Enhancing Event-Level Sentiment Analysis with Structured Arguments

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Dataset: https://github.com/zhangqi-here/E3SA

Reported by Dongdong Hu

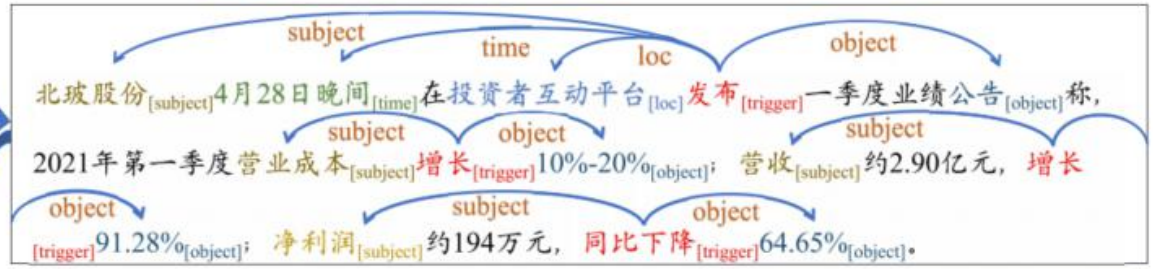
Introduction

Trigger extraction

北玻股份4月28日晚间在投资者互动平台发布一季度业绩公告称，2021年第一季度营业成本增长10%-20%；营收约2.90亿元，增长91.28%；净利润约194万元，同比下降64.65%。
On the evening of April 28, BeiBo co.,ltd released its first-quarter results announcement on the interactive platform for investorsa, stating that the first quarter of 2021, operating costs increased 10%-20%; revenue was about 290 million yuan, increasing about 91.28%; net profit was about 1.94 million yuan, year on year decreasing 64.65%.

Argument extraction

北玻股份4月28日晚间在投资者互动平台发布[trigger]一季度业绩公告称，2021年第一季度营业成本增长[trigger]10%-20%；营收约2.90亿元，增长[trigger]91.28%；净利润约194万元，同比下降[trigger]64.65%。



Sentiment classification

Event		Polarity
[trigger1]	发布 (released)	Neutral
[subject1]	北玻股份 (BeiBo co.)	
[object 1]	公告 (announcement)	
[time 1]	4月28日晚间 (On the evening of April 28)	
[loc 1]	投资者互动平台 (interactive platform for investorsa)	
[trigger2]	增长 (increase)	Negative
[subject2]	营业成本 (operating costs)	
[object 2]	10%-20%	
[trigger3]	增长 (increase)	Positive
[subject3]	营收 (revenue)	
[object 3]	91.28%	
[trigger4]	同比下降 (year on year decrease)	Negative
[subject4]	净利润 (net profit)	
[object 4]	64.65%	

Previous studies about event-level sentiment analysis (SA) usually model the event as a topic, a category or target terms

while the structured arguments (e.g., subject, object, time and location) that have potential effects on the sentiment are not well studied.

Method

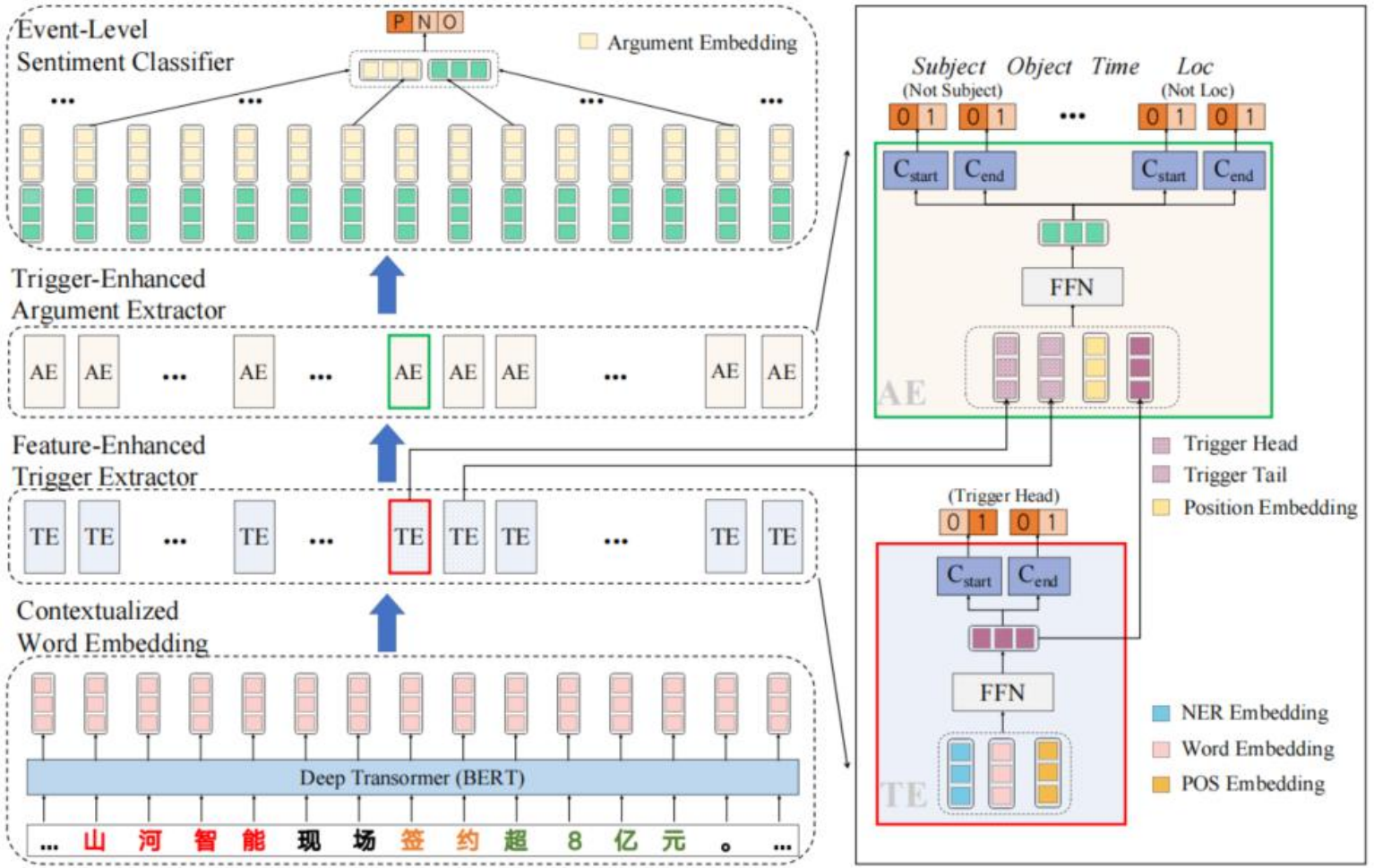


Figure 2: Our E^3SA framework.

Method

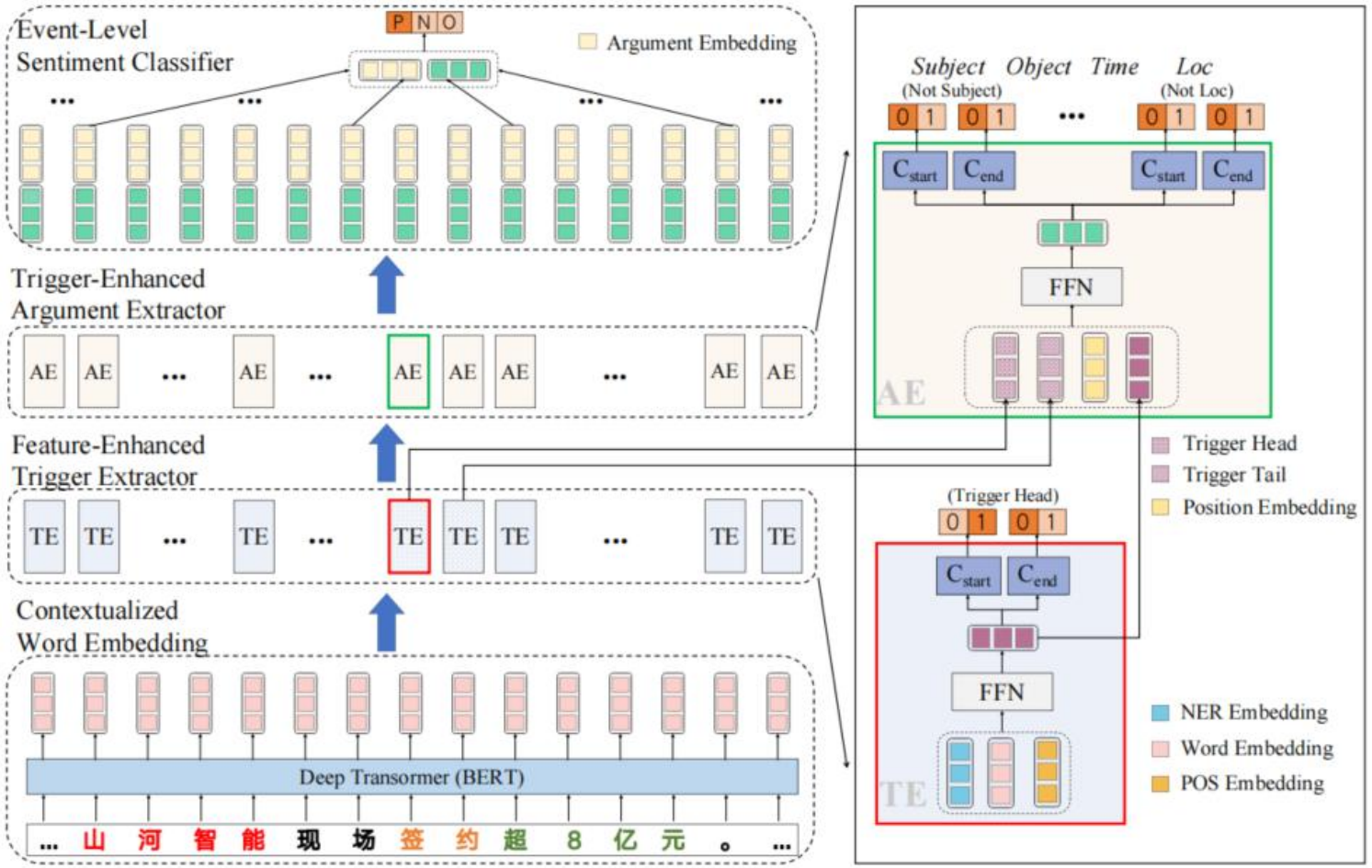


Figure 2: Our E^3SA framework.

$$d = \{s_1, \ldots, s_{|d|}\}$$

$$\{w_1^{(i)}, \ldots, w_{|s_i|}^{(i)}\}$$

$$E = \{\text{event}_1, \ldots, \text{event}_{|E|}\}$$

$$\text{event}_k = (t_k, a_k, y_k)$$

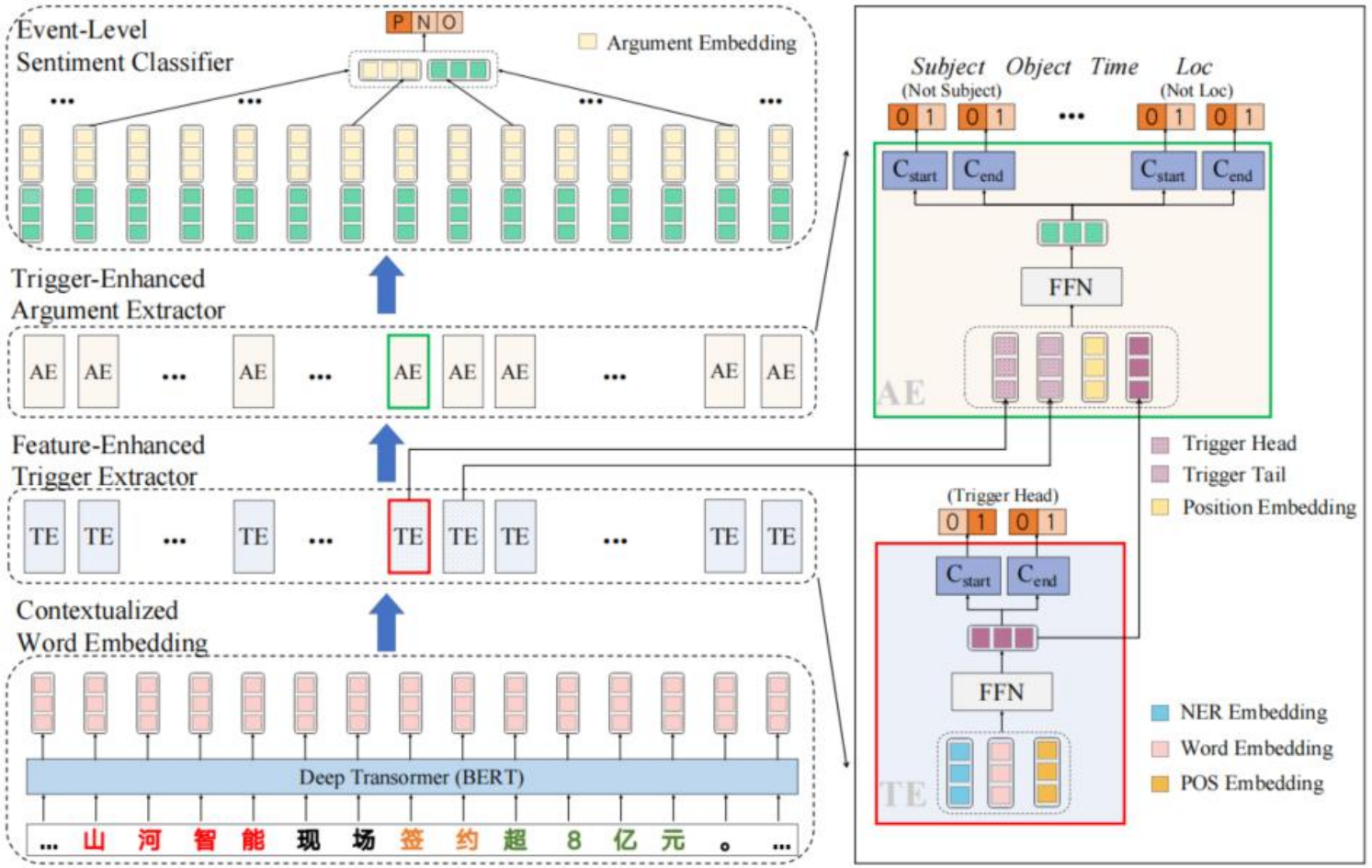
triggers t_k

arguments a_k (subject sub_k, object obj_k, time time_k, location loc_k)

sentiment polarities y_k

$$y_k \in \{P, N, O\}$$

Method



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Feature-Enhanced Trigger Extractor

$$\{[\text{CLS}], w_1, w_2, ..., w_m, [\text{SEP}]\}$$

$$\text{word embeddings } \{x^w_{[\text{CLS}]}, x^w_1, x^w_2, ..., x^w_m, x^w_{[\text{SEP}]}\}$$

$$x^f_i = \text{FFN}(\text{concat}(x^w_i, x^{pos}_i, x^{ner}_i)).$$

$$p^{t^s}_i = \text{Sigmoid}(W^{t^s} x^f_i + b^{t^s}); p^{t^e}_i = \text{Sigmoid}(W^{t^e} x^f_i + b^{t^e})$$

here ^{s} and ^{e} denote the start and end indices, W^{t^s}, W^{t^e}, b^{t^s} and ^{e} are the learnable weights.

$$\mathcal{L}_t = \frac{1}{m}\sum_{i=1}^{m} \text{CE}(y^{t^s}_i, p^{t^s}_i) + \text{CE}(y^{t^e}_i, p^{t^e}_i)$$

Method

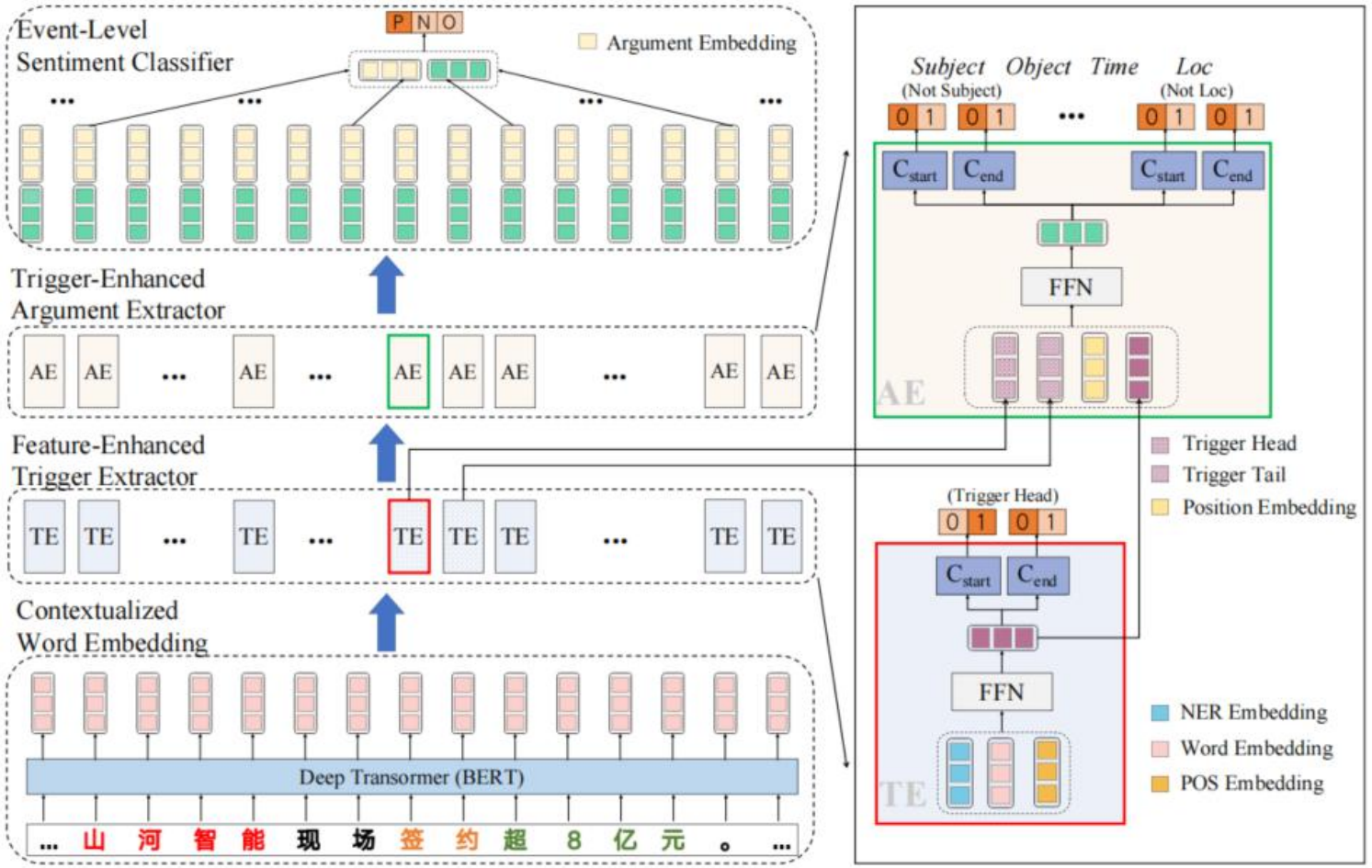


Figure 2: Our E^3SA framework.

Trigger-Enhanced Argument Extractor

$$x_i^{t_k} = \text{FFN}(\text{concat}(x_i^f, x_{t_k^s}^f, x_{t_k^e}^f, x_i^{\text{position}_k}))$$

where $x_{t_k^s}^f$ and $x_{t_k^e}^f$ is the head and tail representation of the trigger t_k obtained from x^f.

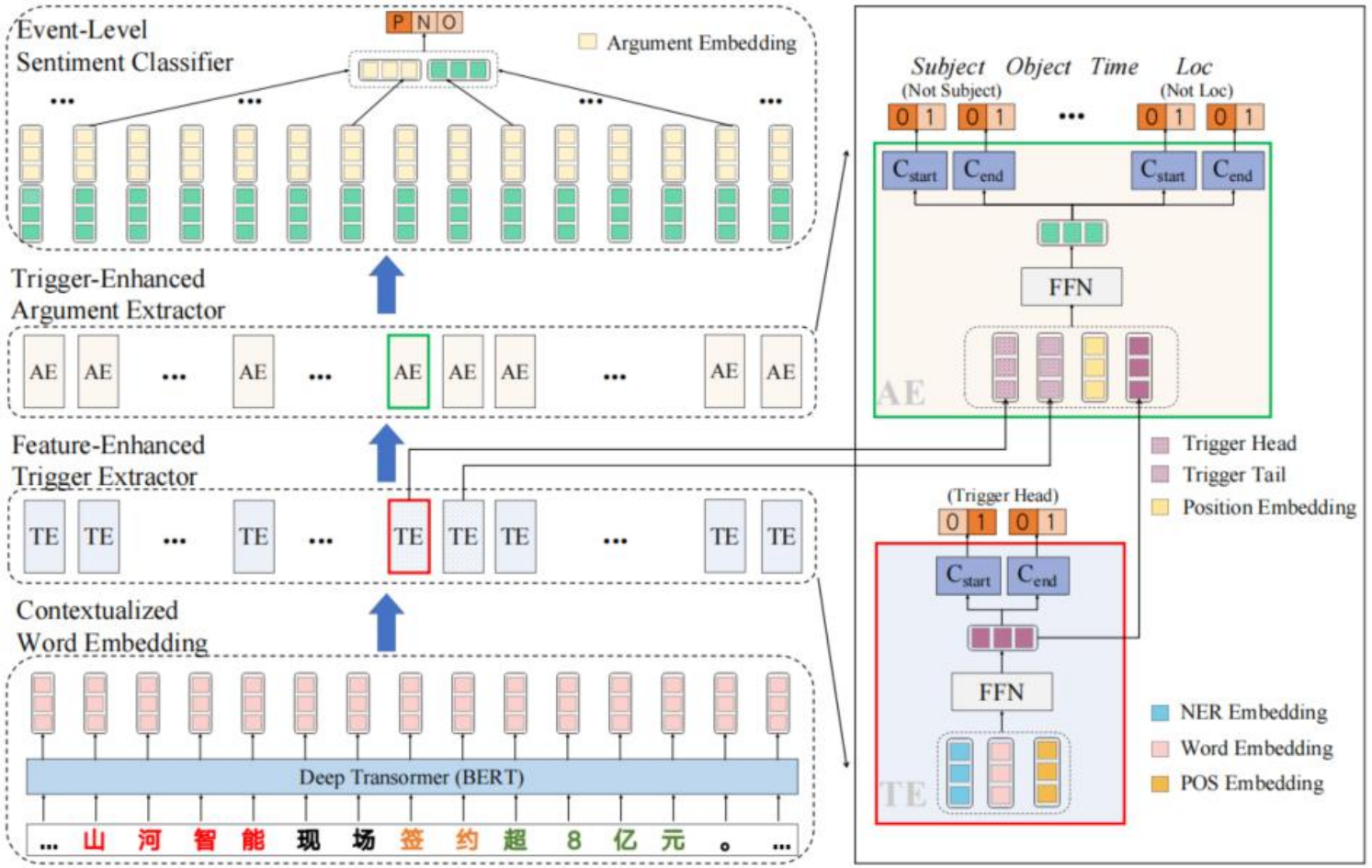
$$p_i^{r_k^s} = \text{Sigmoid}(W^{r^s} x_i^{t_k} + b^{r^s}); p_i^{r_k^e} = \text{Sigmoid}(W^{r^e} x_i^{t_k} + b^{r^e}$$

The loss function for argument extraction is,

$$\mathcal{L}_a = \frac{1}{|E| \times |R| \times m} \sum_{k=1}^{|E|} \sum_{r \in |R|} \sum_{i=1}^{m} \text{CE}(y_i^{r_k^s}, p_i^{r_k^s}) + \text{CE}(y_i^{r_k^e}, p_i^{r_k^e})$$

where R is the set of roles, including subject, object, time and location.

Experiments



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Event-Level Sentiment Classifier

$$x_i^{r_k}$$

$$v^{\text{event}_k} = \text{MaxPooling}(\text{concat}(x_i^{t_k}, x_i^{r_k}))$$

$$p_k = \text{Softmax}\,(W^c v^{\text{event}_k} + b^c),$$

$$\mathcal{L}_c = \frac{1}{|E|} \sum_{k=1}^{|E|} \text{CE}(y_k, p_k)$$

$$\mathcal{L} = \mathcal{L}_t + \mathcal{L}_a + \mathcal{L}_c.$$

Method

Table 1: The statistic information of our dataset.

	#Doc	#AvgLen	#E	#MultiE	#PosE	#NegE	#NeuE	#AvgS	#MultiP	#E-Across
Train	2142	148.78	4210	1281	2659	635	916	3.41	1134	474
Dev	500	151.75	962	293	591	154	216	3.41	265	104
Test	500	148.14	1005	317	662	138	205	3.51	280	122
Total	3142	149.15	6177	1891	3912	927	1337	3.42	1679	593

Table 2: The comparison with the existing datasets

Task	Dataset	Event	Doc	E-Across	MultiE	Sentiment
EE	ACE05	√	√	-	-	-
	MUC-4 Event	√	√	√	√	-
	DocEDAG	√	√	√	√	-
ABSA	Twitter	-	-	-	-	√
	Rest 14	-	√	-	√	√
	Lap 14	-	√	-	√	√
Our task	Our dataset	√	√	√	√	√

Experiments

Table 3: The results of event-level SA with extracted arguments. The best scores are marked with bold.

	Trigger			Arguments												Sentiment		
				Sub			Obj			Time			Loc					
	P	R	F1	P	R	F1	P	R	F1	P	R	F1	P	R	F1	P	R	F1
DCFEE-O	41.69	27.59	33.21	43.40	14.73	21.99	50.79	19.30	27.97	71.90	48.46	57.89	0.00	0.00	0.00	19.75	13.07	15.73
DCFEE-M	33.87	44.64	38.52	34.66	19.00	24.55	40.81	25.17	31.14	58.62	59.91	59.26	16.67	9.09	11.76	14.60	19.24	16.60
GreedyDec	**67.23**	24.62	36.04	67.78	16.12	26.05	63.74	16.62	26.36	79.08	53.30	63.68	0.00	0.00	0.00	15.93	5.83	8.54
Doc2EDAG	38.94	16.49	23.17	62.11	14.03	22.89	58.75	14.03	22.65	56.25	11.89	19.64	0.00	0.00	0.00	30.73	13.01	18.28
BERT-QA	51.40	60.85	55.73	69.16	55.22	61.80	**69.96**	52.84	59.20	75.58	57.27	65.16	0.00	0.00	0.00	44.53	52.72	48.28
E^3*SA* (Ours)	54.79	**62.82**	**58.53**	**69.83**	**60.80**	**65.00**	64.68	**55.02**	**59.46**	**89.54**	**60.35**	**72.11**	**66.67**	**18.18**	**28.57**	**48.24**	**55.30**	**51.53**

Experiments

Table 4: The results of event-level SA with gold arguments.

		P	R	F1	Acc
Non-BERT-based	MemNet	71.25	69.65	70.41	78.41
	ATAE_LSTM	74.84	67.92	70.72	80.00
	MGAN	76.37	69.95	72.45	81.59
	TNet	79.53	66.74	71.16	81.19
BERT-based	BERT-SPC	82.27	79.92	80.71	85.17
	AEN_BERT	79.94	73.11	75.93	83.18
	LCF-BERT	81.42	80.16	80.91	85.87
Ours	E^3SA	**82.57**	**80.24**	**81.32**	**86.17**

Experiments

Table 5: The results of ablation studies in terms of F1.

	Trigger	Argument				Sentiment
		Sub	Obj	Time	Loc	
E^3SA (Ours)	**58.53**	65.00	**59.46**	**72.11**	**28.57**	**51.53**
Pipeline	56.05	64.89	58.16	71.22	16.67	50.25
- Feature	58.35	62.13	58.68	69.36	24.06	50.08
- Trigger Info	57.93	54.41	55.43	67.36	18.24	51.04
- Argument Info	58.52	**65.14**	58.54	71.85	27.50	50.97
- Trigger+Argument	57.20	53.07	50.06	36.43	00.00	49.58

Thanks