Intelligent User Interfaces

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Intelligent User Interfaces (IUI)

- User interfaces – a software interface for human users
  - Very concrete but open-ended

Intelligent User Interfaces (IUI)

- User interfaces – a software interface for human users
  - Very concrete but open-ended

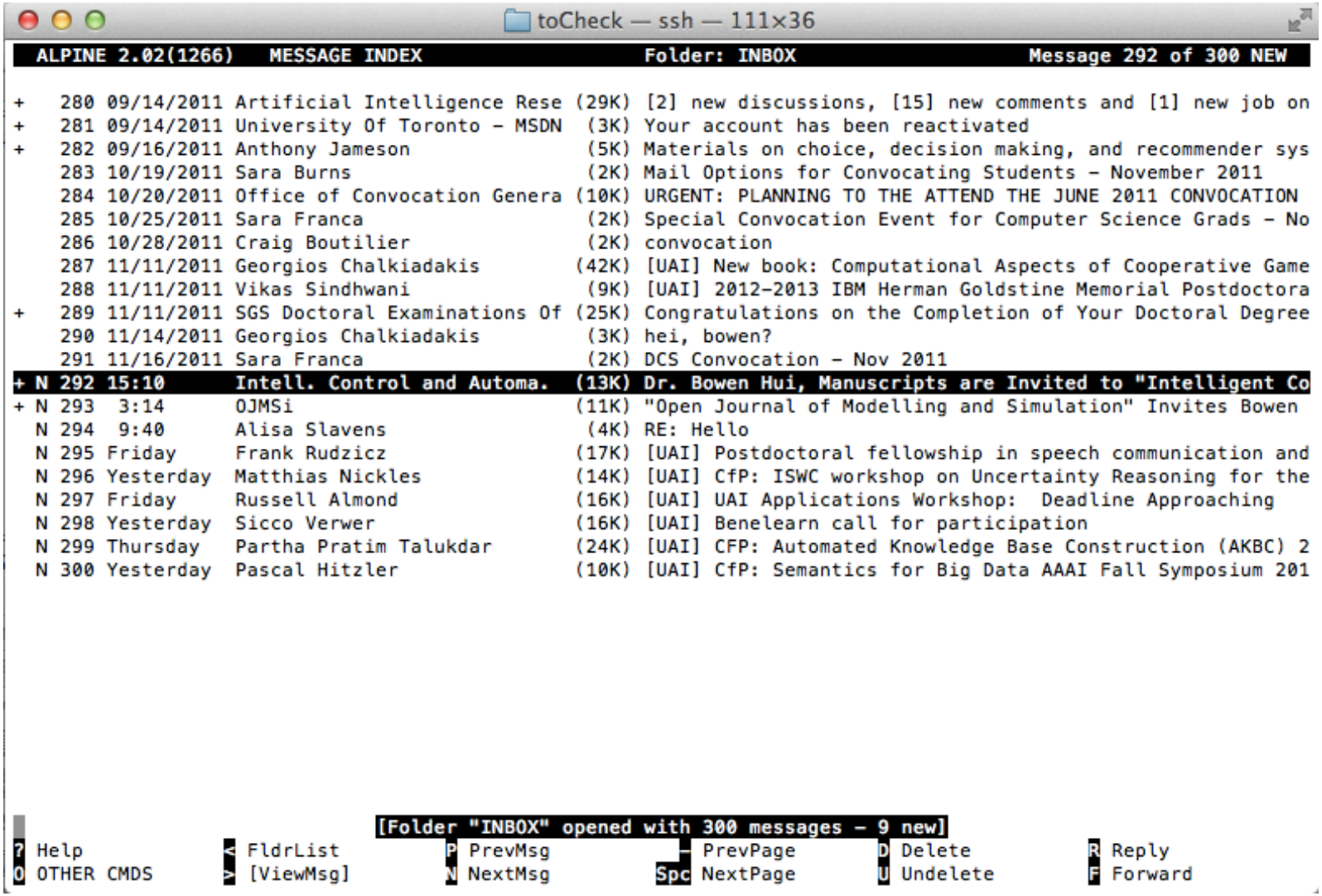
- Intelligent – does something the user wants, even when not asked
  - Completely subjective

Why IUI?

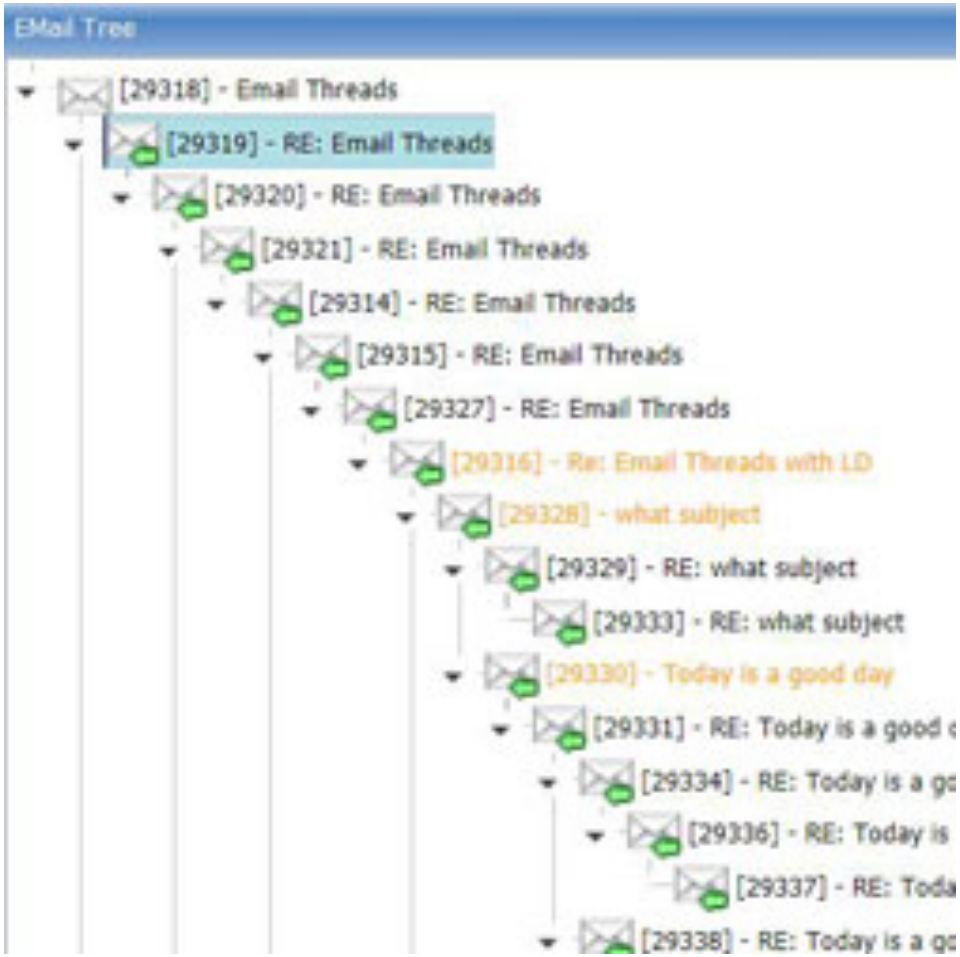
- Increasing complexity in software
- Less time to do stuff
- Lower cost of development
- Increase software acceptance
- Application for AI techniques

Evolution of Email

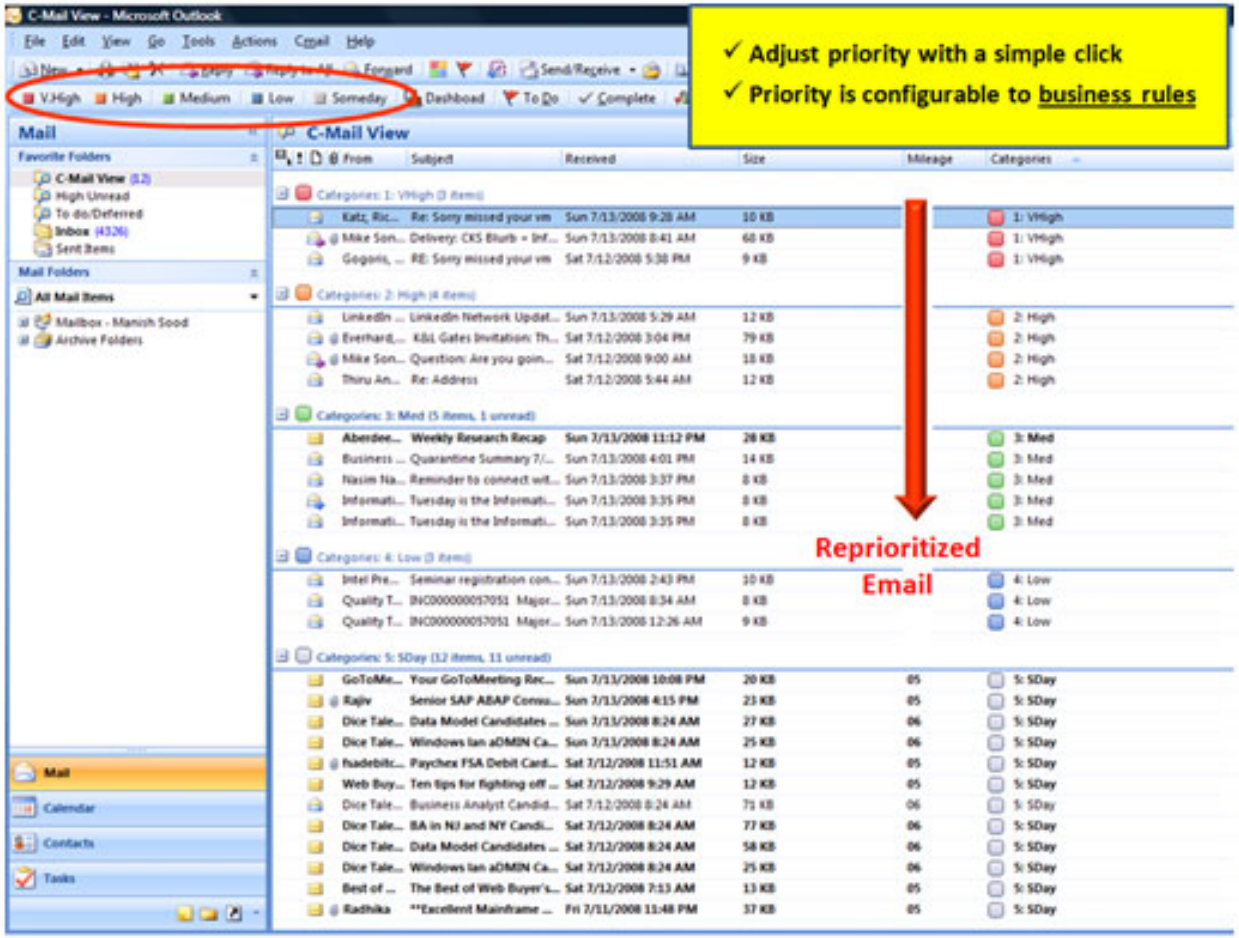
Pine Email


toCheck — ssh — 111×36
ALPINE 2.02(1266) MESSAGE INDEX Folder: INBOX Message 292 of 300 NEW
+ 280 09/14/2011 Artificial Intelligence Rese (29K) [2] new discussions, [15] new comments and [1] new job on
+ 281 09/14/2011 University Of Toronto - MSDN (3K) Your account has been reactivated
+ 282 09/16/2011 Anthony Jameson (5K) Materials on choice, decision making, and recommender sys
283 10/19/2011 Sara Burns (2K) Mail Options for Convocating Students - November 2011
284 10/20/2011 Office of Convocation Genera (10K) URGENT: PLANNING TO THE ATTEND THE JUNE 2011 CONVOCATION
285 10/25/2011 Sara Franca (2K) Special Convocation Event for Computer Science Grads - No
286 10/28/2011 Craig Boutilier (2K) convocation
287 11/11/2011 Georgios Chalkiadakis (42K) [UAI] New book: Computational Aspects of Cooperative Game
288 11/11/2011 Vikas Sindhwani (9K) [UAI] 2012-2013 IBM Herman Goldstine Memorial Postdoctora
+ 289 11/11/2011 SGS Doctoral Examinations Of (25K) Congratulations on the Completion of Your Doctoral Degree
290 11/14/2011 Georgios Chalkiadakis (3K) hei, bowen?
291 11/16/2011 Sara Franca (2K) DCS Convocation - Nov 2011
+ N 292 15:10 Intell. Control and Automa. (13K) Dr. Bowen Hui, Manuscripts are Invited to "Intelligent Co
+ N 293 3:14 OJMSi (11K) "Open Journal of Modelling and Simulation" Invites Bowen
N 294 9:40 Alisa Slavens (4K) RE: Hello
N 295 Friday Frank Rudzicz (17K) [UAI] Postdoctoral fellowship in speech communication and
N 296 Yesterday Matthias Nickles (14K) [UAI] CfP: ISWC workshop on Uncertainty Reasoning for the
N 297 Friday Russell Almond (16K) [UAI] UAI Applications Workshop: Deadline Approaching
N 298 Yesterday Sicco Verwer (16K) [UAI] Benelearn call for participation
N 299 Thursday Partha Pratim Talukdar (24K) [UAI] CFP: Automated Knowledge Base Construction (AKBC) 2
N 300 Yesterday Pascal Hitzler (10K) [UAI] CfP: Semantics for Big Data AAAI Fall Symposium 201
[Folder "INBOX" opened with 300 messages - 9 new]
? Help
O OTHER CMDS
< FldrList
> [ViewMsg]
P PrevMsg
N NextMsg
- PrevPage
Spc NextPage
D Delete
U Undelete
R Reply
F Forward

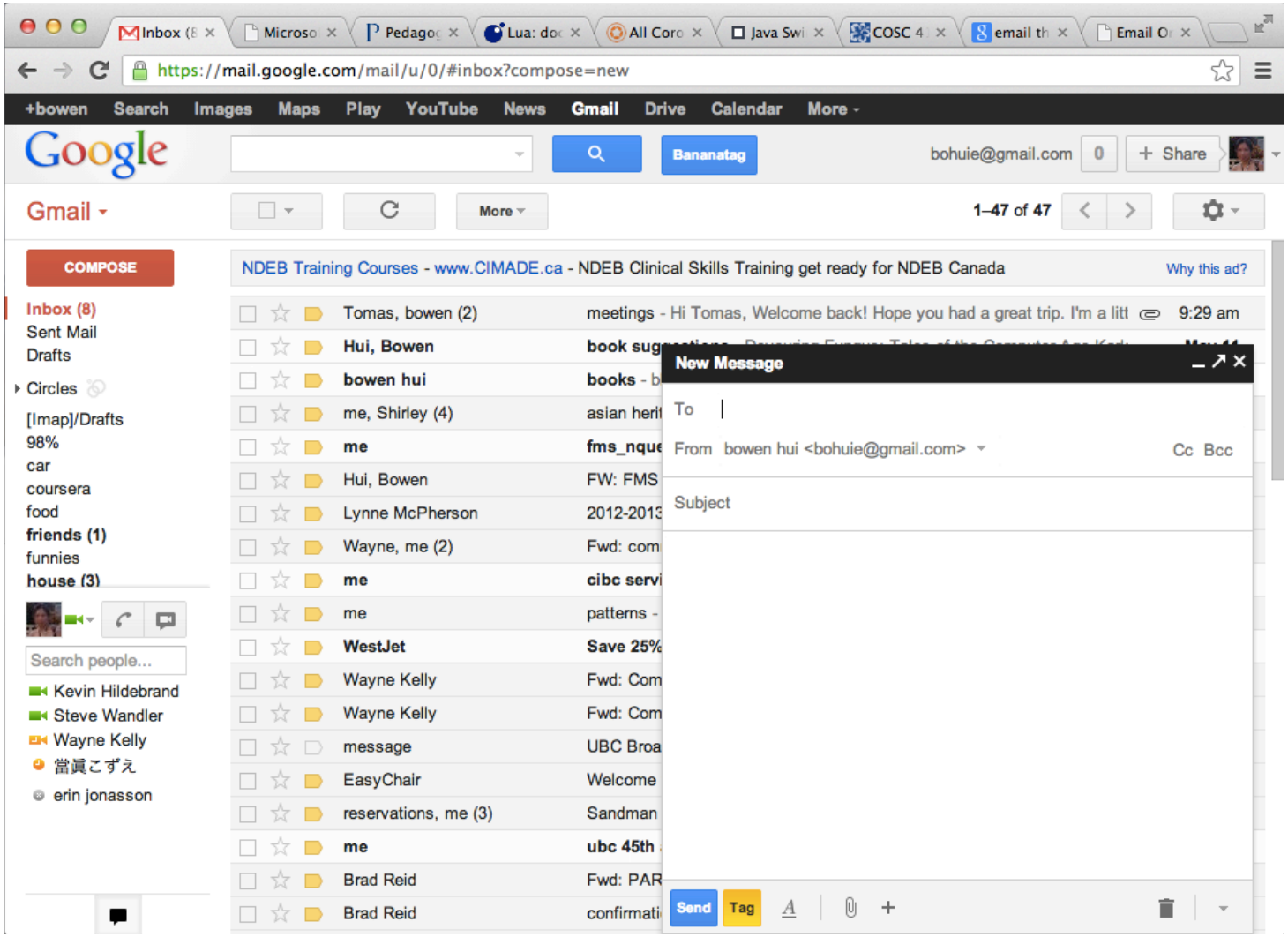
Email Threads



Email Priorities



Email Tracking



Objectives of IUI

- Increase productivity
- Decrease expenditures
- Lower level of expertise required to use software
- Overall: to improve efficiency, effectiveness, and naturalness of interaction
- How?
  - Use AI representation, reasoning, models

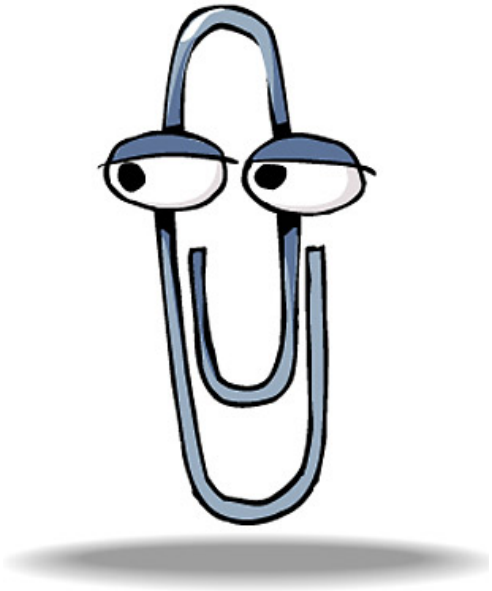
Ex: Mail Filters

- What is the UI aspect?
- What is the intelligent aspect?
- What are the potential user benefits?

Ex: Speech Recognition Software

- What is the UI aspect?
- What is the intelligent aspect?
- What are the potential user benefits?

Ex: Desktop Assistant Software



- What is the UI aspect?
- What is the intelligent aspect?
- What are the potential user benefits?

What Could Go Wrong?

- Risks:

What Could Go Wrong?

- Risks:
  - Don't do what the user wants
    - Sometimes this is okay
  - Interrupt the user at a bad time
  - Frustrate user
  - Lose use trust/loyalty
- How should the system decide?

Design Opportunities

- Needs-driven:
  - Consider interface aspects
  - Consider domains of applications
  - What can be better?
    - Faster, cheaper, more “naturally”
- Technique-driven:
  - How can I use *XX* technique fruitfully?

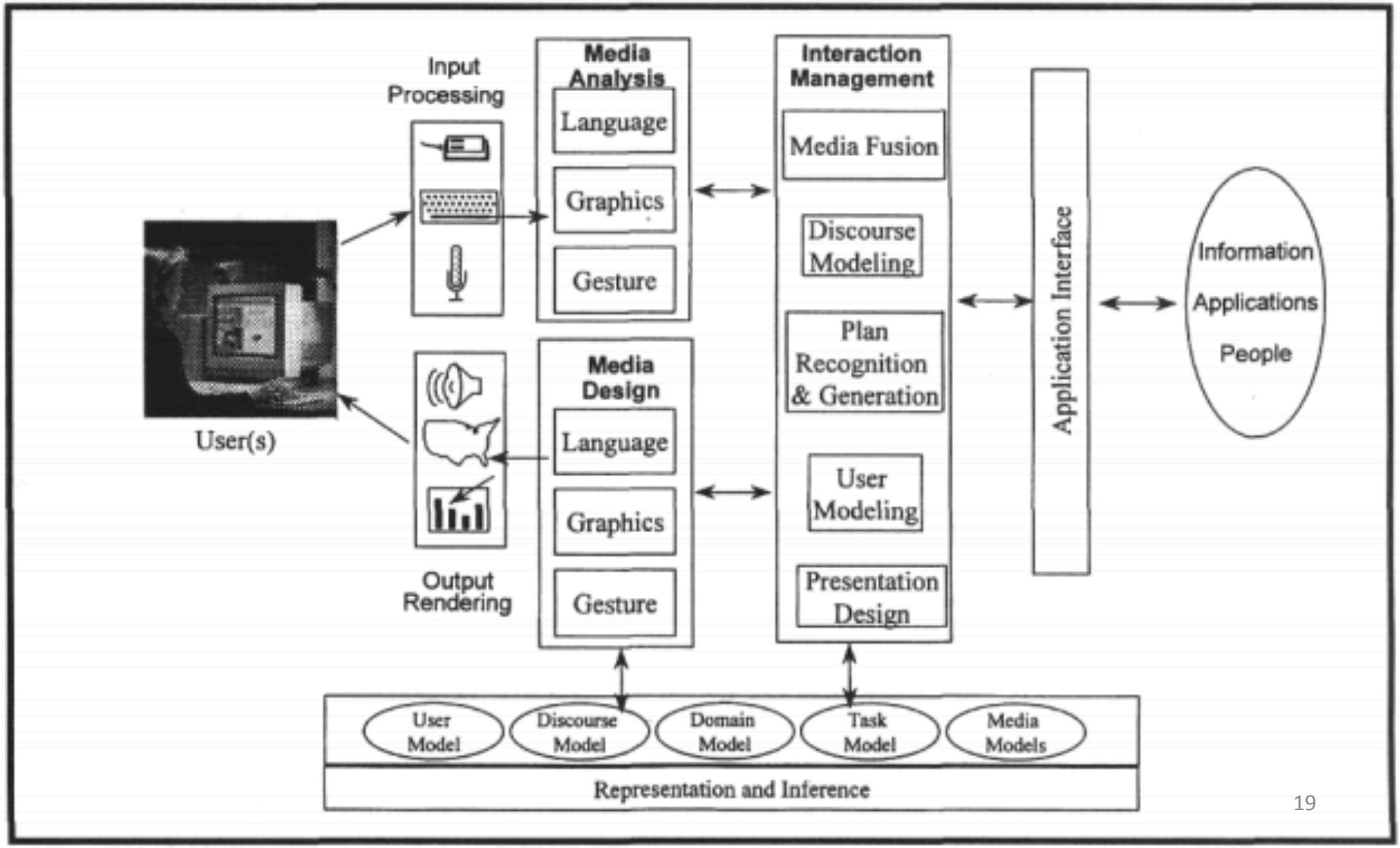
User Interface Components?

- What are some specific UI components that you/others interact with?
  - Desktop/Web apps
  - Ubiquitous and pervasive apps
  - Mobile apps
  - Very large displays

Application Domains?

- What do you use software for?
  - School
  - Work
- What do you want to use software for?
  - Games
  - Entertainment
  - Socialization

IUI Architecture (1999)



Medium and Modality

- Medium
  - Material object used for presenting, saving, or handling information
  - E.g., paper, CD, microphone, mouse
- Modality
  - Human senses used to process information
    - Vision, audition, olfaction, touch, taste
  - Also called mode

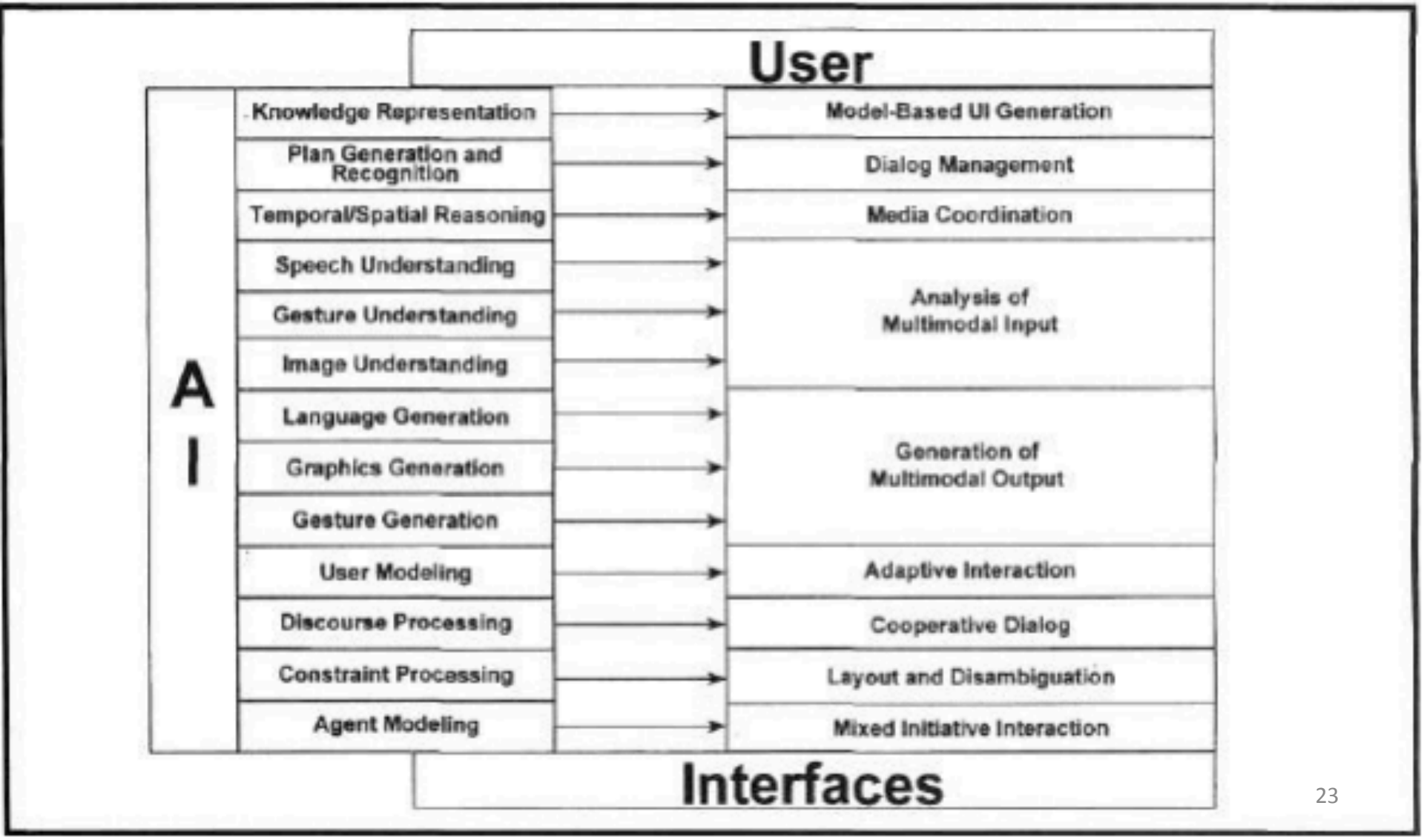
Why So Complex?

- How would you respond to someone saying to you, “I want to go to the bank”?

Why So Complex?

- How would you respond to someone saying to you, “I want to go to the bank”?
  - Disambiguation: Which bank?
  - Task: What for?
  - Planning: By when?
  - Formality: How do you respond back?
  - Relevant Context: …?

AI Meets HCI


User
AI
Knowledge Representation
Plan Generation and Recognition
Temporal/Spatial Reasoning
Speech Understanding
Gesture Understanding
Image Understanding
Language Generation
Graphics Generation
Gesture Generation
User Modeling
Discourse Processing
Constraint Processing
Agent Modeling
Model-Based UI Generation
Dialog Management
Media Coordination
Analysis of Multimodal Input
Generation of Multimodal Output
Adaptive Interaction
Cooperative Dialog
Layout and Disambiguation
Mixed Initiative Interaction
Interfaces

Movement Towards Automation

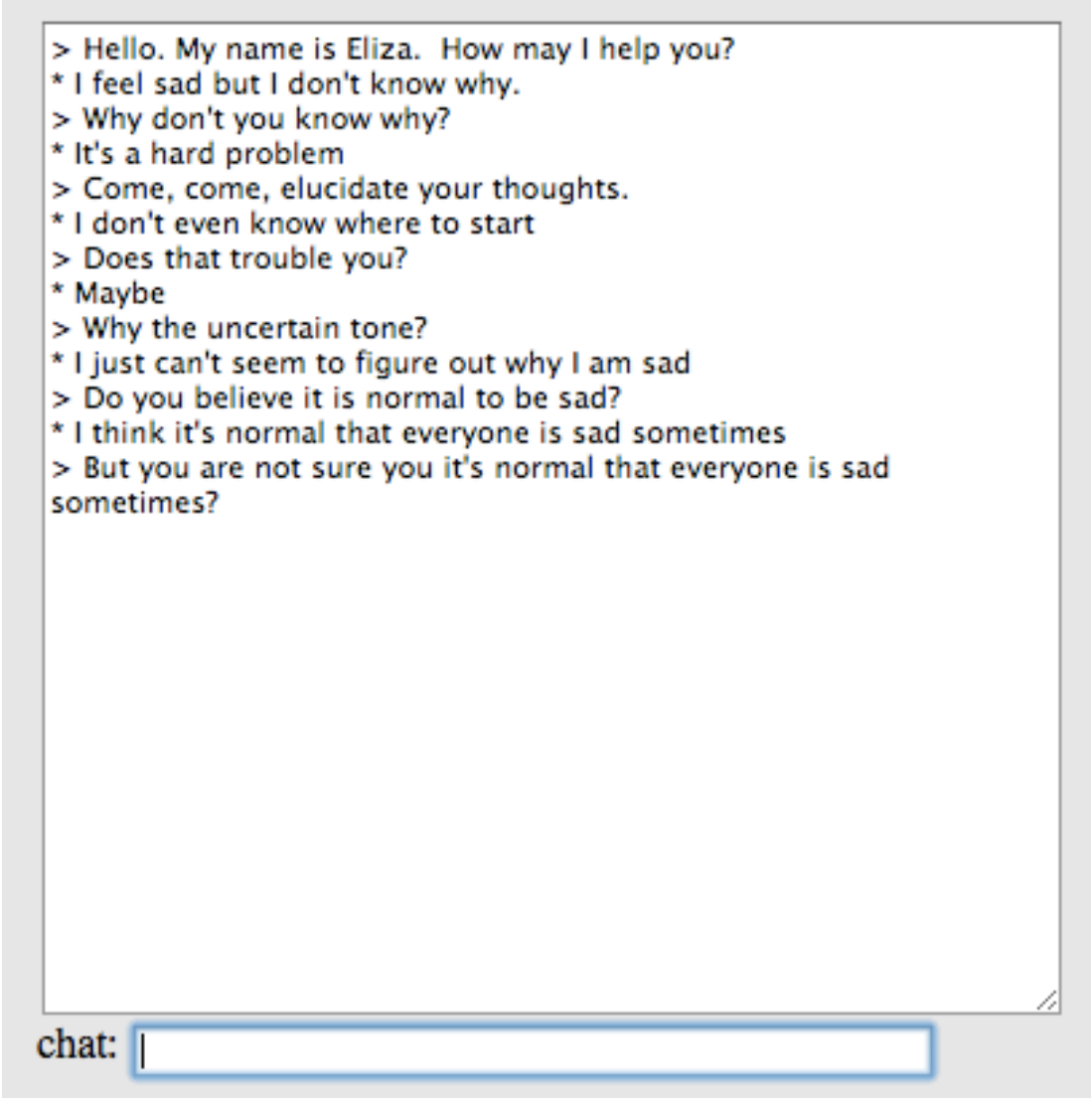
- Roughly, input processing requires system to "*understand*" input
- Likewise, output display requires system to "*generate*" output
  - Historically, canned output used
  - Generation on the fly
  - Requires common representation of knowledge
  - Towards model-based solutions

The Famous Eliza Agent

- Psychotherapist who repeats your thoughts
  - "Yes, tell me more about _____"
  - "Do you think it is _____ to _____"
  - "I understand. I am listening."

- Try it out at: http://nlp-addiction.com/eliza/

Sample Conversation with Eliza



Ex: Sentence Generation

- Solution 1: Hardcode a bunch of sentences
- Solution 2:
  - Define S = N V NP
  - Specify list of nouns, verbs, model for NP, etc.
- Benefits
  - More structure (better understanding)
  - Easier to change
  - Easier to extend

Range of Information Presentation

- Formal representation of info to be conveyed (1999)
  - Pure linguistic form
  - … (spectrum)
  - Pure visualization

- Missing dimensions beyond the visual modality

Design of Basic Intelligent Agent

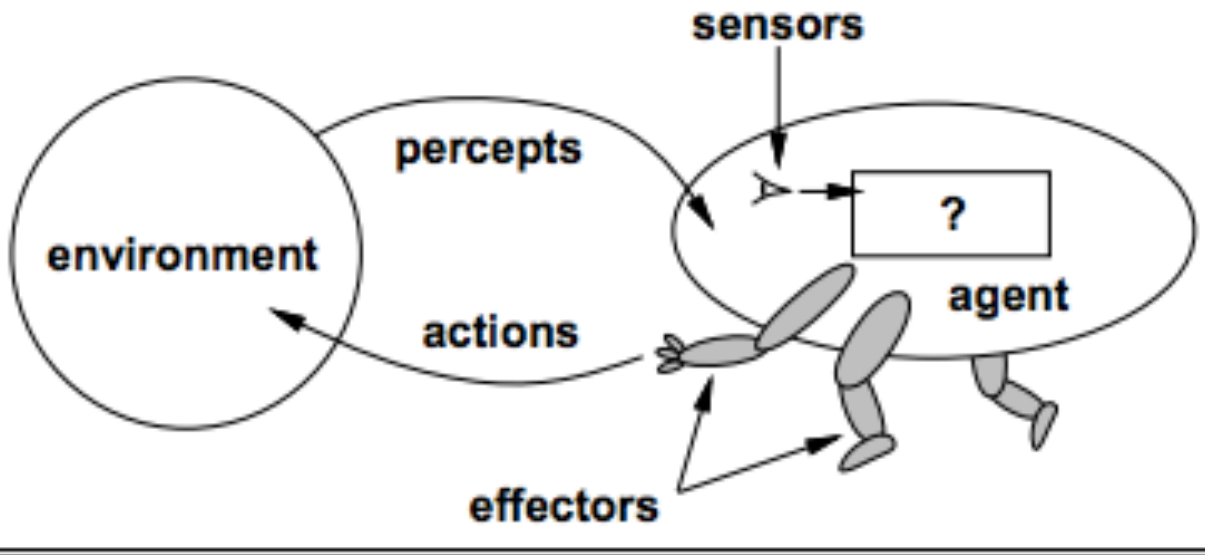


Figure 2.1 Agents interact with environments through sensors and effectors.

Environment?

- Everything “outside” the agent software
- Examples:
  - Operation system
  - Other software
  - The Internet
  - Input and output devices
  - User

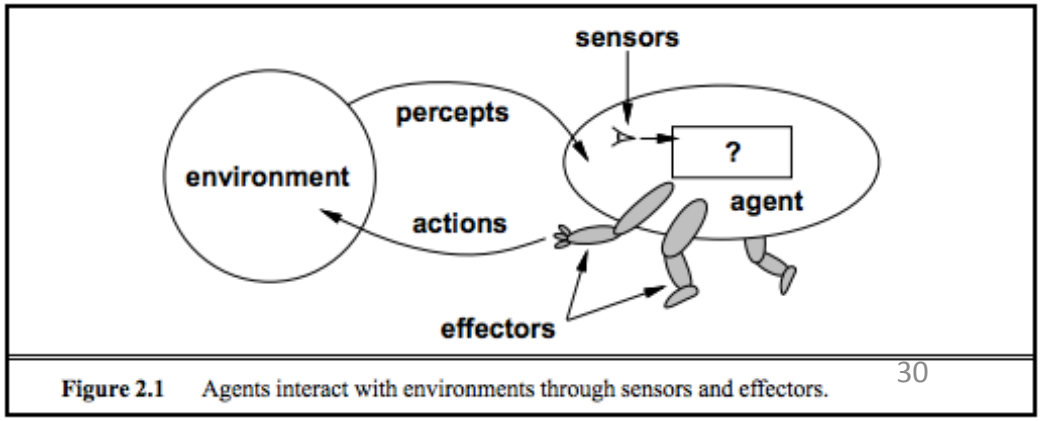


Figure 2.1 Agents interact with environments through sensors and effectors.

Percepts?

- Anything that can be monitored (observable)
- Examples:
  - Keystrokes and mouse movements
  - Gestures
  - Facial expressions
  - Conversational syntax
  - Dialogue structure

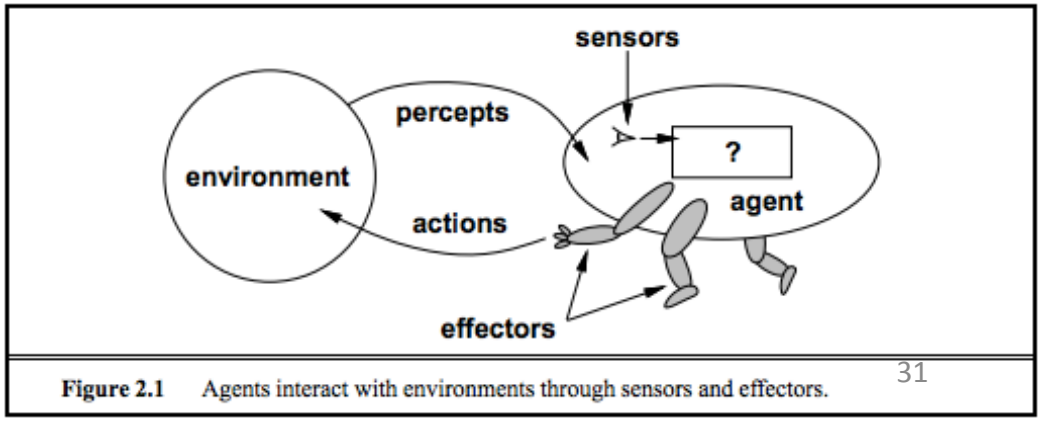


Figure 2.1 Agents interact with environments through sensors and effectors.

Actions?

- Anything that the agent software can do to the environment
- Examples:
  - Pop up dialog box
  - Ask question or follow-up question
  - Show hint balloon
  - Auto-completion
  - Change layout

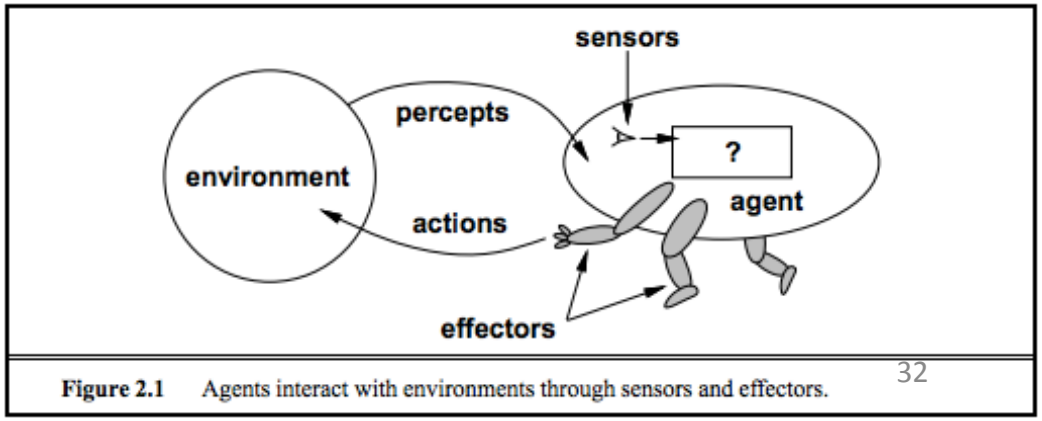


Figure 2.1 Agents interact with environments through sensors and effectors.

Ex: Simple Reflex Agent

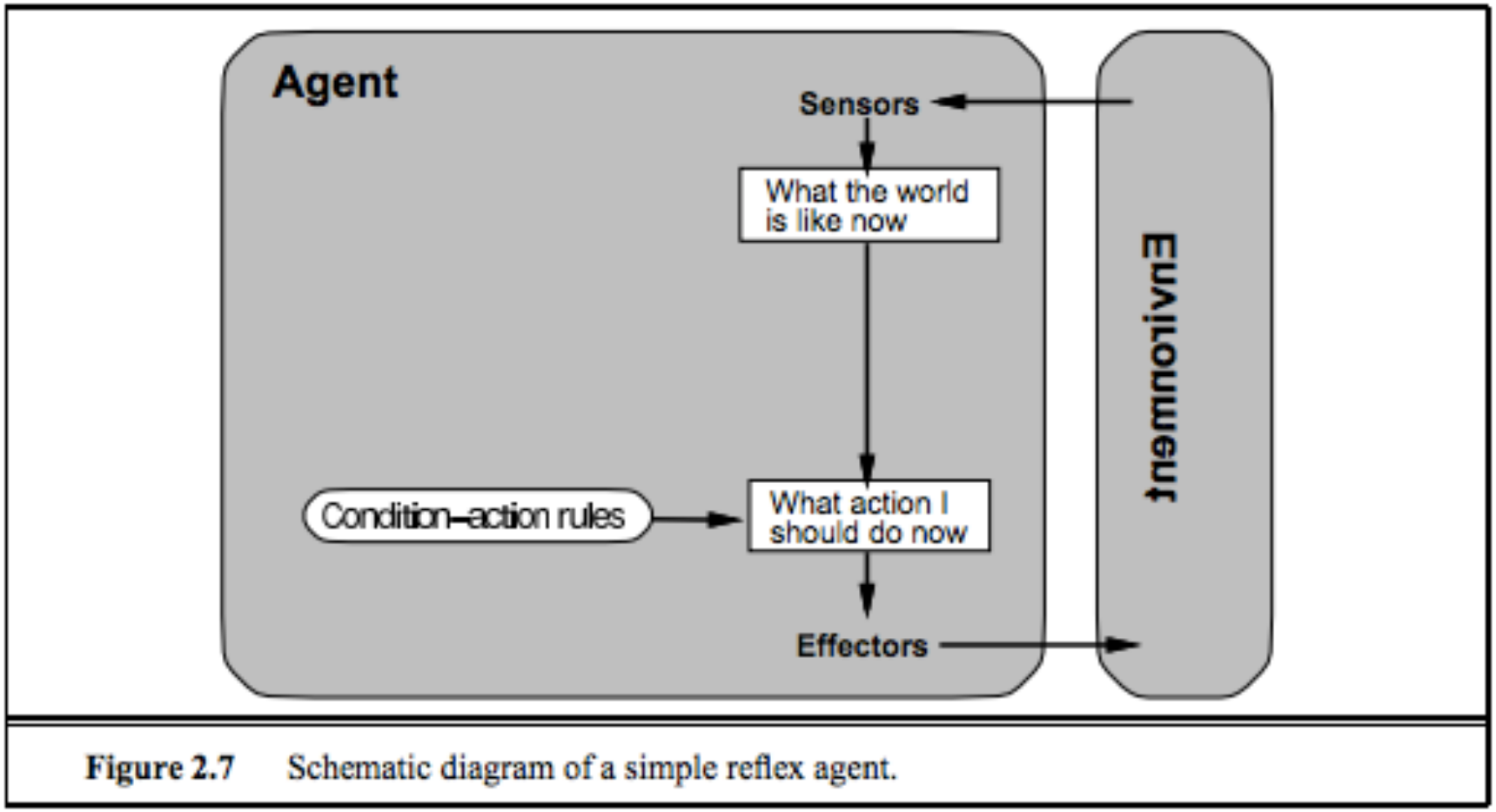


Figure 2.7 Schematic diagram of a simple reflex agent.

Look up table implementation

Ex: Reflex Agent with Internal State

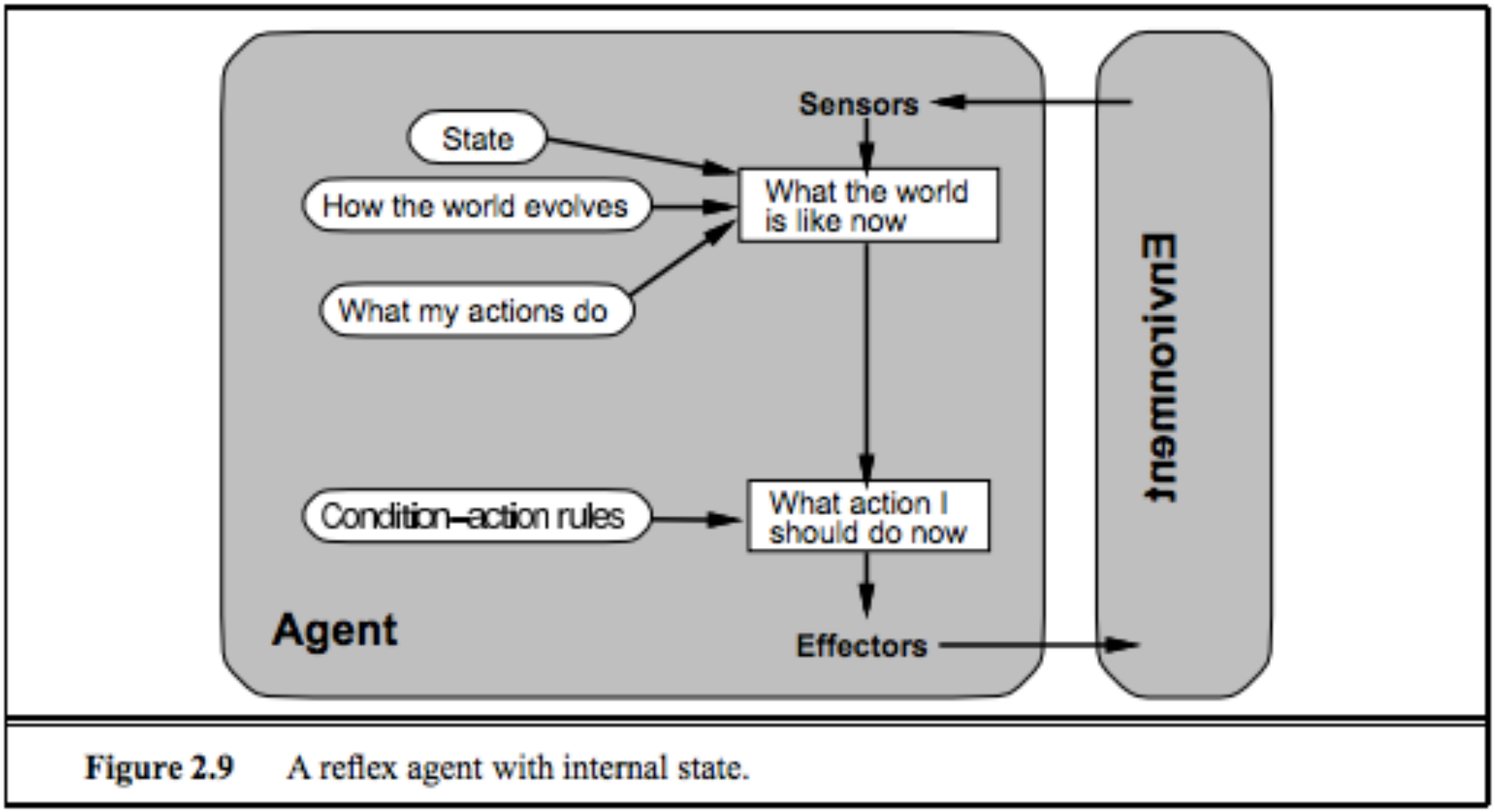


Figure 2.9 A reflex agent with internal state.

Gives memory capability

Ex: Goal-Based Agent

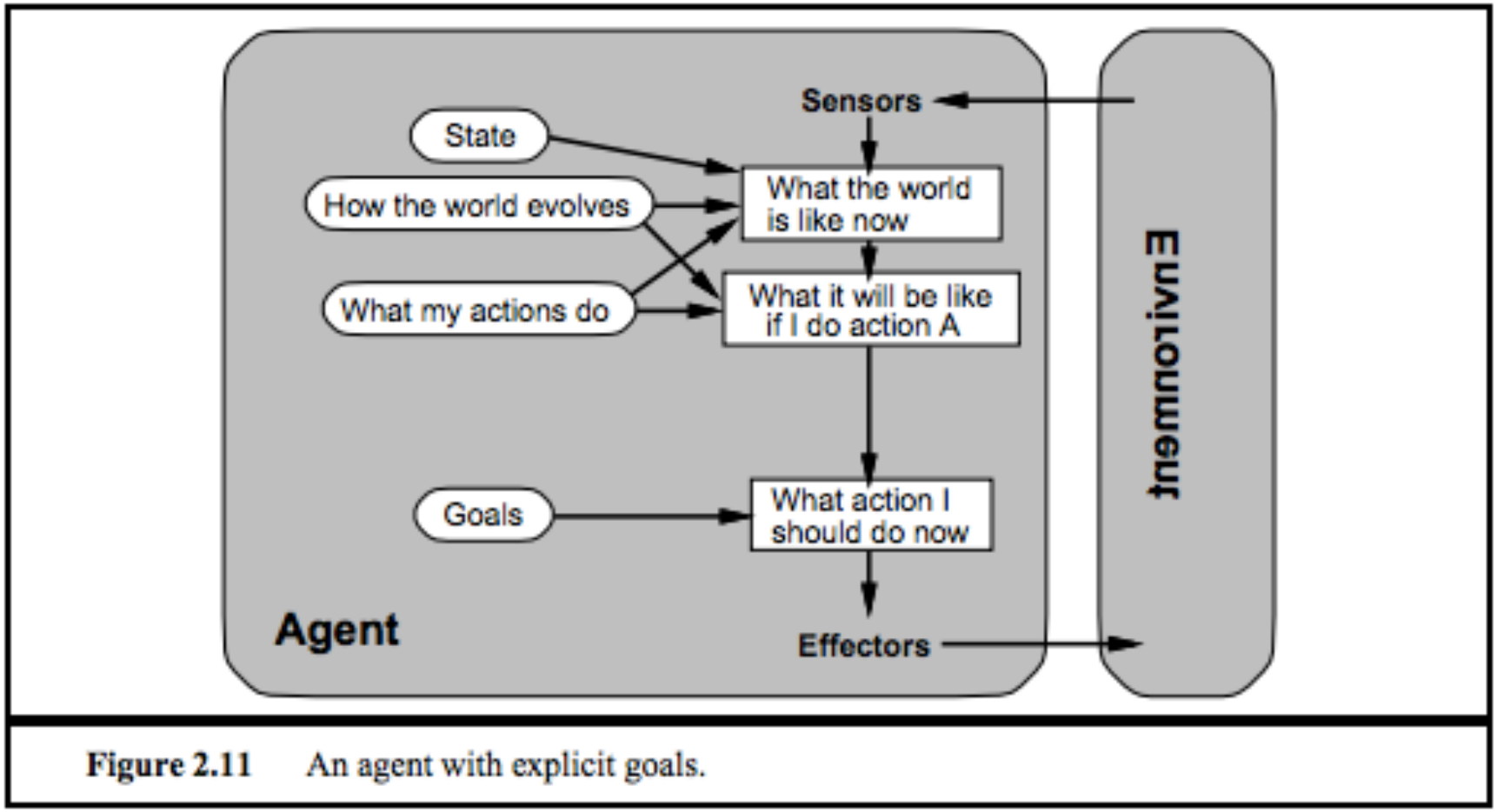


Figure 2.11 An agent with explicit goals.

Gives goals modeling + planning capability

Ex: Utility-Based Agent

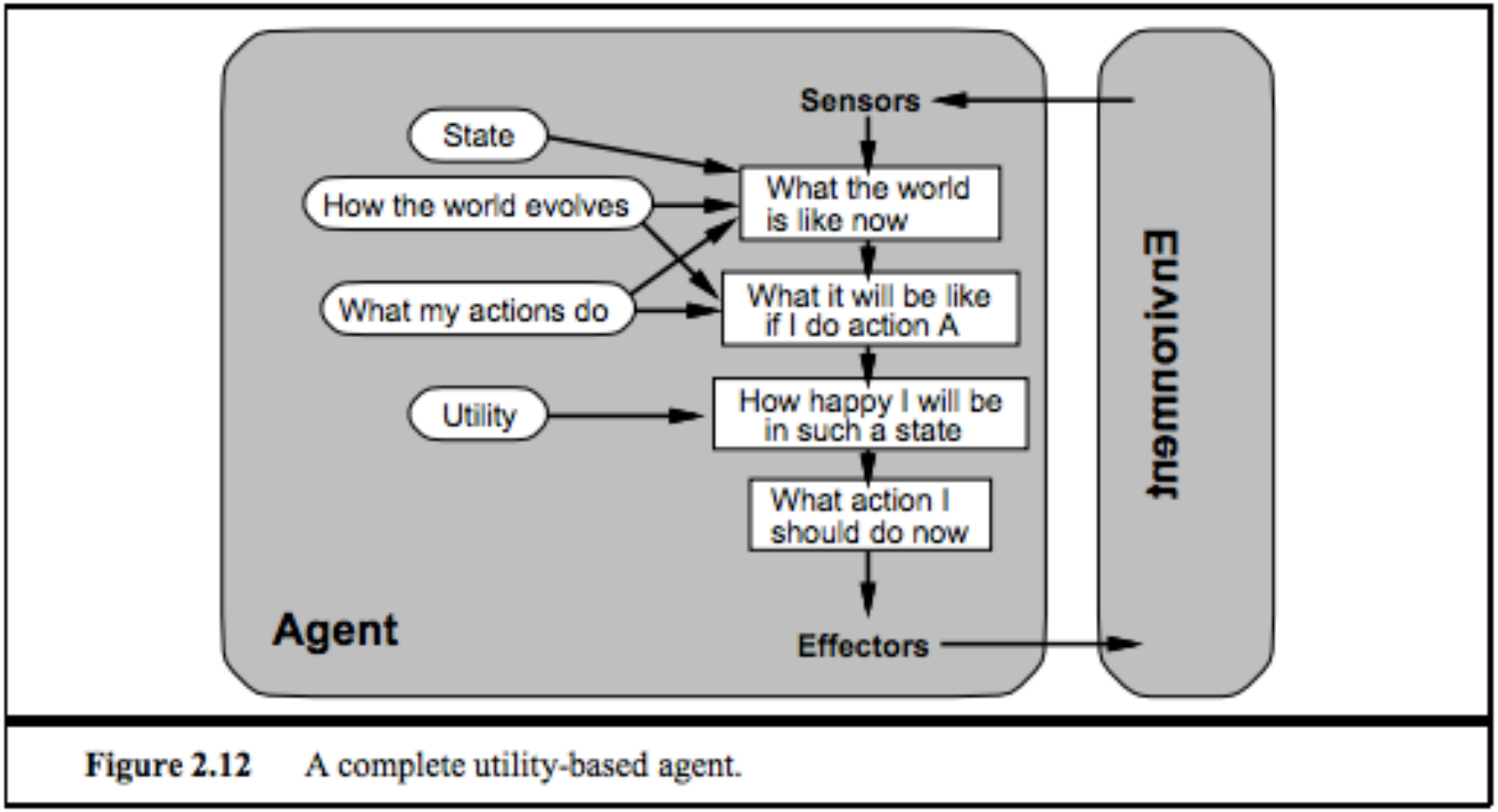
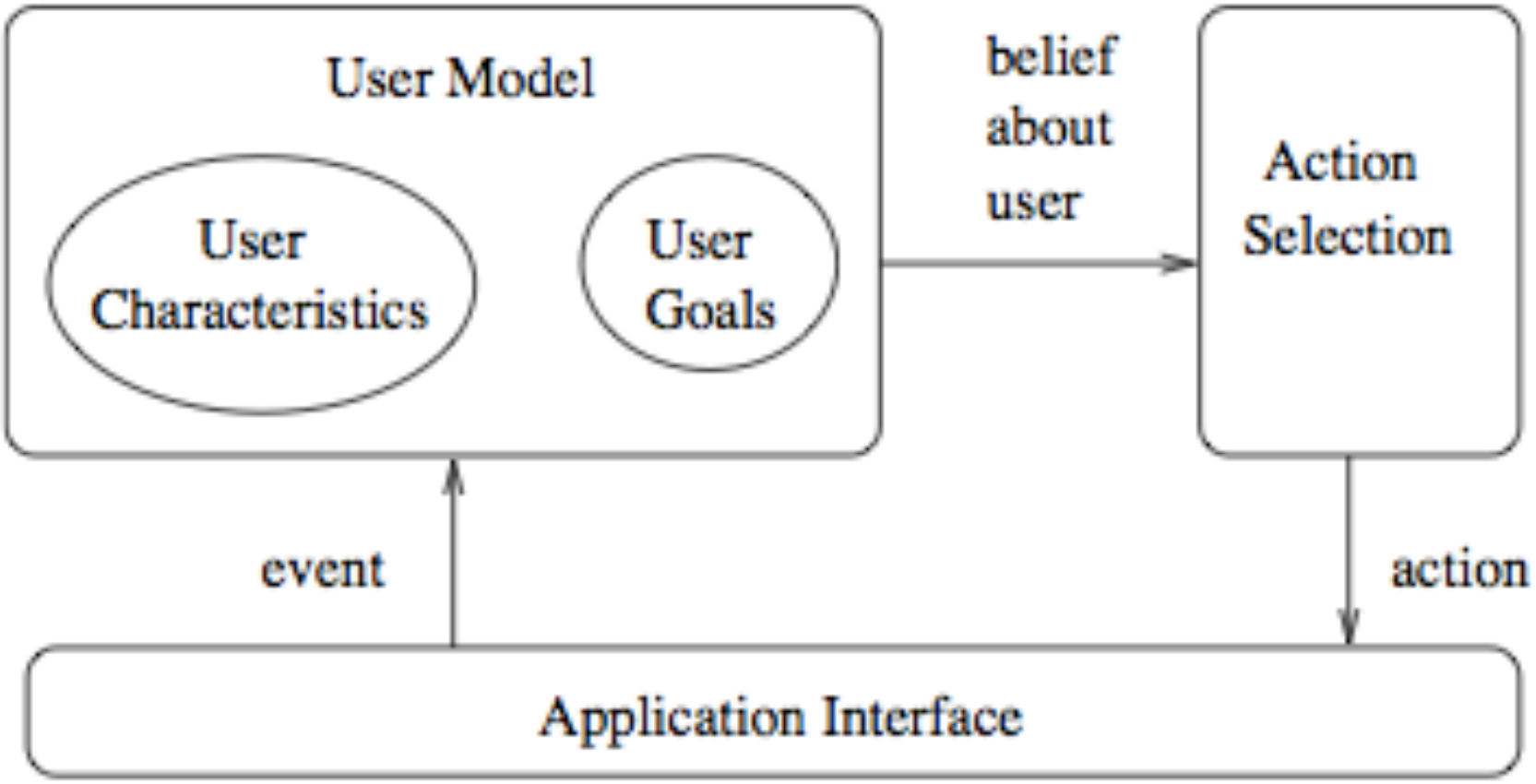


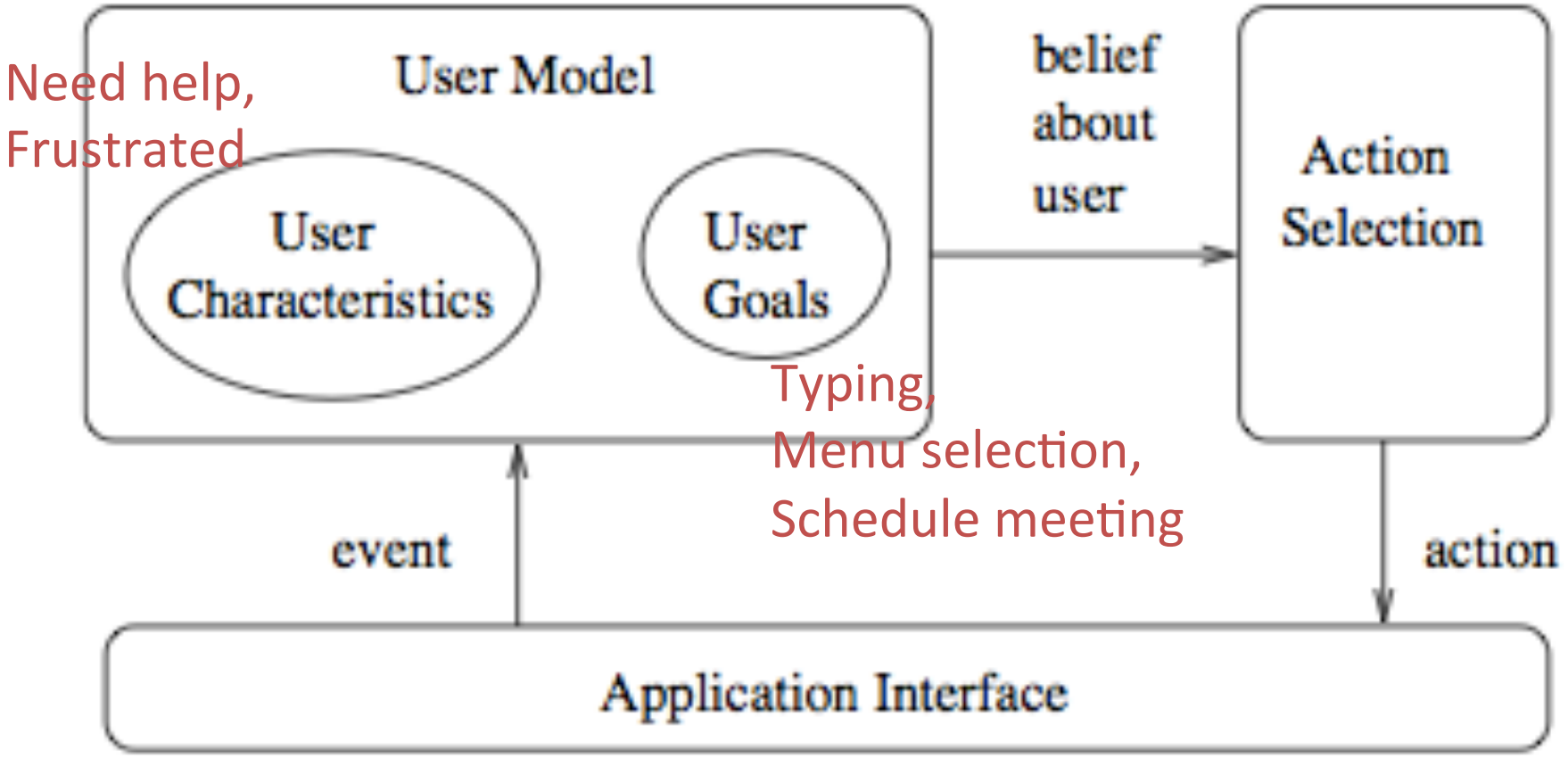
Figure 2.12 A complete utility-based agent.

Gives decision making capability

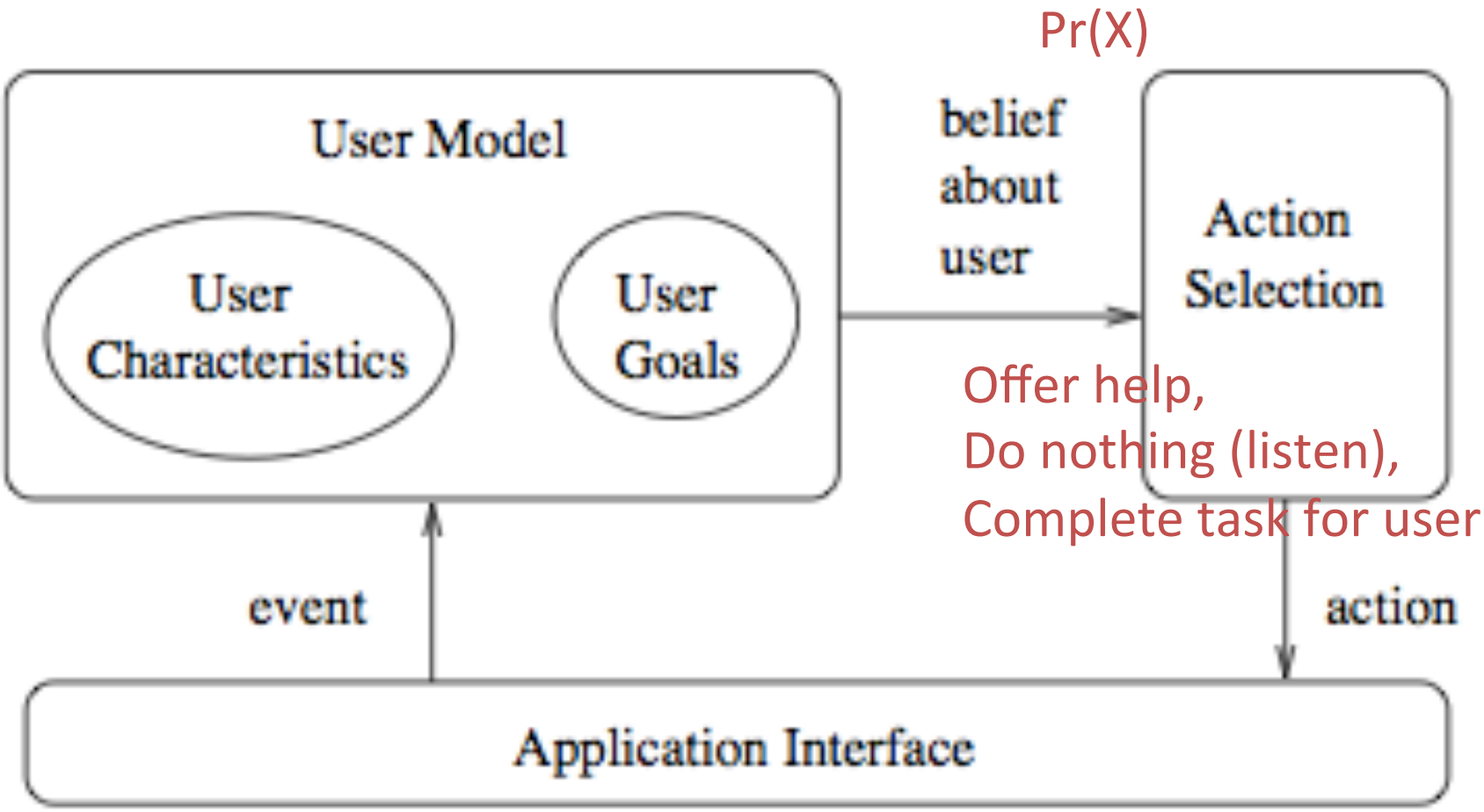
General IUI Architecture



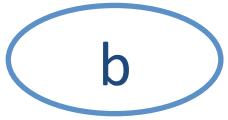
General IUI Architecture

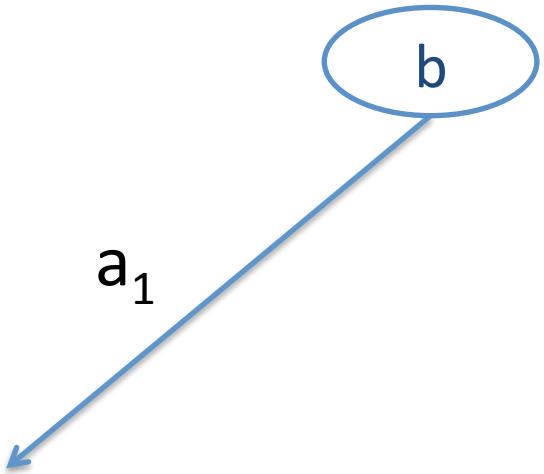


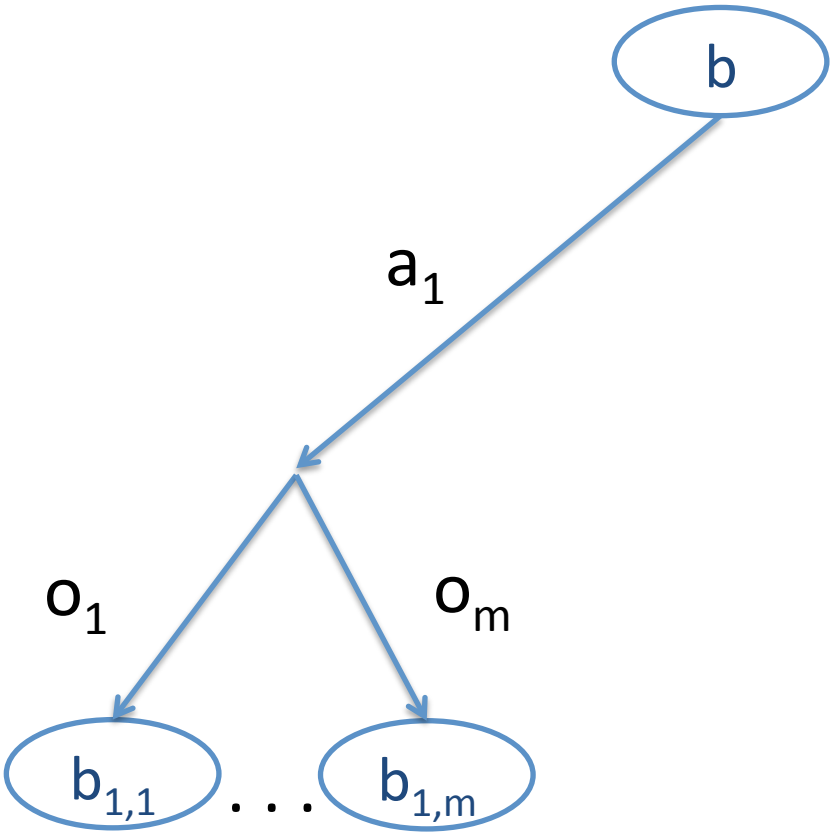
General IUI Architecture



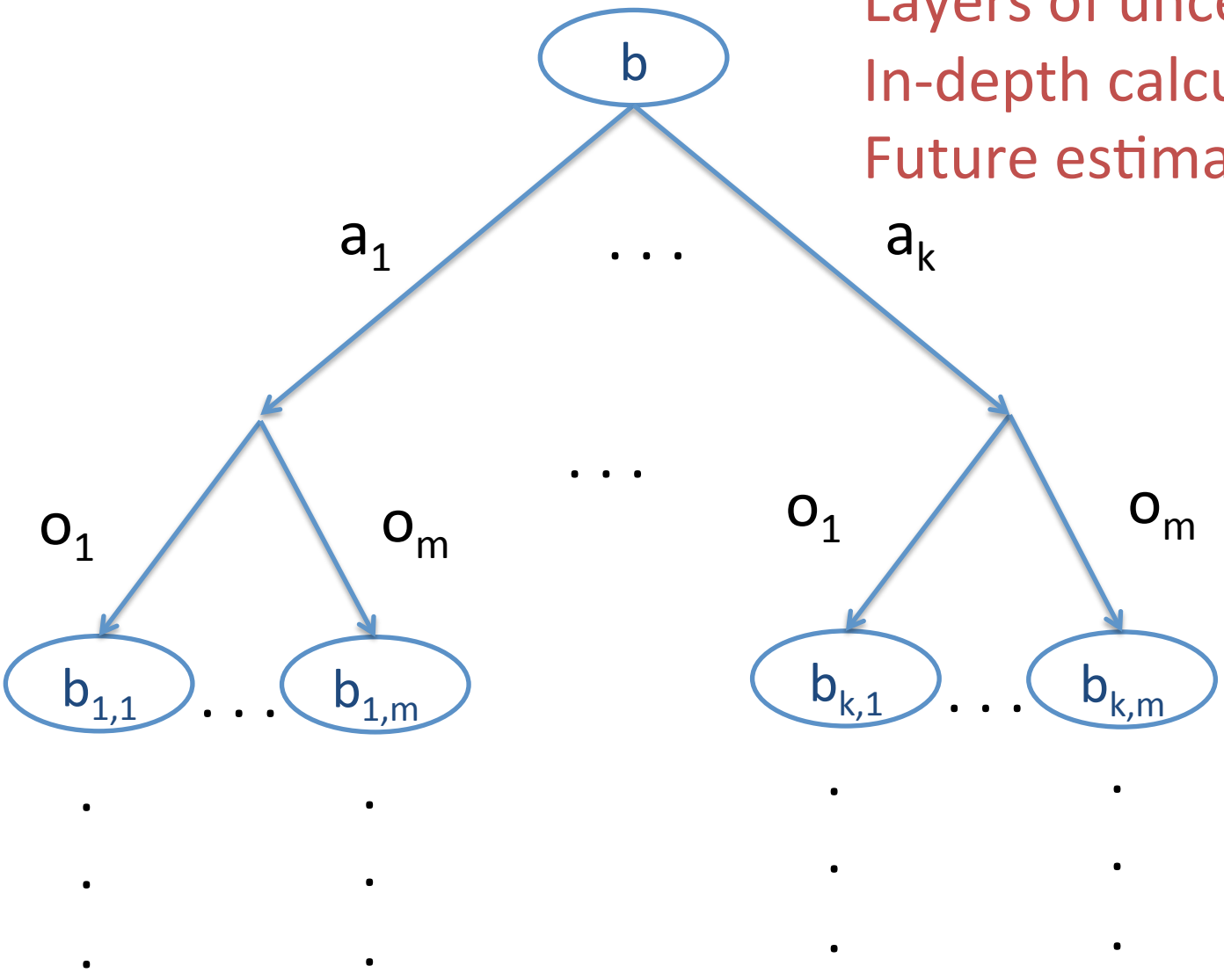
Motto: Agent is happy if the user is happy


b


b
a_1

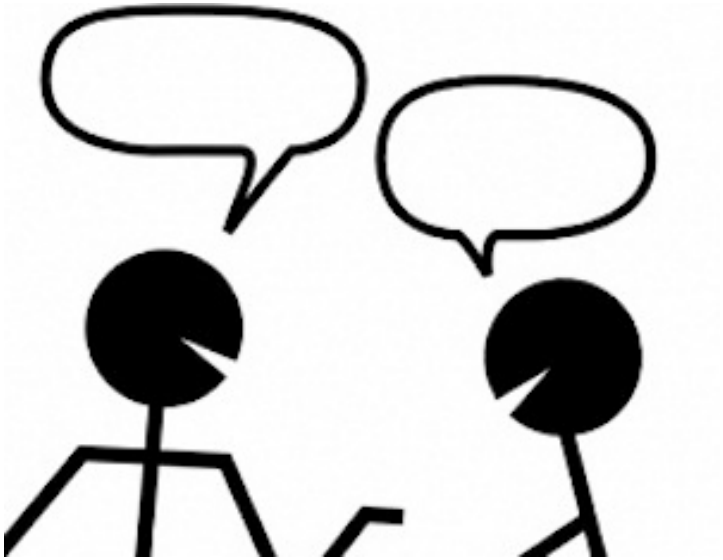

b
a_1
o_1
o_m
$b_{1,1}$
. . .
$b_{1,m}$

Complex!
Layers of uncertainties!
In-depth calculations!
Future estimations!



Mixed-Initiative (MI) Interaction

- Historically, user-initiated commands only
- Intelligent aspect is to have mixed-initiation
- Dialogue analogy:



- Imagine system-initiated commands only!

Ex: Command Line Interface

toCheck — bash — 111×36

```
-rw-r--r-- 1 bowen    7709 Aug 15  2002 groupware.eps
-rw-r--r-- 1 bowen    8571 Aug 17  2002 influenceC.eps
-rw-r--r-- 1 bowen   11153 Aug 17  2002 influence.eps
-rw-r--r-- 1 bowen   40140 Jun 15  2002 llncs.cls
-rw-r--r-- 1 bowen  122393 Aug 18  2002 maze.ps
drwxr-xr-x 2 bowen      29 Oct 26  2003 papers/
-rw-r--r-- 1 bowen    6076 Jul 26  2002 partialtax.eps
drwxr-xr-x 2 bowen      56 Aug 22  2002 pix/
-rw-r--r-- 1 bowen    7034 Aug 21  2002 ptree.eps
-rw-r--r-- 1 bowen    5276 Aug 21  2002 Rdistribution.eps
-rw-r--r-- 1 bowen   31142 Aug 14  2002 Rdistribution.ps
-rw-r--r-- 1 bowen    7739 Aug 14  2002 regcon.eps
-rw-r--r-- 1 bowen    6630 Aug 14  2002 regconG.eps
-rw-r--r-- 1 bowen    3892 Aug 14  2002 regconP.eps
-rw-r--r-- 1 bowen    4632 Aug 17  2002 RL.eps
-rw-r--r-- 1 bowen    6420 Aug 18  2002 RLtwoagents.eps
-rw-r--r-- 1 bowen    9942 Jul 25  2002 scheduling.eps
-rw-r--r-- 1 bowen   14770 Aug 17  2002 states.eps
-rw-r--r-- 1 bowen   10274 Aug 17  2002 statespaceC.eps
-rw-r--r-- 1 bowen    9920 Aug 17  2002 statespace.eps
-rw-r--r-- 1 bowen   12572 Aug 21  2002 suboptexplore.eps
(41)apps0:~/courses/2534/project>ls
actionpair.eps  draft.ps.gz         figure2.eps     llncs.cls          Rdistribution.ps  states.eps
bib-full.bib    draft.tex           figure3.eps     maze.ps            regcon.eps        statespaceC.eps
draft2.ps       elicitinterface.ps  final.tex       papers/            regconG.eps       statespace.eps
draft.bib       email.txt           floatfig.sty    partialtax.eps     regconP.eps       suboptexplore.eps
draft.dvi       faces.eps           groupware.eps   pix/               RL.eps
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bib-full.bib    email.txt           floatfig.sty    partialtax.eps     regconP.eps       suboptexplore.eps
```

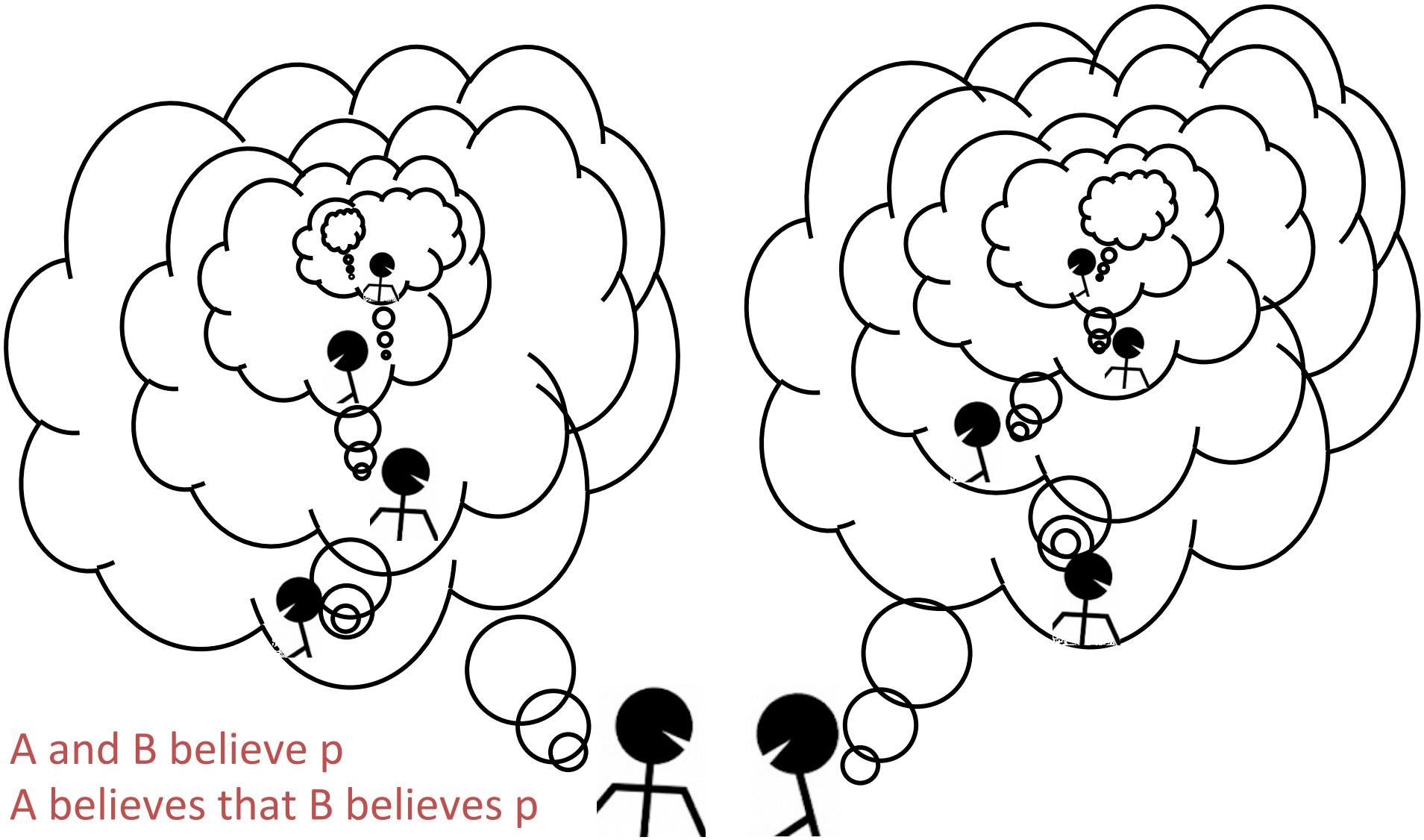
MI Goals

- Aims to support efficient, naturally interleaving contributions of work
- Both parties converge to same solution for a problem
- Objectives:
  - Solve a problem together
  - Achieve the same goal
  - Come to a common understanding
- Improve quality of interaction flow when working with computers

Difficulties

- How to establish common ground?
- What is the user's current focus of attention?
- What is the user's level of understanding of the problem?
- What are the user's beliefs?
- What are the user's abilities and intentions to contribute to solution?

Mutual Beliefs between A and B

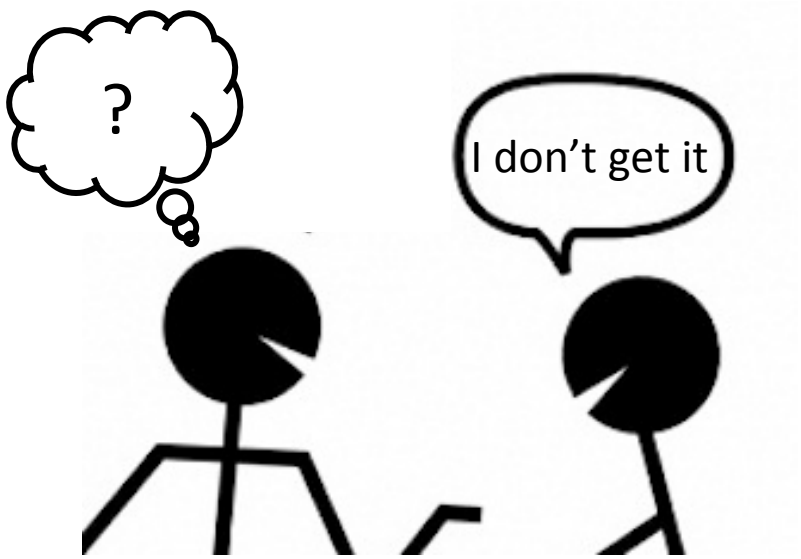


A and B believe p

A believes that B believes p

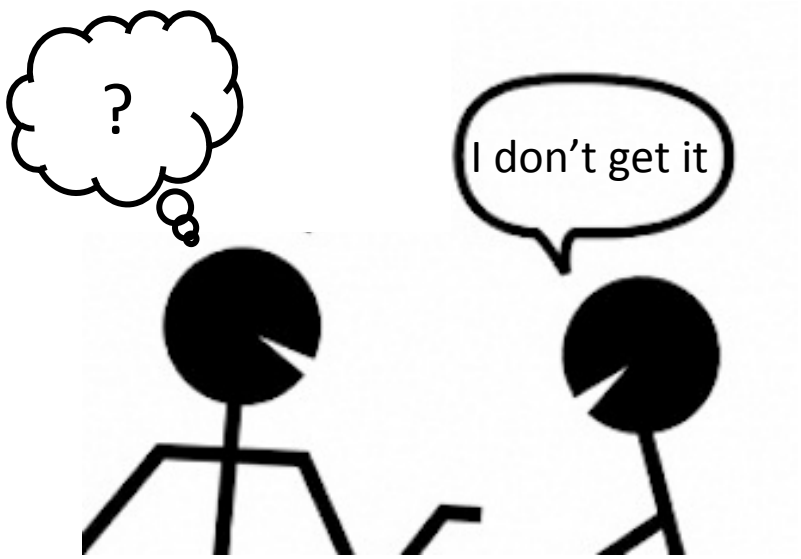
A believes that B believes that A believes p . . .

Ex: Intelligent Tutoring System



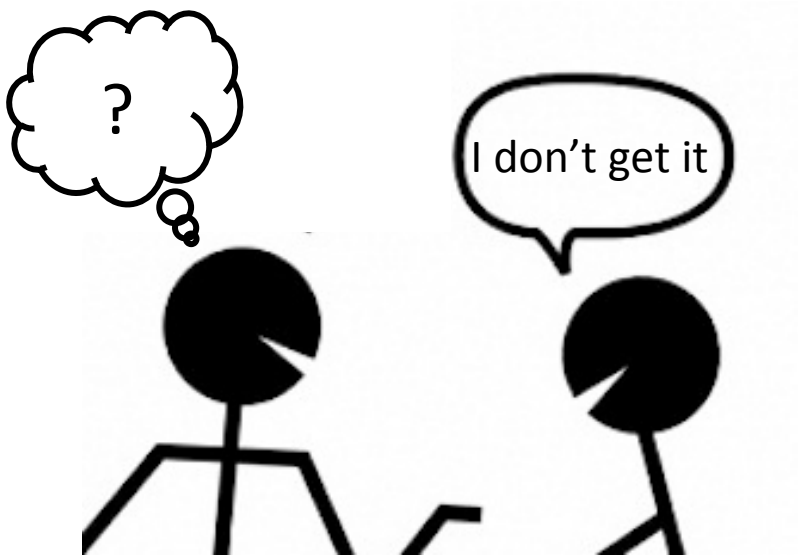
Ex: Intelligent Tutoring System

- Student's current level of understanding?
  - Student's focus, abilities, intentions
  - Student's past successes, mistakes, learning patterns



Ex: Intelligent Tutoring System

- Student's current level of understanding?
- How best to help student?
  - Watch, show similar example, give hint, give complete solution



Is It Any Good?

- Recall: IUIs do what users want
- General evaluation methods
  - Simulation across variety of scenarios
  - Empirical studies with variety of users
- Criteria based on metrics
  - E.g., time to select target
  - E.g., accuracy percentage in target selection
  - E.g., level of frustration perceived
- Comparisons of methods (benchmarking)

Major Challenges

- Modeling what users want
- Eliciting what users want
- Not knowing the “true” world state
- Planning and reasoning ahead
- Continually learning model parameters

Major Challenges

- Modeling what users want
  - Quantifying using a utility function
  - Shape of function? Additivity?
  - Based on what interaction principles?
  - Learning model parameters offline vs. online

Major Challenges

- Modeling what users want
- Eliciting what users want
  - What to ask, when, how often
  - What is the value of information?
  - What if they change? How do you know?

Major Challenges

- Modeling what users want
- Eliciting what users want
- Not knowing the "true" world state
  - Partial observability vs. full observability
  - Uncertainy about the state
  - Noise in the model
  - Complex mathematical models required

Major Challenges

- Modeling what users want
- Eliciting what users want
- Not knowing the "true" world state
- Planning and reasoning ahead
  - Expected costs and benefits of each action
  - Myopic decision making vs. N-step look-ahead vs. long term decision making
  - Complex mathematical models required

Class Topics

- Adaptable vs. adaptive interfaces
- Natural language interfaces
- Social media analysis
- User types
- Activity recognition

Logistics

- Next class:
  - Systems that Adapt to their Users (Bowen)
  - Socially-Adaptable Interfaces: Crowdsourcing Customization (?)
- Presentation rotation
- Paper review form
- Study material: logic, probability

Additional Image References

- http://www.deepakarora.com/how-to-hide-your-email-address-from-spam-robots/
- http://media-dis-n-dat.blogspot.ca/2010/07/speech-recognition-software-continues.html
- http://www.time.com/time/specials/packages/article/0,28804,1991915_1991909_1991755,00.html
- http://www.cs.berkeley.edu/~russell/aima1e/chapter02.pdf
- http://themediaonline.co.za/2012/01/fun-client-conversations-or-nobody-likes-to-be-first/
- https://www.msimaging.com/services/ediscovery/advanced-review-tools/
- http://email-organization.com/email_productivity_solutions/email_productivity_best_practices.html