On Web-based Plagiarism Analysis

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What is Plagiarism?

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Fact: About 50% of the students admit to plagiarize from Internet documents (study on 18,000 students).

[McCabe 2005]

Current Research on Plagiarism Analysis

Current research is corpus-oriented.

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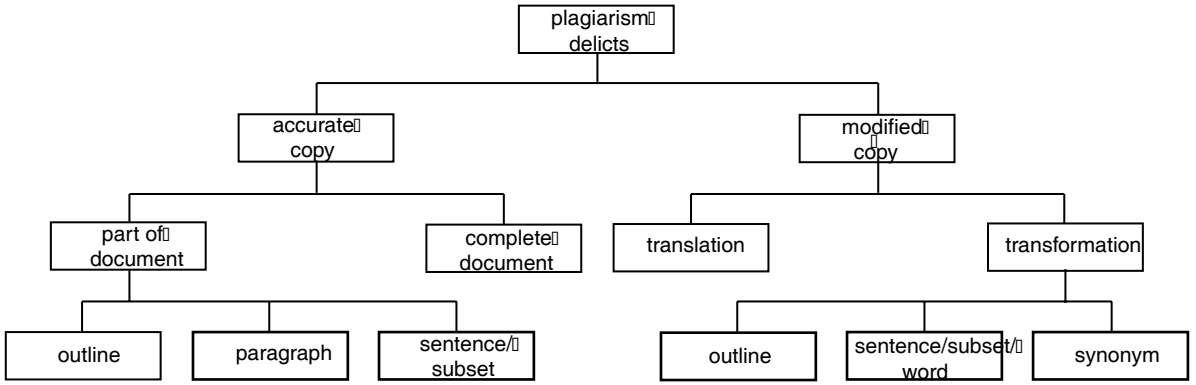
Research questions:

- How can a corpus of potentially original documents be constructed from the Web?
- Can plagiarized parts be detected *without* a corpus?

Plagiarism Forms

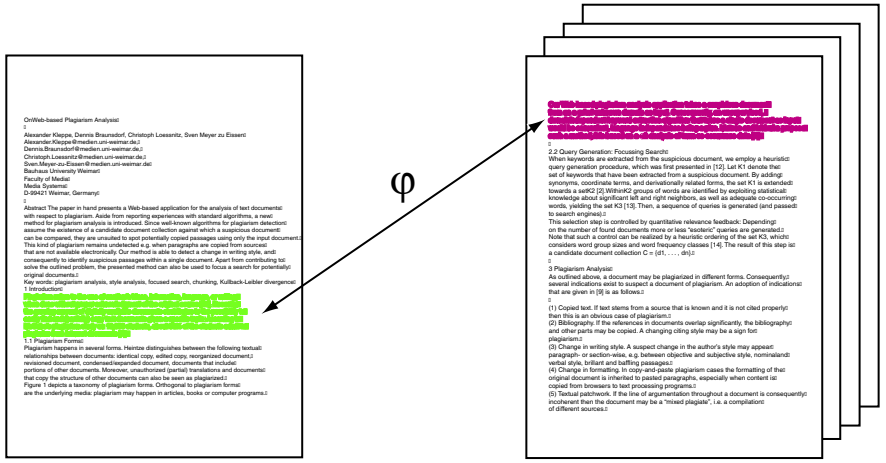
Plagiarism may happen in manyfold variants:



Plagiarism Analysis against a Corpus (1)

Intuition:

- Partition each document in meaningful units (“chunks”).
- Compare them with a similarity function φ (pairwise).



suspicious document corpus documents

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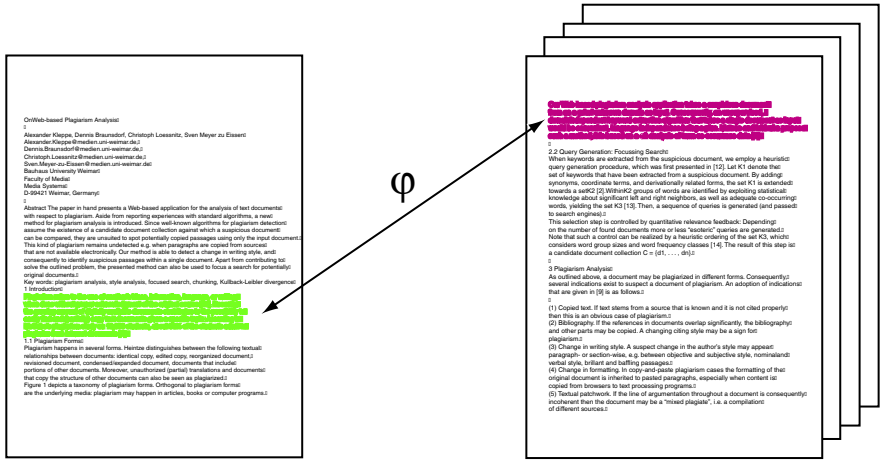

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Complexity:

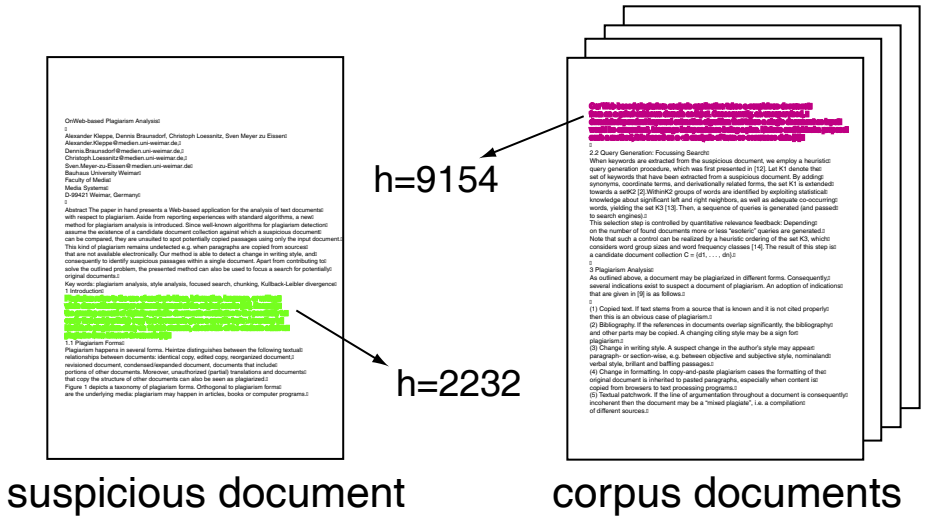
n documents in corpus, c chunks per document on average

➜ $O(n \cdot c^2)$ comparisons

Plagiarism Analysis against a Corpus (2)

Text comparison with digital fingerprints:

- Partition each document in meaningful units (“chunks”).
- Compute fingerprints of the chunks using a hash function h.
- Put all hashes into a hashtable. A collision indicates matching chunks.



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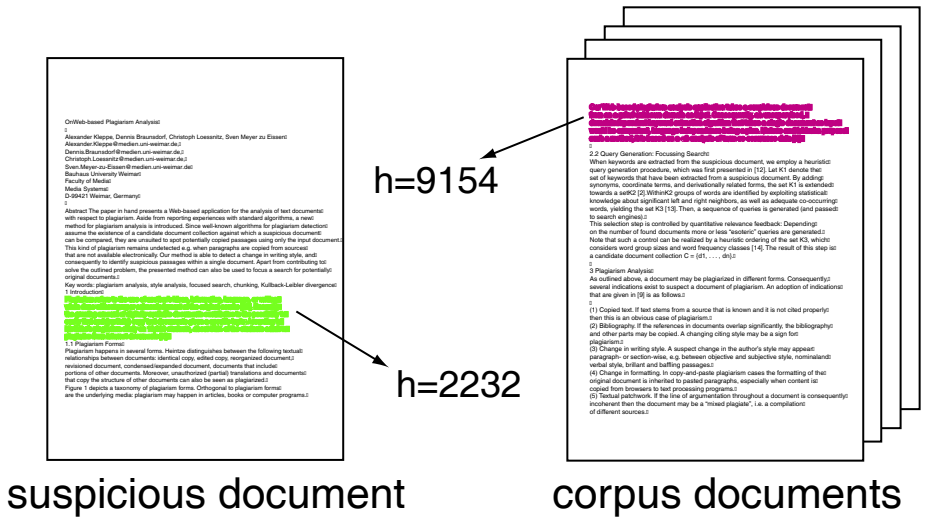

Complexity:

n documents in corpus, c chunks per document on average

➜ $O(n \cdot c)$ operations (fingerprint generation, hashtable operations).

Plagiarism Analysis against a Corpus (3)

Discussion :

- Hashing is fast, but sensitive to (even small) changes:
  $h(c_1) = h(c_2) \Rightarrow c_1 = c_2$ (with very high probability).
- Pairwise comparisons based on similarity-function φ are too expensive.

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Current research:

- Focus on *fuzzy* hash functions h_F:
  $h_F(c_1) = h_F(c_2) \Rightarrow \varphi(c_1, c_2) \geq 1 - \varepsilon$ [Stein 2005]
- Fuzzy hash functions allow for big chunk sizes (speed-up) and are not sensitive to changes.

Indications for Plagiarism

Text similarity is not the only indication for plagiarism.

Indications include:

- Changes in formatting.
- *Changes in writing style*.
- Broken argumentation.
- Inconsistent spelling.
- Outmoded diction.

These indications can be detected (by humans) without corpora.

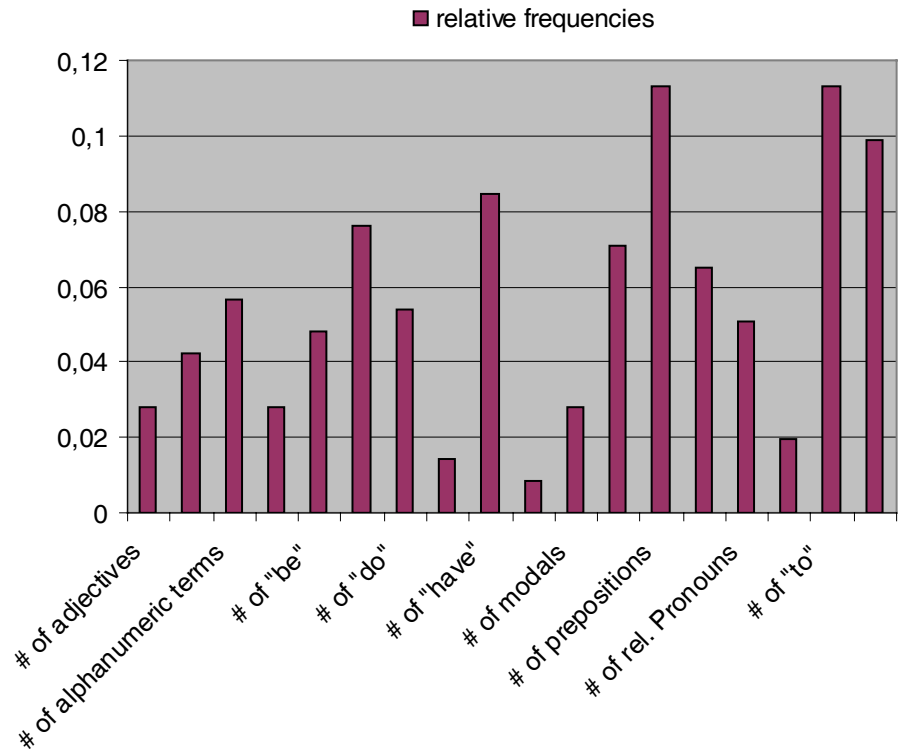
➜ How can we operationalize the detection of these indications?

Style Analysis

Q: How can writing style changes be measured?

A: Not directly, but divergences of word class distributions give hints.

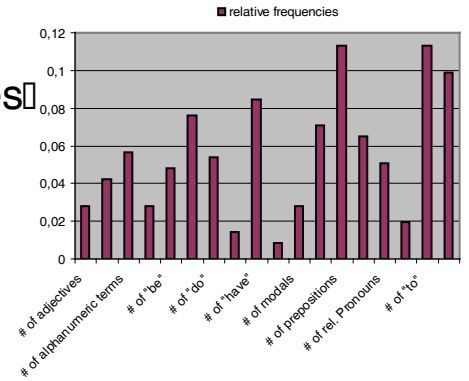
Word class use in a document:



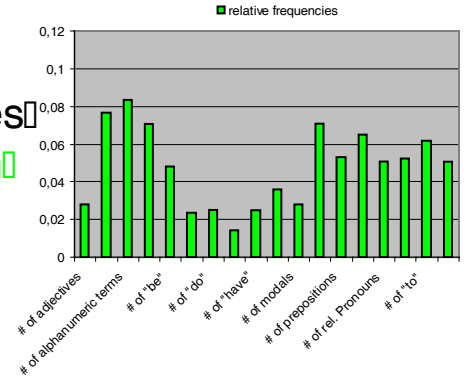
Style Analysis

Idea: Compare the word class distribution of each paragraph to the distribution of the entire document.

word-class frequencies for the document (global distribution)



word-class frequencies for a single paragraph (local distribution)



Style Analysis

The divergence can be measured by means of the Kullback-Leibler divergence.

Let W denote the set of word classes, let $w \in W$,

let $p(w)$ denote local word class frequencies,

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The Kullback-Leibler divergence measure is defined as

$$KL_W(p,q) = \sum_{w \in W} p(w) \log \frac{p(w)}{q(w)} = H(p,q) - H(p) \in \mathbf{R}_0^+$$

If $KL_W(p,q)$ is significant then the paragraph that is associated with p may be copied.

We found KL_W to work very well when single paragraphs are copied from one document to another.

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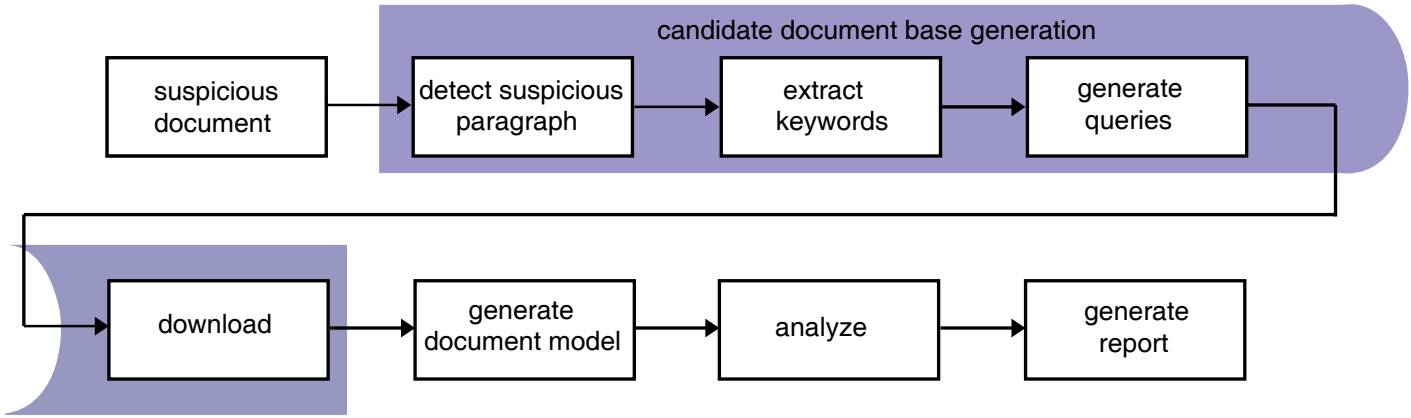
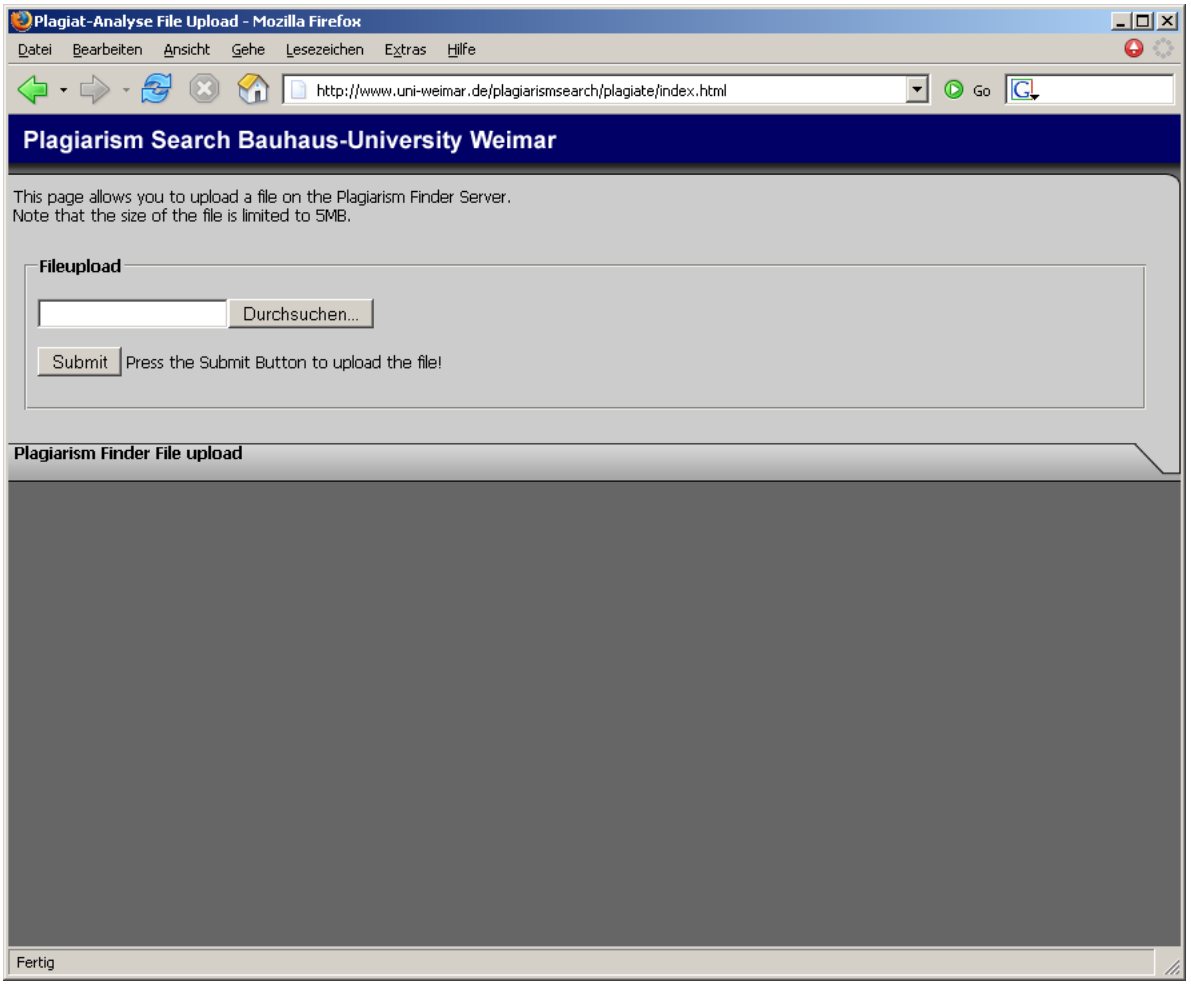


Prototypic Implementation



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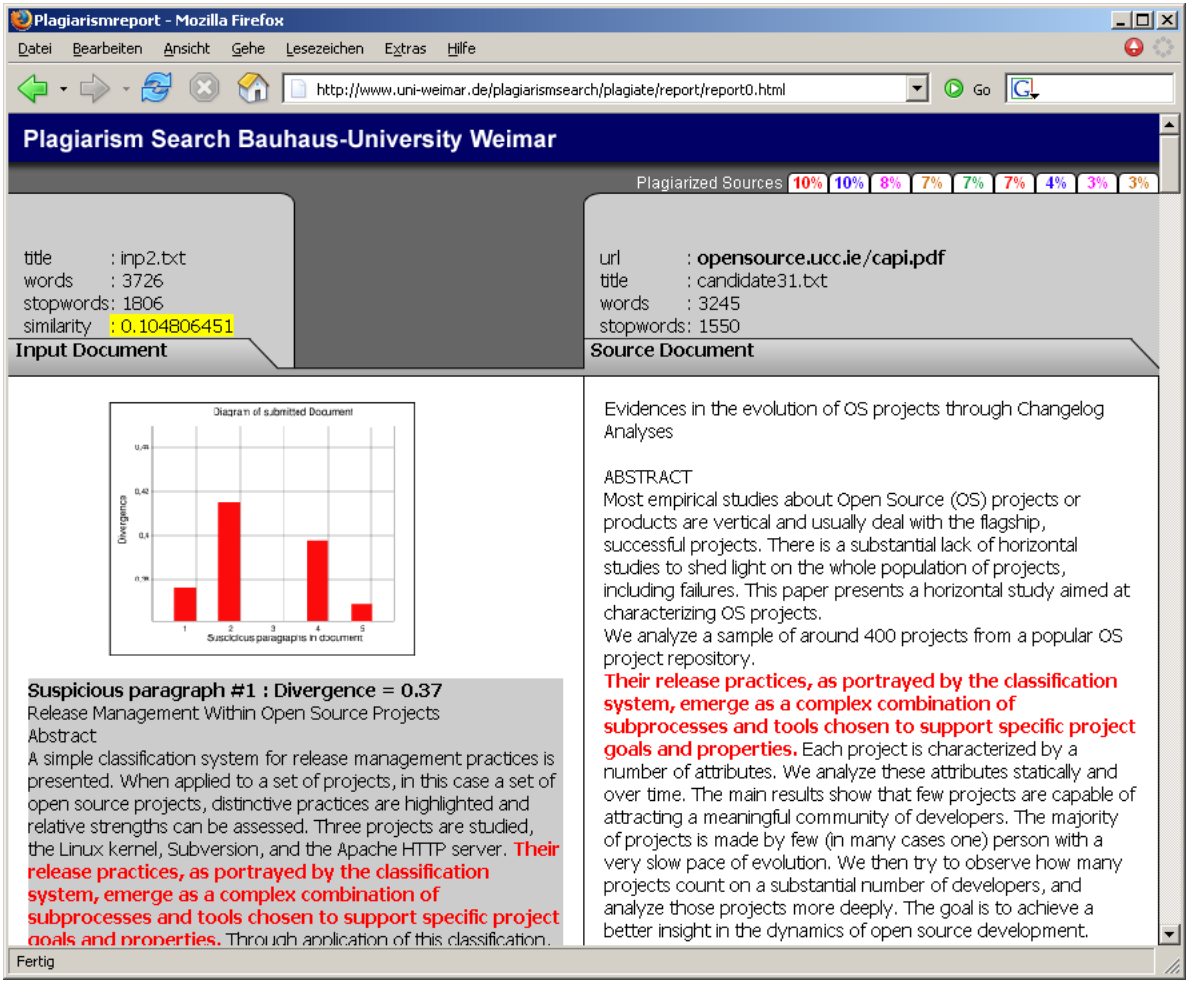

Thank You!

Questions?