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Making Flexible Use of Sub-tasks: A Multiplex Interaction Network for Unified Aspect-based Sentiment Analysis

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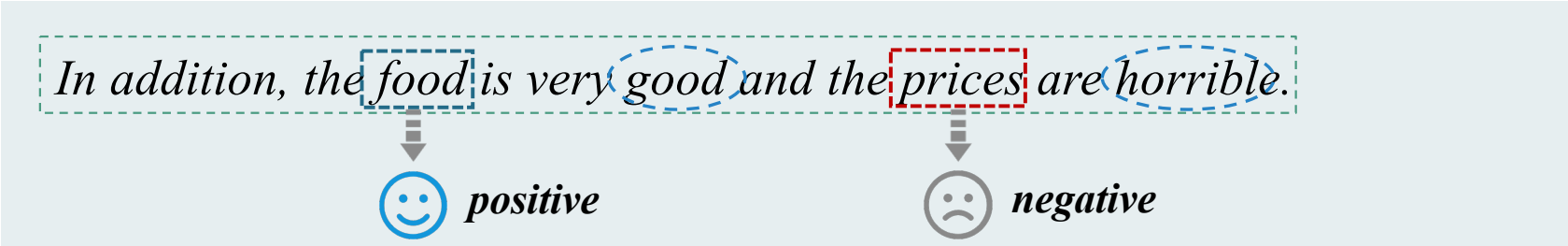
Unified Aspect-based Sentiment Analysis (ABSA)

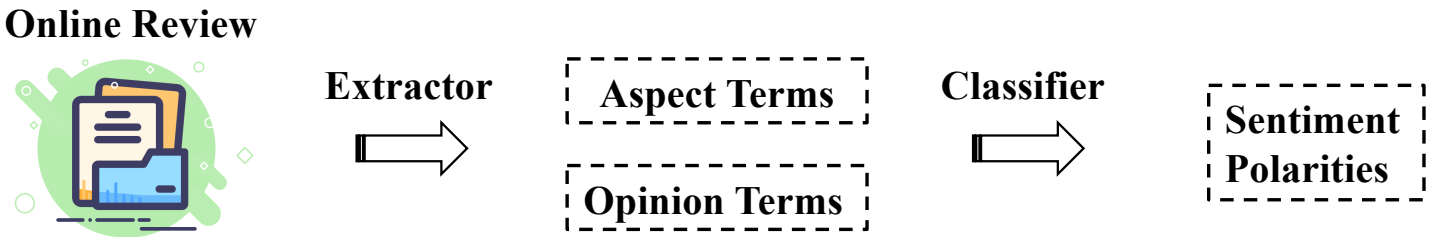
ABSA generally consists of three sub-tasks, namely, Aspect Terms Extraction (ATE), Opinion Terms Extraction(OTE) and Aspect Sentiment Classification.



ATE extracts the aspect terms with obvious emotion inclinations.
OTE aims to extract the opinion terms that express emotions.
ASC predicts the sentiment polarities of aspect terms in the given sentence.

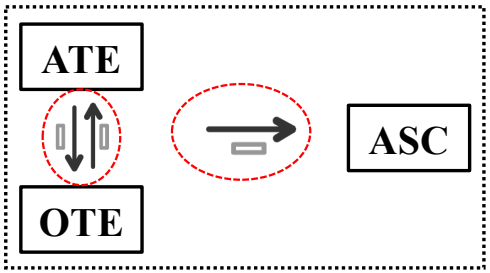
Pipeline Methods for Unified ABSA

Integrate existing method for separate tasks into a pipeline model.



Key problems:

Error Accumulation!

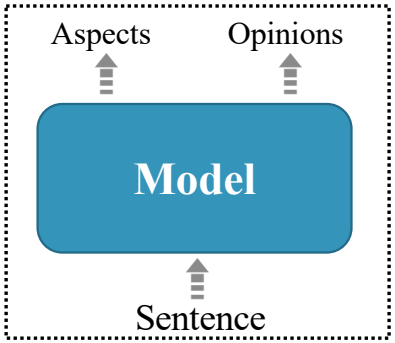


Interactions are ignored!

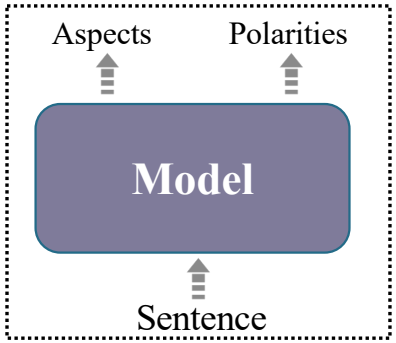
Joint Methods for Unified ABSA

Incorporate different number of sub-taks and formulate them as sequence labeling tasks .

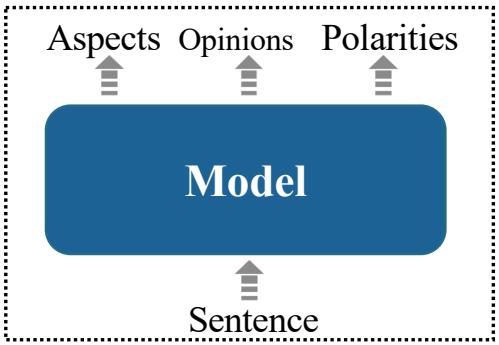
✓ ATE + OTE



✓ ATE + ASC



✓ ATE + OTE + ASC



Cannot benefit from OTE or ASC even though there exists corresponding annotations. (Interactive relations are not appropriately explored.)

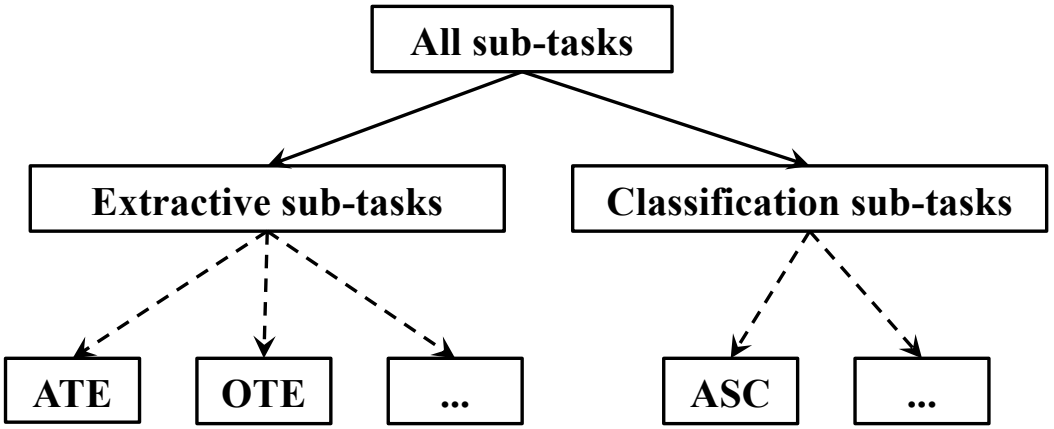
Fragile when any of the sub-tasks is absent.

Challenge

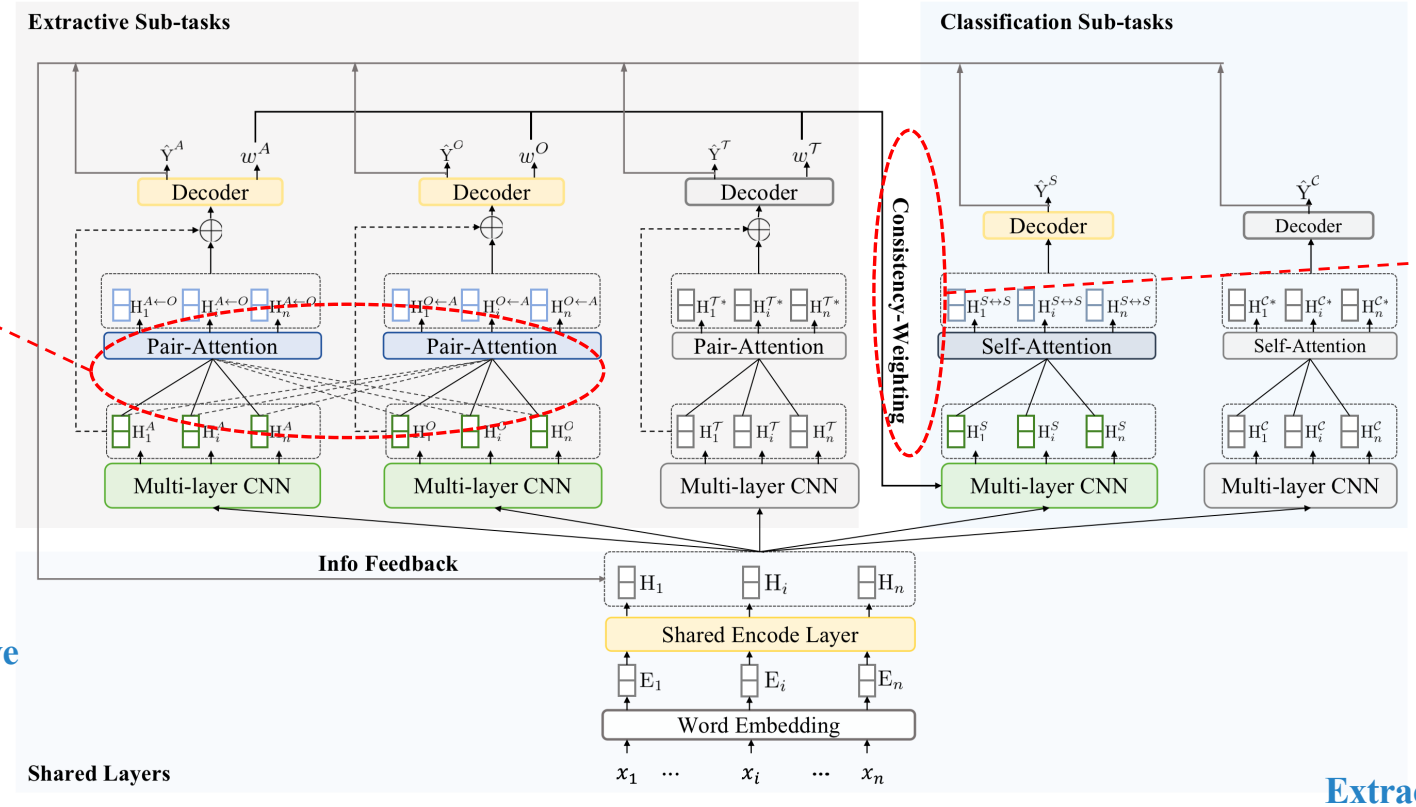
Manage ABSA with arbitrary number of sub-tasks and allow sub-tasks to share interactive information in a unified learning manner.

Solutions

We divide the sub-tasks of ABSA into two categories and design task-agnostoc mechanisms to exploit interactions between different types of sub-tasks.



A Multiplex Interaction Network



Bidirectional interaction: pair attention between extractive sub-tasks

ATE ⇄ OTE

Extractive ⇄ Extractive

Unidirectional interaction: consistency weighting between extractive sub-tasks and classification sub-tasks

ATE
OTE
→ ASC

Extractive → Classification

Loss Function

We use cross-entropy losses for all sub-tasks:

- ATE

$$\mathcal{L}^A = -\frac{1}{N}\sum_{i=1}^{N}\frac{1}{n_i}\sum_{j=1}^{n_i}(y_{ij}^A \cdot \log(\hat{y}_{ij}^A)),$$

- OTE

$$\mathcal{L}^O = -\frac{1}{N}\sum_{i=1}^{N}\frac{1}{n_i}\sum_{j=1}^{n_i}(y_{ij}^O \cdot \log(\hat{y}_{ij}^O)),$$

- ASC

$$\mathcal{L}^S = -\frac{1}{N}\sum_{i=1}^{N}\frac{1}{n_i}\sum_{j=1}^{n_i}(y_{ij}^S \cdot \log(\hat{y}_{ij}^S)),$$

Main Results

SemEval 2014 Task4

Dataset		Sentence	Opinion	Aspect		
				Pos	Neu	Neg
Res14	Train	3,044	3,484	2,164	807	637
	Test	800	1,008	728	196	196
Lap14	Train	3,048	2,504	994	870	464
	Test	800	674	341	128	169

ATE + ASC

Model	Res14			Lap14		
	AE-F1	AS-F1	O-F1	AE-F1	AS-F1	O-F1
DECNN-TNet*	82.79	70.45	65.80	79.38	68.69	57.39
DECNN-TCaps*	82.79	71.77	66.84	79.38	69.61	57.71
PIPELINE-MIN	84.00	71.75	68.36	78.43	71.45	59.19
MNN*	**85.84**	67.93	–	79.91	58.30	–
E2E-ABSA*	83.92	68.38	66.60	77.34	68.24	55.88
DOER*	84.63	64.50	68.55	**80.21**	60.18	56.71
MIN	84.80	**73.91**	**69.57**	79.94	**71.57**	**60.39**

ATE + OTE + ASC

Model	Res14				Lap14			
	AE-F1	OE-F1	AS-F1	O-F1	AE-F1	OE-F1	AS-F1	O-F1
CMLA-TNet*	81.91	83.84	69.69	64.49	77.49	76.06	68.30	55.94
CMLA-TCaps*	81.91	83.84	71.32	65.68	77.49	76.06	69.49	56.30
IMN*	84.01	85.64	71.90	68.32	78.46	78.14	69.92	57.66
RACL*	**85.37**	85.32	74.46	70.67	81.99	79.76	71.09	60.63
MIN	85.27	**86.85**	**76.39**	**70.92**	**82.24**	**80.56**	**72.60**	**61.35**
IMN-BERT	84.06	85.10	75.67	70.72	77.55	81.00	**75.56**	61.73
RACL-BERT	86.38	**87.18**	**81.61**	75.42	81.79	79.72	73.91	63.40
MIN-BERT	**87.91**	85.66	80.48	**76.02**	**83.22**	**81.80**	74.95	**64.83**

Flexibility

Different combinations of sub-tasks.

	Res14		Lap14	
ATE+OTE	AE-F1	OE-F1	AE-F1	OE-F1
IMN	84.83	86.32	78.31	77.58
RACL	85.47	86.48	**81.83**	78.19
MIN	**85.78**	**86.71**	81.74	**78.29**
OTE+ASC	OE-F1	AS-F1	OE-F1	AS-F1
IMN	NA	NA	NA	NA
RACL	81.27	63.16	79.32	65.45
MIN	**86.14**	**71.15**	**79.58**	**68.13**
ATE+ASC	AE-F1	AS-F1	AE-F1	AS-F1
IMN	84.78	70.46	79.22	69.65
RACL	**85.66**	70.78	79.76	68.87
MIN	84.80	**73.91**	**79.94**	**71.57**

Ablation Test and Case Study

Model	Res14	Lap14
Full Model	70.92	61.35
w/o Pair-attention	69.82	59.37
w/o Consistency-weighting	69.46	60.84
w/o Info Feedback	69.07	59.17
w/o Self-Attention	67.63	57.03

Case	IMN		RACL		MIN	
	ATE,ASC	OTE	ATE,ASC	OTE	ATE,ASC	OTE
(1) If you 're craving some [**serious**] [**indian food**]$_{pos}$ and desire a [**cozy**] [**ambiance**]$_{pos}$, this is quite and [**exquisite**] choice.	[indian food]$_{pos}$ [ambiance]$_{pos}$ [choice✗]$_{pos}$	[serious] [cozy] [exquisite]	[indian food]$_{pos}$ [ambiance]$_{pos}$ [choice✗]$_{pos}$	[craving✗] [serious] [cozy] [exquisite]	[indian food]$_{pos}$ [ambiance]$_{pos}$	[serious] [cozy] [exquisite]
(2) The [**fajita**]$_{neg}$ we tried was [**tasteless**] and [**burned**] and the [**mole sauce**]$_{neg}$ was way [**too sweet**] .	[fajita]$_{neg}$ [mole sauce]$_{pos}$✗	[tasteless] [burned] [too sweet]	[fajita]$_{neg}$ [mole sauce]$_{neu}$✗	[tasteless] [burned] [sweet✗]	[fajita]$_{neg}$ [mole sauce]$_{neg}$	[tasteless] [burned] [too sweet]

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Thanks for listening~

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