Dialog Systems and How to Score Them

Valentin Malykh, MIPT
iPavlov Project

Devoted to develop a library with building blocks for (almost) any NLP task

Sponsored by National Technology Initiative and Sberbank

3 years

Open to collaboration

iPavlov.ai
Dialog Systems: Where are they?

Hey Cortana
Dialog Systems: Examples
Dialog Systems: Examples

- **Auto-informer**
  - Closed-Domain
  - Task-oriented

![Auto-informer](image_url)
Dialog Systems: Examples

- Closed-Domain
- General

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**ELIZA**

BE SURE CAPS LOCK IS ON
TYPE ↑ TO TERMINATE
NO COMMAS PLEASE
ELIZA TAKES A FEW SECONDS TO
THINK BEFORE ANSWERING YOU.

Hit I'M ELIZA THE BROADCAST PSYCHIATRIST,
WHAT IS YOUR PROBLEM?
? I'M at the end of my rope.
SAY, DO YOU WORK IN BROADCASTING?
? no
WHAT DOES THAT SUGGEST TO YOU?
? Well, that I work in some other field.
?Redo from start
? But we've come so far!
Dialog Systems: Examples

Karpathy’s CharRNN
- Open-Domain
- General

General

Task-oriented

Open Domain

Closed Domain

CharRNN

ELIZA

авто-информаторы
Dialog Systems: Examples

Karpathy’s CharRNN
- Open-Domain
- General
- Reactive
- Not that “smart”

General
Task-oriented

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CharRNN
авто-информаторы

Closed Domain  Open Domain
Dialog Systems: Examples

ConvAI Goal
- Open-Domain
- Task-oriented
Dialog Systems: Examples

True AI
- Open-Domain
- Task-oriented

Task-oriented

General

ConvAI

Closed Domain

Open Domain

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CharRNN

авто-информаторы
Dialog Systems: Examples

- True AI
  - Open-Domain
  - Task-oriented
  - Pro-active

- ConvAI
  - CharRNN
  - авто-информаторы

- General

- Closed Domain
  - Open Domain
Conversational Intelligence Challenge

- Task-oriented
- General

NIPS 2017 Live Competition

Presumed Dataset Size: 1000+ dialogs

convai.io
Conversational Intelligence Challenge

- Task-oriented
- General

Person chats with a bot (or another person)
Conversational Intelligence Challenge

- Task-oriented
- General

Person chats with a bot (or another person)

They are discussing a news article
Conversational Intelligence Challenge

- Task-oriented
- General

Person chats with a bot (or another person)

They are discussing a news article

Human judgment at the end (consistency, overall adequacy)
Conversational Intelligence Challenge

The Judgement Scheme

- Like/dislike for each line of a bot
- End scoring:
  - quality
  - breadth
  - engagement
Turing Test

Two persons are talking indirectly

⅔ of persons who talked to a bot should say that it’s a human
Dialog Systems: How to Score Them?
Task-oriented Systems

Task Completion Rate (TCR)

\[
\text{Task Completion Rate} = \frac{\text{# Successful Runs}}{\text{# All Runs}}
\]

End-to-end LSTM-based dialog control optimized with supervised and reinforcement learning

Jason D. Williams, Geoffrey Zweig, \textit{arxiv:1606.01269}
General Systems

- Word-Overlap
  - ROUGE
  - BLEU
  - METEOR

\[
P_n(r, \hat{r}) = \frac{\sum_k \min(h(k, r), h(k, \hat{r}_i))}{\sum_k h(k, r_i)}
\]

\[
\text{BLEU-N} := b(r, \hat{r}) \exp\left(\sum_{n=1}^{N} \beta_n \log P_n(r, \hat{r})\right)
\]
General Systems

- **Word-Overlap**
  - ROUGE
  - BLEU
  - METEOR

- **Embedding-based**
  - Greedy Matching
  - Embedding Average
  - Extreme Vector

\[
\bar{e}_r = \frac{\sum_{w \in r} e_w}{\sum_{w' \in r} e_{w'}}
\]

\[
EA := \cos(\bar{e}_r, \bar{e}_r')
\]
General Systems

(a) Twitter

(b) Ubuntu
General Systems


Chia-Wei Liu, Ryan Lowe, Iulian V. Serban, Michael Noseworthy, Laurent Charlin, Joelle Pineau, arxiv:1603.08023
How to Live with That?
How to Live with That: Reinforcement Learning

Diagram:
- Agent
- Environment
- State
- Reward
- Action
How to Live with That

- Reward-based Imitation (RBI)
- Forward Prediction (FP)

Dialog-based Language Learning

Jason Weston, arXiv:1604.06045
How to Live with That

<table>
<thead>
<tr>
<th>Model</th>
<th>$r = 0$</th>
<th>$r = 0.1$</th>
<th>$r = 0.5$</th>
<th>$r = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reward Based Imitation (RBI)</td>
<td>0.333</td>
<td>0.340</td>
<td>0.365</td>
<td>0.375</td>
</tr>
<tr>
<td>Forward Prediction (FP)</td>
<td>0.358</td>
<td>0.358</td>
<td>0.358</td>
<td>0.358</td>
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<tr>
<td>RBI+FP</td>
<td>0.431</td>
<td>0.438</td>
<td>0.443</td>
<td>0.441</td>
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</tbody>
</table>

Dialogue Learning With Human-In-The-Loop

Jiwei Li, Alexander H. Miller, Sumit Chopra, Marc'Aurelio Ranzato, Jason Weston, *arxiv:1611.09823*
How to Live with That

<table>
<thead>
<tr>
<th>bAbI Task 6: Partial Rewards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mary went to the hallway.</td>
</tr>
<tr>
<td>John moved to the bathroom.</td>
</tr>
<tr>
<td>Mary travelled to the kitchen.</td>
</tr>
<tr>
<td>Where is Mary?</td>
</tr>
<tr>
<td>Yes, that’s right!</td>
</tr>
<tr>
<td>Where is John?</td>
</tr>
<tr>
<td>Yes, that’s correct! (+)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WikiMovies Task 6: Partial Rewards</th>
</tr>
</thead>
<tbody>
<tr>
<td>What films are about Hawaii?</td>
</tr>
<tr>
<td>Correct!</td>
</tr>
<tr>
<td>Who acted in Licence to Kill?</td>
</tr>
<tr>
<td>No, the answer is Timothy Dalton.</td>
</tr>
<tr>
<td>What genre is Saratoga Trunk in?</td>
</tr>
<tr>
<td>Yes! (+)</td>
</tr>
<tr>
<td>...</td>
</tr>
</tbody>
</table>
Questions?