

# Approaches to Dialogue Systems and Dialogue Management

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# Outline for Course

- Today: Introduction,
  - Example Systems,
  - Architecture of Dialogue Systems
  - Dialogue Structure
- Tomorrow: Simple structures: S-R, IR-based, finite State
- Wednesday: Frame-based and Information State
- Thursday: Plan-based and Logic Based
- Friday: Advanced Topics



# Outline for Today

- Basic Terms & Example Systems
- Dialogue System Components
- Dialogue Management Approaches
  - Structural
  - Principle-based
- Overview of Dialogue Structure



# NL Dialogue Overview

- Communication involving:
  - Multiple contributions,
  - Coherent Interaction
  - More than one participant
- Interaction modalities:
  - Input: Speech, typing, writing, menu, gesture
  - Output: Speech, text, graphical display/presentation, animated body



# Types of Dialogue Agents

- Information provider
- Advisor
- Service provider
- Collaborative partner
- Tutor
- Instruction-giver
- Conversational Partner
- Competitor
- Antagonist



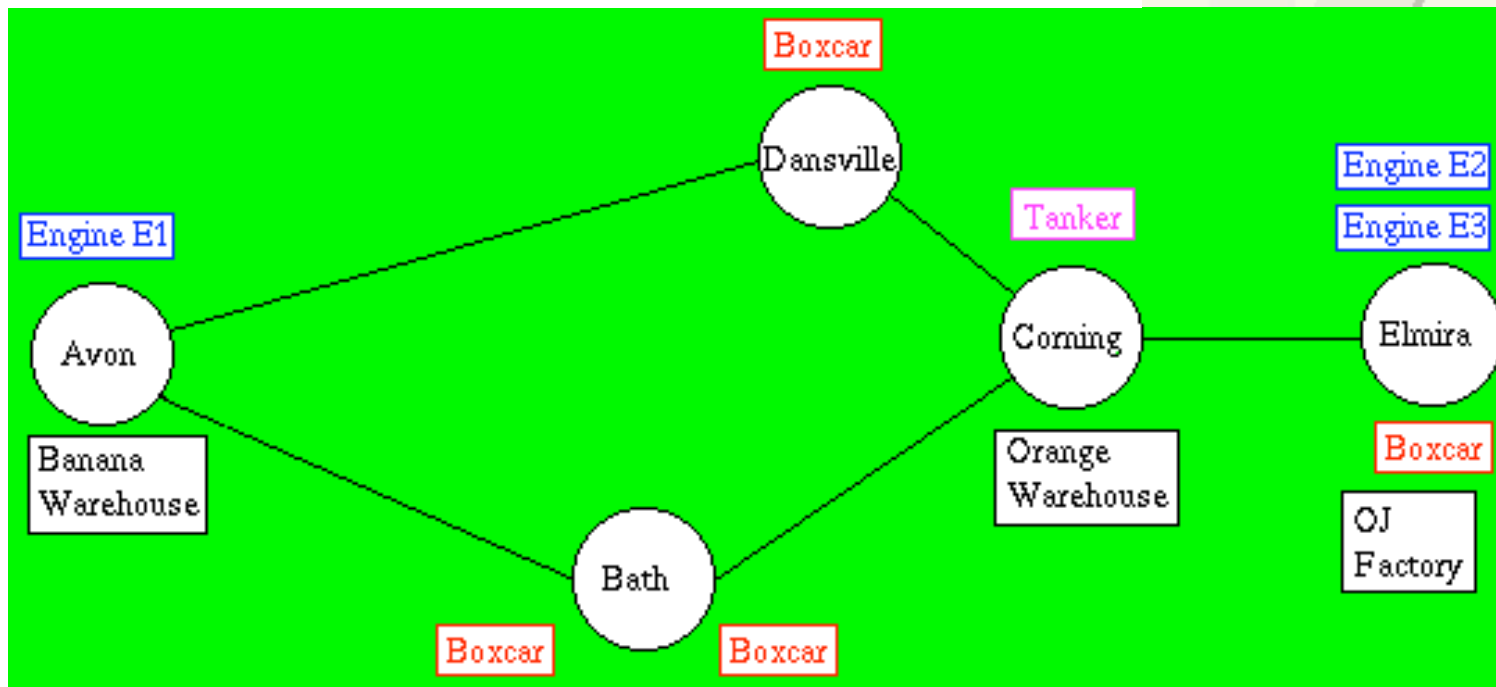
# Dialogue Systems: State of the Art

- Deployed Commercial Systems
  - Call routing/call center first contact
  - Simple information tasks
  - Voice menus
  - in car navigation
- Useful systems
  - Medium-sized tasks (communicator)
  - Command & control
  - Language tutoring
- Advanced Research Prototypes
  - Collaborative systems
  - Adaptive systems
  - Multi-modal systems
  - Immersive Training



Manager: We better ship a boxcar of oranges to Bath by eight a.m.	(1.1)
System: OK	(2.1)
Manager: So we need to get a boxcar to Corning, where there are oranges.	(3.1)
There are oranges at Corning.	(3.2)
Right?	(3.3)
System: Right	(4.1)
Manager: So we need an engine to move the boxcar.	(5.1)
Right?	(5.2)
System: Right	(6.1)
Manager: So there's an engine at Avon.	(7.1)
Right?	(7.2)
System: Right	(8.1)
Manager: So we should move the engine at Avon, engine E1, to Dansville	(9.1)
to pick up the boxcar there	(10.1)
System: Okay	(11.1)
Manager: and move it from Dansville to Corning	(11.2)
load up some oranges in the boxcar	(11.3)
and then move it on to Bath	(12.1)
System: Okay	(13.1)
Manager: How does that sound?	(14.1)
System: That's no problem	(15.1)
Manager: Good	

# Rochester: TRAINS-93



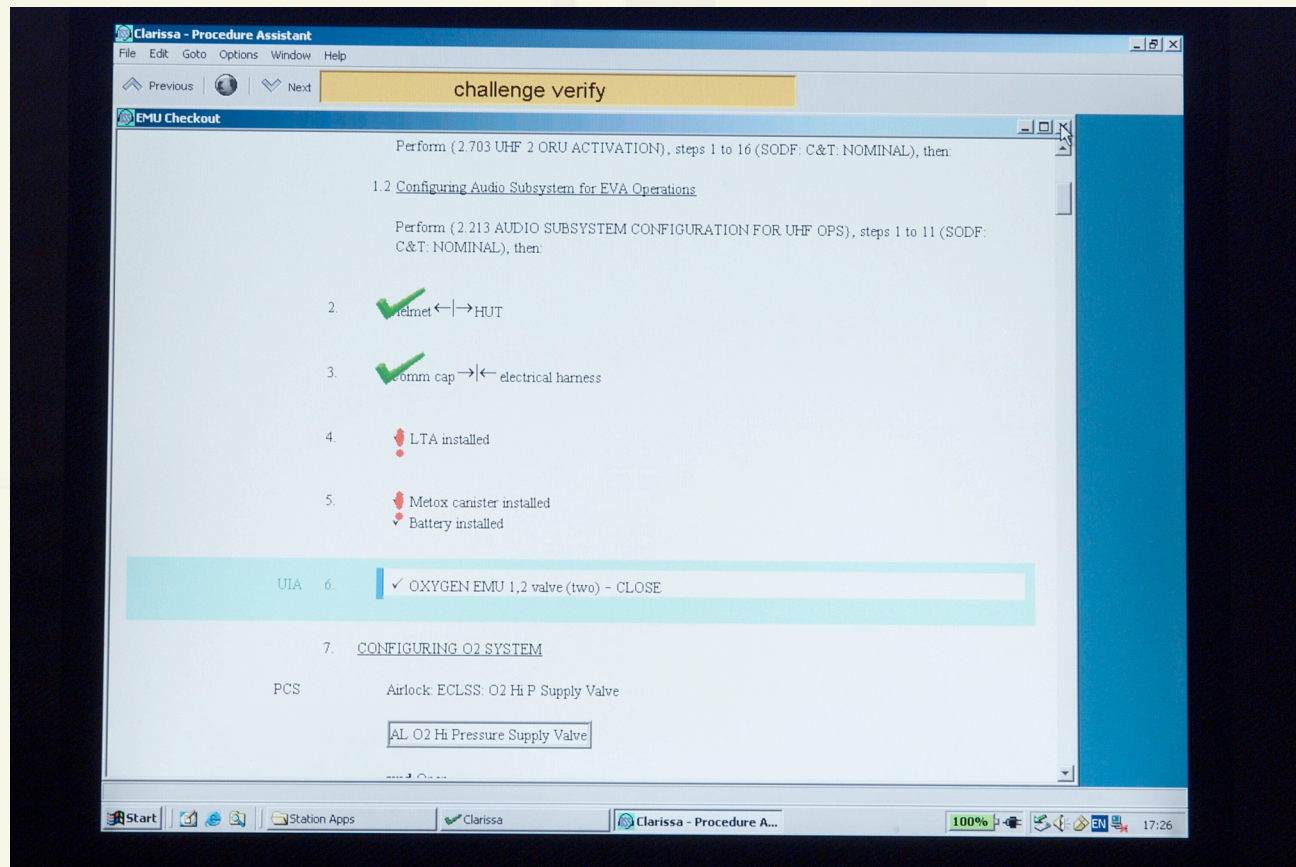
# MERL: Sample Collagen System: VCR Help



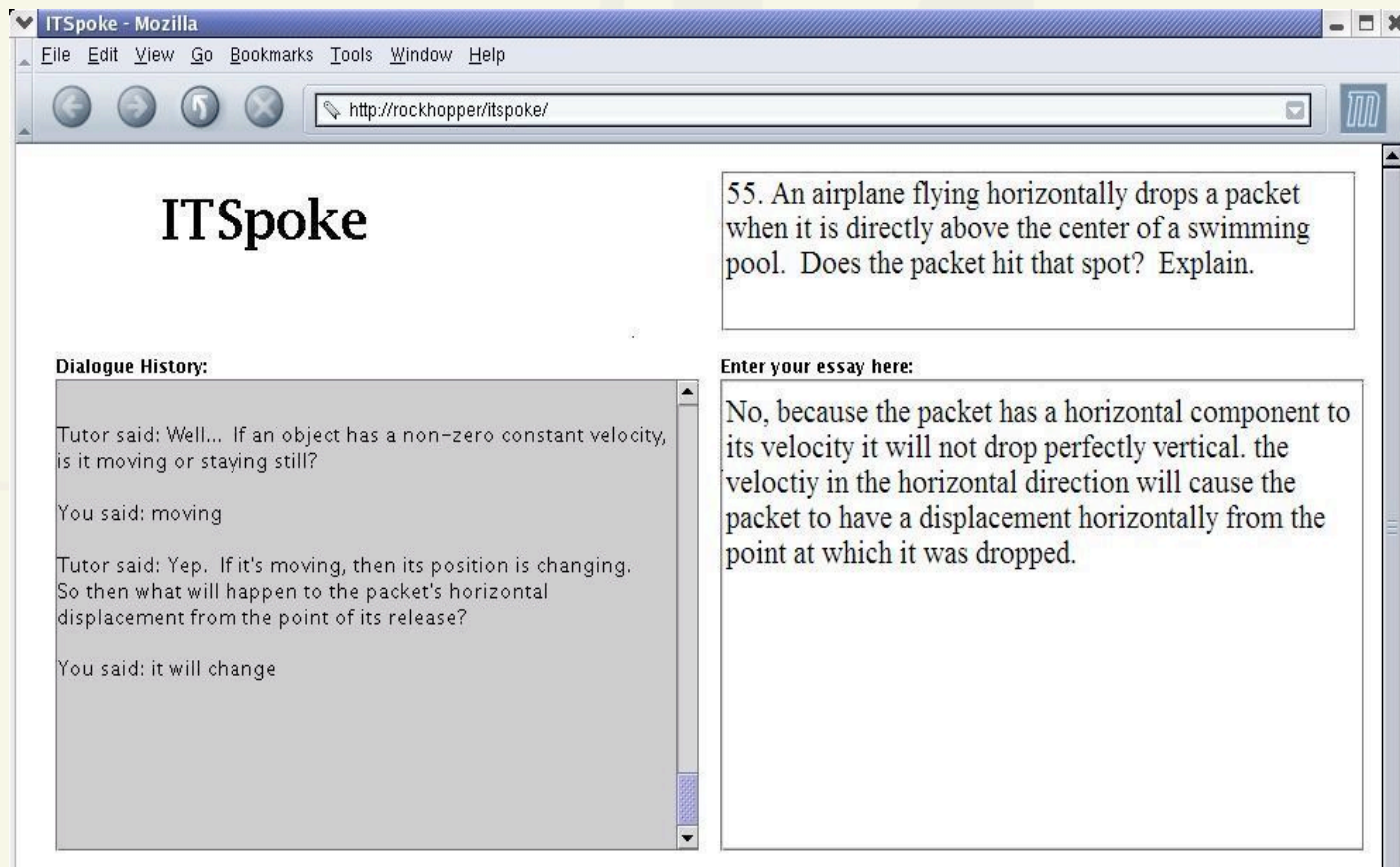
- 1 User says "Hello."
- 2 Agent says "Hello, what's your name?"
- 3 User says "Candy."
- 4 Agent says "Hello, Candy!"
- 5 User says "Let's set the clock."
- 6 Agent says "What is the time?"
- 7 User says "The time is 11:00 AM."
- 8 Agent sets the clock to 11:00 AM.
- ...
- 9 User says "How do I play back a video from my camcorder?"
- 10 Agent says "First, plug in the camcorder cables."
- 11 User says "How do I plug in the camcorder cables?"
- 12 Agent points to where you plug in the camcorder cables.
- 13 Agent says "The red cable plugs into the red terminal, the black cable plugs into the black terminal, and the yellow cable plugs into the yellow terminal. Make sure the other ends of the cables plug into the corresponding colors on the camcorder."
- 14 User says "What next?"
- 15 Agent says "Now press Play on your camcorder. You should see a picture on the TV screen."
- 16 User says "Ok."



# NASA Clarissa System



# U Pittsburgh: ITSpoke



The screenshot shows a Mozilla browser window titled "ITSpoke - Mozilla". The address bar displays "http://rockhopper/itspoke/". The main content area is titled "ITSpoke" and contains a physics problem and a dialogue history.

**ITSpoke**

55. An airplane flying horizontally drops a packet when it is directly above the center of a swimming pool. Does the packet hit that spot? Explain.

**Dialogue History:**

Tutor said: Well... If an object has a non-zero constant velocity, is it moving or staying still?

You said: moving

Tutor said: Yep. If it's moving, then its position is changing. So then what will happen to the packet's horizontal displacement from the point of its release?

You said: it will change

**Enter your essay here:**

No, because the packet has a horizontal component to its velocity it will not drop perfectly vertical. the velocity in the horizontal direction will cause the packet to have a displacement horizontally from the point at which it was dropped.

USC

# Virtual Humans @ USC/ICT

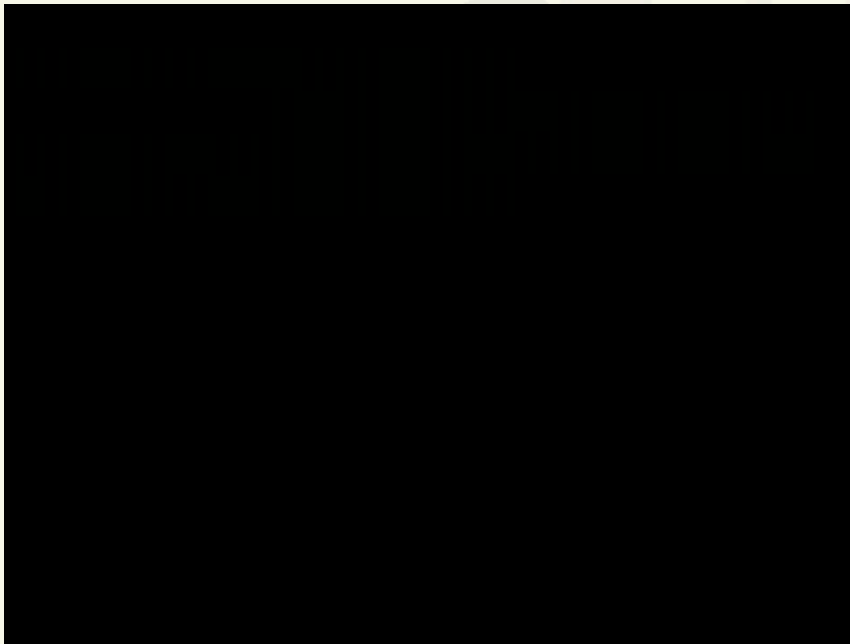
- Mission Rehearsal
- SASO-ST





# Virtual Humans @ USC/ICT

- Mission Rehearsal Exercise
- SASO-ST



# Dialogue terms

- Dialogue Modelling
  - Formal characterization of dialogue, evolving context, and possible/likely continuations
- Dialogue system
  - System that engages in a dialogue (with a user)
- Dialogue Manager
  - Module of a system concerned with dialogue modelling and decisions of how to contribute to dialogue
  - Cf speech recognizer, domain reasoner, parser, generator, tts,...

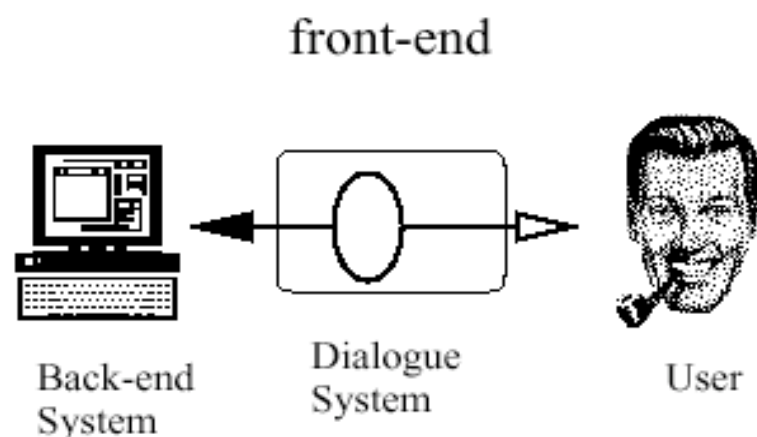


# Dialogue Management Tasks

- Maintaining & Updating Context
- Deciding what to do next
- Interface with back-end/task model
- Provide expectations for interpretation



# Two Approaches to Dialogue Systems:

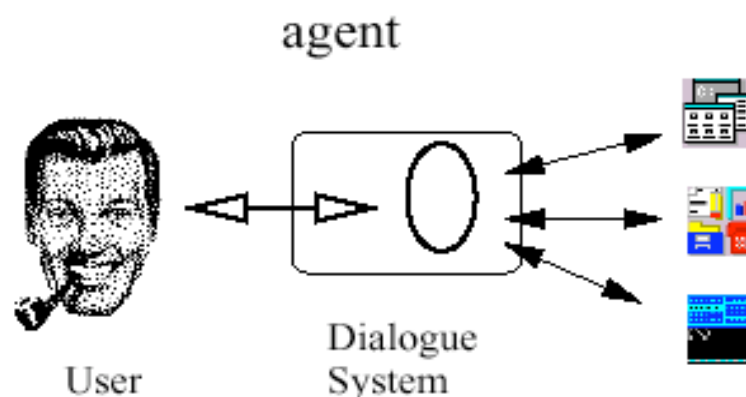


System as "translator" between user and backend system

Examples: Sundial (European Train Info), MITRE systems, MIT Galaxy

Key design question: how to provide back-end with understandable messages (in a manner natural to the user)?

Key run-time question: what messages should be sent to back-end (or generated to user)?



System as "homunculus", with access to task-specific functionality

Examples: TRAINS (Rochester), Circuit-Fixit (Duke), Artemis (France Telecom)

Key design question: how to coordinate with the user to accomplish a task?

Key run-time question: what should be done now (given context, inputs, goals)?

# Using Data

- Corpus Collection
  - Human-Human
  - Wizard of OZ
  - Human-System
- Annotation
  - Coding Scheme
  - Coding
    - Automatic
    - Tool-assisted
    - Inter-coder Reliability (Kappa)





# Evaluation

- Objective Metrics
  - Task success
  - Resources used (time, turns, attention,...)
- Subjective Evaluation
- Issues
  - On-line vs off-line
  - Black Box vs. Glass Box
  - Class of User (Expert, Novice)
  - Feedback into system design



# SDS Components

- Architecture
- Back-end/Domain Reasoners
- Input Interface (Audio, Keyboard, etc)
- Interpretation (internal representation)
- Dialogue Management
- Generation
- Output Interface



# Dialogue Manager Architectures

- Integrated (tree-based)
- Finite-state
- Frame-based
- Plan-based
- Agent-based (BDI)



# Interpretation: Speech Recognition

- Phases
  - Signal Processing
  - Acoustic Model, tri-phones
  - Language Model (N-grams)
- Issues
  - Small or large vocabulary
  - N-gram or grammar-based language model
  - Integrated or pipelined understanding
  - Output (concepts, n-best word list, lattice)
  - Unified or State-specific recognizers



# Interpretation: Parsing/Semantic Representation

- Tasks
  - Retrieval/Classification
  - Understanding/Extraction
- Output
  - Response
  - (aspects of) Meaning (e.g., semantic roles, speech acts, parse)
- Styles
  - Key-word
  - Language model
  - Grammar-based
  - Concept-based (semantic parser)
  - Expectation-driven
- Spoken Dialogue vs. Written text
  - Utterance length, grammaticality, interactivity, repairability, transience, ...



# Generation & Synthesis

- Generation
  - Output
    - Text
    - Prosodic cues
    - multimodal generation
  - Method
    - Grammar-based
    - Statistical Language model
    - Template-based
    - Fixed
- Synthesis
  - Voice Clip, or TTS
  - TTS or Concept to Speech



# Dialogue Management Tasks

- Updating Context
- Deciding what to do next
- Interface with back-end/task model
- Provide expectations for interpretation



# Dialogue Manager Organizing Principles

- Structure-based
  - Script
  - Local
    - Exchange
    - Word-based
      - Keyword spotting
      - Advanced techniques
        - » AIML recursion
        - » Statistical Language model
    - Meaning-based
      - Speech acts
  - Grammar
  - Tree/FSM
- Principle-based
  - Frame
  - Logic
  - Plan
  - Information-State





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