AI Applications

CPSC 322 Lecture 3

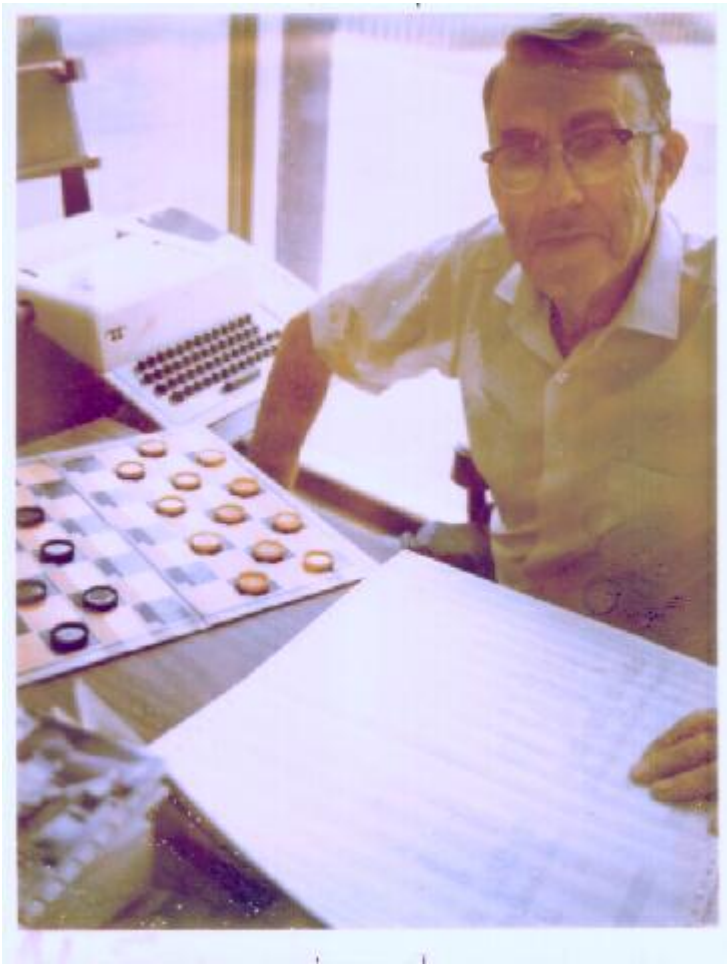
January 9, 2006

Modules we'll cover in this course

1. Making single decisions in deterministic environments
   - Search, CSPs
2. Making sequential decisions in deterministic environments:
   - Planning
3. Richer representations in deterministic environments:
   - Logic
4. Making single decisions in stochastic environments:
   - Bayes Nets, Influence Diagrams
5. Making sequential decisions in stochastic environments:
   - MDPs
6. Multiagent systems
   - Zero-sum games; Nash equilibria

Search/CSPs: Checkers

- Arthur Samuel at IBM wrote programs to play checkers (1950s)
  - initially, they played at a strong amateur level
  - however, they used some (simple) machine learning techniques, and soon outperformed Samuel



Source: *IBM Research*

Search/CSPs: Chess

- In 1996 and 1997, Gary Kasparov, the world chess grandmaster played two tournaments against Deep Blue, a program written by researchers at IBM

Source: *IBM Research*

Search/CSPs: Chess

- Deep Blue's Results in the first tournament:
  - won 1 game, lost 3 and tied 1
    - first time a reigning world champion lost to a computer
    - although Kasparov didn't see it that way…

Source: *CNN*

Search/CSPs: Chess

- Deep Blue's Results in the second tournament:
  - second tournament: won 3 games, lost 2, tied 1

May 11th, 1997

Computer won world champion of chess

(Deep Blue) (Garry Kasparov)

(Reuters = Kyodo News)

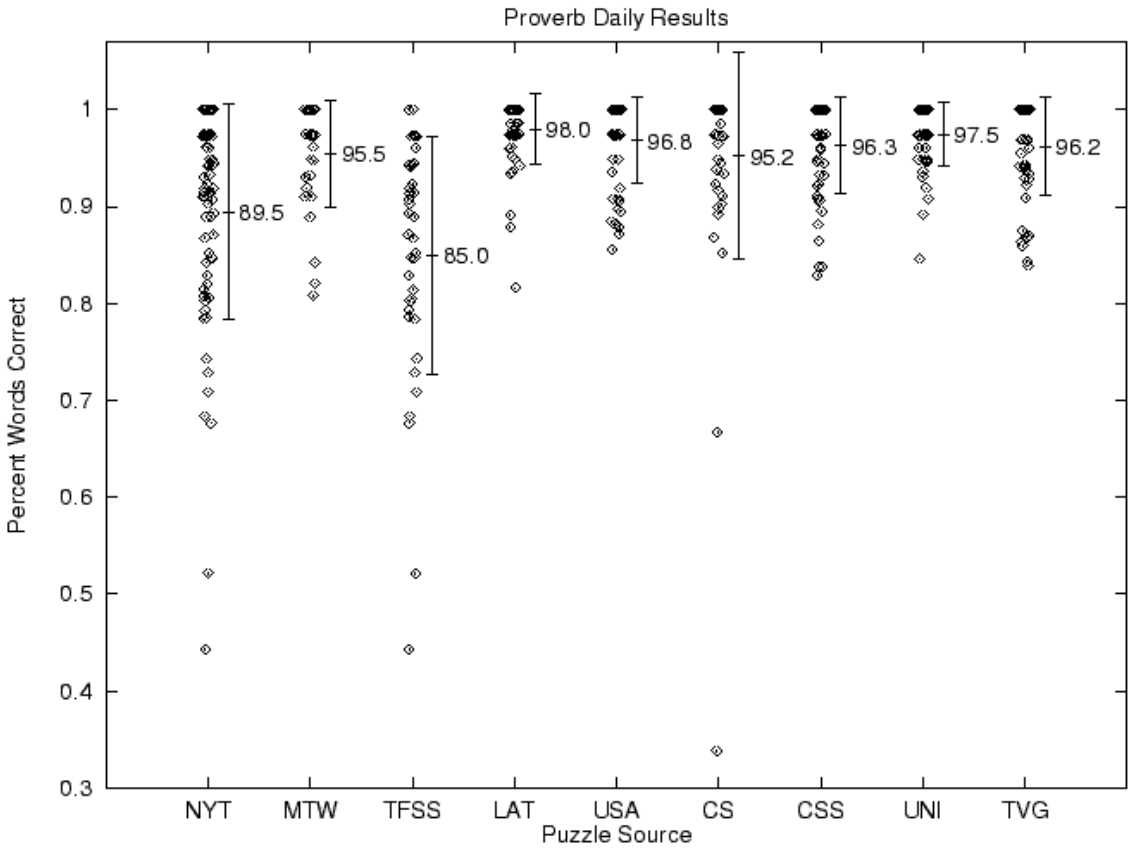
Search/CSPs: Crossword Puzzles

Daily Puzzles

370 puzzles from 7 sources.

Summary statistics:

- 95.3% words correct (miss three or four words per puzzle)
- 98.1% letters correct
- 46.2% puzzles completely correct

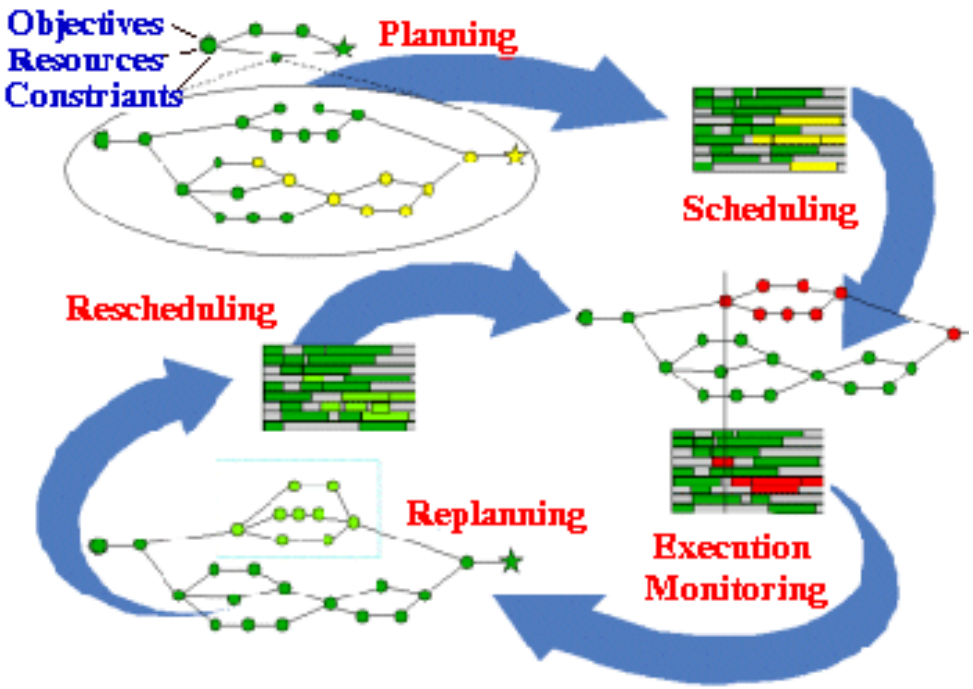


P	O	L	O	N	E	■	P	A	L	O	M	I	N	O
A	S	I	M	O	V	■	I	S	O	L	A	T	E	D
S	L	E	E	V	E	■	T	H	W	A	R	T	E	D
T	I	G	G	E	R	■	C	O	R	N	Y	■	■	■
A	N	E	A	L	E	■	A	R	I	D	■	J	A	M
■	■	■	■	E	S	P	I	E	S	■	L	O	G	O
S	E	A	O	T	T	E	R	■	E	E	E	N	O	N
A	B	B	O	T	■	A	N	A	■	U	S	A	G	E
B	O	O	Z	E	S	■	S	N	A	P	S	H	O	T
E	N	V	Y	■	P	L	I	N	T	H	■	■	■	■
R	Y	E	■	H	I	E	S	■	T	E	A	S	E	T
■	■	■	K	A	R	E	L	■	I	M	P	A	L	E
M	A	R	I	N	A	R	A	■	M	I	A	S	M	A
A	B	E	R	D	E	E	N	■	E	S	C	H	E	R
B	B	N	K	Y	A	R	D	■	S	M	E	A	R	S

Source: *Michael Littman*

Planning: Logistics

- Dynamic Analysis and Replanning Tool (Cross & Walker)
  - logistics planning and scheduling for military transport
  - used in the 1991 Gulf War by the US
  - problems had 50,000 vehicles; different starting points and destinations

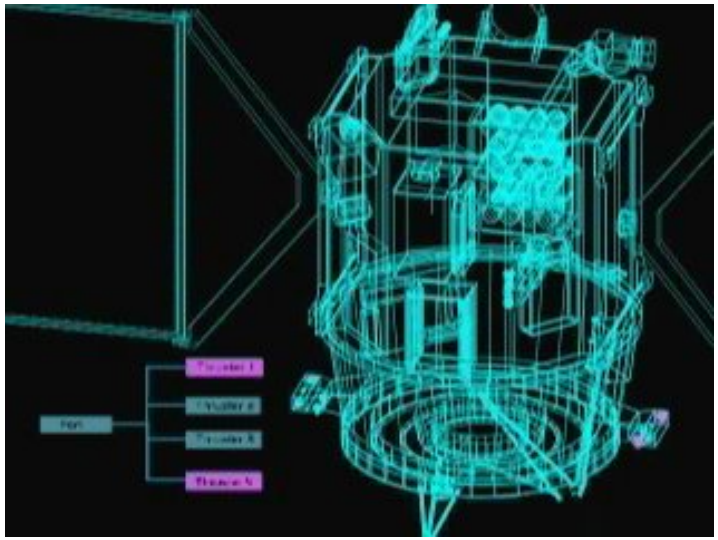


Source: *DARPA*

Planning: Spacecraft Control

NASA: Deep Space One spacecraft

- operated autonomously for two days in May, 1999:
  - determined its precise position using stars and asteriods
    - despite a malfunctioning ultraviolet detector
  - planned the necessary course adjustment
  - fired the ion propulsion system make this adjustment



Source: *NASA*

Planning: Autonomous Delivery Robot

- Roams in an office environment making deliveries
  - observations: cameras, range finders, microphone, …
  - prior knowledge: map, people in the world

Source:
Pantalis Elinas

Logic: Cyc

"Day after day since 1984, teams of programmers, linguists, theologians, mathematicians and philosophers have plugged away at a $60-million project they hope will transform human existence: teaching a computer common sense.

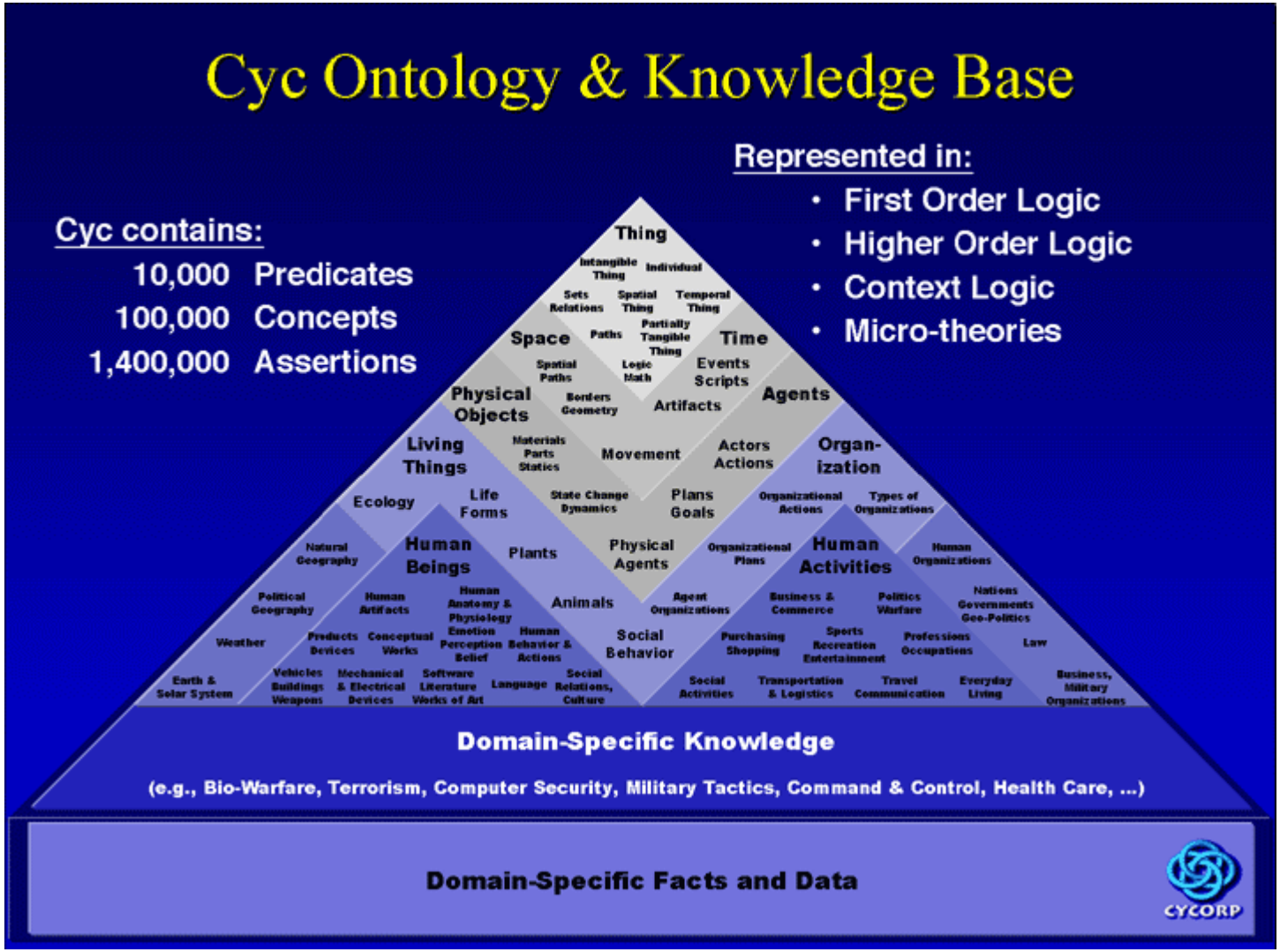
"They have been feeding a database named Cyc over a million truths and generalities about daily life so it can automatically make assumptions humans make, such as:

- Creatures that die stay dead.
- Dogs have spines.
- Scaling a cliff requires intense physical effort.

"Though some critics question the potential of this painstaking effort, the inventors believe Cyc will form the brains of computers with supercharged reasoning abilities - which could help us work more efficiently, make us understand each other better and even help us predict the previously unforeseeable."

Quoted from: *Independent Online*

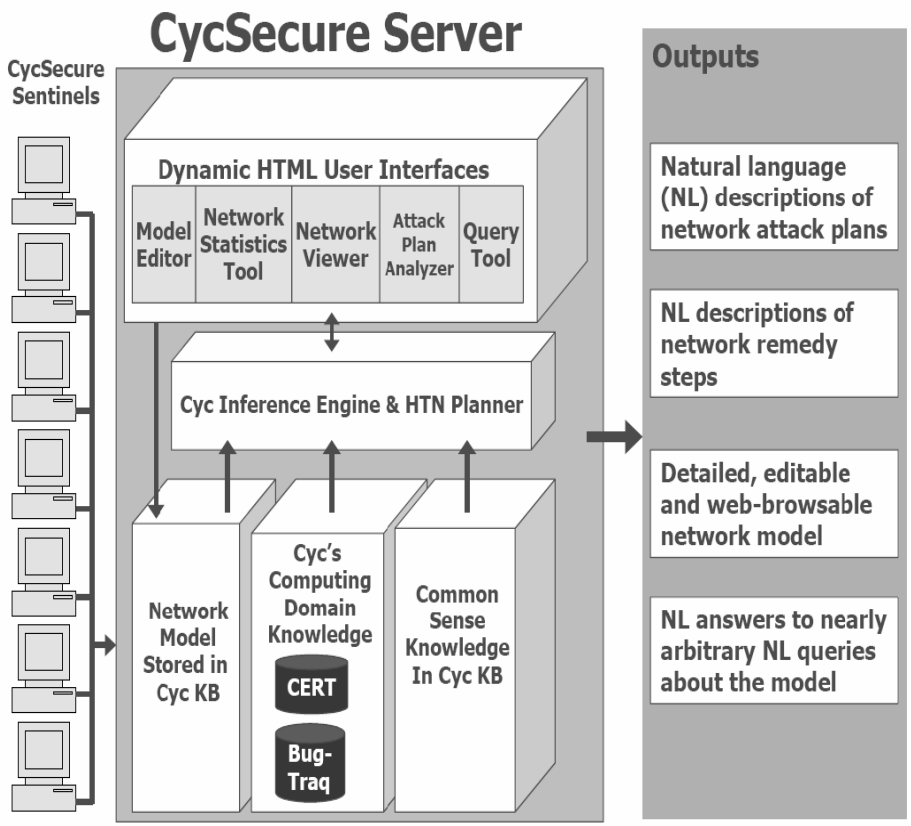
Logic: Cyc



Source: *Cycorp*

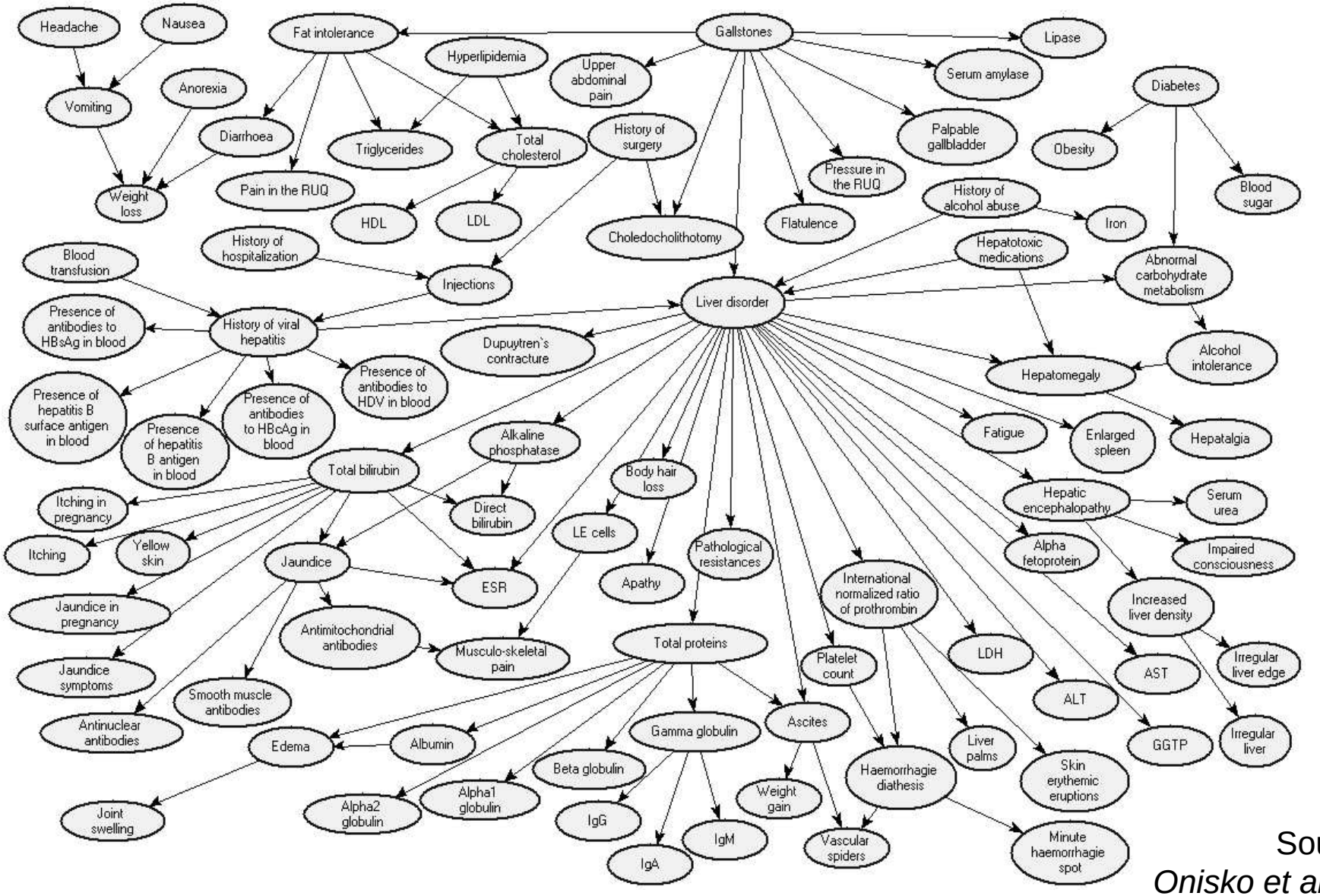
Logic: CycSecure

- "CycSecure scans a computer network to build a formal representation of the network, based on Cyc's pre-existing ontology of networking, security, and computing concepts:
  - information about what computers are on the network, what programs are installed or running on those computers, what privileges the running programs have, what users are logged into the computers, etc.
- This formal representation also allows users to interact directly with the model of the network, allowing testing of proposed changes."



Excerpted from: *Shepard et al., 2005*

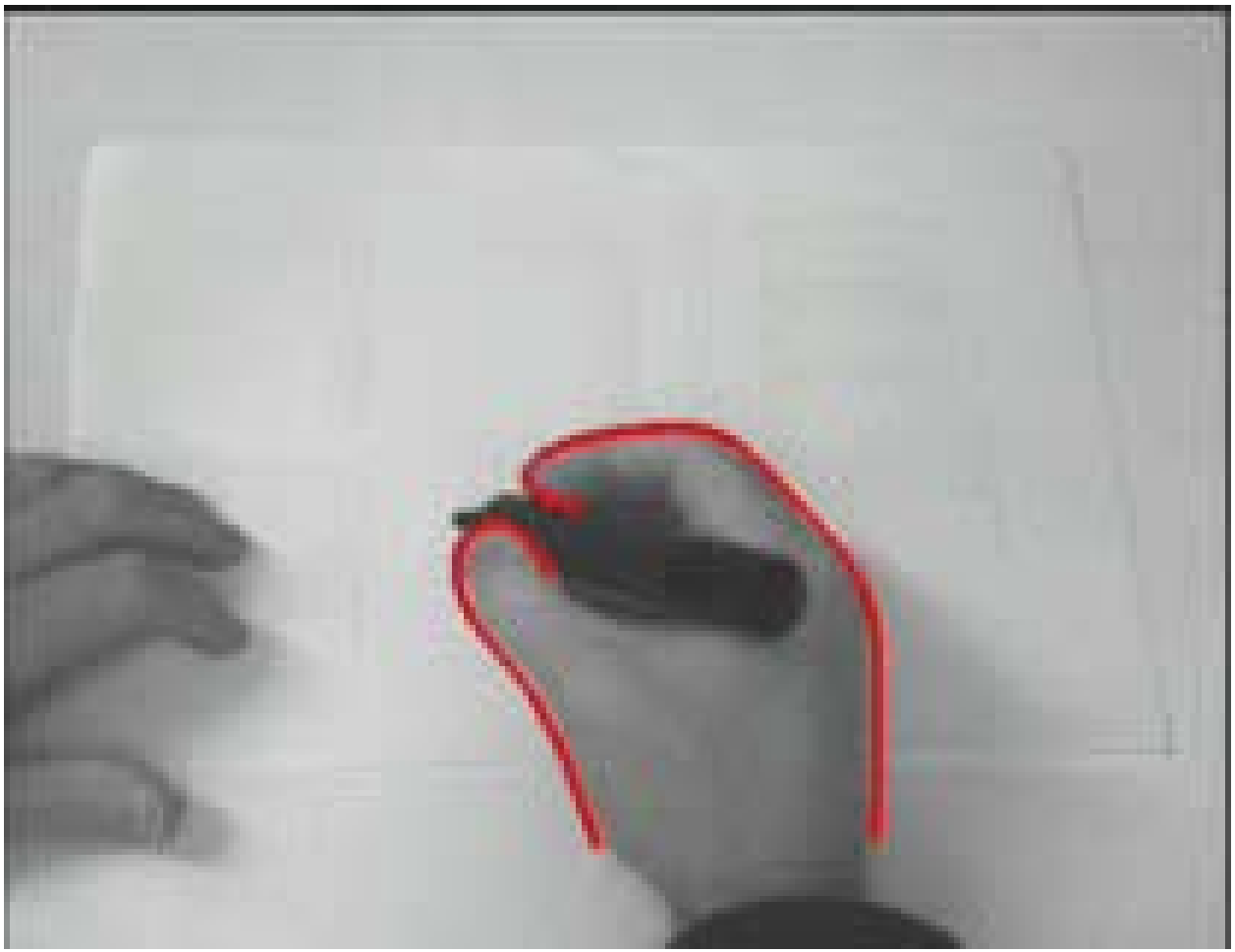
Reasoning under Uncertainty: Diagnosis



Source:
Onisko et al., 99

Reasoning under Uncertainty

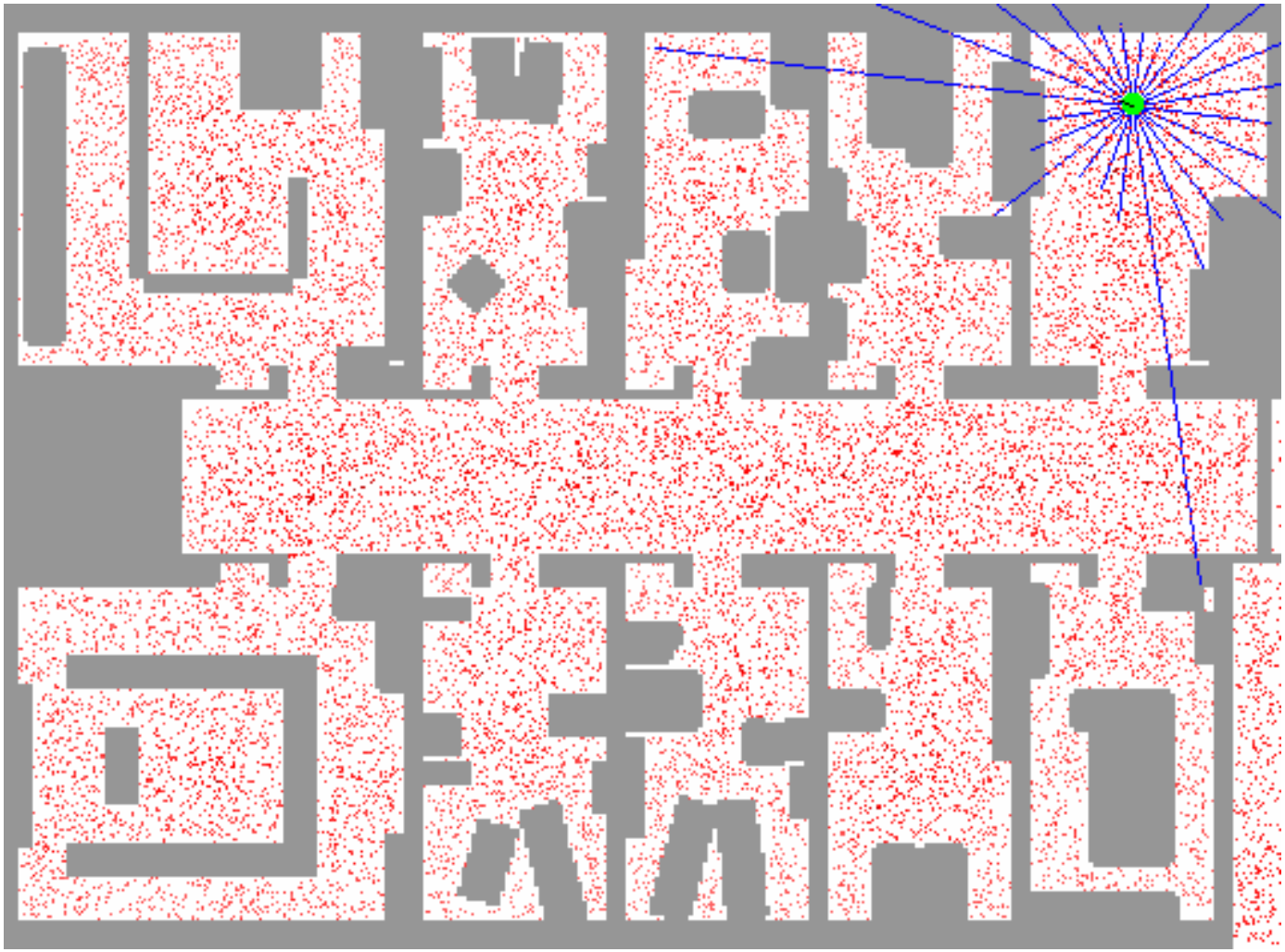
- Track a hand and estimate activity:
  - drawing, erasing/shading, other



Source:
Kevin Murphy

Planning Under Uncertainty

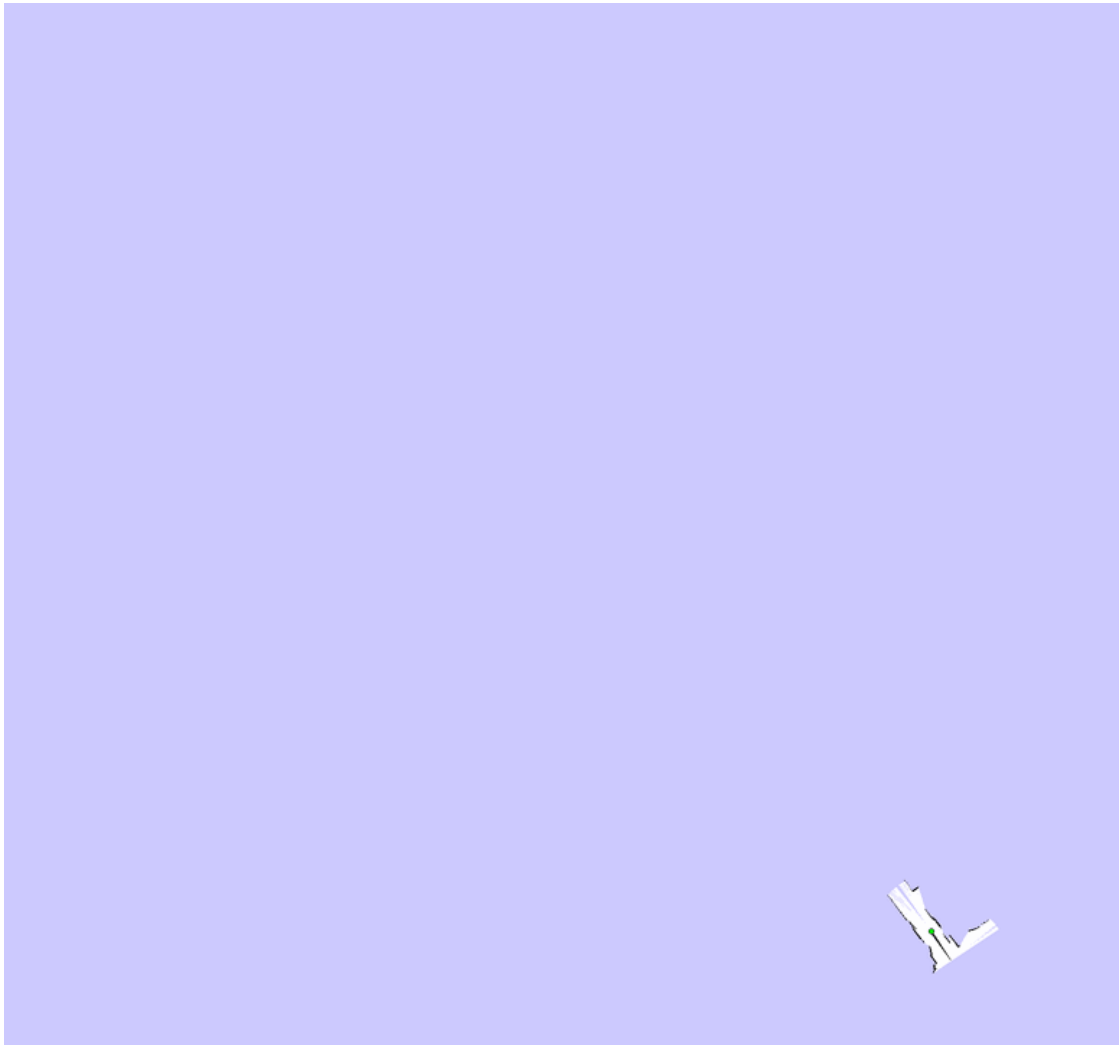
Office robot with laser rangefinder: particle filtering



Source: *Sebastian Thrun*

Planning Under Uncertainty

Mine mapping



Source:
Sebastian Thrun

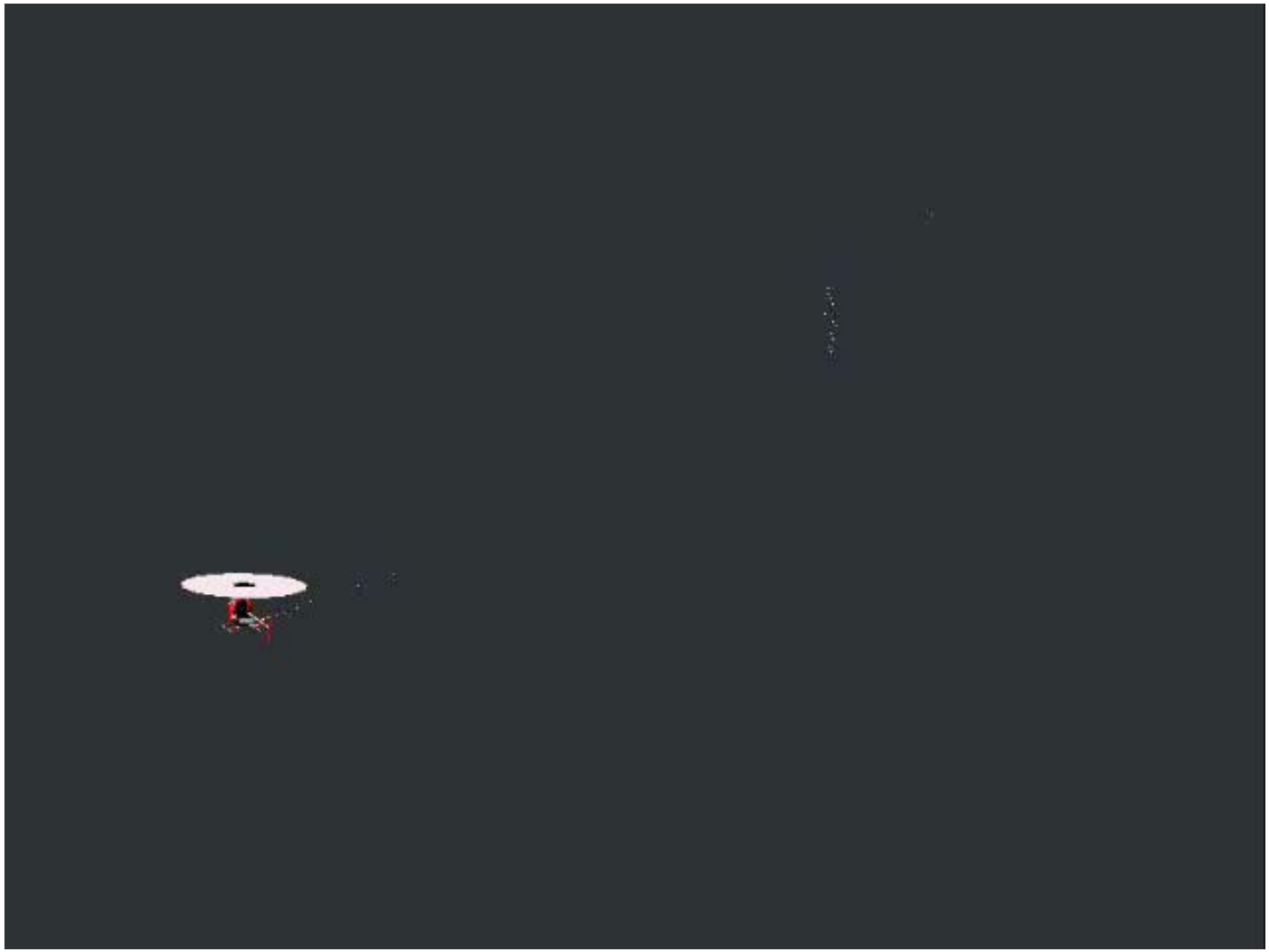
Planning Under Uncertainty

Helicopter control: MDP, reinforcement learning

Source: *Andrew Ng*

Planning Under Uncertainty

Helicopter Mapping



Source:
Sebastian Thrun

Planning Under Uncertainty

Autonomous driving: DARPA Grand Challenge

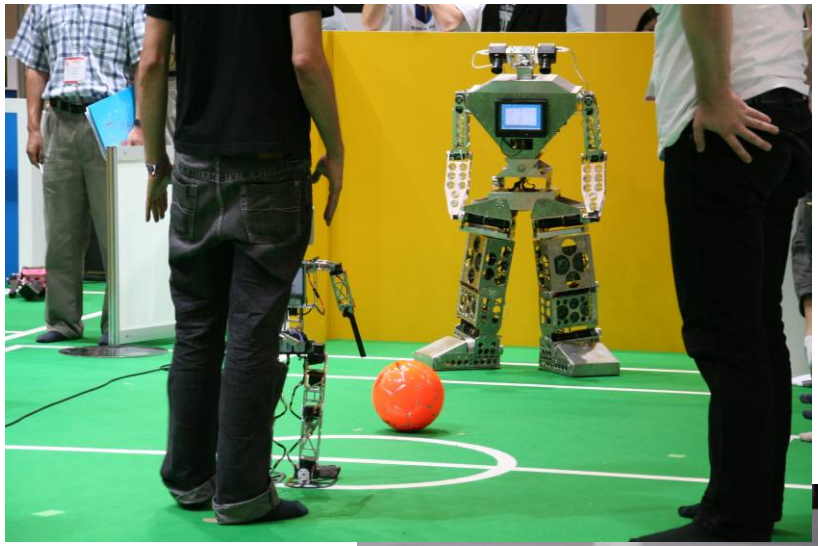
Source: *Sebastian Thrun*

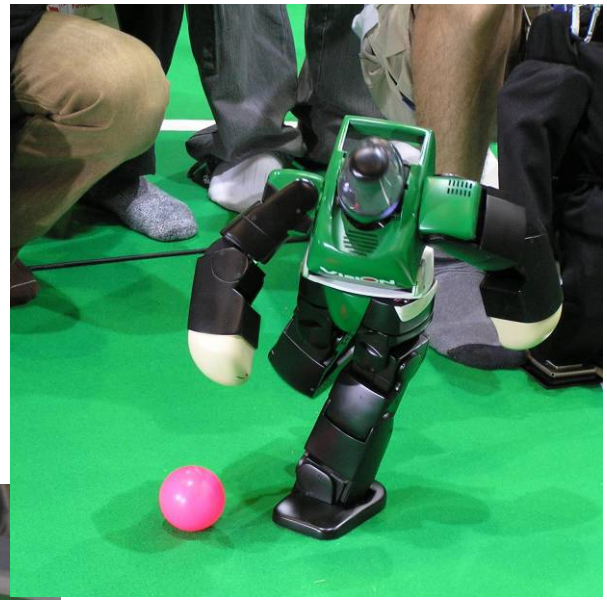
Multiagent Systems: Poker

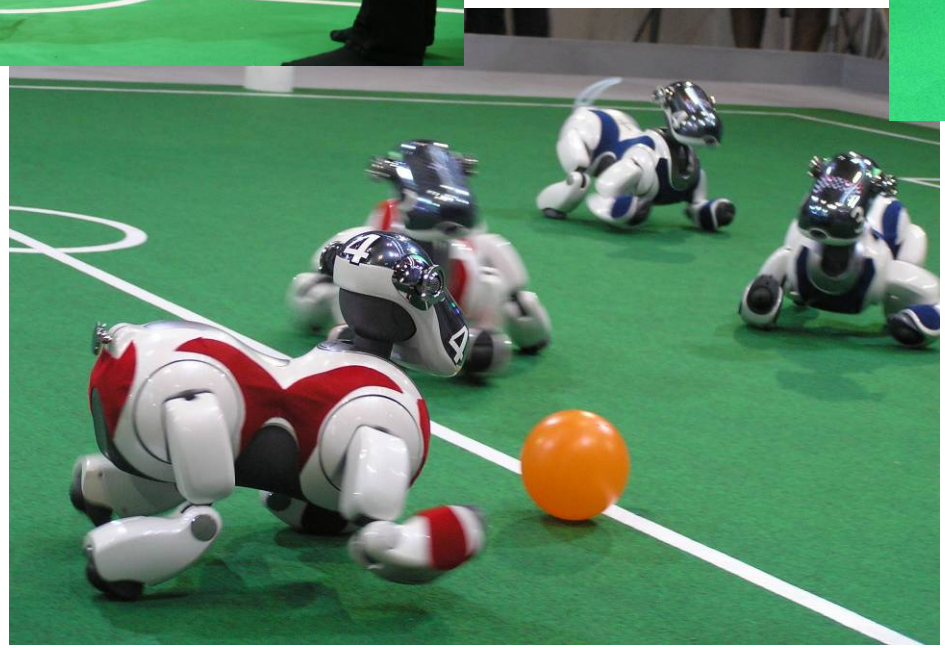
- In full 10-player games Poki is better than a typical low-limit casino player and wins consistently; however, not as good as most experts
- New programs being developed for the 2-player game are quite a bit better, and we believe they will very soon surpass all human players

Source: *The University of Alberta GAMES Group*

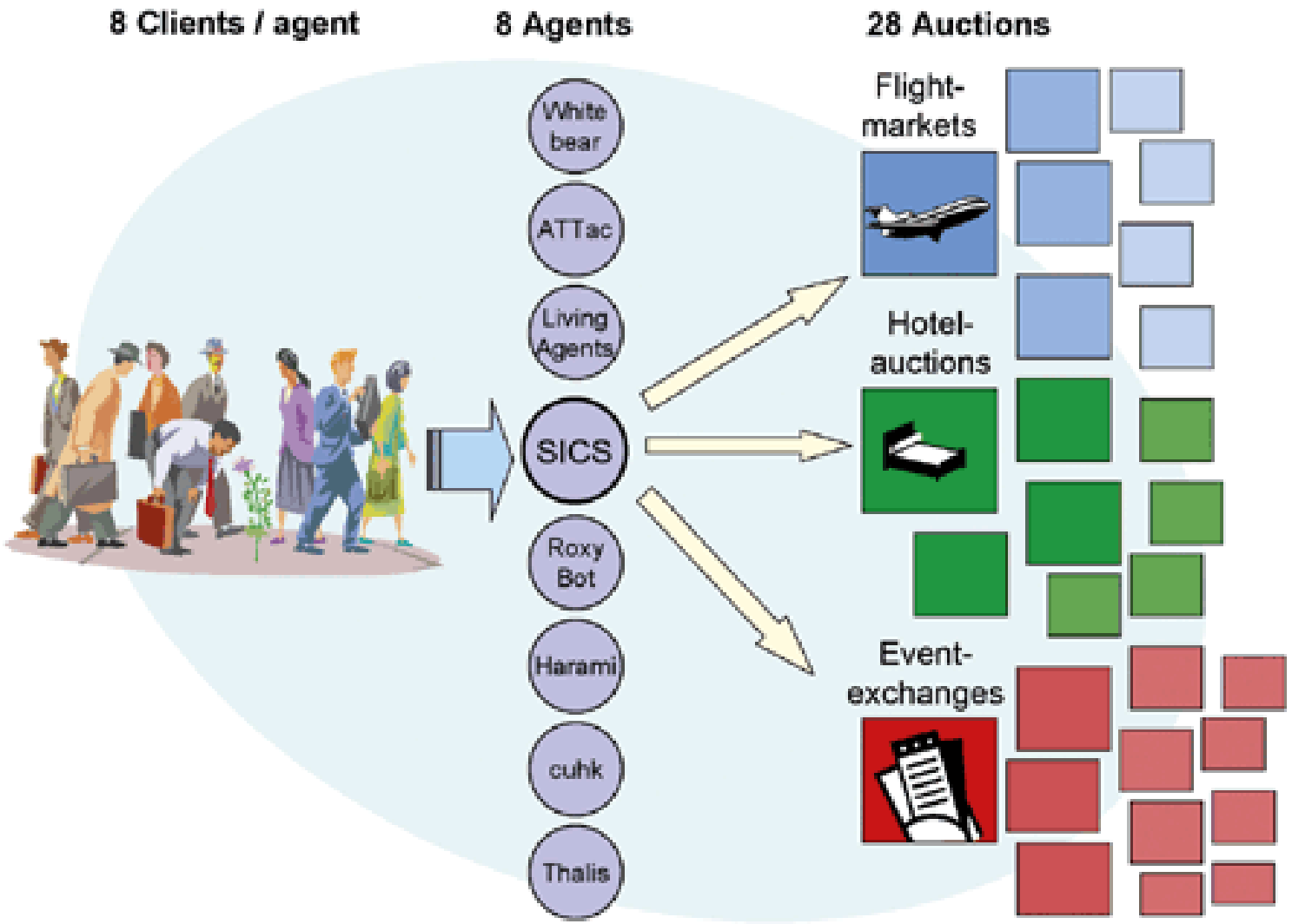
Multiagent Systems: Robot Soccer







Multiagent Systems: Trading Agents



Source: *Swedish Institute of Computer Science*