A Effects of Fine-Tuning for Cross-Lingual Training

For our cross-lingual experiments in Section 2.3, we observe that fine-tuning on the target treebank always improves parsing performance. Table 9 reports LAS for cross-lingual models with and without fine-tuning.

size	cross-base	+Morph	+Nonce			
$\mathcal{T}_{100} \ \mathcal{T}_{50} \ \mathcal{T}_{10}$	57.9 (+4.6)	59.5 (+6.2)	59.3 (+6.0)			
	48.3 (+5.8)	49.8 (+7.3)	50.1 (+7.6)			
	29.8 (+11.3)	34.9 (+16.4)	34.8 (+16.3)			
\downarrow with fine tuning (FT) \downarrow						
$\mathcal{T}_{100} \ \mathcal{T}_{50} \ \mathcal{T}_{10}$	61.3 (+8.0)	60.9 (+7.6)	61.7 (+8.4)			
	52.0 (+9.5)	51.7 (+9.2)	52.0 (+9.5)			
	34.7 (+16.2)	37.3 (+18.8)	35.4 (+16.9)			

Table 9: Effects of fine-tuning on North Sámi development data, measured in LAS. *mono-base* and *crossbase* are models without data augmentation. % improvements over *mono-base* shown in parentheses.

B Cyrillic to Latin Alphabet mapping

We use the following character mapping for Cyrillic to Latin Kazakh treebank transliteration.

Cyrillic	Latin	Cyrillic	Latin	Cyrillic	Latin
U				-	
Α	Α	Φ	\mathbf{F}	қ	k
Ð	Α	X	\mathbf{H}	л	1
Б	В	h	Η	М	\mathbf{m}
в	V	Ц	Ts	н	n
Γ	\mathbf{G}	Ч	\mathbf{Ch}	ң	n
Ŧ	G	Ш	\mathbf{Sh}	0	0
Д	D	Щ	\mathbf{Sh}	Θ	0
\mathbf{E}	\mathbf{E}	Ъ	,	п	р
Ë	\mathbf{E}	Ы	Y	р	r
Ж	J	I	Ι	с	s
З	\mathbf{Z}	Ь	,	т	t
И	Ι	Э	\mathbf{E}	у	u
Й	Ι	Ю	Ju	¥	u
K	Κ	Я	$_{\mathrm{Ja}}$	Y	u
K	Κ	a	a	ф	\mathbf{f}
Л	\mathbf{L}	ə	a	x	\mathbf{h}
Μ	Μ	б	b	h	\mathbf{h}
Η	Ν	в	v	ц	\mathbf{ts}
ң	Ν	г	g	ч	$^{\mathrm{ch}}$
0	0	F	g	ш	$^{\rm sh}$
Θ	0	д	d	щ	\mathbf{sh}
П	Р	е	e	ъ	,
Р	\mathbf{R}	ë	e	ы	У
\mathbf{C}	\mathbf{S}	ж	j	i	i
Т	т	з	z	ь	,
У	\mathbf{U}	и	i	Э	e
¥	U	й	i	ю	ju
Y	U	к	k	я	ja

Figure 3: Cyrillic to Latin alphabet mapping.