D(h)ante: A New Set of Tools for XIII Century Italian

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Abstract
In this paper we describe 1) the process of converting a corpus of Dante Alighieri from a TEI XML format in to a pseudo-CoNLL format; 2) how a pos-tagger trained on modern Italian performs on Dante’s Italian 3) the performances of two different pos-taggers trained on the given corpus. We are making our conversion scripts and models available to the community. The two other models trained on the corpus performs reasonably well. The tool used for the conversion process might turn useful for bridging the gap between traditional digital humanities and modern NLP applications since the TEI original format is not usually suitable for being processed with standard NLP tools. We believe our work will serve both communities: the DH community will be able to tag new documents and the NLP world will have an easier way in converting existing documents to a standardized machine-readable format.

Keywords: digital humanities, old italian, pos-tagging

1. Introduction
It is commonly known that Computational Linguistics (CL) originated in the 1950s with the efforts to use computers to automatically translate texts from foreign languages (Camburn, 2013). Not everyone is aware, however, that in the same period of time Roberto Busa1 gave rise to the humanities branch of CL now known as Digital Humanities (DH). Since then the two branches have been developed rather independently. The DH community has focused on deriving standardized methods for working with digitized literary work (Burnard, 2014), while the NLP branch concentrated on computational models of language to be used in more general language tasks. Only in the last decade, the two fields started to converge (Pacanowski and Zanzotto, 2008).

In this work we attempt to contribute to the latter trend. More specifically, we build upon the linguistic annotation work of (Tavoni, 2010) to develop a Part of Speech Tagger (PoS) of XIII century Italian language. The objective of the work is twofold: (1) to provide the NLP community with a tool to perform automatic processing of ancient text and (2) to provide the literature community with more powerful tools for simplifying the annotation process and performing more advanced data analysis.

The rest of the paper is organized as follows: in section 2 we describe the corpus being used, in section 3 the transformation we had to perform to convert the corpus into a more consistent format suitable for performing NLP tasks. Finally, section 4 comprises the description of two PoS tagger models we have built and the experiments we have run to compare their performance.

2. Corpus Description

Documents
The corpus we have used consists of the following documents, all belonging to Dante Alighieri: Divina Commedia (Inferno, Purgatorio, Paradiso), Convivio, Detto d’amore, Rime, Vita Nuova, Fiore. It is a subset of the DanteSearch corpus (Tavoni, 2005)2.

It is not a complete corpus of the author: five documents are missing. Only one document is in prose form, one is in a mixed form and all the others are written in verse. The language is mostly Italian; some documents contain short snippets of Latin language: these tokens are marked as foreign words and all together add up to 312.

Annotation
The annotation task has been performed manually by Italian native speakers (PhD/Master students in Italian literature).

Each word token is marked with a POS tag and lemmatized. Punctuation is not tokenized and thus not tagged: in some cases it is glued together with the preceding word, while in others it is left outside the XML word tag:

```
<LM lemma="il" catg="rdms">Nel</LM>
```

Listing 1: Example of LM tags.

An additional LM1 tag is used for those cases in which a single form can be mapped to two different lemmas.

```
<LM1>
<LM lemma="il" catg="rdms">nel</LM>
<LM lemma="in" catg="epaks1">nel</LM>
</LM1>
```

Listing 2: Example of LM1 tags.

Each word token is marked with a POS tag and lemmatized. Punctuation is not tokenized and thus not tagged: in some cases it is glued together with the preceding word, while in others it is left outside the XML word tag:

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1 He was an Italian Jesuit priest who in 1949 met with Thomas J. Watson, the founder of IBM, and was able to persuade him to sponsor the Index Thomisticus, a tool for performing text searches within the massive corpus of Aquinas’s works (Busa, 1974 1980; David Bamman and Crane, 2008)

2 See http://cibit.humnet.unipi.it/ for a description of the critical editions of the texts upon which the corpus documents are based on.
This (non)-tagging schema does not contain end-of-sentence marks. Multi-word expressions and proper nouns are not tokenized:

\[ \text{Guiglielmo Borsiere} \]
\[ \text{quando che sia} \]

The tagset cardinality amounts to 2244: the count is high because the schema includes fine-grained morphological information.

**Statistics** Table 1 highlights some basic statistics about the corpus. We used the LM tags to extract these statistics. The lexical richness is computed with a simple formula:

\[
\frac{n(\text{types})}{n(\text{tokens})} \quad (1)
\]

The transformed corpus, as shown in the next section, allows for refined statistics and more details.

### 3. Corpus Transformation

While perfect for some tasks (i.e. fine-grained search, manual lookup), the tagset and the format used in the original corpus are not fit for other NLP tasks. The partial tokenization and the rich tagset are not appropriate for performing advanced statistics (e.g., stylometry) and also are not appropriate for direct use with standard NLP tools. To address these problems we performed the following transformations:

1. full tokenization
2. 1-word-2-lemma nodes merging
3. punctuation tagging
4. sentence segmentation
5. tagset conversion to ELRA set

Except for the last one, all the operations have been performed via XSL transformation. The XSL code used to convert this specific corpus can be used with small changes to handle different documents encoded in the TEI format. The code is open source and can be found at [https://github.com/anbasile/DH](https://github.com/anbasile/DH).

Since punctuation was not tagged, in the original corpus there were no sentence boundaries. After properly tagging the punctuation, we decided to split sentences on periods only: the corpus is extremely rich in dialogues, so using exclamation marks and question marks as well would have produced incorrect results: indirect speech is often used to introduce direct speech and these often terminates with exclamation or question marks; splitting the sentence in a naive way on these marks too would leave the rest (indirect speech) in a meaningless form.

The tagset conversion task has been completed in a **Python** environment: we defined a dictionary that maps each new tag to the original via regular expression. The following is an excerpt of the dictionary, showing how singular and plural determined articles have been handled:

\[
\text{post_conversion} = \{ \\
\text{‘r..p$’: ‘RP’}, \\
\text{‘r..s$’: ‘RS’}, \\
\}
\]

This method can be seen as a middle way between a full manual conversion (which can be extremely time consuming) and statistical/automatic tagset conversion method. For this corpus a small amount of noise is introduced since the tag categorization conflicts for some elements, but our method allows for certain flexibility in the translation. We used the Morph-it! lexicon (Zanchetta and Baroni, 2005) to resolve the conflicts. A working description of the ELRA tagset can be found at [http://hlt-services2.fbk.eu/textpro/?p=89](http://hlt-services2.fbk.eu/textpro/?p=89).

The output of the transformation is a pseudo-CoNLL format. See Table 2 for a sample output taken from the *incipit* of *Purgatorio*.

The tagset conversion process will need additional work in the future: the ELRA set was choosen only because it is the one used by TextPro\(^3\) and since we wanted to evaluate its performance on this corpus we were forced to this choice. It remains to be investigated if the following could be a better solution: converting both the original corpus tagset and the ELRA tagset to a middle layer, namely the Universal Pos Tagset.

### 4. Experiments

As a first experiment, we have assessed how a state-of-the-art PoS tagger trained on modern Italian would perform on the XIII century text of the DanteSearch corpus. For this we have employed the PoS tagger of the TextPro NLP Suite (Pianta and Zanoli, 2009; Pianta et al., 2008). Next, we have trained two PoS taggers on the converted corpus: TreeTagger and the Stanford tagger using standard settings.\(^4\)

**TreeTagger** We have employed TreeTagger version 3.2 (Schmid, 1995; Schmid, 1997).\(^5\)

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\(^3\)TextPro is the one tagger trained on contemporary Italian.

\(^4\)Different settings may yield slightly different results.

\(^5\)We have used a standard context length of 2 and the following list of closed-classed tags: XPS, XPW, XPB, XPO, RS, RP, C, CCHE, CCHI.
Table 1: Corpus statistics

| doc       | tokens | types | lex. richness |
|-----------|--------|-------|---------------|
| convivio.xml | 73457  | 6826  | 0.09          |
| dettodamore.xml | 2503   | 766   | 0.31          |
| fiore.xml   | 23698  | 4420  | 0.19          |
| inferno.xml | 34280  | 6704  | 0.19          |
| paradiso.xml| 33717  | 6339  | 0.19          |
| purgatorio.xml | 34146  | 6591  | 0.19          |
| rime.xml    | 12102  | 2733  | 0.22          |
| vitanuova.xml | 18988  | 3004  | 0.16          |
|           | 232891 | 20562 | 0.09          |

Table 2: Sample output

| id | token | lemma | pos | mwe | eos | sentenceid |
|----|-------|-------|-----|-----|-----|------------|
| 0  | Per   | per   | epsf| 0   | 0   | 1          |
| 1  | correr| correrre| vta2fp| 0   | 0   | 1          |
| 2  | miglior | migliore | a2fp | 0   | 0   | 1          |

Table 3: Overall accuracy of the three PoS taggers.

| Model      | Accuracy |
|------------|----------|
| TextPro*   | 0.72     |
| TreeTagger | 0.90     |
| Stanford   | 0.92     |

Stanford POS tagger We have employed the MaxEnt Stanford Tagger part of the CoreNLP version 3.5.2 (Toutanova and Manning, 2000; Toutanova et al., 2003). For the training and test set selection we shuffled the order of all the sentences from the corpus and then we divided this shuffled set in three parts: 80% for the training set, 10% for the development set and 10% for the test set.

4.1. Results

Table 3 shows the overall results of the PoS taggers. The two models which were trained on the XIII century corpus are clearly outperforming the baseline model trained on modern Italian. Among the two best performing models, the Stanford tagger is the one with the highest accuracy. The result of TextPro is not unexpected: it is known that Dante’s Italian contains from 65% to 70% of the words used in currently spoken Italian.

For a more detailed comparison between the TreeTagger and the Stanford tagger, we have produced two confusion matrices in figure 1 (see caption for more explanation).

We have assessed how an out-of-the-box PoS tagger (TextPro) trained on modern Italian performs on this corpus, and showed how state-of-the-art PoS taggers (TreeTaggers and Stanford) properly trained on this resource largely outperform the previous model.

We are going to release the tool behind the transformation procedure (TEI2CONLL) which could assist other researchers who wish to convert TEI encoded resources into a format which is more suitable for NLP analysis. Additionally, we are going to release the tagger models to the DH community at large, which can be used to simplify the process of annotating additional material belonging to Dante and other XIII century Italian poets.

We believe that these tools can be a good starting point for the construction of a usable pipeline for handling old documents: digital humanities is rapidly growing field and there will be the need for these tools.

5.1. Future work

Some points will require additional work in the future. First, we need to try using a middle layer for the tagging conversion process. Second, we are going to analyze the errors of the taggers and see where the one trained on modern Italian fails. Third, sentence segmentation needs a more robust approach.

5. Conclusions

In this paper we described the process of transforming the annotated corpus of DanteSearch provided by (Tavoni, 2005) into a format which is more suitable for developing NLP applications.

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