Extracting contextual information from scientific literature using CERMINE system

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Overview

CERMINE is a comprehensive system for **extracting structured meta-data and references** from **born-digital scientific literature**. Among other information, the system extracts information related to **the context the article was written in**, such as the authors and their affiliations, the relations between them or references to other articles. Extracted information is presented in a **structured, machine-readable form**. CERMINE is based on a **modular workflow**, whose loosely coupled architecture allows for individual steps evaluation, adjustment or replacement and facilitates future architecture expanding. The implementation is based mostly on **supervised and unsupervised machine-learning techniques**, which simplifies adapting the system to new document layouts.

Usage

Web service:

cermine.ceon.pl

Open-source code:

github.com/CeON/CERMINE

A **RESTful service** for executing the extraction process by machines:

```
$ curl -X POST --header "Content-Type: application/binary" \
--data-binary @article.pdf http://cermine.ceon.pl/extract.do
```

Workflow Architecture

- **Basic structure extraction** path takes a PDF file on the input and outputs its **geometric hierarchical representation**, composed of pages, zones, lines, words and characters, along with their coordinates and dimensions, the reading order and general categories (*metadata, references, body* or *other*) assigned to zones.
- **Metadata extraction** path analyses metadata parts of the structure and extracts a **rich set of document's metadata**, including authors, affiliations and relations between them.
- **Bibliography extraction** path analyses parts of the structure labelled as *references* in order to extract a **list of parsed citations**.

1. Layout Extraction

Character
Extraction:
iText library

Page
Segmentation:
*enhanced
Docstrum*

Reading Order
Resolving:
*bottom-up
heuristic-based
algorithm*

2. Content Classification

Content classification is done in two stages:

- **initial classification** assigns general categories to zones
- **metadata classification** labels *metadata* zones with specific metadata classes

Zones are classified with the use of **Support Vector Machines** and a rich set of features: geometrical, lexical, sequential, formatting and heuristics-based.

3a. Affiliation Extraction

Individual author names, affiliations strings, as well as relations between them are determined using **zone labels** and **heuristics**.

If authors are grouped together in a form of a list, and affiliations are also placed together, the authors are split using a set of separators. Then affiliation indexes are detected based on predefined set of symbols and geometric features. Detected indexes are then used to split affiliation lists and assign affiliations to authors.

ESWC Challenge

CERMINE is participating in Task 2 of **Semantic Publishing Challenge** of ESWC 2015. The system extracts data sufficient for answering queries related to affiliations and citations. Solving queries **Q2.1 (Affiliations in a paper)** and **Q2.2 (Papers from a country)** relies on the features: title, authors and affiliations extraction, establishing author - affiliations relations, detecting country in affiliations.

Solving queries **Q2.3 (Cited Works)**, **Q2.4 (Recent Cited Works)** and **Q2.5 (Cited Journal Papers)** relies on features: extracting citations, detecting DOI, title and year in the citation string, recognizing the type of a citation.

The **LOD dataset** generated by the workflow uses **Dublin Core** and **vCard** ontologies and contains resources: volumes, documents, authors, affiliations, countries and citations.

3b. Bibliography Extraction

Reference Extraction: extracting individual reference strings using **K-Means clustering** and both geometric and textual features

[9] L. O'Gorman. *The document spectrum for page layout analysis*. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 15(11):1162-1173, 1993.

Reference Parsing: extracting metadata from references strings using **Conditional Random Fields** token classifier and textual features

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