

Dialogue Systems

Lecture 24: November 28, 2013

CS886-2 Natural Language Understanding
University of Waterloo

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Dialog Systems

- Conversational agents
 - NLU (understanding) + **Decision making + NLG (generation)**
- Spoken Dialogs
 - Speech based conversational agents
 - Call centers, Siri, car control system
- **Textual dialogs**
 - Text based conversational systems
 - Chatbots, helpdesks

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Dialog Types

- **Task-based dialogs**
 - Book a flight, helpdesk, directory assistance, tutoring
 - Restricted domain (easier)
 - Specific goal (harder to experiment)
- **Open ended dialogs**
 - Casual chat
 - No specific domain (harder)
 - Entertainment (easier to experiment)

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Task-based Dialogs

- Often formulated as **slot filling problems**
- Examples
 - Flight Booking
 - Restaurant recommendation

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Dialog Manager Architecture

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Utterance Analysis

- Utterance Categories
 - Greeting
 - End of conversation
 - Agreement
 - Disagreement
 - Question
 - Slot type

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Utterance Categorization

- Rule based systems
 - Keywords, n-grams, regular expressions
 - Simple and effective for restricted domains
- Supervised learning techniques
 - Naïve Bayes, support vector machines, decision trees
 - Need labeled data
 - Tag corpus of human dialogs

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Slot Analysis

- Analyze the values mentioned for a slot
 - Value assignment
 - Value list
 - Value confirmation
 - Value negation
- Value inference
 - E.g., Infer absolute date/time

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States

- **State**: summary of conversation so far
- State features:
 - Slots
 - Last generated utterance
- State: joint assignment of values to slots and last generated utterance
 - Example:

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State Update

- **Deterministic update**: $S \times userUtterance \rightarrow S'$
 - Rule based systems
 - Finite state machine
- **Probabilistic update**: $\Delta S \times userUtterance \rightarrow \Delta S'$
 - Belief monitoring in hidden Markov model

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Hidden Markov Model

- Graphical Model

Decision Making

- Task: decide what kind of utterance to generate next
- Rule based systems and fully observable Markov decision processes: $S \rightarrow \text{systemUtterance}$
- Partially observable Markov decision processes: $\Delta S \rightarrow \text{systemUtterance}$

System Utterances

- Common system utterances
 - Greeting
 - End of conversation
 - Slot confirmation
 - Question about slot

Markov Decision Processes

- Graphical Model

Policy Optimization

- **Dynamic Programming**
 - Pre-compute a policy
 - Fast execution, but difficult to cover all situations
- **Forward simulation**
 - Optimize next action on the fly
 - Tailored to current situation

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Parameter Estimation

- Hand code parameters
- HMM unsupervised learning
 - E.g., EM, Gibbs sampling
- Reinforcement learning
 - Estimate parameters as decisions are made
 - Form of interactive learning

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Utterance Generation

- Canned utterances (prompts)
- Templates
- Natural language generation