Document-Level Event Role Filler Extraction using Multi-Granularity Contextualized Encoding

Xinya Du and Claire Cardie
Department of Computer Science
Cornell University

ACL2020
Document-level Event Extraction

• Given an article, the task requires:
  + Role filler extraction.
  + Noun phrase coreference resolution.
  + Event Tracking.

• Dataset: Message Understanding Conference 3+4
  Including 1,700 articles describing terrorist incidents.
BOGOTA, 3 APR 90 (INRAVISION TELEVISION CADENA 1) -- [REPORT] [JORGE ALONSO SIERRA VALENCIA] [TEXT] LIBERAL SENATOR FEDERICO ESTRADA VELEZ WAS KIDNAPPED ON 3 APRIL AT THE CORNER OF 60TH AND 48TH STREETS IN WESTERN MEDELLIN, ONLY 100 METERS FROM A METROPOLITAN POLICE CAFE [IMMEDIATE ATTENTION CENTER]. THE ANTIOQUIA DEPARTMENT LIBERAL PARTY LEADER HAD LEFT HIS HOUSE WITHOUT ANY BODYGUARDS ONLY MINUTES EARLIER. AS HE Waited FOR THE TRAFFIC LIGHT TO CHANGE, THREE HEAVILY ARMED MEN FORCED HIM TO GET OUT OF HIS CAR AND get INTO A BLUE RENAULT.

HOURS LATER, THROUGH ANONYMOUS TELEPHONE CALLS TO THE METROPOLITAN POLICE AND TO THE MEDIA, THE EXTRADITABLES CLAIMED RESPONSIBILITY FOR THE KIDNAPPING. IN THE CALLS, THEY ANNOUNCED THAT THEY WILL RELEASE THE SENATOR WITH A NEW MESSAGE FOR THE NATIONAL GOVERNMENT.

LAST WEEK, FEDERICO ESTRADA VELEZ HAD REJECTED TALKS BETWEEN THE GOVERNMENT AND THE DRUG TRAFFICKERS.
Document-level Roll Filler Extraction

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Newspaper El Espectador</td>
</tr>
<tr>
<td>Perpetrator</td>
<td>four terrorists</td>
</tr>
<tr>
<td>Organization</td>
<td>-</td>
</tr>
<tr>
<td>Victim</td>
<td>Teofil Forero Castro, Luis Carlos Galan Sarmiento</td>
</tr>
<tr>
<td>Weapon</td>
<td>car bomb, dynamite</td>
</tr>
</tbody>
</table>

**[S1]** ... by special urban troops, four terrorists have been arrested in soacha.

**[S2]** They are responsible for the car bomb attack on the Newspaper El Espectador, to a series of bogota dynamite attacks, to the freeing of a group of paid assassins.

**[S3]** The terrorists are also connected to the murder of Teofil Forero Castro, ...

**[S4]** General Ramon is the commander of the 13th infantry brigade.

**[S5]** He said that at least two of those arrested have fully confessed to having taken part in the accident of Luis Carlos Galan Sarmiento in soacha, Cundinamarca.

**[S6]** ... triumph over organized crime, its accomplices and its protectors.
Create Training Data

1. Constructing positive sequences of length \( k \) (\( k=1 \) in this example) with BIO labels.

2. Training the sequence reader.
Model: k-sentence Reader

- **Embedding layer:**
  \[ x_{e_i} = E(x_i) \]
  \[ x_b_1, x_b_2, ..., x_b_m = BERT(x_1, x_2, ..., x_m) \]
  \[ x_i = \text{concat}(x_{e_i}, x_{b_i}) \]

- **BiLSTM layer:**
  \[ \{p_1, p_2, ..., p_m\} = \text{BiLSTM}(\{x_1, x_2, ..., x_m\}) \]

- **CRF layer:**
  \[ \text{score}(X, y) = \sum_{i=0}^{m} A_{y_i, y_{i+1}} + \sum_{i=1}^{m} P_{i, y_i} \]
Model: Multi-Granularity Reader
Model: Multi-Granularity Reader

• Sentence-level BiLSTM:

\[
\{\tilde{p}_1^{(1)}, \tilde{p}_2^{(1)}, \ldots, \tilde{p}_{l_1}^{(1)}\} = \text{BiLSTM}_{\text{sent.}}(\{\tilde{x}_1^{(1)}, \tilde{x}_2^{(1)}, \ldots, \tilde{x}_{l_1}^{(1)}\})
\]

\[
\vdots
\]

\[
\{\tilde{p}_1^{(k)}, \tilde{p}_2^{(k)}, \ldots, \tilde{p}_{l_k}^{(k)}\} = \text{BiLSTM}_{\text{sent.}}(\{\tilde{x}_1^{(k)}, \tilde{x}_2^{(k)}, \ldots, \tilde{x}_{l_k}^{(k)}\})
\]

• Paragraph-level BiLSTM:

\[
\{\hat{p}_1^{(1)}, \ldots, \hat{p}_{l_1}^{(1)}, \ldots, \hat{p}_1^{(k)}, \ldots, \hat{p}_{l_k}^{(k)}\} = \text{BiLSTM}_{\text{para.}}(\{\tilde{x}_1^{(1)}, \ldots, \tilde{x}_{l_1}^{(1)}, \ldots, \tilde{x}_1^{(k)}, \ldots, \tilde{x}_{l_k}^{(k)}\})
\]

• Fusion layer:

\[
g_i^{(j)} = \text{sigmoid}(W_1\hat{p}_i^{(j)} + W_2\tilde{p}_i^{(j)} + b)
\]

\[
p_i^{(j)} = g_i^{(j)} \odot \tilde{p}_i^{(j)} + (1 - g_i^{(j)}) \odot \hat{p}_i^{(j)}
\]

\[\odot: \text{element-wise product}\]
## Results

<table>
<thead>
<tr>
<th>System Name</th>
<th>Prec.</th>
<th>Recall</th>
<th>F-1</th>
<th>Prec.</th>
<th>Recall</th>
<th>F-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLACIER (Patwardhan and Riloff, 2009)</td>
<td>47.80</td>
<td>57.20</td>
<td>52.08</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TIER (Huang and Riloff, 2011)</td>
<td>50.80</td>
<td>61.40</td>
<td>55.60</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cohesion Extract (Huang and Riloff, 2012)</td>
<td>57.80</td>
<td>59.40</td>
<td>58.59</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>w/o contextualized embedding</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-Sentence Reader</td>
<td>48.69</td>
<td>56.11</td>
<td>52.14</td>
<td>46.16</td>
<td>53.16</td>
<td>49.41</td>
</tr>
<tr>
<td>Double-sentence Reader</td>
<td>56.37</td>
<td>47.53</td>
<td>51.57</td>
<td>53.70</td>
<td>43.95</td>
<td>48.34</td>
</tr>
<tr>
<td>Paragraph Reader</td>
<td>53.19</td>
<td>53.16</td>
<td>53.17</td>
<td>49.45</td>
<td>49.26</td>
<td>49.35</td>
</tr>
<tr>
<td>Chunk Reader</td>
<td><strong>61.76</strong></td>
<td>37.04</td>
<td>46.31</td>
<td><strong>56.91</strong></td>
<td>34.92</td>
<td>43.28</td>
</tr>
<tr>
<td><strong>w/ contextualized embedding</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contextualized Single-Sentence Reader</td>
<td>47.32</td>
<td>61.26</td>
<td>53.39</td>
<td>44.40</td>
<td><strong>57.67</strong></td>
<td>50.17</td>
</tr>
<tr>
<td>Contextualized Double-sentence Reader</td>
<td>57.17</td>
<td>53.36</td>
<td>55.20</td>
<td>53.38</td>
<td>49.22</td>
<td>51.22</td>
</tr>
<tr>
<td>Contextualized Paragraph Reader</td>
<td>56.78</td>
<td>52.64</td>
<td>54.64</td>
<td>53.36</td>
<td>49.65</td>
<td>51.44</td>
</tr>
<tr>
<td>Contextualized Chunk Reader</td>
<td>60.90</td>
<td>41.10</td>
<td>49.07</td>
<td>55.18</td>
<td>37.51</td>
<td>44.66</td>
</tr>
<tr>
<td>Multi-Granularity Reader</td>
<td>56.44</td>
<td><strong>62.77</strong></td>
<td><strong>59.44</strong></td>
<td>52.03</td>
<td>56.81</td>
<td><strong>54.32</strong></td>
</tr>
</tbody>
</table>