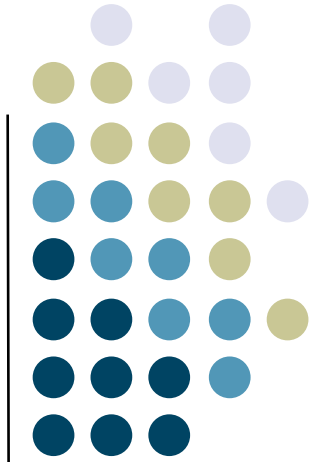
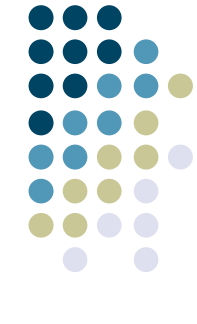
Speech-Based Interaction



Georgia Tech

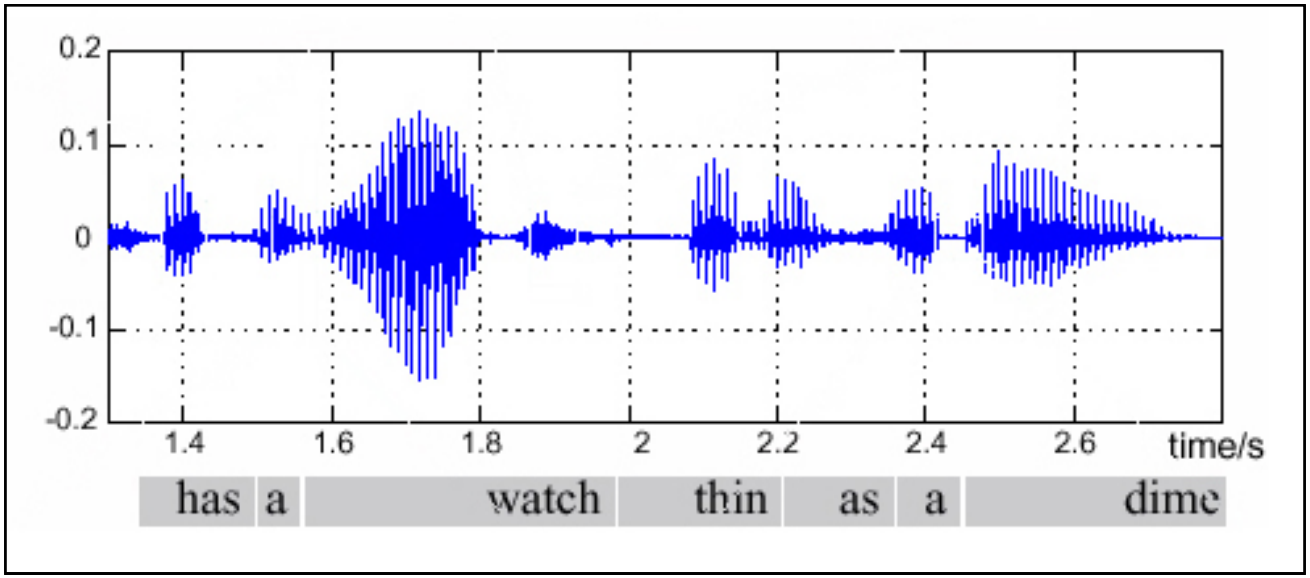
Using Speech as a "Natural" Data Type



- Speech as Input
  - Chief decision: Recognition versus Raw Data
  - Recognition
    - Translate into other information (words)
    - Must deal with errors
    - Useful for either human *or* machine consumption of results
  - Raw Data
    - For use "as data" (not commands) for human consumption
    - Often linked with other context (time) in capture applications
- Speech as Output
  - Main issues: length of presentation time, lack of persistence, etc.

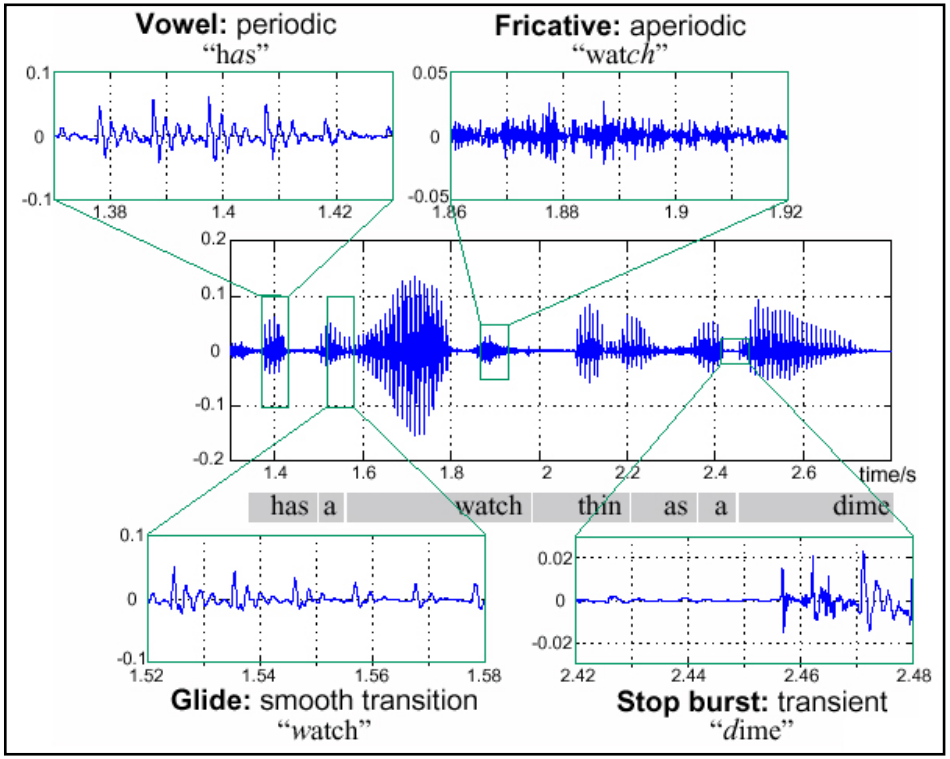
Issues in Speech as Input

- Perfect recognition of speech (or semantic understanding of any kind of audio) is difficult to achieve



- Challenge: How would you begin?
  - Segmentation
  - Syntax

Interesting features in speech



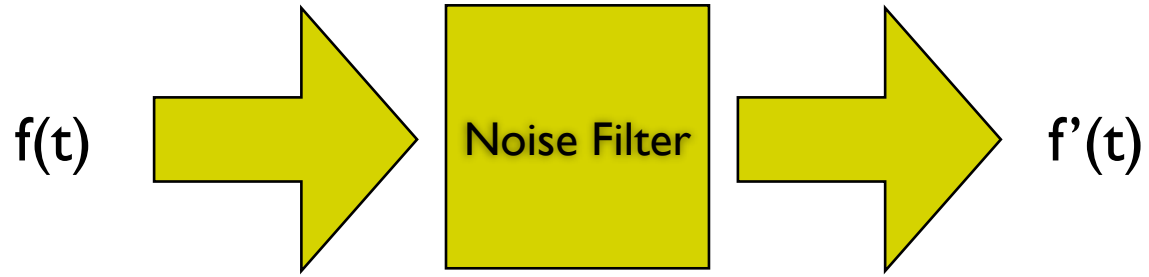
- Pauses between phrases as well…

Issues

- Use of open air microphones & speakers can result in undesired audio
  - ambient noise
  - audio feedback

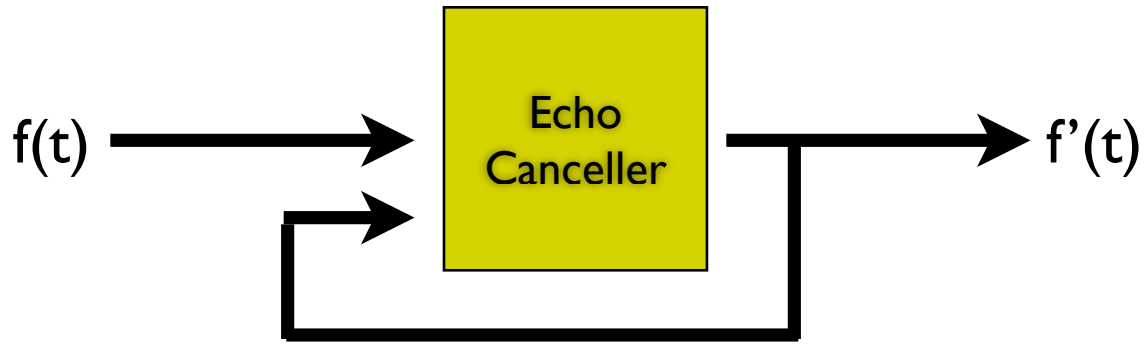
- Challenge: allow developers to easily add/use functions in their applications
  - Noise reduction
  - Enhance audio quality
  - Echo cancellation

Noise Reduction



- Random noise is hard to predict

Echo Cancellation



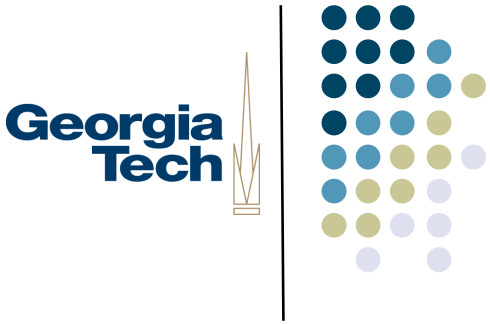
- Software and hardware exist, but are hard for developers to easily add to application
- Random noise is hard to predict, but echoes are not so random...

More Issues

- It is still difficult to:
  - grab
  - chunk (segment)
  - store
  - search/index/grep
  - playback (think about the pain of automated phone menus...)

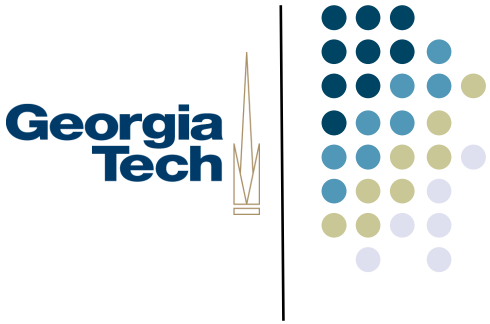
- Challenge: provide support for handling audio in manner similar to text

Most Straightforward Speech Interface



- Voice menu systems
- System speaks list of possibilities then waits for you to select one
  - Minor improvement: you can jump in whenever you hear the item you want
- Why are these so painful?

Most Straightforward Speech Interface



- Voice menu systems
- System speaks list of possibilities then waits for you to select one
  - Minor improvement: you can jump in whenever you hear the item you want
- Why are these so painful?
  - Hierarchy -- very wide and deep makes for a big search space
  - Often no easy way to jump around in the tree
  - "Where you are" matters, but there's no way to know "where you are" other than just hearing the menu again
  - Presentation time -- reading of long lists of options
- There are good points:
  - You know what you can do at any given time
- Triumph of ease of implementation over imagination

Audio Features

- Think of as "degrees of freedom" of speech as an input device

- Pauses
  - Analogy to mouse up/down/drag?
- Who is speaking?
  - Turn-taking
- How is someone speaking?
  - Prosody, afffect
- What is being said?
  - Recognition of words

Case Study: Speech Acts

- Big idea: move away from voice as a replacement for menus (easy to implement but painful to use), toward more conversational interfaces
  - "Designing SpeechActs: Issues in Speech User Interfaces," Yankelovich, Levow, Marx, CHI'95
- Mail:

```
SpeechActs:   You have 14 new messages and 47 old
      messages. The first new message is from
      Eric Baatz regarding "report completed."
   User:   Let me hear it.
   SpeechActs:   "The first draft is ready for your comments.
      Eric."
   User:   Reply and include the current message.
   SpeechActs:   Preparing message to Eric Baatz. Begin
      recording after the tone. When finished,
      pause for several seconds.
   User:   Eric, I'll get those to you this afternoon.
   SpeechActs:   Say cancel, send, or review.
   User:   Send.
   SpeechActs:   Message sent. What now?
   User:   Next message.
   SpeechActs:   New message two from Stuart Adams,
      subject "Can we meet at 3:00 today?"
   User:   Switch to calendar...
```

- Other commands:

```
What do I have tomorrow?
   What about Bob?
   What did he have last Wednesday?
   And next Thursday?
   What was Paul doing three days after Labor Day?
What's the weather in Seattle?
    How about Texas?
    I'd like the extended forecast for Boston.
```

Speech Acts

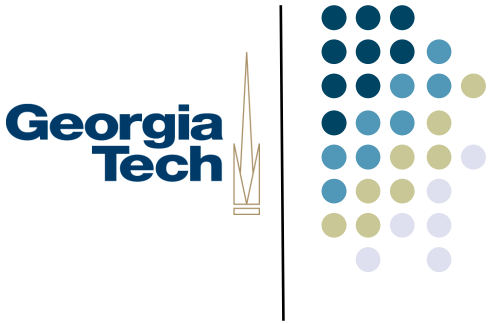
- How is this an improvement over voice menu systems?
  - No formal hierarchy -- so no need for commands to navigate it
  - "Where you are" doesn't matter so much, so no need to fret over how to present it
  - Presentation time -- minimizes output from the system, focusing on *content* rather than *commands* or *context*
  - Conversational -- takes advantage of implicit contextual cues in the workflow, mimicking the way human conversation works
- Bad points?
  - You may not know what you have to say in order to control the system (not as explicit as in menus)

Speech Acts Design Challenges

- Simulating Conversation
  - Avoid prompting wherever possible
  - Build context around subdialogs
  - Output prosodics: system asks "huh?"
  - Pacing: people often have to speak more slowly when talking to machines; need a way to "barge in" to machine output
- Transforming GUIs into SUIs
  - Vocabulary: need wide, domain-dependent vocabulary
  - Information organization: how to present content like email messages, flags, message numbers, etc., with consistency and w/o overwhelming the user
  - Information flow: speech "dialog boxes" (force users into a small set of choices) don't fit well into conversational style (Users ignore or may produce unexpected answers: "Do you have the time?" not always answered by yes/no)

Good Information Flow

Speech Acts Design Challenges (cont'd)



- Recognition errors
  - Rejection errors (utterance not recognized) are frustrating. Can yield "brick wall" of "I don't understand" messages. Solution: provide progressive assistance
  - Substitution errors are damaging. Don't want to verify every utterance. Approach: commands that present data are verified implicitly; commands that destroy data or are undoable are verified explicitly
  - Insertion errors (background audio picked up as commands or data). Solution: key to turn off recognizer
- The Nature of Speech
  - Lack of visual feedback. Users feel less in control; users can be faced with silence if they don't do anything; long pauses in conversations are uncomfortable so users may feel a need to respond quickly; less information transmitted to hte user at one time
  - Speed and persistence: although speech is easy for humans to produce it is hard to consume. Also not persistent: easy to forget, no on-screen reminder.

Speech Acts Summary

- SpeechActs shows the challenges in doing speech "right" (as opposed to just voice menus)
  - Speech as input
  - Speech as output
  - Real recognition
- Other systems that address the same set of challenges:
    - Voice Notes (MIT): speech as data, plus input and output
- There are other uses of speech that don't involve so much hard (recognition and design) work though
  - Case studies:
    - Suede (Berkeley): faking "working" speech for UI design
    - Personal audio loop (GT): uninterpreted audio UI for human consumption
    - Family Intercom (GT): uninterpreted audio UI for human consumption

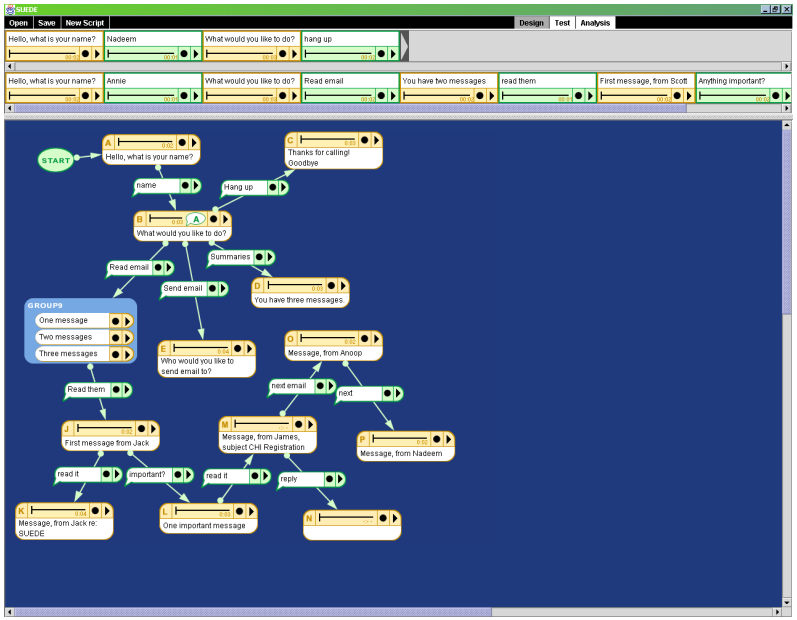
A few more research case studies

- Speech Acts is an example of a "high end" speech-oriented interface
  - Speech input, speech output, highly dependent on machine recognition
- Other uses of speech rely less on recognition
  - Suede: an environment for prototyping speech based interfaces, relying on humans for recognition during prototype and evaluation
  - Personal Audio Loop: machine storage and processing of audio, but no recognition
  - Family Intercom: no machine processing (other than transmission) at all: audio intended for human-human communication at a distance

- Note analogs to pen-based computing:
  - Many ways to use digital ink that don't necessarily rely on recognition

Case Study: Suede

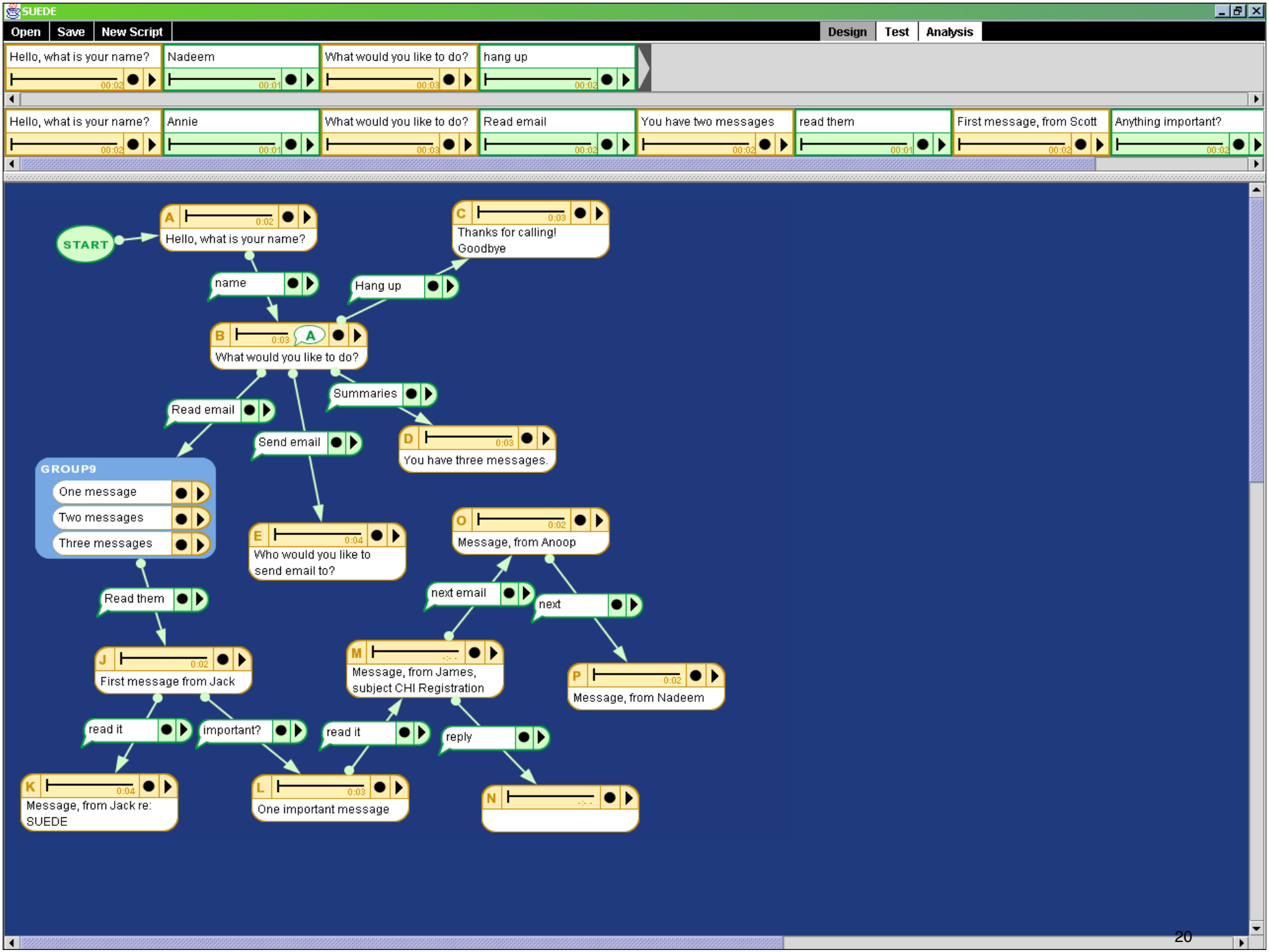
- Toolkit for prototyping speech interface

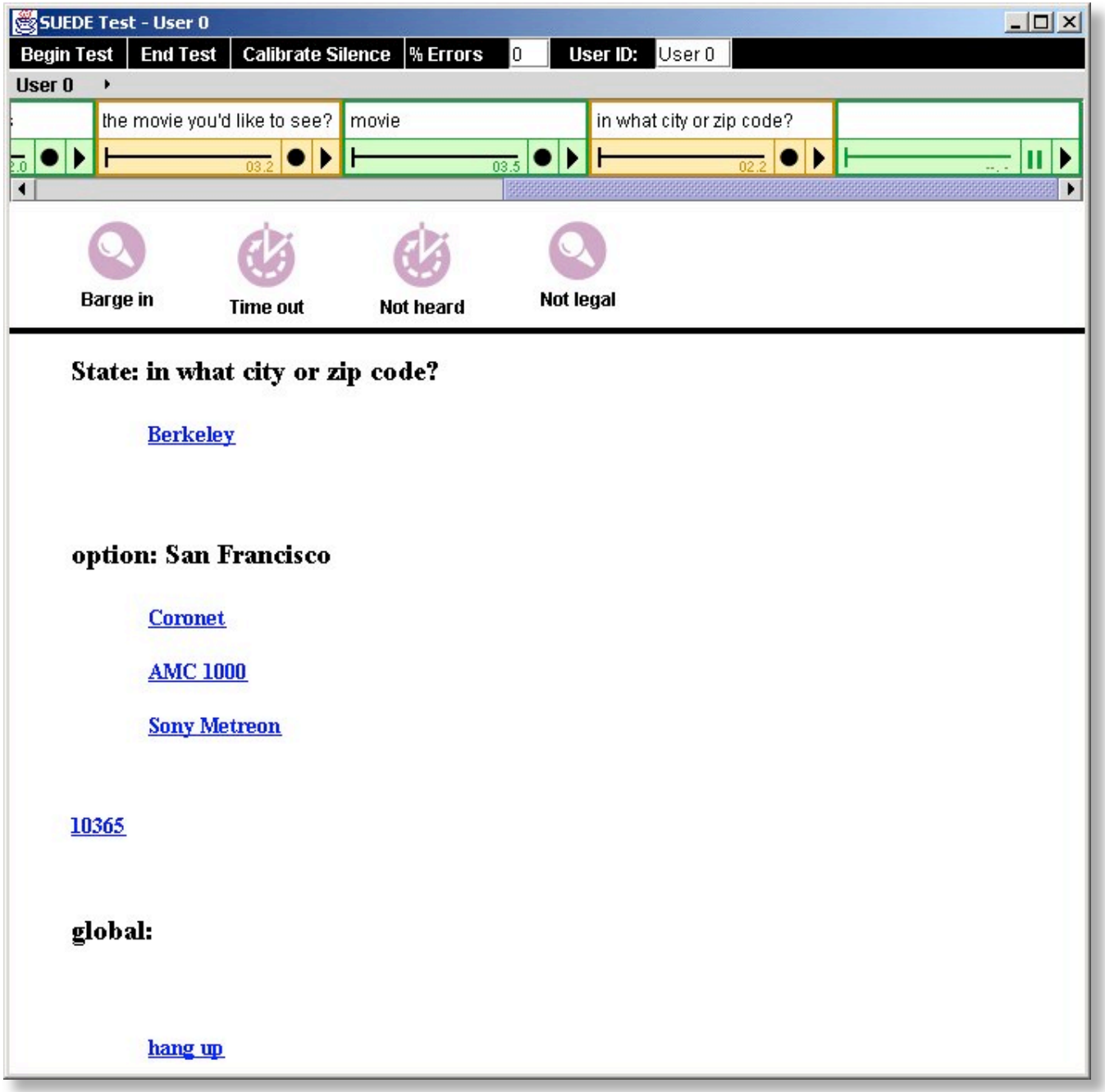


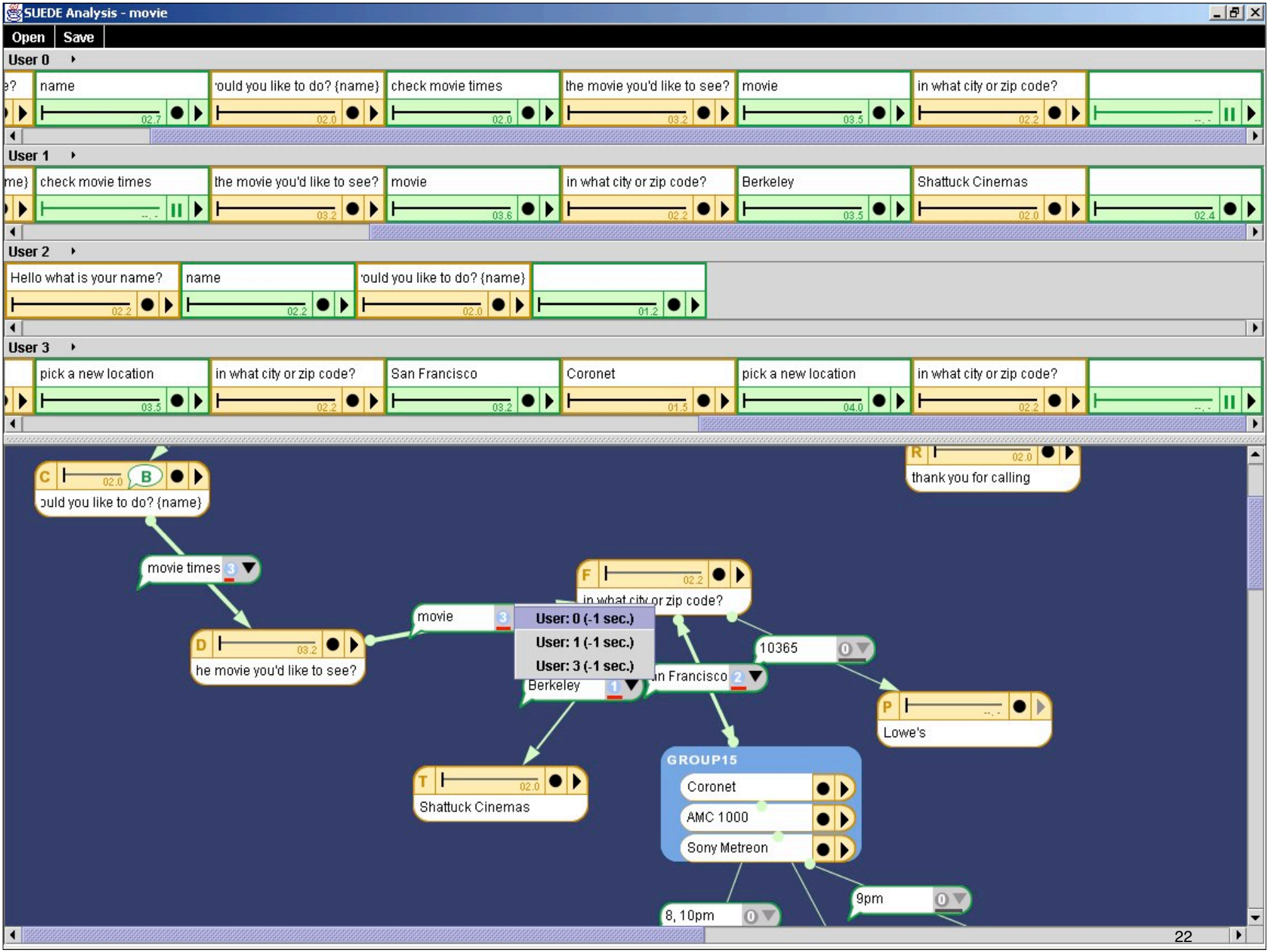
- http://guir.berkeley.edu/projects/suede/

Suede

- Addresses question:
  - How do you prototype and evaluate speech-based interfaces?
  - Especially if the formal vocabulary and recognition technology may not be fully developed yet?
- Traditional HCI approach:
  - "Wizard of Oz" -- let the human take over the role of the recognition system
  - Human operator acts as the recognizer, controls system outputs in response to human inputs
  - Can fake recognition (or other) errors
- Suede: a framework to allowing users to easily prototype *and run and evaluate* speech-based interfaces


SUEDE
Open
Save
New Script
Design
Test
Analysis
Hello, what is your name?
Nadeem
What would you like to do?
hang up
Hello, what is your name?
Annie
What would you like to do?
Read email
You have two messages
read them
First message, from Scott
Anything important?
START
A
Hello, what is your name?
C
Thanks for calling!
Goodbye
name
Hang up
B
What would you like to do?
Summaries
Read email
Send email
D
You have three messages.
GROUP9
One message
Two messages
Three messages
E
Who would you like to send email to?
O
Message, from Anoop
next email
next
Read them
M
Message, from James, subject CHI Registration
P
Message, from Nadeem
J
First message from Jack
read it
important?
read it
reply
K
Message, from Jack re: SUEDE
L
One important message
N


SUEDE Test - User 0
Begin Test
End Test
Calibrate Silence
% Errors
0
User ID:
User 0
User 0
the movie you'd like to see?
movie
in what city or zip code?
03.2
03.5
02.2
Barge in
Time out
Not heard
Not legal
State: in what city or zip code?
Berkeley
option: San Francisco
Coronet
AMC 1000
Sony Metreon
10365
global:
hang up


SUEDE Analysis - movie
Open
Save
User 0
name
'ould you like to do? {name}
check movie times
the movie you'd like to see?
movie
in what city or zip code?
User 1
check movie times
the movie you'd like to see?
movie
in what city or zip code?
Berkeley
Shattuck Cinemas
User 2
Hello what is your name?
name
'ould you like to do? {name}
User 3
pick a new location
in what city or zip code?
San Francisco
Coronet
pick a new location
in what city or zip code?
thank you for calling
movie times
movie
User: 0 (-1 sec.)
User: 1 (-1 sec.)
User: 3 (-1 sec.)
he movie you'd like to see?
in what city or zip code?
10365
Berkeley
Lowe's
Shattuck Cinemas
GROUP15
Coronet
AMC 1000
Sony Metreon
9pm
8, 10pm
22

Case Study: Personal Audio Loop

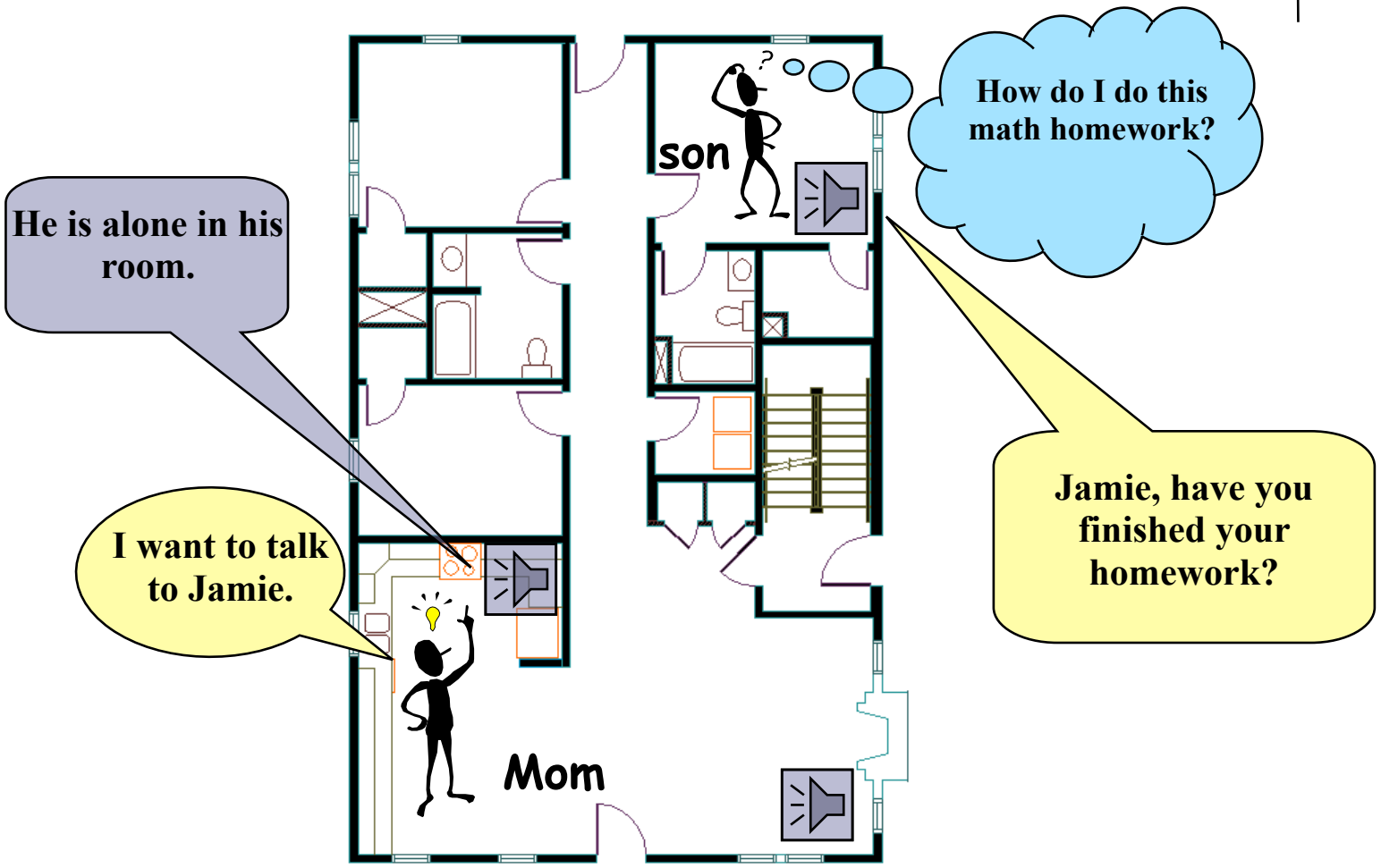
- Application which continuously buffers user's last 15 minutes of audio
  - "What were we talking about…?"
  - "What was that phone number I heard?"
- Features above are used to speed up audio playback when skimming for point of access
  - compressed or discarded in some cases
- Doesn't focus on recognition, but on speech as (uninterpreted) data

Case Study: The Family Intercom

- Use location sensing in context-aware environment to connect people in different places in a conversation

- Doesn't use recognition; tools that allow *humans* to communicate using voice at a distance

The Family Intercom (Ubicomp 2001)



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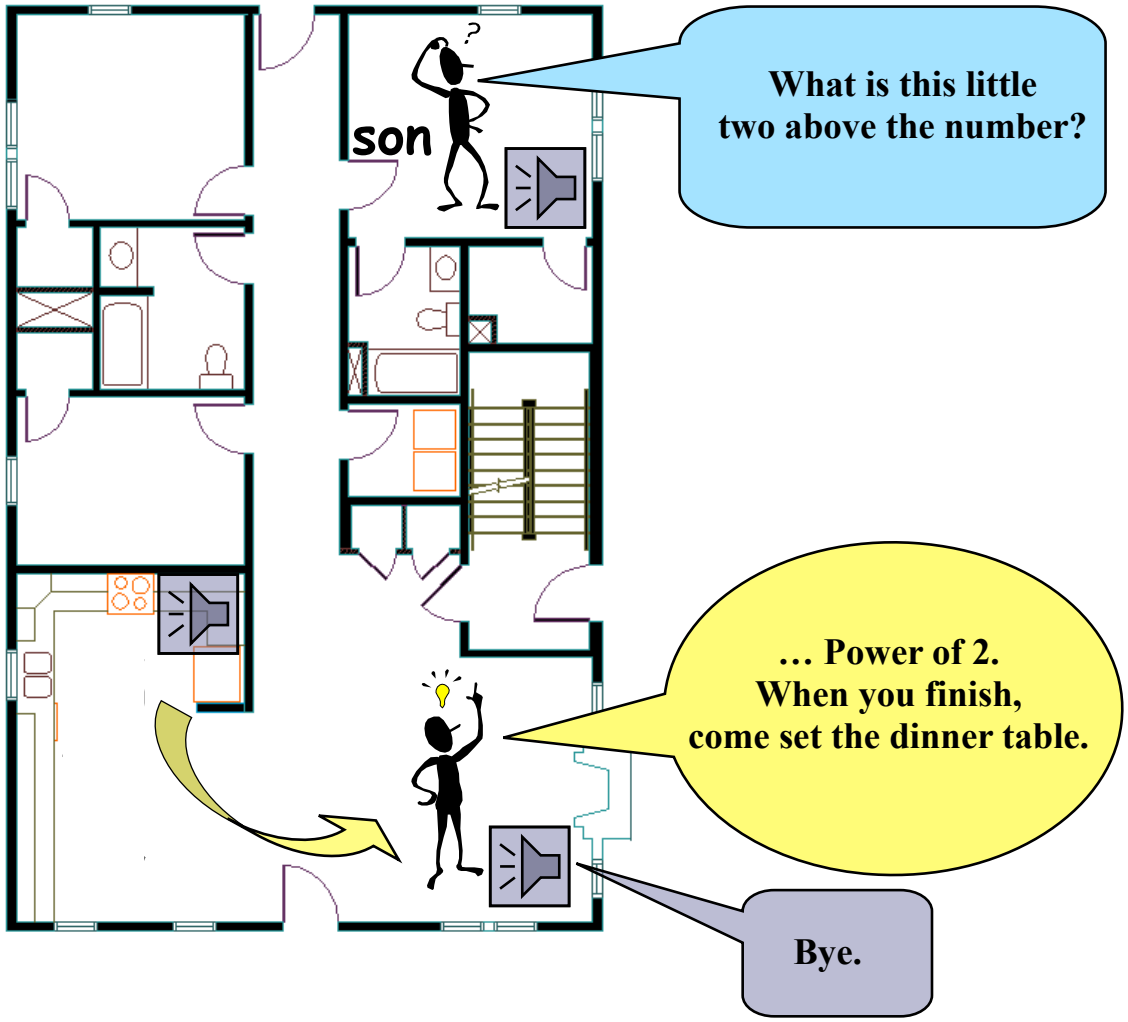

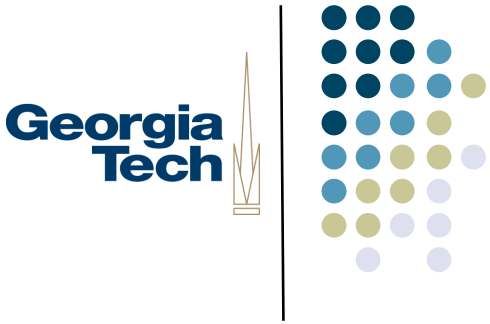

Resources

- Java Speech API:
  - Recognition and synthesis
  - http://java.sun.com/products/java-media/speech/
- FreeTTS:
  - A Java port of a very high quality speech synthesis package:
  - http://freetts.sourceforge.net/docs/index.php