Speech Recognition and Coversational Interfaces

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(content adapted from Jim Glass)
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The Space of Recognition

	Domain	
Speaker	Dependent	Independent
Dependent	not interesting	Transcription (training)
Independent	We are here	Ultimate Goal (requires knowledge)

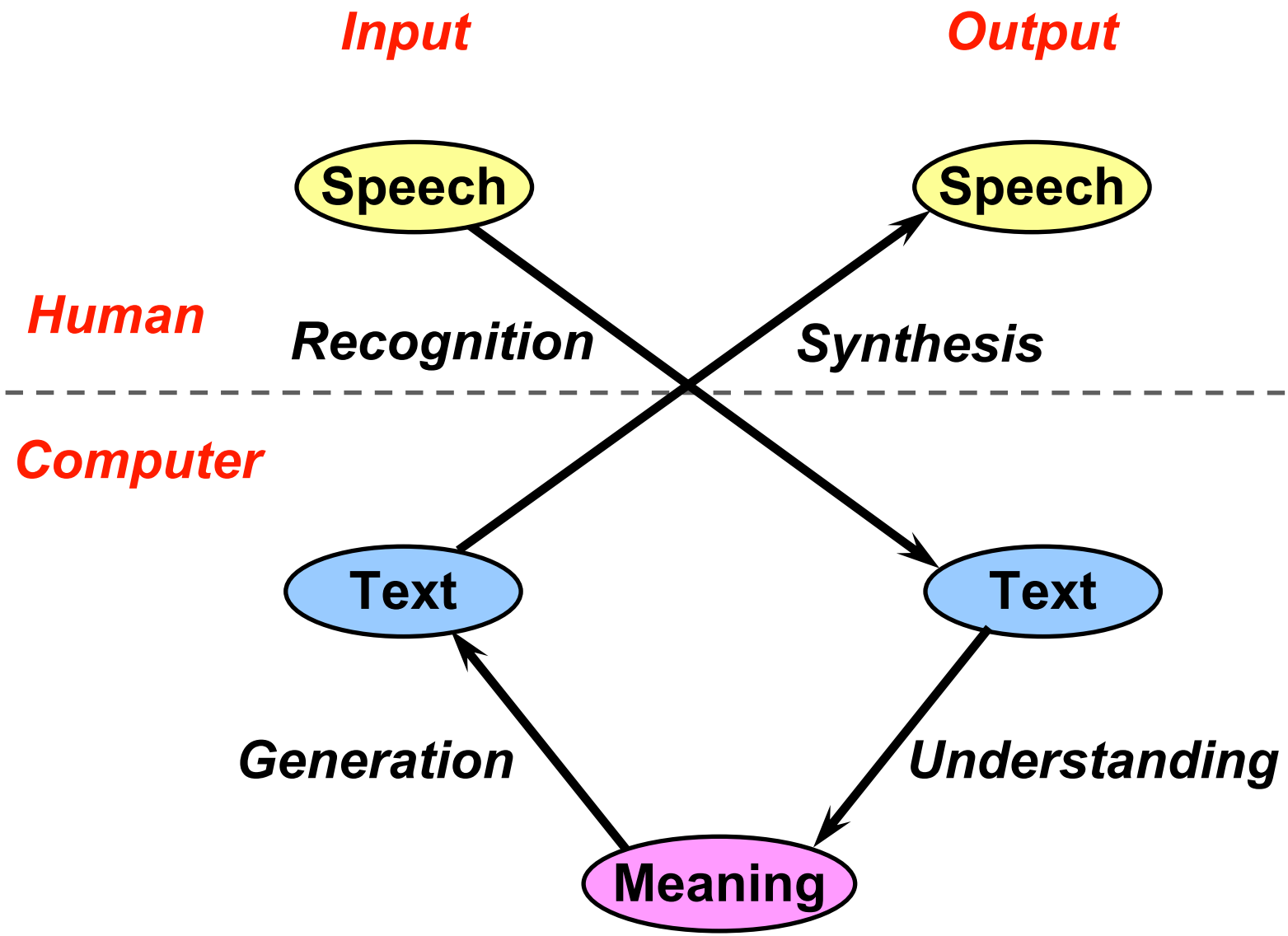
The Space of Recognition

- Speaker dependent
  - First train the system to recognize your speaking
  - Better recognition rates -- can learn idiosynchroses
- Domain dependent:
  - Only recognize what is in the domain
    - Better recognition rates
  - Domain can be large. How is it specified?

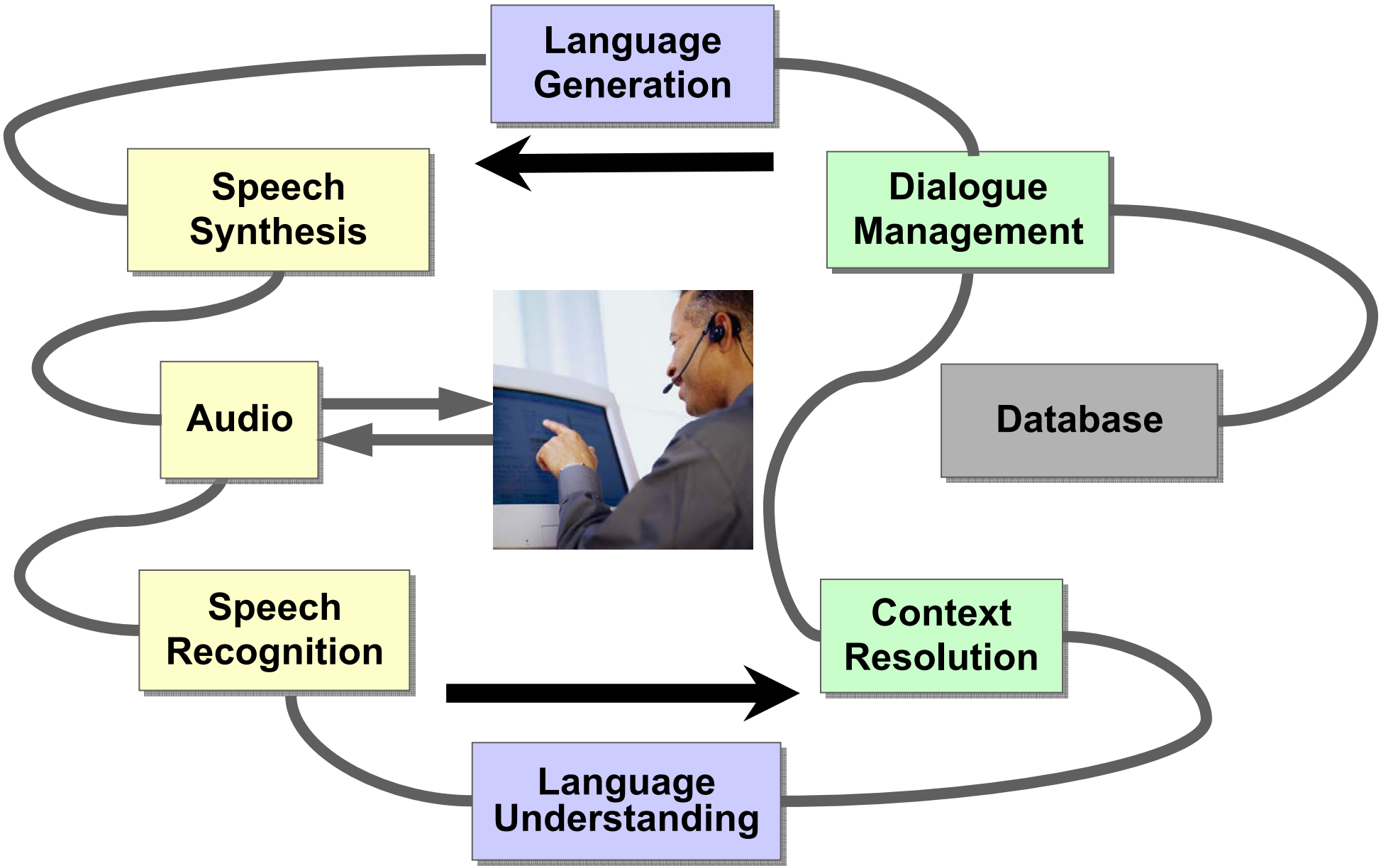
Why Speech?

- No special training -- naive users(?)
- Leaves hands and eyes free -- but must know when to start recognition
- High data rate -- assuming low errors
- Inexpensive I/O -- microphone, speaker, button
  - speaker needed for feedback
- Some things are easier to specify with speech

Communication via Spoken Language



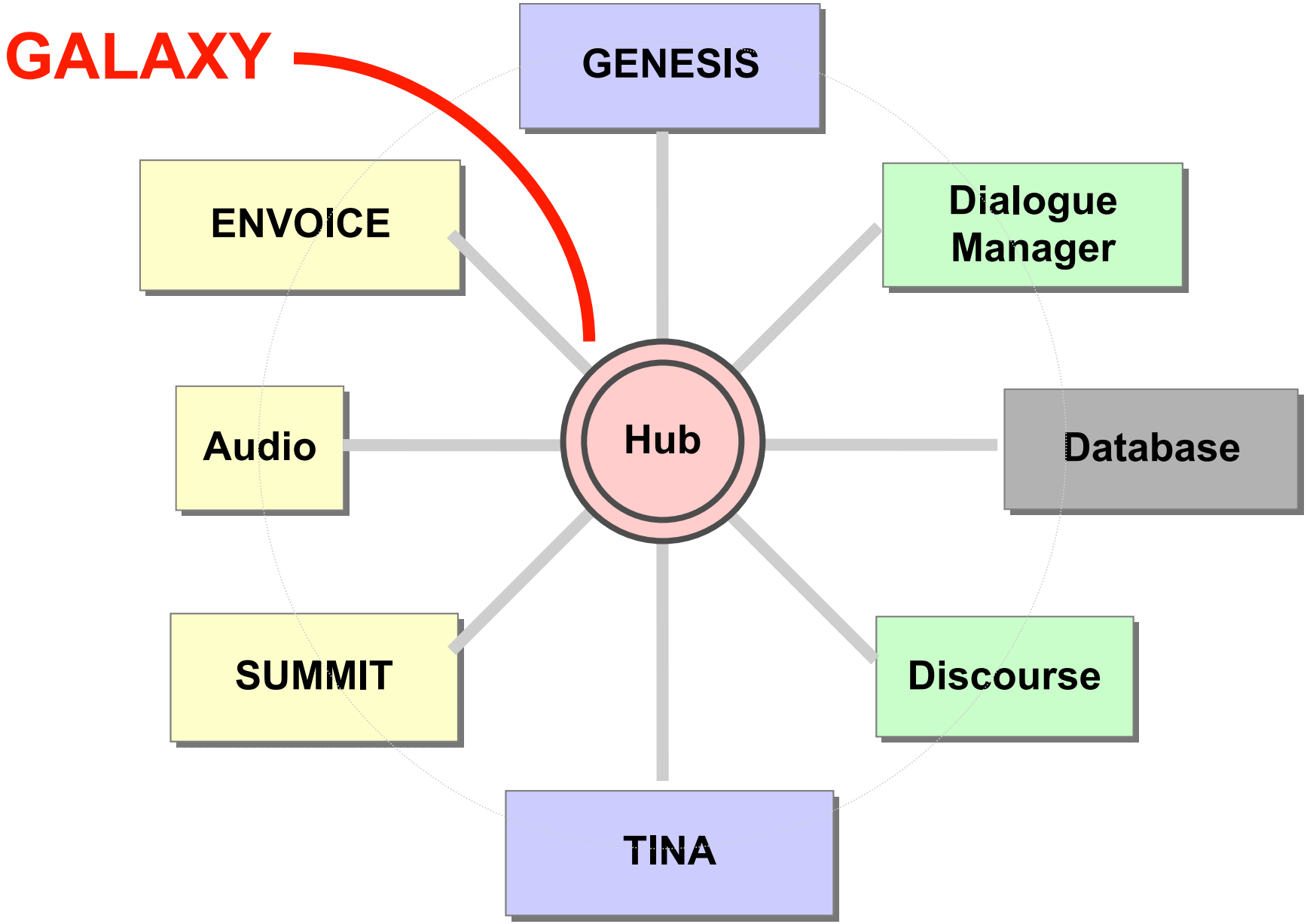
Components of Conversational Systems



Galaxy -- MIT SLS group

- SLS: Spoken Language Systems
- We will be making use of some of there technology
  - There are similar components developed by other groups (and some are public domain).
- The Galaxy System is organized around this cycle for conversational interfaces

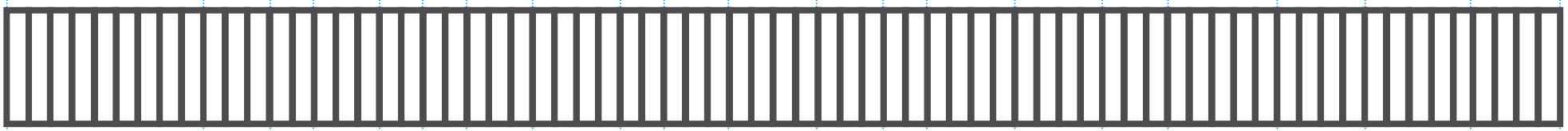
Components of MIT Conversational Systems



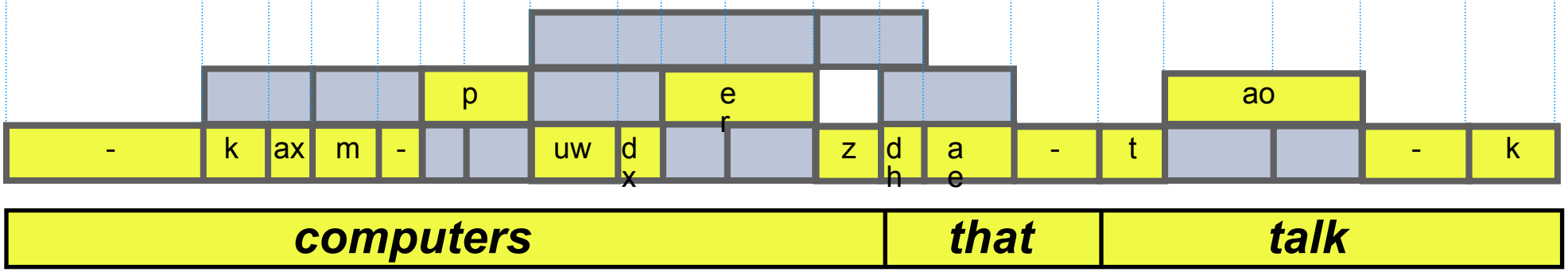
Segment-Based Speech Recognition

Waveform

Frame-based measurements (every 5ms)

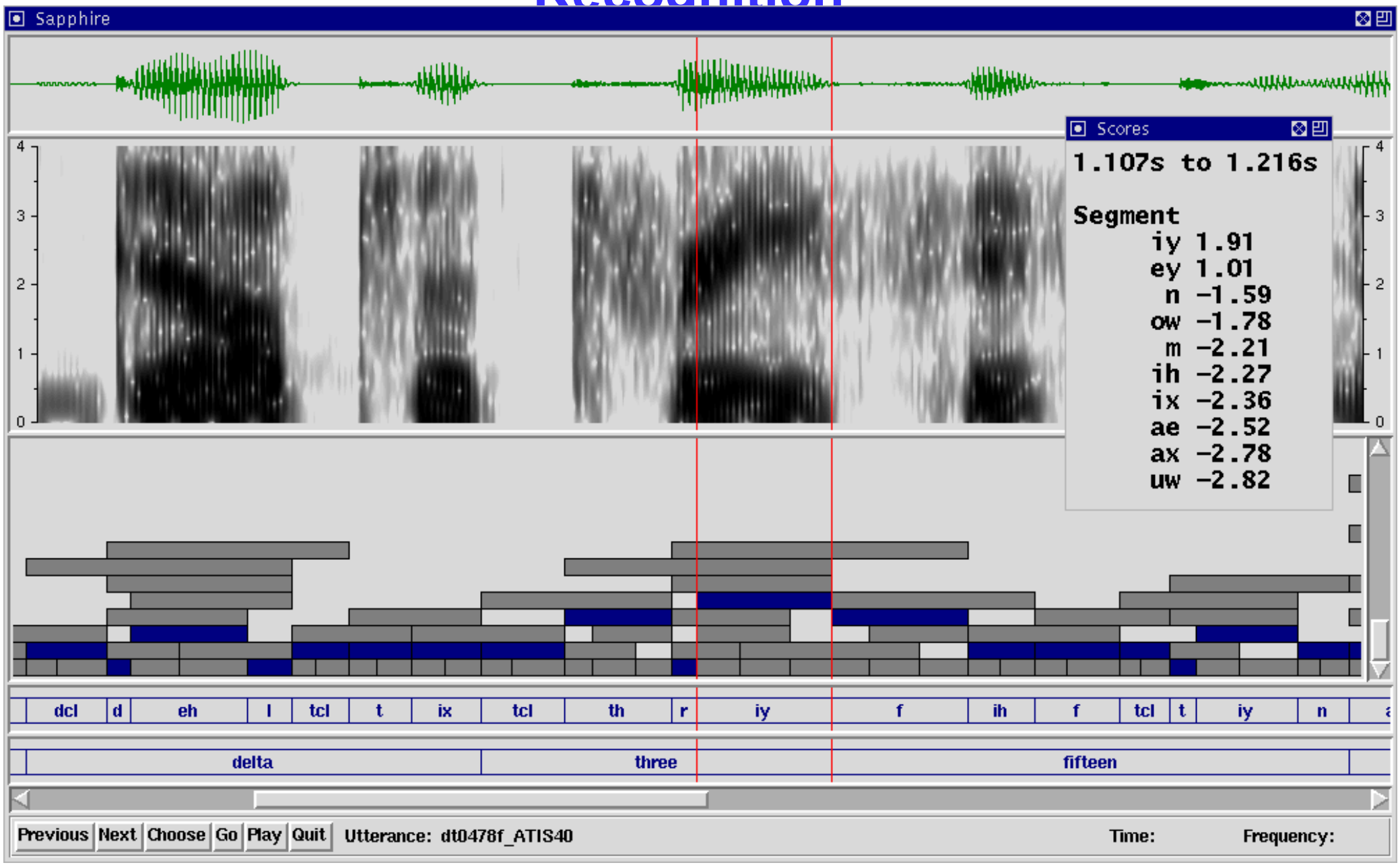


Segment network created by interconnecting spectral landmarks

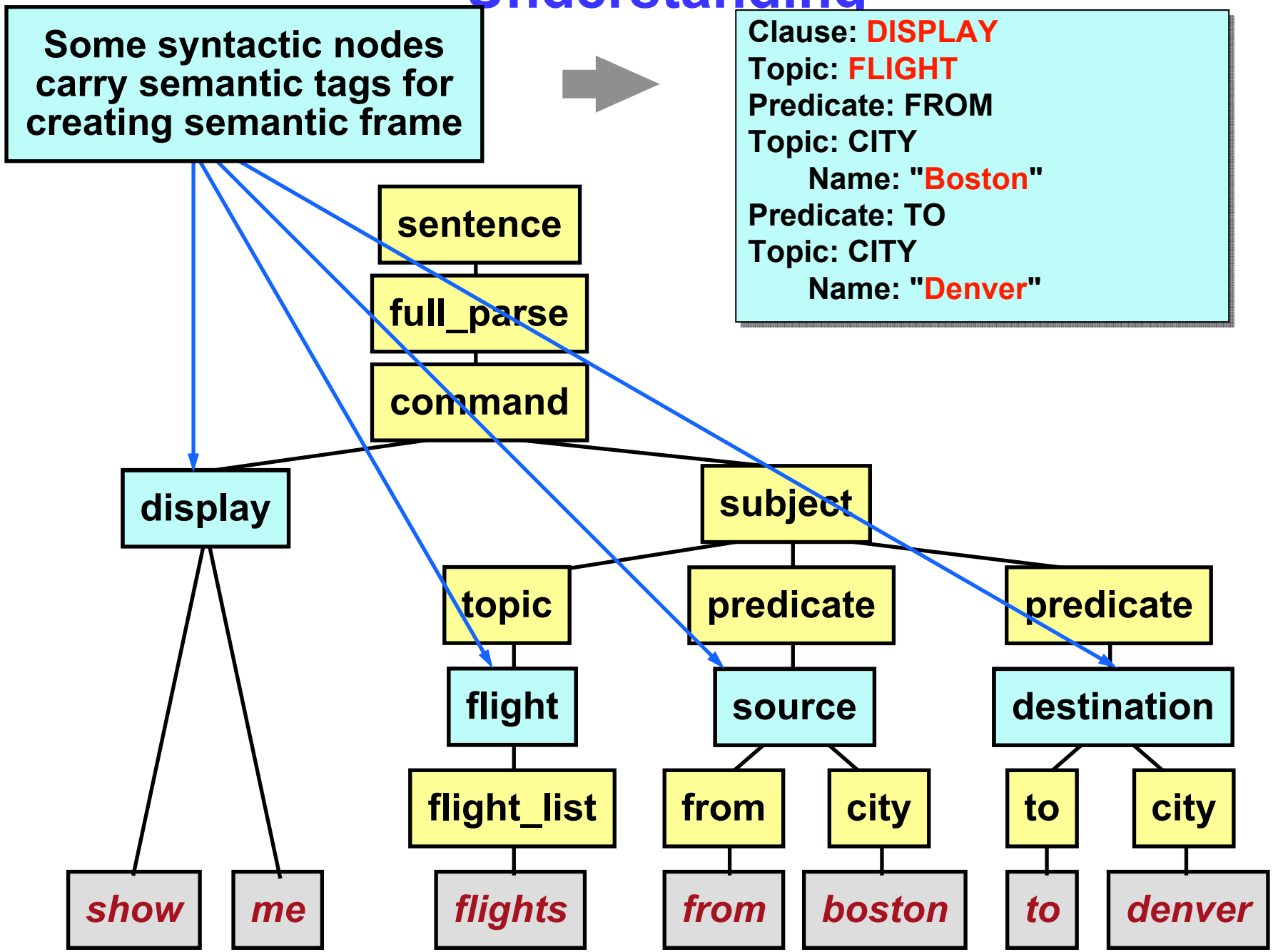


Probabilistic search finds most likely phone & word strings

Segment-Based Speech Recognition

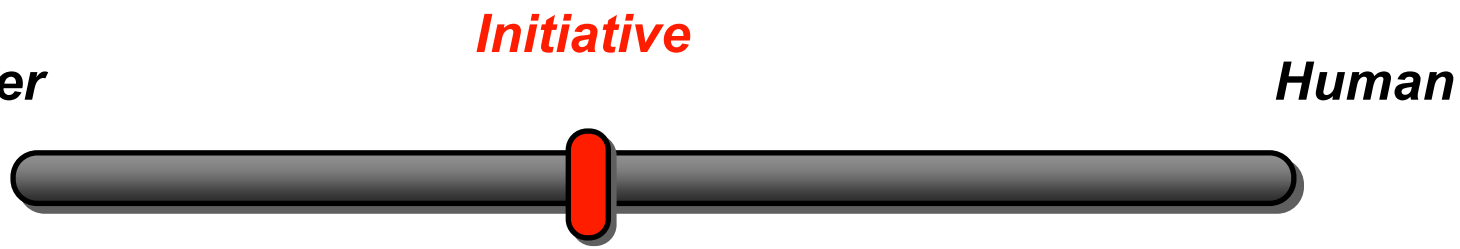


Natural Language Understanding



Dialogue Modeling Strategies

- **Effective conversational interface must incorporate extensive and complex dialogue modeling**
- **Conversational systems differ in the degree with which human or computer takes the initiative**



- **Computer maintains tight control**
- **Human is highly restricted**

C: *Please say the departure city.*

- **Human takes complete control**
- **Computer is totally passive**

H: *I want to visit my grandmother.*

- **The Galaxy System use a *mixed initiative* approach, where both the human & the computer play an active role**

Different Roles of Dialogue Management

- **Pre-Retrieval: Ambiguous Input => Unique Query to DB**

U: I need a flight from Boston to San Francisco
C: Did you say Boston or Austin?
U: Boston, Massachusetts
C: I need a date before I can access Travelocity
U: Tomorrow
C: Hold on while I retrieve the flights for you

Clarification (recognition errors)

Clarification (insufficient info)

- **Post-Retrieval: Multiple DB Retrievals => Unique Response**

C: I have found 10 flights meeting your specification. When would you like to leave?
U: In the morning.
C: Do you have a preferred airline?
U: United
C: I found two non-stop United flights leaving in the morning…

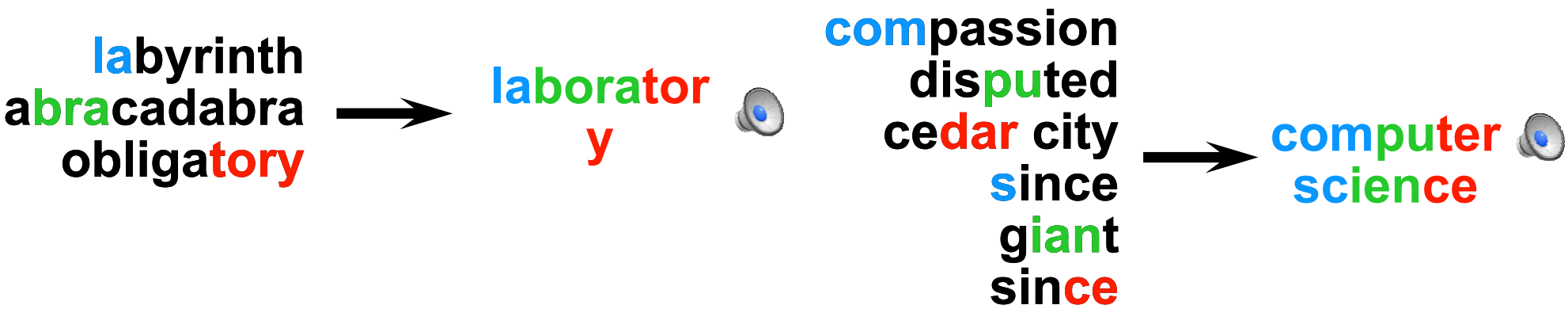
Help the user narrow down the choices

Concatenative Speech Synthesis

- Output waveform generated by concatenating segments of pre-recorded speech corpus.
- Concatenation at phrase, word or sub-word level.

Synthesis Examples

The third ad is a 1996 black Acura Integra with 45380 miles.
The price is 8970 dollars. Please call (404) 399-7682.

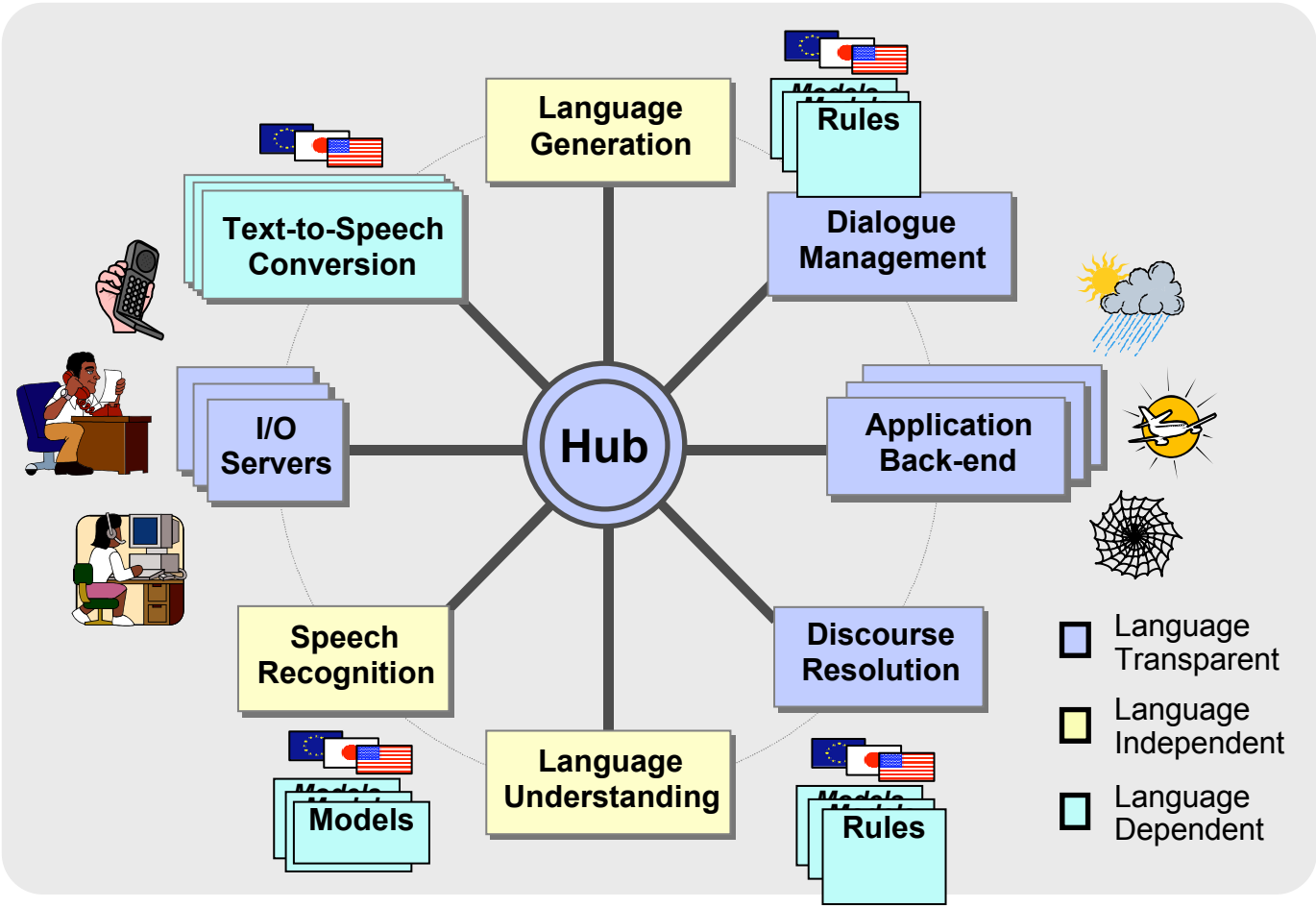


Continental flight 4695 from Greensboro is expected in Halifax at 10:08 pm local time.

Multilingual Conversational Interfaces

- Adopts an *interlingua* approach for multilingual human-machine interactions

- **Applications:**
  - MuXing: Mandarin system for weather information
  - Mokusei: Japanese system for weather information
  - Spanish systems are also under development
  - New speech-to-speech translation work (Phrasebook)

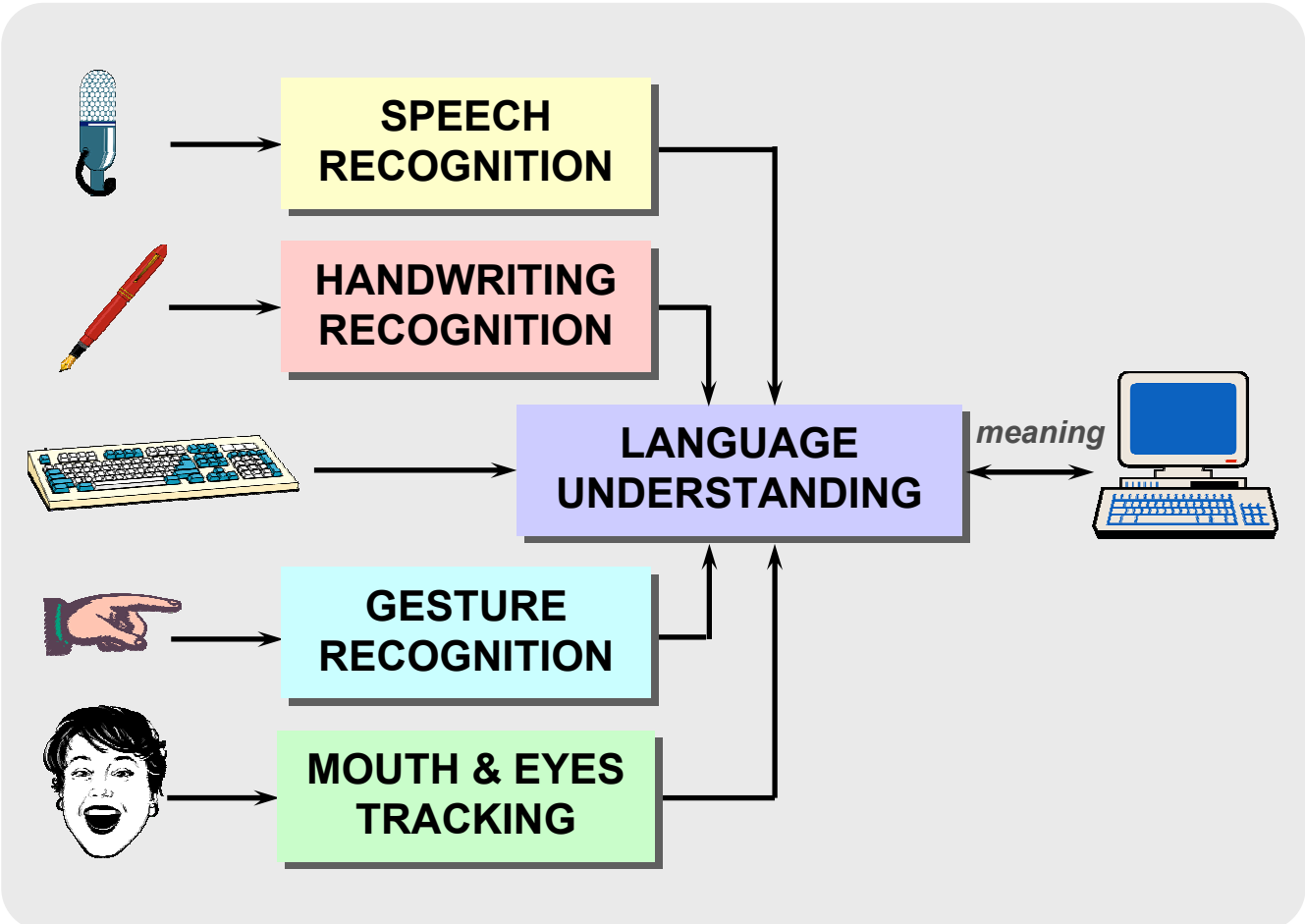


Bilingual Jupiter Demonstration

Multi-modal Conversational Interfaces

- Typing, pointing, clicking can augment/complement speech
- A picture (or a map) is worth a thousand words

- **Applications:**
  - WebGalaxy
  - Allows typing and clicking
  - Includes map-based navigation
  - With display
  - Embedded in a web browser
  - Current exhibit at MIT Museum



WebGalaxy Demonstration

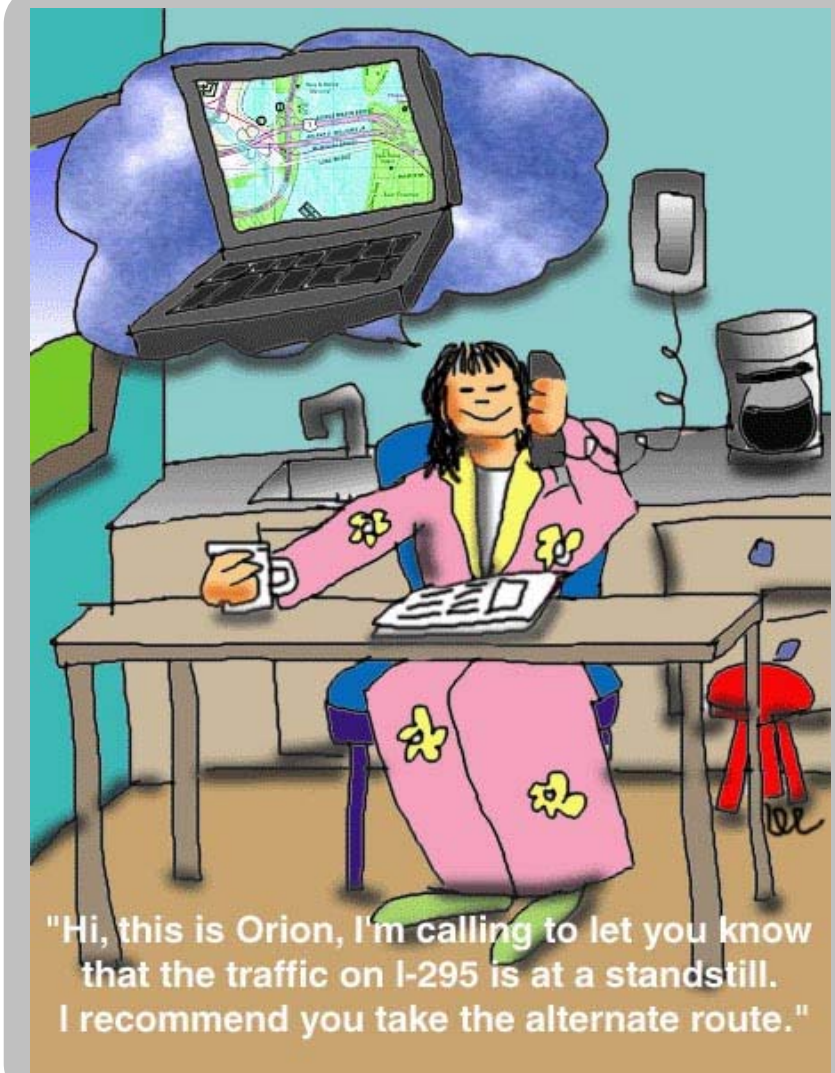
Delegating Tasks to Computers

- **Many information related activities can be done off line**
- **Off-line delegation frees the user to attend to other matters**

- **Application: Orion system**
  - Task Specification: User interacts with Orion to specify a task

    "Call me every morning at 6 and tell me the weather in Boston."

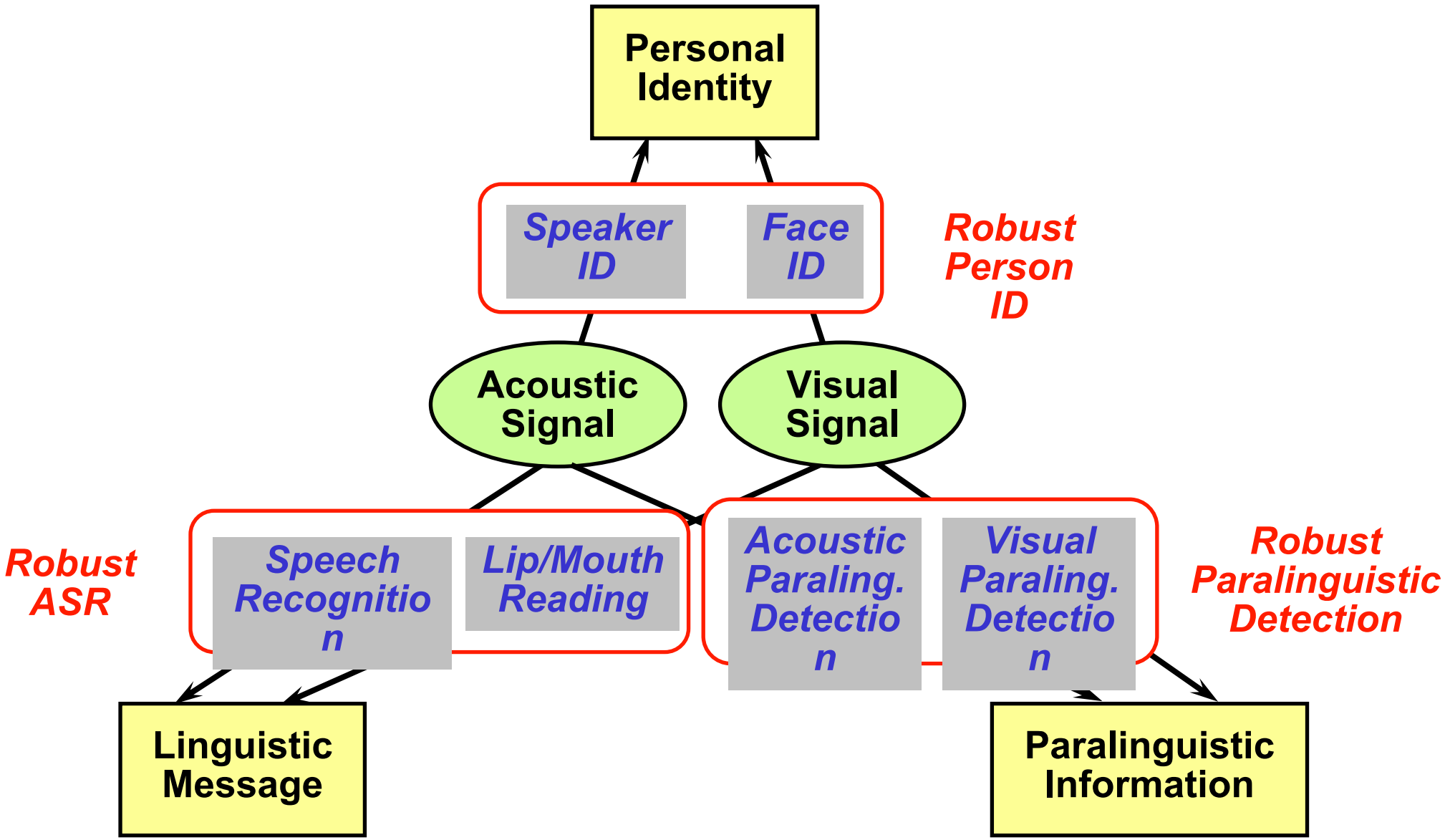
    "Send me e-mail any time between 4 and 6 p.m. if the traffic on Route 93 is at a standstill."
  - Task Execution: Orion leverages existing infrastructure to support interaction with humans
  - Event Notification: Orion calls back to deliver information



Audio Visual Integration

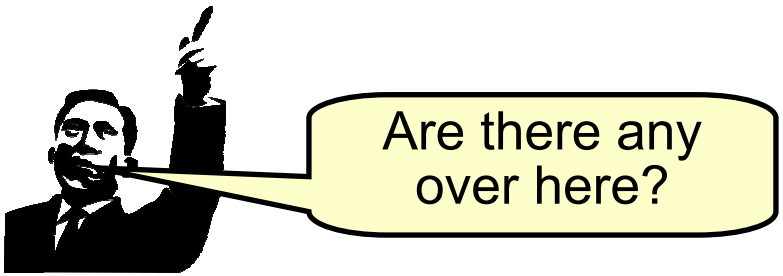
- **Audio and visual signals both contain information about:**
  - Identity of the person: *Who is talking?*
  - Linguistic message: *What's (s)he saying?*
  - Emotion, mood, stress, etc.: *How does (s)he feel?*
- **The two channels of information**
  - Are often inter-related
  - Are often complementary
  - Must be consistent
- **Integration of these cues can lead to enhanced capabilities for future human computer interfaces**

Audio Visual Symbiosis



Multi-modal Interfaces: Beyond Clicking

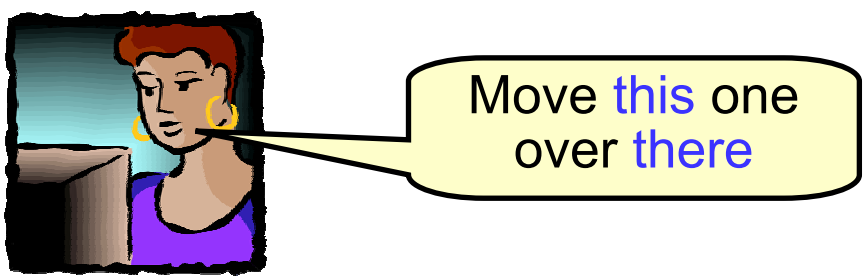
- **Inputs need to be understood in the proper context**



What does he mean by “any,” and what is he pointing at?

Does this mean “yes,” “one,” or something else?

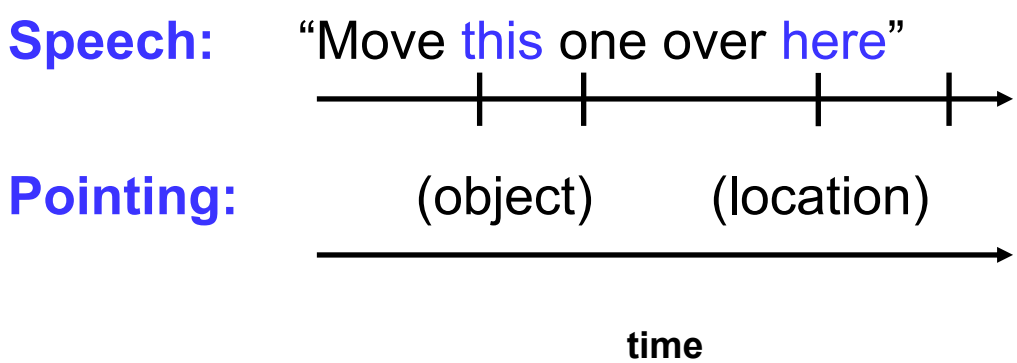
- **Timing information is a useful way to relate inputs**



Where is she looking or pointing at while saying “this” and “there”?

Multi-modal Fusion: Initial Progress

- **All multi-modal inputs are synchronized**
  - Speech recognizer generates absolute times for words
  - Mouse and gesture movements generate {x,y,t} triples
  - Network Time Protocol (NTP) is used for msec time resolution
- **Speech understanding constrains gesture interpretation**
  - Initial work identifies an object or a location from gesture inputs
  - Speech constrains what, when, and how items are resolved
  - Object resolution also depends on information from application



Multi-modal Demonstration

- **Manipulating planets in a solar-system application**
- **Created w. SpeechBuilder utility with small changes**
- **Gestures from vision (Darrell & Demirdjien)**

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