A Multi-Granularity Matching Attention Network for Query Intent Classification in E-commerce Retrieval

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2023. 6. 25 • ChongQing

—— WWW 2023

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1.Introduction

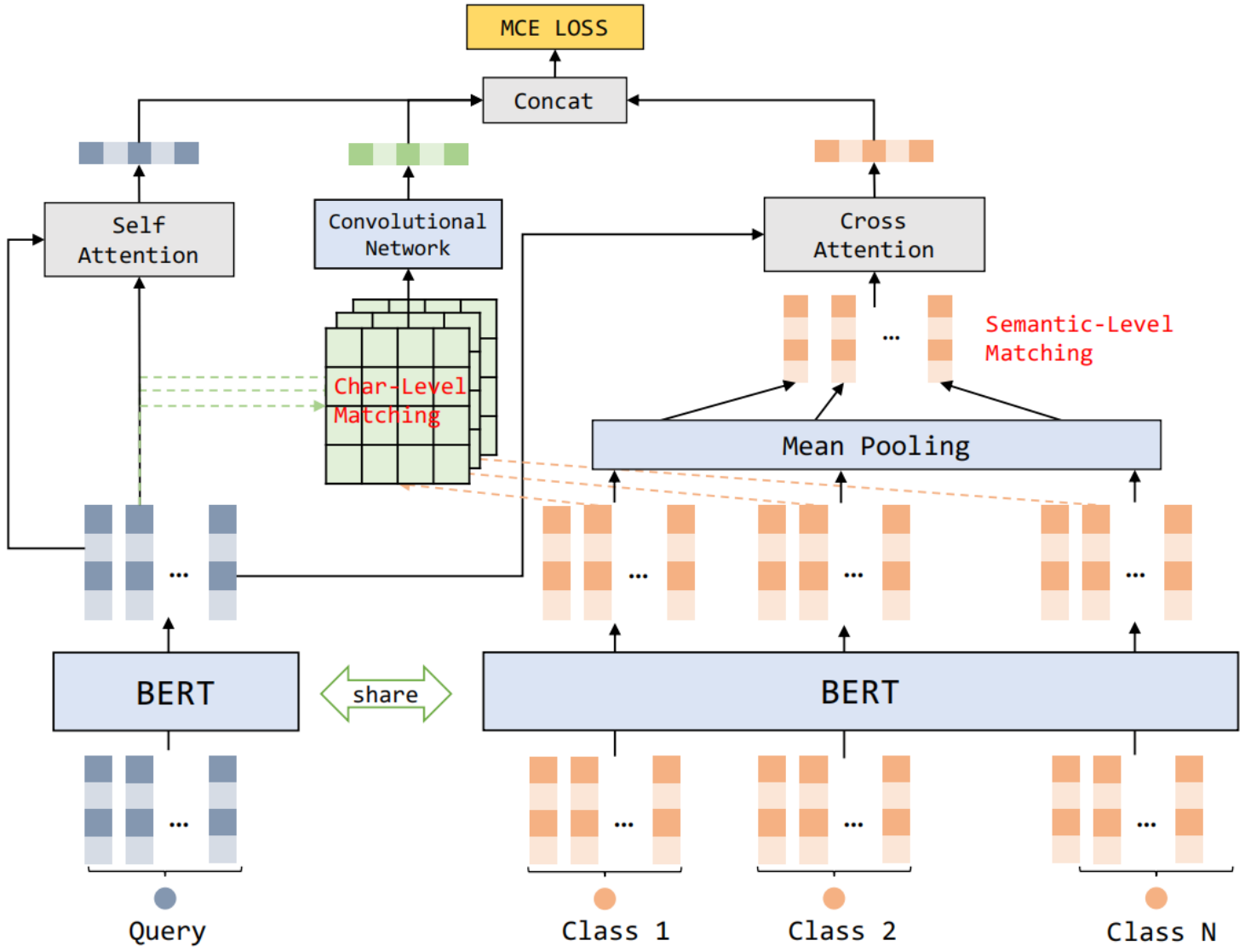
2.Overview

3.Methods

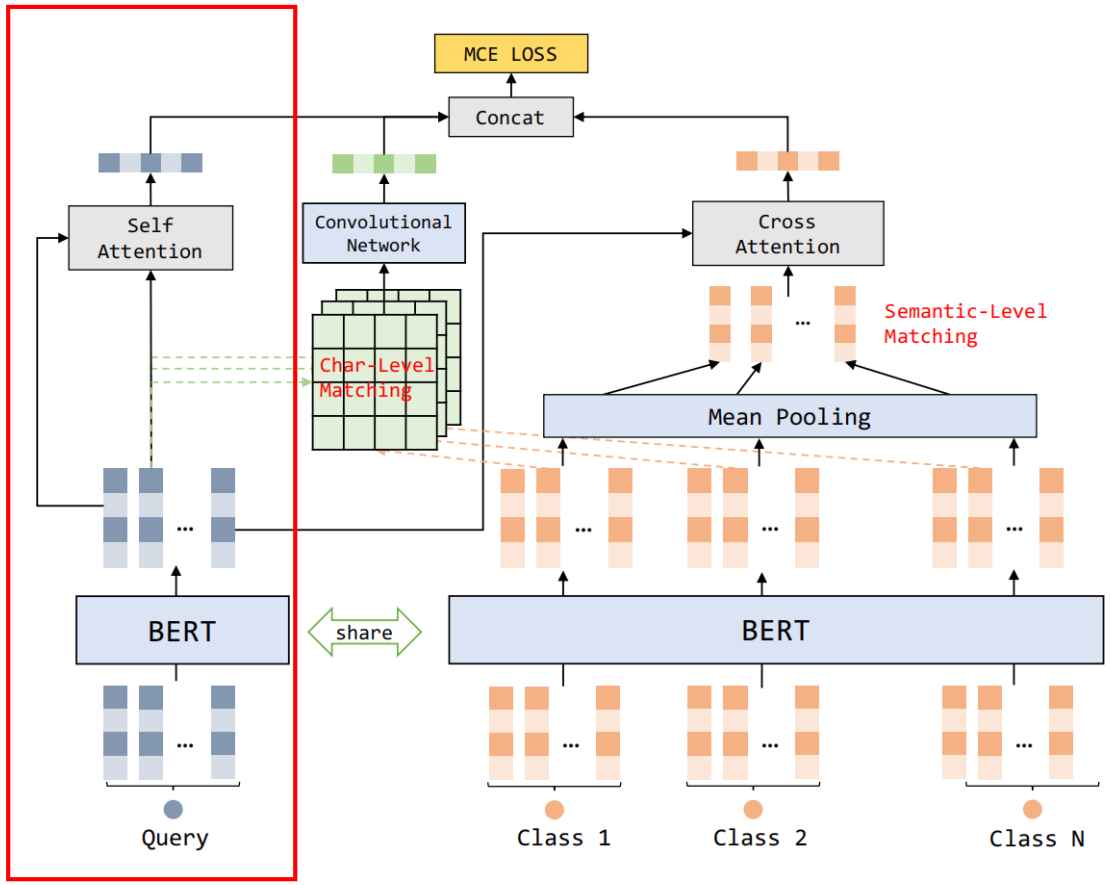
4.Experiments

Introduction

Overview


MCE LOSS
Concat
Self Attention
Convolutional Network
Cross Attention
Char-Level Matching
Semantic-Level Matching
Mean Pooling
BERT
share
BERT
Query
Class 1
Class 2
Class N

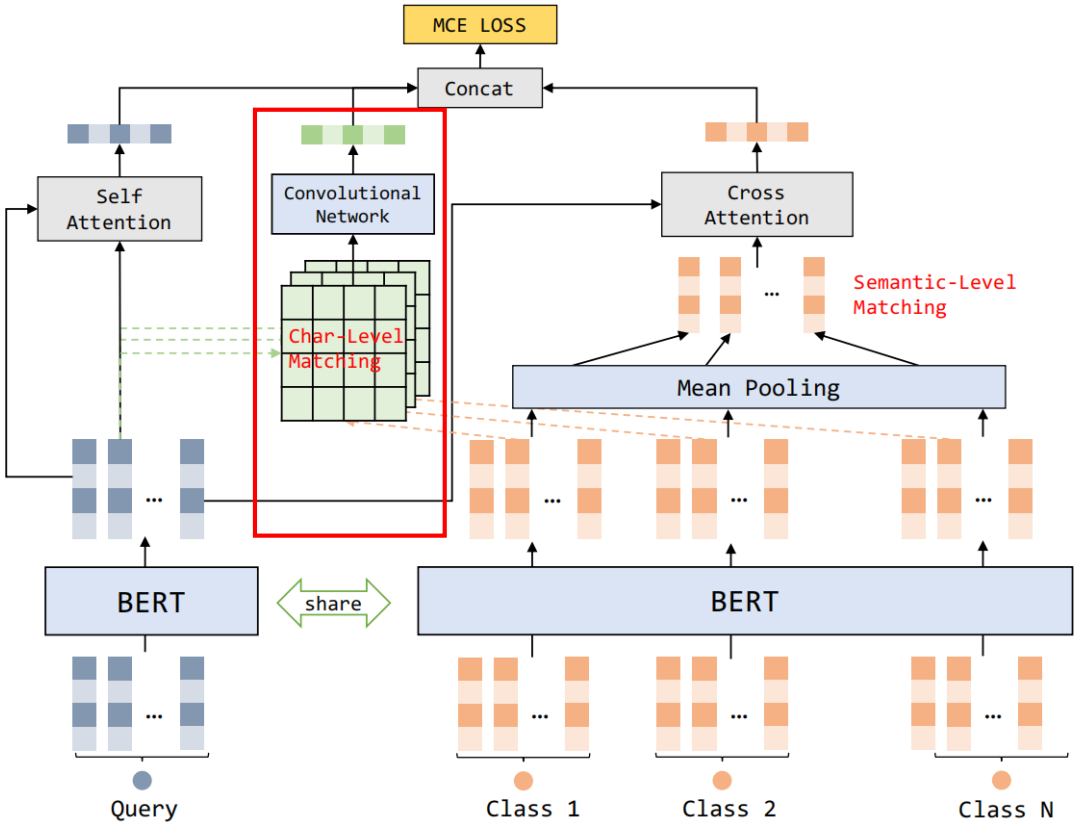
Method



$$\mathbf{Q}_i = \mathrm{BERT}_{\mathrm{Token}}([x_1, x_2, \ldots, x_{L_q}]),$$
$$\mathbf{C}_j = \mathrm{BERT}_{\mathrm{Token}}([n_1, n_2, \ldots, n_{L_n}, m_1, m_2, \ldots, m_{L_m}]), \quad (1)$$

$$\mathbf{u}_i = \mathbf{v}_i \tanh\left(\mathbf{W}_q \mathbf{Q}_i^T\right),$$
$$\mathbf{q}_i = \sum_{t=1}^{L_q} \mathbf{Q}_{i,t} \mathbf{softmax}(\mathbf{u}_{i,t}), \quad (2)$$

Method



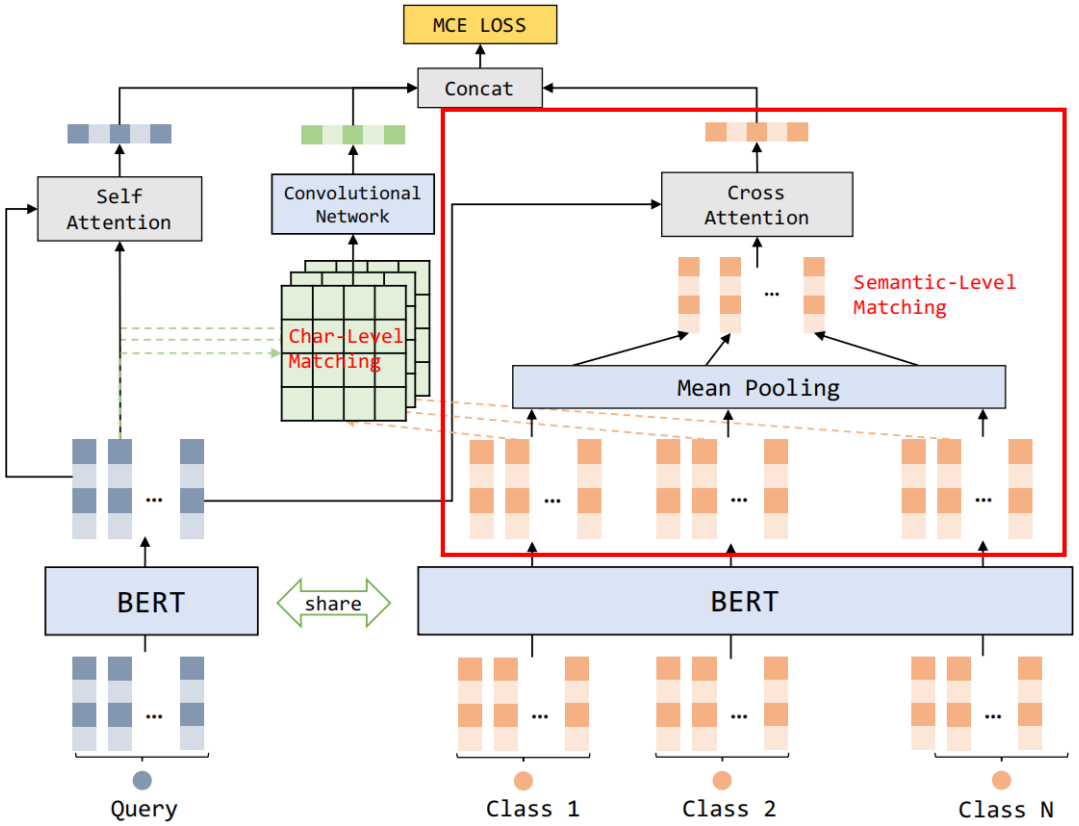
$$\mathbf{M}_j = \mathbf{Q}_i \mathbf{W}_{qc} \mathbf{C}_j^T, \quad \mathbf{M} = [\mathbf{M}_1, \mathbf{M}_2, \ldots, \mathbf{M}_C], \tag{3}$$

$$\mathbf{s}_{i,j}^{(k)} = ReLU\left(\sum_{a=0}^{r_w}\sum_{b=0}^{r_h} \mathbf{W}_{a,b}\mathbf{M}_{i+a,j+b}^{(k)} + \mathbf{b}\right), \tag{4}$$

$$\tilde{\mathbf{s}}_{i,j}^{(k)} = \max_{0\le c\le p_w} \max_{0\le d\le p_h} \mathbf{s}_{i+c,j+d}^{(k)}, \tag{5}$$

$\mathbf{Z}_1 \in \mathbb{R}^{|C|\times d}$, which contains fine-grained matching features between query and each category

Method

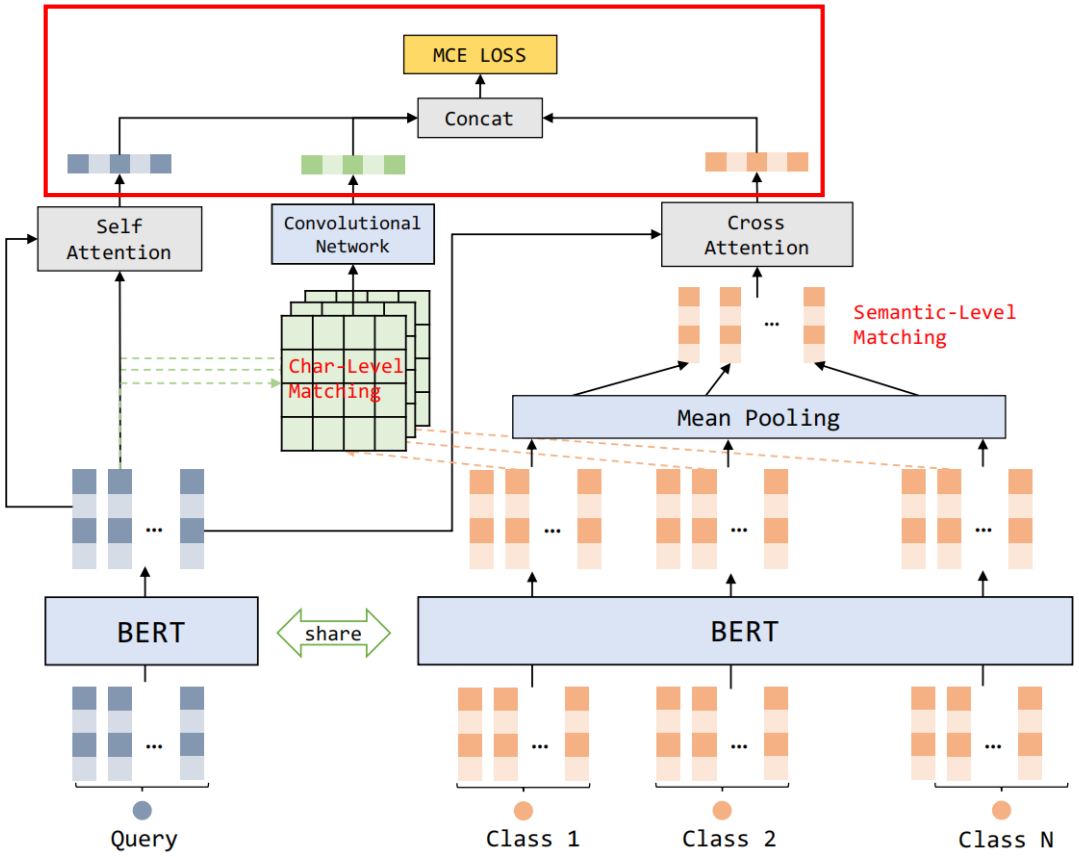


$$\mathbf{c}_i = \mathbf{mean}(\mathbf{C}_i)\,,$$
$$\mathbf{C} = [\mathbf{c}_1, \mathbf{c}_2, \ldots, \mathbf{c}_{|C|}]\,, \tag{6}$$

where $\mathbf{C} \in \mathbb{R}^{|C| \times d}$ is the representation of all categories.

$$\mathbf{Z}_2 = \mathbf{Q}_i^T \mathbf{softmax}(\mathbf{C}\mathbf{W}_{qs}\mathbf{Q}_i^T)\,, \tag{7}$$

Method



$$\widehat{y} = \mathbf{W}_x^T ReLU\left(\mathbf{q}_i \mathbf{W}_{qf} + [\mathbf{Z}_1, \mathbf{Z}_2]\mathbf{W}_z\right), \tag{8}$$

$$\mathcal{L} = -\sum_{c=1}^{C} y^c \log\left(\sigma\left(\widehat{y}^c\right)\right) + \left(1 - y^c\right) \log\left(1 - \sigma\left(\widehat{y}^c\right)\right), \tag{9}$$

Experiments

Table 1: Dataset statistics.

Statistic	Scene Data		Category Data	
	Train	Test	Train	Test
Queries	4,459,214	9,877	4,593,037	9,877
Total Labels	8	8	90	90
Avg. chars	7.63	5.00	7.69	5.00
Avg. # of labels	1.04	1.67	1.19	1.77
Min. # of labels	1	1	1	1
Max. # of labels	7	3	26	21

Experiments

Table 2: The experimental results that compared with multi-label classification and query intent classification models.

Models	Scene Data						Category Data					
	Micro			Macro			Micro			Macro		
	Prec.	Recall	F1	Prec.	Recall	F1	Prec.	Recall	F1	Prec.	Recall	F1
RCNN [6]	94.14	77.67	85.11	83.09	86.01	83.69	69.76	54.03	60.89	70.51	62.42	62.15
XML-CNN [7]	94.73	76.00	84.34	80.87	86.47	81.91	66.73	56.36	61.11	68.08	64.15	62.12
LEAM [12]	94.19	68.46	79.29	88.84	78.60	82.84	72.67	49.91	59.18	69.96	47.56	52.15
LSAN [14]	94.73	74.14	83.18	80.31	86.05	81.48	68.33	51.36	58.64	71.64	61.00	61.93
PHC [17]	94.63	77.93	85.47	83.17	86.62	83.74	60.12	**59.41**	59.76	64.08	64.90	60.67
DPHA [20]	95.23	77.43	85.41	82.01	84.35	82.06	71.55	54.06	61.58	75.39	54.99	61.83
SSA-AC [18]	94.82	78.15	85.68	84.15	84.26	83.92	72.36	53.20	61.32	74.38	62.19	63.38
MMAN	**95.52**	**82.26**	**88.39**	**87.26**	86.15	**85.93**	**75.64**	55.07	**63.74**	**75.77**	64.56	**66.47**
w/o self-matching	**96.03**	81.24	88.02	**88.14**	85.72	84.86	75.25	54.35	63.11	73.26	64.08	65.68
w/o char matching	95.16	80.28	87.09	82.12	**89.38**	83.74	68.72	**57.13**	62.39	72.16	62.58	65.12
w/o semantic matching	95.86	81.14	87.89	84.36	87.62	84.15	72.18	56.16	63.17	73.61	63.27	65.05
BERT [4]	95.39	79.22	86.56	81.20	88.48	83.00	65.88	56.23	60.67	68.47	**67.28**	64.53

Experiments

Table 3: Online improvements of the MMAN. Improvements are statistically significant with $p < 0.05$ on paired t-test.

	GMV	UV value	UCVR
Online model (BERT)	-	-	-
MMAN	+0.351%	+0.401%	+0.113%

Experiments

Table 4: Online performance of the MMAN compared with the online BERT model. Improvements of MMAN are statistically significant with $p < 0.01$ on paired t-test.

Scene	PV	Click
hotel booking	+74.85%	+36.49%
travel and vacation	+9.94%	+1.75%
checkup service	+5.95%	+4.89%
aesthetic medicine	+44.42%	+26.30%
medical consultation	+22.76%	+5.66%
car service	+20.17%	+9.38%
furniture customization	+10.07%	+6.60%
Overall	+19.62%	+7.78%

Thanks!