Regression or classification? Automated Essay Scoring for Norwegian

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In short

First results for the task of Automated Essay Scoring for Norwegian learner language. We analyze a number of properties of this task experimentally and assess

(i) the formulation of the task as either regression or classification,

(ii) the use of various non-neural and neural machine learning architectures with various types of input representations, and

(iii) applying multi-task learning for joint prediction of essay scoring and native language identification.

We find that a GRU-based attention model trained in a single-task setting performs best at the AES task.

The ASK corpus

- Norwegian learner essays from two different language tests which test proficiency at the B1 and B2 levels.

First language	AL test	IL test	Total
English	100	100	200
Polish	100	100	200
Russian	100	100	200
Somali	7	100	107
Spanish	100	100	200
German	100	100	200
Vietnamese	5	100	105
Subtotal (included languages)	512	700	1212
(Albanian)	24	100	124
(Bosnian-Croatian-Serbian)	100	100	200
(Dutch)	100	100	200
(Norwegian nynorsk)	21	11	32
(Norwegian bokmål)	79	89	168
Subtotal (excluded languages)	324	400	724
Total (all languages)	836	1100	1936

Models

- Linear models: Regression, Classification
- Neural: CNNs, RNNs, Attention
- Multi-tasking model: NLI as auxiliary task

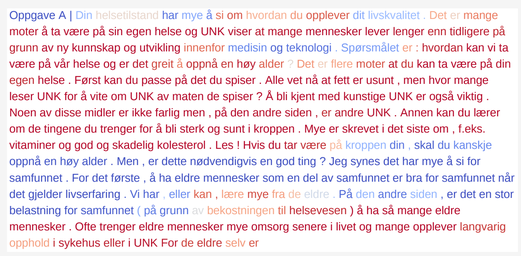
AES: Linear

	All labels		Collapsed labels	
Model	Macro F_1	Micro F_1	Macro F_1	Micro F_1
Majority	0.040	0.163	0.127	0.341
LogReg BOW	0.199	0.317	0.384	0.626
LogReg Char	0.221	0.317	0.399	0.602
LogReg POS	0.190	0.301	0.312	0.569
LogReg Mix	0.213	0.341	0.337	0.577
SVC BOW	0.210	0.317	0.391	0.610
SVC Char	0.189	0.293	0.347	0.537
SVC POS	0.157	0.244	0.336	0.618
SVC Mix	0.215	0.350	0.319	0.585
SVR BOW	**0.444**	0.415	0.429	0.659
SVR Char	0.252	0.317	0.440	0.602
SVR POS	0.334	0.358	**0.476**	0.593
SVR Mix	0.312	0.350	0.441	0.659

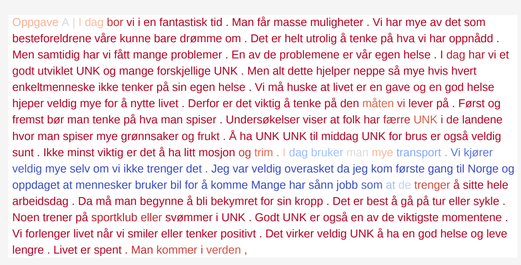
AES: RNNs

	All labels		Collapsed labels	
Model	Macro F_1	Micro F_1	Macro F_1	Micro F_1
Random init, unidirectional GRU				
Mean	0.264	0.374	0.455	0.675
Max	0.219	0.325	0.487	0.683
Attn	0.434	0.431	**0.806**	0.805
+POS Mean	0.348	0.398	0.450	0.642
+POS Max	0.230	0.374	0.500	0.748
+POS Attn	0.434	0.423	0.718	0.813
Mix Mean	0.225	0.333	0.388	0.634
Mix Max	0.200	0.398	0.398	0.756
Mix Attn	0.302	**0.455**	0.509	0.780
Random init, BiGRU				
Mean	0.314	0.333	0.444	0.667
Max	0.160	0.325	0.460	0.691
Attn	0.459	0.447	0.805	0.805
+POS Mean	0.373	0.333	0.425	0.683
+POS Max	0.175	0.309	0.503	0.748
+POS Attn	**0.460**	0.447	0.687	**0.821**
Mix Mean	0.231	0.350	0.395	0.642
Mix Max	0.200	0.382	0.405	0.764
Mix Attn	0.275	**0.455**	0.617	0.707
Pre-trained, unidirectional GRU				
Mean	0.274	0.366	0.463	0.715
Max	0.185	0.350	0.401	0.756
Attn	0.414	0.431	0.678	0.797
+POS Mean	0.282	0.382	0.477	0.699
+POS Max	0.193	0.382	0.405	0.764
+POS Attn	0.409	0.423	0.746	0.789
Pre-trained, BiGRU				
Mean	0.266	0.390	0.435	0.707
Max	0.187	0.398	0.393	0.740
Attn	0.454	0.447	0.773	0.797
+POS Mean	0.281	0.382	0.480	0.724
+POS Max	0.183	0.341	0.397	0.748
+POS Attn	0.433	0.439	0.758	0.805

Attention visualization



Essay by English native speaker



Essay by Russian native speaker

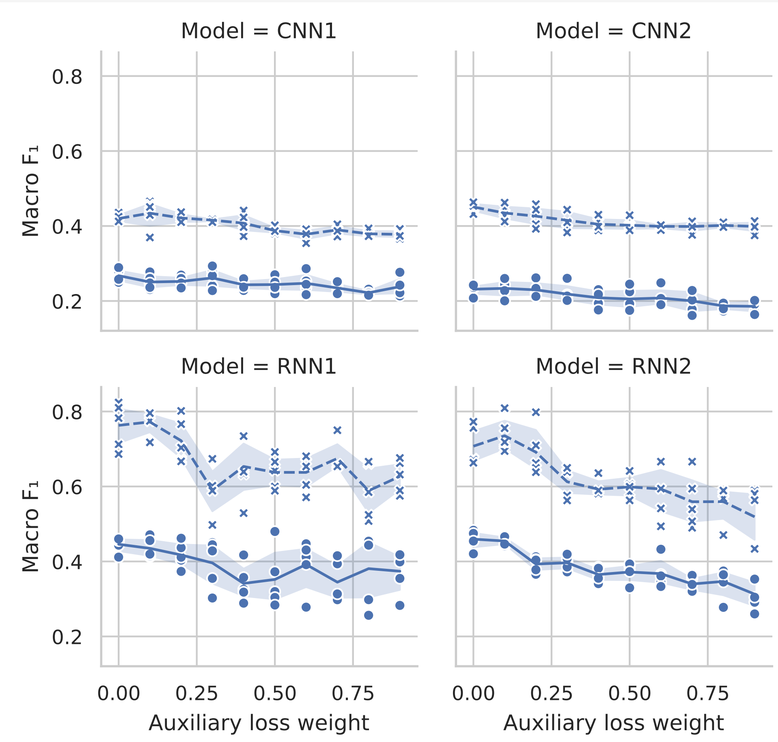
NLI

Model	Macro F_1	Micro F_1
Mean	**0.520**	**0.537**
Max	0.401	0.390
Attn	0.447	0.480
+POS Mean	0.467	0.480
+POS Max	0.406	0.431
+POS Attn	0.454	0.463

Multi-task Learning: Best settings

Hyperparameter	RNN1	RNN2
Word embeddings	Dynamic	
Embedding size	100	
RNN cell	GRU	
Pooling method	Attention	
Bidirectional	Yes	
Embedding init	Random	Pre-trained
Input representation	Tokens+UPOS	Tokens

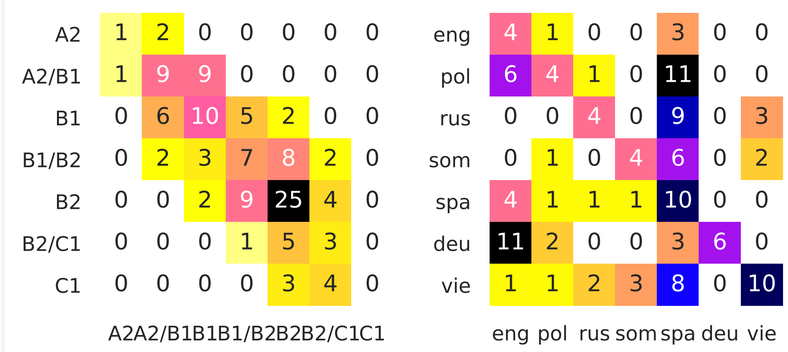
Multi-task Learning: Loss curves



Held-out set results

	All labels		Collapsed labels	
Model	Macro	Micro	Macro	Micro
Majority	0.045	0.187	0.127	0.341
SVR BOW	0.231	0.285	0.420	0.602
SVR POS	0.271	0.350	0.422	0.602
RNN1	0.291	0.439	0.478	0.724
RNN2	**0.388**	**0.480**	**0.511**	**0.724**
Multi-RNN1	0.266	0.398	0.509	0.707
Multi-RNN2	0.356	0.447	0.443	0.724

Error Analysis



Conclusion

- AES task is best modeled as regression for ASK corpus.
- mean-over-time BiGRU model performed the best at NLI task.
- Auxiliary loss weight of 0.1 is best suited for joint modeling of AES and NLI tasks.
- Pretrained embeddings achieve the best results.