Optimizing a PoS Tag Set for Dependency Parsing

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Abstract

Abstraction ensues.

1 Introduction

PoS tagging is an important preprocessing step for many NLP tasks, such as parsing, named entity recognition and sentiment analysis. Whereas much effort has gone into the development of PoS-taggers, to the effect that this task is often considered more or less a solved task, considerably less effort has been devoted to empirical evaluation of the PoS tag sets themselves. PoS tag sets are usually employed in a "one size fits all" fashion, regardless of the requirements posed by the downstream NLP tasks for which PoS-tagging is performed.

It is well known that syntactic parsing often benefits from quite fine-grained morphological distinctions since morphology interacts with syntax though phenomena such as agreement and case marking. However, in a realistic setting where the aim is to automatically parse raw text, the generation of morphological information will often require a separate step of morphological analysis that can be quite costly.

In this paper, we optimize a Norwegian PoS tag set for the task of data-driven dependency parsing. In a set of experiments, various morphological distinctions are introduced and evaluated both intrinsically, i.e. in terms of PoS-tagging accuracy and extrinsically, in terms of parsing accuracy. Our results show that the introduction of morphological distinctions not present in the original tag set, whilst compromising tagger accuracy, actually leads to significantly improved parsing accuracy. This optimization allows us to bypass the additional step of morphological analysis, framing the whole preprocessing problem as a simple tagging task.

The article is structured as follows. We start out by reviewing previous work on tag set evaluation in Section 2 and 3 provides an overview of the treebank used for experimentation. Section 4 describes the experimental setup used in our work and Section 5 goes on to provide the results from our optimization experiments. Finally, Section 7 summarizes our main findings and discusses some avenues for future work.

2 Previous/Related work

There is a considerable lack of previous efforts on extrinsic evaluation of the effects of PoS tag sets on downstream applications. We will consider(/noe annet, considerable...consider) papers that evaluate the effects of PoS tag set granularity on PoS tagging. This includes investigation of the effects of PoS tag sets on tagging of Swedish (Megyesi, 2001; Megyesi, 2002) and English (MacKinlay, 2005). Increases in tagger accuracy does not readily translate to improved parsing.

(Megyesi, 2001; Megyesi, 2002) trained and evaluated a range of PoS taggers on the Stockholm-Umeå Corpus (SUC) (Gustafson-Capková and Hartmann, 2006), annotated with a Swedish version of PAROLE tags, with the tag set totaling 139 tags. Furthermore, they investigated the effects of tag set size on tagging by mapping the original tag set into smaller subsets designed for parsing. They argue that a tag set with complete morphological tags may not be necessary for all NLP applications, for instance syntactic parsing. They found that the smallest tag set comprising 26 tags yields the lowest tagger error rate. However, for some of the taggers, augmenting the tag set with more linguistically informative tags may actually lead to a drop in error rate. They argue that this shows that the size of

the tag set as well as the type of information in the tags are crucial factors for tagger performance. However/unfortunately, they do not report results of parsing with the various PoS tag sets.

Similarly, MacKinlay (2005) investigated the effects of PoS tag sets on PoS tagger performance in English, specifically the Penn Treebank (Marcus et al., 1993). They mapped the original tag set of Penn Treebank to more fine-grained tag sets "in terms of" linguistic utility. the additional linguistic information included in the tags may assist the tagger. utility/motivation to investigate whether linguistically motivated tag set modifications can improve the tagger accuracy while increasing the linguistic information in the tag set. Experimenting with both morphologically and syntactically motivated modifications, they found that more fine-grained tag sets rarely led to improvements in tagger accuracy, where the most successful modification yielded an improvement in tagger accuracy of 0.05 percentage points.

3 Data

3.1 The Norwegian Dependency Treebank

We used the newly developed Norwegian Dependency Treebank (NDT) (Solberg et al., 2014), which is the first publicly available treebank for Norwegian. It was developed at the National Library of Norway in collaboration with the University of Oslo, and contains manual syntactic and morphological annotation. The treebank contains 311 000 tokens of Bokmål and 303 000 tokens of Nynorsk. The annotated texts are mostly newspaper text, but also include government reports, parliament transcripts and excerpts from blogs. The annotation process of the treebank was supported by the Oslo-Bergen Tagger (Hagen et al., 2000) and then manually corrected by annotators.

Morphological Annotation The morphological annotation and PoS tag set of NDT follows the Oslo-Bergen Tagger (Hagen et al., 2000; Solberg, 2013), which in turn is largely based on the work of Faarlund et al. (1997). The tag set consists of 12 morphosyntactic PoS tags, with 7 additional tags for punctuation and symbols. The tag set is thus rather coarse-grained, with broad categories such as `subst` (noun) and `verb` (verb). The PoS tags are complemented by a large set of morphological features, providing information about morphological properties such as definiteness, number and

Tag	Description
adj	Adjective
adv	Adverb
det	Determiner
inf-merke	Infinitive marker
interj	Interjection
konj	Conjunction
prep	Preposition
pron	Pronoun
sbu	Subordinate conjunction
subst	Noun
ukjent	Unknown (foreign word)
verb	Verb

Table 1: Overview of the tag set of NDT.

Head	Dependent
Preposition	Prepositional complement
Finite verb	Complementizer
First conjunct	Subsequent conjuncts
Finite auxiliary	Lexical/main verb
Noun	Determiner

Table 2: Annotation choices in NDT.

tense. These features are used in our tag set modifications, where the coarse PoS tag of relevant tokens are concatenated with one or more of these features. This allows us to include more linguistic information in the tags.

Syntactic Annotation The syntactic annotation choices in NDT are largely based on the Norwegian Reference Grammar (Faarlund et al., 1997). The annotation choices are outlined in Table 2, taken from Solberg et al. (2014), providing overview of the analyses of syntactic constructions that often distinguish dependency treebanks, such as coordination and the treatment of auxiliary and main verbs. The set of dependency relations contains 29 dependency relations, including ADV (adverbial), SUBJ (subject) and KOORD (coordination).

4 Experimental Setup

In preparation to conducting our experiments with linguistically motivated tag set modifications, a concrete setup for the experiments needed to be established, which is presented in the following.

Data Set Split As there was no standardized data set split of NDT due to its very recent development, we needed to establish a data set split (training/development/test) in preparation to our experiments. Our data set split of the

treebank follows the standard 80-10-10 (training/development/test) split and will be distributed with the treebank and proposed as the new standard(?). In creating the data set split, care has been taken to preserve contiguous texts in the various data sets while keeping the split balanced in terms of genre (and source). Our proposed data set split was used in the Norwegian contribution to the Universal Dependencies project (Øvrelid and Hohle, 2016). The split will be made available at a companion website.

Tagger   For our experiments with tag set modifications, we wanted a PoS tagger that is both fast and accurate. There is often a trade-off between the two, as the best taggers tend to suffer in terms of speed due to their complexity. However, a tagger that achieves both close to state-of-the-art accuracy as well as very high speed is TnT (Brants, 2000). The fact that TnT was used for evaluating the universal tag set (Petrov et al., 2012), served as another good indication of TnT being appropriate for our task. The sum of these factors led to TnT being the tagger of choice for our experiments.

Parser   In choosing a syntactic parser for our experiments, we considered previous work on dependency parsing of Norwegian, specifically that of (Solberg et al., 2014). They found the Mate parser (Bohnet, 2010) to be the most successful parser for the parsing of NDT. Furthermore, recent dependency parser comparisons (Choi et al., 2015) showed that Mate performed very well on parsing of the English portion of the OntoNotes 5 corpus, beating a range of contemporary state-of-the-art parsers.

Tag Set Mapping   In order to alter the tag set of NDT, we created a mapping for carrying out the tag set modifications. We created a mapping for carrying out the tag set modifications that maps the relevant existing tags to new, more fine-grained tags including more relevant morphological features for the applicable tokens.

Baseline   It is common practice to compare the performance of PoS taggers to a pre-computed baseline for an initial point of comparison. For PoS tagging, a commonly used baseline is the Most Frequent Tag (MFT) baseline, which we use in our experiments. This involves labeling each word with the tag it was assigned most frequently in the training. All unknown words, i.e., words

not seen in the training data, are assigned the tag most frequently assigned to words seen only once in the training. Unknown and infrequent words have in common that they rarely occur, and we might therefore expect them to have similar properties.

Tags & Features   As we seek to quantify the effects of PoS tagging in a realistic setting, we want to run the parser on automatically assigned PoS tags. For the training of the parser, however, we have two options: using either gold standard or automatically assigned tags. In order to settle on a configuration, we conducted experiments with gold standard and automatically assigned tags to see how they differ with respect to performance. The results of our experiments reveal that the combination of training and testing on automatic tags is superior to training on gold standard tags and testing on automatic tags, surprisingly. Consequently, the parser was both trained and tested on automatically assigned tags in our experiments.

Note that it is absolutely crucial that the morphological features in the treebank are removed when using automatic tags, as they are still gold standard. For instance, if a verb token is erroneously tagged as a noun, we could potentially have a noun token with verbal features such as tense, which markedly obfuscates the training and parsing. Another important factor is that we want to isolate the effect of PoS tags, necessitating the exclusion of morphological features.

5   Tag Set Optimization/Experiments

With more fine-grained linguistically motivated distinctions, we increase the linguistic information represented in the tags, which may assist the tagger in disambiguating ambiguous and unknown words, which in turn may aid the parser in recognizing and generalizing syntactic patterns. However, the addition of more linguistic information to the tags and thus a more fine-grained tag set will most likely lead to a drop in tagger accuracy, due to the increase in complexity. The best tagging does not necessarily lead to the best parse, and it is therefore interesting to investigate how the tag set modifications may affect the interplay between tagging and parsing.

5.1   Tag Set Experiments

We modified the tags for nouns, verbs, adjectives, determiners and pronouns in NDT by appending

selected sets of morphological features to each tag in order to increase the linguistic information expressed by the tags. For each tag, we first experimented with each of the features in isolation before employing various combinations of them. We based our choices of combinations on how promising the features are and what we deem worth investigating in terms of linguistic utility, in order to see how the features might interact.

Nouns   In Norwegian, nouns are assigned gender (feminine, masculine, neuter), definiteness (indefinite or definite) and number (singular or plural). There is agreement in gender, definiteness and number between nouns and their modifiers (adjectives and determiners).

Verbs   Verbs are inflected for tense (infinitive, present, preterite, past perfect) in Norwegian and can additionally take on mood (imperative, indicative) and voice (active or passive).

Adjectives   Adjectives agree with the noun they modify in terms of gender, number and definiteness in Norwegian.

Determiners   Like adjectives, determiners in Norwegian agree with the noun they modify in terms of gender, number and definiteness.

Pronouns   Pronouns in Norwegian include personal, reciprocal, reflexive and interrogative. They can exhibit gender, number and person. Personal pronouns have case (accusative or nominative).

6   Optimized Pipeline

7   Summary/Conclusion and Future Work

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4

Category	Feature(s)	MFT	Accuracy	LAS	UAS
Baseline	—	94.14%	97.47%	87.01%	90.19%
Noun	Type, case & definiteness	89.61%	97.05%	88.81%	91.73%
Verb	Finiteness	93.72%	97.35%	87.30%	90.43%
Adjective	Degree	94.13%	97.41%	87.29%	90.44%
Determiner	Definiteness	94.13%	97.49%	87.30%	90.42%
Pronoun	Type & case	94.12%	97.51%	87.30%	90.41%

Table 3: Results of tagging and parsing with the most successful tag set modification for each category.

Tag	Description
adj|komp	Comparative adjective
adj|pos	Positive adjective
adj|sup	Superlative adjective
det|be	Definite determiner
det|ub	Indefinite determiner
pron|pers	Personal pronoun
pron|pers|akk	Personal pronoun, accusative
pron|pers|nom	Personal pronoun, nominative
pron|refl	Reflexive pronoun
pron|res	Reciprocal pronoun
pron|sp	Interrogative pronoun
subst|appell	Common noun
subst|appell|be	Common noun, definite
subst|appell|be|gen	Common noun, definite, genitive
subst|appell|ub	Common noun, indefinite
subst|appell|ub|gen	Common noun, indefinite, genitive
subst|prop	Proper noun
subst|prop|gen	Proper noun, genitive
verb|fin	Finite verb
verb|infin	Nonfinite verb

Table 4: Overview of the optimized tag set.

Tag set	MFT	Accuracy	LAS	UAS
Original	**94.14%**	**97.47%**	87.01%	90.19%
Full	85.12%	93.46%	87.13%	90.32%
Optimized	89.20%	96.85%	**88.87%**	**91.78%**

Table 5: Results of tagging and parsing with the optimized tag set, compared to the initial tag sets.