Recent Approaches to Dialog Management for Spoken Dialog Systems

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Outline

- Roles of Dialog Management
- Degrees of Initiative
- Error Handling
- Recent Approaches
Components of Spoken Dialog Systems

- User Input
- Automatic Speech Recognition
- Spoken Language Understanding
- Dialog Management
- Natural Language Generation
- System Output
Roles of Dialog Management

- Using a knowledge database based on current input and discourse context, search and provide query results
- In case of inappropriate query, ask for more information
- In case of unclear information, ask user to confirm or rephrase the input
- Predict the next system action
- Implementation of more human-like dialog systems by controlling generic conversational mechanisms in human-human dialogs
Degrees of Initiative

- Who directs the progression of the dialog
- System initiative
- User initiative
- Mixed initiative
System-initiative Dialog

- System: Please state the name of the city which you are visiting.
- System: Okay New York. What sort of cuisine would you like?
- User: Korean.
User-initiative Dialog

- User: I want to go to Korean restaurant in New York.
- System: There are 10 Korean restaurants in New York.
- User: Where is Mapo BBQ?
Mixed-initiative

- System: Where are you going?
- User: Korean restaurant in New York.
- System: There are 10 Korean restaurants in New York. What is the restaurant's name?
- User: Are there any cheap ones?
Error Handling

- ASR and SLU are not perfect
- User input may be unclear or incomplete
- Noisy environments and unexpected input may decrease the performance
- Errors should be handled at conversational level
- Error recovery strategies
Explicit Confirmation

- User: I want to go to Korean restaurant in New York.
- System: So you want to go to Korean restaurant in New York? Please answer yes or no.
- User: Yes.
Implicit Confirmation

- User: I want to go to Korean restaurant in New York.
- System: What is the name of Korean restaurant in New York?
- User: Mapo BBQ.
Static Rephrasal

- User: I want to go to Korean restaurant in New York.
- System: Sorry. Would you please rephrase?
- User: I'd like to go to Korean restaurant in New York.
Dynamic Rephrasal

- User: I want to go to Korean restaurant in New York.
- System: Sorry. Would you please rephrase using expression “I'd like to go to [RES-TYPE] in [LOC-ADDRESS]”.
- User: I'd like to go to Korean restaurant in New York.
Recent Approaches to Dialog Management

- Knowledge-based dialog management
- Data-driven dialog management
- Hybrid dialog management
Knowledge-based dialog management

- Requires domain specific knowledge
- Highly structured tasks and system-initiative dialogs
- Hand-crafted rules
- Strong typed interaction with clearly defined structures and goals
Knowledge-based dialog management

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**Example Dialogue:**

<table>
<thead>
<tr>
<th>Turn</th>
<th>Speaker</th>
<th>Utterances</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>System</td>
<td>Please state the name of the city which you are visiting.</td>
</tr>
<tr>
<td>2</td>
<td>User</td>
<td>New York</td>
</tr>
<tr>
<td>3</td>
<td>System</td>
<td>Are you going to New York?</td>
</tr>
<tr>
<td>4</td>
<td>User</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>System</td>
<td>What sort of cuisine would you like?</td>
</tr>
<tr>
<td>6</td>
<td>User</td>
<td>Korean</td>
</tr>
<tr>
<td>7</td>
<td>System</td>
<td>Is the cuisine of a restaurant Korean?</td>
</tr>
<tr>
<td>8</td>
<td>User</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Knowledge-based dialog management

Although this approach is very simple, hand-crafted rules are difficult and it has poor domain portability
Knowledge-based dialog management

- Agenda or task models
- Large tasks into smaller subtasks
Knowledge-based dialog management

- Domain-dependent and domain-independent aspects are separated
- Developer provides a hierarchical tree structure for interaction
- Still time consuming
- Unsupervised clustering technique to build a domain model automatically
Data-driven dialog management

- Requires time consuming annotation
- Automatic training
- Requires less human supervision
- More portable
Data-driven dialog management

- Reinforcement Learning based on Markov Decision Process (MDP) or partially observable MDP
- Error handling with no extra mechanism due to the nature of POMDP
Data-driven dialog management

- However;
- Optimized policy disables developers to control dialog flow
- Dialog control is very difficult
Data-driven dialog management

- Supervised approach
- Maximum Likelihood Estimation of stochastic model from human-human dialog corpus
- Discourse history as dialog state sequences
Data-driven dialog management

- Example based approach
- Same actions in similar dialog states
- Lack of prior knowledge and weakness to ASR and SLU
Hybrid Approaches to Dialog Management

- User simulation techniques to generate large number of simulated dialogs
- Both dialog examples and prior knowledge are used
- Agenda graph as prior knowledge
- Predict next action with this knowledge
Conclusion

- Roles of Dialog Management
- Degrees of Initiative
- Error Handling
- Recent Approaches
Reference

Thank you for listening