

AI Applications

CPSC 322 Lecture 4

January 15, 2007

Modules we'll cover in this course

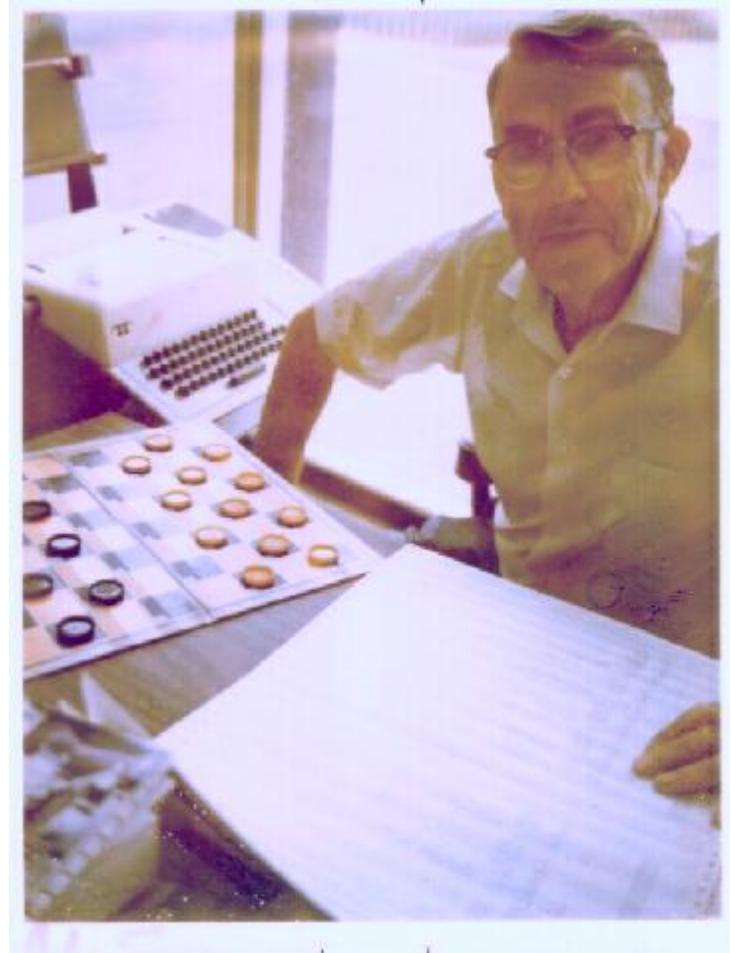
1. Making single decisions in deterministic environments
 - ▶ Search, CSPs
2. Making sequential decisions in deterministic environments:
 - ▶ Planning
3. Richer representations in deterministic environments:
 - ▶ Logic
4. Making single decisions in stochastic environments:
 - ▶ Bayes Nets, Influence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

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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



Search/CSPs: Crossword Puzzles

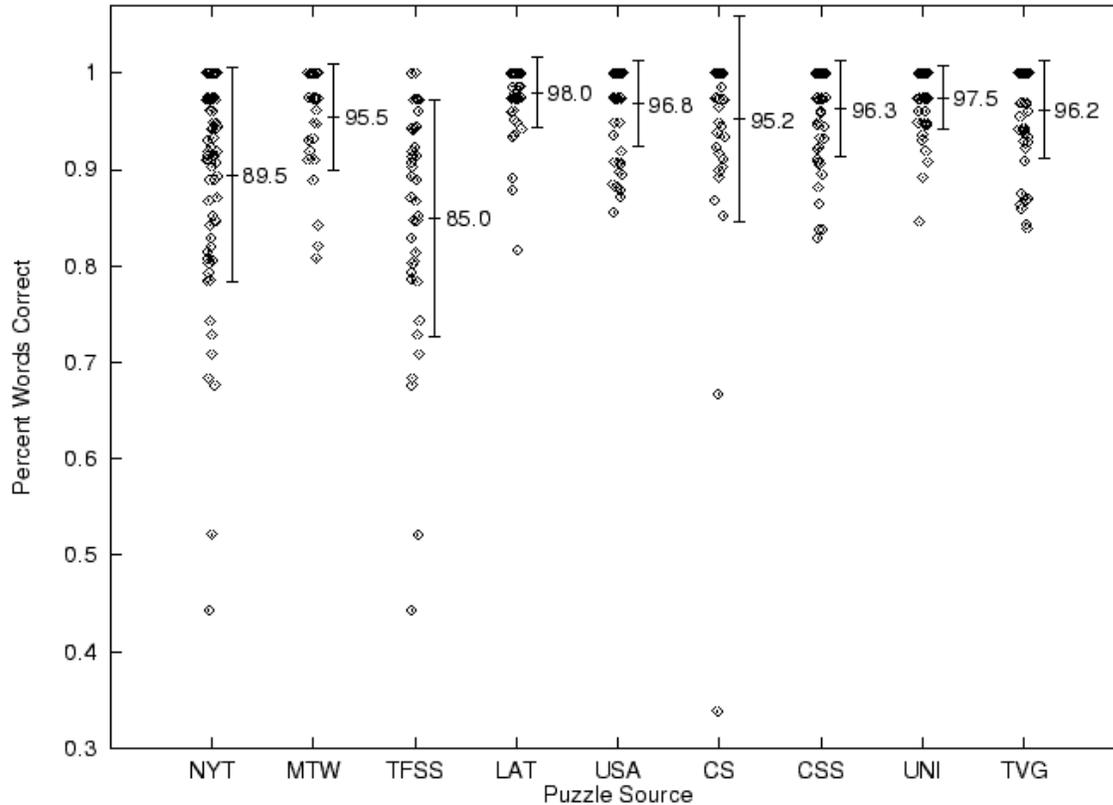
Daily Puzzles

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

Proverb Daily Results



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	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	H	N	K	Y	A	R	D				S	M	E	A	R	S	

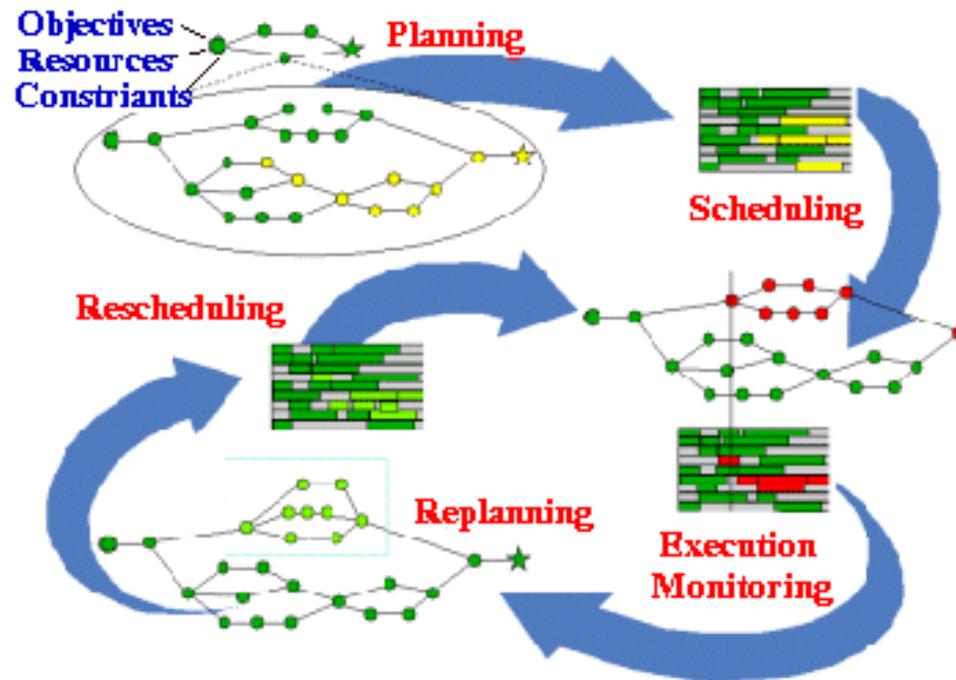
Source: *Michael Littman*

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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

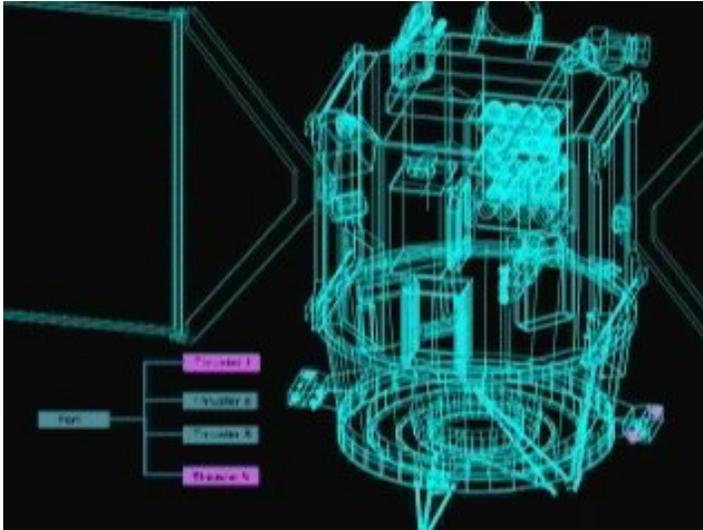


Source: DARPA

Planning: Spacecraft Control

NASA: Deep Space One spacecraft

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

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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

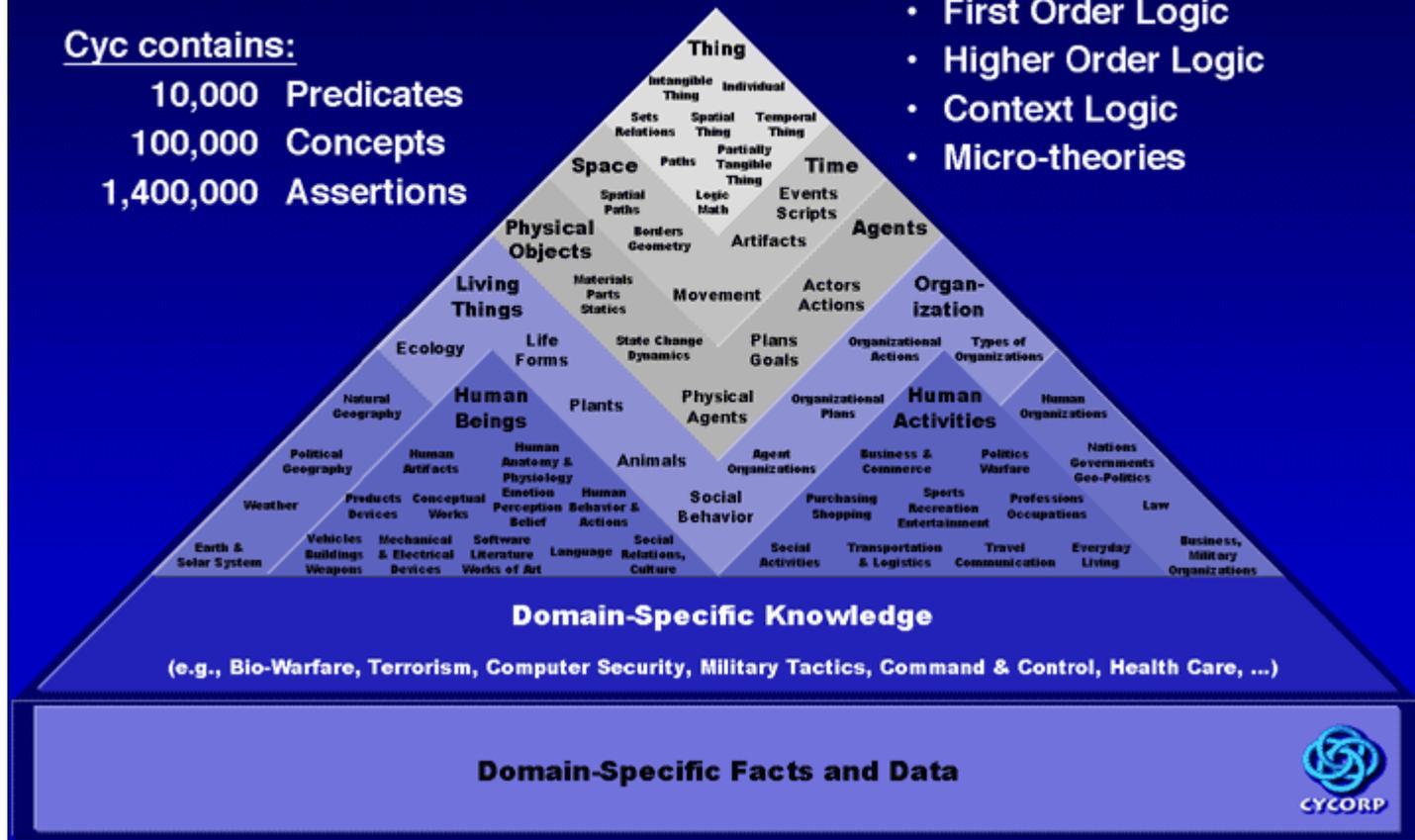
Cyc Ontology & Knowledge Base

Cyc contains:

10,000 Predicates
100,000 Concepts
1,400,000 Assertions

Represented in:

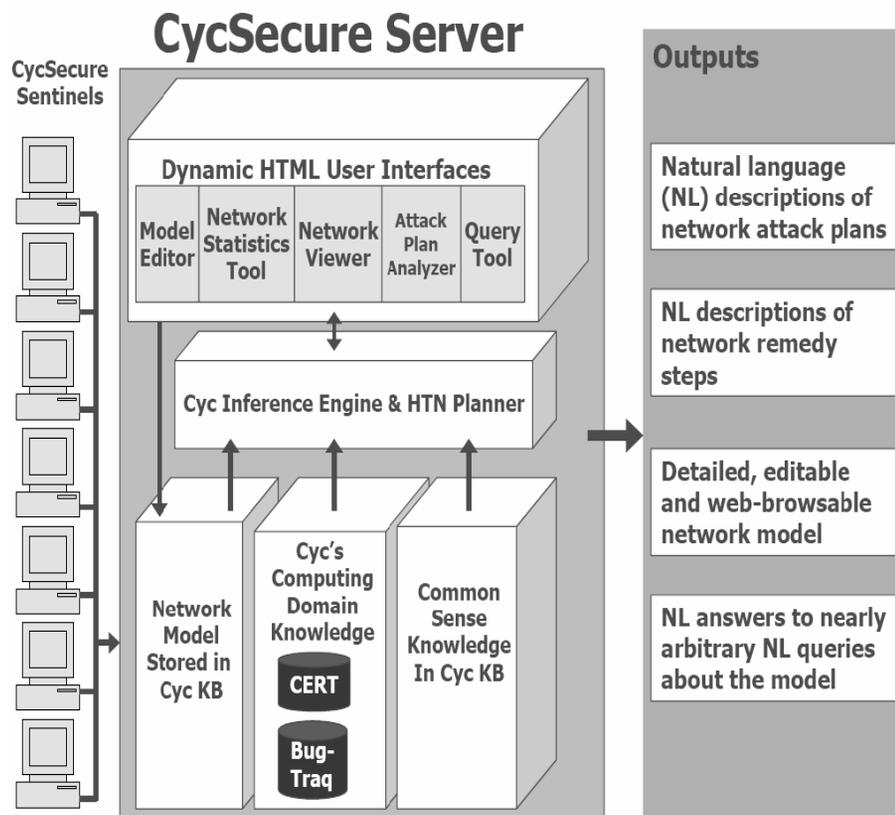
- First Order Logic
- Higher Order Logic
- Context Logic
- Micro-theories



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*

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Reasoning Under Uncertainty

- Texture classification using SVMs
 - foliage, building, sky, water

foliage



Source: *Mike Cora, UBC*

Reasoning under Uncertainty

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



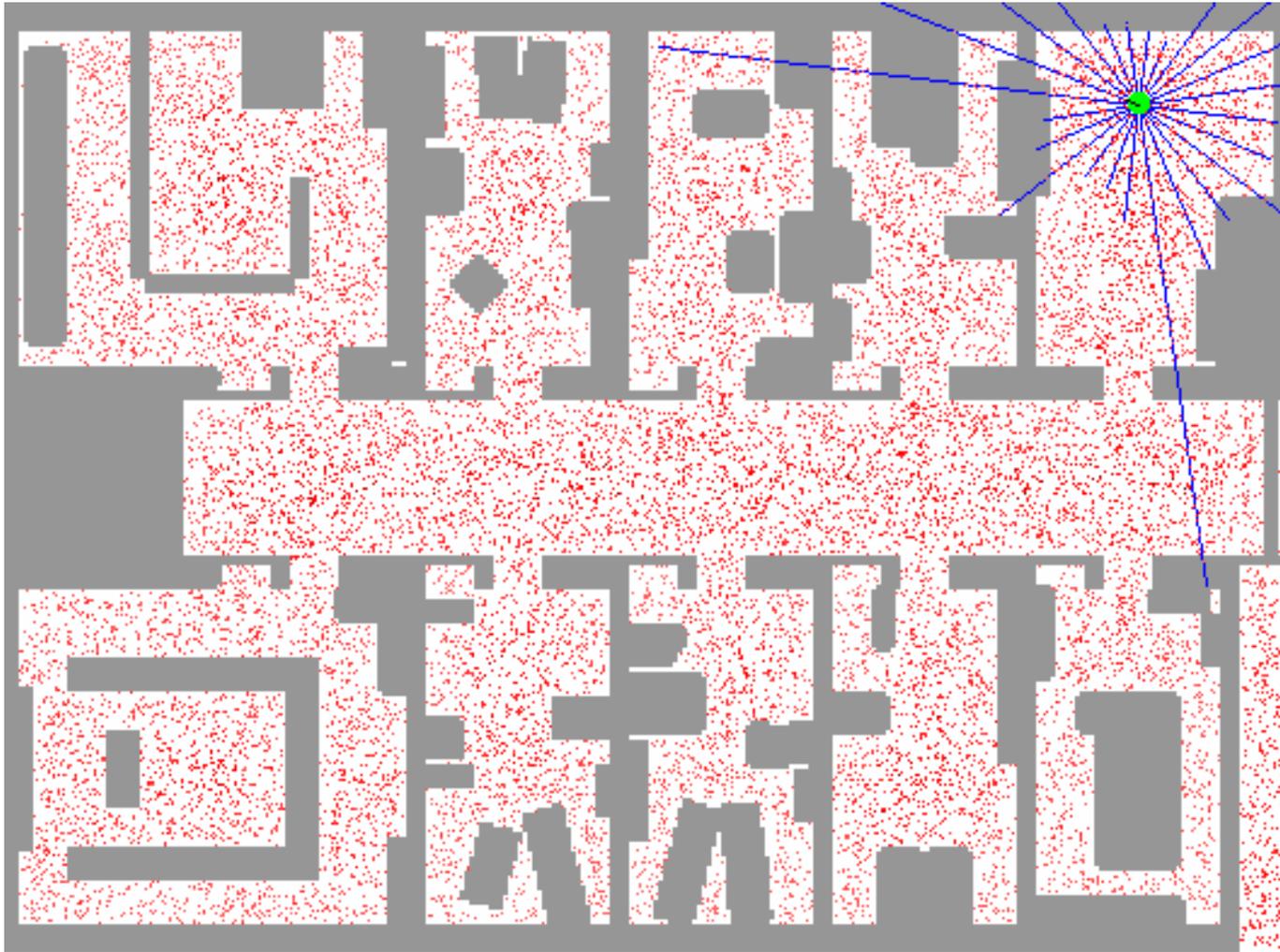
Source:
Kevin Murphy,
UBC

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Planning Under Uncertainty

Localization: office robot with laser rangefinder



Source:
*Sebastian
Thrun*

Planning Under Uncertainty

Simultaneous Localization & Mapping: Mine mapping



Source:
*Sebastian
Thrun*

Planning Under Uncertainty

SLAM in 3D: Helicopter Mapping



Source:
*Sebastian
Thrun*

Planning Under Uncertainty

Helicopter control: MDP, reinforcement learning



Source:
*Andrew
Ng*

Planning Under Uncertainty

Autonomous driving: DARPA Grand Challenge

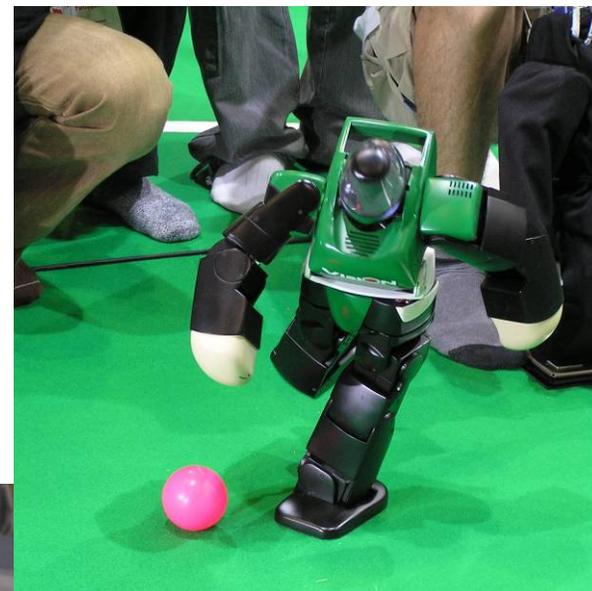
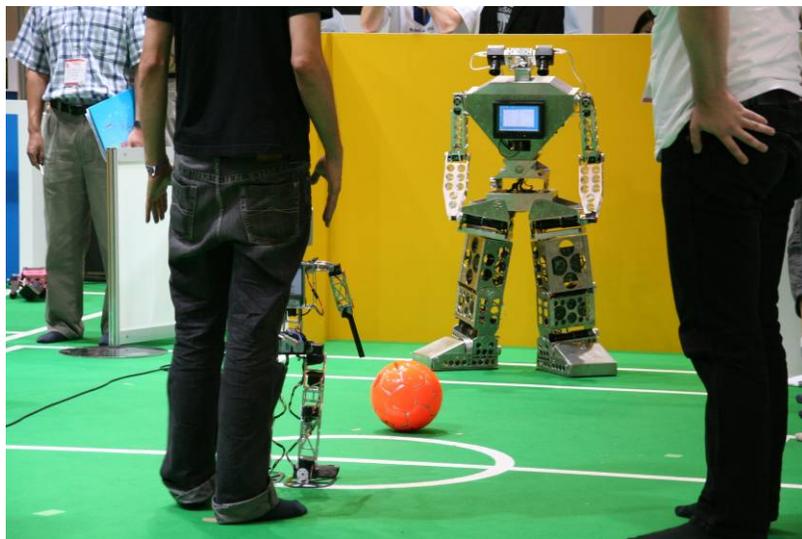
Dr. Sebastian Thrun
Stanford Racing Team Leader & Director
Stanford Artificial Intelligence Lab

Source:
*Sebastian
Thrun*

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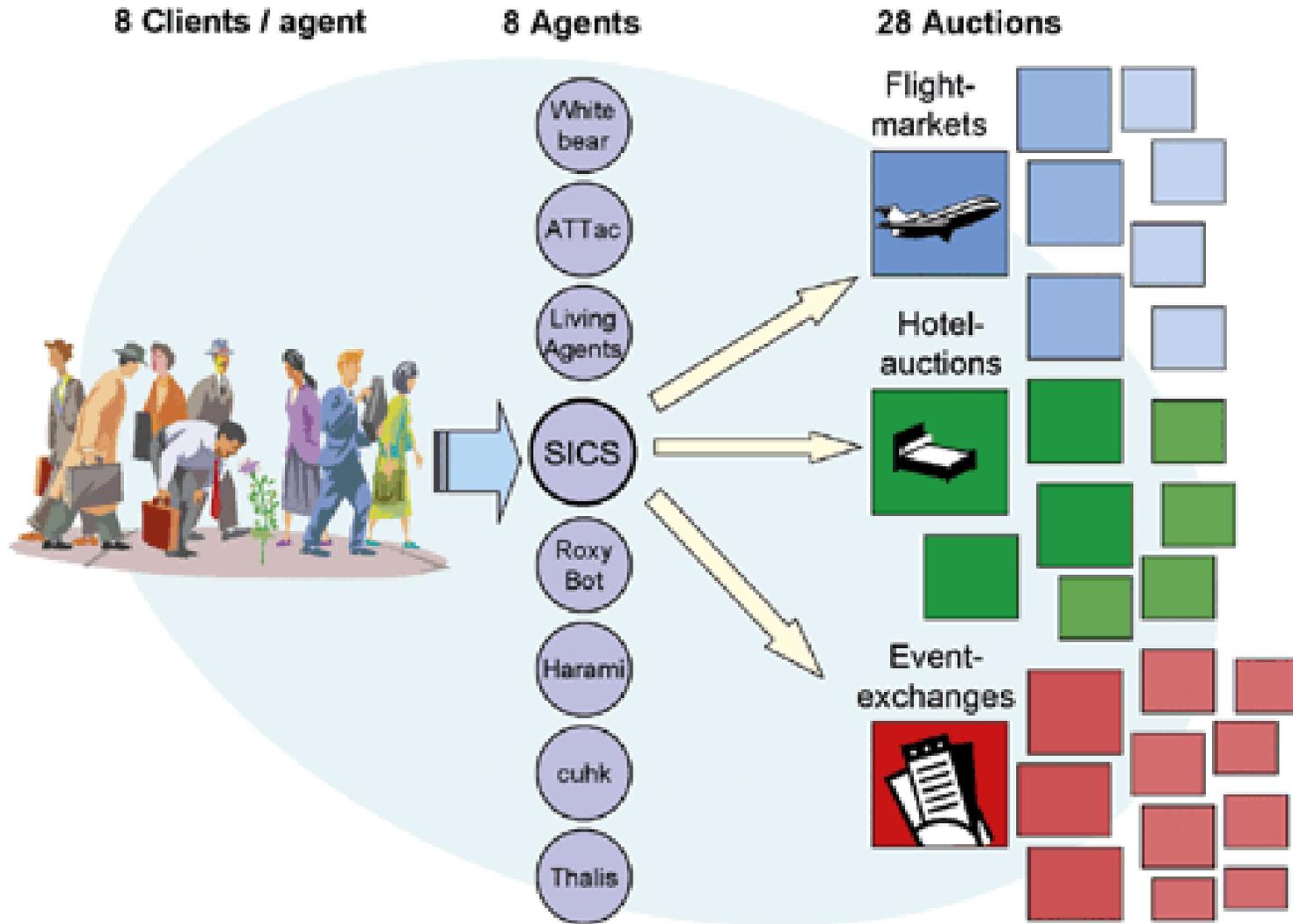
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Multiagent Systems: Robot Soccer



Source:
RoboCup web site

Multiagent Systems: Trading Agents



Source: *Swedish Institute of Computer Science*

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