Mem2Seq: Effectively Incorporating Knowledge Bases into End-to-End Task-Oriented Dialog Systems
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Introduction

- End-to-end task-oriented dialog systems usually suffer from the challenge of incorporating knowledge bases (KBs).
- Mem2Seq is the first neural generative model combining the multi-hop attention over memories with the idea of pointer network.
- Mem2Seq can be trained faster and attain the state-of-the-art performance on three different task-oriented dialog datasets.
- We empirically prove that multi-hop attention mechanism helps in learning correlations between memories.
- The model is general without complicated task-specific designs.

Attention Read Out

Mem2Seq is composed of two components: the MemNN encoder, and the memory decoder.

- The encoder uses a MemNN with adjacent weighted tying.
- The decoder uses a RNN to generating dynamic query for a MemNN.
- At each time step, two distributions are generated using the RNN hidden state $h_t$, one over all the words in the vocabulary.

\[ p_{\text{vocab}}(y_t) = \text{Softmax}(W[h_t; o_t]) \]

and one over the memory contents

\[ p_{\text{mem}}(k) = p^K \]

which $p^K$ is the attention at the last MemNN hop. The next word is selected using an hard gating mechanism (i.e. sentinel).
- All the parameters are jointly learned by minimizing the sum of two standard cross-entropy losses.

Example

In-Car BLEU Ent. F1 BLEU Ent. F1

- bAbI dialogs: we report the per-response and per-dialog accuracy.
- DSTC2 Seq2Seq (+attn and +copy) is reported from Eric et al. (2017).
- In-Car Assistant: both BLEU and Entity F1 are improved without using canonical form.

Results

<table>
<thead>
<tr>
<th>bAbI</th>
<th>QRN</th>
<th>MemNN</th>
<th>Seq2Seq</th>
<th>Ptr-Unk</th>
<th>Mem2Seq</th>
<th>DSTC-2</th>
<th>Ent. F1</th>
<th>BLEU</th>
<th>Per-Resp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>99.4</td>
<td>99.9</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>-</td>
<td>QRN</td>
<td>-</td>
<td>43.8</td>
</tr>
<tr>
<td>T2</td>
<td>94.7</td>
<td>94.7</td>
<td>94.7</td>
<td>94.7</td>
<td>94.7</td>
<td>MemNN</td>
<td>Seq2Seq</td>
<td>69.7</td>
<td>55.0</td>
</tr>
<tr>
<td>T3</td>
<td>74.8</td>
<td>74.8</td>
<td>74.8</td>
<td>74.8</td>
<td>74.8</td>
<td>+Attn</td>
<td>71.6</td>
<td>56.6</td>
<td>46.0</td>
</tr>
<tr>
<td>T4</td>
<td>57.2</td>
<td>59.5</td>
<td>57.2</td>
<td>57.2</td>
<td>57.2</td>
<td>+Copy</td>
<td>75.3</td>
<td>55.4</td>
<td>47.3</td>
</tr>
<tr>
<td>T5</td>
<td>99.6</td>
<td>96.1</td>
<td>98.4</td>
<td>99.4</td>
<td>97.9</td>
<td>Mem2Seq</td>
<td>75.3</td>
<td>55.4</td>
<td>47.3</td>
</tr>
</tbody>
</table>

Mem2Seq

- T1-OOV 83.1 72.3 81.7 92.5 94.0
- T2-OOV 78.9 78.9 78.9 83.2 86.5
- T3-OOV 79.2 74.4 75.3 83.2 89.2
- T4-OOV 60.9 57.6 57 100 100
- T5-OOV 67.8 65.5 65.7 73.6 84.5

By advancing into the city, the road is heavy traffic. Through the directions, the closest parking garage is civic center garage at 270 altaire walk 4 miles away. The parking garage is in civic center garage at 270 altaire walk 4 miles through the directions.