Analysing Inconsistencies and Errors in PoS Tagging in two Icelandic Gold Standards

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Abstract

This paper describes work in progress. We experiment with training a state-of-the-art tagger, Stagger, on a new gold standard, MIM-GOLD, for the PoS tagging of Icelandic. We compare the results to results obtained using a previous gold standard, IFD. Using MIM-GOLD, tagging accuracy is considerably lower, 92.76% compared to 93.67% accuracy for IFD. We analyze and classify the errors made by the tagger in order to explain this difference. We find that inconsistencies and incorrect tags in MIM-GOLD may account for this difference.

1 Introduction

For some years a new gold standard, MIM-GOLD, for training PoS taggers has been under development (Loftsson et al., 2010; Helgadóttir et al., 2012). This corpus contains approximately one million tokens of text from various sources from the period 2000–2009.

State-of-the-art PoS tagging accuracy for Icelandic, 92.82%, was achieved by Loftsson and Östling (2013), using the Averaged Perceptron Tagger Stagger without an external lexicon. All PoS taggers tested so far for Icelandic have been developed or trained and tested on the Icelandic Frequency Dictionary (IFD) (Pind et al., 1991).

In this paper we describe the training and testing of Stagger on MIM-GOLD. Results are compared to the results for training and tagging IFD reported by Loftsson and Östling (2013). Tagging errors made by Stagger, when tagging the two gold standards, are examined and classified to explain the difference in tagging accuracy.

In Section 4 we discuss the results. In Section 5 we report on the analysis of errors made by Stagger when tagging the two corpora, and in Section 6 we conclude.

2 Resources

2.1 The IFD corpus

The IFD contains 100 fragments of text published for the first time in 1980–1989. Each fragment contains about 5,000 tokens. There are five categories of text in the corpus, approximately equally sized, four of which (80%) are literary texts from published books. The fifth category contains non-fictional texts from various sources. The tagset used in IFD is based on the traditional Icelandic analysis of word classes and grammatical categories, with some exceptions where that classification has been rationalized. The tagset contains about 700 possible tags of which 639 occur in IFD. The size of the tagset mirrors the morphological complexity of Icelandic. The corpus was tagged with a combination of automatic methods and manual checking. In the work on training and testing Stagger on IFD (Loftsson and Östling, 2012), the authors used a reduced tagset of 565 tags and a corrected version of IFD (Loftsson, 2009). 15.9% of the word forms in the IFD are ambiguous as to the tagset within the IFD. This figure is quite high, which illustrates the complex inflectional morphology of Icelandic. We will show in Section 5 that many of the errors made by the taggers when tagging Icelandic are due to this high ambiguity rate.

2.2 The MIM-GOLD corpus

The foundation for the building of MIM-GOLD is the Tagged Icelandic Corpus (MIM), which was released in the spring of 2013, both for search1

1http://mim.arnastofnun.is/
and download\textsuperscript{2}. This corpus contains 25 million running words from various genres dating from the first decade of the 21\textsuperscript{st} century (Helgadóttir et al., 2012). The compilation of MIM-GOLD has been described in two papers (Loftsson et al., 2010; Helgadóttir et al., 2014). MIM-GOLD contains about one million tokens which were sampled from 13 text types in MIM. The largest contributions are newspaper texts, text from published books and blog text. Other text classes include text from various websites, law text, text from school essays, text written-to-be-spoken, text from adjudications, text from radio news scripts and e-mails. MIM-GOLD is thus twice the size of IFD and the texts are more varied. About 80\% of the texts in IFD are literary texts compared to less than 25\% in MIM-GOLD.

The texts were tagged with the program CorpusTagger, which was developed for sentence segmentation, tokenization and tagging of MIM-GOLD (Loftsson et al., 2010). Five different individual taggers were used, after which CombiTagger (Henrich et al., 2009) was applied to select a single tag. All the taggers used were trained or developed using IFD. The IFD tagset was therefore used with some adjustments. Three different correction phases have been applied to the tagging of MIM-GOLD. In the first phase, systematic ways of error detection were applied in the form of noun phrase (NP), prepositional phrase (PP), and verb phrase (VP) error detection programs described by Loftsson (2009). In the second correction phase, all the tags in MIM-GOLD were checked manually. The third phase was carried out in a semi-automatic manner using IceTagger (Loftsson, 2008). The tags output by IceTagger were compared with the (presumed) correct tags in the corpus. If a difference was found, the line containing the discrepancy was marked as an error candidate and inspected manually. The total number of tags corrected in all three phases was just under 130.000.

Some adjustments were made to the tagset of IFD for MIM-GOLD, in line with the reduction of the IFD-tagset reported for the experiment with Stagger. Named entity classification for proper nouns was removed and all number constants were labelled with a single tag. Two other modifications were made. Tagging and tokenization of abbreviations was modified, and foreign names in IFD were tagged as proper nouns and provided with a gender in a similar fashion to Icelandic names. There is, however, considerable inconsistency in the tagging of foreign names in MIM-GOLD. During the second correction phase foreign names were tagged as proper nouns and marked for gender, if they were common and exhibited Icelandic inflection. When gender was difficult to decide they were tagged with unspecified gender. During the third correction phase this decision was modified such that foreign names were simply classified as foreign words. As a result foreign names in MIM-GOLD are classified in three different ways: As foreign words; as proper nouns with gender specified or as proper nouns with gender unspecified. As a part of further correcting the tagging of MIM-GOLD it is necessary to tackle this inconsistency. Since the texts in IFD date from the period 1980–1989 and are mainly literary texts no e-mail addresses or web addresses occur in the text. For MIM-GOLD a new tag was used for these entities.

2.3 The Database of Icelandic Inflection

In experiments with tagging Icelandic, extended lexicons have been derived from the Database of Icelandic Inflection (BÍN)\textsuperscript{3} (Bjarnadóttir, 2012). This was done in the experiment with training and testing Stagger on IFD and is also used in the experiment reported here.

3 Experiment

The experiment with training and testing Stagger on IFD reported by Loftsson and Östling (2013) was repeated for MIM-GOLD. We evaluated the version of Stagger using linguistic features (LF) and the unknown word guesser IceMorphy (Loftsson, 2008) and added an extended lexicon based on BÍN. We did not add word embeddings (WE) as was done in the original experiment. Results are shown in Table 1. Average unknown word ratio for the IFD corpus when using BÍN is 0.97\% and for the MIM-GOLD corpus 3.43\%.

4 Results

As shown in Table 1, overall accuracy for IFD is 93.67\%. Comparable result for MIM-GOLD is

\textsuperscript{3}BÍN contains about 270,000 paradigms with about 5.8 million inflectional forms. It is available at http://bin.arnastofnun.is/

\textsuperscript{2}http://malfong.is/
Table 1: Tagging accuracy when tagging IFD and MIM-GOLD using 10-fold cross-validation.

| Corpus     | Unknown words | Known words | All words |
|------------|---------------|-------------|-----------|
| IFD        | 58.31         | 94.02       | 93.67     |
| MIM-GOLD   | 68.97         | 93.61       | 92.76     |

92.76%. Accuracy for known words is higher for IFD (94.02%) than for MIM-GOLD (93.61%), but accuracy for unknown words is higher for MIM-GOLD (68.97%) than for IFD (58.31%).

The higher accuracy for known words in IFD can be explained by a greater number of tagging errors and more inconsistencies in MIM-GOLD. Higher accuracy for unknown words in MIM-GOLD are explained, at least in part, by a higher number of unknown tokens in MIM-GOLD that are relatively easy for the tagger to tag correctly, such as web addresses, e-mails and foreign words. In the next Section we will perform error analysis to try to explain this difference in accuracy.

5 Error analysis

Manning (2011) trained and tested the Stanford PoS tagger (Toutanova et al., 2003) on standard splits of the Wall Street Journal (WSJ) portion of the Penn Treebank for PoS tagging. In order to understand how tagging accuracy could be improved, Manning analyzed the errors made by the tagger, and suggested that the largest opportunity for further progress comes from improving the linguistic resources from which taggers are trained. To get a rough breakdown of how the linguistic resources can be improved, Manning did a small error analysis, taking a sample of 100 errors which the Stanford tagger made when tagging the WSJ. We did a similar analysis to try to explain the difference in tagging accuracy when Stagger was trained and tested on the two Gold standards, as described in Section 3. We took a random sample of 300 errors from each corpus. The errors were divided into six classes, as shown in Table 2.

1. Unknown words/word forms: The word either did not appear in the training data, so the tagger had to rely on context features, or the word form did not appear with the tag it has in this context. The most common errors in this category are proper nouns tagged as common nouns. Other errors include adverbs tagged as nouns, and incorrect gender or case for words with case inflection.

2. Improvable tagging: This category has errors for which we could imagine a tagger finding the right tag, either by looking at the context of a few more words or looking at particular features of surrounding words. The most common errors in this category are incorrect case or gender tags for nouns and adjectives. Often there were wrong tags, even though the tagger tagged adjacent words correctly, and there should be agreement for case or gender with the word in question. In many of these errors the case is determined by a preceding verb.

Example of failure in agreement in two adjacent words: "í guðrækilegum [correct: singular; tagged as: plural] umvöndunartóni [correct: singular; tagged as: singular]" (e. in a tone of religious disapproval).

3. Insufficient contextual knowledge: The determination of the correct tag requires broad contextual knowledge, such as (i) incorrect case with prepositions where semantics are required for the correct case; (ii) long distance assignment of case, gender or person; (iii) incorrect tagging of lower case word forms in multiword named entities.

Example of long distance assignment of person: "Ég nefndi [correct: 1st person; tagged as: 1st person] sifoat tvö af þessum orðum og boðaði [correct: 1st person; tagged as: 3rd person] ..." (e. The last time, I talked about two of these words and announced ...)

4. Ambiguous tags: Unclear or ambiguous tags, in the context, such as (i) verb tense, where a verb has the same form for past and present tense and it is unclear which is being...
used; (ii) words that are commonly used in either of two genders, and (iii) examples where it is not clear whether plural or singular forms are being used, e.g. in headlines.

Example of the homonymic past and present form: "Meðan ég elti [In corpus: past tense; Tagged as: present tense] hann." (e. While I chase/chased him.)

5. Gold standard inconsistency: Due to discrepancy in annotation of particular word classes.

6. Gold standard errors: In MIM-GOLD there are two common error types responsible for the majority of errors in this category. 11 of the 33 errors were unanalyzed tags where a correct tag could easily be determined and is determined correctly by the tagger. 6 errors were due to split sentences, because of incorrectly determined sentence breaks. Other error types were found in both MIM-GOLD and IFD.

The above classification is subjective and other researchers might have classified a few of the errors differently, in particular when choosing between the categories improvable tagging and insufficient contextual knowledge.

For our purposes, the most important categories are the last two, where the gold standard is wrong or inconsistent.

|                | IFD (%) | MIM-GOLD (%) |
|----------------|---------|--------------|
| Correct tag    | 93.67   | 92.76        |
| Unknown        | 0.51    | 1.18         |
| Improvable tagging | 2.40   | 2.27         |
| Insufficient context | 2.28   | 2.14         |
| Ambiguous tags | 0.72    | 0.51         |
| Inconsistency  | 0.06    | 0.34         |
| Gold standard error | 0.36 | 0.80         |
| **Total**      | **100.0** | **100.0**   |

Table 3: Tagging categorization in the corpora.

6 Discussion and further work
Generalizing from our sample and looking at the percentage of tags in the tagger output that falls into each category, we see a clear difference between the corpora (Table 3). We confirmed that there is statistically significant difference (p<0.001) in error types between the two corpora by performing a chi-square test. The proportion of words falling into the category insufficient contextual knowledge is roughly the same. The same applies to improvable tagging. Unknown words are more common in MIM-GOLD. This can be explained by the fact that the texts in this corpus come from more varied sources than the texts in IFD. Ambiguous tags are somewhat more common in IFD, this can possibly be explained by IFD containing mostly literary texts. The lower score for 10-fold validation is likely explained by the high rate of wrong tags and inconsistencies in MIM-GOLD, 1.14% of the total compared to 0.42% in IFD, a difference of 0.72% compared to 0.91% difference in tagging accuracy.

Results from the tagging experiment show lower tagging accuracy for MIM-GOLD than IFD. We have shown that this may, at least in part, be explained by a higher number of inconsistencies and incorrect tags in MIM-GOLD than IFD. To determine the most cost-efficient way of reducing these errors, a further error analysis should be carried out and decisions made, based on that data, as to where we should focus our efforts. When the tagging accuracy in MIM-GOLD has been improved, experiments will be made to merge the two corpora in training data-driven taggers.

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