# Pair-Based Joint Encoding with Relational Graph Convolutional Networks for Emotion-Cause Pair Extraction

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Code： https://github.com/tutuDoki/PBJE-ECPE

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**Reported by Renhui Luo**

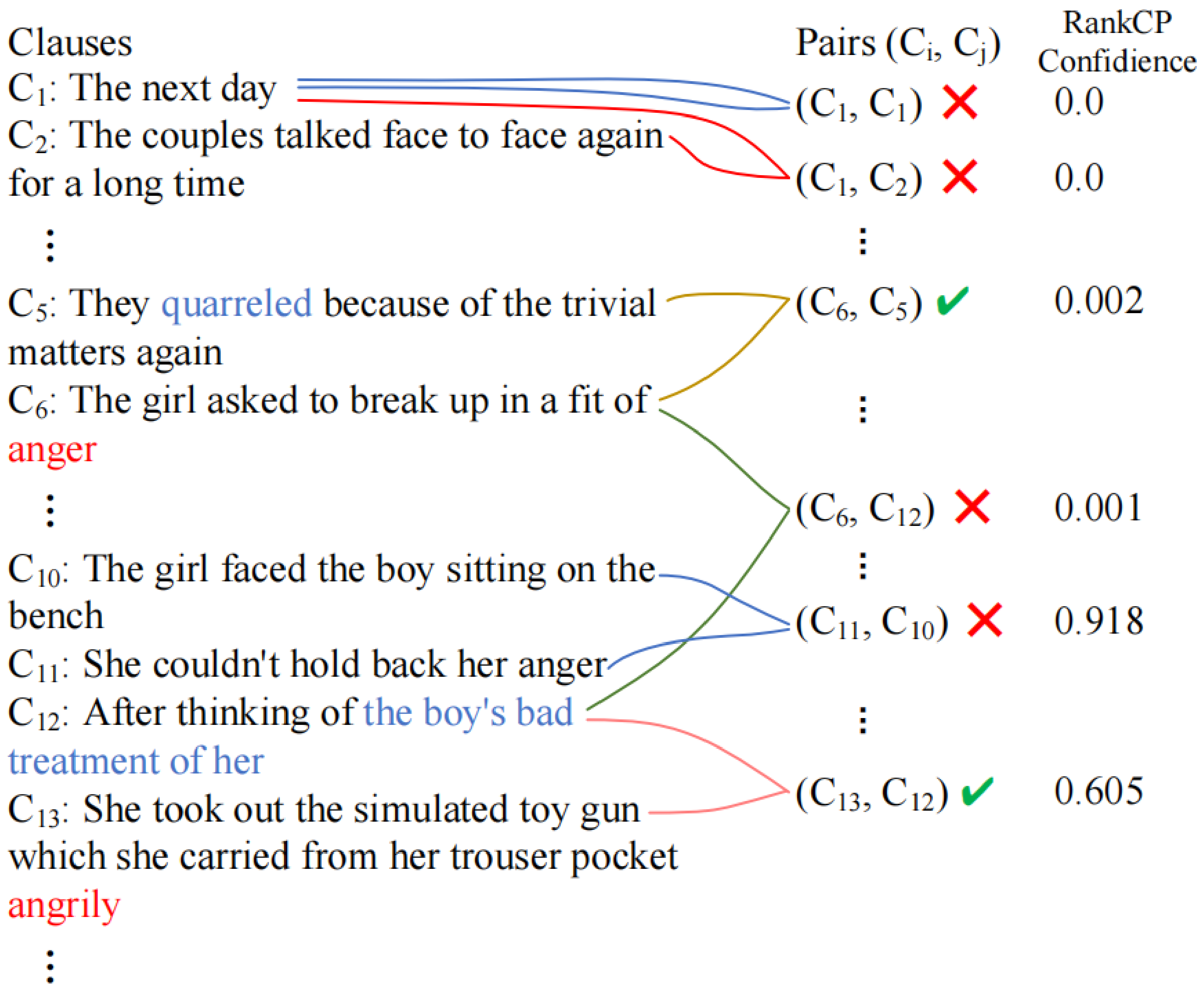
1.Introduction

2.Overview

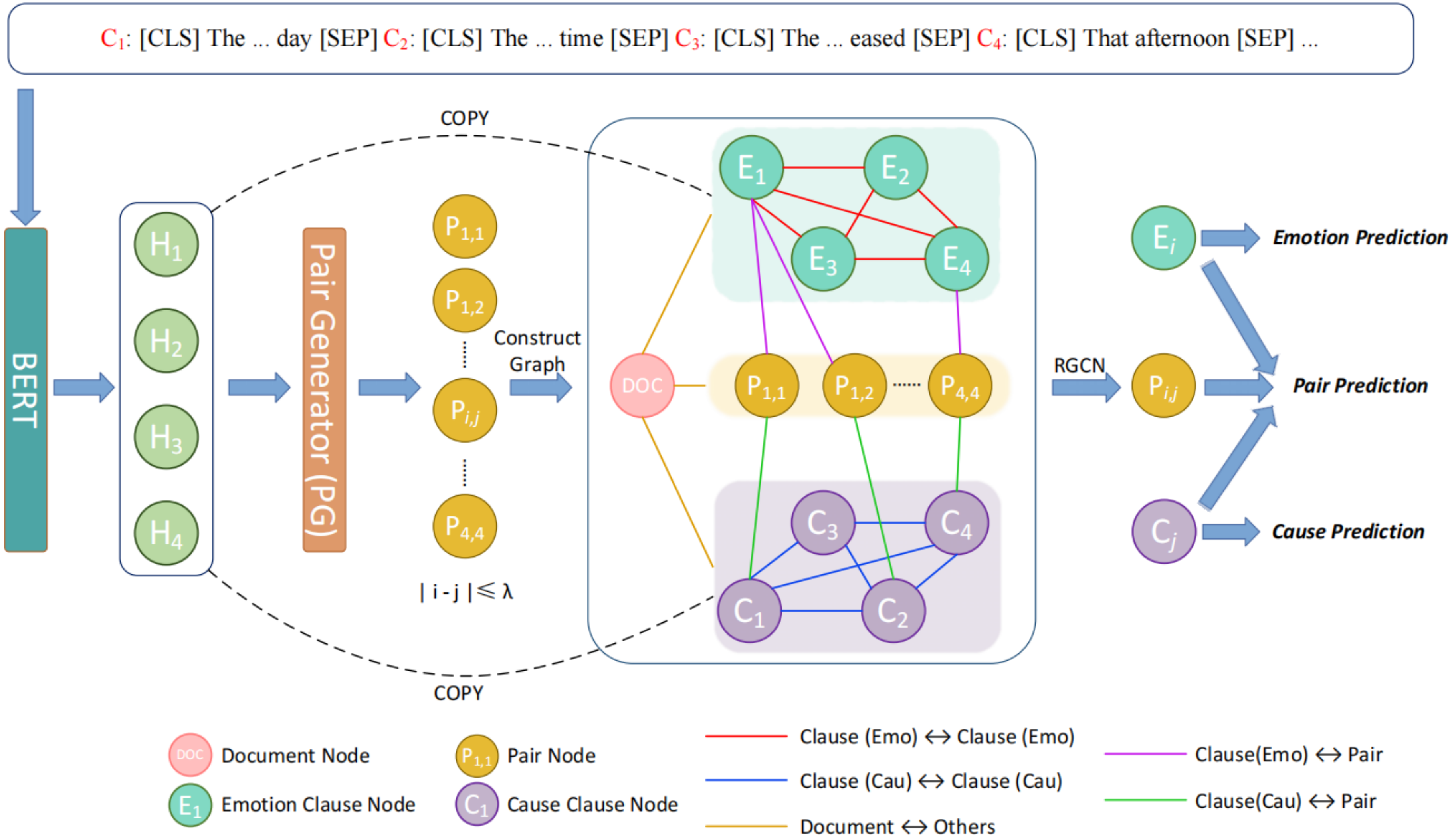
3.Methods

4.Experiments

# Introduction



# Overview




$$D = (c_1, c_2, \ldots, c_N)$$

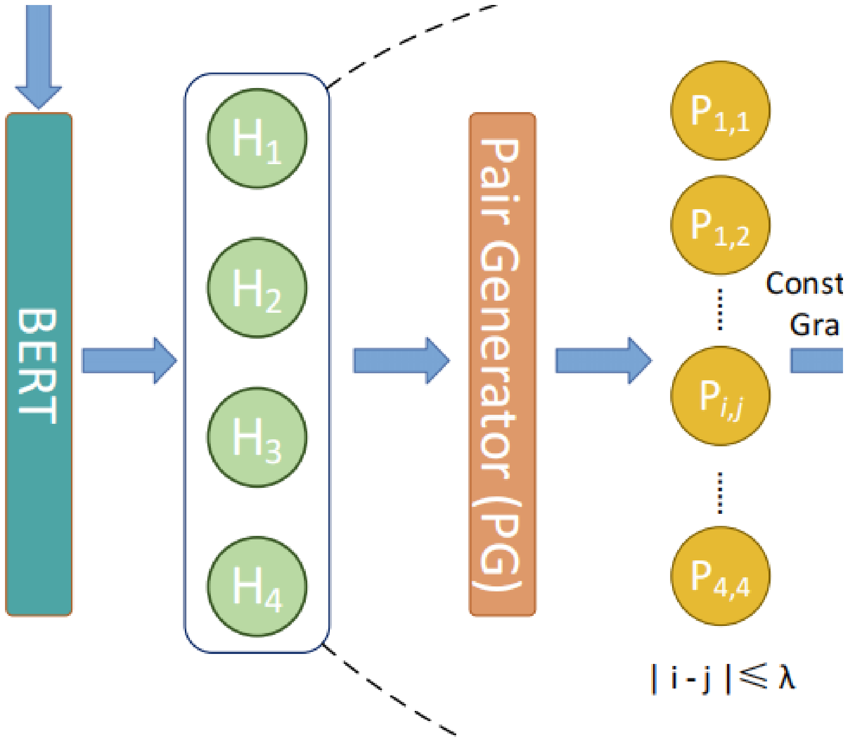
$$c_i = (w_1^i, w_2^i, \ldots, w_M^i)$$

$$P = \{\ldots, (c_i, c_j), \ldots\} \quad (1 \le i, j \le N) \quad (1)$$

$$y_i^{emo} = \begin{cases} 1, & if \quad \exists c_j \in D, (c_i, c_j) \in P \\ 0, & otherwise \end{cases} \quad (2)$$

where $y_i^{emo} = 1$ means $c_i$ is an emotion clause. The extraction of cause clauses is the same as emotion clauses.

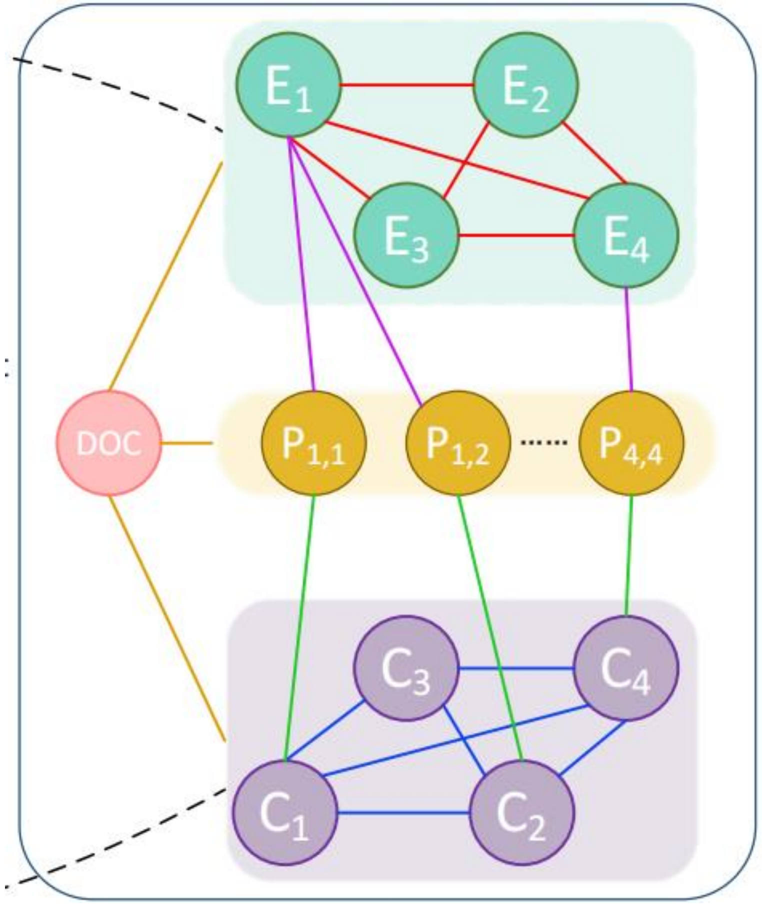
# Method




$$H = \{h_1, h_2, \ldots, h_N\} \tag{3}$$

$$p_{ij} = W_p[h_i, h_j] + b_p + r_{i-j} \tag{4}$$

# Method




$$H_E^{(0)} = H,\ H_C^{(0)} = H \qquad (5)$$

$$H_P^{(0)} = \{p_{11}, p_{12}, \ldots, p_{NN}\} \qquad (6)$$

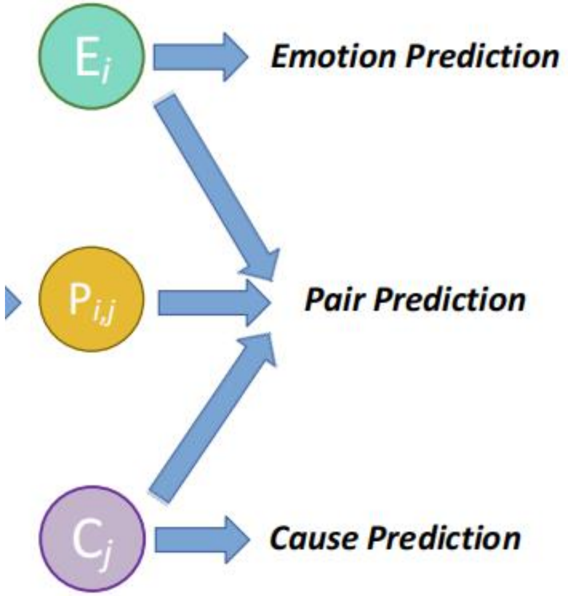
$$H_D^{(0)} = Avgpool(H) \in \mathbb{R}^d \qquad (7)$$

$$s_u^{(l)} = W_s^{(l)} h_u^{(l)} + b_s^{(l)} \qquad (8)$$

$$t_u^{(l+1)} = s_u^{(l)} + \sum_{r \in \mathcal{R}} \sum_{v \in \mathcal{N}_r(u)} \frac{1}{|\mathcal{N}_r(u)|} W_r^{(l)} h_v^{(l)} + b_r^{(l)} \qquad (9)$$

$$h_u^{(l+1)} = ReLU\left(t_u^{(l+1)}\right) \qquad (10)$$

# Method




$$\hat{y}_{ij}^{p} = \sigma\left(MLP\left([P_{ij}, E_i, C_j]\right)\right) \qquad (12)$$

$$\mathcal{L}_p = -\sum_{i}^{N}\sum_{j}^{N} y_{ij}^{p}\log(\hat{y}_{ij}^{p}) \qquad (13)$$

$$\hat{y}_i^{e} = \sigma\left(W_e E_i + b_e\right) \qquad (14)$$

$$\hat{y}_j^{c} = \sigma\left(W_c C_j + b_c\right) \qquad (15)$$

$$\mathcal{L}_e = -\sum_{i}^{N} y_i^{e}\log(\hat{y}_i^{e}) \qquad (16)$$

$$\mathcal{L}_c = -\sum_{j}^{N} y_j^{c}\log(\hat{y}_j^{c}) \qquad (17)$$

$$E = H_E^{(\theta)},\ C = H_C^{(\theta)},\ P = H_P^{(\theta)} \qquad (11)$$

$$\mathcal{L} = \alpha\mathcal{L}_p + \beta\mathcal{L}_e + \gamma\mathcal{L}_c \qquad (18)$$

# Experiments

| Item | Quantity | Percentage(%) |
|---|---|---|
| # of documents | 1,945 | 100 |
| - w/ 1 pair | 1,746 | 89.77 |
| - w/ 2 pairs | 177 | 9.10 |
| - w/ $\geq$ 3 pairs | 22 | 1.13 |
| # of pairs | 2167 | 100 |
| - w/ 0 relative position | 511 | 23.58 |
| - w/ 1 relative position | 1342 | 61.93 |
| - w/ 2 relative position | 224 | 10.34 |
| - w/ $\geq$ 3 relative position | 90 | 4.15 |
| Avg. # of clauses per document | 14.77 | |
| Max. # of clauses per document | 73 | |

Table 1: The detail of the Chinese corpus.

# Experiments

| Approach | Emotion-Cause Pair Extraction | | | Emotion Clause Extraction | | | Cause Clause Extraction | | |
|---|---|---|---|---|---|---|---|---|---|
| | $P$ | $R$ | $F1$ | $P$ | $R$ | $F1$ | $P$ | $R$ | $F1$ |
| ECPE-2D | 72.92 | 65.44 | 68.89 | 86.27 | **92.21** | <u>89.10</u> | 73.36 | 69.34 | 71.23 |
| TransECPE | <u>77.08</u> | 65.32 | 70.72 | 88.79 | 83.15 | 85.88 | 78.74 | 66.89 | 72.33 |
| PairGCN | 76.92 | 67.91 | 72.02 | 88.57 | 79.58 | 83.75 | 79.07 | 68.28 | 73.75 |
| UTOS | 73.89 | 70.62 | 72.03 | 88.15 | 83.21 | 85.56 | 76.71 | 73.20 | 74.71 |
| MTST-ECPE⋄ | 75.78 | 70.51 | 72.91 | 85.83 | 80.94 | 83.21 | 77.64 | 72.36 | 74.77 |
| RankCP | 71.19 | **76.30** | 73.60 | **91.23** | 89.99 | **90.57** | 74.61 | <u>77.88</u> | 76.15 |
| ECPE-MLL† | 77.00 | 72.35 | <u>74.52</u> | 86.08 | <u>91.91</u> | 88.86 | 73.82 | **79.12** | <u>76.30</u> |
| PBJE | **79.22** | <u>73.84</u> | **76.37*** | <u>90.77</u> | 86.91 | 88.76 | **81.79** | 76.09 | **78.78** |

Table 2: The results comparison with baselines on the ECPE corpus for Emotion-Cause Pair Extraction and the two sub-tasks: Emotion clause Extraction and Cause clause Extraction. We introduce these baselines in Appendix A. The best performance is in **bold** and the second best performance is <u>underlined</u>. Approach with † is previous state-of-the-art method. Approach with ⋄ is based on our implementation. * denotes $p < 0.0005$ for a two-tailed t-test against the RankCP.

# Experiments

| Approach | Emotion-Cause Pair Extraction | | | Emotion Clause Extraction | | | Cause Clause Extraction | | |
|---|---|---|---|---|---|---|---|---|---|
| | $P$ | $R$ | $F1$ | $P$ | $R$ | $F1$ | $P$ | $R$ | $F1$ |
| PBJE | **79.22** | **73.84** | **76.37** | 90.77 | 86.91 | 88.76 | **81.79** | **76.09** | **78.78** |
| - w/o Clause-Clause Edge | 77.81 | 73.36 | 75.45 | 90.76 | 87.64 | **89.14** | 80.07 | 75.3 | 77.54 |
| - w/o Clause-Pair Edge | 78.14 | 72.62 | 75.21 | 90.76 | 86.74 | 88.66 | 80.15 | 74.51 | 77.16 |
| - w/o Pair Node | 76.92 | 72.37 | 74.54 | 89.83 | 86.62 | 88.18 | 79.50 | 74.81 | 77.05 |
| - w/o PG | 78.02 | 72.13 | 74.93 | **91.22** | 86.73 | 88.89 | 80.07 | 74.00 | 76.89 |
| - w/o Pair Node & PG | 74.49 | 73.24 | 73.76 | 89.93 | **87.83** | 88.82 | 78.94 | 75.63 | 77.18 |

Table 3: The results of ablation study on the benchmark corpus for emotion-cause pair extraction and the two sub-tasks. The best performance is in **bold** and the second best performance is underlined.

# Experiments

| #Pairs | Approach | $P$ | $R$ | $F1$ |
|---|---|---|---|---|
| 1 per doc. | PBJE | **78.44** | 80.00 | **79.21** |
| | RankCP | 72.03 | **81.23** | 76.33 |
| 2 or more per doc. | PBJE | **83.98** | 45.29 | **58.84** |
| | RankCP | 67.72 | **51.46** | 58.02 |

Table 4: The results of ECPE for documents with different numbers of pairs.

# Experiments

| Relative Position | Approach | P | R | F |
|---|---|---|---|---|
| $\leq 1$ | PBJE | **80.69** | 81.26 | **80.97** |
| | RankCP | 77.45 | **83.38** | 80.30 |
| $\geq 2$ | PBJE | **58.55** | 28.43 | **38.28** |
| | RankCP | 31.60 | **32.91** | 32.24 |

Table 5: The results of ECPE for pairs of different relative positions.

# Experiments

| | | | |
|---|---|---|---|
| ...It's time for Chinese New Year.($c_4$) The creditor removed all his family's grain.($c_5$) Other families are celebrating the New Year happily.($c_6$) But his family even did not have money for meat.($c_7$) His daughter and wife sorrowed.($c_8$)... | | | |
| PBJE | [$c_8$,$c_7$] | RankCP | [$c_6$,$c_5$],[$c_6$,$c_7$],[$c_8$,$c_7$] |
| Ground Truth | [$c_8$,$c_7$] | | |

Table 6: An example predicted by PBJE and RankCP. The words in red are the emotion keywords, and the words in blue are the cause keywords. The pairs in green are the correct prediction, and the pairs in red are incorrect. We translate it from Chinese into English for ease of reading.

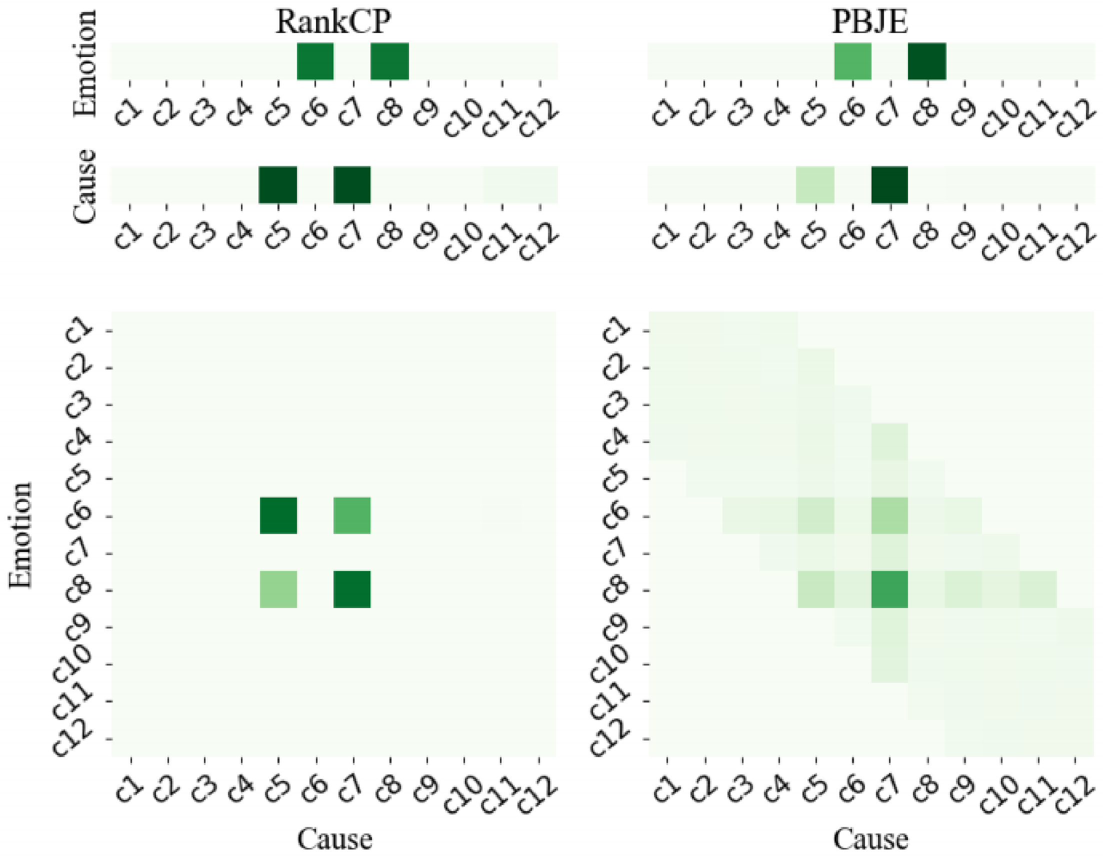



Figure 3: Visualization of the confidence of each prediction in RankCP and PBJE. The deeper color means the higher confidence.

# Thanks!