Is Typology-Based Adaptation Effective for Multilingual Sequence Labelling?

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Abstract

Recent work has shown that a single multilingual model with typologically informed parameter sharing can improve the performance in dependency parsing on both high-resource and zero-shot conditions. In this work, we investigate whether such progress occurs in different tasks such as POS, NER and morphological tagging.

1 Introduction

Recent studies have shown that state-of-the-art neural models can successfully be trained on multiple languages simultaneously for various NLP tasks such as named-entity recognition (Mulcaire et al., 2019; Rahimi et al., 2019), morphosyntactic tagging (Tsai et al., 2019), dependency parsing (Ammar et al., 2016; Kondratyuk and Straka, 2019), and machine translation (Johnson et al., 2017; Aharoni et al., 2019). Multilingual approaches have the following benefits over monolingual counterparts: (1) Multilingual models learn better generalization by sharing model parameters among multiple source languages which enables cross-lingual transfer and zero-shot learning. (2) Maintaining a single multilingual model is easier than a large set of language-specific models which increase the total size and system complexity.

However, a multilingual model trained on a high number of languages can face the "transfer - interference trade-off" (Johnson et al., 2017; Arivazhagan et al., 2019; Conneau et al., 2019). This trade-off leads multilingual models to outperform monolingual baselines on low/zero-resource languages (*positive transfer*), but to underperform on high-resource languages due to the lack of language specific capacity (*negative interference*). Moreover, multilingual transfer could give mixed results when the model is trained on a diverse set of source languages in terms of script, phonology, morphology, syntax, and semantics.

Üstün et al. (2020) have recently proposed a multilingual dependency parser with language-specific and typologically informed parameter sharing, which leads to higher accuracy on high-resource languages as well as similar or higher accuracy on low-resource ones, when compared to various non-adapted baselines. In this work, we extend this approach to three other sequence labelling tasks, namely: POS tagging, NER and morphological (MORPH) tagging. We present results on a large set of languages, including the zero-shot setting, and compare them to the parsing results presented in (Üstün et al., 2020).

2 Background

Early work on multilingual learning has been applied in POS and MORPH tagging (Gillick et al., 2016; Tsai et al., 2019), NER (Gillick et al., 2016; Mulcaire et al., 2019; Rahimi et al., 2019), and UD parsing (Ammar et al., 2016; Kondratyuk and Straka, 2019; Üstün et al., 2020). Although a single neural model that is trained on multiple languages has clear advantages on low-resource languages, multilingual models rarely perform better than monolingual models on high-resource languages. Gillick et al. (2016) showed that a compact multilingual model operating on bytes could reach similar or better performance in POS and NER.

Mulcaire et al. (2019) and Wu and Dredze (2019) showed that multilingual language model pretraining based on ELMo (Peters et al., 2018) and BERT (Devlin et al., 2019), improves the performance on POS, NER and UD tasks, including zero-shot settings. More recently, Kondratyuk and Straka (2019) trained a massively multilingual UD parser on 75 languages using multilingual BERT (mBERT), which shows competitive or improved performance, but mostly on low-resource languages.

	ar	eu	fi	he	hi	ko	ru	sv	tr	zh	be*	fo*	kk*	olo*	sa*	yue*	hr-avg	lr-avg
POS tagging (Accuracy)																		
UDify	95.7	93.2	95.7	95.8	96.1	94.1	98.2	97.1	91.8	92.5	94.7	79.9	84.7	74.3	41.9	69.3	95.3	74.1
UDapter	96.5	94.8	96.5	96.6	97.0	95.7	98.6	97.9	93.5	94.3	96.6	79.8	84.1	74.4	50.2	66.5	96.3	75.3
Morphological Tagging (F1)																		
UDify	88.3	77.4	84.7	86.8	89.9	-	92.6	93.7	75.4	90.0	78.5	32.3	26.6	44.7	-	-	88.2	45.5
UDapter	91.6	84.1	89.5	90.0	92.1	-	95.0	95.7	82.5	92.7	77.1	29.7	25.8	43.0	-	-	91.5	43.9
NER (F1)																		
UDify	86.5	90.2	89.7	82.4	84.8	85.4	86.9	93.3	91.0	76.4	80.2	75.7	72.5	-	53.8	74.0	85.0	71.3
UDapter	87.2	91.3	91.2	84.2	85.2	86.5	88.7	93.6	91.8	78.6	77.4	77.6	72.7	-	45.4	69.4	86.3	68.5
Dependency Parsing (LAS)																		
UDify	80.12	76.4	85.1	84.4	89.3	78.0	89.0	86.2	62.7	77.8	80.1	68.6	61.9	42.1	19.4	30.5	83.0	50.4
UDapter	84.42	83.3	89.0	88.8	92.0	85.9	92.2	90.3	69.6	83.2	79.3	69.2	60.7	43.3	22.2	32.8	87.3	51.3

Table 1: Results of UDapter (Üstün et al., 2020) and UDify (Kondratyuk and Straka, 2019) trained per task on 13 languages. `'hr-avg'` is calculated over all 13 training languages. '*' indicates the zero-shot experiments.

Üstün et al. (2020) recently applied task-specific adapters to mBERT (Houlsby et al., 2019) and contextual parameter generation (Platanios et al., 2018) to balance maximum sharing and language-specific capacity in a multilingual dependency parser. While typology features had been used before (Ammar et al., 2016), this work was the first to report improvements on both high-resource and zero-shot results, while not using gold POS tags.

3 Experiments

We modify UDapter (Üstün et al., 2020), by adding simple task-specific softmax layers for POS, MORPH tagging, and NER. Parameters of task-specific layers are modified by typologically informed language embeddings as in the original model[1]. As a baseline, we use UDify (Kondratyuk and Straka, 2019). Both UDapter and UDify are trained separately for three tasks on the concatenation of all training languages. We train both models by using the same hyper-parameter setting as in Üstün et al. (2020) for 10 epochs.

For training languages, following Kulmizev et al. (2019), we choose Arabic (ar), English (en), Basque (eu), Hebrew (he), Hindi (hi), Italian (it), Japanese (ja), Korean (ko), Russian (ru), Swedish (sv), Turkish (tr) and Chinese (zh). Table 1 shows 10 of them representing the main trends. In the zero-shot setup, both models are evaluated on Belarusian (be), Faroese (fo), Kazakh (kk) and Livvi (olo), Sanskrit (sa) and Cantonese (yue). We selected this subset so that each language is from the same family as one of the high-resource languages.

For POS and MORPH tagging, we use UD 2.3 (Nivre et al., 2018) and for NER, we use WikiANN (Pan et al., 2017) which was divided into train/dev/test by Rahimi et al. (2019).

4 Results and Conclusion

Table 1 shows the results in POS, MORPH tagging and NER. Additionally, dependency parsing scores are reported from Üstün et al. (2020). Language-specific adaptation of a multilingual model with typological features increases the performance in all tasks for high-resource (HR) languages. More specifically, the increase in MORPH tagging and parsing are larger than the other two tasks.

However, for low-resource (LR) languages, we find a mixed picture. In POS tagging and parsing, UDapter outperforms UDify but the improvements are rather small compared to HR. In MORPH tagging and NER, unlike the other two tasks, UDapter has significantly lower performance. A possible explanation is that while POS tagging and parsing have more structured and universal representation which allows the model to exploit multilingual sharing even for unseen words, MORPH tagging and NER requires better word-level representations where typological features may not have benefits. Moreover, the low representation quality of LR languages in mBERT (Wu and Dredze, 2020) may have a stronger negative effect on these tasks.

This is work in progress. We are currently studying the reasons of the different trends and we plan to present a detailed analysis on few selected languages during the presentation of this work.

[1]Typology features are taken from the URIEL database (Littell et al., 2017)

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