Welcome
2017 Faculty Summit
Attendees

Faculty Summit 2017
microsoftfacultysummit.com

Microsoft Research
Microsoft.com/research

Facebook
@microsoftresearch

Twitter
@MSFTResearch
#FacSumm
#EdgeofAI
Learning end-to-end task-oriented dialog systems with Hybrid Code Networks

Jason D. Williams, MSR AI
In collaboration with many others at Microsoft
Hybrid Code Networks (HCNs)

- End-to-end recurrent neural network (LSTM) for dialog learning
  - Words + other features as input; actions templates as output
  - Infers its own representation of dialog state
  - Generalization via word embeddings

- Interactive learning approach, plus reinforcement learning
  - To start: Provide a few example dialogs, then interactively correct errors
  - Optionally, autonomously improve with reinforcement learning
  - No ML expertise required

- Extensible/customizable with code
  - Add business rules to constrain which actions are available
  - Create actions which are API calls (in addition to text actions)
  - Developer can integrate arbitrary domain-specific back-end
What's the weather this week in Seattle?

Interactive demonstration

- Weather domain
- Wrote code to access WUnderground API for doing lat/lon resolution and obtaining weather forecasts
- Initialize an HCN model with 3 entities and 3 actions
- Entity extraction with LUIS ([www.luis.ai](http://www.luis.ai))

<table>
<thead>
<tr>
<th>Action</th>
<th>Rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which city?</td>
<td>Mask if <code>{city}</code> entity is already known</td>
</tr>
<tr>
<td>Which day?</td>
<td>Mask if <code>{date}</code> entity is already known</td>
</tr>
<tr>
<td><code>{forecast}</code></td>
<td>Mask if <code>{forecast}</code> not available</td>
</tr>
</tbody>
</table>
Facebook bAbI dialog dataset results

<table>
<thead>
<tr>
<th>Model</th>
<th>Task5-OOV</th>
<th>Task6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Turn Acc.</td>
<td>Dialog Acc.</td>
</tr>
<tr>
<td>Rules</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Bordes and Weston (2016)</td>
<td>77.7%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Liu and Perez (2016)</td>
<td>79.4%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Eric and Manning (2017)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Seo et al. (2016)</td>
<td>96.0%</td>
<td>—</td>
</tr>
</tbody>
</table>

Past work (end-to-end network, no domain knowledge)

Simulated dialogs

Real human-computer dialogs

SL and RL can be combined, and interleaved

- RL with REINFORCE-style update
  \[ w \leftarrow w + \alpha \left( \sum_t \nabla_w \log \pi(a_t|h_t; w) \right) (G - b) \]

- Colors: Supervised learning pre-training with N dialogs
Summary

• Hybrid Code Networks are an ML-driven approach to creating real-world, domain-specific dialog systems
• Combines an LSTM with code that expresses domain knowledge
• Three learning modes: interactive teaching (SL), labeled examples (SL), and autonomous learning (RL)
• State-of-the-art quantitative results, and can be used to build practical systems
Learning end-to-end task-oriented dialog systems with Hybrid Code Networks

Jason D. Williams
MSR AI

In collaboration with many others at Microsoft
Thank you