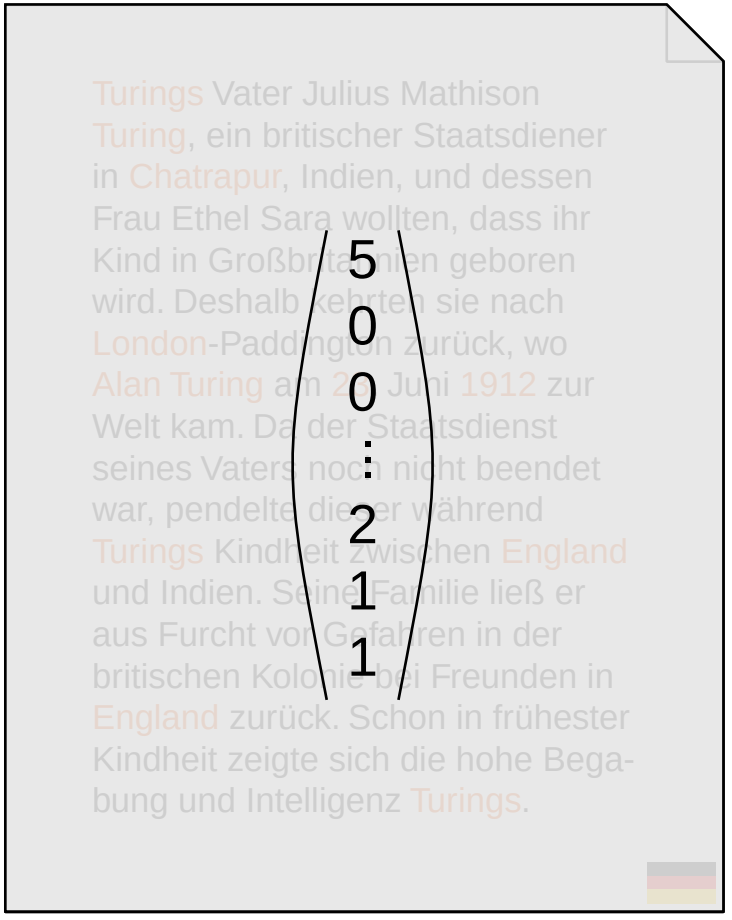

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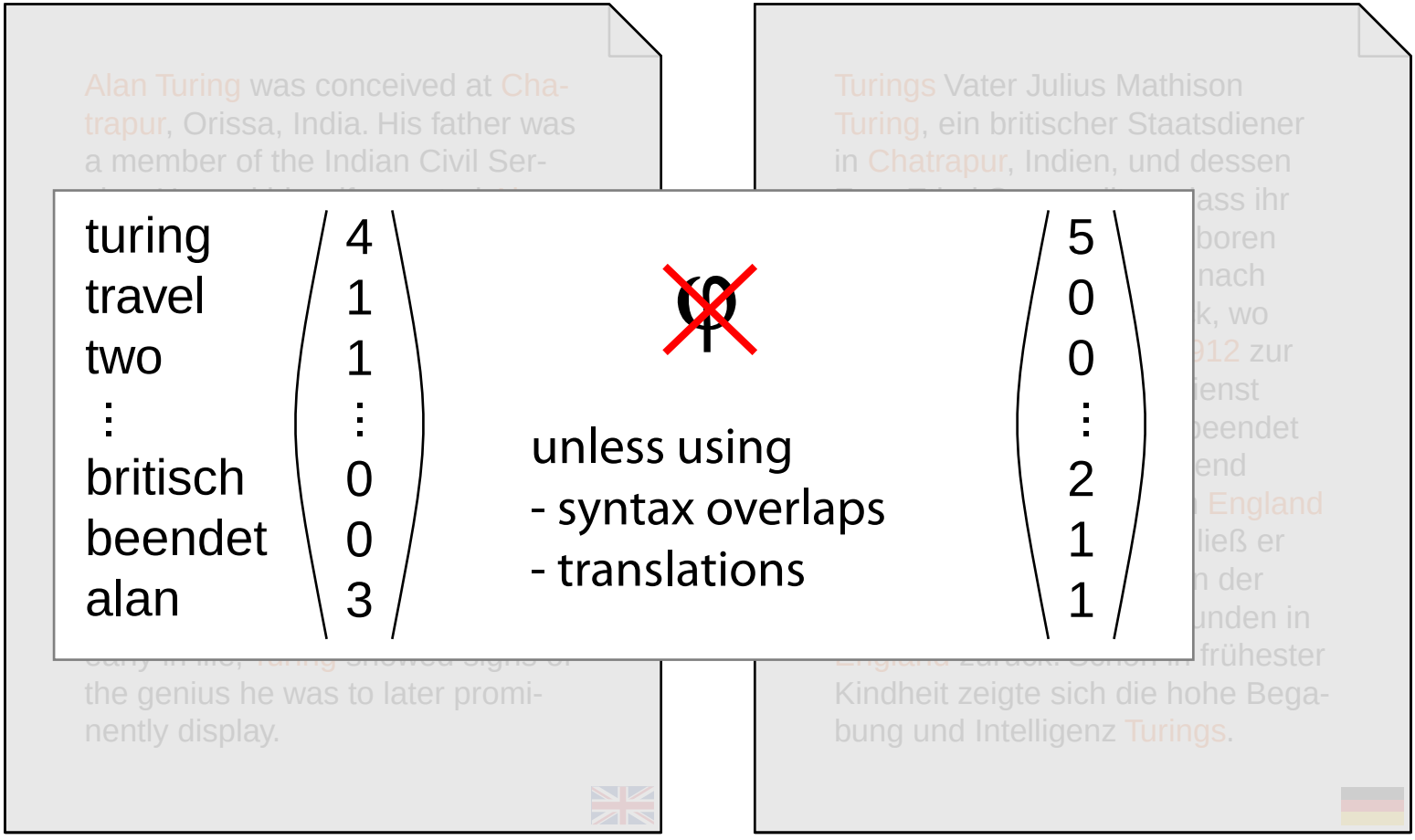

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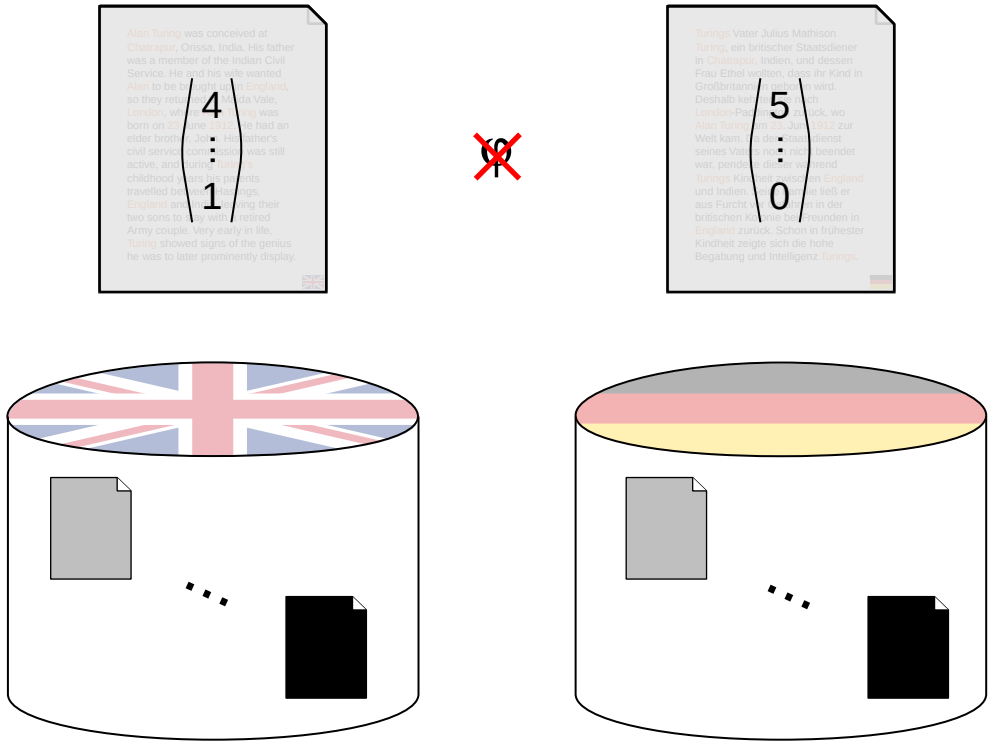

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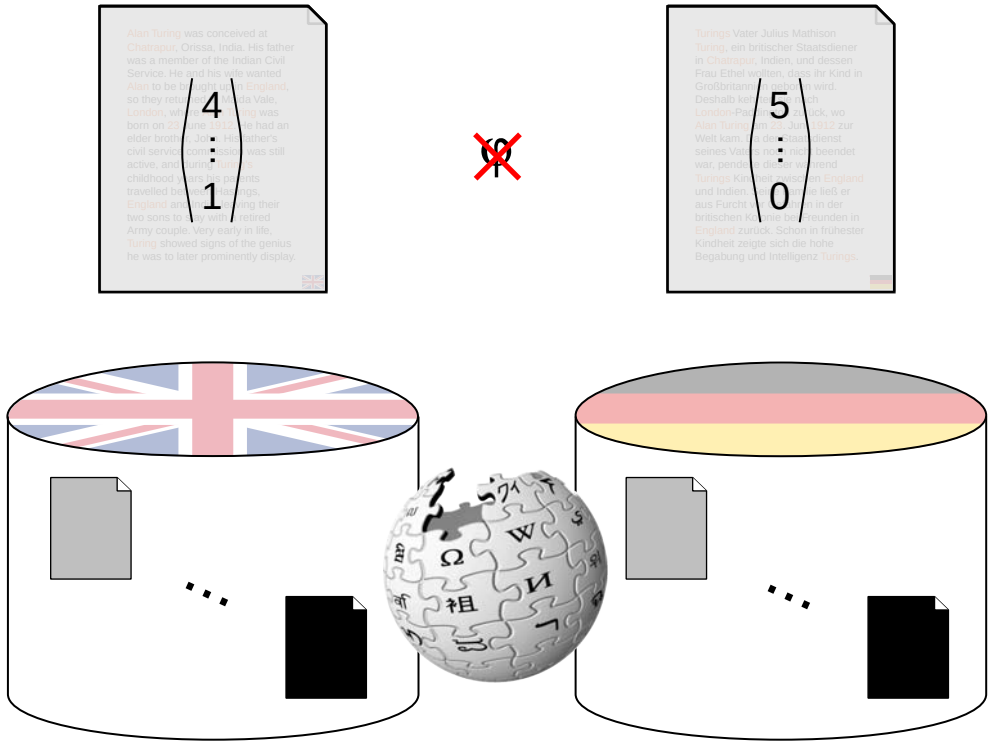

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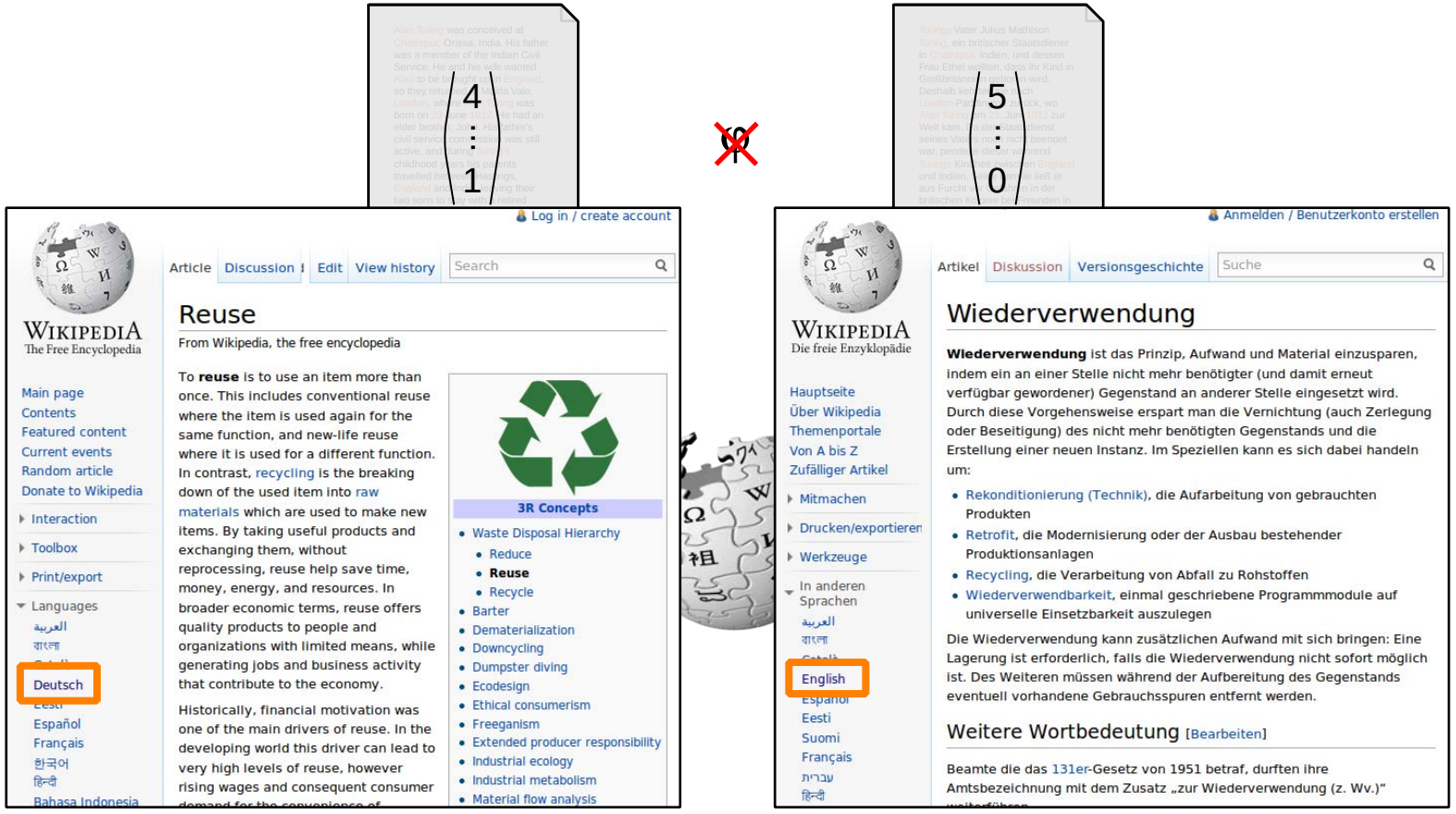

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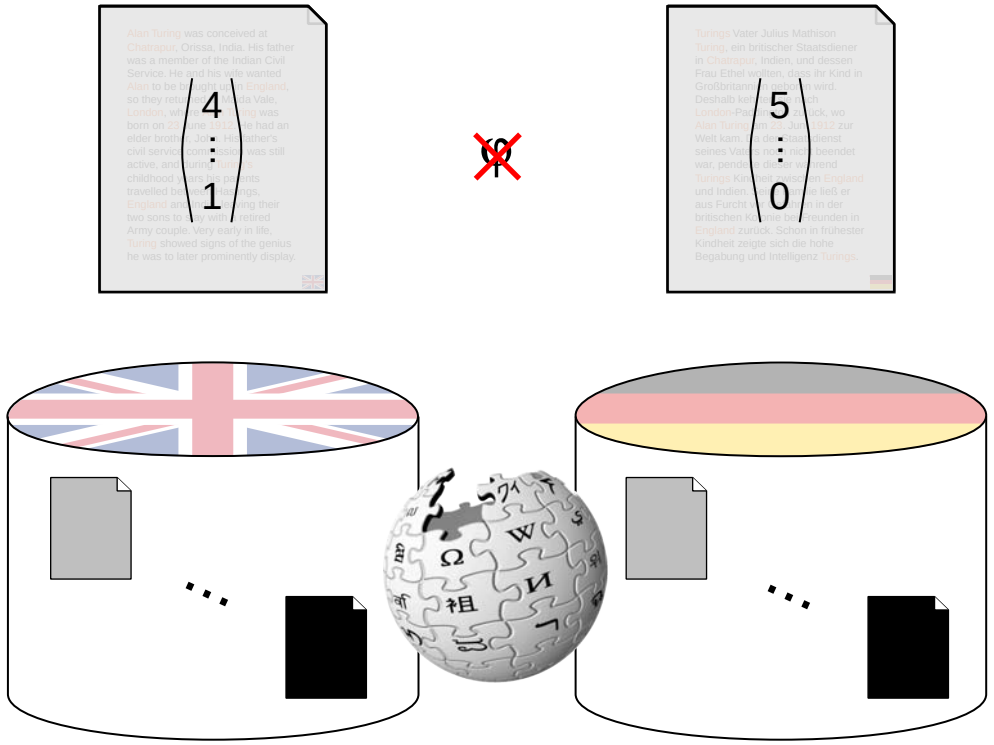

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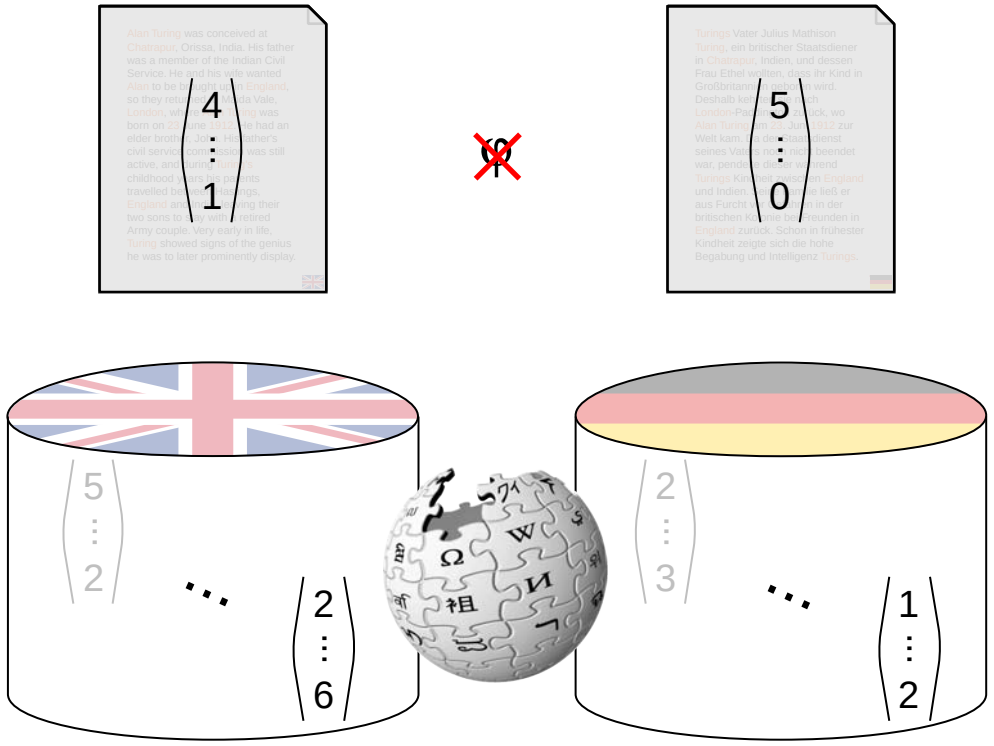

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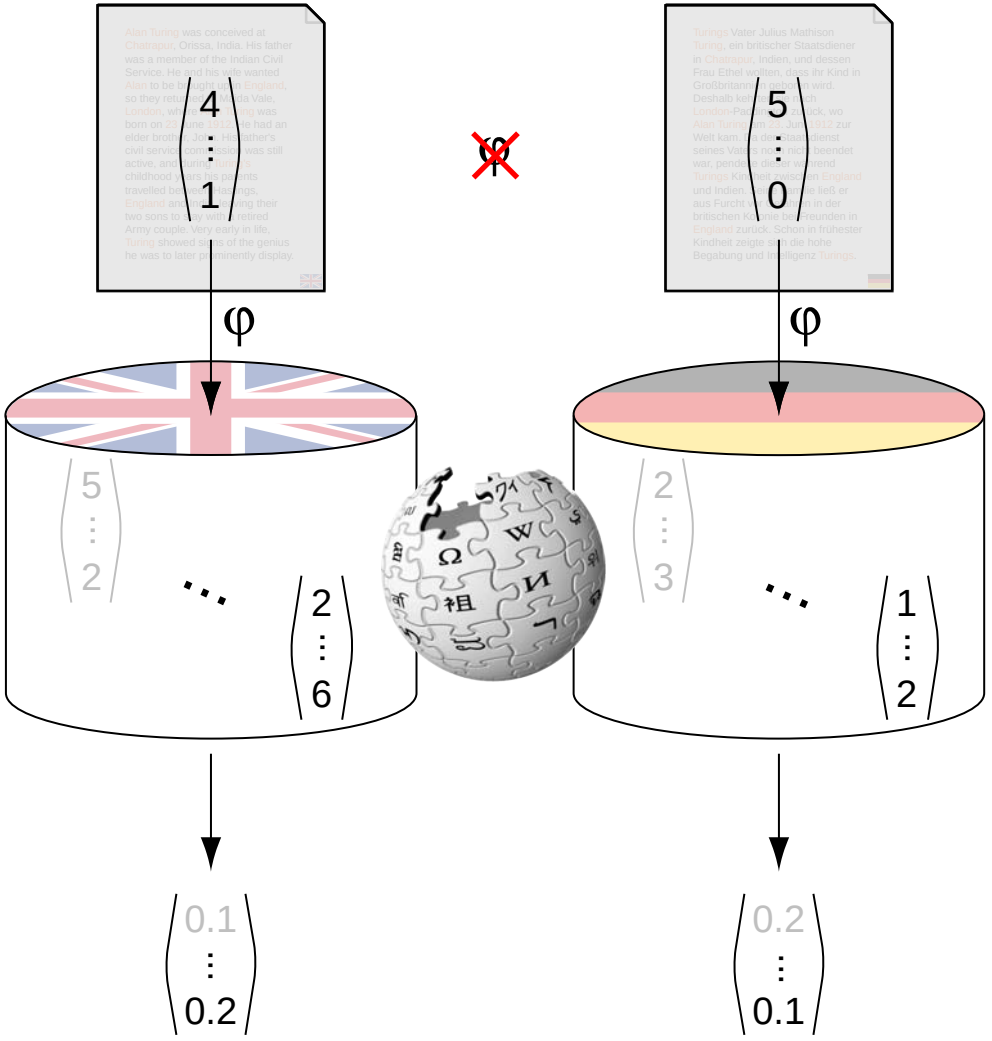

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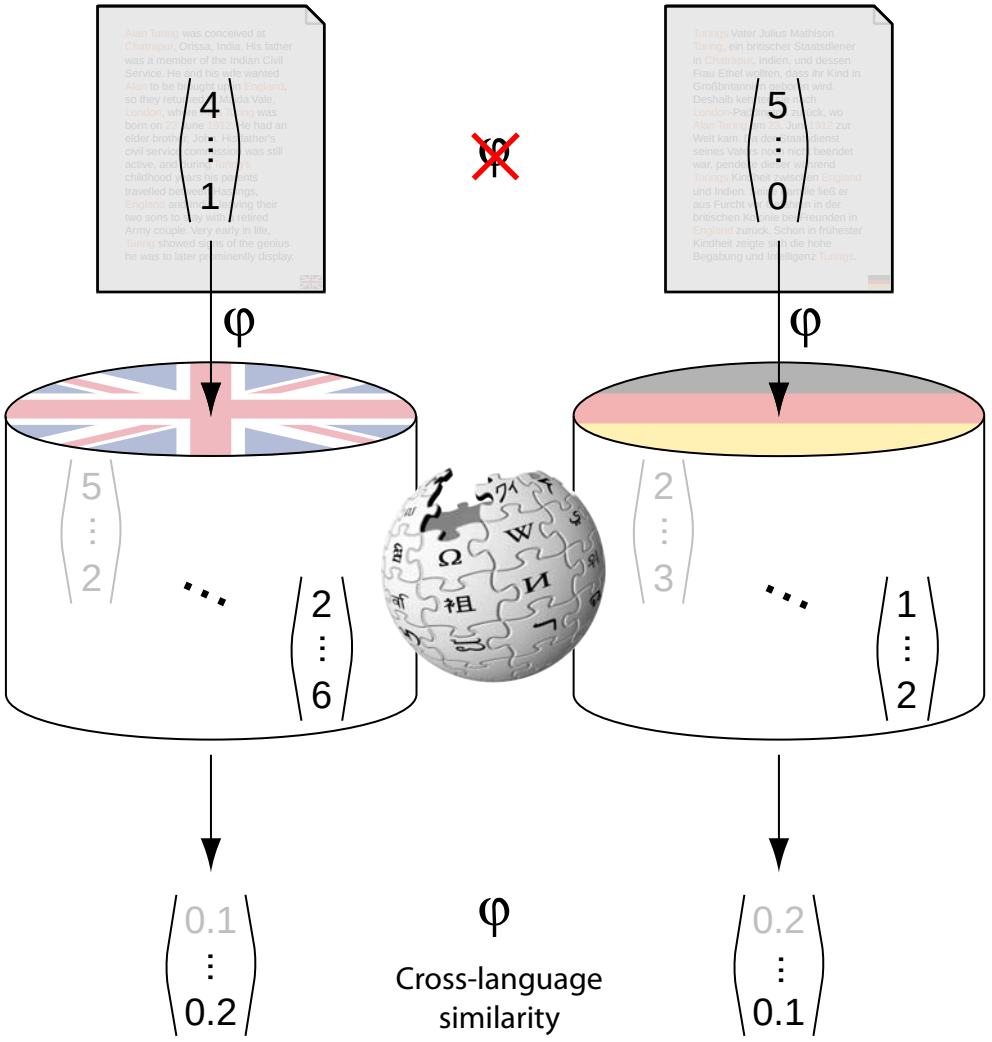


Cross-language Explicit Semantic Analysis

Experiments

1. cross-language ranking
2. bilingual rank correlation
3. cross-language similarity distribution
4. quality vs. dimensionality of CL-ESA
5. multilingualism (number of possible simultaneous languages)
6. runtime

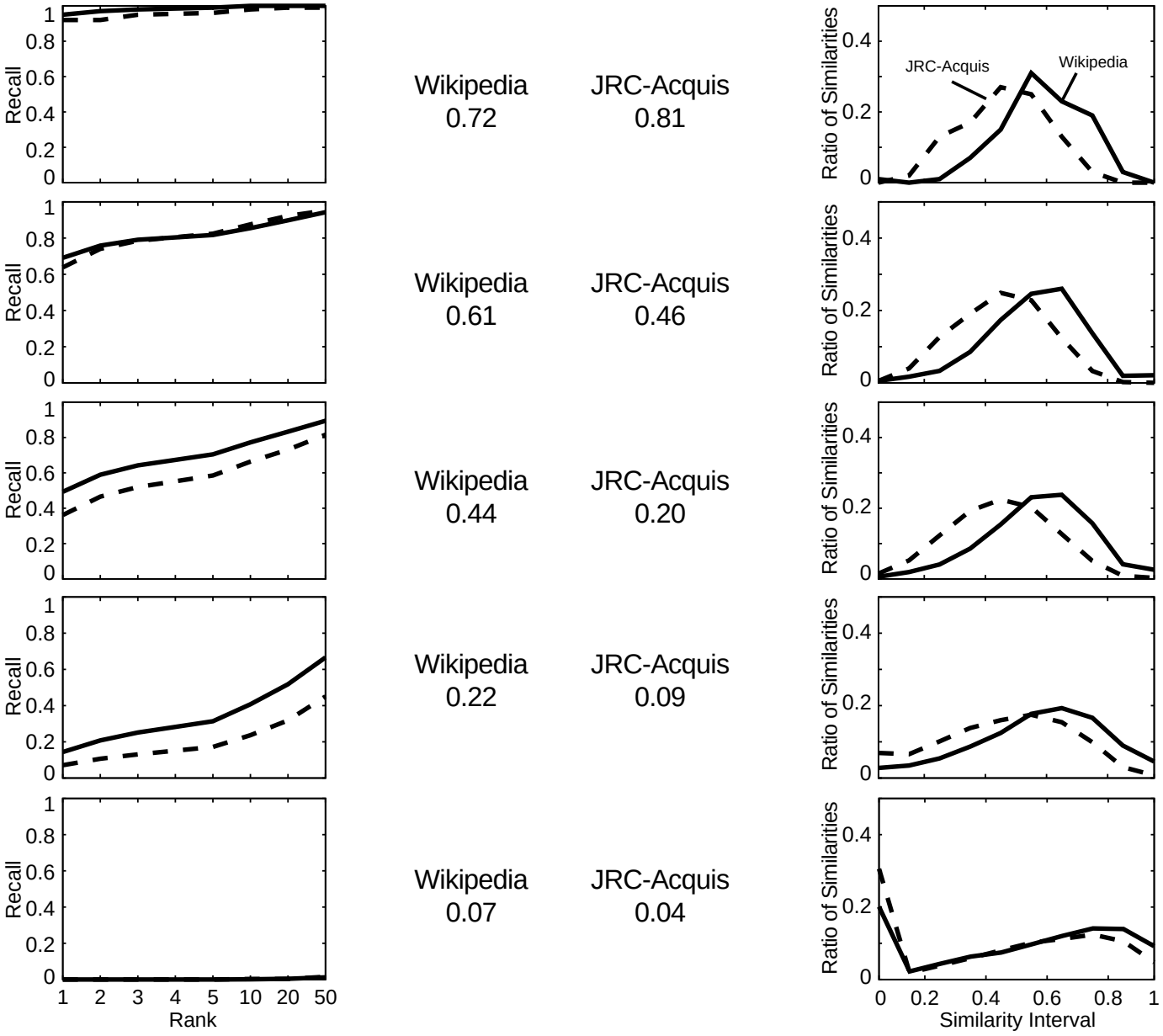
- comparison to two other state of the art models
- usage of 2 multilingual test collections
- comparison on 6 pairs of languages
- more than 100 000 documents in each of several dozen runs
- > 100 million similarities computed

Experiment 1
Cross-language Ranking

Experiment 2
Bilingual rank correlation

Experiment 3
Cross-language Similarity Distribution

Dimensions



Evaluating Plagiarism Detectors

Detection Performance Measures

Suspicious Document d_{plg}

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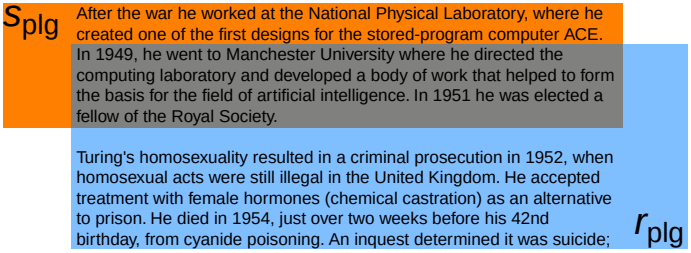
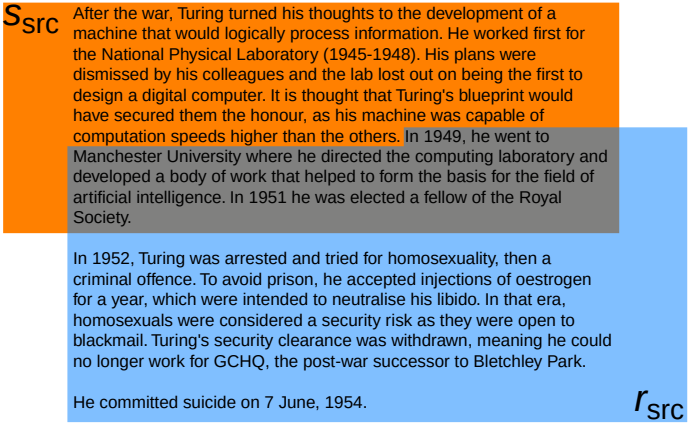
- What is the detection quality?

Detection Performance Measures





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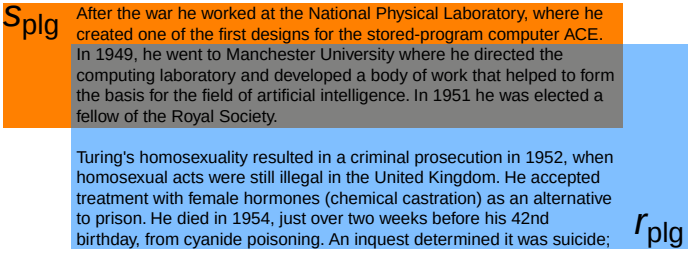
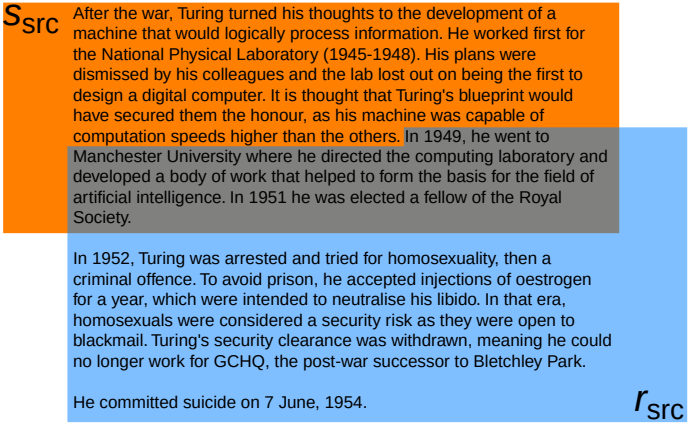
Detection Performance Measures



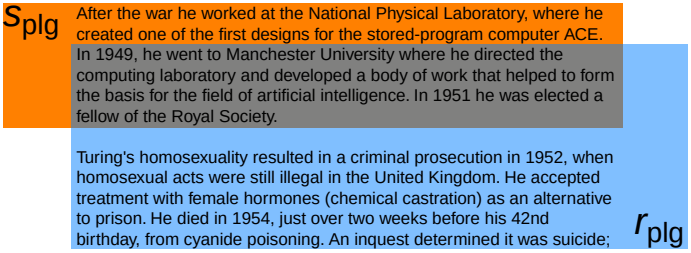


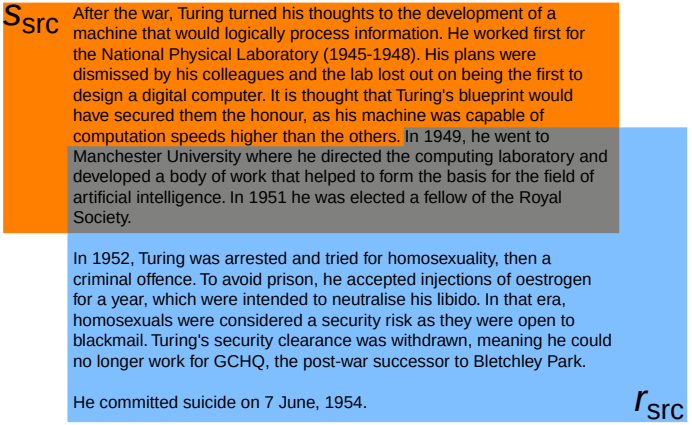
- Plagiarism $s = \langle s_{plg}, d_{plg}, s_{src}, d_{src} \rangle$
- Detection $r = \langle r_{plg}, d_{plg}, r_{src}, d'_{src} \rangle$

- What is the detection quality?

- r detects s iff $r_{plg} \cap s_{plg} \neq \emptyset$, $r_{src} \cap s_{src} \neq \emptyset$, and $d'_{src} = d_{src}$

Detection Performance Measures





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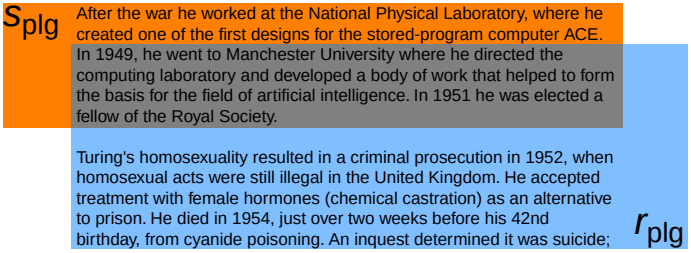

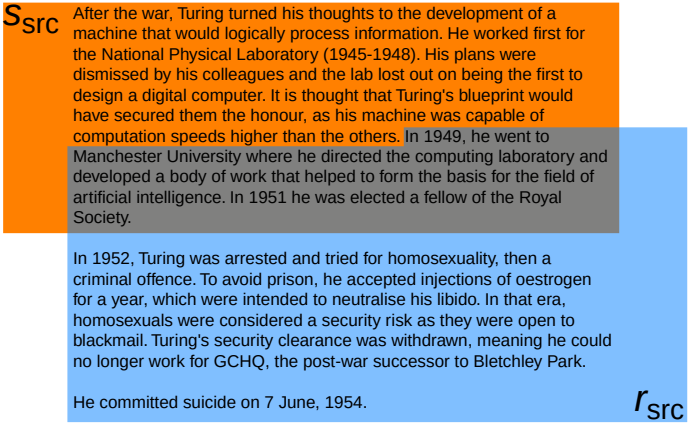

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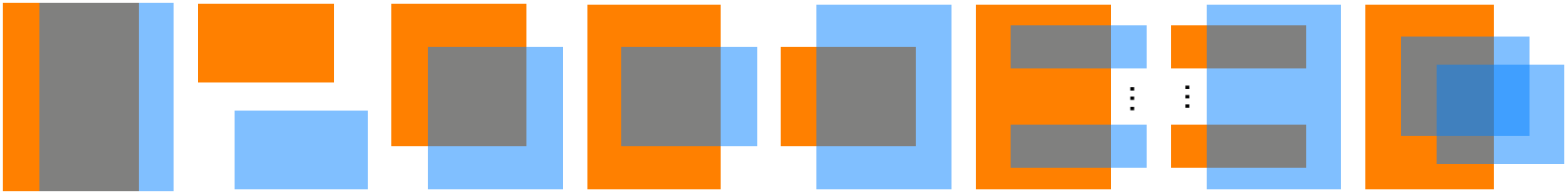
- *precicion*$(s, r) = \dfrac{|s \sqcap r|}{|r|} = 0.38$

- *recall*$(s, r) = \dfrac{|s \sqcap r|}{|s|} = 0.45$

Detection Performance Measures

Possible patterns:



+ combinations thereof
+ combinations regarding pairs of suspicious and source documents

Detection Performance Measures

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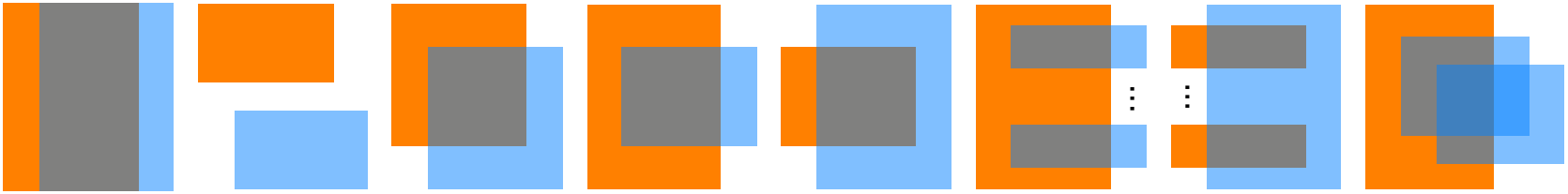

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- no 1:1 correspondence between plagiarism cases and detections
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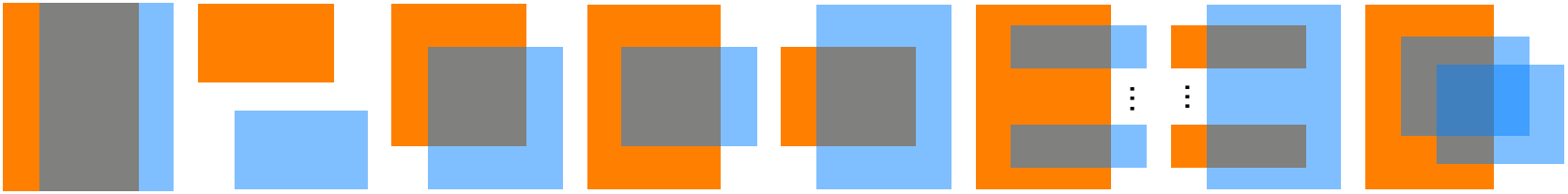

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- no 1:1 correspondence between plagiarism cases and detections
- deal with sets of detections R and plagiarism cases S
- avoid double-counting of detection overlaps (inclusion-exclusion principle)
- measure precision for each detection and recall for each plagiarism case, averaging the results:

$$\mathit{precicion}(S, R) = \frac{1}{|R|} \sum_{r \in R} \frac{\left| \bigcup_{s \in S} (\mathbf{s} \sqcap \mathbf{r}) \right|}{|\mathbf{r}|}$$

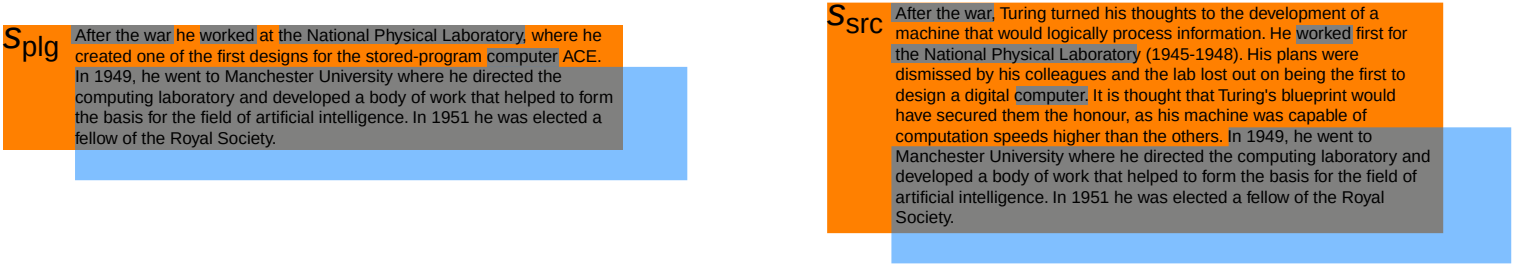
$$\mathit{recall}(S, R) = \frac{1}{|S|} \sum_{s \in S} \frac{\left| \bigcup_{r \in R} (\mathbf{s} \sqcap \mathbf{r}) \right|}{|\mathbf{s}|}$$

Detection Performance Measures

s_{plg} After the war he worked at the National Physical Laboratory, where he created one of the first designs for the stored-program computer ACE. In 1949, he went to Manchester University where he directed the computing laboratory and developed a body of work that helped to form the basis for the field of artificial intelligence. In 1951 he was elected a fellow of the Royal Society.

s_{src} After the war, Turing turned his thoughts to the development of a machine that would logically process information. He worked first for the National Physical Laboratory (1945-1948). His plans were dismissed by his colleagues and the lab lost out on being the first to design a digital computer. It is thought that Turing's blueprint would have secured them the honour, as his machine was capable of computation speeds higher than the others. In 1949, he went to Manchester University where he directed the computing laboratory and developed a body of work that helped to form the basis for the field of artificial intelligence. In 1951 he was elected a fellow of the Royal Society.

Detection Performance Measures



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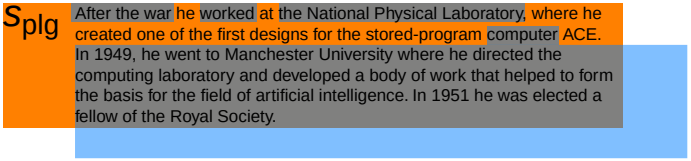

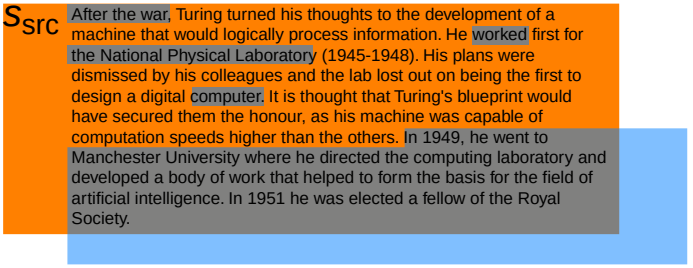

- undesirable fragmentation of the detection
- measure the average number of times a plagiarism case is detected:

$$\mathit{granularity}(S, R) = \frac{1}{|S_R|} \sum_{s \in S_R} |R_s|$$

where $S_R \subseteq S$ are detected cases, and $R_s \subseteq R$ are detections of s

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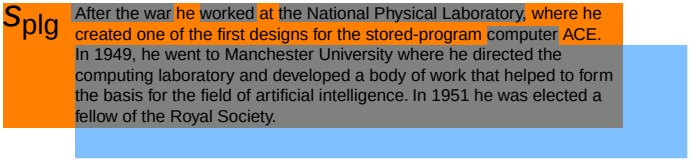

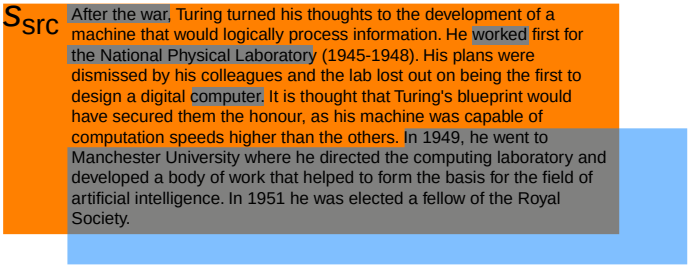

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- *precicion*, *recall*, and *granularity* allow only for a partial order
- combination of the three measures into one score:

$$\mathit{plagdet}(S, R) = \frac{F_1}{\log_2(1 + \mathit{granularity}(S, R))}$$

where F_1 is the harmonic mean of *precicion* and *recall*

Evaluation Competitions at PAN 2009-2011

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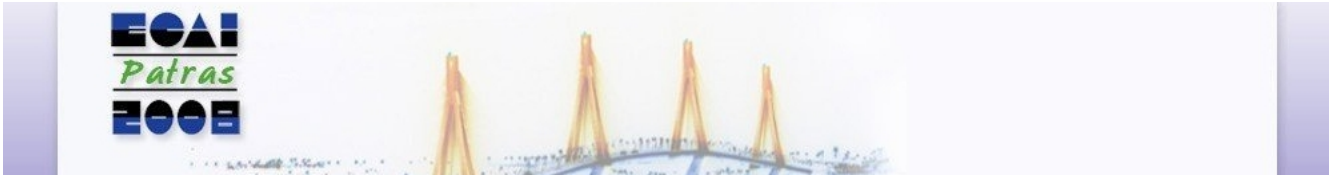
2007

2008



2009

2010

2011

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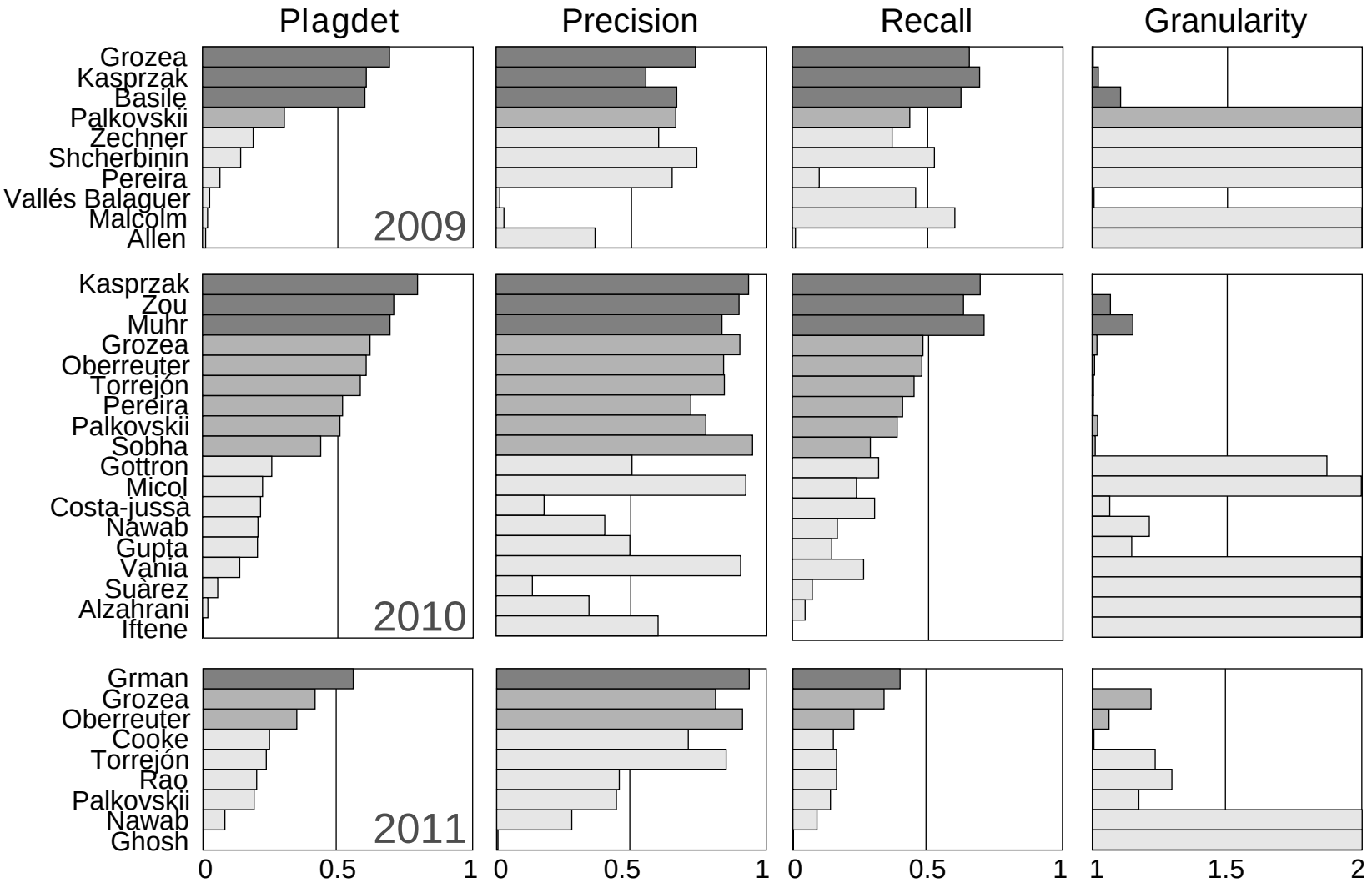

Reusing the Web for Writing Assistance

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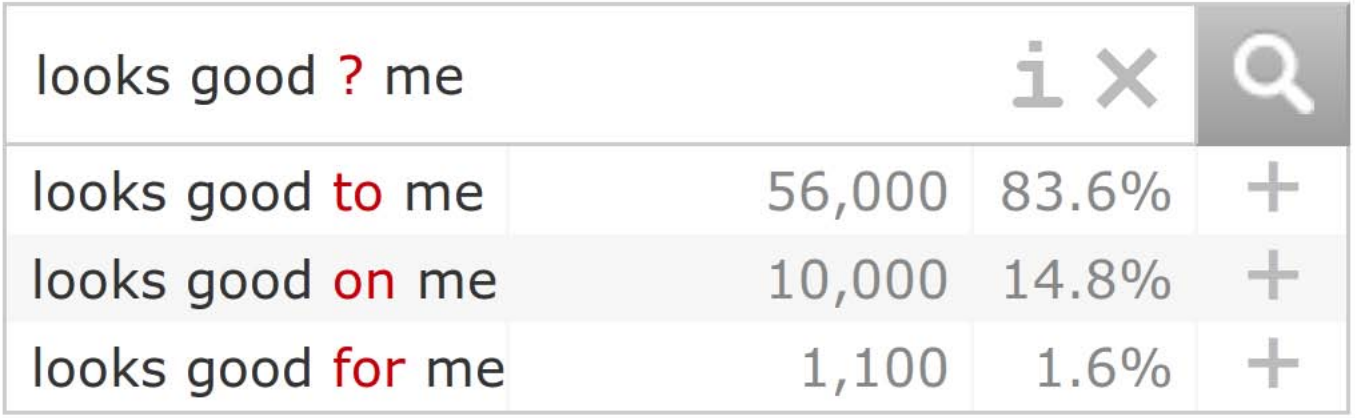
- writing is not so much about what to write, but how
- finding the right words is essential to maximize understanding
- Netspeak is a search engine for words in context:



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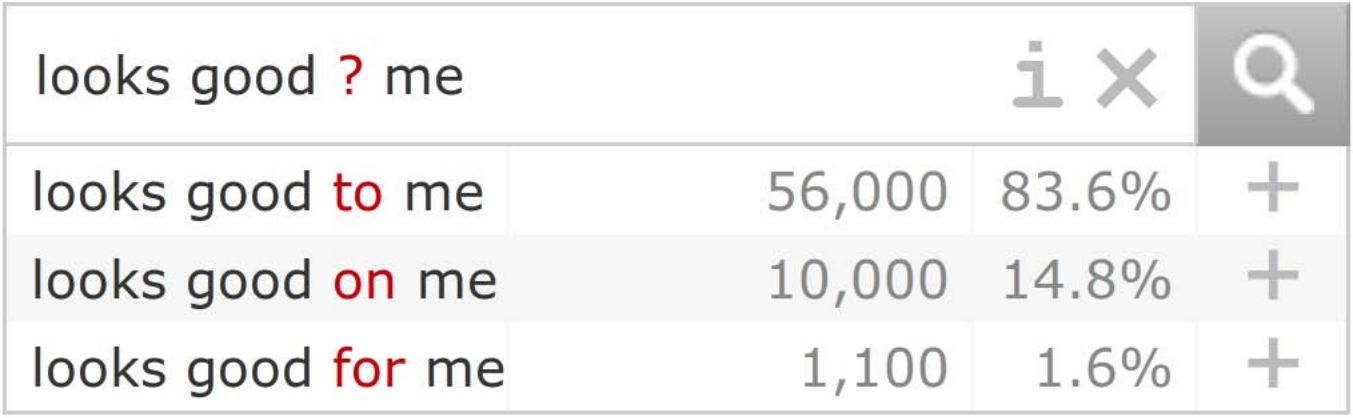
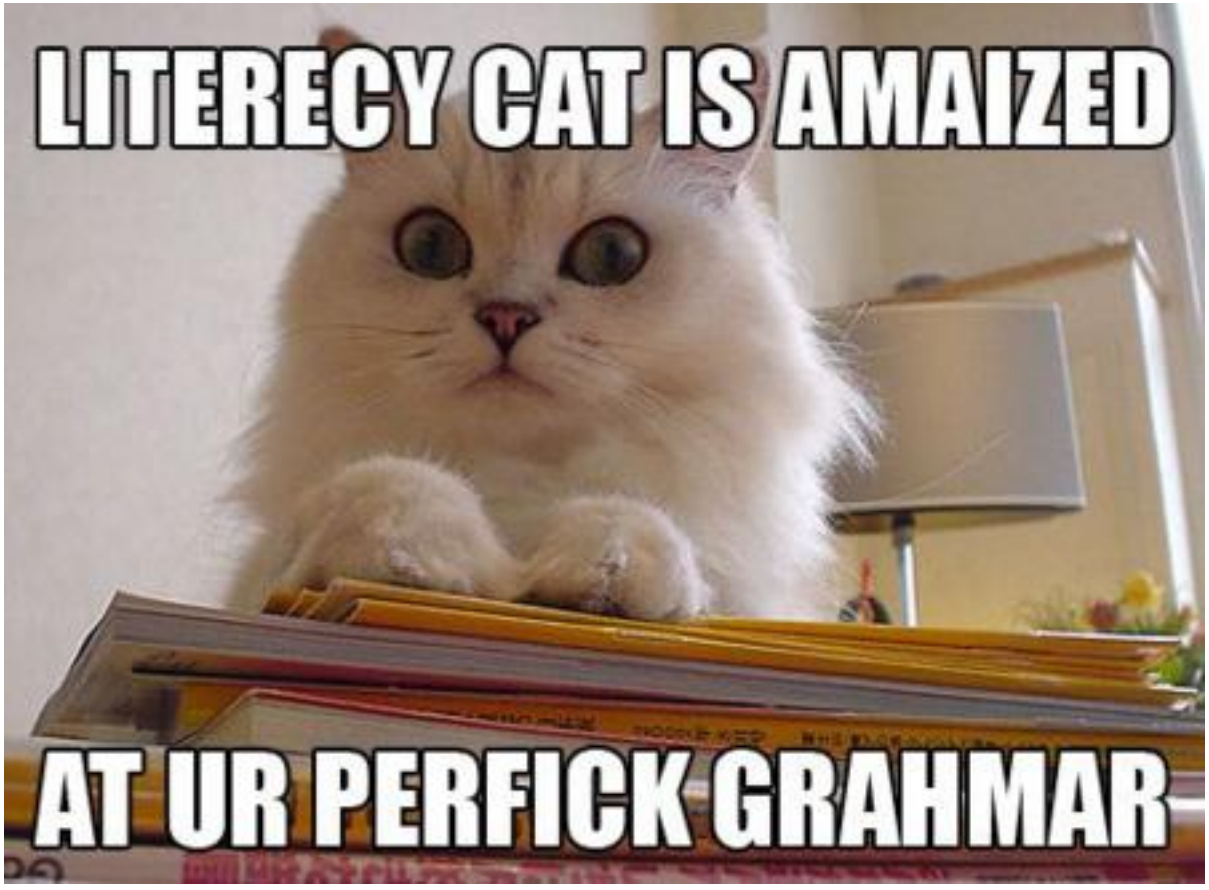


Technical details:

- > 3 billion phrases and their usage frequencies as of 2006.
- > 120 GB inverted index data structure (scalable)
- < 1 second response time
- > 4300 users / month
- wildcard query processor
- instant search



Contributions of Technologies for Reusing Text from the Web

1. Models & Algorithms
   - Unifying fingerprinting framework
   - Cross-language ESA
   - Comment cross-media similarity
   - Query segmentation algorithms

2. Surveys
   - Fingerprinting
   - Plagiarism detection
   - Web comment retrieval
   - Query segmentation

3. Evaluation Resources
   - Wikipedia as near-duplicate corpus
   - Wikipedia as cross-language corpus
   - 3 measures for plagiarism detection
   - 3 plagiarism corpora
   - Query segmentation corpus

4. Comparative Evaluations
   - 5 fingerprint algorithms
   - 3 cross-language models
   - 32 plagiarism detectors within 3 PAN evaluation competitions
   - 8 query segmentation algorithms

5. Tools
   - Netspeak
   - Picapica
   - OpinionCloud
   - Altools lib

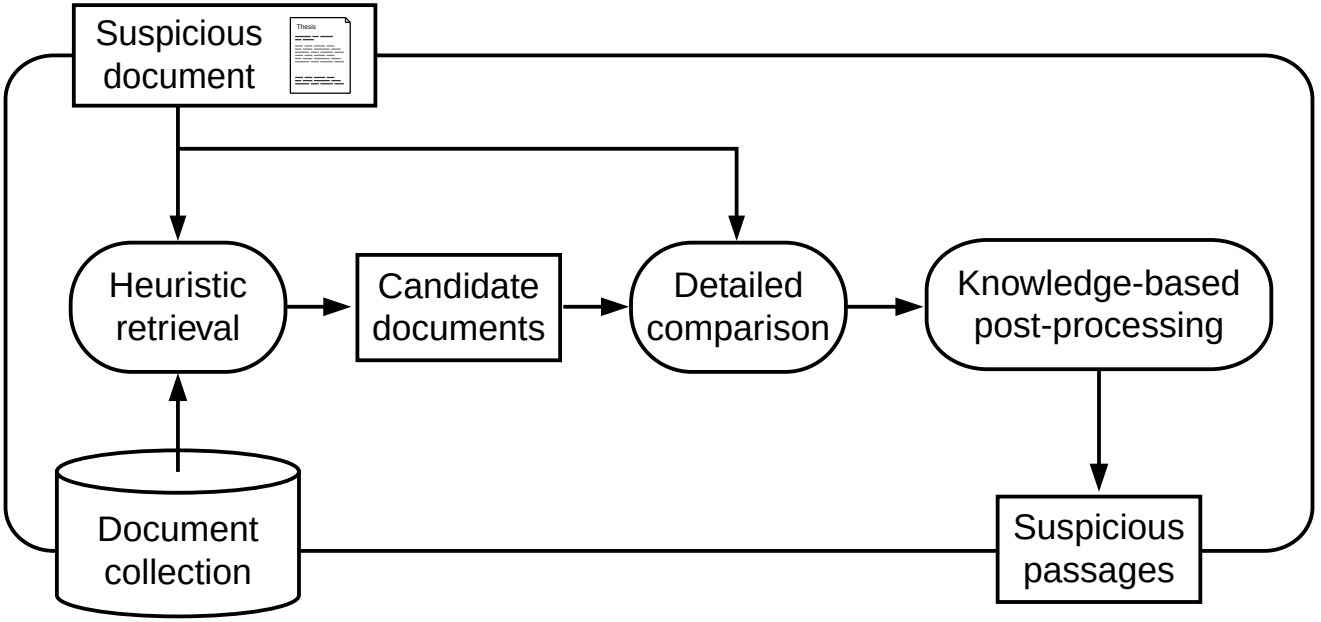
Benno Stein ❑ Maik Anderka ❑ Steven Burrows ❑ Tim Gollub ❑ Matthias Hagen ❑ Dennis Hoppe ❑ Nedim Lipka ❑ Sven Meyer zu Eißen ❑ Peter Prettenhofer ❑ Patrick Riehmann ❑ Bernd Fröhlich ❑ Alberto Barrón-Cedeño ❑ Paolo Rosso ❑ Paul Clough ❑ Steffen Becker ❑ Christof Bräutigam ❑ Andreas Eiselt ❑ Robert Gerling ❑ Teresa Holfeld ❑ Alexander Kümmel ❑ Fabian Loose ❑ Martin Trenkmann ❑ Dietmar Bratke ❑ Jürgen Eismann ❑ Nadin Glaser ❑ Maria-Theresa Hansens ❑ Melanie Hennig ❑ Dana Horch ❑ Antje Klahn ❑ Hildegard Kühndorf ❑ Tina Meinhardt ❑ Christin Oehmichen ❑ Ursula Schmidt ❑ Katja Schöllner ❑ Nils Rethmeier ❑ Tsvetomira Palakarska ❑ Steven Rönisch ❑ Hagen Christian Tönnies ❑ Michael Völske ❑ Anita Schilling ❑ Michael Bierstedt ❑ Christoph Lössnitz ❑ Dennis Braunsdorf ❑ Alexander Kleppe ❑ Franz Coriand ❑ Verena Skuk ❑ Anne Köpsel ❑ Marcel Heunemann ❑ Stefan Knoblauch ❑ Klaus Krämer ❑ Christian Fricke ❑ Denis Kreis ❑ Clement Welsch ❑ Maximilian Michel ❑ Jan Grassegger ❑ Jan Dittrich ❑ Fabian Vogelsteller ❑ Felicitas Höbelt ❑ Carsten Tetens ❑ Jan Hühne ❑ Nils Gründl ❑ André Zölitz ❑ Michael Hengst ❑ Yunlu Ai ❑ Markus Riedel ❑ Bjarne-Vanja Melani ❑ Henning Gründl ❑ Stephan Bongartz ❑ Daniel, Wiebke, Marc und Merle Potthast ❑ Steffi, Leonie und Louisa Daniel ❑ Gabi und Günter Aab ❑ Georg Potthast und Hildegard Knoke ❑ Ellinor Pfützner ❑ Martin Weitert ❑ Daniel Warner ❑ Christian Ederer

Thank you!

Appendix

- Detecting Plagiarism and Evaluating Detectors
- Survey of Plagiarism Detection Evaluations
- Plagiarism Corpus Construction
- Netspeak Experiments

Detecting Plagiarism



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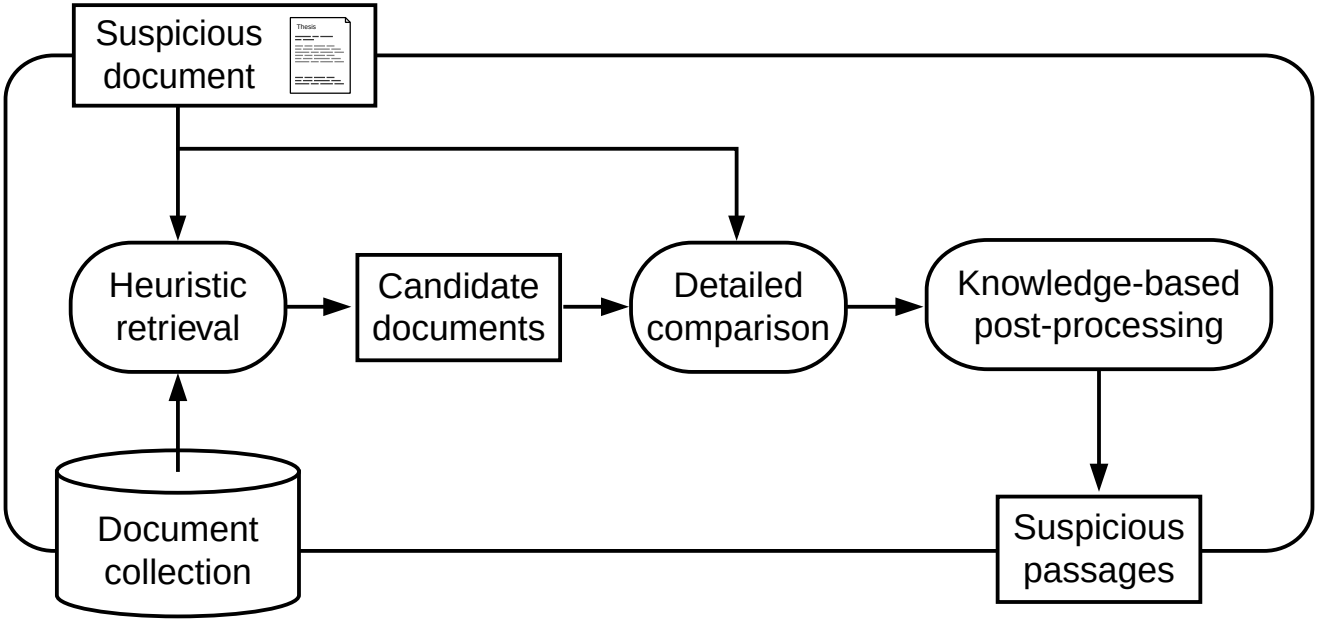

Evaluating Plagiarism Detectors

Simulate inputs — measure output quality — repeat

What's required:

- corpus of plagiarism cases
- performance mesaures
- alternative implementations

Survey of Plagiarism Detection Evaluations

Evaluation Aspect	Text	Code
Experiment Task		
local collection	80%	95%
Web retrieval	15%	0%
other	5%	5%
Performance Measure		
precision, recall	43%	18%
manual, similarity	35%	69%
runtime only	15%	1%
other	7%	12%
Comparison		
none	46%	51%
parameter settings	19%	9%
other algorithms	35%	40%

Evaluation Aspect	Text	Code
Corpus Acquisition		
existing corpus	20%	18%
homemade corpus	80%	82%
Corpus Size [# documents]		
$[1, 10)$	11%	10%
$[10, 10^2)$	19%	30%
$[10^2, 10^3)$	38%	33%
$[10^3, 10^4)$	8%	11%
$[10^4, 10^5)$	16%	4%
$[10^5, 10^6)$	8%	0%

- more than 200 papers were reviewed
- many struggle with proper evaluation

Plagiarism Corpus Construction

Corpus overview:

- real plagiarism cases not available on a large scale
- plagiarism was generated automatically using heuristics
- plagiarism was also crowdsourced via Amazon's Mechanical Turk
- the corpus was compiled 3 years in a row, improving it each time
- $\sim$ 27 000 documents (obtained from the Project Gutenberg)
- $\sim$ 61 000 plagiarism cases

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Corpus parameters:

1. document length
2. document purpose
3. plagiarism per document
4. plagiarism case length
5. plagiarism case obfuscation

Corpus Parameters

100%	26 939 documents

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Document length:

50% 1-10 pages	35% 10-100 pages	15% 10^2-10^3 pp.

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50% source documents	50% suspicious documents

Plagiarism per suspicious document:

50% none	50% range from little to entirely

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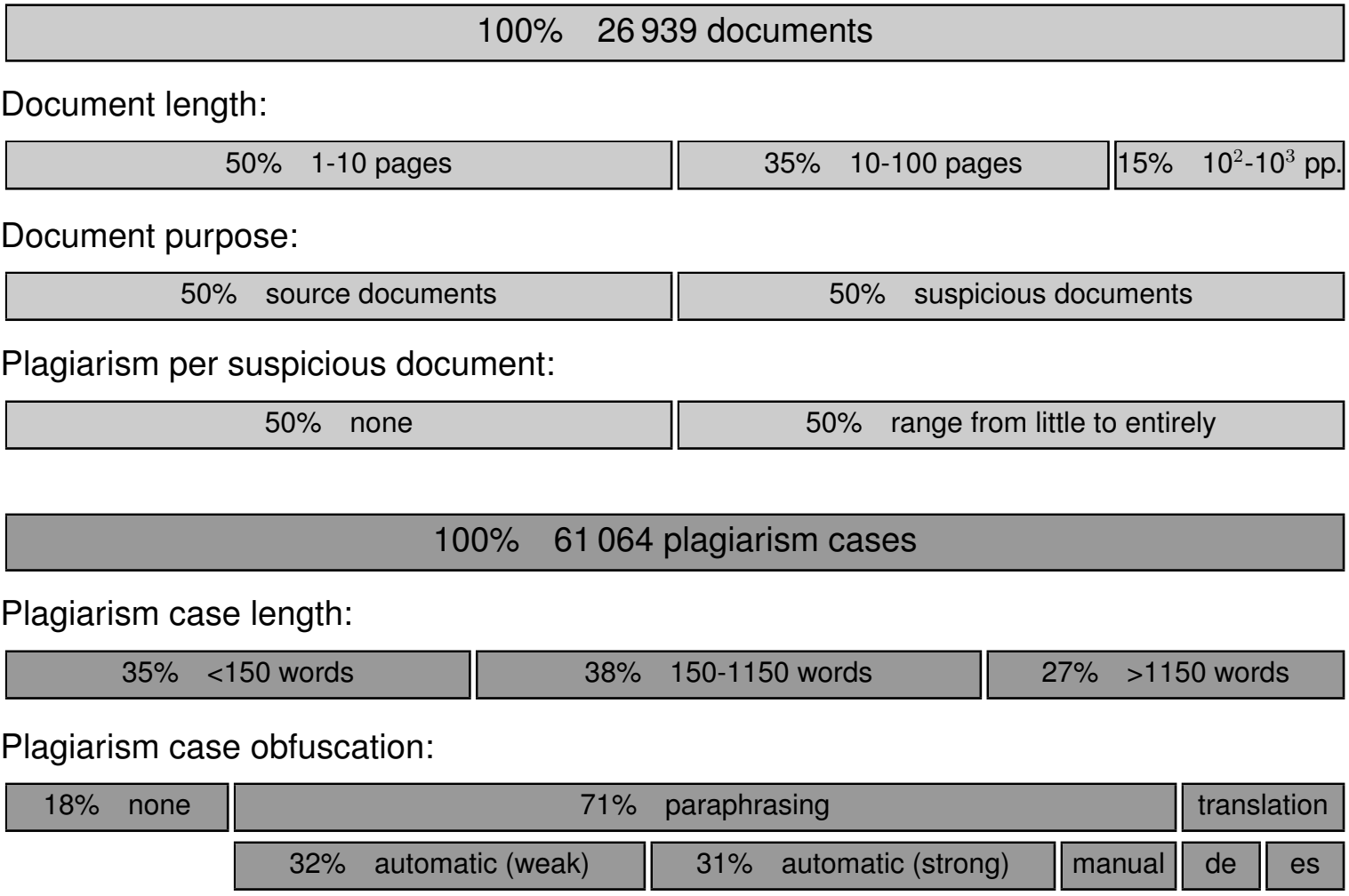

- Manual paraphrases (8%) via Amazon's Mechanical Turk.
- Translations (11%) via Google Translate from de→en and es→en.

Netspeak Experiments