Task-Aware Representation of Sentences for Generic Text Classification

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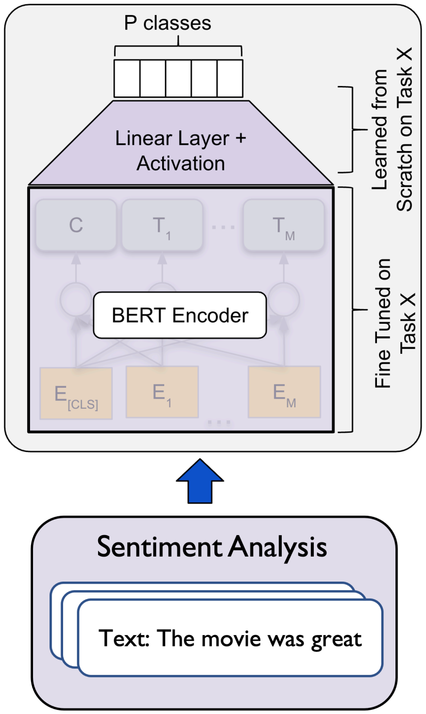
Text Classification: Forms and Standards

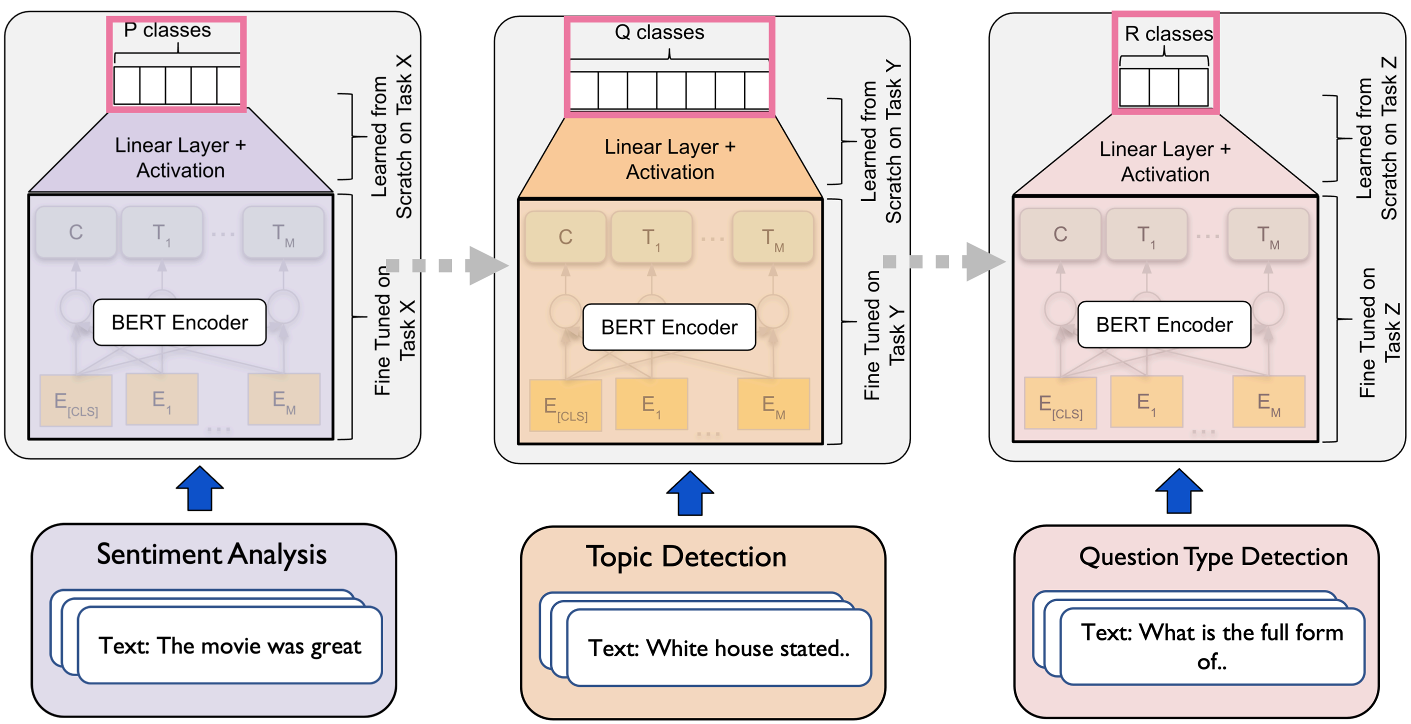
- Task: Classify textual documents into pre-defined classes
- Used in variety of downstream applications:
  - Sentiment Analysis, Topic Detection, Question Type



Standard Formulation

$$f: text \rightarrow \{0,1\}^P$$

Text Classification: Common Transfer Learning Practices



Standard Formulation

$$f: text \rightarrow \boxed{\{0,1\}^P}$$

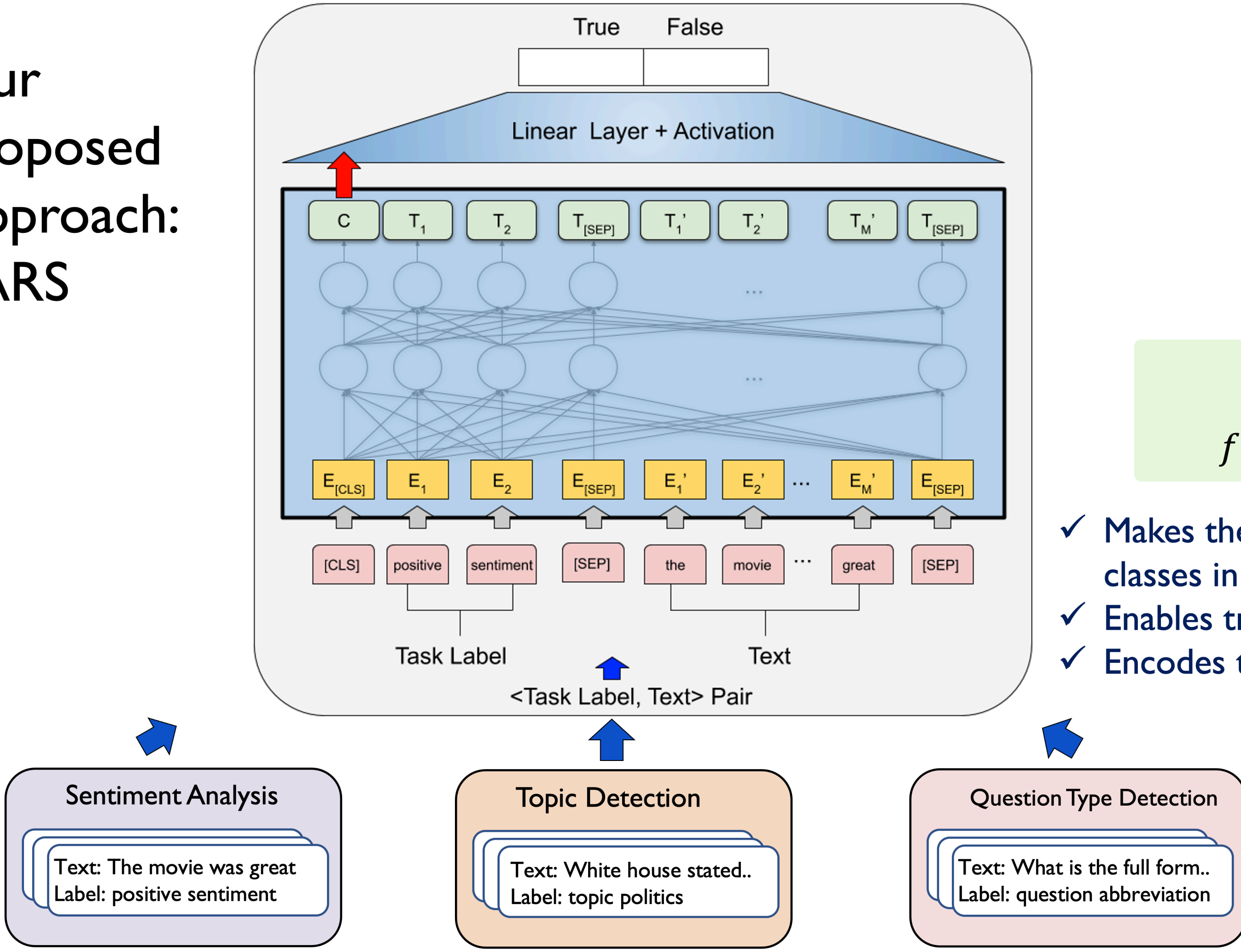
Limitation #1

- $P \neq Q \neq R$
- Information in the decoder can not be transferred

Limitation #2

- Class semantics are learned implicitly from the training samples
- Can not leverage label names e.g.,"Politics"

Our Proposed Approach: TARS



Task-Aware Representation of Sentences for Generic Text Classification

Standard Formulation

$$f: text \rightarrow \{0,1\}^P$$

Our Formulation

$$f: < task\ label, text > \rightarrow \{0,1\}$$

- ✓ Makes the *entire stack* independent of number of classes in a task
- ✓ Enables transfer of *all parameters* between tasks
- ✓ Encodes the label names *explicitly* from tasks

TARS: Working Principle

Our Formulation

$f :< task\ label, text > \rightarrow \{0, 1\}$

Sentiment Analysis

Positive, Neutral, Negative

Training Sample

Text: "I enjoyed the movie a lot", Label: Positive

Transformed Input to TARS

"Positive Sentiment [SEP] I enjoyed the movie a lot", Label: 1

"Neutral Sentiment [SEP] I enjoyed the movie a lot", Label: 0

"Negative Sentiment [SEP] I enjoyed the movie a lot", Label: 0

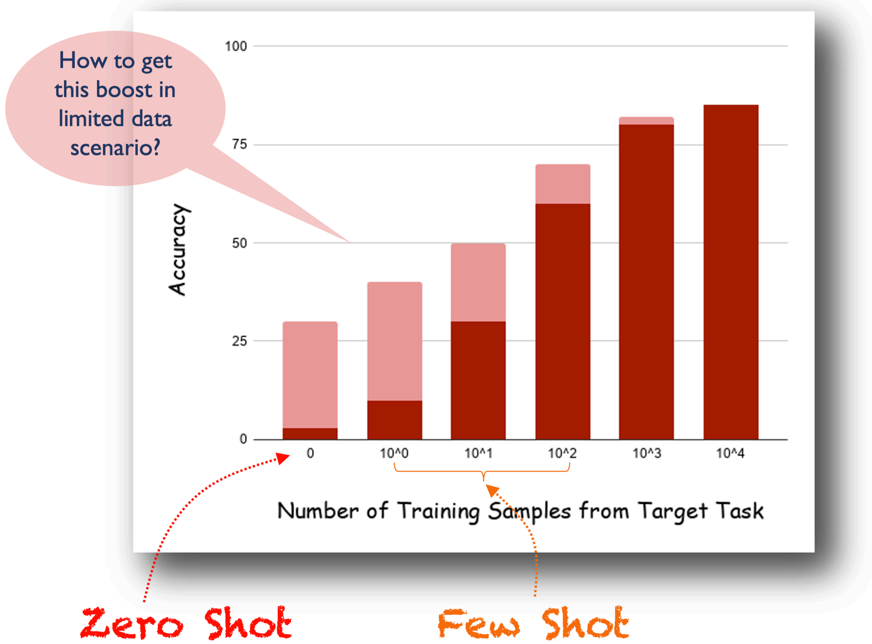
Inference

1. Populate $< task\ label, text >$ tuples from input text
2. Perform $argmax$ over all classes

Complexity

Grows linearly with number of classes in a task

Research Questions



Training Data size vs Accuracy of a Typical Model

Can the Task-Aware formulation help in zero/few shot scenario?

How does the semantic distance between tasks affect the transfer learning capability?

How well does TARS memorize multiple tasks?

Experiments: Baseline Setup

Used Standard Datasets from
Multiple Classification Task Types

Dataset	Type	#classes
TREC-6 (Li and Roth, 2002)	Question	6
TREC-50 (Li and Roth, 2002)	Question	50
YELP-FULL (Zhang et al., 2015)	Sentiment	5
AMAZON-FULL (Zhang et al., 2015)	Sentiment	5
AGNEWS (Zhang et al., 2015)	Topic	4
DBPEDIA (Zhang et al., 2015)	Topic	14

Evaluation of Transfer Learning Capability

- Train classification model on *source task* with all labeled samples
- Fine Tune the model on limited labeled samples from *target task*
- Compare Accuracy of Baseline models on the **entire test set** from *target task*

Model	Source Task	Target Task
$\text{BERT}_{\text{BASE}}$	No Access	Limited Access
$\text{BERT}_{\text{BASE}}$ (*ft*)	Full Access	Limited Access
TARS	Full Access	Limited Access

Experiments: Baseline Comparison (In Domain)

Domain: Sentiment Analysis									
Yelp-full → Amazon-full					Amazon-full → Yelp-full				
M	k	$\text{BERT}_{\text{BASE}}$	$\text{BERT}_{\text{BASE}}$ (ft)	TARS	M	k	$\text{BERT}_{\text{BASE}}$	$\text{BERT}_{\text{BASE}}$ (ft)	TARS
	0	–	–	**51.8**		0	–	–	**50.6**
	1	21.8±1.7	27.5±6.5	**51.0**±0.3		1	22.5±3.2	28.0±5.3	**53.0**±0.3
	2	24.6±1.1	36.4±7.0	**52.7**±0.2		2	22.6±1.7	33.7±4.1	**52.2**±0.7
5	4	25.8±1.7	43.2±3.0	**52.3**±0.5	5	4	26.5±2.3	44.1±1.4	**52.0**±2.1
	8	25.4±1.8	45.0±1.1	**49.9**±1.7		8	31.9±2.0	46.5±2.0	**53.3**±1.1
	10	29.0±1.5	45.2±1.0	**51.6**±0.4		10	32.8±2.1	47.2±3.0	**52.5**±0.3
	100	50.7±0.9	53.2±0.4	**53.4**±0.4		100	53.9±1.8	55.8±0.5	**56.4**±0.7
Domain: Topic Classification									
DBpedia → AGNews					AGNews → DBpedia				
M	k	$\text{BERT}_{\text{BASE}}$	$\text{BERT}_{\text{BASE}}$ (ft)	TARS	M	k	$\text{BERT}_{\text{BASE}}$	$\text{BERT}_{\text{BASE}}$ (ft)	TARS
	0	–	–	**52.4**		0	–	–	**51.2**
	1	41.6±6.5	66.6±4.6	**72.1**±3.4		1	45.4±2.6	45.2±3.7	**76.6**±2.7
	2	56.0±3.3	69.8±2.7	**74.3**±4.5		2	76.4±2.4	66.0±4.2	**81.7**±3.8
4	4	70.8±5.6	78.5±2.3	**80.2**±0.9	14	4	**91.3**±0.5	84.4±2.7	90.1±1.3
	8	78.3±1.3	80.1±2.1	**81.0**±0.8		8	**96.5**±0.4	93.5±1.4	94.8±0.7
	10	80.1±2.9	82.0±0.6	**83.5**±0.2		10	**97.6**±0.3	95.8±0.1	96.6±0.2
	100	**87.8**±0.4	86.9±0.4	86.7±0.3		100	**98.7**±0.0	98.4±0.0	98.4±0.0

Model	Model Size	AGNews	DBpedia
GPT-2 (2019)	117M	40.2*	39.6*
TARS	110M	**52.4**	**51.2**

Task-Aware Representation of Sentences for Generic Text Classification

M: Number of classes in target task
k: Number of labelled samples per class used for training

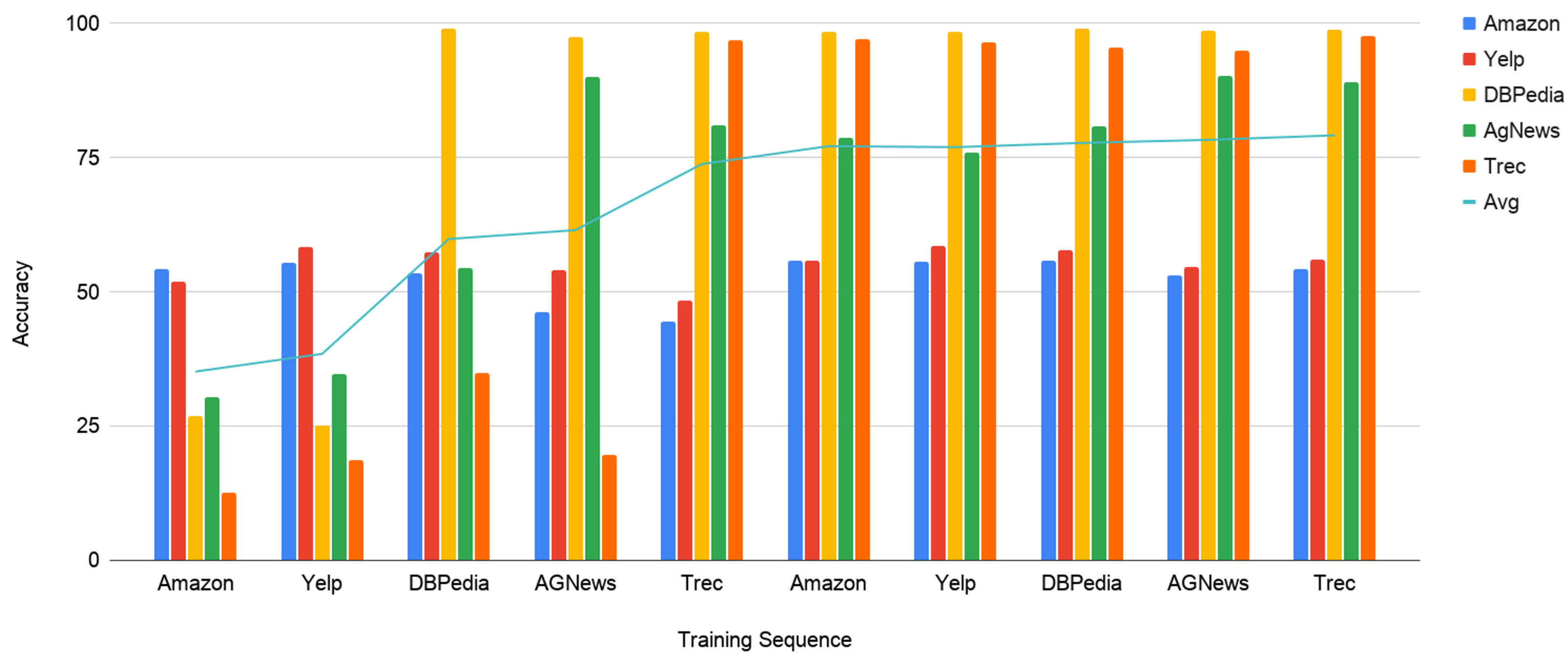
- TARS shows impressive improvement in zero/few shot scenarios
- The binary text classification is effective compared to other zero shot formulations

Experiments: Baseline Comparison (Cross Domain)

DBPEDIA (Topic) → TREC-6 (Question Type)					AMAZON-FULL (Sentiment) → AGNEWS (Topic)				
M	k	$\text{BERT}_{\text{BASE}}$	$\text{BERT}_{\text{BASE}}$ (ft)	TARS	M	k	$\text{BERT}_{\text{BASE}}$	$\text{BERT}_{\text{BASE}}$ (ft)	TARS
	0	–	–	**43.0**		0	–	–	**28.0**
	1	26.4±4.2	38.5±3.9	**45.7**±6.2		1	**43.8**±4.0	29.8±0.7	42.9±3.5
	2	36.9±6.0	32.8±7.1	**62.9**±5.7		2	**59.6**±1.1	37.1±4.3	49.5±1.0
6	4	43.5±3.2	45.3±3.0	**62.7**±2.2	6	4	**70.4**±4.6	49.0±2.8	63.7±6.4
	8	56.4±3.1	57.2±1.8	**61.9**±1.9		8	**80.5**±0.3	57.4±0.8	79.2±0.2
	10	58.8±6.6	63.7±2.3	**64.7**±1.0		10	**81.4**±0.7	65.4±6.3	79.6±0.7
	100	92.5±0.8	**93.4**±1.0	91.6±0.9		100	**88.0**±0.1	86.9±0.4	86.6±0.6

- Cross domain transfer remains a challenging task
- If domains are very different (both nature of task, and formalism), knowledge from the *source task* becomes less effective

Experiments: Pushing TARS beyond Single Task



- Continue training a single TARS model on all the datasets
- Observe accuracy across all datasets after each training round
- The final model does not show catastrophic forgetting
- All 5 tasks can be performed well by the final model

Conclusion

- Proposed a task label aware formulation for text classification called TARS
- Allows full transfer of model weights on unseen tasks
- Performed experiments to track its effectiveness in limited data scenario i.e., zero/few shot
- TARS can perform accurate zero shot predictions
- Outperforms other transfer learning mechanisms in few shot cases
- TARS can encapsulate multiple tasks in a single model, does not show catastrophic forgetting
- Ready-to-use implementation available in flair

Thanks for listening!
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Paper: bit.ly/TARS-PDF
Code: bit.ly/TARS-CODE