SD study:
Exploiting knowledge base to generate responses for natural language dialog listening agents
About this paper

Sangdo Han, Jeesoo Bang, Seonghan Ryu, Gary Geunbae Lee. "Exploiting knowledge base to generate responses for natural language dialog listening agents."

Abstract

We developed a natural language dialog listening agent that uses a knowledge base (KB) to generate rich and relevant responses. Our system extracts an important named entity from a user utterance, then scans the KB to extract contents related to this entity. The system can generate diverse and relevant responses by assembling the related KB contents into appropriate sentences. Fifteen students tested our system; they gave it higher approval scores than they gave other systems. These results demonstrate that our system generated various responses and encouraged users to continue talking.
1. Introduction

● Listening agent

*The main objective of the listening agent is to analyze user’s utterances and to generate appropriate response that satisfies user’s desire to speak* (Meguro et al., 2009).

To satisfy user’s desire to talk:

● Contents

● Various responses

→ Exploiting knowledge base
Examples

User: “I like Messi.”
Sys: “Huh.” / “I see.” ← Boring

User: “I like Messi.”

User: “I like Messi.”
Sys: “Do you like David Beckham, too?” / “You like Messi, a football player.” ← Interesting
2. Related Work

Verbal listening agent

- **ELIZA [Weizenbaum 1996]**
  - Based on keyword matching and slot replacing
  - Quite limited variety of responses

- **Counseling dialog system [Han+ 2015]**
  - Based on an basic communication technique (microskills) [Ivey+ 2013]
  - The variety of responses is also limited


[Ivey+ 2013]
3. System architecture

Five modules:

- Emotion detection
- NLU
- Related Info Extraction
- Dialog management
- NLG
3.1 Emotion Detection

Keyword based method [Guinn+ 2013]

● 170 keywords
● 7 basic emotions
  □ Sadness, anger, happiness, fear, disgust, contempt, surprise

● When a user utterance includes ‘feeling words’, basic emotions are detected.
3.2 Natural Language Understanding (NLU)

- User intention detection
- Triple extraction
- Entity recognition
3.2.1 User Intention Detection

Dialog collection

- 15 students, 77 text dialogs, 10 min per dialog
- Speaker versus listener
- Listeners responded based on microskills
- The dialog topic was chosen freely by the speaker

Defined user intentions

Greeting, self-disclosure, informing, questioning, and else

Total 1281 utterances

51.2% self-disc, 32.7% informing, 7.6% else, 5.7% greeting, 2.7% question
3.2.1 User Intention Detection

Maximum entropy classifier
word n-gram (n=1,2,3) feature
3.2.2 Triple Extraction

Triple: [subject, verb, object]

e.g. “I like Messi.” → [I, like, Messi]

Extracted using ClausIE [Del Corro+ 2013]

3.2.3 Entity Recognition

Named entities (NEs) are recognized by matching to an entity name in DBpedia

E.g.
User: “I like Messi.” → Detected “Lionel Messi” in DBpedia
3.3 Related Information Extraction

When users utterance includes a football player
→ System response should also be about football players or the player’s position

RIE module takes a recognized entity as input
→ Extract type, instances of the type, properties of the type
  e.g. “Messi” → “football player” (type)
  → “David Beckham” (instance of football player)
  → “position” (property of football player)
3.3 Related Information Extraction

Notable type: a type that could be the best disambiguator
e.g.
“Barack Obama” → “US president (notable type)”,
“Person”, “Plitician”, ...

RIE module outputs one type, one instance and one property
Instance and property are chosen randomly from top-10
3.4 Dialog Management

System intentions:

● Greeting: Say hello to user
● Attending: e.g. S: “Tell me more.”
● Paraphrasing: e.g. U: “I watched Avatar.” → S: “You watched Avatar.”
● Questioning:
  e.g. U: “I watched Avatar.” → S: “Did you watch Titanic, too?”
● Reflect feeling: e.g. U: “I was so angry.” → S: “You were so mad.”
● Questioning response:
  Change topic or ask users to talk about themselves
  e.g. U: “Who is your mother?” → S: “Why don’t we talk about you?”
3.4 Dialog Management

Algorithm 1 Dialog Management Strategy

\begin{algorithm}
\begin{algorithmic}
\State \textbf{if} User Intention = Greeting \textbf{then}
\State \quad \textbf{return} Greeting
\State \textbf{else if} User Intention = Questioning \textbf{then}
\State \quad \textbf{return} Questioning Response
\State \textbf{else if} User Intention = Information \textbf{then}
\State \quad \textbf{return} Paraphrasing or Questioning
\State \textbf{else if} User Intention = Self Disclosure \textbf{then}
\State \quad \textbf{if} Emotion Detected \textbf{then}
\State \quad \quad \textbf{return} Reflect Feeling
\State \quad \textbf{else}
\State \quad \quad \textbf{return} Paraphrasing or Questioning
\State \textbf{end if}
\State \textbf{else}
\State \quad \textbf{return} Attending
\State \textbf{end if}
\end{algorithmic}
\end{algorithm}
# 3.5 Natural Language Generation

<table>
<thead>
<tr>
<th>System Intention</th>
<th>Entity Location</th>
<th>Related Information</th>
<th>Emotional Keyword</th>
<th>Response Template</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greeting</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>Nice to meet you.</td>
</tr>
<tr>
<td>Attending</td>
<td>*</td>
<td>type</td>
<td>*</td>
<td>Please tell me about the [type], [entity].</td>
</tr>
<tr>
<td>Paraphrase</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>[S] [V] [O].</td>
</tr>
<tr>
<td>Paraphrase</td>
<td>S</td>
<td>property</td>
<td>*</td>
<td>[entity], whose [property] is [object], [V] [O]</td>
</tr>
<tr>
<td>Questioning</td>
<td>O</td>
<td>instance, type</td>
<td>*</td>
<td>[S] [V] another [type], [instance], too?</td>
</tr>
<tr>
<td>Reflect</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>Sad</td>
</tr>
<tr>
<td>Feeling</td>
<td>*</td>
<td></td>
<td></td>
<td>Oh, cheer up.</td>
</tr>
<tr>
<td>Questioning Response</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>Why don’t we talk about you?</td>
</tr>
</tbody>
</table>

Table 1: System Utterance Template Examples. Slots: [S] subject of triple; [V] verb of triple; [O] object of triple; [object] object instance of Freebase triple ; * for don’t care condition
## Dialog Example

<table>
<thead>
<tr>
<th>Speaker</th>
<th>Utterance</th>
</tr>
</thead>
<tbody>
<tr>
<td>User</td>
<td>Hello.</td>
</tr>
<tr>
<td>System</td>
<td>Hi. What do you want to talk about?</td>
</tr>
<tr>
<td>User</td>
<td>I want to talk about Messi.</td>
</tr>
<tr>
<td>System</td>
<td>Lionel Messi, a football player?</td>
</tr>
<tr>
<td>User</td>
<td>Yes. Messi is my favorite.</td>
</tr>
<tr>
<td>System</td>
<td>Is David Beckham your favorite, too?</td>
</tr>
<tr>
<td>User</td>
<td>No, I just like Messi.</td>
</tr>
<tr>
<td>System</td>
<td>What is Lionel Messi’s position?</td>
</tr>
<tr>
<td>User</td>
<td>It’s forward.</td>
</tr>
</tbody>
</table>

### Table 2: Dialog Example
4. Experiment and Results

15 students chatted with 3 systems for 10 min (ELIZA, counseling dialog system and proposed system)

3 questions, Likert scale (1 to 10)
- Various response
- Encourage dialog
- Dialog satisfaction

Figure 2: Averaged user experiment score.
5. Conclusion

We designed a natural language dialog listening agent that exploits the important and relevant information to the utterance from the KB. Results of our experiment indicated that our usage of a KB generated various responses and encouraged users to continue talking. Related information diversified the contents of system responses, and made users talk with the related information. Dialog satisfaction was increased by pin-pointing the content that user want to talk about.