



Cognitive Assistant that Learns and Organizes

calo

# Machine Learning in the User Interface: Experience in TaskTracer and CALO

Tom Dietterich  
Oregon State University

CALO Team  
SRI International and 25+ subcontractors

Cognitive Assistant that Learns and Organizes

# CALO Summary

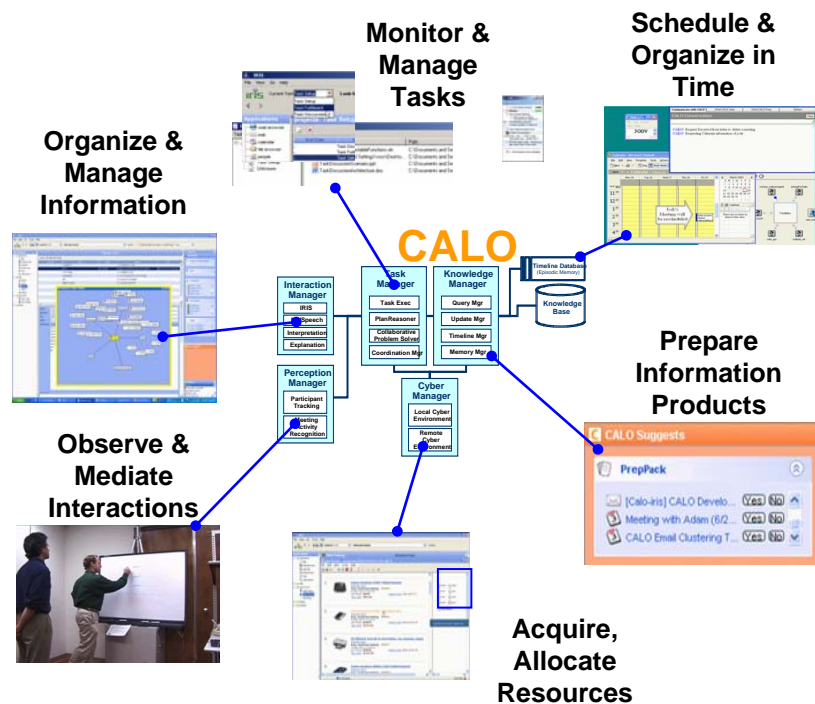
- CALO is one of two projects funded by DARPA under the Personalized Assistants that Learn (PAL) program
- It is a five-year project, that started in May 2003. We are just starting Year 4
- The main objective of the program is to develop, evaluate and demonstrate learning technology within a personalized assistant application
- The project is led by SRI, with the participation of over 25 universities and companies.

# Outline

- CALO objectives and summary of functions
- Organize and Prepare Information
  - IRIS Interface
  - TaskTracer System
- Monitor and Manage Tasks
  - TODO Manager
  - Teaching CALO Procedures
- Meeting Assistant
  - Extract action items, topics, GANTT charts from meetings

# What is CALO?

## *User functionality*



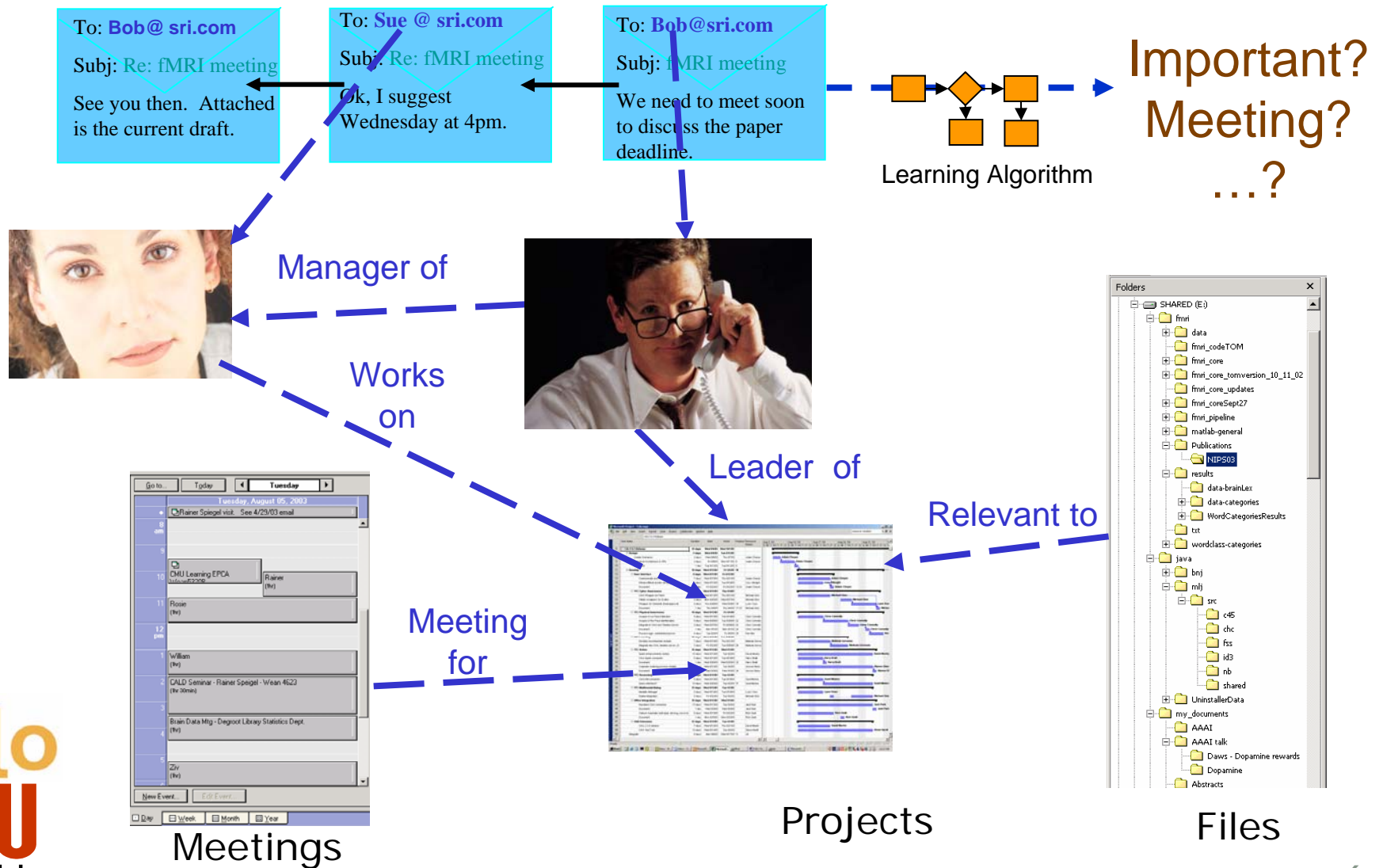
- Continuously learning and organizing the user's office world
  - Desktop
  - Internet and intranet
  - Meetings
- Learning new tasks and taking delegation
- Proactively managing to-do lists
- Assembling relevant material and preparing documents
- Recording action items in meetings



calo

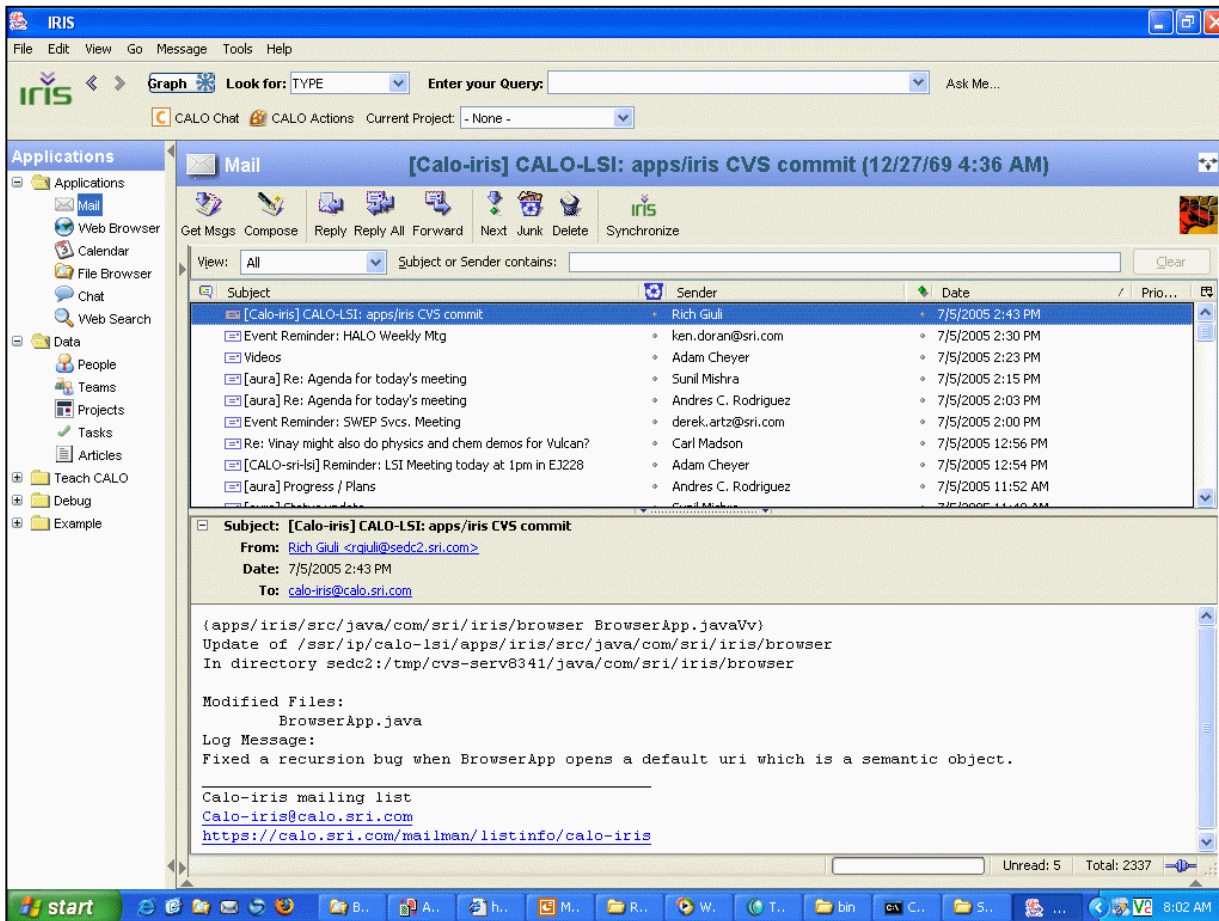
# Organizing and Preparing Information

# Learning to Organize



# Learning to Organize (Example)

- CALO discovers Projects through email clustering



# Learning to Organize (Example)

The screenshot displays the IRIS software interface. The main window is titled "Projects" and shows a table of projects. The "SWEP Website Security" project is highlighted. Below the table, there are sections for "Summary" and "Participants". The "Participants" section lists names like Adam, All, Rod, David, John, Ken, Mark, Carla, and Derek. The interface also includes a search bar, a sidebar with "Applications" and "Data" categories, and a taskbar at the bottom.

End Date	Name	Status	Summary	URL
	CALO	On schedule	Cognitive Assistant that Learns and Org...	http://calo2.sri.com
	Gardening	-	Gardening Gardening Gardening	-
	SWEP Website Security	-	Website Security	-
	Midpeninsula Open Space	-	midpen created by ProjectPicker	-
	Carrot Web Search	-	Carrot2 web search clustering tool	http://ldss.cs.put.p...
	ASQ	-	American Society for Quality	www.asq.org
	Architecture	-	CALO Architecture	-

First name	Last name
Adam	Chey
All	Staff
Rod	Morimoto
David	Wu
John	Pedersen
Ken	Doran
Mark	Gondek
Carla	Woodworth
Derek	Artz

■ CALO discovers Projects through email clustering

■ CALO links participants to Projects

# Learning to Organize (Example)

The screenshot shows the IRIS software interface. At the top, there's a search bar with 'Look for: TYPE' and 'Enter your Query:'. Below that, a navigation pane on the left lists various applications like Mail, Web Browser, Calendar, File Browser, Chat, Web Search, Data, People, Teams, Projects, Tasks, Articles, Teach CALO, Debug, and Example. The main window displays a 'People' list with columns for Work Email, First Name, Last Name, and Work Phone. The list includes entries for Ken Conley, David Morley, Adam Cheyer, John Pedersen, Rod Morimoto, Derek Artz, and Carla Woodworth. Below the list, a detailed view for Adam Cheyer is shown, including his home page, company (SRI International), title (Program Director), and contact information (address, phone, email, etc.). On the right side, there are several panels: 'Summary', 'Connections', 'Notes', 'Projects' (listing CALO, Military Transition, and SWEP Website Security), 'Tasks', 'CALO Suggests' (with a calendar view for 7/15/2005), 'Useful CALO Tasks' (with buttons for 'Schedule THIS!', 'TAG THIS!', and 'Contact!'), and 'History'. A black box highlights the contact information section, and a black arrow points from this box to the 'Contact Info' bullet point in the list on the right.

- CALO discovers Projects through email clustering

- CALO links participants to Projects

- For each person, CALO discovers

- Contact Info

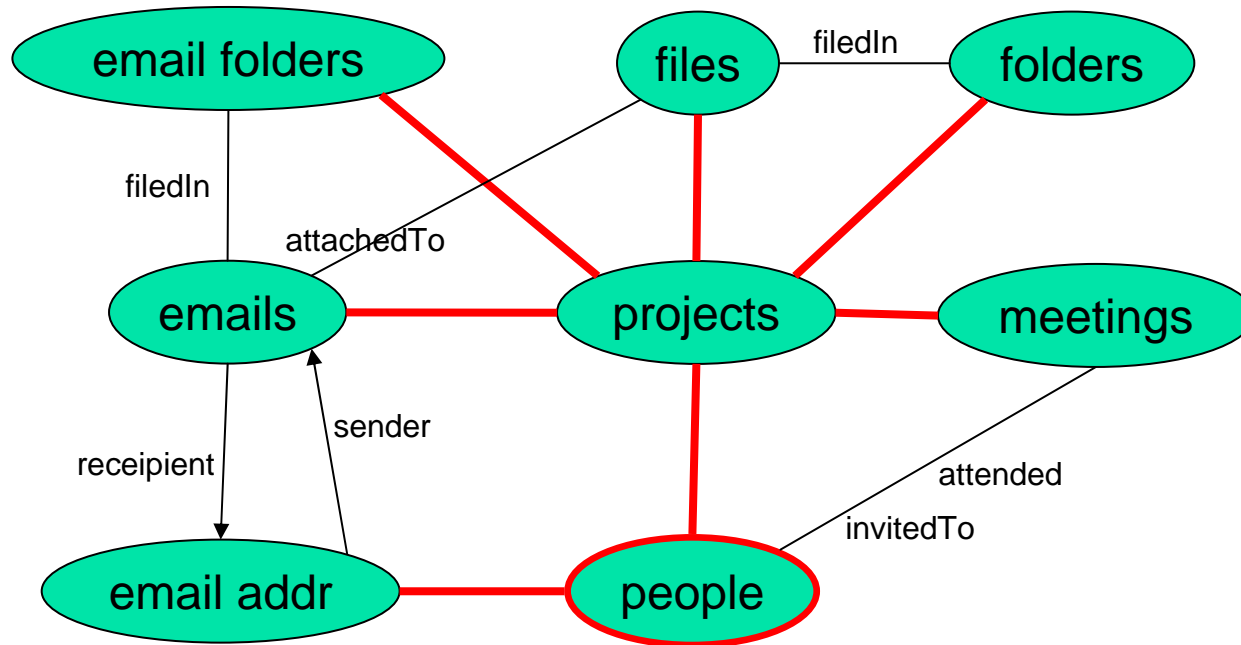
- Role

- Expertise

- ...



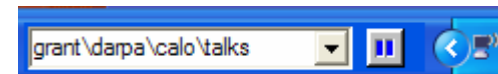
# TaskTracer: Populating Relational Model by Observation



- Relational model of user's world
  - black: observed
  - red: learned

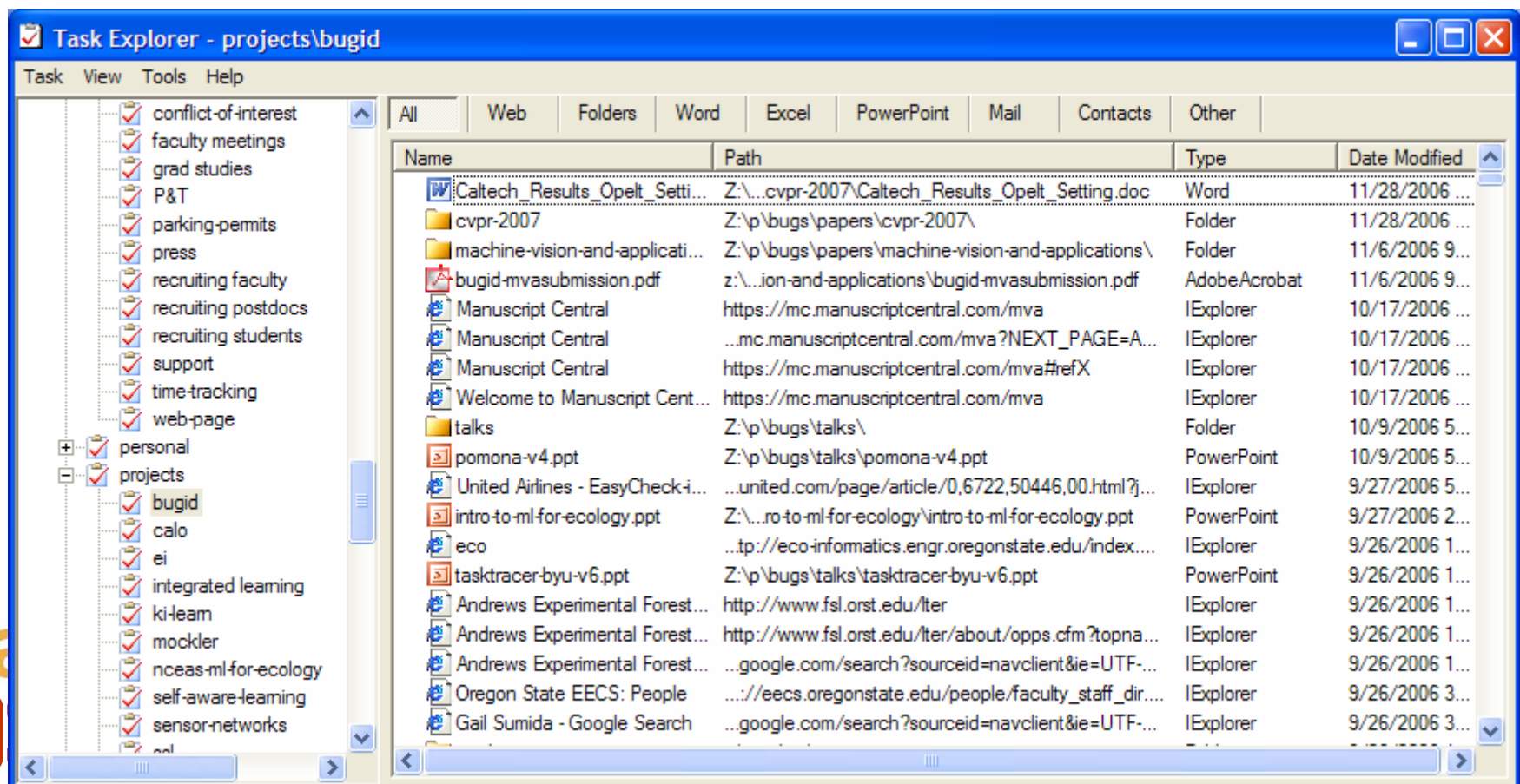
# TaskTracer

- Instrument desktop applications
  - Outlook, Word, PowerPoint, Excel, IE
- “Current Project”
  - User can specify or
  - TaskTracer can predict
- When user opens/saves/attaches “document”, it is associated with the current project by default
- Learning algorithms then learn to predict current project from visited “document” or from incoming email message
- User gives implicit feedback in several ways



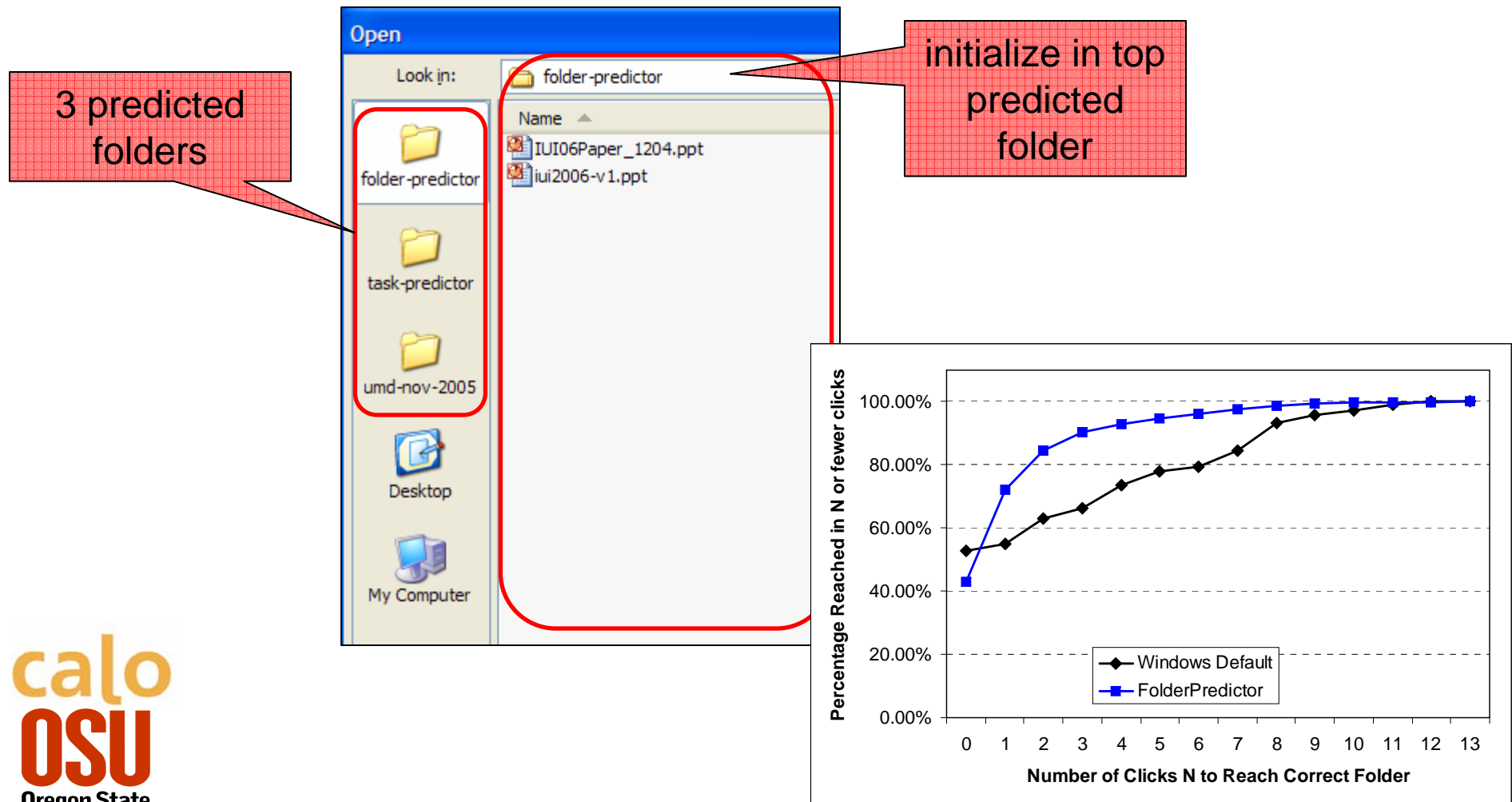
# TaskTracer helps user

- Recover from interruptions
- Save things in the right folders



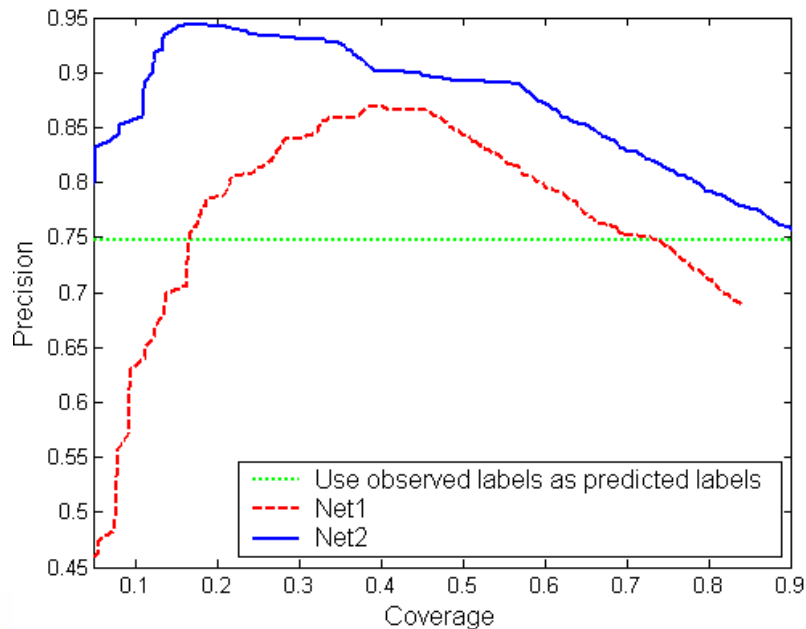
# TaskTracer Folder Predictor

- Modifies the Open/Save dialogue box(es) in Windows

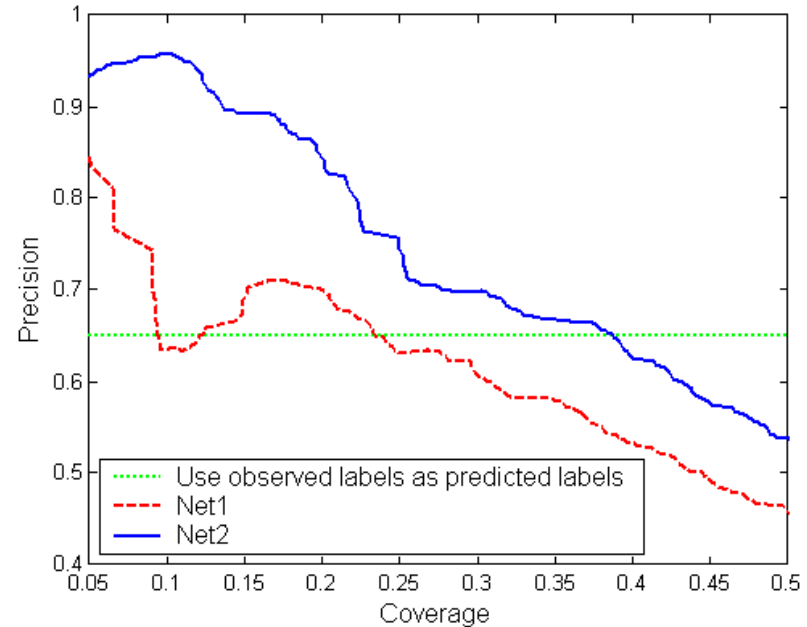


# TaskTracer Project Predictor

- Predict current project based on
  - last user-declared “current project”
  - bag of words describing the current window-in-focus



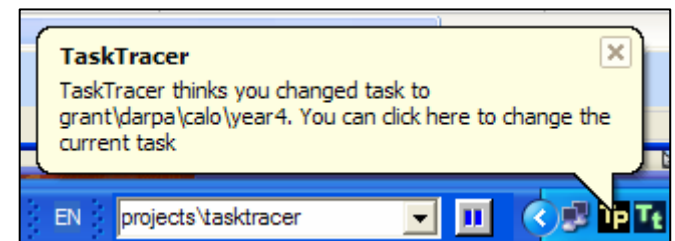
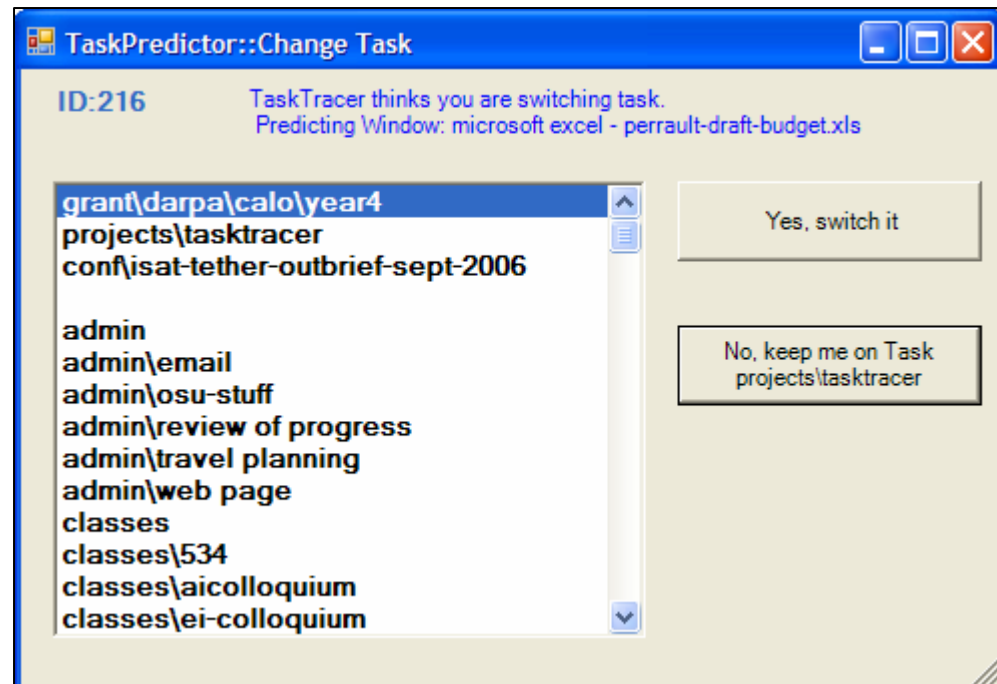
SA



FB

# Project Predictor UI

- Interface: balloon alert in lower right corner of display
- Offers choice of
  - stay with current project
  - switch to predicted project
  - choose from menu of all projects



# PrepPak



- Finds and ranks relevant documents, meetings, events, people
- E.g., documents
  - Uses Full Text Query to gather potential documents
  - Ranks using:
    - Context data gathered while the user accesses emails, files, etc
    - Provenance data on the documents (number of times accessed, first/last time accessed, number of keywords matched)
    - User feedback

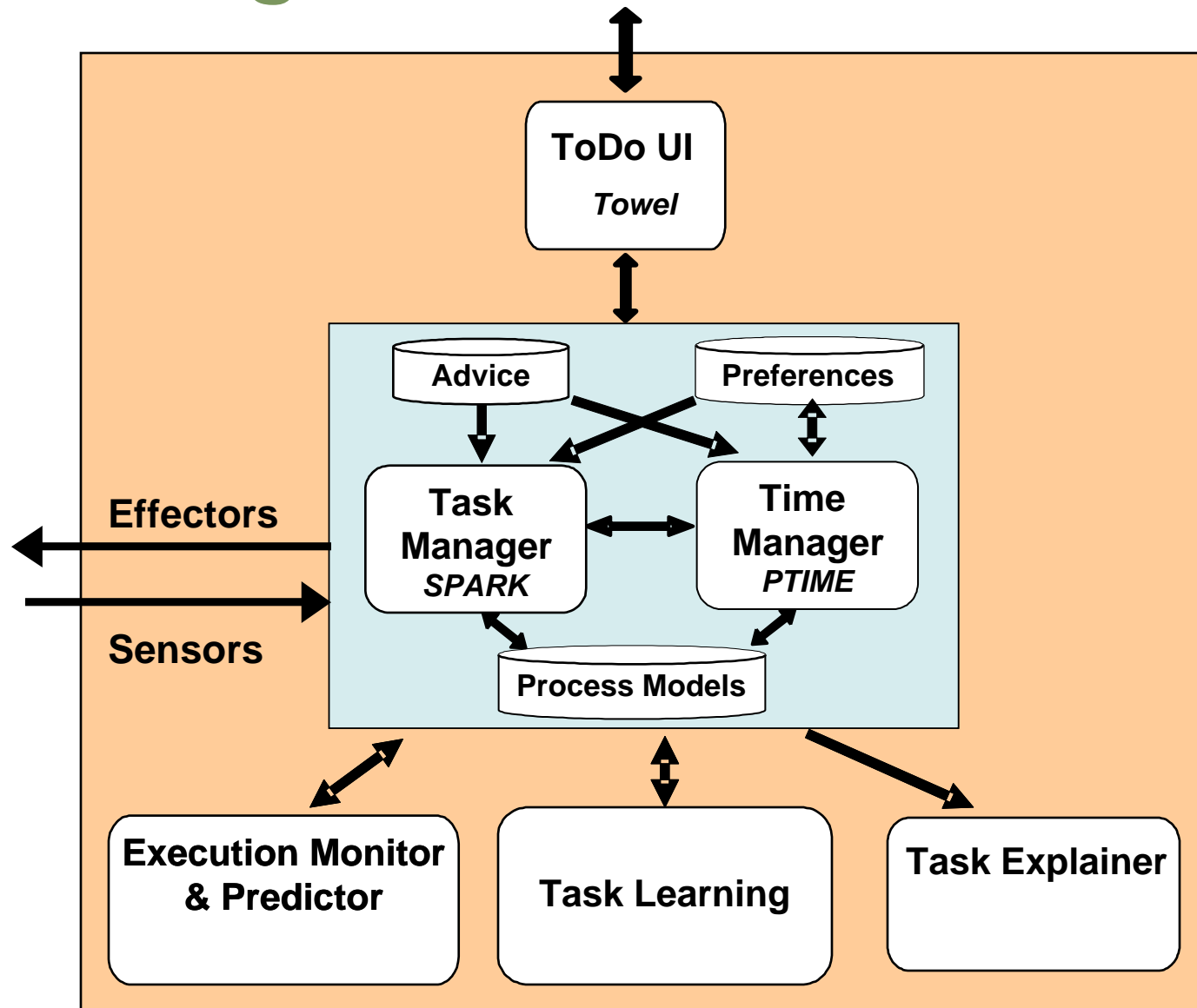


# OPI Video

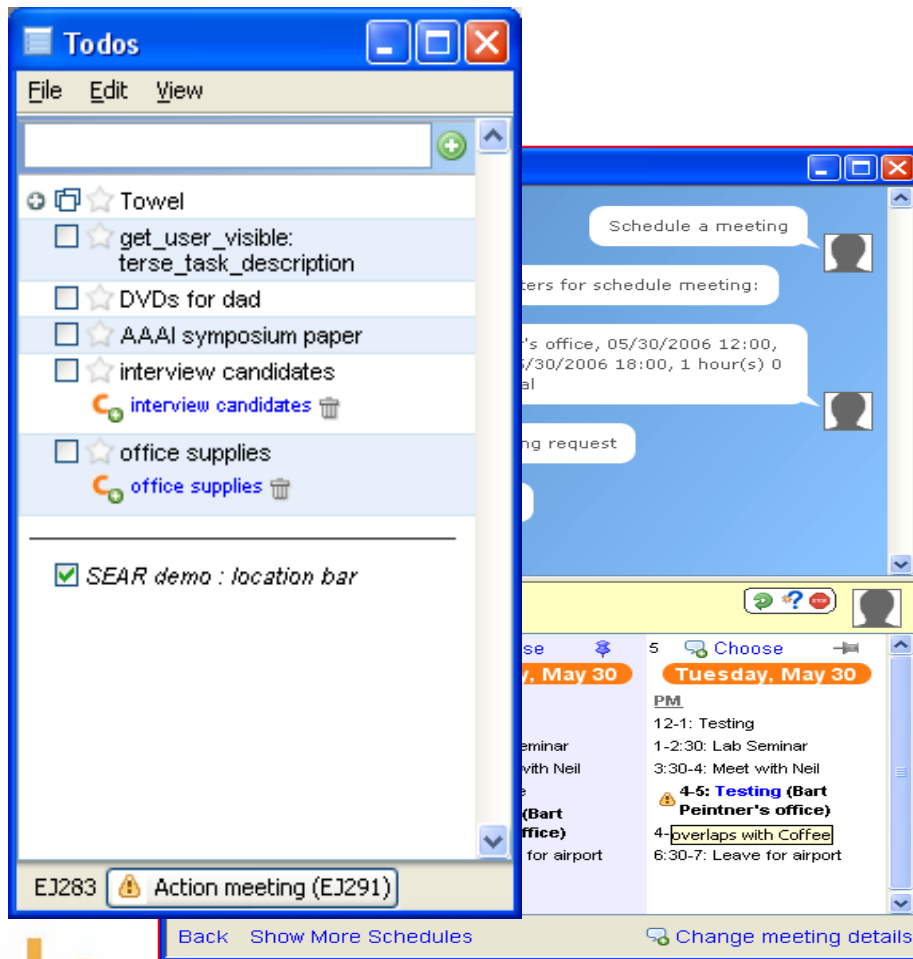
# Monitor and Manage Tasks

- Teach CALO Procedures
  - By discussion
  - By demonstration
  - By instruction
- Autonomous Procedure Execution
  - Triggered by events (arrival of email)
  - Initiated by user
- Unified TODO Manager
- Calendar and Time Manager

# Task Management Framework

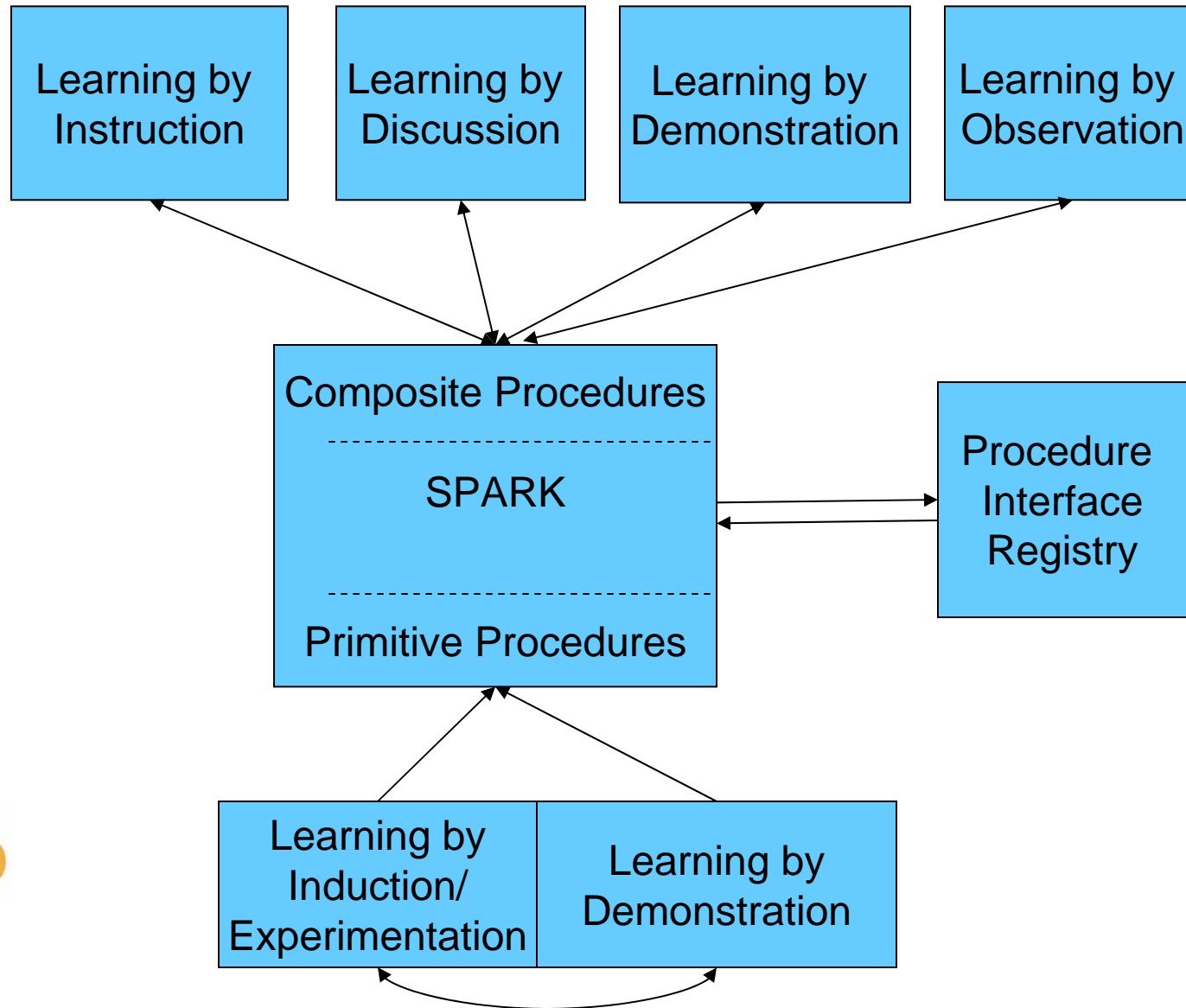


# Towel: Task Management UI



- Unified interface for task dispatch, delegation, viewing, organization, and explanation
- Supports user tasks, CALO tasks, and tasks delegated to other team members
- Combines 'to do' list view of tasks with task-specific dialog window
- Nexus for integration with other CALO technologies:
  - Activity recognition
  - Concept learning
  - State estimation

# Procedure Learning



Plow video

# Meeting Assistance



- Capture, interpret, and share team notes and sketches
- Recognize and document decisions, plans, schedule, assignments
- Provide searchable summaries with links to detail

# Meeting Assistance - System

Lightweight clients  
(anywhere)

VoIP Speech  
(wireless microphones)

remote sites

Meeting Applications

- Auto-login
- Shared notes & sketches
- Action items & topics browser

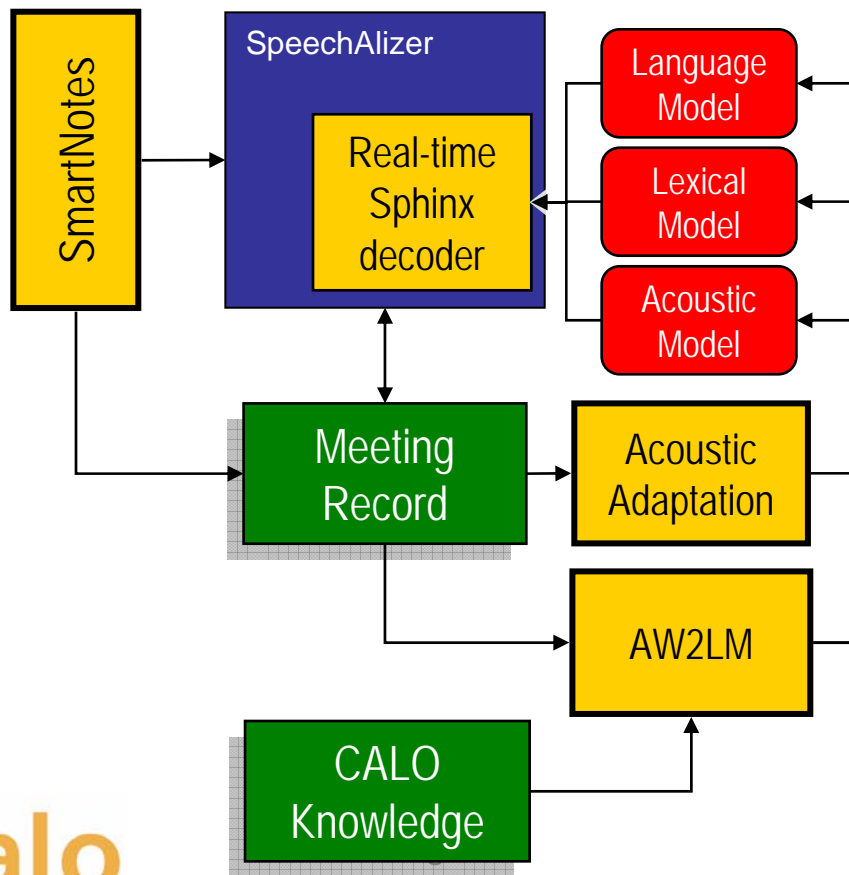
Shared artifact  
(digital paper)

Gaze &  
Gesture  
(close-up video)

Servers (Menlo Park)

- Collect, archive meeting data
- Hosted applications
- Speech, handwriting, NL, MMUI processing

# Adaptive Speech Recognition for Meeting Assistance



- **Need:** Understanding real, spontaneous speech in meetings
- **Approach:**
  - Use knowledge of speaker identity to adapt acoustic models on a continuous meeting to meeting basis
  - Use information from the CALO environment (and meeting notes) to prime expected meeting vocabulary
- **Benefits:** Increased recognition accuracy (e.g., 6% relative word error decrease over a meeting sequence)

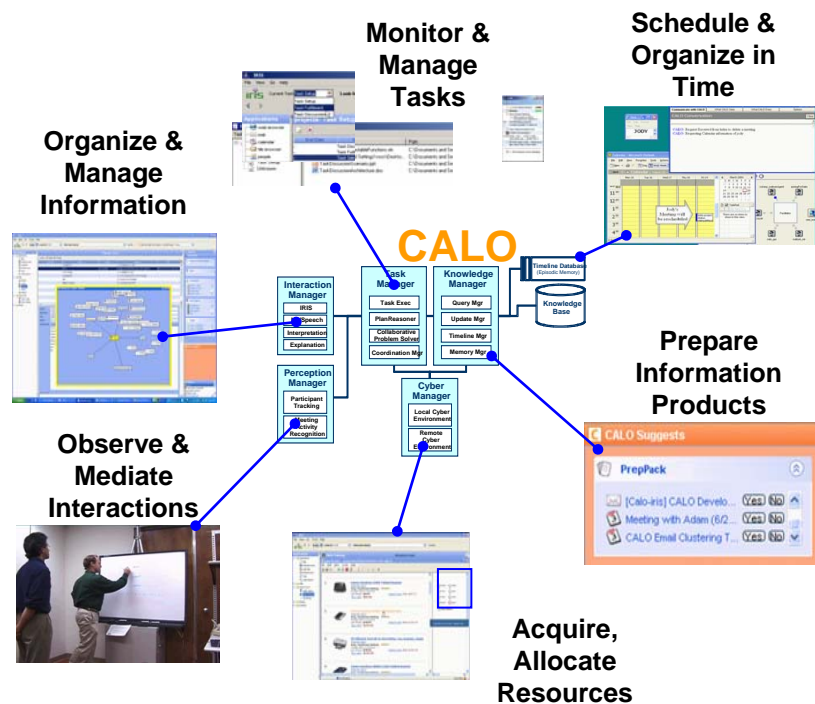


Cognitive Assistant that Learns and Organizes

calo

# Meeting Assistance Video

# Summary



- Continuously learning and organizing the user's office world
  - Desktop
  - Internet and intranet
  - Meetings
- Learning new tasks and taking delegation
- Proactively managing to-do lists
- Assembling relevant material and preparing documents
- Recording action items in meetings