Semantically Weighted Similarity Analysis for XML-based Content Components

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Technical Documentation

- XML-based content components
  - Self-contained building blocks e.g. chapter-sized
  - Reuse, translation, aggregation, delivery
- Semantic XML information models
- Large databases of content components
- Product variants -> content variants

```
<descriptive nodeid="PI-70006536">
  <heading>Fuel Gas Requirements</heading>
  <descriptive_body>
    <paragraph>This Section defines […]
      <table>
      <row>
        <entry>
          <paragraph>Permissible range</parag
        </entry>
        <entry>
          <paragraph>
            <inlinedata>
              <si-value>
                <number>5</number>
                <unit>°C</unit>
              </si-value>
            </inlinedata>to
            <inlinedata>
              <si-value>
                <number>120</number>
                <unit>°C</unit>
              </si-value>
            </inlinedata>
          </paragraph>
```

Motivation

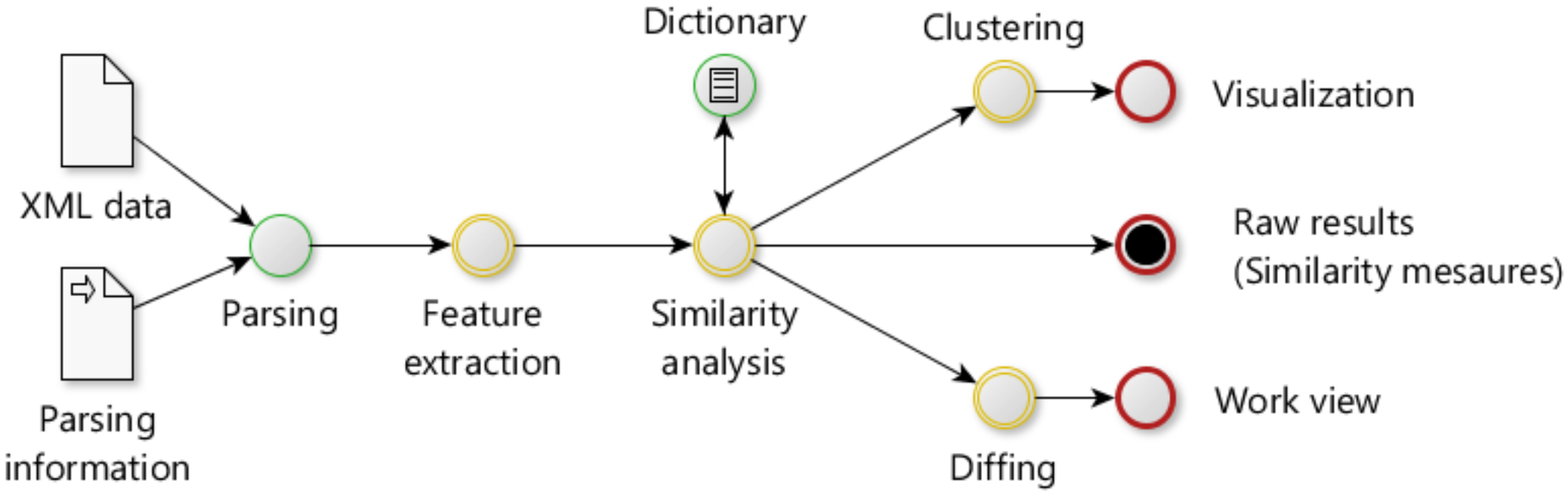
- Similar or duplicate content components
  - Document-based migration
  - Uncontrolled reuse / copying
  - Not checking / finding existing content

- Why is this bad?
  - Information retrieval / content delivery
    - high recall, low precision
  - Higher translation cost for variants
  - Time spent (re)writing existing content

Requirements & Implications

- Large amounts of content components
  - Computational efficient algorithm
- Simple similarity measure
  - Reliable against semantically similar differences
- (Non-)Detection of intentional variants
  - Weighting of semantically relevant text properties
- Quality assurance
  - UI for checking flagged relations

Architecture



Similarity analysis

- Similarity relations are symmetrical
- Total number of all relations (C) can grow rapidly

$$|C| = \frac{n * (n-1)}{2}$$

- Cosine similarity (s) for comparing vectors with extracted features
- Threshold for similarity measure to reduce total number of relations to check (r)

$$s = \frac{\vec{a} \cdot \vec{b}}{|\vec{a}| * |\vec{b}|}$$

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Semantic similarity

expected similarity

A

```
<paragraph nodeid="a">This device is designed to work with
a voltage of <inlinedata><si-value><number>110</number>
<unit>V</unit></si-value></inlinedata> only.</paragraph>
```

B

```
<paragraph nodeid="b">This device is designed to work with
a voltage of <inlinedata><si-value><number>220</number>
<unit>V</unit></si-value></inlinedata> only.</paragraph>
```

C

```
<paragraph nodeid="c">This device works with a voltage of
<inlinedata><si-value><number>110</number><unit>V</unit>
</si-value></inlinedata> only.</paragraph>
```

Semantic weighting

- Extracted text from weighted elements treated separately
- Weighting artificially increases feature count by quantifier (q)
- Influences similarity in predictable ways
- Does not add to the complexity of the similarity analysis

	A	B	C
A		0.45	0.98
B	0.90		0.36
C	0.75	0.63	

semantic similarity

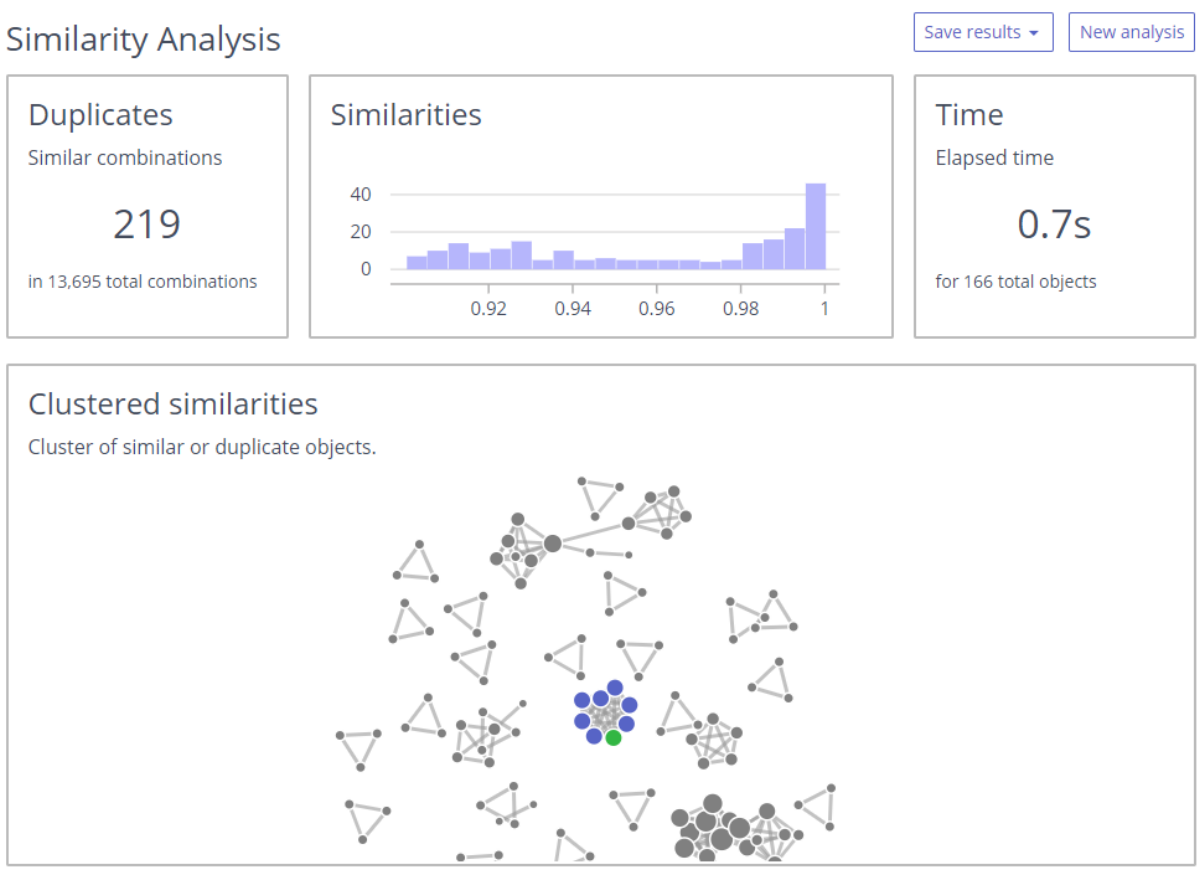
standard similarity

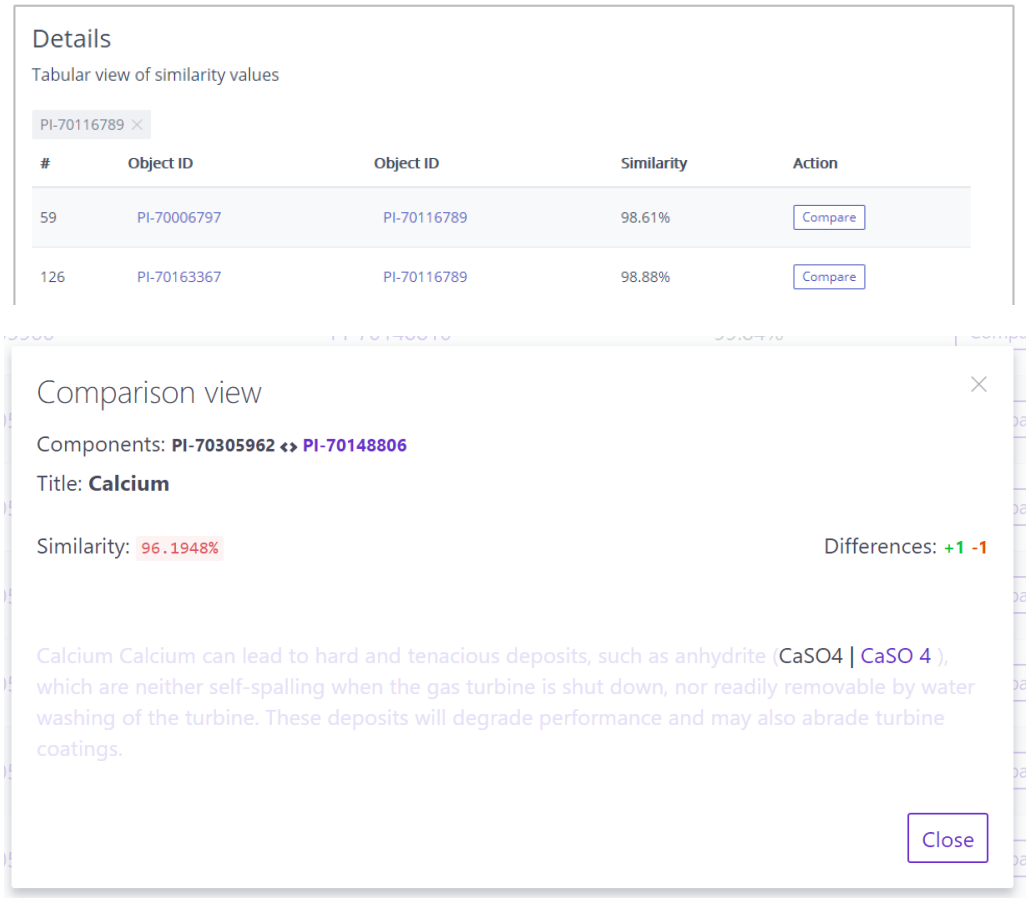
Implementation

- Implemented in JavaScript
- All processing is done client-side (browser), heavy calculations in own threads (web worker)
- Tested efficiency on standard hardware

Set	**units** (n)	**comb.** ($\|C\|$)	$\frac{\text{words}}{\text{unit}}$	**total t** [s]	$\frac{\text{t}}{\|C\|}$ [ms]
A	166	13,695	455.8	0.7	0.052
B	1,600	1,279,200	178.0	243.7	0.191
C	2,501	3,126,250	353.4	650.7	0.208
D	4,101	8,407,050	278.9	2,878.0	0.342

Workbench-like user interface





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Similarity Analysis

Save results ▾ New analysis

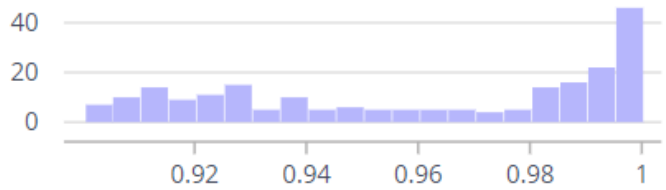
Duplicates

Similar combinations

219

in 13,695 total combinations

Similarities



Time

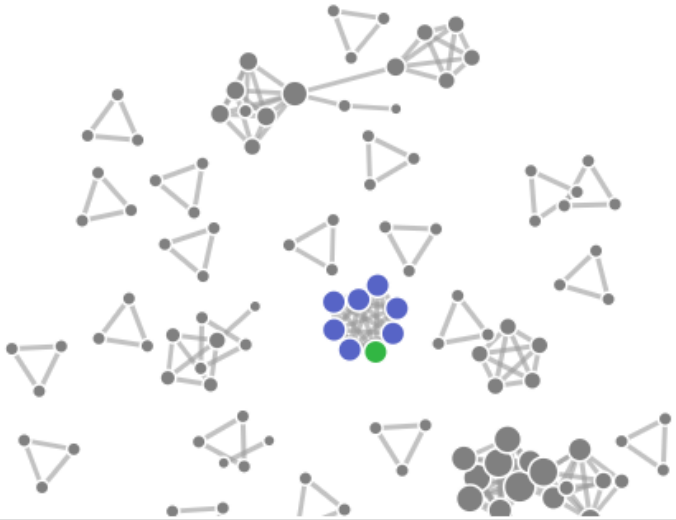
Elapsed time

0.7s

for 166 total objects

Clustered similarities

Cluster of similar or duplicate objects.



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Details

Tabular view of similarity values

PI-70116789

#	Object ID	Object ID	Similarity	Action
59	PI-70006797	PI-70116789	98.61%	Compare
126	PI-70163367	PI-70116789	98.88%	Compare

Comparison view

Components: **PI-70305962 ↔ PI-70148806**

Title: **Calcium**

Similarity: 96.1948%

Differences: +1 -1

Calcium Calcium can lead to hard and tenacious deposits, such as anhydrite (CaSO4 | CaSO 4), which are neither self-spalling when the gas turbine is shut down, nor readily removable by water washing of the turbine. These deposits will degrade performance and may also abrade turbine coatings.

Close

Outlook & Conclusion

- RegEx or NER to in preprocessing to add XML tags
- Alternative similarity measures
- Integration with CCMS, give recommendations
- Research dependency to information model semanticity

- Simple method which can improve similarity results
- Real-world relevance through customer project with Siemens Energy (TecDoc Department)

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Contact

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Code & Demo

github.com/j-oe/semsim

semsim.fastclass.de