Common Viewpoint

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Establishing a Common Viewpoint

- Align internal representations of shared domain
- Mediate by multiple representations of domain of activity
- Shared external representation does not guarantee common viewpoint

Context Dependent

- Physical context
- History of the activity
- Representational system
- Design of task environment
- Coordinating representation
  - Shared external representation
  - Mediates the alignment of individual representations of collaborative activities

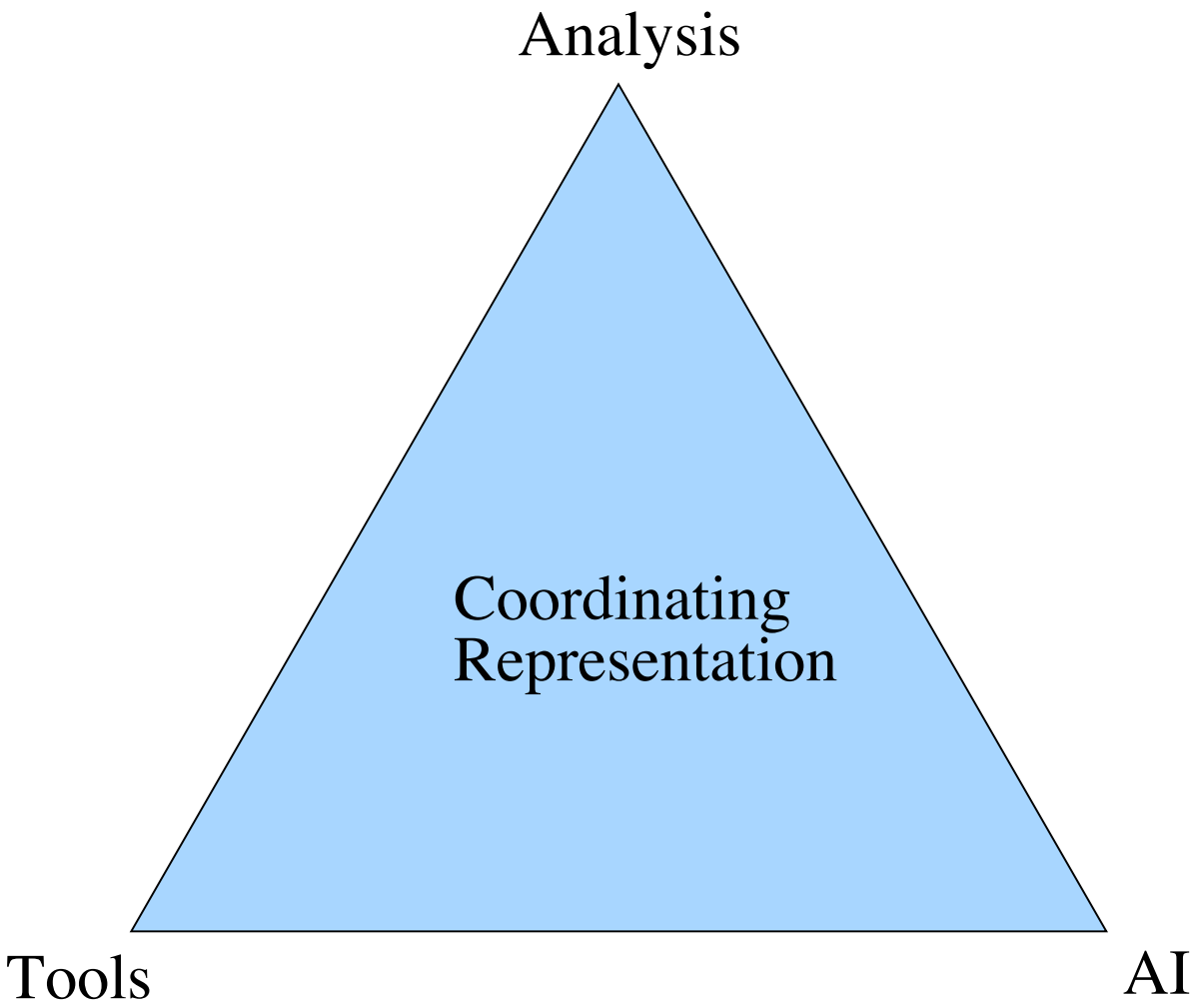
Computer-Mediated Cooperation

- Groupware system supports groups of people engaged in a common task (or goal)
  - Provide an interface to shared environments
  - Facilitate communication, coordination, and collaboration of group effort
- All of interaction data available
- Groupware provides representational system
- Same time/ Different Place

Basic Methodology
(As cognitive engineering task)

Assume history of collaboration within community:

1. Base system includes only general purpose coordination methods (whiteboard, chat)
   - Sometimes this is enough
2. Otherwise, **analyze interaction**
3. Rebuild systems using coordinating representations


Analysis
Coordinating
Representation
Tools
AI

Rest of Talk

- Analysis
  - Tools and methods (Alex Feinman)
- New Domains
  - Groupware construction toolkit (Seth Landsman)
- AI
  - Intent Inference (Josh Introne)

Analysis & Tools

Talk & Action

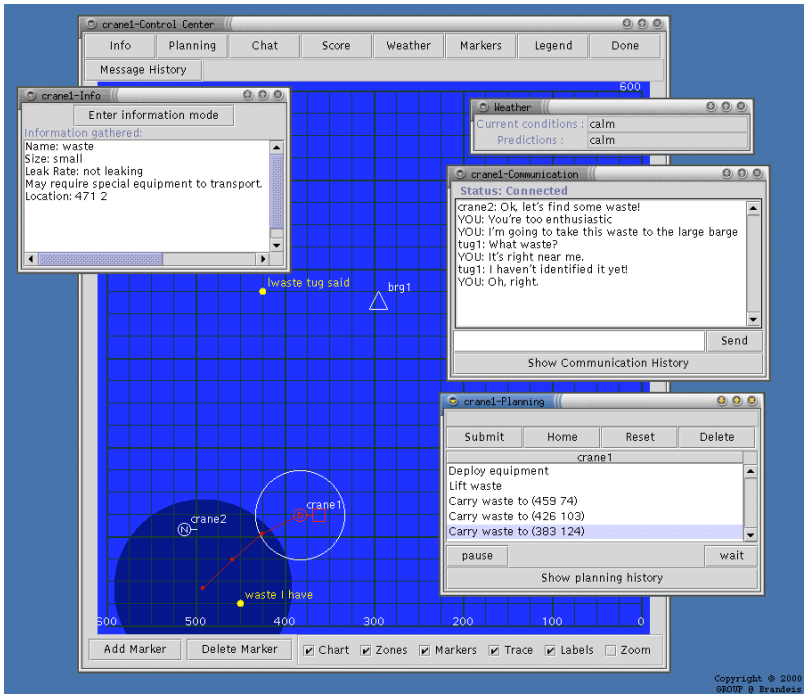
- Misaligned individual representations lead to problems of coordination
- Cooperating actors require communication to coordinate
- Difficulty at coordination and the amount of talk in coordinating a joint behavior are directly related
- Talk produces structure that organizes activity

Analysis: Coordination Work

- Analyze coordination work as it reflected in discourse of participants
  - Recurrent patterns of coordination
  - Repeated errors or trouble spots in coordination
  - Development of organizational structure

Adjacency pairs for close coordination

1. Crane1: sub lift
2. Crane2: LL
3. Crane2: k
4. Crane2: sub load
5. Tug1: the next XL needs nothing
6. Crane1: k
7. Crane2: ok, then XLD right?
8. Crane2: sub Lift
9. Tug1: yep
10. Crane1: k
11. Crane2: sub load
12. Crane1: k
13. Crane2: sub sep
14. Crane1: sep



Evaluation

- Compare groups with/without Coordinating Representations
- Training + 10 hours of problem-solving
- 3 groups without & 3 groups with CR's
  - 49% improvement in clock time
  - 38% reduction in the number of events generated
  - 57% reduction in the amount of electronic chatting
  - 61% reduction in total errors
- The high-level planning CR was not used

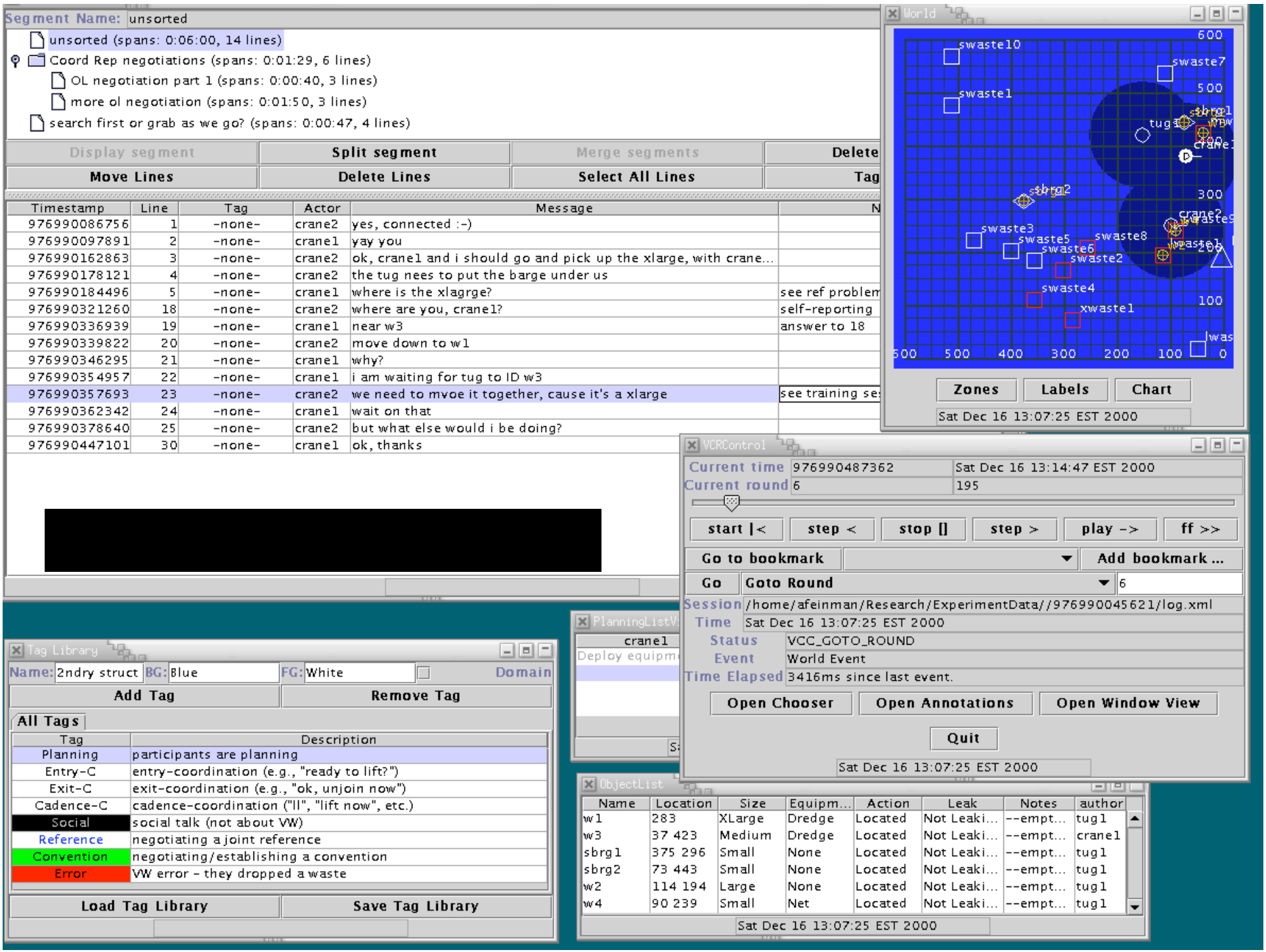
Analysis: Referential Structure

- Discourse analysis techniques for examining cognitive load of communication
- Track referential structure
  - Plans, domain objects
- Measure cognitive load using features like duration of relevance and frequency of reference
- Cognitively model as working memory and reading/writing plans

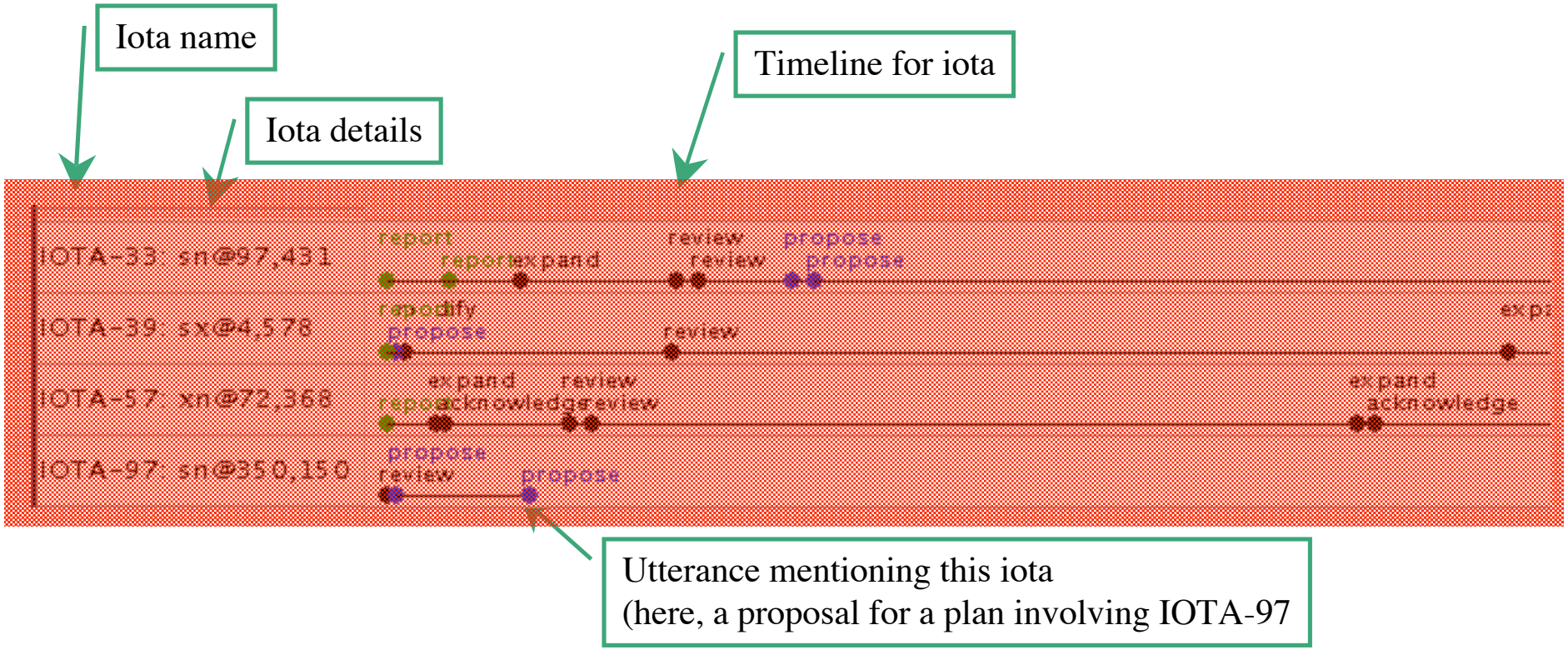
Data Summary

Iota Type	% seen	Refs	Lifespan	Density
Plan	57%	3.4	12.0	28.5%
Waste	17%	6.6	168.7	3.9%
Repair	8%	3.0	4.8	62.5%
Location	8%	2.6	62.6	4.2%
Barge	4%	11.9	294.0	4.0%
Vessel	4%	3.1	183.6	1.7%
Convention	2%	5.5	109.5	5.0%

- Plan iotas have short lifespan, high density
- Waste iotas have long lifespan, low density
- Locations have moderate lifespan, low density
- Repairs have very short lifespan, very high density

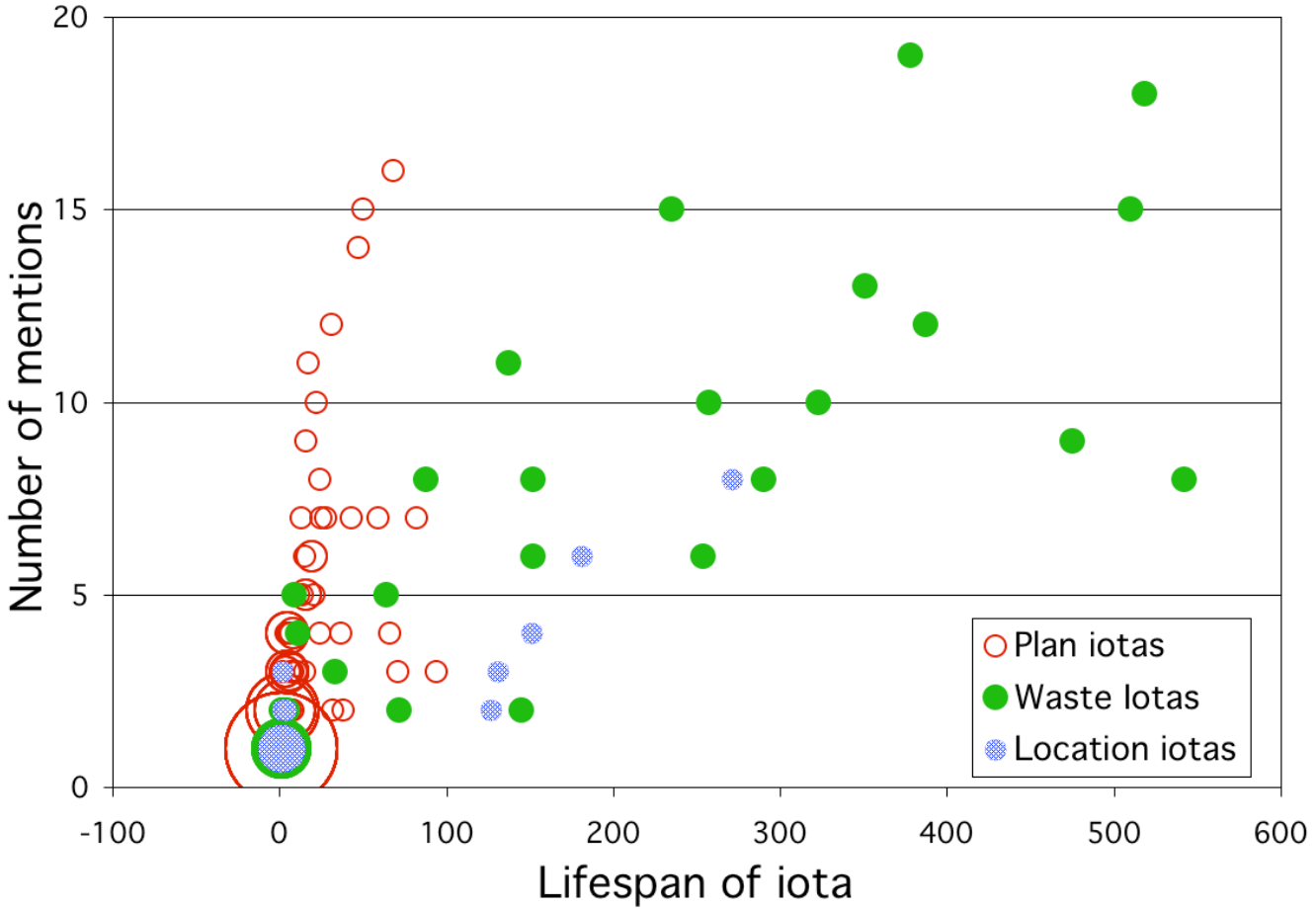

Segment Name: unsorted
unsorted (spans: 0:06:00, 14 lines)
Coord Rep negotiations (spans: 0:01:29, 6 lines)
OL negotiation part 1 (spans: 0:00:40, 3 lines)
more ol negotiation (spans: 0:01:50, 3 lines)
search first or grab as we go? (spans: 0:00:47, 4 lines)
Display segment
Split segment
Merge segments
Delete
Move Lines
Delete Lines
Select All Lines
Tag
Timestamp Line Tag Actor Message
976990086756 1 -none- crane2 yes, connected :-)
976990097891 2 -none- crane1 yay you
976990162863 3 -none- crane2 ok, crane1 and i should go and pick up the xlarge, with crane...
976990178121 4 -none- crane2 the tug nees to put the barge under us
976990184496 5 -none- crane1 where is the xlagrge?
976990321260 18 -none- crane2 where are you, crane1?
976990336939 19 -none- crane1 near w3
976990339822 20 -none- crane2 move down to w1
976990346295 21 -none- crane1 why?
976990354957 22 -none- crane1 i am waiting for tug to ID w3
976990357693 23 -none- crane2 we need to mvoe it together, cause it's a xlarge
976990362342 24 -none- crane1 wait on that
976990378640 25 -none- crane2 but what else would i be doing?
976990447101 30 -none- crane1 ok, thanks
see ref problem
self-reporting
answer to 18
see training se
World
swaste10
swaste7
swaste1
sbrg1
tug1
crane1
sbrg2
crane2
swaste3
swaste5
swaste8
swaste6
swaste2
swaste4
xwaste1
600
500
400
300
200
100
0
Zones
Labels
Chart
Sat Dec 16 13:07:25 EST 2000
VCRControl
Current time 976990487362 Sat Dec 16 13:14:47 EST 2000
Current round 6 195
start |<
step <
stop []
step >
play ->
ff >>
Go to bookmark
Add bookmark ...
Go
Goto Round
6
Session /home/afeinman/Research/ExperimentData//976990045621/log.xml
Time Sat Dec 16 13:07:25 EST 2000
Status VCC_GOTO_ROUND
Event World Event
Time Elapsed 3416ms since last event.
Open Chooser
Open Annotations
Open Window View
Quit
Sat Dec 16 13:07:25 EST 2000
Tag Library
Name: 2ndry struct
BG: Blue
FG: White
Domain
Add Tag
Remove Tag
All Tags
Tag Description
Planning participants are planning
Entry-C entry-coordination (e.g., "ready to lift?")
Exit-C exit-coordination (e.g., "ok, unjoin now")
Cadence-C cadence-coordination ("ll", "lift now", etc.)
Social social talk (not about VW)
Reference negotiating a joint reference
Convention negotiating/establishing a convention
Error VW error - they dropped a waste
Load Tag Library
Save Tag Library
PlanningListV
crane1
Deploy equipm
ObjectList
Name Location Size Equipm... Action Leak Notes author
w1 283 XLarge Dredge Located Not Leaki... --empt... tug1
w3 37 423 Medium Dredge Located Not Leaki... --empt... crane1
sbrg1 375 296 Small None Located Not Leaki... --empt... tug1
sbrg2 73 443 Small None Located Not Leaki... --empt... tug1
w2 114 194 Large None Located Not Leaki... --empt... tug1
w4 90 239 Small Net Located Not Leaki... --empt... tug1
Sat Dec 16 13:07:25 EST 2000

Analyzing Referential Structure of Discourse



- Plans have short lifespan, very high density
- Wastes have long lifespan, short density

Visualizing the Data, cont.

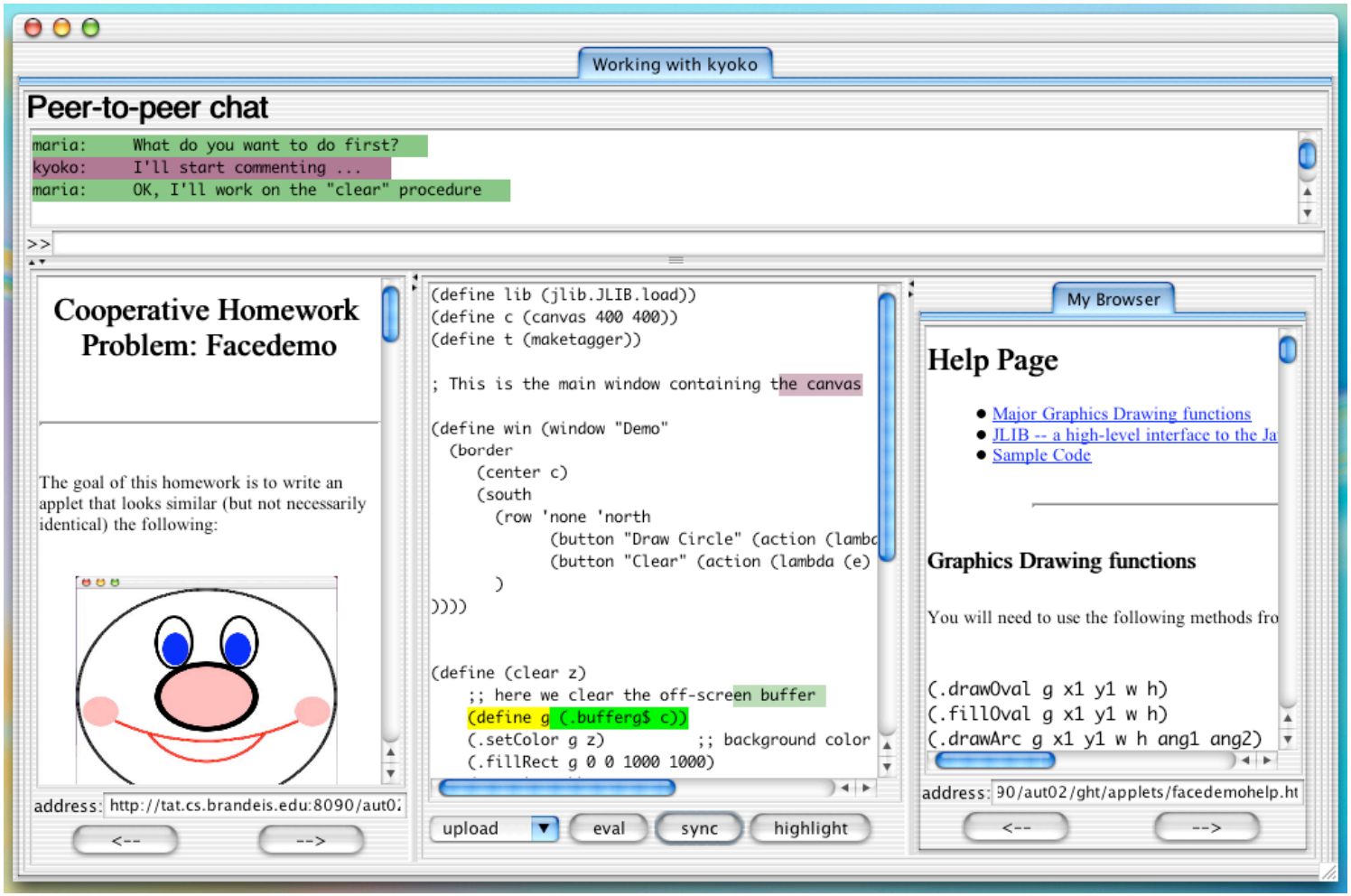


- Scatter plot
  - Reveals clustering by types of iotas

New Domains &
Groupware Construction Kit

Group Homework Tool

(work with Tim Hickey)



Groupware Construction Toolkit: THYME

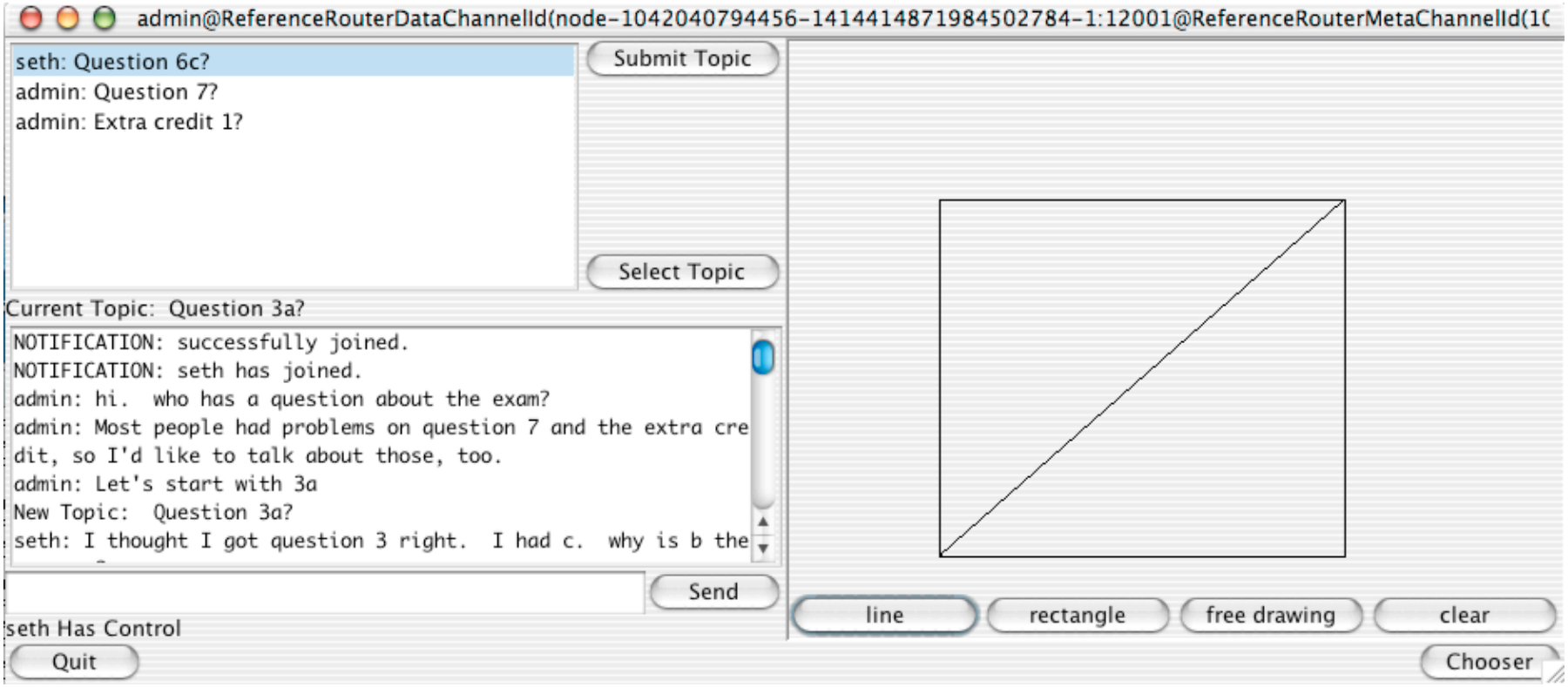
- Component-oriented architecture for construction groupware applications
  - Shared Whiteboard
  - Chat Room
  - Shared Browser
- Semi-automatically provides analysis capabilities
  - Transcript
  - Replay tool

HCI Class Project

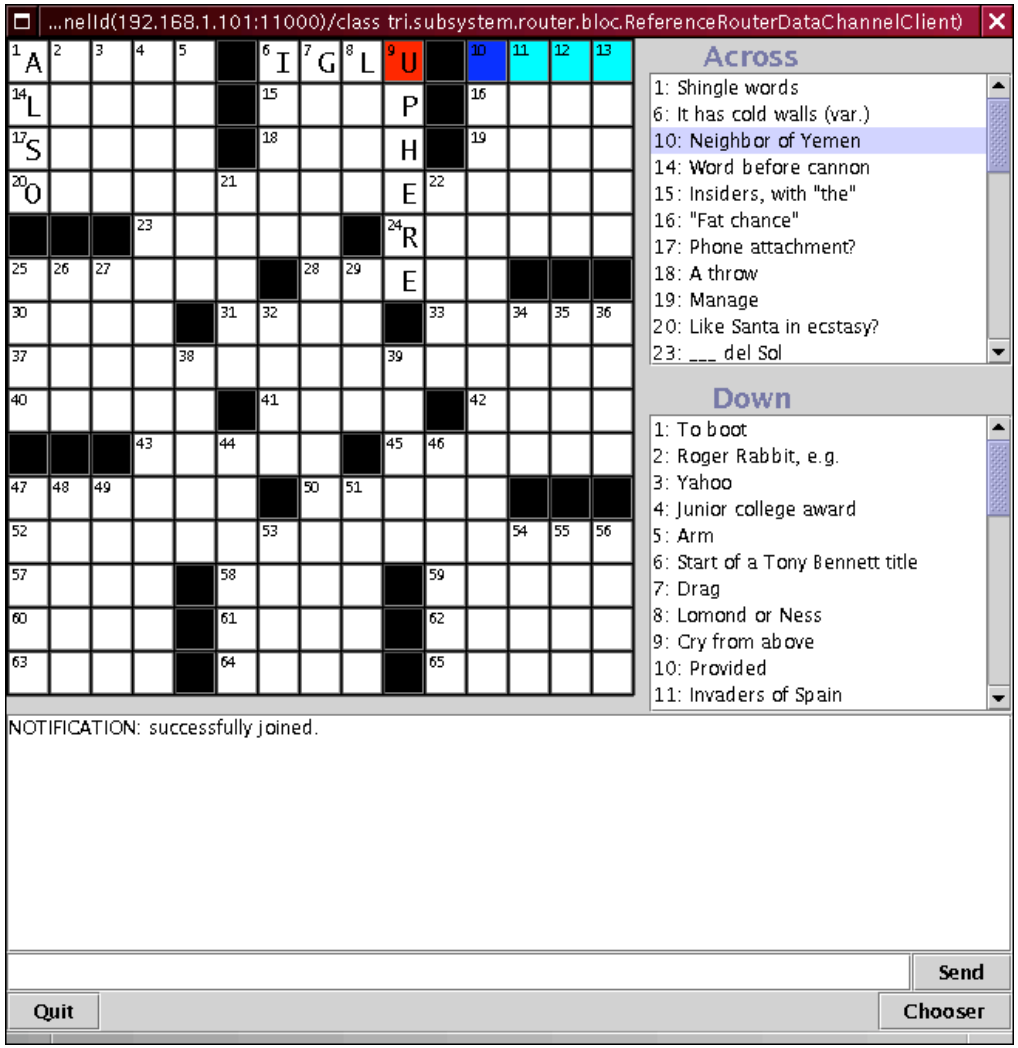
- Every group used THYME and completed a project
  - Amount of code that had to be written by the the developers was minimal
  - Students given about a month to build groupware system
- Several outstanding projects (all of these are functional)
  - Online Research Assistant
  - Online discussion tool.
  - Crossword Puzzle
  - Dominos
  - Resident Assistant Scheduler
  - Counterstrike Strategy
  - Multiplayer strategy game

Online Research Assistant

Online Discussion Tool



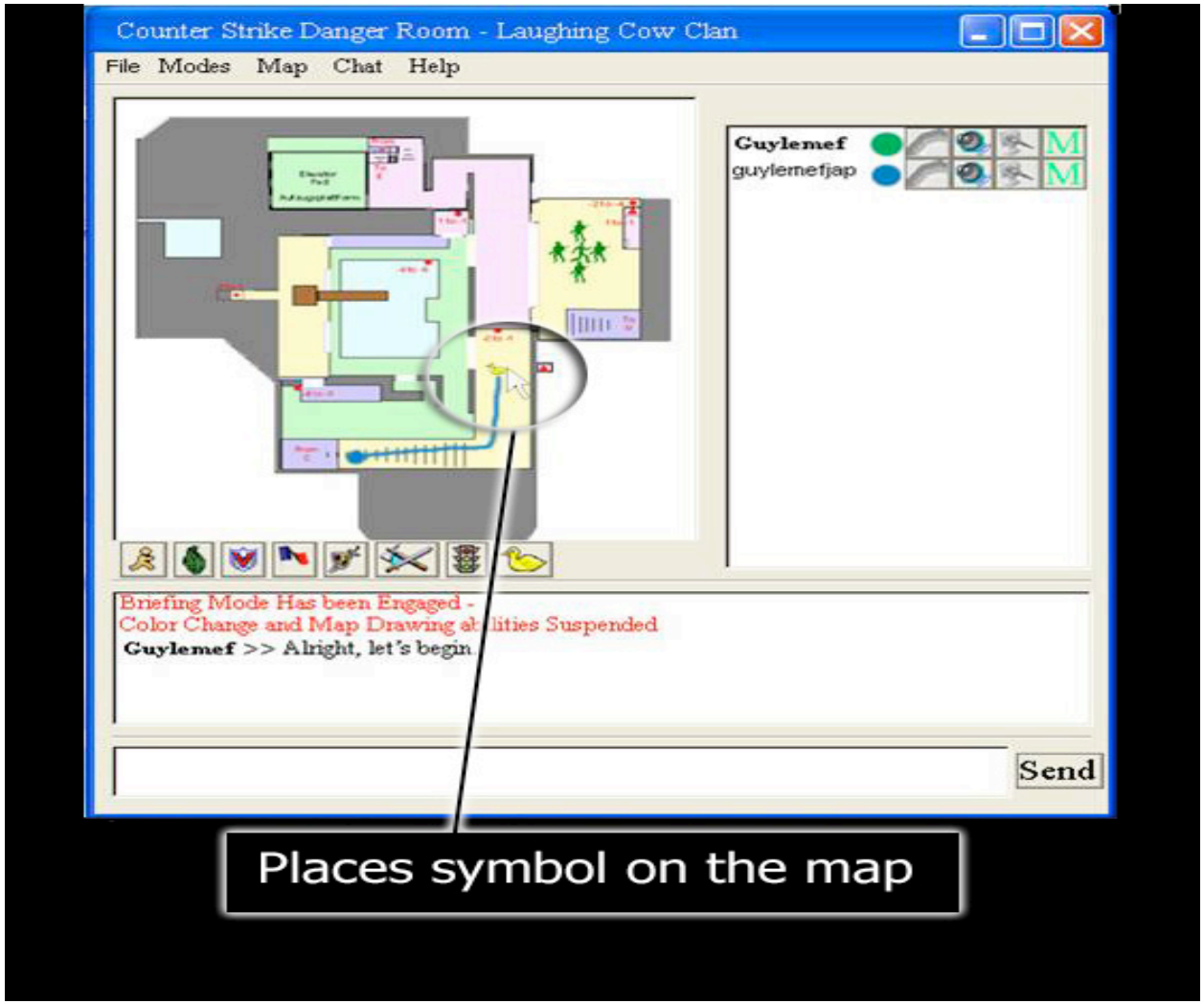
Crossword


...nelId(192.168.1.101:11000)/class tri.subsystem.router.bloc.ReferenceRouterDataChannelClient)
Across
1: Shingle words
6: It has cold walls (var.)
10: Neighbor of Yemen
14: Word before cannon
15: Insiders, with "the"
16: "Fat chance"
17: Phone attachment?
18: A throw
19: Manage
20: Like Santa in ecstasy?
23: ___ del Sol
Down
1: To boot
2: Roger Rabbit, e.g.
3: Yahoo
4: Junior college award
5: Arm
6: Start of a Tony Bennett title
7: Drag
8: Lomond or Ness
9: Cry from above
10: Provided
11: Invaders of Spain
NOTIFICATION: successfully joined.
Send
Quit
Chooser

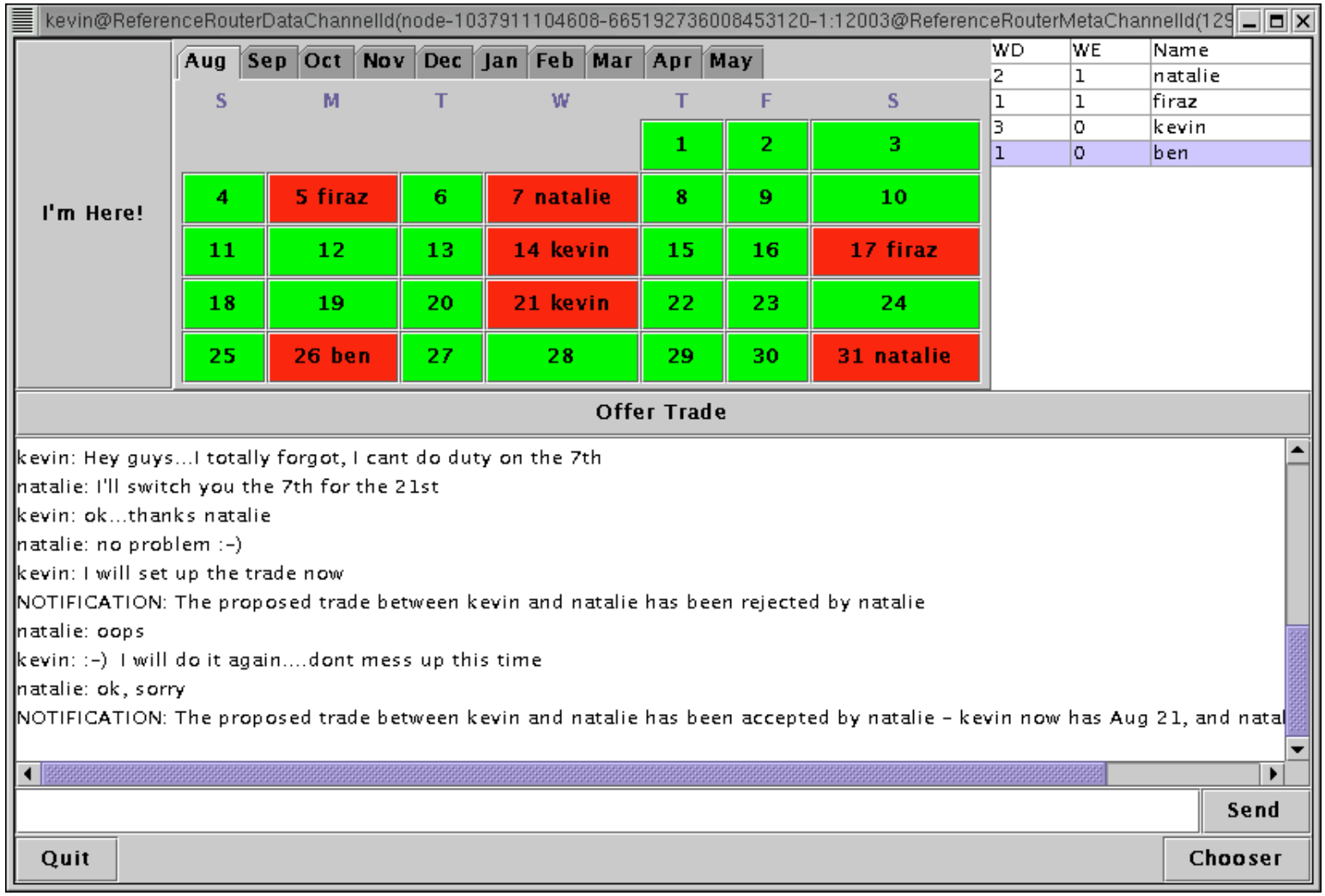
Dominos


seth@ReferenceRouterDataChannelId(node-1041889993826-6779096085214676992-1:12001@ReferenceRouterMetaChannelId(192.168.42.80:11000
File View Help
seth
boneyard
30
tiles
It is foo's turn.
Draw from Boneyard
Help
Confirm Moves
Start Game
End Game
Would you like to play teams?
Team 1 Team 2 Team 3
Name Team Tiles Turn
seth 13
foo 9
Kick Player
Exit Room
Automatic Horizontal Vertical Flip/Rotate
****NOTIFICATION: successfully joined.
****NOTIFICATION: seth has joined.
****NOTIFICATION: seth is currently hosting this game room.
****NOTIFICATION: foo has joined.
****NOTIFICATION: The host just started the game.
****NOTIFICATION: The room is now closed to new entry.
****NOTIFICATION: IT IS NOW foo'S TURN.
****NOTIFICATION: IT IS NOW seth'S TURN.
****NOTIFICATION: IT IS NOW foo'S TURN.
seth: I'm losing badly.
Send

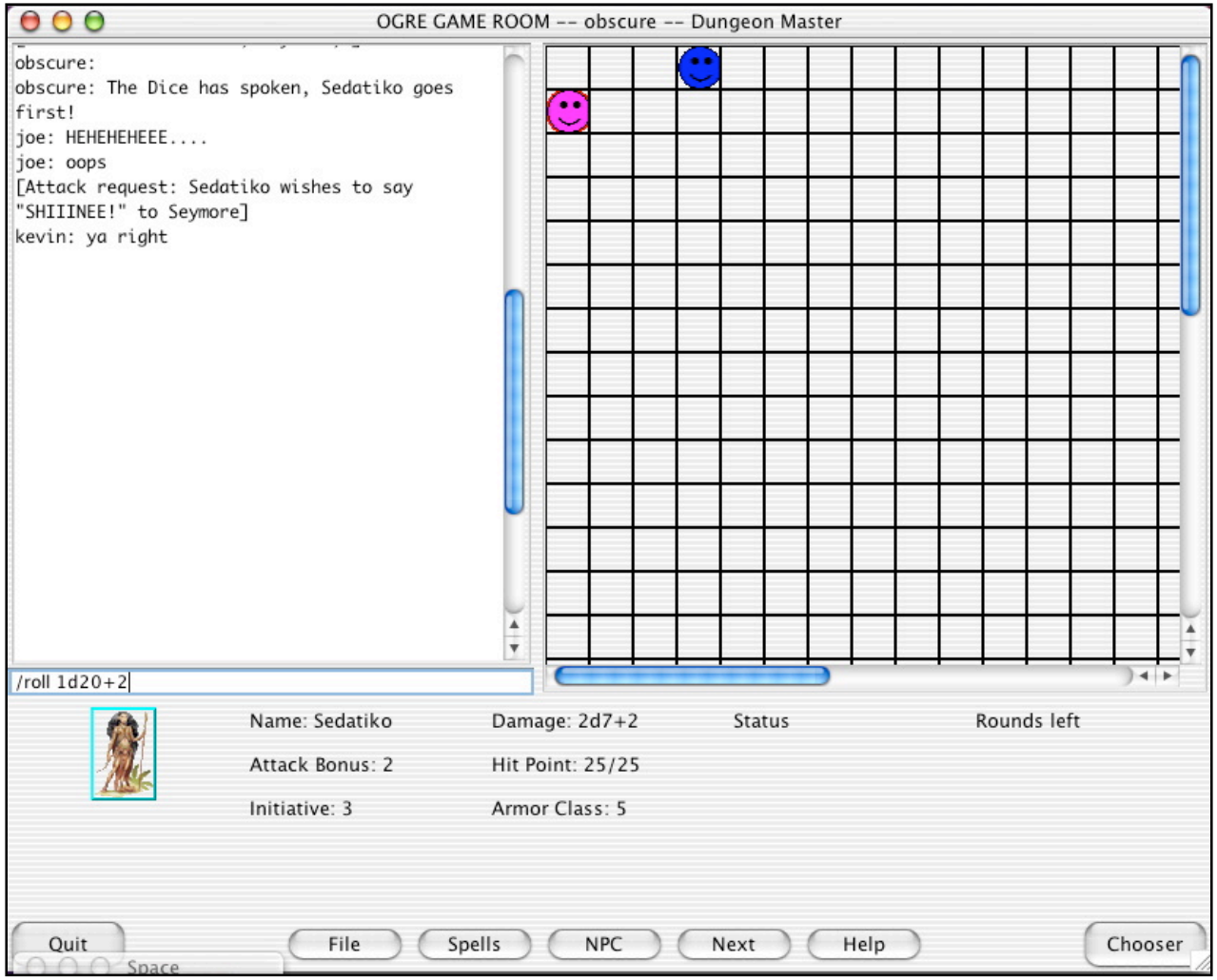
Counterstrike Strategy



RA Scheduler



Multiplayer Strategy Game



of Projects that Modified Components

- Implemented New Components: 2
- Extended Components: 2
- Modified Shared Whiteboard: 3
- Modified Chat room: 2
- Hijacked Chat room: 2
- Used supplied components: 4

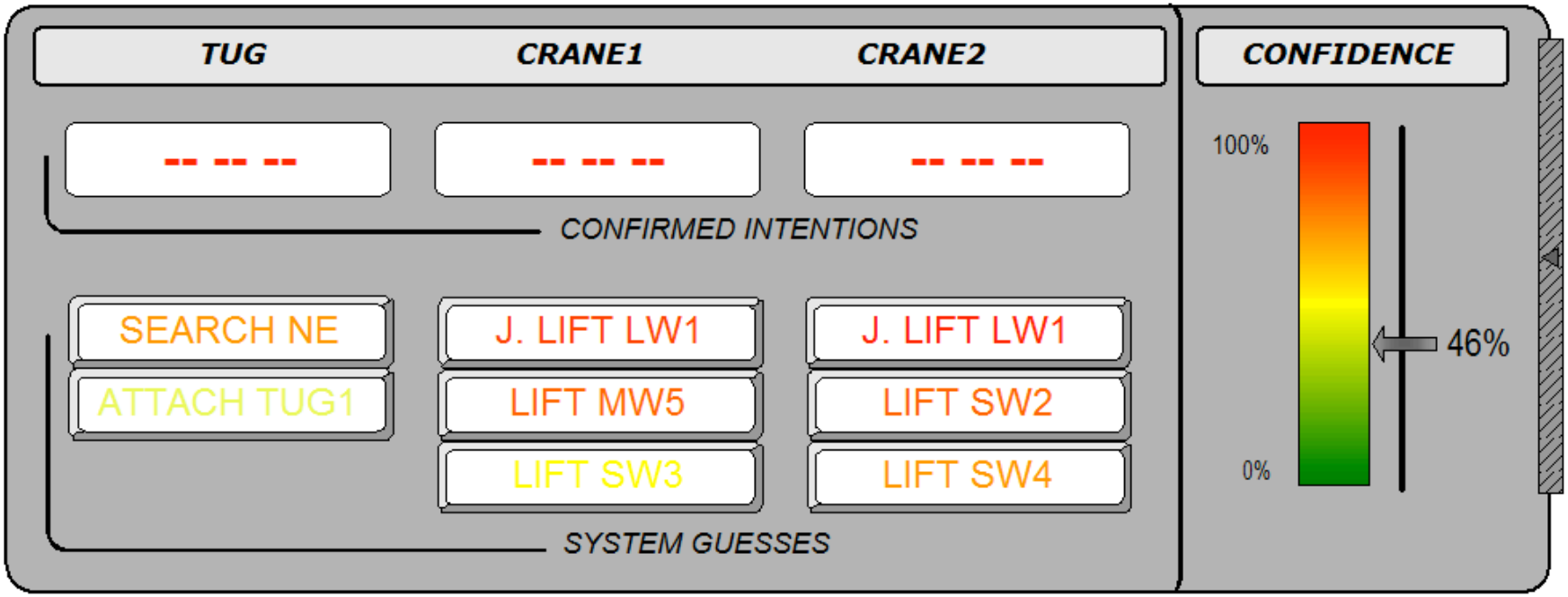
AI & Intent Inference

Adaptive Capability

- Groupware supports user efforts to stay coordinated
  - Design Time
  - Runtime adaptations
- Coordination requires the users infer one another's intentions
- Make this easier by automatically inferring intent, and providing this information to users

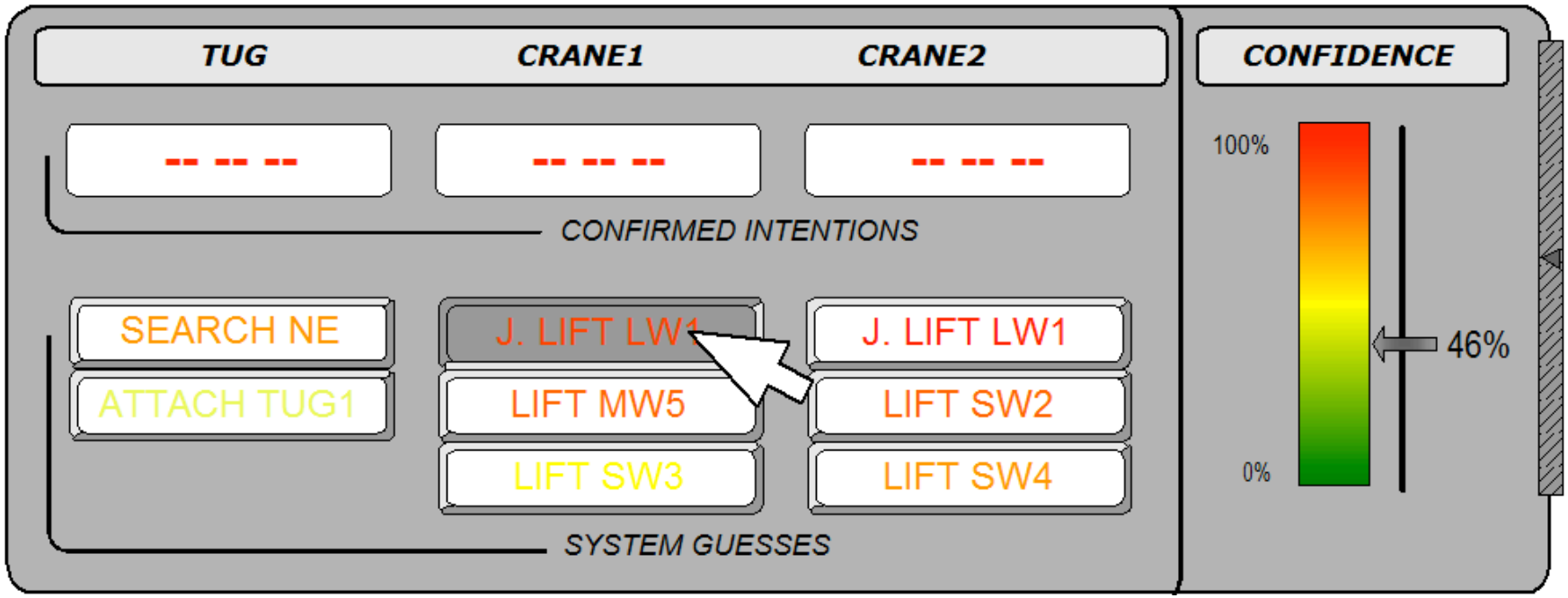
CoWare in action

- System provides a set of (up to 3, in this example) guesses about the intentions of each actor
- Guesses are sorted by confidence; only guesses with a confidence higher than the minimum are shown



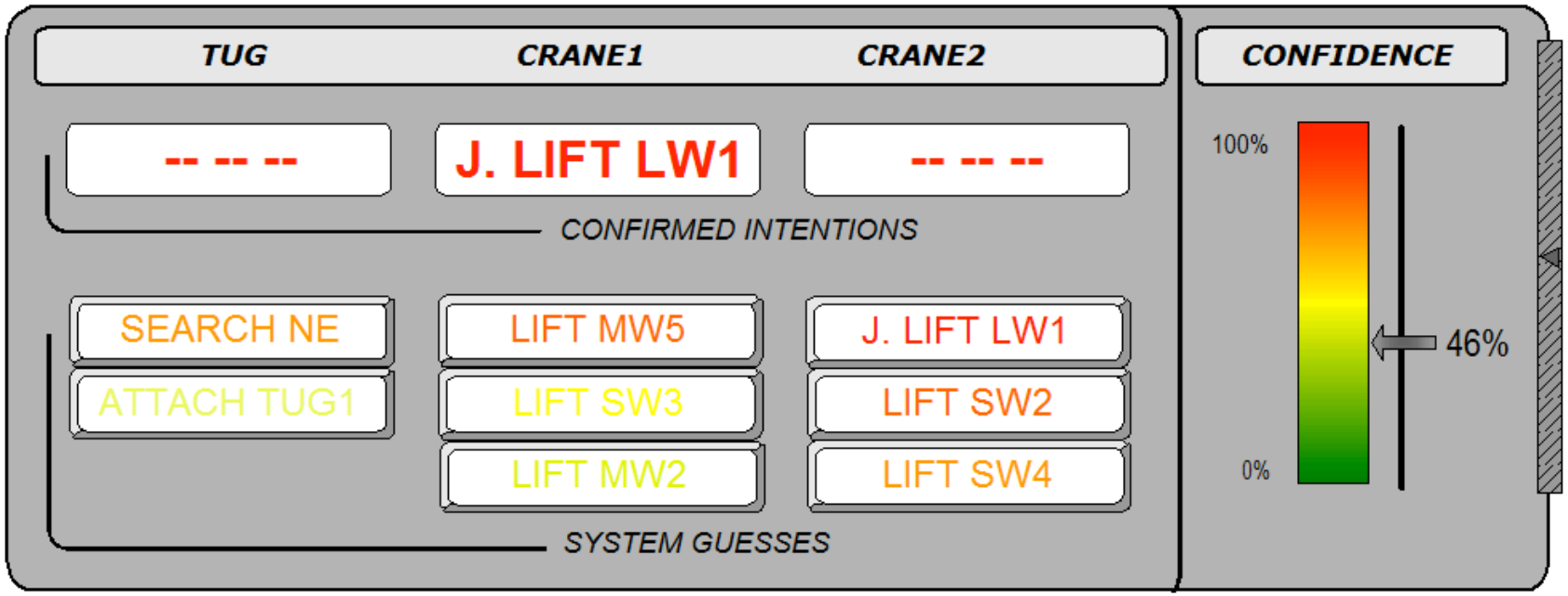
CoWare in action

- The user clicks on a guess to confirm it as a correct intention.



CoWare in action

- The confirmed guess is moved into the "Confirmed Intention" field for that actor.
- Plan that satisfies the intention is generated automatically for the user.



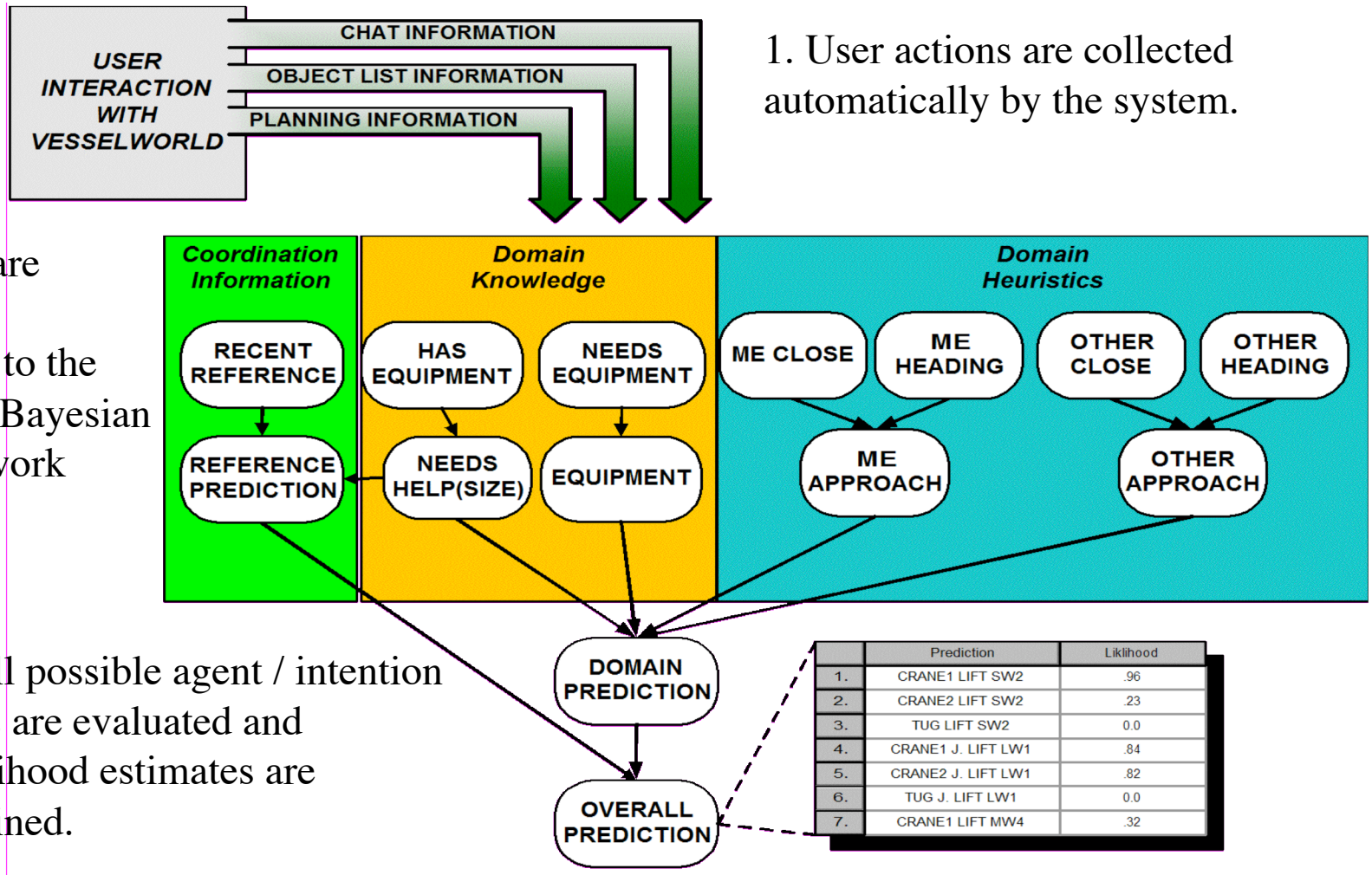
Approach

- Users communicate to stay coordinated
- Coordinating representations support this kind of communication
- Coordinating representations add structure
- Structured representations reduce AI problem in recognizing intent

Coordinating Representations

- It is work the user wants to do.
- It is work that directly benefits the user on the current problem.
- It is work that is readily convertible into system adaptation.

Prediction Process



1. User actions are collected automatically by the system.

2. Actions are posted as "evidence" to the underlying Bayesian Belief Network

3. All possible agent / intention pairs are evaluated and likelihood estimates are obtained.

Results

Data presented for one group, spanning 7 sessions, and 7.7 hours of play time.

Min Conf.	Rate		1 Guess	2 Guess	3 Guess
0	100%	Coverage	87.99%	96.38%	98.32%
		Accuracy	51.68%	70.15%	77.11%
.75	54.14%	Coverage	87.99%	96.38%	98.32%
		Accuracy	69.31%	86.58%	91.63%
.76	50.85%	Coverage	86.57%	94.96%	96.90%
		Accuracy	69.91%	86.64%	91.99%
.77	49.76%	Coverage	85.67%	92.40%	96.00%
		Accuracy	69.46%	80.79%	91.92%

Discussion

- Results are in general good, and excellent where three goals are allowed in a single prediction.
- Less than perfect coverage is due to inaccurate use of the Object List (mislabelled wastes).

However

- **Hand tuning parameters is a time consuming and imprecise endeavor.**

Tuning BN parameters

- Batch Learning
  - Given a set of positive and negative examples, automatically derive better estimates for the probability parameters (Conditional Probability Tables) in the network.
  - Several approaches exist. (We've implemented two.)
  - Experimental results show batch learning does better than hand tuning
- On-line Learning (working on)
  - Advantage is access to user feedback
  - Adjust CPTs over time to match changing properties in the world.
  - Cutting edge, but several avenues of approach given appropriate algorithms.

Batch Learning: Results

Min Conf.	Rate		1 Guess	2 Guess	3 Guess
0	100%	Coverage	94.93%	97.83%	98.55%
		Accuracy	58.62%	74.83%	81.02%
BEST	n/a	Coverage	94.93%	97.83%	98.55%
		Accuracy	79.16%	88.98%	93.41%

- "Best" confidence is the lowest confidence that preserves maximal coverage and produces the best accuracy.
- Varies between case files after adaptation.

Summary

- Common Viewpoint
  - Context dependent
  - Coordinating Representations
- Analysis
  - Tools and methods (Alex Feinman)
- New Domains
  - Groupware construction toolkit (Seth Landsman)
- AI
  - Intent Inference (Josh Introne)

Expected Final Products

- Theoretical model of joint sensemaking
- Cognitive model of online same time/different place communication
- Methodology for cognitively engineering computer-mediated collaborations
- Taxonomy of coordinating representations
- Groupware construction toolkit
- Analysis and Visualization tools
- Modular adaptive learning engine
- Formal analysis of VesselWorld Domain

Experiments Completed

- Utility of CR's
- Visible VesselWorld
- Experiment with Belief Nets
- Experiment with batch learning and Belief Nets
- Collected data from HCI Class using THYME

Experiments Planned

- Experienced programmers using THYME
- Verify cognitive model of reading/writing plans
- Verify analysis based on referential structure
- Verify utility of CoWare component
- Test online learning algorithms
- Mixed human/agent cooperation

Planned Publications

- A Common Viewpoint
- Using Referential Structure to Model Interaction
- A Cognitive Approach to Designing Groupware
- Analyzing Usage of Groupware
- Building Groupware on THYME
- User Guided Model for Intent Inference
- CoWare: Supporting Intent Awareness in Groupware