Meta-Learning Neural Bloom Filters

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Architecture
Interested in neural networks with compressive, distributed memories.

Problem
Trend in the use of neural networks to replace classical data-structures.
Bloom Filter

$k = 3$

$\begin{array}{ccc}
    h_1 & h_2 & h_3 \\
\end{array}$

$m = 10$

$\begin{array}{cccccccccccc}
    1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 \\
\end{array}$
Bloom Filter

The Case for Learned Index Structures
Kraska et al. (2017)
Often data-structures are not created in isolation. E.g. a Bigtable database with 10,000 tablets. Common rowkey schema and query distribution. Meta-learning: slow-learn common distribution, fast-learning of specific set.
Neural Bloom Filter

\[ x \rightarrow z \rightarrow q \rightarrow A \rightarrow a \rightarrow M \rightarrow r \rightarrow o \rightarrow z \rightarrow w \]
## Database Task

<table>
<thead>
<tr>
<th>FPR</th>
<th>Neural Bloom Filter</th>
<th>Cuckoo Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>5%</td>
<td>35.8x</td>
<td>0.9x</td>
</tr>
<tr>
<td>1%</td>
<td>32.0x</td>
<td>1.2x</td>
</tr>
<tr>
<td>0.1%</td>
<td>2.9x</td>
<td>1.2x</td>
</tr>
</tbody>
</table>

Space reduction over Bloom Filter for storage set of 5,000 strings.
<table>
<thead>
<tr>
<th>Model</th>
<th>Query + Insert Latency</th>
<th>Query Throughput (QPS)</th>
<th>Insert Throughput (IPS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CPU</td>
<td>GPU</td>
<td>CPU</td>
</tr>
<tr>
<td>Bloom Filter [1]</td>
<td>0.02ms</td>
<td>-</td>
<td>61K</td>
</tr>
<tr>
<td>Neural Bloom Filter</td>
<td>5.1ms</td>
<td>13ms</td>
<td>3.5K</td>
</tr>
<tr>
<td>LSTM</td>
<td>5.0ms</td>
<td>13ms</td>
<td>3.1K</td>
</tr>
<tr>
<td>Learned Index [2]</td>
<td>780ms</td>
<td>1.36s</td>
<td>3.1K</td>
</tr>
</tbody>
</table>

Talk to me at my poster: #43

More experiments:

Comparisons to MemNets, DNCs, and LSTMs.

Image tasks with varying structure.

Model ablations to different learned algorithms.

(Too small to see so you have to come to my poster for the real deal)