Event Extraction as Machine Reading Comprehension

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Overview

• This paper casts the event extraction (EE) as a machine reading comprehension (MRC) task.
• This strategy has been done before for other tasks, e.g., Relation Extraction, Document-level Event Argument Extraction.
• The main contribution of this paper is how they design the questions which are decomposed into two components: (i) Question Topic, and (ii) Question Context.
• Casting EE as a MRC task enables the use of data augmentation.
• Finally, their MRC-based method achieves state-of-the-art performance on ACE2005 dataset with a significant margin.
Casting EE as a MRC task

S1: On Sunday, a protester stabbed an officer with a paper cutter.

1) Event Trigger Extraction
   \[ Q_{\text{trigger}}: [EVENT] \]
   \[ A_{\text{trigger}}: \text{stabbed (Type=Attack)} \]

2) Unsupervised Question Generation
   \[ Q_{\text{instrument}}: [\text{What is the instrument}] [\text{that a protester use to stab an officer?}] \]

3) Event Argument Extraction
   \[ Q_{\text{instrument}}: \text{What is the instrument that a protester use to stab an officer?} \]
   \[ A_{\text{instrument}}: \text{a paper cutter} \]
   \[ Q_{\text{Attacker}}: \text{Who is the attacker that stabbed an officer?} \]
   \[ A_{\text{Attacker}}: \text{a protester.} \]

EE Result: Stabbed (Type=Attack) Instrument=\text{a paper cutter}, Attacker=\text{a protester}, Target=\text{an officer}, Time=\text{Sunday}
Finding event triggers

- Finding event triggers:

[CLS] [EVENT] [SEP] Sentence [SEP]

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1) Event Trigger Extraction

Q\_trigger: [EVENT]
A\_trigger: stabbed (Type=Attack)
Finding event arguments

• Generating questions to find event arguments:

S1: On Sunday, a protester stabbed an officer with a paper cutter.

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   Q\text{trigger}: \{EVENT\}
   A\text{trigger}: stabbed (Type=Attack)

2) Unsupervised Question Generation
   Instrument \downarrow Template
   Q\text{instrument}: [What is the \text{instrument} that a protester use to stab an officer?]
Finding event arguments

• Generating questions to find event arguments:
  + Question topic generation:

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>ROLE</th>
<th>TEMPLS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time-related</td>
<td>Time</td>
<td>When</td>
</tr>
<tr>
<td>Place-related</td>
<td>Place</td>
<td>Where</td>
</tr>
<tr>
<td>Person-related</td>
<td>Victim, Attacker, ...</td>
<td>Who is the ROLE</td>
</tr>
<tr>
<td>General role</td>
<td>Instrument, Target, ...</td>
<td>What is the ROLE</td>
</tr>
</tbody>
</table>
Finding event arguments

• Generating questions to find event arguments:
  + Question context generation:
    - Crawl (topic description, question) pairs from question.com
Finding event arguments

- Generating questions to find event arguments:
  + Question context generation:
    - Crawl (topic description, question) pairs from question.com
    - Train a MT system to "translate" topic descriptions to questions.

\[ P_{S\rightarrow Q}(q_s | s) \]
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- Inference: the evidence sentence \( s_x \) is formed by taking a window of text around the predicted trigger.

\[ q_{s_x} = \arg \max_{q_s} P_{S \rightarrow Q}(q_{s_x} | s_x) \]
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- Create the final question: \( Q = [\text{Question topic}] + [\text{Question Context}] \)
Finding event arguments

- Finding event arguments: standard MRC model.
  \[ H^q_c = \text{BERT( [CLS] Question [SEP] Sentence [SEP] )} \]
- Start and end token of the argument is determined by:
  \[ p_{\text{start}} = \text{softmax}(H^q_c W_{\text{start}}) \]
  \[ p_{\text{end}} = \text{softmax}(H^q_c W_{\text{end}}) \]
Data Augmentation

• Pretrain the model with SQUAD 2.0 dataset.
• Use pretrained MRC model to train it on ACE2005.
## Results: standard case

<table>
<thead>
<tr>
<th>METHOD</th>
<th>$G_E$</th>
<th>$P_E$</th>
<th>ΔF1</th>
</tr>
</thead>
<tbody>
<tr>
<td>JointBeam (2013)</td>
<td>52.7</td>
<td>41.8</td>
<td>↓10.9</td>
</tr>
<tr>
<td>DMCNN (2015)</td>
<td>56.8</td>
<td>48.0†</td>
<td>↓8.8</td>
</tr>
<tr>
<td>JMEE (2018b)</td>
<td>60.3</td>
<td>50.4†</td>
<td>↓9.9</td>
</tr>
<tr>
<td>BERTEE</td>
<td>60.6†</td>
<td>51.9†</td>
<td>↓8.7</td>
</tr>
<tr>
<td>Joint3EE (2019)</td>
<td>-</td>
<td>52.1</td>
<td>-</td>
</tr>
<tr>
<td>JointTrans (2019)</td>
<td>-</td>
<td>53.3</td>
<td>-</td>
</tr>
<tr>
<td>RCEE</td>
<td>63.6</td>
<td><strong>59.3</strong></td>
<td>↓4.3</td>
</tr>
<tr>
<td>RCEE w/o DA</td>
<td>62.7</td>
<td>58.7</td>
<td>↓4.0</td>
</tr>
</tbody>
</table>

Table 3: Results of argument extraction with unknown entities ($P_E$). ΔF1 indicates the performance gap compared with results with known entities ($G_E$).
Results: zero-short (golden triggers)

<table>
<thead>
<tr>
<th>METHOD</th>
<th>1%</th>
<th>5%</th>
<th>10%</th>
<th>20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMCNN</td>
<td>-</td>
<td>8.7</td>
<td>16.6</td>
<td>23.7</td>
</tr>
<tr>
<td>dbRNN</td>
<td>-</td>
<td>8.1</td>
<td>17.2</td>
<td>24.1</td>
</tr>
<tr>
<td>BERTEE</td>
<td>2.20</td>
<td>10.5</td>
<td>19.3</td>
<td>28.6</td>
</tr>
<tr>
<td>RCEE</td>
<td>38.8</td>
<td>51.3</td>
<td>55.7</td>
<td>59.4</td>
</tr>
<tr>
<td>RCEE w/o DA</td>
<td>2.00</td>
<td>23.8</td>
<td>35.2</td>
<td>49.2</td>
</tr>
<tr>
<td>RCEE_ER</td>
<td>49.8</td>
<td>59.9</td>
<td>65.1</td>
<td>67.6</td>
</tr>
<tr>
<td>RCEE_ER w/o DA</td>
<td>2.20</td>
<td>26.5</td>
<td>37.8</td>
<td>54.1</td>
</tr>
</tbody>
</table>

Table 4: F1 score (%) on exploring the extremely data-scarce scenarios.