Simple models of dialogue structure

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CSCI 599 Special Topic:
Natural Language Dialogue Systems
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Dialogue structure

- Local
  - What binds utterances together?
  - What makes one utterance coherent (or incoherent) when following another?

- Global
  - What is the structure of a conversation?
  - What is the structure of a task (that a conversation is “oriented” to)?

- How many levels of structure are there?
Simple models of dialogue structure

- key phrase reactive approaches
- trees and finite state approaches
- information retrieval-based approaches
Simple models of dialogue structure

- key phrase reactive approaches
- trees and finite state approaches
- information retrieval-based approaches
What do these “simple” models have in common?

- Dialogue structure and control are mostly implemented at the surface level.
- Dialogue structure is also modeled at a very local level:
  - common to respond based only on the last user utterance.
- Systems enforce strict turn-taking and simple models of initiative.
Key phrase reactive approaches

- These are systems that react primarily based on spotting of *key words* or *key phrases* in the user's *last utterance*
  - Example rule: if user's utterance contains the word *thanks* then respond *you're welcome*
- Examples of the key phrase reactive approach:
  - ELIZA
  - AIML
ELIZA

• Course reading:

• An important reference point in the history of dialogue systems
• Designed to engage in “psychotherapy” dialogues
• Demo: emacs doctor program (M-x doctor)
• Source code in java and lisp
  – http://hampshire.edu/lspector/courses/eliza-simple.lisp
  – http://www.chayden.net/eliza/Eliza.html
Example ELIZA dialogue

Men are all alike.

IN WHAT WAY?

They're always bugging us about something or other.

CAN YOU THINK OF A SPECIFIC EXAMPLE?

Well, my boyfriend made me come here.

YOUR BOYFRIEND MADE YOU COME HERE

He says I'm depressed much of the time.

I AM SORRY TO HEAR YOU ARE DEPRESSED
ELIZA implementation

- Very local structure
  - Limited memory
- Keyword-based transformation of text input used to produce system response
  - Keyword spotting
  - Pattern recognition
  - Transformation rules
- Example rules:
  - "I am BLAH" → "How long have you been BLAH?" or "Why do you say you are BLAH?"
  - "X are Y" → "Did you think they might not be Y?"
Criticisms of ELIZA

- “No real understanding”
  - Few of the words in user utterances play any role in the system's responses (only keywords matter)
  - It is “only keyword spotting”
  - It's responses are based only at the text level
- The user's concerns (e.g. feeling depressed) are deflected back to the user rather than addressed directly
  - A deliberate ruse to mask system's lack of understanding
- System forgets (almost) everything you say to it immediately
  - Little dialogue state
  - Doesn't learn from its dialogues (still common...)
AIML

• Course reading:
  AIML Overview by Dr. Richard S. Wallace

• Artificial Intelligence Mark-up Language
  – designed for creating chat-bots
  – part of A.L.I.C.E (Artificial Linguistic Internet Computer Entity) free software framework

• XML Syntax

• Stimulus-response interaction
Example interaction with A.L.I.C.E.

judge: men are all alike
ALICE: I think there might be a few exceptions.
judge: really? name one
ALICE: Take it easy. Mike.
judge: okay
ALICE: Ahem.
judge: They're always bugging us about something or other.
ALICE: Why are they?
judge: i don't know
ALICE: Me either.
AIML vs. ELIZA

- AIML rules support ELIZA-like transformations of user utterances
- AIML's `<srai>` operator makes additional capabilities based on simple recursion easy to implement, e.g.:
  - Simplification of utterances
  - Splitting (segmenting) user utterances and responding to each segment
  - Conditional branching
- Also:
  - “That” variable refers to the system's previous utterance
  - Can get & set variables (like user's name)
  - Can organize response rules by TOPIC
AIML example rules

<category>
<pattern>DO YOU KNOW WHO * IS</pattern>
<template><srai>WHO IS <star/></srai></template>
</category>

<category>
<pattern>MOTHER</pattern>
<template>Tell me more about your family.</template>
</category>

<category>
<pattern>YES</pattern>
<that>DO YOU LIKE MOVIES</that>
<template>What is your favorite movie?</template>
</category>
Homework 1 discussion

- Chatterbox challenge
Trees and finite state approaches

- These approaches model the dialogue as a path through a tree or finite state graph structure
  - Builds more context into system responses than simple reactive approaches
  - Provides a convenient way to model dialogue interactions that can be described by a small fixed number of information exchanges
Example: ‘Bridge of Death’ scene from Monty Python & the Holy Grail

- http://www.youtube.com/watch?v=IMxWLuOFyZM
  - scene starts at 0:53
BoD: Preamble

• **GALAHAD**: There it is!
• **ARTHUR**: The Bridge of Death!
• **ROBIN**: Oh, great.
• **ARTHUR**: Look! There's the old man from scene twenty-four!
• **BDEVERE**: What is he doing here?
• **ARTHUR**: He is the keeper of the Bridge of Death. He asks each traveler five questions--
• **GALAHAD**: Three questions.
• **ARTHUR**: Three questions. He who answers the five questions--
• **GALAHAD**: Three questions.
• **ARTHUR**: Three questions may cross in safety.
• **ROBIN**: What if you get a question wrong?
• **ARTHUR**: Then you are cast into the Gorge of Eternal Peril.
BoD: Preamble (2)

- **ROBIN:** Oh, I won't go.
- **GALAHAD:** Who's going to answer the questions?
- **ARTHUR:** Sir Robin!
- **ROBIN:** Yes?
- **ARTHUR:** Brave Sir Robin, you go.
- **ROBIN:** Hey! I've got a great idea. Why doesn't Lancelot go?  
  **LAUNCELOT:** Yes. Let me go, my liege. I will take him single-handed. I shall make a feint to the north-east that s--
- **ARTHUR:** No, no. No. Hang on! Hang on! Hang on! Just answer the five questions--
- **GALAHAD:** Three questions.
- **ARTHUR:** Three questions as best you can, and we shall watch... and pray.
- **LAUNCELOT:** I understand, my liege. **ARTHUR:** Good luck, brave Sir Lancelot. God be with you.
BoD: Dialogue 1: Lancelot

- **BRIDGEKEEPER**: Stop! Who would cross the Bridge of Death must answer me these questions three, ere the other side he see.
- **LANCELOT**: Ask me the questions, bridgekeeper. I am not afraid.
- **BRIDGEKEEPER**: What... is your name? **LANCELOT**: My name is 'Sir Lancelot of Camelot'.
- **BRIDGEKEEPER**: What... is your quest? **LANCELOT**: To seek the Holy Grail. **BRIDGEKEEPER**: What... is your favourite colour? **LANCELOT**: Blue.
- **BRIDGEKEEPER**: Right. Off you go.
- **LANCELOT**: Oh, thank you. Thank you very much.
BoD: Dialogue 2: Robin

- **BRIDGEKEEPER:** Stop! Who approacheth the Bridge of Death must answer me these questions three, ere the other side he see.
- **ROBIN:** Ask me the questions, bridgekeeper. I'm not afraid.
- **BRIDGEKEEPER:** What... is your name?
- **ROBIN:** 'Sir Robin of Camelot'.
- **BRIDGEKEEPER:** What... is your quest?
- **ROBIN:** To seek the Holy Grail.
- **BRIDGEKEEPER:** What... is the capital of Assyria? [pause]
- **ROBIN:** I don't know that! Auuuuuuuuugh!
BRIDGEKEEPER: Stop! What... is your name?

GALAHAD: 'Sir Galahad of Camelot'.

BRIDGEKEEPER: What... is your quest?

GALAHAD: I seek the Grail. BRIDGEKEEPER: What... is your favourite colour?

GALAHAD: Blue. No, yel-- auuuuuuuuugh!

BRIDGEKEEPER: Hee hee heh.
BoD: Dialogue 3: Galahad

- **BRIDGEKEEPER**: Stop! What... is your name?
- **GALAHAD**: 'Sir Galahad of Camelot'.
- **BRIDGEKEEPER**: What... is your quest?
- **GALAHAD**: I seek the Grail. **BRIDGEKEEPER**: What... is your favourite colour?
- **GALAHAD**: Blue. No, yel-- auuuuuuuuugh!
  **BRIDGEKEEPER**: Hee hee heh.
BoD: Dialogue 4: Arthur

- **BRIDGEKEEPER**: Stop! What... is your name?
- **ARTHUR**: It is 'Arthur', King of the Britons.
- **BRIDGEKEEPER**: What... is your quest?
- **ARTHUR**: To seek the Holy Grail.
- **BRIDGEKEEPER**: What... is the air-speed velocity of an unladen swallow?
- **ARTHUR**: What do you mean? An African or European swallow?
- **BRIDGEKEEPER**: Huh? I-- I don't know that. Auuuuuuuugh!
- **BEDEVERE**: How do know so much about swallows?
- **ARTHUR**: Well, you have to know these things when you're a king, you know.
Trees and finite state models

- Can be used to model dialogue interactions using such reusable fixed patterns of exchanges
  - E.g.: three system questions (name, quest, favorite color or challenge question), system responses determined by user answers
- Trees and FSMs are easily applied in applications that have
  - system initiative
  - need for specific information to collect from the user (questionnaires, form-filling, favorite color, etc.)
  - fixed set of user response options for each question
Example finite state model

- This FSM confirms a user specified travel destination and day of the week
- FSMs are often used to model subdialogue structure in more complex dialogue systems (later in the course)
- VoiceXML can be used to represent simple form-filling dialogues like this one

From course reading: Jokinen & McTear 2.1, p. 25

FIGURE 2.1: A dialogue graph.
Comments on FSMs

- Researchers often build task-specific FSMs for their domains
- FSMs can easily get very complex
  - Combinatorial possibilities in dialogue
  - Many decisions to make on whether and how to expand an FSM to cover a new observation
- FSMs can be brittle (coverage gaps)
- Editing and maintaining FSMs can be fussy, detailed, and time-consuming
- FSMs for dialogue modeling are often expressed in terms of speech acts rather than surface texts (next week)
- Researchers often add mechanisms that can expand the expressive power of the FSMs (e.g. adding variables or programming capabilities on nodes or arcs)
FSM for greeting a user

current-user-speech-act(login)

node4

< LE(greeting-counter,1.0)>

node5

<conventional-opening.generic>

node6

<default> <internal.timer GE(timesincelastaction,12.0)> <conventional-opening.generic>

node7

node8

node9

node10

node11

node12

node2
FSM for asking a question from a questionnaire
Homework 1 discussion

• Airline flight status systems
  – Evaluation and optimization of these systems
Assignment 2 (part 1)

- See course web page
- Does everyone have access to a Windows machine?
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