State-Regularized Recurrent Neural Networks

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Recurrent Neural Networks

What exactly RNNs learn on sequential inputs?

Tend to generalize poor on longer sequence

Samples

- Train set (depth <= 5): (((())), (())()), (((()))))
  - Errors(%) = 0.00

- Test set (depth <=20): (((((((()))(()))))))), (((()())(())(((()))))))
  - Errors(%) = 0.33

LSTMs memorize with hidden states

LSTMs have drifting behavior
State-Regularized Recurrent Neural Networks

- Learning a finite set of states (k centroids)
- Force RNNs operate like automata with external memory

- SR-LSTMs maintain two states
- SR-LSTMs memorize with memory cell
Regular Language: DFA Extraction

SR-GRU on Tomita Grammar 1

Extracted DFAs for Grammars:

1.  2.  3.  4.  7.
Non-regular Language: Long-Term Memorization

<table>
<thead>
<tr>
<th>Depth</th>
<th>LSTM</th>
<th>SR-LSTM-P</th>
</tr>
</thead>
<tbody>
<tr>
<td>d=5</td>
<td>0.002</td>
<td>0.000</td>
</tr>
<tr>
<td>d=10</td>
<td>0.207</td>
<td>0.004</td>
</tr>
<tr>
<td>d=20</td>
<td>0.543</td>
<td>0.020</td>
</tr>
</tbody>
</table>

Error rate for the balanced parentheses test sets.

Thank You!

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For more results, please visit our poster@Pacific Ballroom #68
https://github.com/deepsemantic/sr-rnns