Towards a Tool for the Automatic Extraction of Canonical References

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Overview

- possible applications
- what’s out there about canonical references?
- some Jargon explained
- (live) demo
Citation and Co-citation Networks

http://orgtheory.wordpress.com/2009/08/14/sociologys-citation-core/

Caption: Data compiled from Web of Science. Citing papers include all those published in ASR, AJS, and SF since 1999 that cited one of the most-cited works. Cited works are the 53 pieces most cited by papers published in ASR, AJS or Social Forces since 1999. Node size is proportional to number of cites received. Edges without nodes are from papers that cite only the target node, all other citing papers cite at least two of the 53. Citation ties indicate that the source paper cites the cited work, co-citation links are the number of times two cited works are jointly cited by a single paper.
Fig. 4. Clustered Co-citation Network (Augustine)

Definition

- Abbreviations used to refer to **primary sources** (i.e. works of ancient authors)
- refer to the research object itself (i.e. text passage)
- logical instead of physical citation scheme (e.g., chapter/paragr vs. page)

Example

Hom. II. XII 1
Aesch. 'Sept.' 565-67, 628-30; Ar. 'Arch.' 803
Hes. fr. 321 M.-W.
Callimaco, 'ep.' 28 Pf., 5-6
Problem definition

My Goal

Automatic identification of Canonical Rereferences within (plain) texts

1. extraction (manual | automatic)
2. semantic markup (TEI, HTML + microformats, OpenURL etc.)
3. linking to other resources (from citation to actionable link)
(TuftsU) Perseus DL's navigation tools
(HarvardU) Canonical Text Services (CTS): example, project page
(CornellU+APh) Classical Works Knowledge Base (CWKB): demo
Reference Linking to primary sources as value added service for e-journals (screenshot)
Possible Encodings

**HTML + Microformat (Plut. Sol. XIX 1)**

```html
  <a class="citation" target="_blank" href="[...]">
    <cite class="citet>
      <abbr class="ctauthor" title="urn:cts:ggreekLit:tlg0007">Plut.</abbr>
      <em>
        <abbr class="ctwork" title="urn:cts:ggreekLit:tlg0007.tlg007">Sol.</abbr>
        <abbr class="range" title="19.1">XIX 1</abbr>
      </em>
    </cite>
  </a>
```

**OpenURL for (Aeschylus, Supplices 40-57)**

```
```

**CTS URN for (Ath., Deipn. I)**

```
urn:cts:ggreekLit:tlg0008.tlg001.fhg01:1.1.1–1.1.9
```
Possible approaches to the problem

1. Rule-based parsing (e.g. RegExps)

Example

```java
// tokenizer written in ANTLR syntax

/* Lexicon definition */
SPACE : ('\n' | ' ') + {skip();};
NON_SPACE : (~(' ' | '\n')) +;

/* Grammar definition */
text : (SPACE|NON_SPACE) +;
```

2. Machine Learning-based
Machine Learning (ML) Jargon

- Machine Learning
- Training / Test set
- instances
- Gold standard
- Sequence Labelling
- Baseline
Named Entity Recognition

- shared tasks: CoNLL2002 and 2003 on Language Indipendent NER
- IOB format for annotated texts/corpora

Statistical NER

Use of statistical model as an approach to this task
Information Retrieval (IR) Jargon

### Performance Measures

- **Accuracy** $\text{acc} = \frac{tp + tn}{tp + fp + tn + fn}$
- **Recall** $r = \frac{tp}{tp + fn}$
- **Precision** $p = \frac{tp}{tp + fp}$
- **F-score (aka F-measure)** $f_{score} = 2 \cdot \frac{\text{accuracy} \cdot \text{recall}}{\text{accuracy} + \text{recall}}$

### Example

```python
list = ['a', 1, 'b', 'c', 10, 2, 4]
# filter integers only
out = [10, 2]
# P = 1 (100%), R = 0.5 (50%), A = 0.71 (71%), F1 = 0.66 (66%)
```
**My experiment**

**CRefEX**

- JSTOR data
- Data for Research (DFR) API: pros and cons
- Python program CRefEx [code on github]
- CRF++ (C++ library) to build the statistical model
# Original line: Hom. II. 1, 477; 24, 788;
Hom. B–CRF
II. I–CRF
1, I–CRF
477; I–CRF
24, I–CRF
788; I–CRF

Si O
veda O
anche O
Prop. B–CRF
2, I–CRF
18a, I–CRF
7 1–CRF
ss. 1–CRF
Learning the CRF model

Feature extraction

- case
- punctuation
- number
- first and last 4 characters
- currently *no dictionaries*!

Example

<table>
<thead>
<tr>
<th>Hom.</th>
<th>FINAL_DOT</th>
<th>OTHERS</th>
<th>INIT_CAPS</th>
<th>NO_DIGITS</th>
<th>hom 3</th>
<th>H</th>
<th>Ho</th>
<th>Hom</th>
<th>Hom.</th>
<th>.</th>
<th>m.</th>
<th>om.</th>
<th>Hom.</th>
<th>B–CRF</th>
</tr>
</thead>
<tbody>
<tr>
<td>II.</td>
<td>FINAL_DOT</td>
<td>OTHERS</td>
<td>INIT_CAPS</td>
<td>NO_DIGITS</td>
<td>i</td>
<td>2</td>
<td>I</td>
<td>II</td>
<td>II.</td>
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<td>II.</td>
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<td>477;</td>
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<td>OTHERS</td>
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<td>OTHERS</td>
<td>OTHERS</td>
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<td>4</td>
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<td>OTHERS</td>
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<td>7</td>
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<td>788</td>
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<td>;</td>
<td>8</td>
<td>88</td>
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<td>OTHERS</td>
<td>OTHERS</td>
<td>OTHERS</td>
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<td>;</td>
<td>8</td>
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Running the program

<table>
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<th>Feature extraction</th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hom. → GT_Label &quot;B–CRF&quot; : Label &quot;B–CRF&quot;</td>
<td>alpha: 3.944701</td>
<td>beta: 25.339320</td>
<td>p: 0.998706</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1, → GT_Label &quot;I–CRF&quot; : Label &quot;I–CRF&quot;</td>
<td>alpha: 12.547932</td>
<td>beta: 17.041941</td>
<td>p: 0.999661</td>
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<td></td>
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<tr>
<td>477; → GT_Label &quot;I–CRF&quot; : Label &quot;I–CRF&quot;</td>
<td>alpha: 17.573822</td>
<td>beta: 11.290089</td>
<td>p: 0.997075</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>788; → GT_Label &quot;I–CRF&quot; : Label &quot;I–CRF&quot;</td>
<td>alpha: 25.219915</td>
<td>beta: 2.182355</td>
<td>p: 0.886300</td>
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<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
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<tbody>
<tr>
<td>Average fscore</td>
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<tr>
<td>Average accuracy</td>
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<tr>
<td>Average precision</td>
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</tr>
<tr>
<td>Average recall</td>
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<td></td>
</tr>
</tbody>
</table>
What’s next?

- share code, share training data, etc.
- train the system for specific corpora
- train the system to extract abbreviations for other materials (manuscripts, inscriptions, coins etc.)
- exploit the emerging net of citations/references between primary and secondary sources
Thanks for your attention!
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