Welcome to LCI!

The Laboratory for Computational Intelligence

LCI is the ALPHA lab

Autonomous

Linguistic

Perceptual

Haptic

Agents

laboratory

$$\alpha > \beta$$

LCI Evolution

- 1968 CS starts. Richard Rosenberg arrives!
- 1978 Remote Sensing Program
- 1981 Lab for Computational Vision
- 1984 CIAR AI & Robotics Program
- 1990 Lab for Computational Intelligence
- 1990 IRIS NCE
- 2001 Nando arrives
- 2003 Kevin L.-B. & Giuseppe arrive
- 2004 Kevin M. arrives

LCI People - Faculty

- Giuseppe Carenini
- Cristina Conati
- Nando de Freitas
- Holger Hoos
- Kevin Leyton-Brown
- Jim Little
- David Lowe
- Alan Mackworth
- Karon MacLean
- Kevin Murphy
- Dinesh Pai
- David Poole
- Richard Rosenberg
- Robert Woodham

LCI People

- *Postdocs*: Heather MacLaren, Robert Sim
- *Research Associates*: John Lloyd, Kees van den Doel
- *Faculty Associates*: Uri Ascher, Craig Boutilier, Kurt Eiselt, Wolfgang Heidrich,Peter Lawrence, Ian Mitchell, Raymond Ng, Ron Rensink, Steve Wolfman
- *Secretary*: Valerie McRae (103)
- *Systems*: Luc Dierckx
- *IRIS Engineer*: Bruce Dow
- Too many wonderful graduate students to list here – including you?
- Many distinguished alumni ….

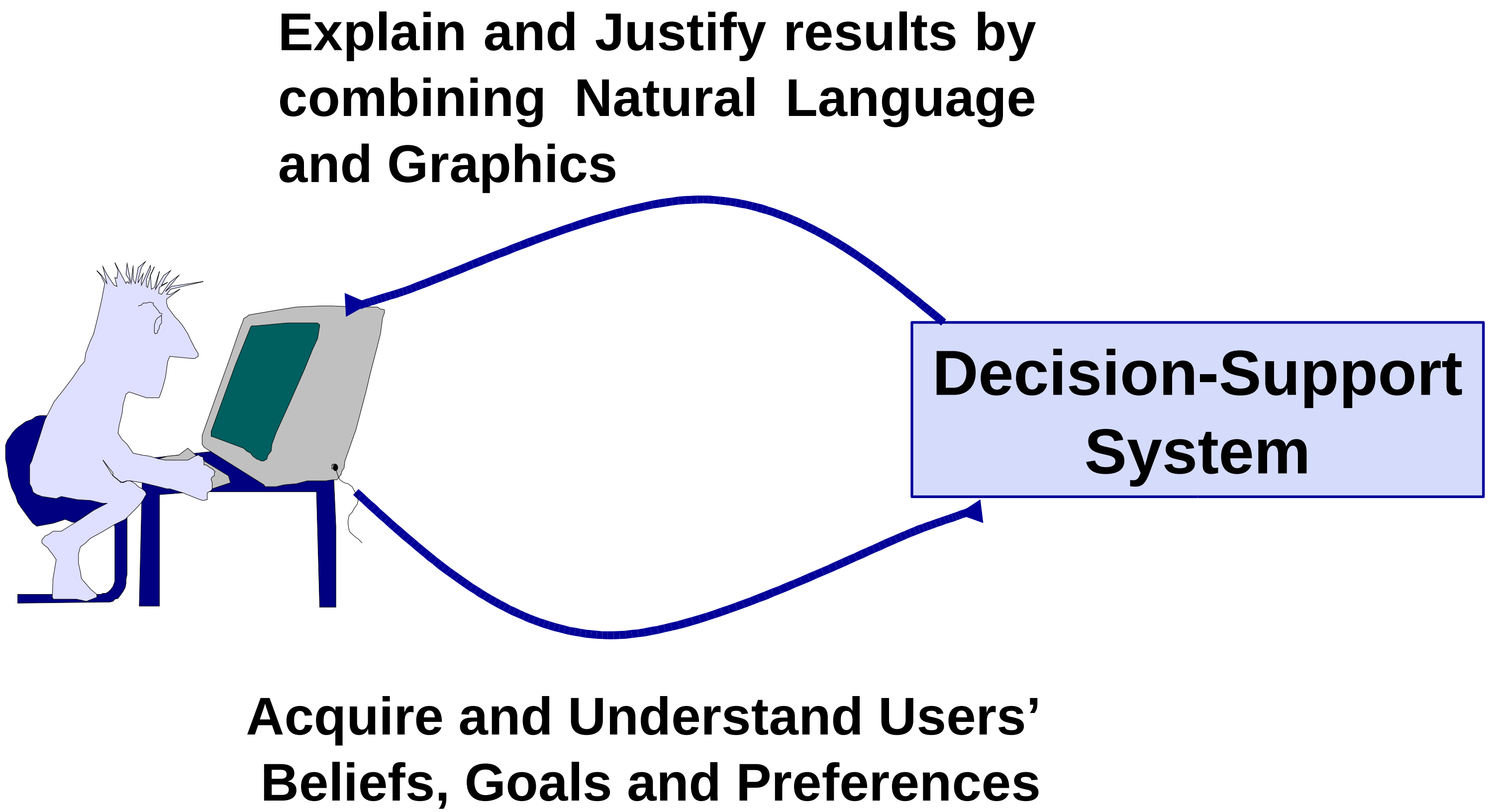
Some Research Groups in LCI

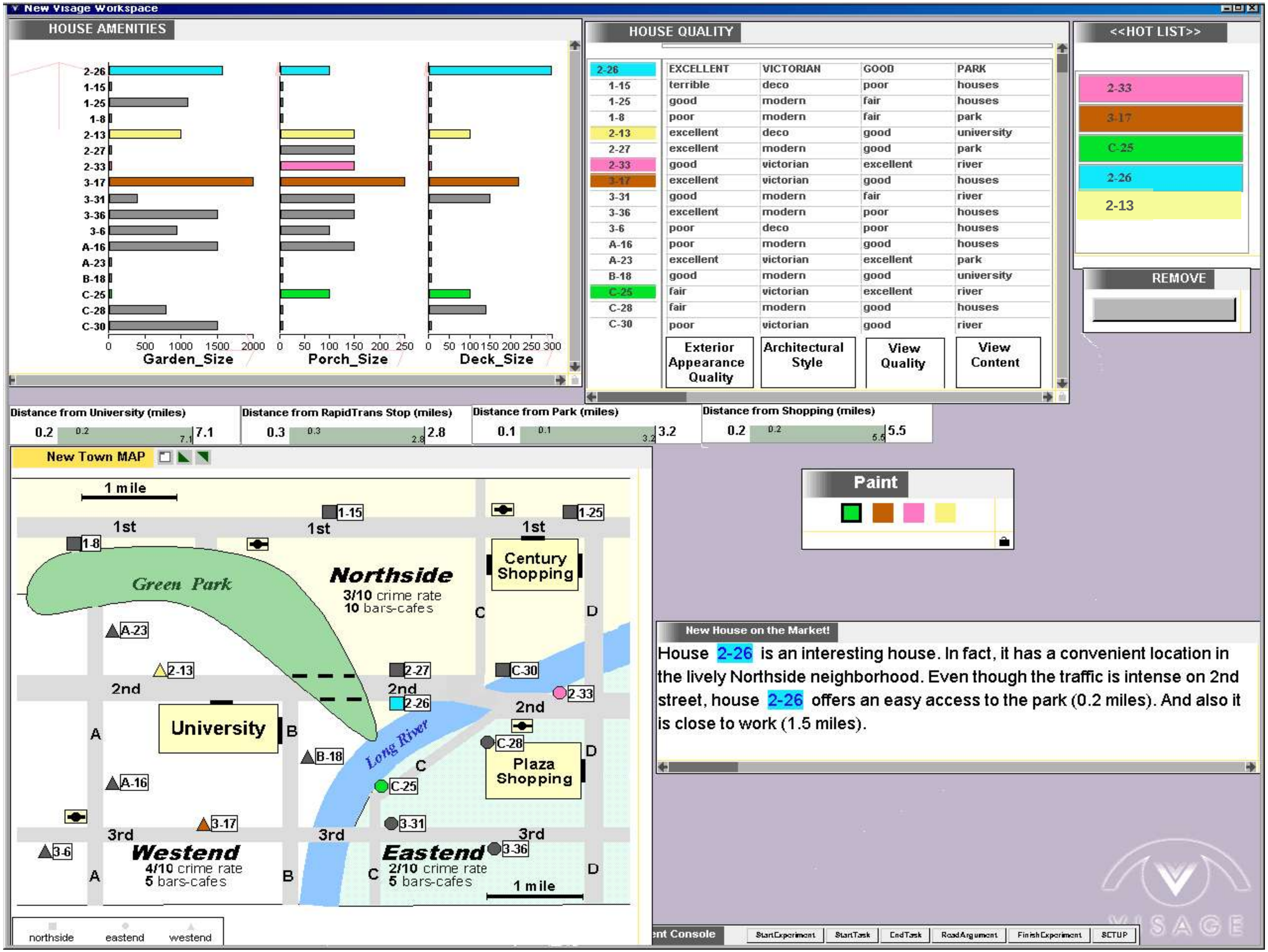
- Machine Learning, Game Theory and Multi-Agent Systems
- Intelligent Tutoring Systems, Haptics, Computational Linguistics
- Computational Vision, Robotics and Constraint-based Systems

Giuseppe Carenini

- intersection of computational linguistics, human-computer interaction and decision theory
- investigate computational principles and techniques to automatically generate understandable and convincing multimedia presentation
  - generating explanations, arguments, reports, summaries and narratives tailored to the user, the problem solving situation and previous dialogue
  - effectively combine natural language and information graphics
  - provide convenient, interactive means for enabling users to further explore the information presented.

Adaptive Decision-Support Systems




New Visage Workspace
HOUSE AMENITIES
2-26
1-15
1-25
1-8
2-13
2-27
2-33
3-17
3-31
3-36
3-6
A-16
A-23
B-18
C-25
C-28
C-30
Garden_Size
Porch_Size
Deck_Size
HOUSE QUALITY
2-26 EXCELLENT VICTORIAN GOOD PARK
1-15 terrible deco poor houses
1-25 good modern fair houses
1-8 poor modern fair park
2-13 excellent deco good university
2-27 excellent modern good park
2-33 good victorian excellent river
3-17 excellent victorian good houses
3-31 good modern fair river
3-36 excellent modern poor houses
3-6 poor deco poor houses
A-16 poor modern good houses
A-23 excellent victorian excellent park
B-18 good modern good university
C-25 fair victorian excellent river
C-28 fair modern good houses
C-30 poor victorian good river
Exterior Appearance Quality
Architectural Style
View Quality
View Content
<<HOT LIST>>
2-33
3-17
C-25
2-26
2-13
REMOVE
Distance from University (miles) 0.2 7.1
Distance from RapidTrans Stop (miles) 0.3 2.8
Distance from Park (miles) 0.1 3.2
Distance from Shopping (miles) 0.2 5.5
New Town MAP
1 mile
1st
Green Park
Northside
3/10 crime rate
10 bars-cafes
Century Shopping
2nd
University
Long River
Plaza Shopping
3rd
Westend
4/10 crime rate
5 bars-cafes
Eastend
2/10 crime rate
5 bars-cafes
northside eastend westend
Paint
New House on the Market!
House 2-26 is an interesting house. In fact, it has a convenient location in the lively Northside neighborhood. Even though the traffic is intense on 2nd street, house 2-26 offers an easy access to the park (0.2 miles). And also it is close to work (1.5 miles).
StartExperiment StartTask EndTask ReadArgument FinishExperiment SETUP
VISAGE

Cristina Conati

Adaptive Interfaces and Intelligent Learning Environments

- integrate research in AI, HCI and Cognitive Science to make complex interactive systems effective and adaptive to the users‘ needs
- extend the range of user's features captured in a computational user model - from purely cognitive features (knowledge, goals, preferences), to meta-cognitive skills (i.e., learning capabilities), personality traits and emotional reactions, to widen the spectrum of information that an interactive system can use to tailor its behaviour to the user.

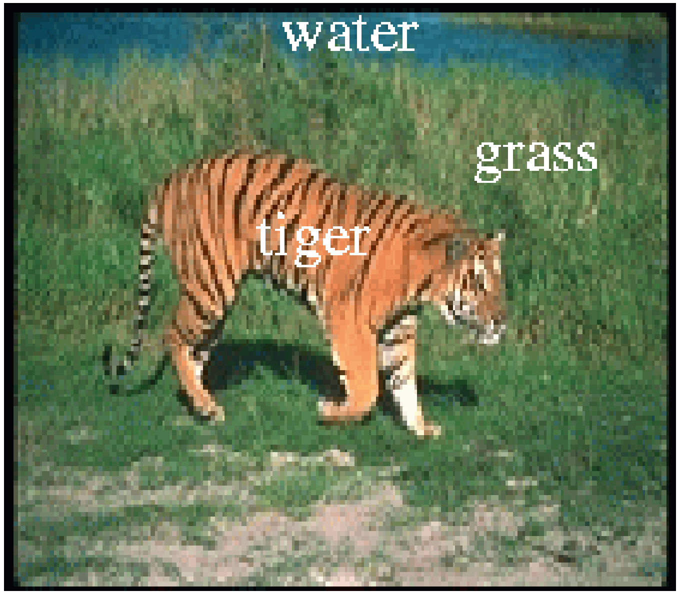
Nando de Freitas

Probabilistic Machine Learning

- design machines that learn about the world and themselves
  - models of Web video, images and text for information retrieval or translation
  - robot models itself and its harsh environment, to enable automatic repair and optimal decision making.
- Probabilistic machine learning has its foundations in AI, probability,information theory and statistics.
- Research area: improving our knowledge of phenomena in high-dimensions - to design algorithms that avoid the ``curses of dimensionality'' and embrace the ``blessings of dimensionality''.

Input

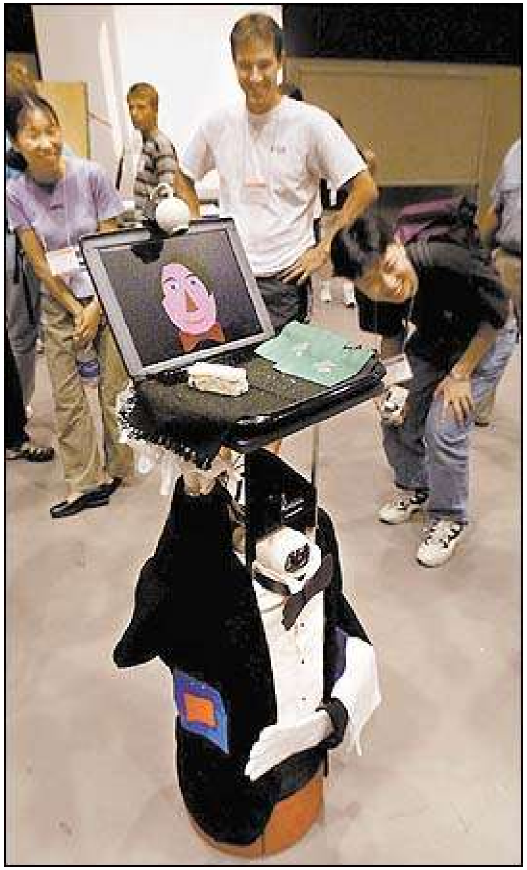
Output



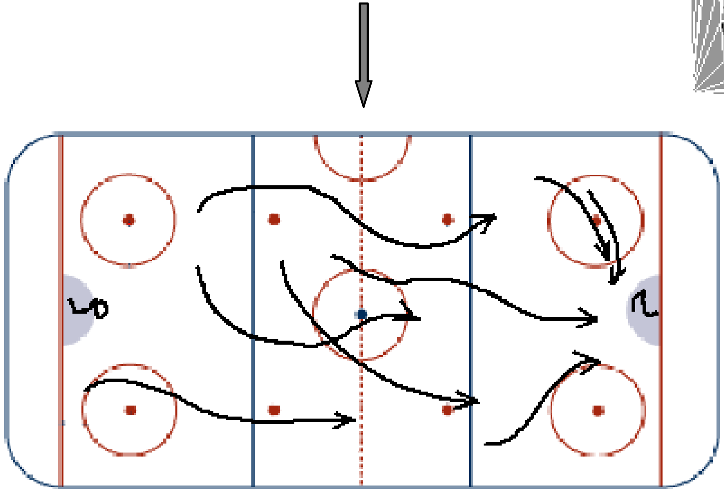
Holger Hoos

- Hard combinatorial problems from
  - AI (SAT, CSP, Combinatorial Auctions, ...
  - Bioinformatics (DNA Word Design, RNA Structure Prediction, ...)
- design and characterisation of stochastic search algorithms for such problems (using empirical methods / computational experiments)
- human-centred information management (storing, representing, and retrieving information in ways which are natural to human users)
- representing and reasoning with user preferences
- computer music (music representation, music information retrieval, ...)

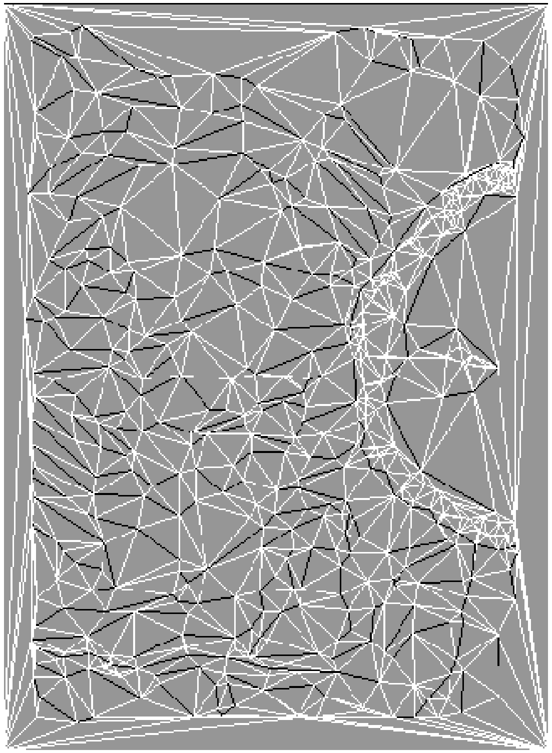
Jim Little



Visually guided robots



Video understanding: tracking



Maps and terrain

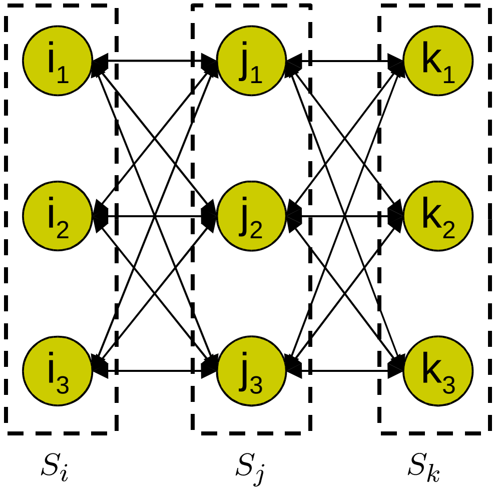
Jim Little: continuing research

- Enhanced interaction with visually guided robots
- Probabilistic models for terrain surface interpretation
- Multi-camera wireless network for monitoring urban environments
- Action understanding from video sequences

Kevin Leyton-Brown

Game Theory

- a formal model of interactions between multiple self-interested agents
- problem: compute equilibrium of games having many players and actions
  - represent the game compactly
  - design an algorithm that leverages this structure

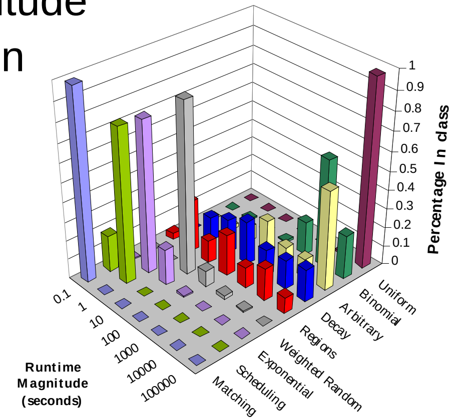


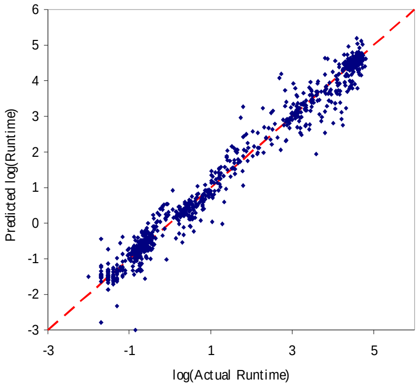
Auctions

- a theoretical framework for resource allocation among self-interested agents
- sample research problems:
  - design an auction that meets a set of both economic and computational requirements
  - predict or suggest strategies for bidders in a complex auction
  - facilitate or deter collusion between bidders
  - combinatorial auctions (many goods sold simultaneously)

Empirical Hardness Models

- Often, empirical runtimes of identically-sized instances of NP-hard problems vary by many orders of magnitude
  - e.g., combinatorial auction winner determination
  - this graph: CPLEX runtimes for 9 CA test distributions, fixed problem size (note log scale)

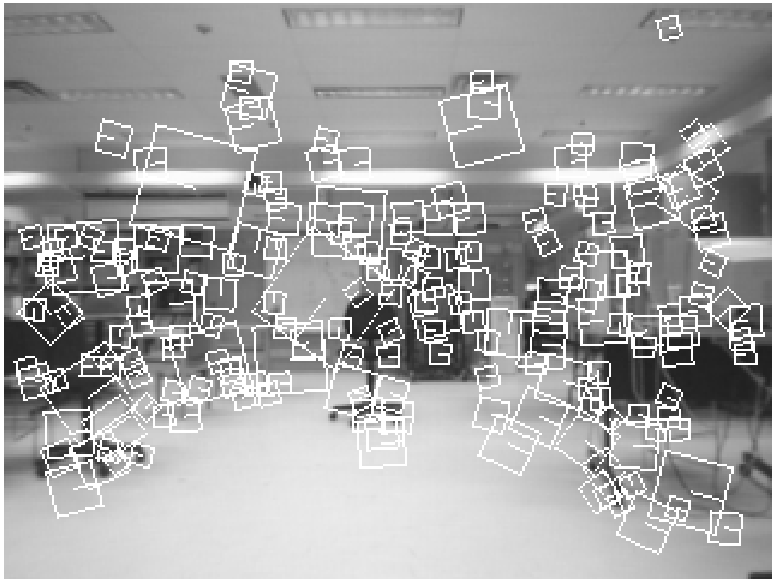




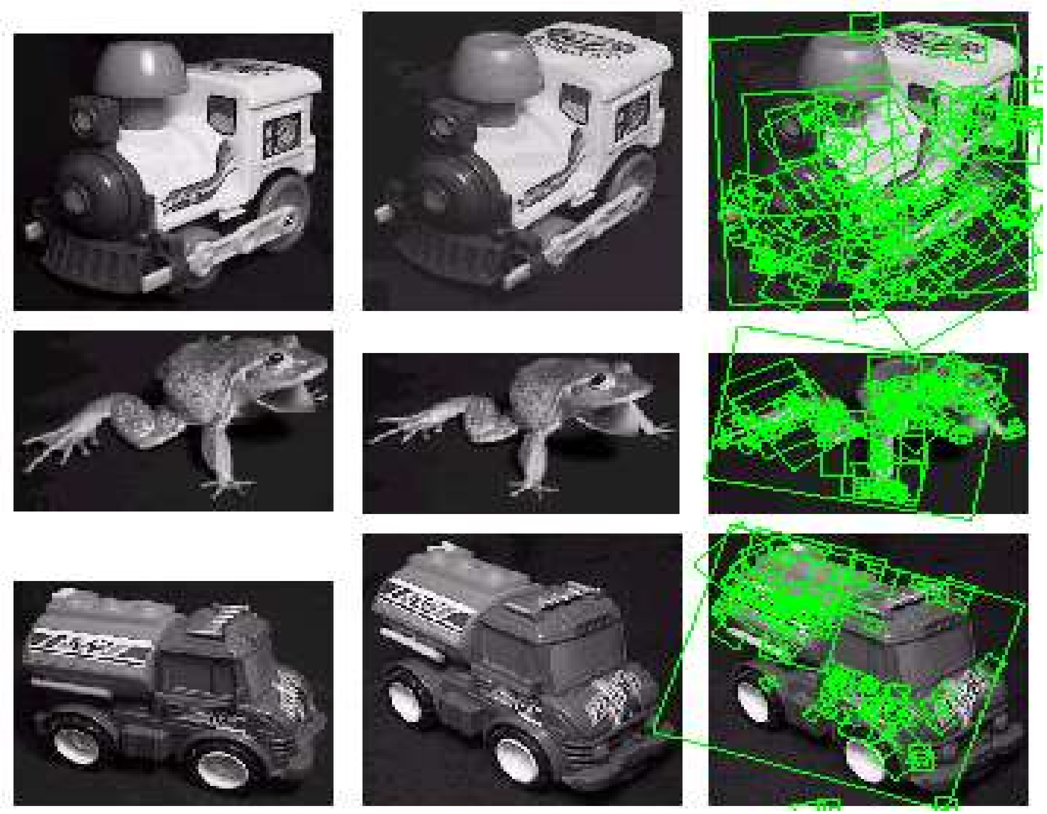
- Research agenda
  - use machine learning to build models of an algorithm's runtime for such a problem
  - analyze this model to understand sources of empirical hardness
  - model several algorithms and build an algorithm portfolio
  - use sampling to build harder benchmark distributions

David G. Lowe

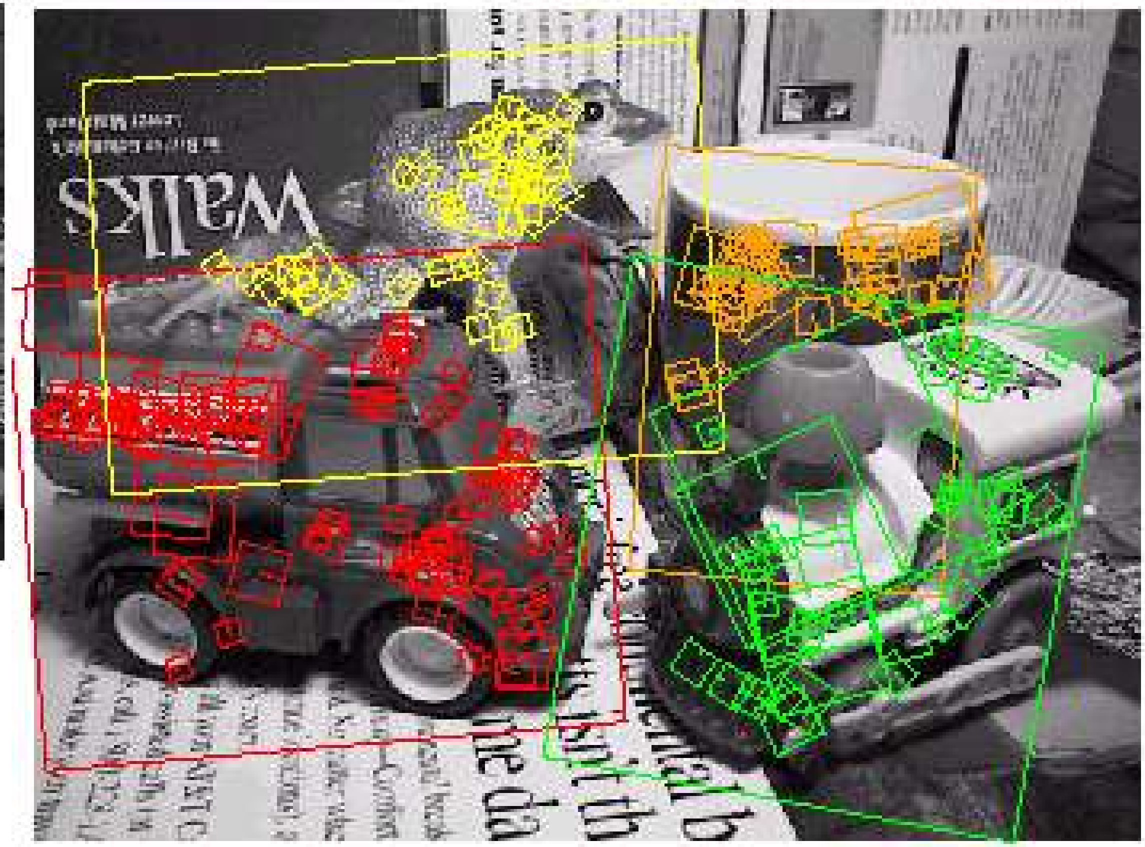
- Computer vision
- Visual object recognition
- Machine learning for vision
- Applications to robotics and localization



Examples of view interpolation



Recognition using View Interpolation



Application of SIFT:

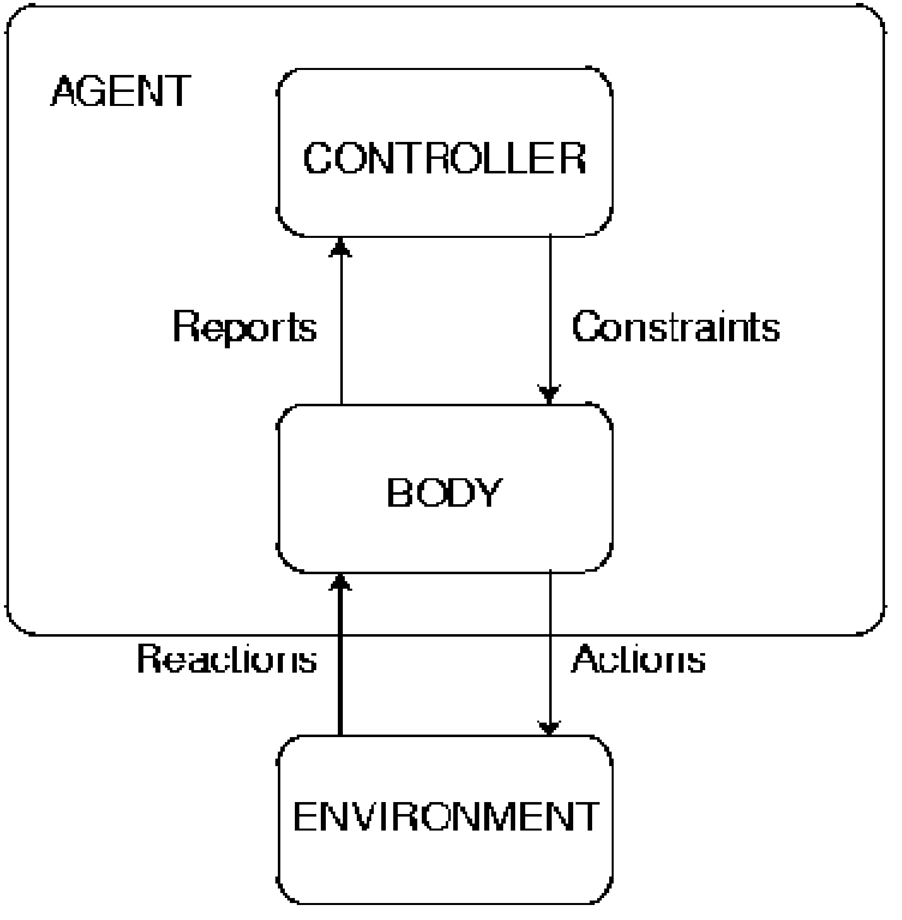
Sony's Aibo

- **Recognizes the charging station**
- **Communicate with visual cards**

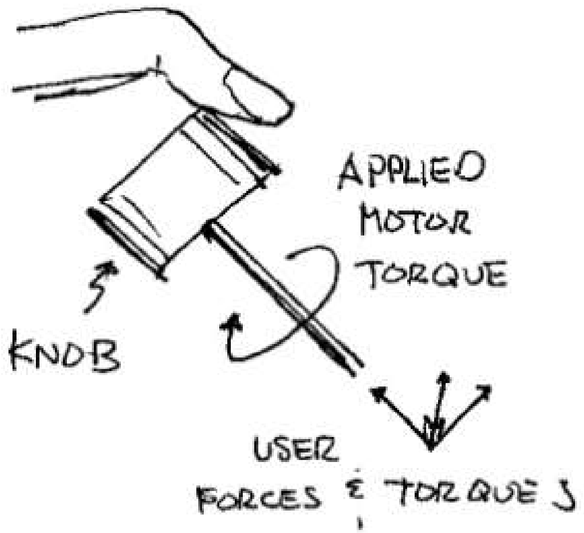
Alan Mackworth

- Constraint-based agents: models, languages and systems
- Computational vision and robotics
- Multi-agent systems including soccer-playing robots
- Specification, modeling and verification of hybrid dynamical systems

Alan Mackworth



A Constraint-Based Agent System



karon maclean

HCI / robotics

physical user interfaces:

talking to computers through your hands

haptic force feedback

- novel devices
- embedding interfaces in the world: *cars, homes, portables*
- expressive control of art & streaming media

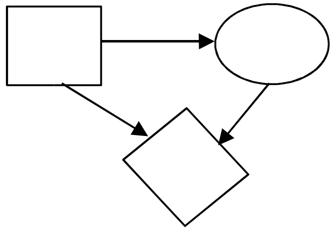
transparent multisensory interfaces

Kevin Murphy

- Machine learning/ computational statistics
  - Probabilistic graphical models (PGMs)
- Applications to computer vision
  - Visual object detection and scene understanding

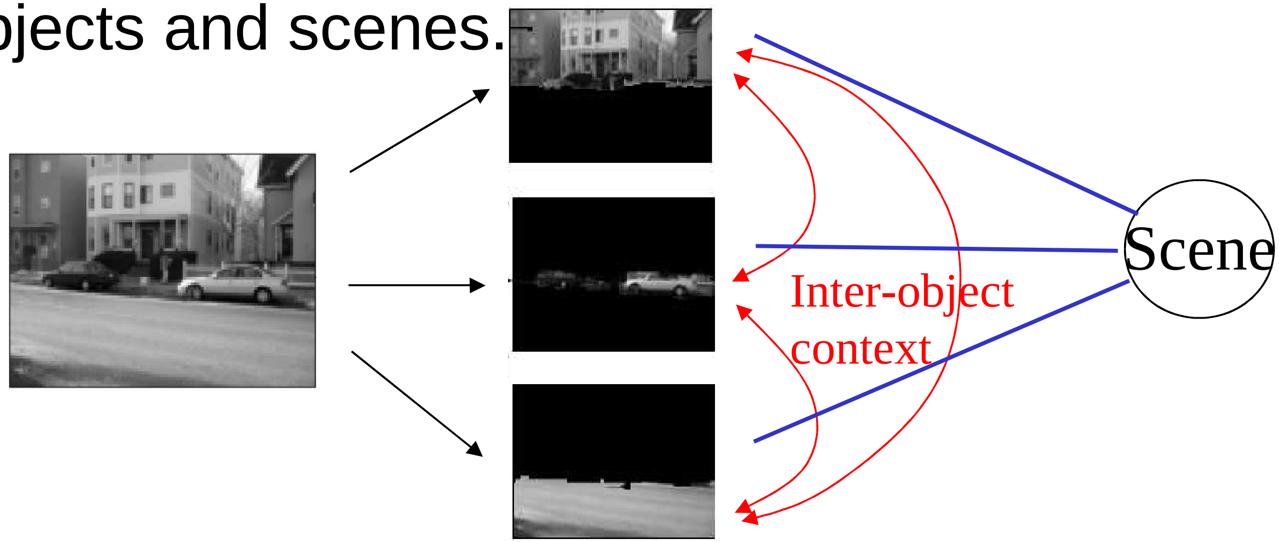
Probabilistic graphical models

- Combines graph theory and probability theory
- My focus:
  - Efficient (exact and approximate) inference algorithms
  - Flexible software toolkits (eg. BNT)
- Take my class CS532c Fall 2004!



Visual object detection and image understanding

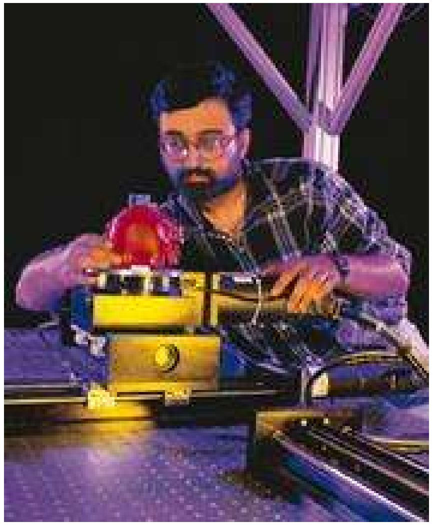
- My focus: model probabilistic relationships between objects and scenes.



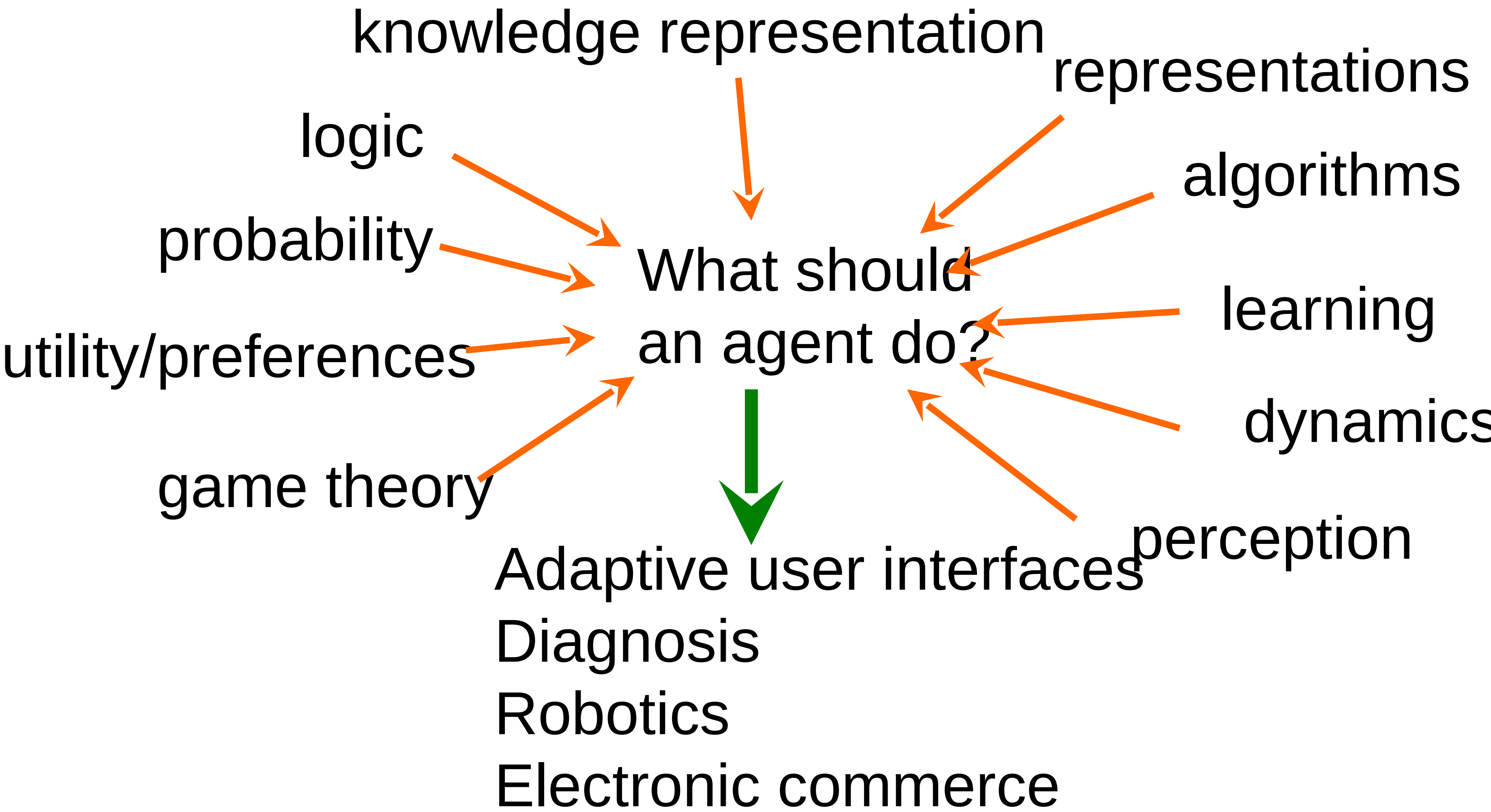
- Applications to wearable computing and mobile robotics.

Dinesh Pai

- computational models of the physical world
  - interactive multimodal simulations of the physical world,   with realistic sounds, deformations, and haptic force feedback
  - building computational models from measurements of real world objects
  - automating the measurement and modeling using robotics



David Poole

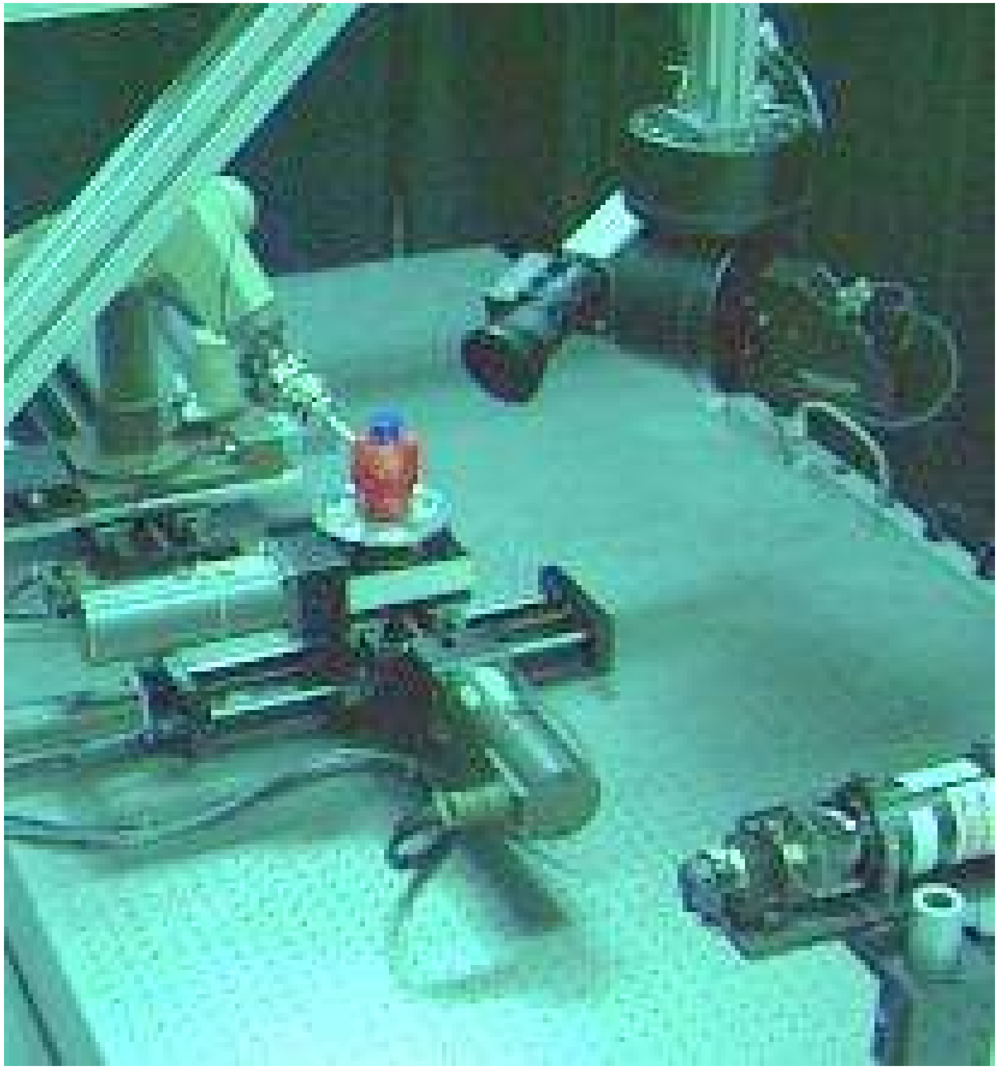

knowledge representation
representations
logic
algorithms
probability
What should
an agent do?
learning
utility/preferences
dynamics
game theory
perception
Adaptive user interfaces
Diagnosis
Robotics
Electronic commerce

Robert J. Woodham

- Focus: Computer interpretation of 3D shape and visual motion
- Objective: To understand how the measurement of visual motion can support high-level interpretation tasks related to object identity, non-visual physical properties and, for an object that is an intelligent agent, to actions and intentions.
- Strategy: Link the interpretation of motion and 3D shape *as early as possible* in visual processing.

Research interests

- Image databases and content-based image retrieval
- Remote sensing and geographic information systems (GIS)
- Connections to biological vision, especially colour vision



LCI-related Grad Courses: Term 1

- CS502: AI I – Mackworth
- CS505: Image Understanding 1 – Little
- CS532c: Graphical Models – K. Murphy
- CS545 : Bioinformatics – Hoos

LCI-related Grad Courses: Term 2

- CS503: Computational Linguistics – Carenini
- CS525: Image Understanding 2 – Lowe
- CS532a: Multi-agent Systems – Leyton-Brown
- CS532b: Adaptive Interface – Conati
- CS532d: Stochastic Search Algorithms – Hoos
- CS540: Machine Learning – de Freitas
- CS543: Physical User Interface Design and Evaluation - MacLean

Meetings and Reading Groups

- Friday Forum with Free Food (FFFF): Friday, 12 noon every 2 weeks, next: Sept. 17, 2004.
- Robuddies
- First Order Probabilistic Inference (FOPI)
- Intelligent User Interfaces
- Lots of Others… Mailing lists: lci-grads, …
- Start your own! Tuum est.

Join LCI:
the world’s best AI lab!

- Great projects
- Great people
- Sense of scientific adventure
- Support for the risky and new
- Good infrastructure
- Fun!