Web Service integration platform for Polish linguistic resources

Maciej Ogrodniczuk, Michał Lenart

Institute of Computer Science
Polish Academy of Sciences
ul. Ordona 21, Warsaw, Poland
maciej.ogrodniczuk@ipipan.waw.pl, michal.lenart@gmail.com

Abstract
This paper presents a robust linguistic Web service framework for Polish, combining several mature offline linguistic tools in a common online platform. The toolset comprise paragraph-, sentence- and token-level segmenter, morphological analyser, disambiguating tagger, shallow and deep parser, named entity recognizer and coreference resolver. Uniform access to processing results is provided by means of a stand-off packaged adaptation of National Corpus of Polish TEI P5-based representation and interchange format.

A concept of asynchronous handling of requests sent to the implemented Web service (Multiservice) is introduced to enable processing large amounts of text by setting up language processing chains of desired complexity. Apart from a dedicated API, a simple Web interface to the service is presented, allowing to compose a chain of annotation services, run it and periodically check for execution results, made available as plain XML or in a simple visualization. Usage examples and results from performance and scalability tests are also included.

Keywords: Web services, language processing chains, Polish, TEI P5, CLARIN

1. Introduction
Following the CLARIN\(^1\) perspective of making language processing tools available online, approximately 200 Web services for 20 languages have been made available (Ogrodniczuk and Przepiórkowski, 2010; Ogrodniczuk and Przepiórkowski, 2011) in CLARIN preparatory phase, finished in June 2011.

This apparent abundance resulted in several initiatives aiming at creating the general technological frameworks for combining these processing tools into ready-to-use packages by offering chaining possibilities. This had to be followed by reuse or adaptation of common representation format for the chain, general enough to cover the diversity of linguistic description on multiple levels.

One of such platforms, further referred to as the Multiservice was created by the Linguistic Engineering Group at the Institute of Computer Science, Polish Academy of Sciences (ICS PAS). It consists of the common TEI P5-based representation format, asynchronous execution architecture and several interfaces for Web service chaining, including a Web-based application.

2. The Integrated Tools
Offline versions of all integrated tools have been used by the linguistic community in Poland for several years and they proved their suitability and efficiency for linguistic engineering tasks. They constitute the basic building blocks of many local processing chains, but have never been made available online in a consistent manner\(^2\) (in a common infrastructure and format). In this respect, bringing the tools online can go beyond just illustrating capabilities of the framework and the format and constitute real value to the community and other interested parties. All integrated tools are open source and all are actively maintained and developed.

Here is the short list of Polish processing tools currently available in the framework:

- **Morfeusz** (Woliński, 2006b) is a morphological analyzer for Polish using a positional tagset (Przepiórkowski and Woliński, 2003); current version of the tool, Morfeusz SGJP, is based on linguistic data coming from The Grammatical Dictionary of Polish (Saloni et al., 2007) – see also http://sgjp.pl/morfeusz.html,

- **TaKIPI** (Piasecki and Wardyński, 2006) is a hybrid (multiclassifier) rule-based morphosyntactic tagger (disambiguator of morphological descriptions) of Polish,

- **Pantera** (Acedański, 2010) is a recently developed morphosyntactic rule-based Brill tagger of Polish using an optimized version of Brill’s algorithm adapted for specifics of inflectional languages,

- **Świgra** (Woliński, 2006a) is a Prolog deep parser of Polish implementing Marek Świdziński’s formal metamorphosis grammar of Polish (Świdziński, 1992), regarded as the largest and most precise formal description of general grammar of Polish,

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\(^1\)Common Language Resources and Technology Infrastructure, see e.g. http://www.clarin.eu/.

\(^2\)Demo online version of the older variant of the morphological analyser, Morfeusz SiAT, is still available at http://sgjp.pl/demo/morfeusz; TaKIPI tagger is also wrapped as a separate Web service which can be tested at http://nlp.pwr.wroc.pl/clarin/ws/takipi/.

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Language processing chains are created by sending requests to the Web service which are being handled in asynchronous manner to allow processing large amounts of text. Invoking one of the available methods results in returning a request status and retrieve the result when processing completes. This design is directly inspired by TaKIPI Web service (Broda et al., 2010) prepared by ICS PAS and Wrocław University of Technology.

Ruler (Ogrodniczuk and Kopeć, 2011) is a rule-based end-to-end coreference resolution system for Polish using syntactic constraints (e.g. elimination of nested nominal groups), syntactic filters (e.g. elimination of syntactic incompatible heads) and selection (weighted scoring) for identity-of-reference chain detection.

 Nerf (Savary et al., 2010) is a statistical CRF-based named entity recognizer trained over 1-million-subcorpus of National Corpus of Polish (Przepiórkowski et al., 2010) and successfully used in the process of automated annotation of its total 1-billion segments.

The chain registering function returns a unique token of request which can be then queried for (by means of `getStatus(token)` method) to periodically check the status of request with the given token (currently one of: PENDING, IN_PROGRESS, DONE or FAILED). If the status of request is DONE, `getResult(token)` function can be executed to return the result of the chain execution (an XML TEI P5 file, see Sec. 4.). The same function is used to return an error message when execution FAILED. Removal of requests is currently not possible.

### 4. The Packaged TEI P5-based Linguistic Representation

To achieve chaining linguistic tools, a common representation and interchange format was necessary to bind the tools together and present results to the user. Such format has been developed for the National Corpus of Polish as a stand-off, TEI P5-encoded annotation which stores different levels of description in separate, interlinked files (Bański and Przepiórkowski, 2009; Bański and Przepiórkowski, 2010; Przepiórkowski and Bański, 2009) similarly to PAULA (Dipper, 2005) or MAF (Clement and de la Clergerie, 2005). For the current interchange activity, a certain method of packaging them has been applied, keeping the NKJP annotation principles on one hand and adapting it to uniformity and performance requirements of the online service on the other.

To meet packaging requirements, the standard TEI approach to storing multiple files in a single entity with creation of an (artificial) corpus has been used, adopting the following structure:

- root `<teiCorpus>` element represents the collection of annotation layers (including the source text),
- child `<TEI>` elements represent each annotation layer (e.g. segmentation, lemmatization etc.).

Linguistic annotations of different levels are stored as `<text>`s of the corpus with embedded `<body>` and `<p>` subelements from the TEI syntax model. At each level minimalistic set of means of TEI expression was used to preserve the information: neutral `<seg>`-ments linked by means of `corresp` attributes and TEI-embedded feature structure mechanism preserving structured annotation. Currently the following layers have been integrated:

- text structure layer: contains “original” representation of text, paragraph-segmented,
- segmentation layer: contains division of text into paragraphs, sentences and tokens,
- morphosyntactic layer: contains disambiguated lexical interpretations of referenced tokens – POS and morphosyntactic tags – together with identified lemmata (with alternative values grouped in `vAlt` elements),
- syntactic word layer: groups individual tokens into higher-level units to facilitate parsing,
- syntactic group (shallow parsing) layer: represents syntactic groups with pointers (`<ptr>`s) to immediate constituents of the group — syntactic words or other syntactic groups, with syntactic and semantic heads specifically marked.
• named entity layer: represents hierarchical named entities providing information on their types,
• deep parsing layer: represents parsing results as a shared parse forest, i.e. a collection of parse subtrees stored in a packed graph format, with each unique subtree stored only once,
• coreference layer: provides information about mentions and coreferential chains.

Below we present a sample partial description from the morphosyntactic layer (see http://nlp.ipipan.waw.pl/TEI4NKJP/ for more detailed and complete examples):

```
<seg xml:id="m-seg1" corresp="#s-seg1">
  <fs type="morph">
    <f name="interps">
      <vAlt>
        <fs type="lex" xml:id="m-seg1-lex">
          <f name="base">
            <string>lato</string>
          </f>
          <f name="ctag">
            <symbol value="subst"></symbol>
          </f>
          <f name="msd">
            <symbol value="pl:gen:n" xml:id="m-seg_1-msd"></symbol>
          </f>
        </fs>
        <fs type="lex" xml:id="m-seg2-lex">
          <f name="base">
            <string>rok</string>
          </f>
          <f name="ctag">
            <symbol value="subst"></symbol>
          </f>
          <f name="msd">
            <symbol value="pl:gen:m3" xml:id="m-seg_2-msd"></symbol>
          </f>
        </fs>
      </vAlt>
    </f>
  </fs>
</seg>
```

5. Interface and Usage
The service is executed in the following manner:
• the user sends to the service a processing request with the linguistic function name and its parameters,
• the user keeps querying the service about the status of execution of a request identified with a given token until the status shows that the execution stopped because of error or ended successfully,
• on information on execution success (or failure), the result (or an error message) can be retrieved by the user and execution stops.

The pull execution method gives potential interfaces far more flexibility and allows for better control over annotation processes as compared to callback-based implementations. This is especially important with respect to the recent hype of using Web services for processing corpora which may result in long processing times.

The Multiservice is intended to be used via a dedicated API, but to offer online access, a simple Web interface (see Fig. 2) is available at http://chopin.ipipan.waw.pl/multiservice/. It allows to enter the text (or URL containing it) to be processed and compose a chain of annotation services.

After starting the analysis, the Web application checks periodically the status of the request. When it ended execution, the result is retrieved and displayed to the user. In case of a failure, an appropriate error message is presented.

6. Notes on Performance and Scalability
Service plugin implementation class does not require the tool being integrated to run as a background daemon (in comparison to starting it for each request separately). However, all existing tools are initialized only once – at the daemon startup. Intermediate results are parsed using StAX-based parser, without keeping the whole XML document in memory. Therefore it is possible to handle quite large text documents. Nevertheless XML parsing still creates significant overhead.

The major challenge for linguistic services is also storing potentially huge amounts of data resulting from processing of rather small input. It is not uncommon e.g. for deep parsing systems which could generate plenty of different result trees even though their subtrees are identical among subsequent results. In case of the Multiservice the problem was diminished by using a shared parse forest representation with each unique subtree stored no more than in one instance.

A simple performance test has been carried out for one of the component services. It shows overhead caused by using the Web service when performing a simple request of tagging n-word text with Pantera tagger (against the execution of the offline tool alone). Results in Table 1 show durations of request execution through Web service on the local host for the most time-consuming operations. It clearly shows that total request execution is 2-3 times longer than invoking the tagger locally. Even though for shorter texts such as a typical newspaper article (of approx. 1 000 tokens) the difference can still seem acceptable, various optimizations are considered. Improvements in XML postprocessing (inclusion of headers, pretty-printing of document generated by C++ application with Pantera) should give the most significant performance boost.
Table 1: Tagging performance test results

| Number of words | Execution time (s) |
|-----------------|--------------------|
|                 | Total  | Tagger | XML | DB |
| 1 000           | 3.2    | 1.0    | 1.2 | 0.1 |
| 2 000           | 4.5    | 1.4    | 2.1 | 0.6 |
| 5 000           | 9.2    | 3.7    | 3.3 | 1.4 |
| 10 000          | 14.9   | 7.0    | 4.8 | 2.7 |
| 20 000          | 32.6   | 14.7   | 10.3| 5.7 |
| 30 000          | 48.3   | 22.4   | 15.7| 8.1 |
| 40 000          | 98.5   | 29.7   | 45.3| 22.1|

It should also be noted that a test version of Multiservice using binary data based on Apache Thrift library as interchange format is currently under development. It is expected to give even better performance results as XML document will be created only at the very end of the execution process.

7. Conclusions and Further Work

Leaving aside the purely engineering task of providing advanced linguistic services for Polish in a common framework, preparation of the Multiservice resulted in several useful developments. The first of them is by far the common tagset-independent TEI P5-based format, proved effective in an undergoing coreference resolution experiments where it serves as a representation and interchange format for pre-resolution linguistic analysis. Being standoff and packaged at the same time and basing on the idea of a TEI corpus, the format is flexible enough to create bundles, represent layers and annotation variants separately which facilitates comparisons of different annotation models (e.g. two sets of parsing trees produced for two different results of tagging over the same input). Another important aspect of the realized solution is definitely the asynchronous character of the service, making it ideal for processing large amounts of data in a convenient way.

The first practical outcome of the implementation is its application to the recent attempts of coreference resolution for Polish where the Multiservice is used to tokenize, disambiguate morphological description and detect noun phrases in the analyzed text.

Further technical work would concentrate on integration of a wider range of input and output formats with multiple encodings and integrated converters as well as plugging in existing offline annotation components3 and future higher-level annotation tools such as word-sense disambiguators.

Research activities would further delve into aspects of maintaining semantic interoperability of the newly developed format (including issues related to Polish morphosyntax vs. e.g. ISOCat Data Category Registry) as well as Web service chaining issues such as algorithms for automated chain detection, currently offered by WebLicht (Hinrichs et al., 2010).

3First candidates are competitive morphological analysers such as Morfologik by Marcin Miłkowski (see http://morfologik.blogspot.com/) or complete language processing toolsets such as UAM Text Tools (see http://atos.wmied.amu.edu.pl/~obrebski/ptx/utt/utt.html).
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