Integrating Pre-trained Model into Rule-based Dialogue Management

Speaker: Qiang Gan

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Event-Trigger-Action

Model-Trigger DM
Pre-trained Model for DM
Model Architecture
Dataset and Experiment
Demo
Event-Trigger-Action

The process of a dialogue turn

- External event
- Internal event

Trigger

The cycle ends when internal event triggers nothing.

Action
Expression Trigger

An expression trigger for “Action1” (slot-filling type):

EventArrival("UserQuery") && ParameterStatus("Action1")="Resolving" &&
LastWinnerParam()=="Action1" && $param : Action2.ResolvedValue ["key1"] > 3 &&
$param:Action1.ResolvedValue["key2"] == null && GetTurnNumber() <= 5

PS:
**Boolean functions** and **string functions** (such as “EventArrival()”, “ParameterStatus()”) are pre-defined.
**All actions** (such as “Action1”, “Action2”) are pre-defined.

◆ The expressions “listen to” customized events, which makes the dialogue logic flexible and
  interpretable.

◆ Developers can hardly summarize and maintain enough explicit rules when the scenario is complex.
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## Dialogue State Feature

<table>
<thead>
<tr>
<th>Turn</th>
<th>Feature</th>
<th>Action (Label)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>True False False False ... ... False False False False False False True</td>
<td>get-informable-slot</td>
</tr>
<tr>
<td>0</td>
<td>False True False False ... ... False False False True False False False</td>
<td>request-db-number-api</td>
</tr>
<tr>
<td>0</td>
<td>False True False False ... ... False False True False False False True</td>
<td>End-Turn</td>
</tr>
<tr>
<td>1</td>
<td>False True True True ... ... False False True False False True True</td>
<td>get-informable-slot</td>
</tr>
</tbody>
</table>

```json
{
    "EventArrival\("dialogstart\")\"": "False",
    "EventArrival\("UserQuery\")\"": "True",
    "EventArrival\("timer\")\"": "False",
    "EventArrival\("dialogend\")\"": "False",
    ...

    "LastWinnerParam()\n== get_informable_slot\": "False",
    "LastWinnerParam()\n== get_requestable_slot\": "False",
    "LastWinnerParam()\n== request_db_number_api\": "False",
    "LastWinnerParam()\n== request_name_api\": "True",
    "LastWinnerParam()\n== request_attribute_api\": "False",
    "LastWinnerParam()\n== farewell\": "False"
}
```

*Used for Expression Trigger*
Pre-trained Model for DM

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Dialogue Context Feature

Pretrain tasks:
(1) Masked Language Modeling
(2) Response Selection

ToD-BERT: Pre-trained Natural Language Understanding for Task-Oriented Dialogues
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Model Architecture

[Diagram showing the model architecture with the following steps:
Prediction Layer -> Combined Feature -> Feature Fusion Layer -> State Feature -> Actions scores (Argmax) -> Winner Action -> End turn (Yes/No)

Inference path:
Prediction Layer -> Combined Feature -> Feature Fusion Layer -> State Feature -> Actions scores (Argmax) -> Winner Action -> End turn (Yes/No)

Training path:

Predefined Dialogue State Variables]
Event-Trigger-Action
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Model Architecture

Dataset and Experiment

Demo
Action Definition (based on CamRest676)

- **get-informable-slot:**
  - type: slot-filling
  - dependent slots: pricerange, area, food

- **request-db-number-api:**
  - type: webhook
  - httpparams: pricerange, area, food

- **request-name-api:**
  - type: webhook
  - httpparams: pricerange, area, food

- **EndTurn

- **get-requestable-slot:**
  - type: slot-filling
  - dependent slots: req-address, req-phone, req-postcode, req-area, req-food, req-pricerange

- **request-attribute-api**
  - type: webhook
  - httpparams: req-address, req-phone, req-postcode, req-area, req-food, req-pricerange, req-name

- **farewell**
  - type: pattern-text
Data Preparation (Create new version of CamRest676)

<table>
<thead>
<tr>
<th>Turn</th>
<th>Dialogue Context</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I am looking for a restaurant that is moderately priced and serves Chinese food.</td>
<td>There are no restaurants that serve Chinese food in the moderate price range.</td>
</tr>
</tbody>
</table>

Annotation

<table>
<thead>
<tr>
<th>Turn</th>
<th>Dialogue Context</th>
<th>Winner Action Sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I am looking for a restaurant that is moderately priced and serves Chinese food.</td>
<td>get_informable_slot, request_db_number_api, request_name_api, end_turn</td>
</tr>
</tbody>
</table>

Featurization

<table>
<thead>
<tr>
<th>Mini-turn</th>
<th>Input 1</th>
<th>Input 2</th>
<th>Output (Label)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Context Feature</td>
<td>State Feature 1</td>
<td>action 1 (get_informable_slot)</td>
</tr>
<tr>
<td>2</td>
<td>Context Feature</td>
<td>State Feature 2</td>
<td>action 2 (request_db_number_api)</td>
</tr>
<tr>
<td>3</td>
<td>Context Feature</td>
<td>State Feature 3</td>
<td>action 3 (request_name_api)</td>
</tr>
<tr>
<td>4</td>
<td>Context Feature</td>
<td>State Feature 4</td>
<td>action 4 (end_turn)</td>
</tr>
</tbody>
</table>
## Few-shot Experiments

<table>
<thead>
<tr>
<th>Training Data Ratio</th>
<th>Feature Fusion Method</th>
<th>Pre-trained Model</th>
<th>Dev Set</th>
<th>Test Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% (406 sessions)</td>
<td>Our Method 3</td>
<td>ToD-BERT (jnt)</td>
<td>93.83</td>
<td>96.07</td>
</tr>
<tr>
<td>50% (203 sessions)</td>
<td>Our Method 3</td>
<td>ToD-BERT (jnt)</td>
<td>93.28</td>
<td>95.37</td>
</tr>
<tr>
<td>25% (101 sessions)</td>
<td>Our Method 3</td>
<td>ToD-BERT (jnt)</td>
<td><strong>92.37</strong></td>
<td><strong>95.46</strong></td>
</tr>
<tr>
<td>10% (40 sessions)</td>
<td>Our Method 3</td>
<td>ToD-BERT (jnt)</td>
<td>84.62</td>
<td>88.98</td>
</tr>
<tr>
<td>100% (406 sessions)</td>
<td>Only State Feature</td>
<td>-</td>
<td>86.02</td>
<td>88.22</td>
</tr>
<tr>
<td>50% (203 sessions)</td>
<td>Only State Feature</td>
<td>-</td>
<td>85.59</td>
<td>89.88</td>
</tr>
<tr>
<td>25% (101 sessions)</td>
<td>Only State Feature</td>
<td>-</td>
<td>86.02</td>
<td>88.12</td>
</tr>
<tr>
<td>10% (40 sessions)</td>
<td>Only State Feature</td>
<td>-</td>
<td>84.20</td>
<td>86.54</td>
</tr>
</tbody>
</table>

![Graph](image.png)
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CamRest676 Bot

I need to find an expensive restaurant that's
THANKS

2020.12.19