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tBERT: Topic Models and BERT Joining Forces for Semantic Similarity Detection

Nicole Peinelt, Dong Nguyen, Maria Liakata

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Authors

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Semantic Similarity Detection for English

– Given a sentence pair, predict binary relatedness

Dataset	Task
Quora	paraphrase detection
MSRP	paraphrase detection
SemEval	(A) internal answer ranking
	(B) paraphrase ranking
	(C) external answer ranking

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Example from Quora:

Sentence Pair:

Which is the best way to learn coding?
How do you learn to program?

Label:
is_paraphrase

Motivation

Feature-engineering

Qin et al. (2009),
Tran et al. (2015),
Mihaylov and Nakov (2016),
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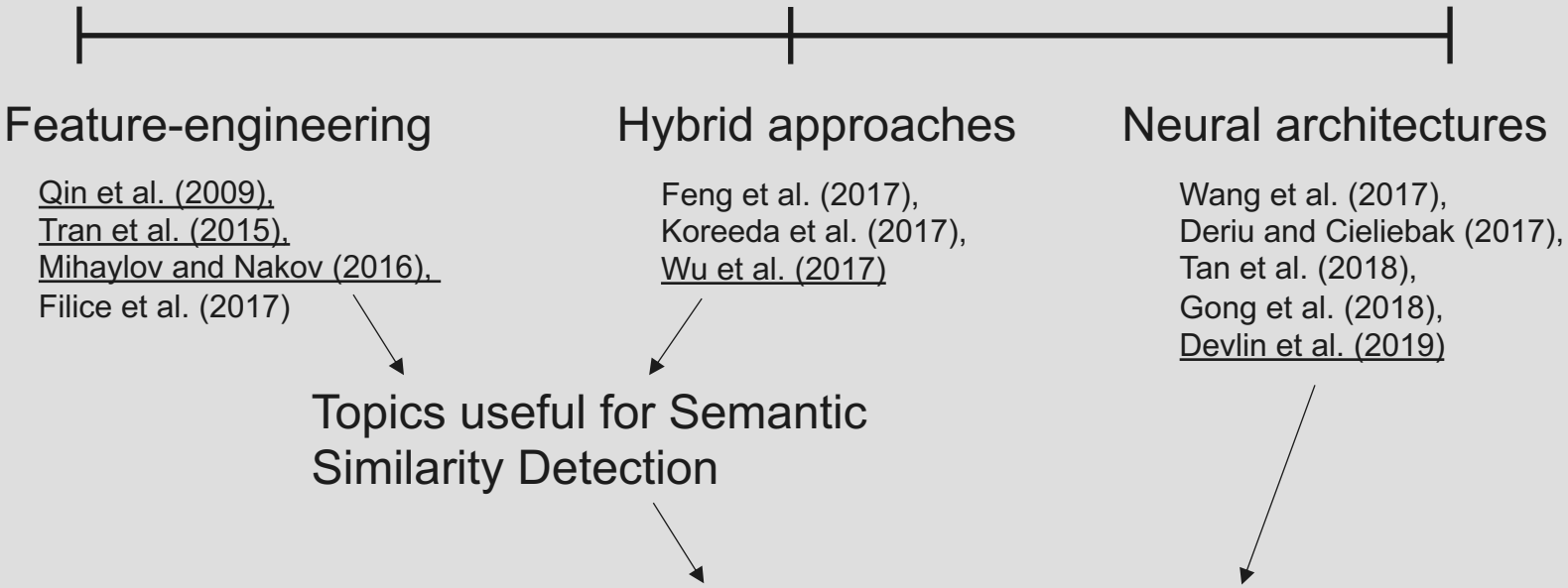
Topics useful for Semantic Similarity Detection

Motivation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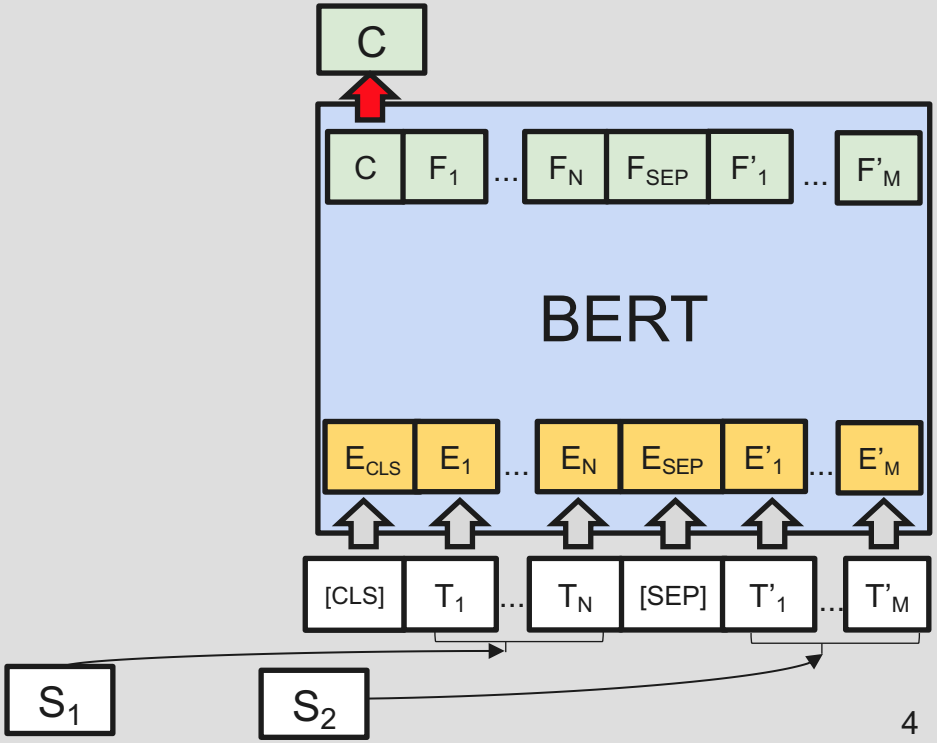
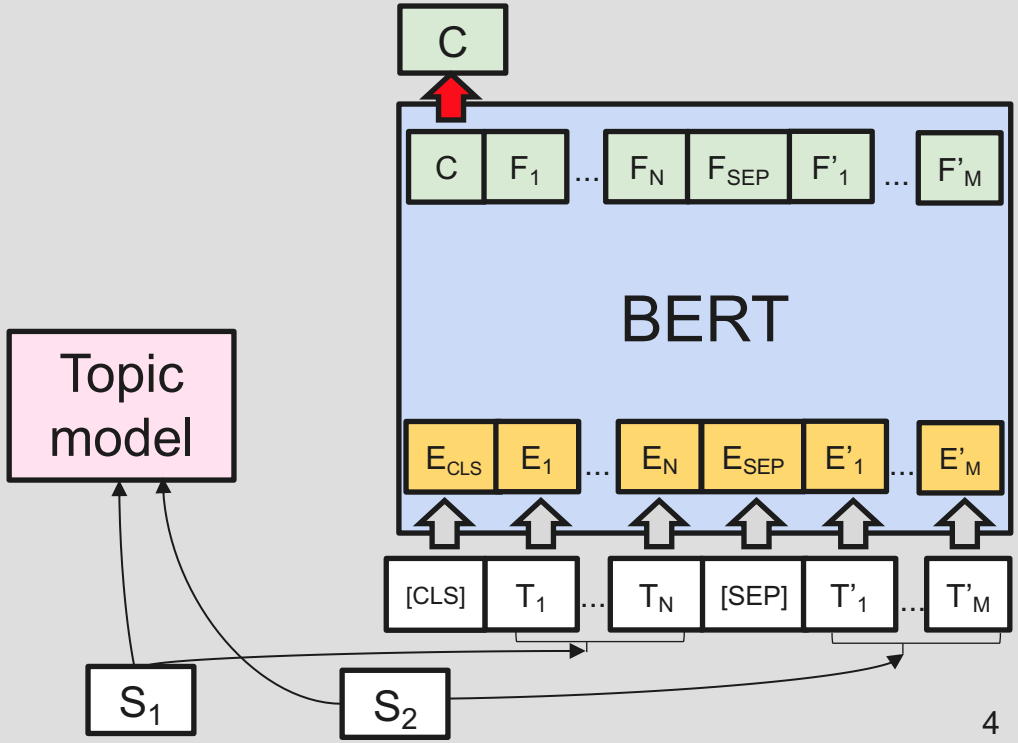
Topics useful for Semantic Similarity Detection
→Idea: Combining topic models and BERT

tBERT


C
C
F1
...
FN
FSEP
F'1
...
F'M
BERT
ECLS
E1
...
EN
ESEP
E'1
...
E'M
[CLS]
T1
...
TN
[SEP]
T'1
...
T'M
S1
S2

tBERT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F1
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Topic model
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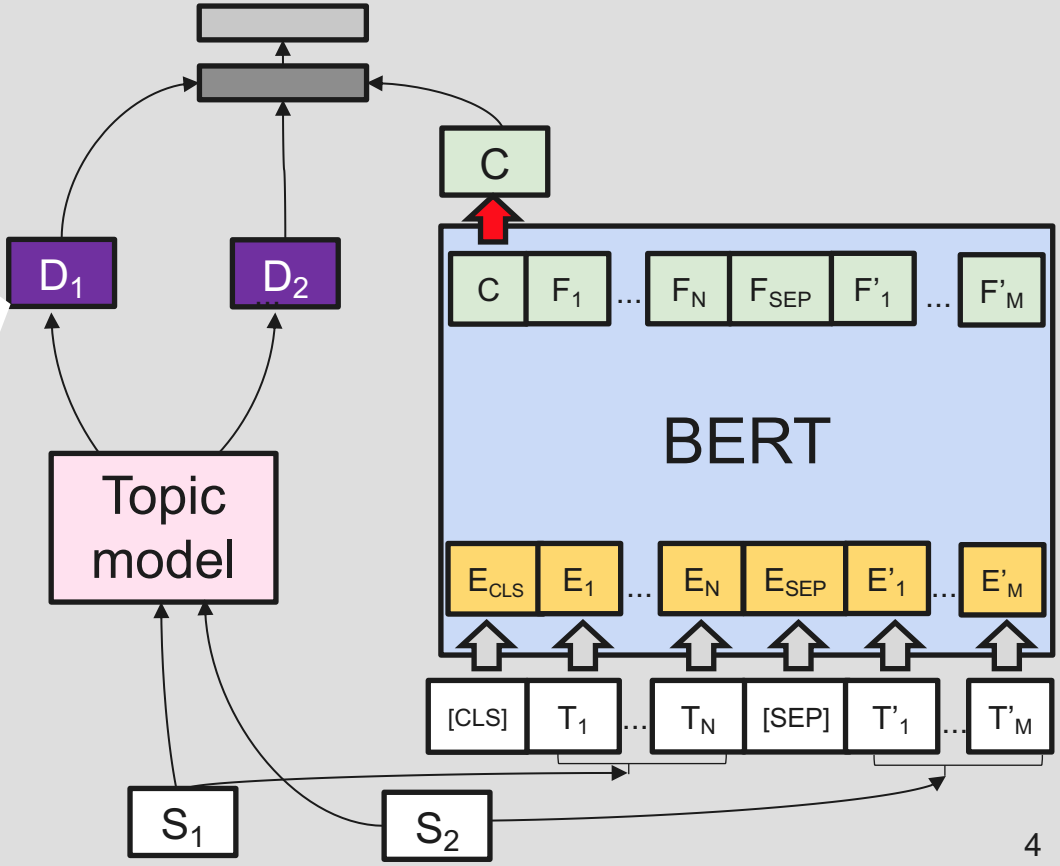
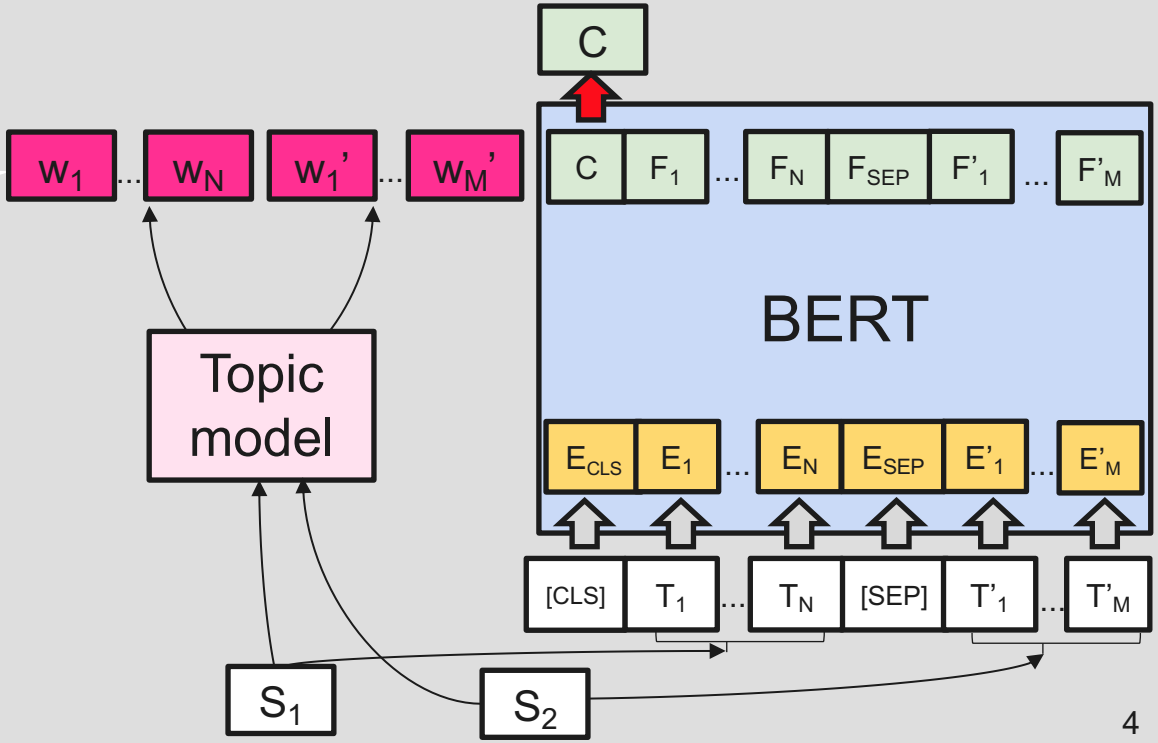
tBERT with document topics

$$D_1 = \text{TopicModel}([T_1, ..., T_N]) \in R^t$$
$$D_2 = \text{TopicModel}([T'_1, ..., T'_M]) \in R^t$$



tBERT with word topics

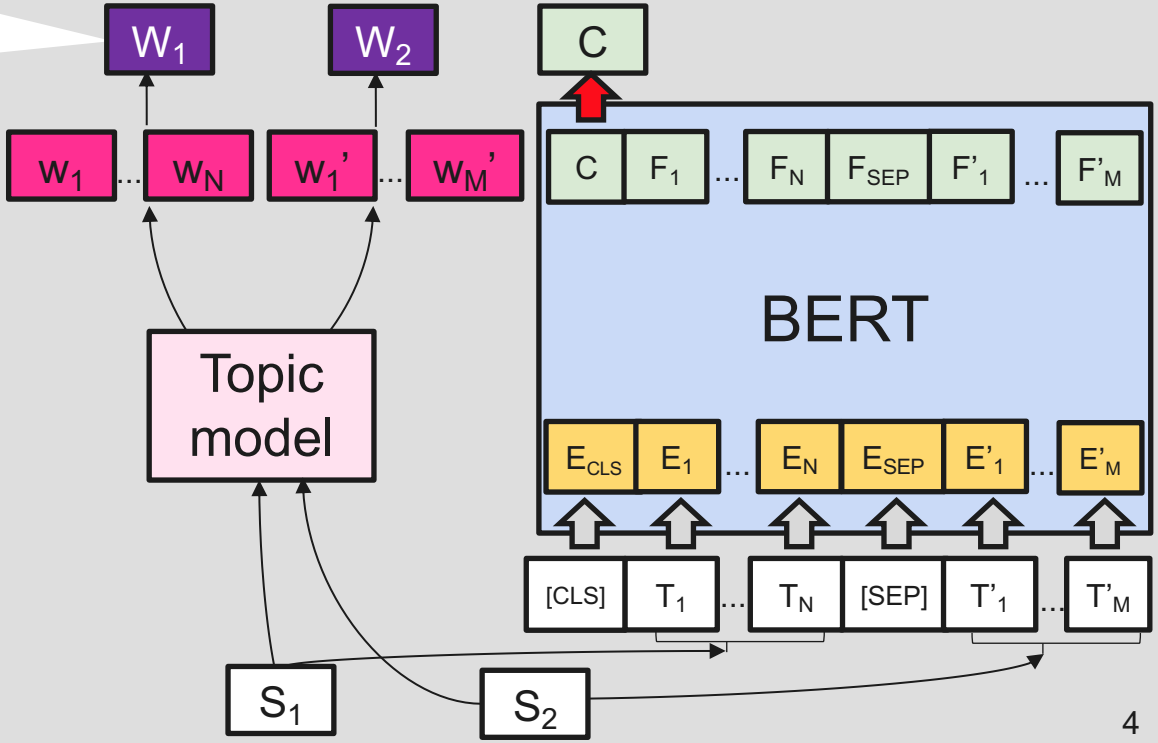
$$w_i = \text{TopicModel}(T_i) \in R^t$$



tBERT with word topics

$$W_1 = \frac{\sum_{i=1}^{N} w_i}{N} \in R^t$$

$$W_2 = \frac{\sum_{i=1}^{M} w'_i}{M} \in R^t$$



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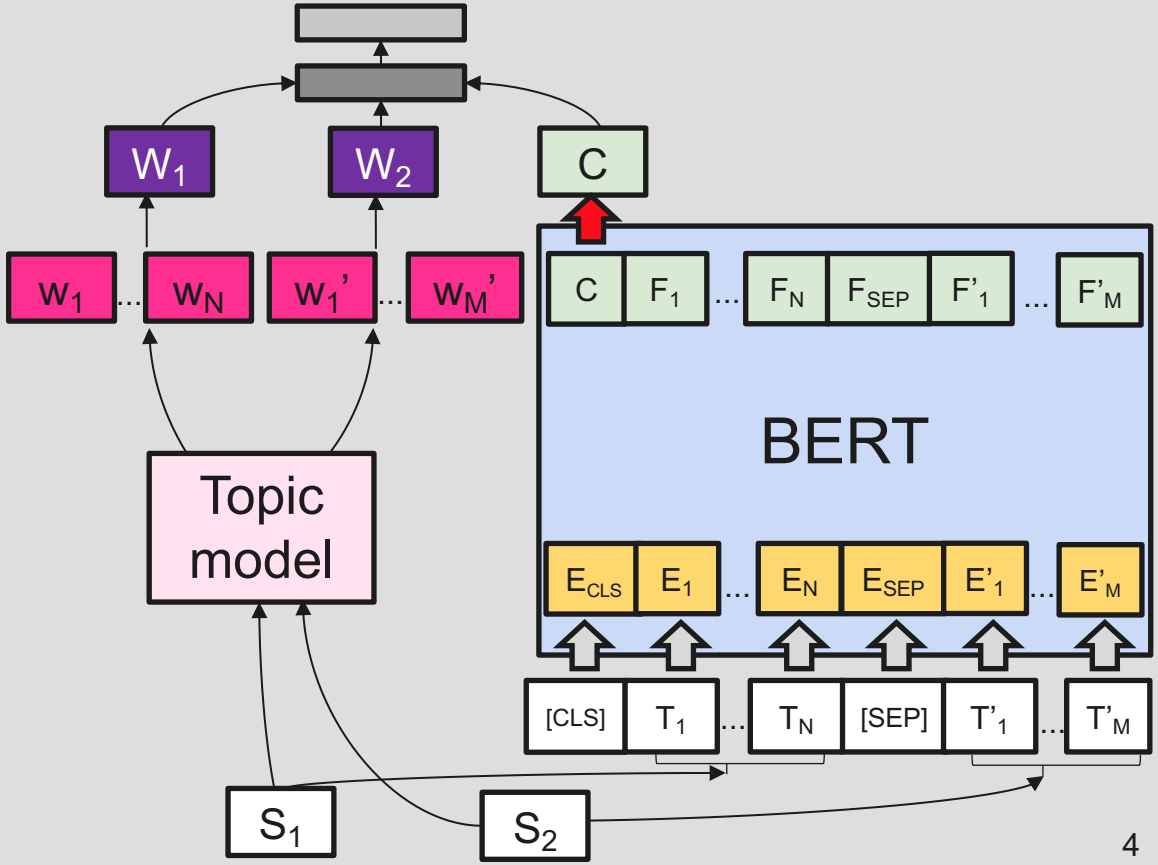

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			F1		
	MSRP	Quora	SemEval		
			A	B	C

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Previous systems					
Filice et al. (2017) - feature-based	-	-	-	.506	-
Wu et al. (2017) - feature-based	-	-	**.777**	-	-
Koreeda et al. (2017) - feature-based	-	-	-	-	.197
Deriu and Cieliebak (2017) - neural	-	-	.433	-	-
Pang et al. (2016) - neural	.829	-	-	-	-
Gong et al. (2018) (accuracy) - neural	-	(.891)	-	-	-

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LDA topic baseline	.799	.736	.684	.436	.096
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tBERT with LDA topics	**.884**	**.905**	.768	**.524**	**.273**
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	MSRP	Quora	SemEval		
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F1 on cases with **named entities** (total: 230/500)					
BERT	.20	**.54**	.50	**.53**	.32
tBERT	**.35**	.49	**.52**	.21	**.56**
(# of cases)	(23)	(31)	(58)	(60)	(58)
F1 on cases with **domain-specific words** (total: 159/500)					
BERT	.18	.00	.36	.36	.26
tBERT	**.67**	**.50**	**.62**	**.40**	**.58**
(# of cases)	(14)	(7)	(36)	(41)	(61)
F1 on cases with **non-standard spelling** (total: 53/500)					
BERT	.00	N/A	.20	**.71**	.43
tBERT	.00	N/A	**.80**	.00	**.62**
(# of cases)	(1)	(0)	(20)	(19)	(13)

Table 4: F1 for BERT and tBERT on annotated development set examples by manually annotated properties.

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s2	Fuwairit is very clean!
gold label	is_relevant

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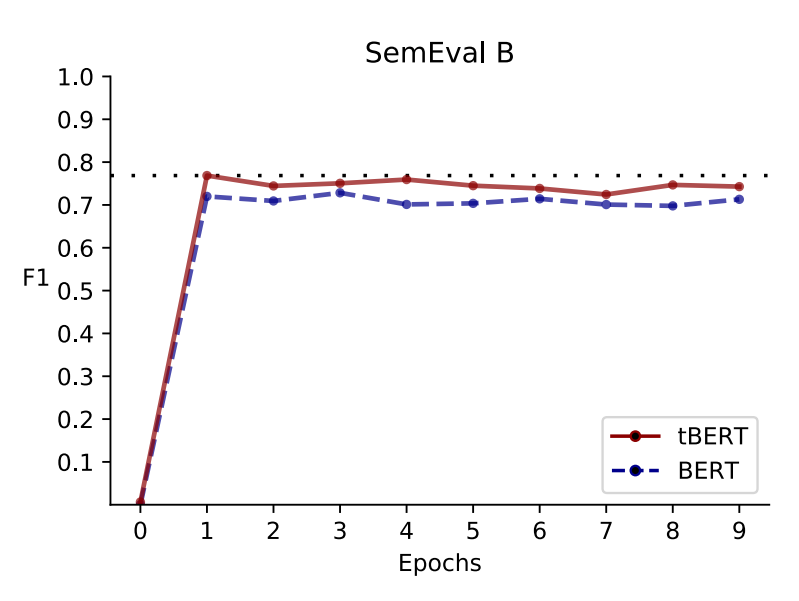
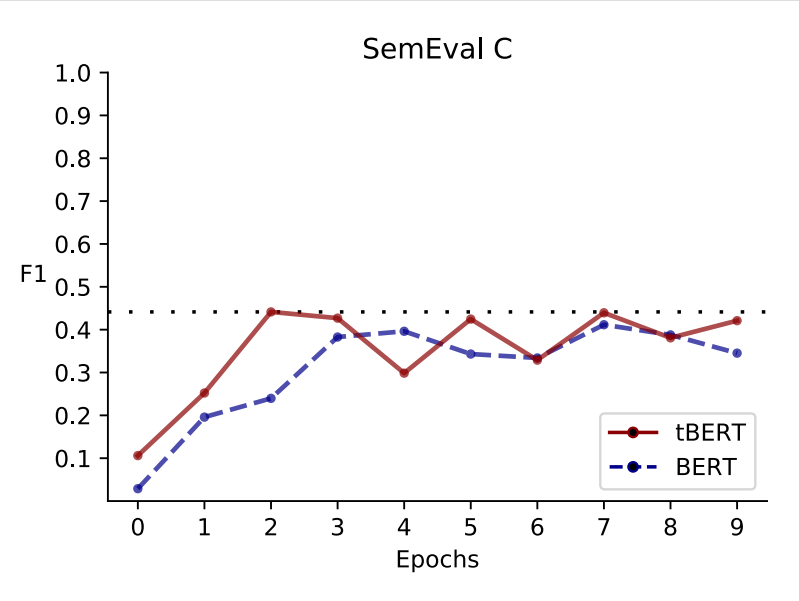
Could we just train BERT longer?





Conclusion

1. Flexible framework for combining topic models with BERT
2. Adding LDA topics to BERT improves performance
3. Improvements mainly on domain-specific examples

Thank you

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github.com/wuningxi/tBERT