Training and Adapting Multilingual NMT for Less-resourced and Morphologically Rich Languages

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Problem

Estonian ↔ Russian

- Both are morphologically rich languages
- A rather small parallel corpus
- Larger corpora available for language pairs including Estonian ↔ English and Russian ↔ English

Model Configuration

	RNN			FConv	Transformer
	MLSTM	GRU			
		Shallow	Deep		
Subword unit vocabulary	25 000 tokens	50 000 tokens			
Layers	1 encoder, 1 decoder	1 encoder, 1 decoder	4 encoder, 4 decoder	15 encoder, 15 decoder	6 encoder, 6 decoder
Maximum sentence length	50			128	

Data

Language pair	Before filtering (Total/Unique)	After filtering (Unique)
En↔Et	62.5M / 24.3M	18.9M
En↔Ru	60.7M / 39.2M	29.4M
Ru↔Et	6.5M / 4.4M	3.5M

Results

Poster

We analyse:

- Translation quality between different NMT architectures (MLSTM, GRU, FConv, and Transformer)
- Translation quality between one-way (U) and multi-way (M) NMT models, deep (D) and shallow (S) NMT models
- Performance in terms of training time, translation speed and resource usage

Resource Usage

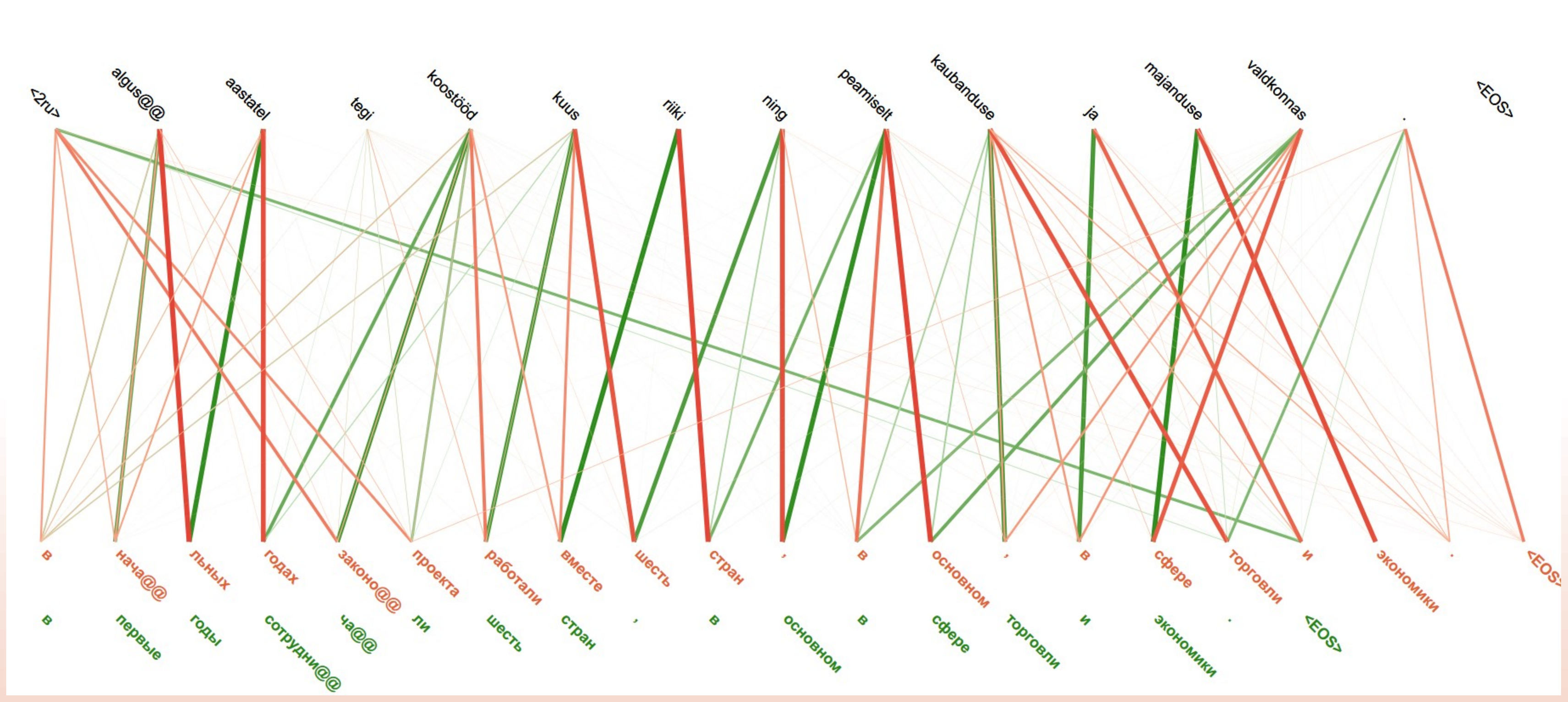
	Seconds		Sentences per second	GPU RAM, MB	Train time, days
	Translation	Per sentence			
Theano-based Nematus					
MLSTM-SM	274.57	0.54	1.86	651	16.4
GRU-SM	211.51	0.41	2.42	**611**	8.5
GRU-DM	460.07	0.9	1.11	979	36.6
MXNet-based Sockeye					
FConv-M	177.19	**0.35**	**2.89**	971	4.5
Transformer-M	191.05	0.37	2.68	1391	**3.8**

Translation Quality

	Development				Test			
	Ru→Et	Et→Ru	En→Et	Et→En	Ru→Et	Et→Ru	En→Et	Et→En
SMT	*27.74*	*25.48*	17.99	25.89	9.88	7.27	21.44	29.69
MLSTM-SU	17.51	18.46	23.79	34.45	11.11	12.32	26.14	36.78
GRU-SM	13.7	13.71	17.95	27.84	10.66	11.17	19.22	27.85
GRU-DU	17.03	17.42	23.53	33.63	10.33	12.36	25.25	36.86
GRU-DM	17.07	17.93	23.37	33.52	13.75	14.57	25.76	36.93
FConv-U	15.24	16.17	21.63	33.84	7.56	8.83	24.87	36.96
FConv-M	14.92	15.8	18.99	30.25	10.65	10.99	21.65	31.79
Transformer-U	17.44	18.9	**25.27**	**37.12**	9.10	11.17	**28.43**	**40.08**
Transformer-M	**18.03**	**19.18**	23.99	35.15	**14.38**	**15.48**	25.56	37.97

Example

Source	Algusaastatel tegi koostööd kuus riiki ning peamiselt kaubanduse ja majanduse valdkonnas.
GRU-DU	в начальных годах законопроекта работали вместе шесть стран, в основном, в сфере торговли и экономики.
(translated into English)	In the initial years of the bill project, six countries worked together, mainly in the sphere of trade and economy.
GRU-DM	в первые годы сотрудничали шесть стран, в основном в сфере торговли и экономики.
(translated into English)	In the first years, six countries cooperated, mainly in the sphere of trade and economy.
Reference	в первый год сотрудничество вели шесть стран , в основном в сфере торговли и экономики.
English Reference	In the early years, the cooperation was between six countries and mainly about trade and the economy.



Conclusions

- Low-resource language pairs benefit in translation quality from adding other language data.
- Multi-way NMT systems improved translation quality for all architectures - deep GRU, FConv, and Transformer.
- The largest improvements and highest overall BLEU scores were achieved using the Transformer model.
- The multi-way approach degraded performance for high-resource language pairs by several BLEU points.
- The most stable NMT architecture for multi-way model training was the deep GRU model, showing improvements for both low-resource and high-resource language pairs on both development and evaluation data sets.
- When training one-way systems for the low-resource language pairs, Fconv and Transformer models under-performed and the best results were achieved by the MLSTM-based models.

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