AI Applications

Computer Science cpsc322, Lecture 3

January, 9, 2009

If your studentID is below we need to talk at the end of lecture

22372056

36966026

63852040

Lecture Overview

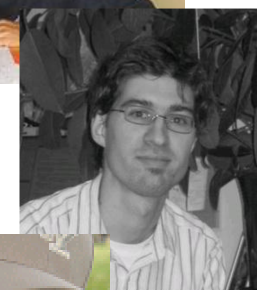
- **Office Hours**
- **Clarifications for last lecture**
- AI applications…

People

Instructor

- Giuseppe Carenini (carenini@cs.ubc.ca; office CICSR 129)

Teaching Assistants



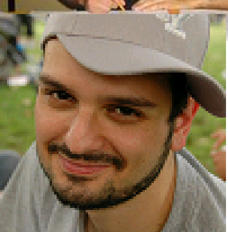
- Jacek Kisynski : kisynski@cs.ubc.ca
- Gustavo Lacerda gusl@cs.ubc.ca
- Peter Carbonetto pcarbo@cs.ubc.ca,

- Gabriel Murray: gabriel.murray@gmail.com

Office Hours

- Go to office hours (newsgroup is NOT a good substitute for this) – times below are still tentative, will be finalized next week

Giuseppe: Tue 2-3 (CICSR #129)



Jacek : Wed 2-3 (learning Center)

- **Gustavo:** Thur 2-3 (learning Center)
- **Peter:** Mon 2-3 (learning Center)

(Peter will start on Jan 26)

Can schedule by appointment if you can document a conflict with the official office hours

Explicit State or propositions

How do we model the environment? efficiency

- You can enumerate the **states** of the world. ←
- A state can be described in terms of **features**
  - Often it is more natural to describe states in terms of assignments of values to variables (features). concise
  - 30 binary features (also called propositions) can represent 2^{30}= 1,073,741,824 states.

one possible state {S, +35, 30°, 110°}

Mars Explorer Example

Weather {S, C} (sunny, cloudy)

Temperature {−40 – +40}

LocX 0° 359° (longitude) *LocY* 0° 179° (latitude)

2 * 81 * 360 * 180

number of possible states

mutually exclusive

Explicit State or propositions or relations

- Features can be described in terms of **objects** and **relationships**.
- There is a proposition for each relationship on each “possible” tuple of individuals.

University Example

Registred(S,C)

Students (S) = { s_1 s_2 s_3 s_4 *}*

Courses (C) = { c_1 c_2 c_3 *}*

- Textbook example: One binary relation and 10 individuals can represents 10^2=100 propositions and 2^{100} states!

Modules we'll cover in this course: R&Rsys

Environment

Problem		Deterministic	Stochastic
Static	Constraint Satisfaction	*Vars + Constraints* Arc Consistency Search	
	Inference	*Logics* Search	*Belief Nets* Var. Elimination
Sequential	Planning	*STRIPS* actions preconds effects Search	*Decision Nets* Var. Elimination *Markov Processes* Value Iteration

Representation

Reasoning Technique

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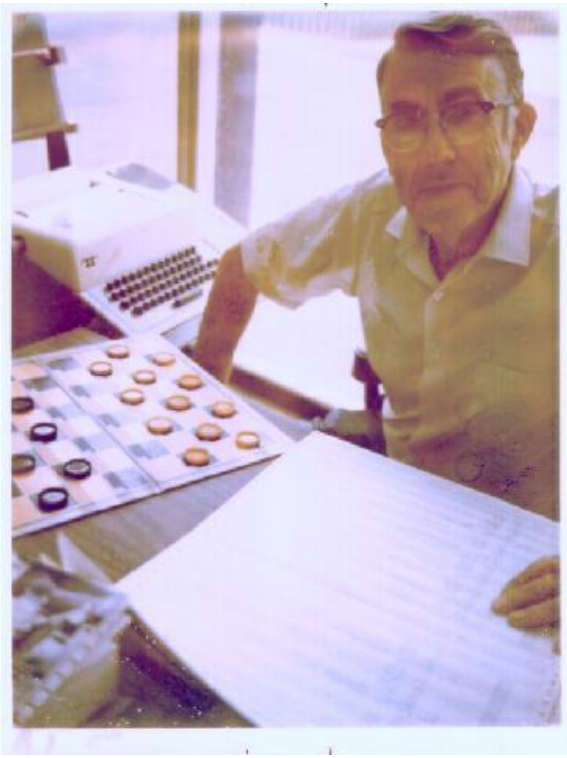
(Adversarial) Search: Checkers

Game playing was one of the first tasks undertaken in AI

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*

Chinook's program was declared the Man-Machine World Champion in checkers in 1994!

…and **completely solved** by a program in 2007!

(Adversarial) Search: 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*

(Adversarial) Search: 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

Source: *CNN*

(Adversarial) Search: Chess

Deep Blue's Results in the second tournament:

- second tournament: won 3 games, lost 2, tied 1

- 30 CPUs + 480 chess processors
- Searched 126.000.000 nodes per sec
- Generated 30 billion positions per move reaching depth 14 routinely

Modules we'll cover in this course: R&Rsys

Problem		Environment: Deterministic	Environment: Stochastic
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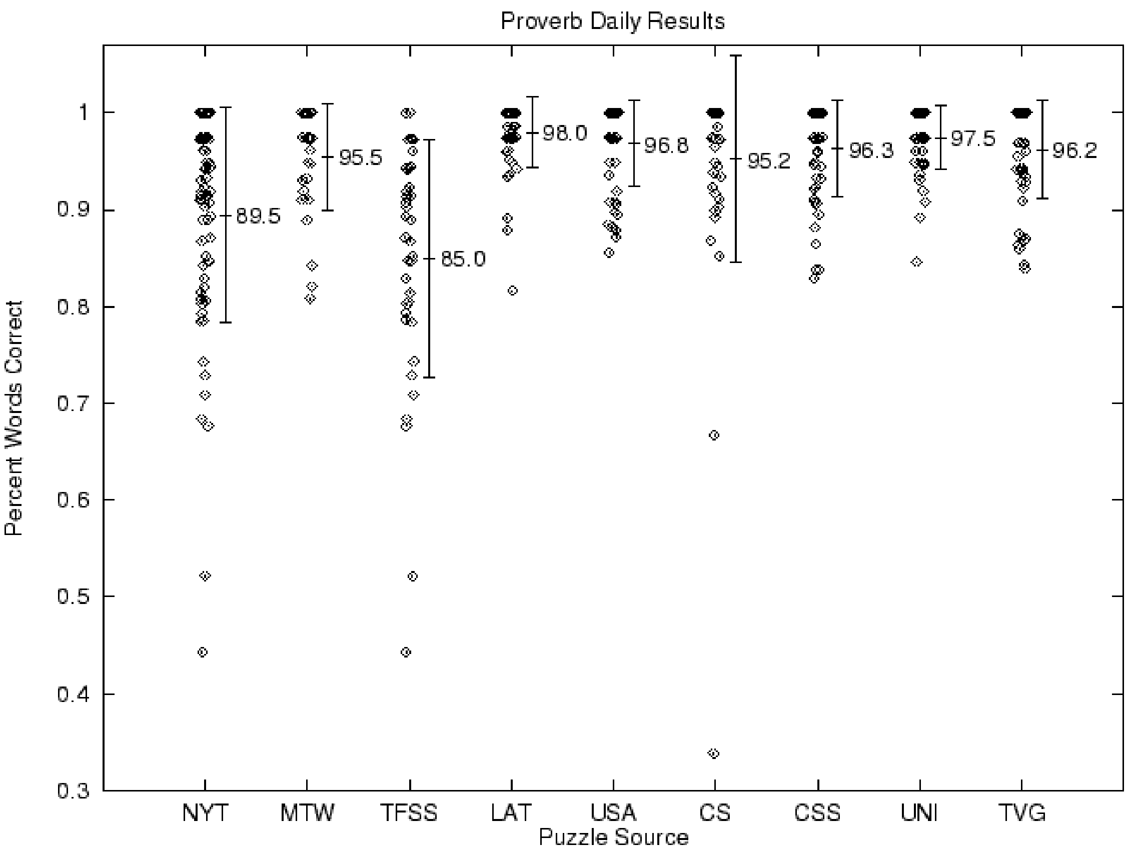
CSPs: Crossword Puzzles

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



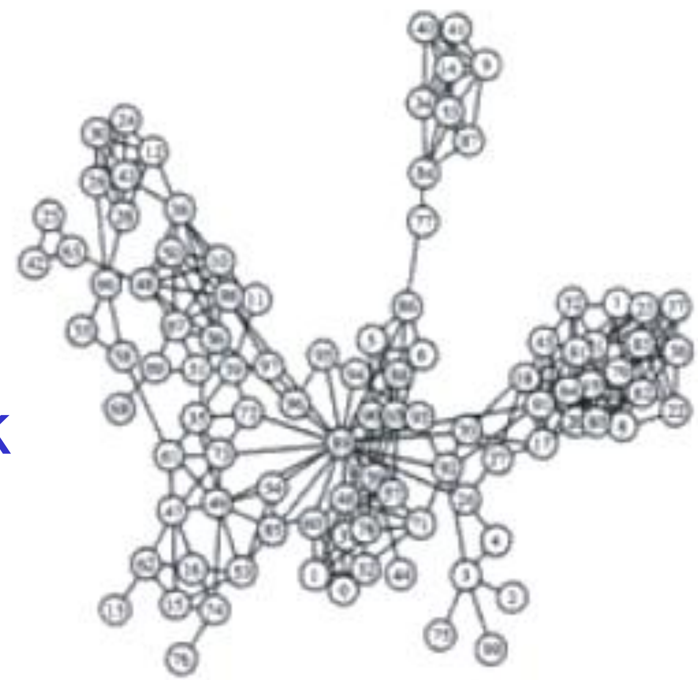
Source: *Michael Littman*

CSPs: Radio link frequency assignment

Assigning frequencies to a set of radio links defined between pairs of sites in order to avoid interferences.
Constraints on frequency depend on position of the links and on physical environment .

Source: *INRIA*

Sample Constraint network



Modules we'll cover in this course: R&Rsys

Problem		Environment: Deterministic	Environment: Stochastic
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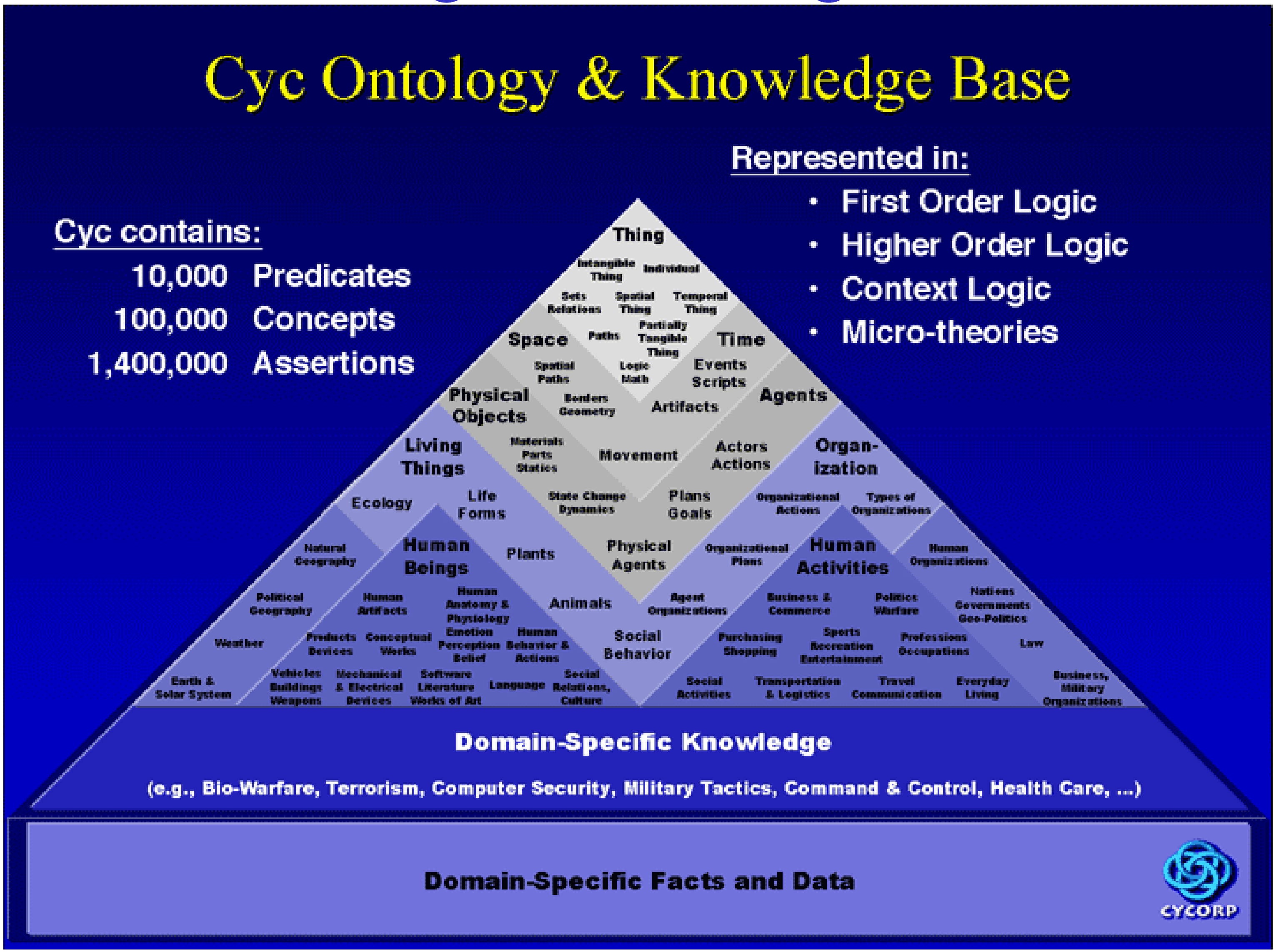
Logic: Ontologies

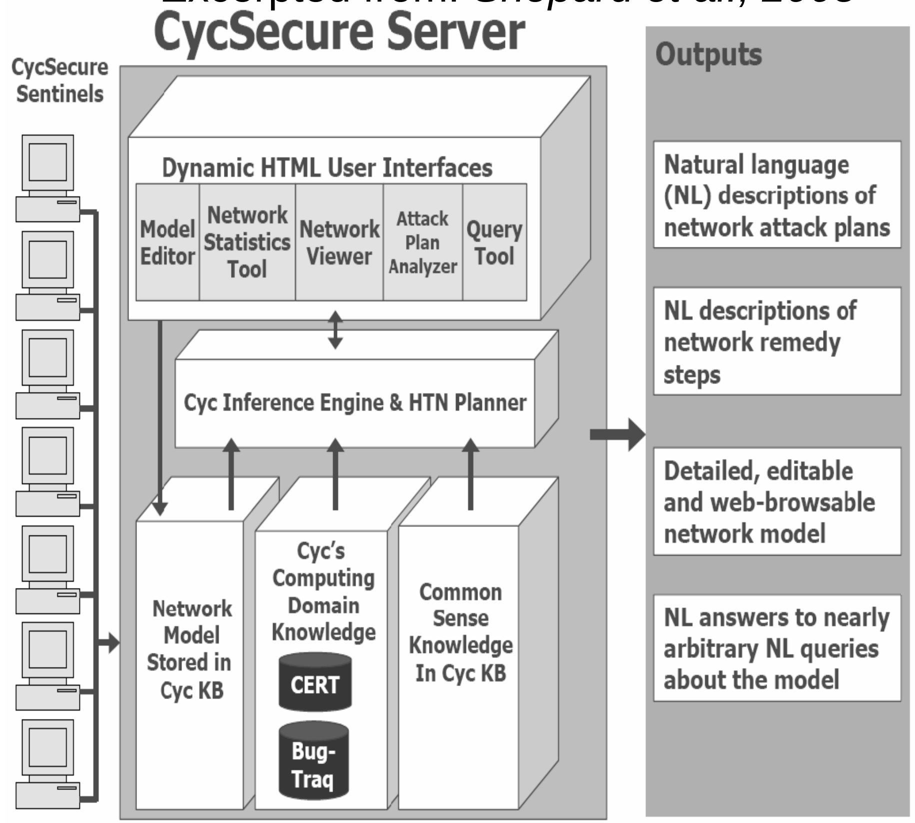


Source: *Cycorp*

Logic: 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:

Excerpted from: *Shepard et al., 2005*



This formal representation also allows users to interact directly with the model of the network, allowing testing of proposed changes."

- Knowledge Representation
- Semantic Web !

Modules we'll cover in this course: R&Rsys

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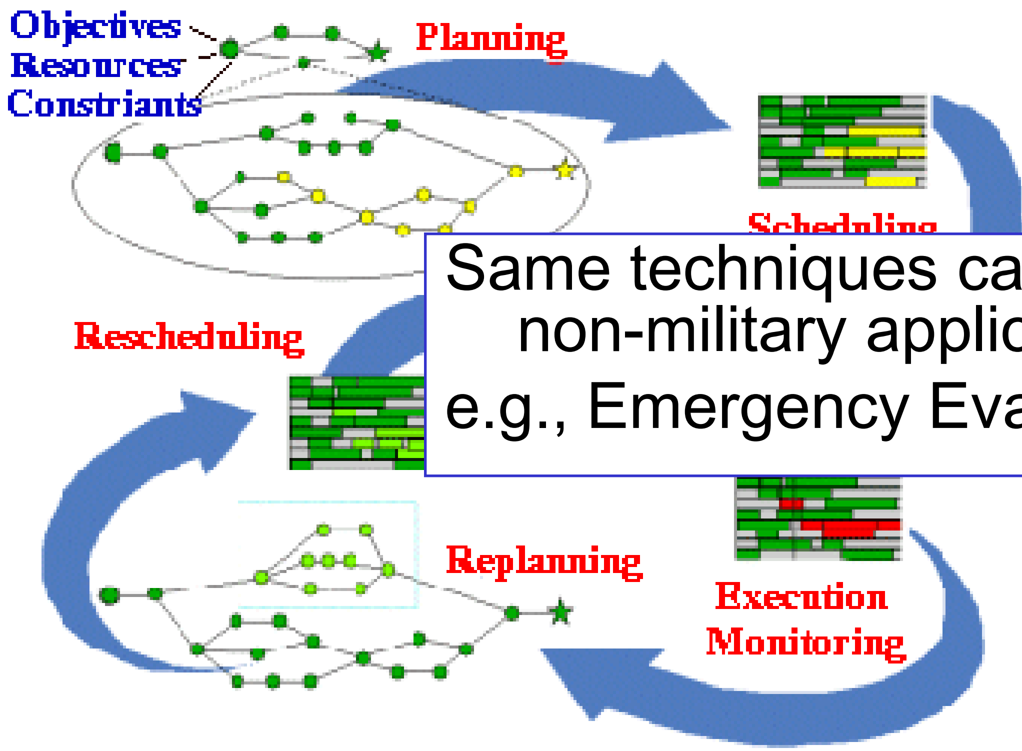
Planning & Scheduling: Logistics

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 entities (e.g., vehicles); different starting points and destinations



Same techniques can be use for non-military applications:

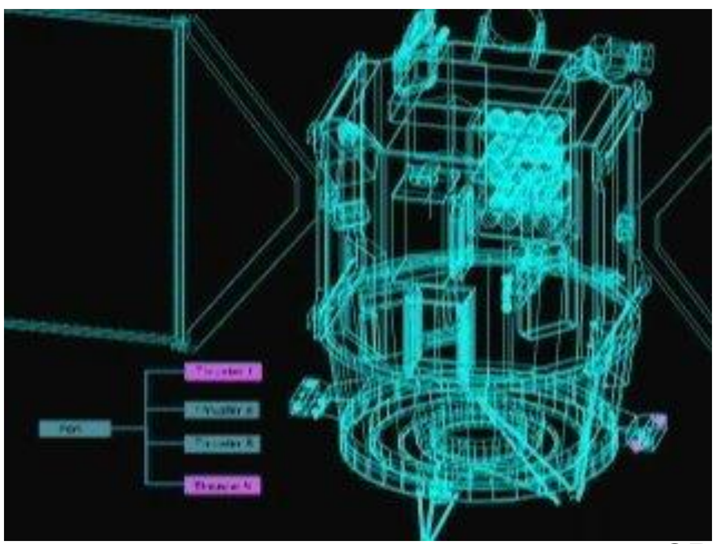
e.g., Emergency Evacuation

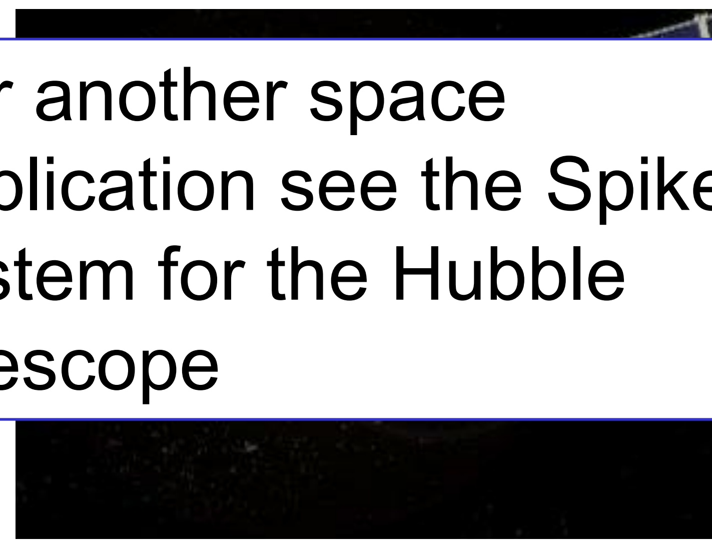
Source: *DARPA*

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 to make this adjustment





For another space application see the Spike system for the Hubble telescope

Source: *NASA*

Modules we'll cover in this course: R&Rsys

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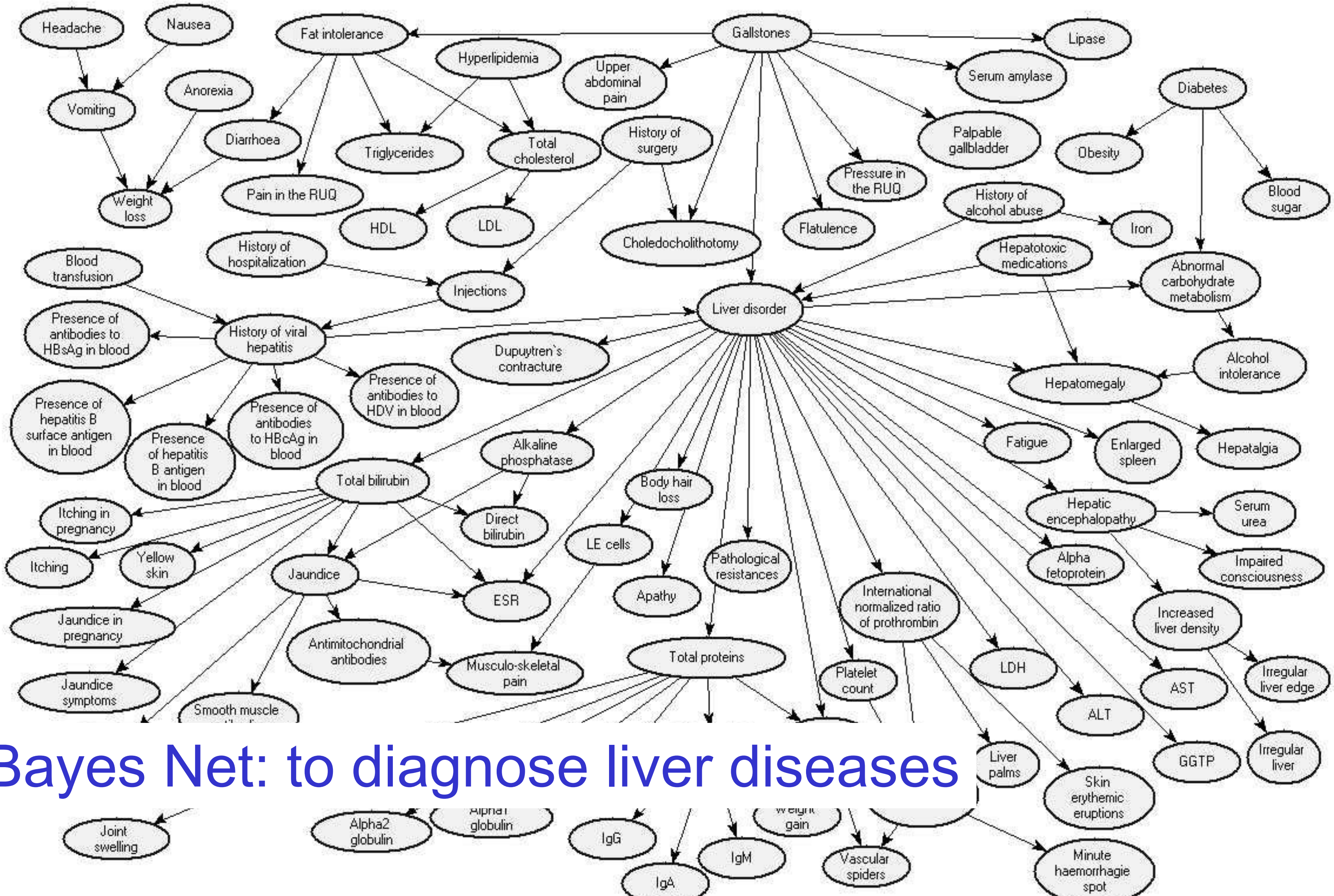
Reasoning under Uncertainty: Diagnosis



Bayes Net: to diagnose liver diseases

Source: *Onisko et al., 99*

Reasoning Under Uncertainty

Texture classification using Support Vector Machines

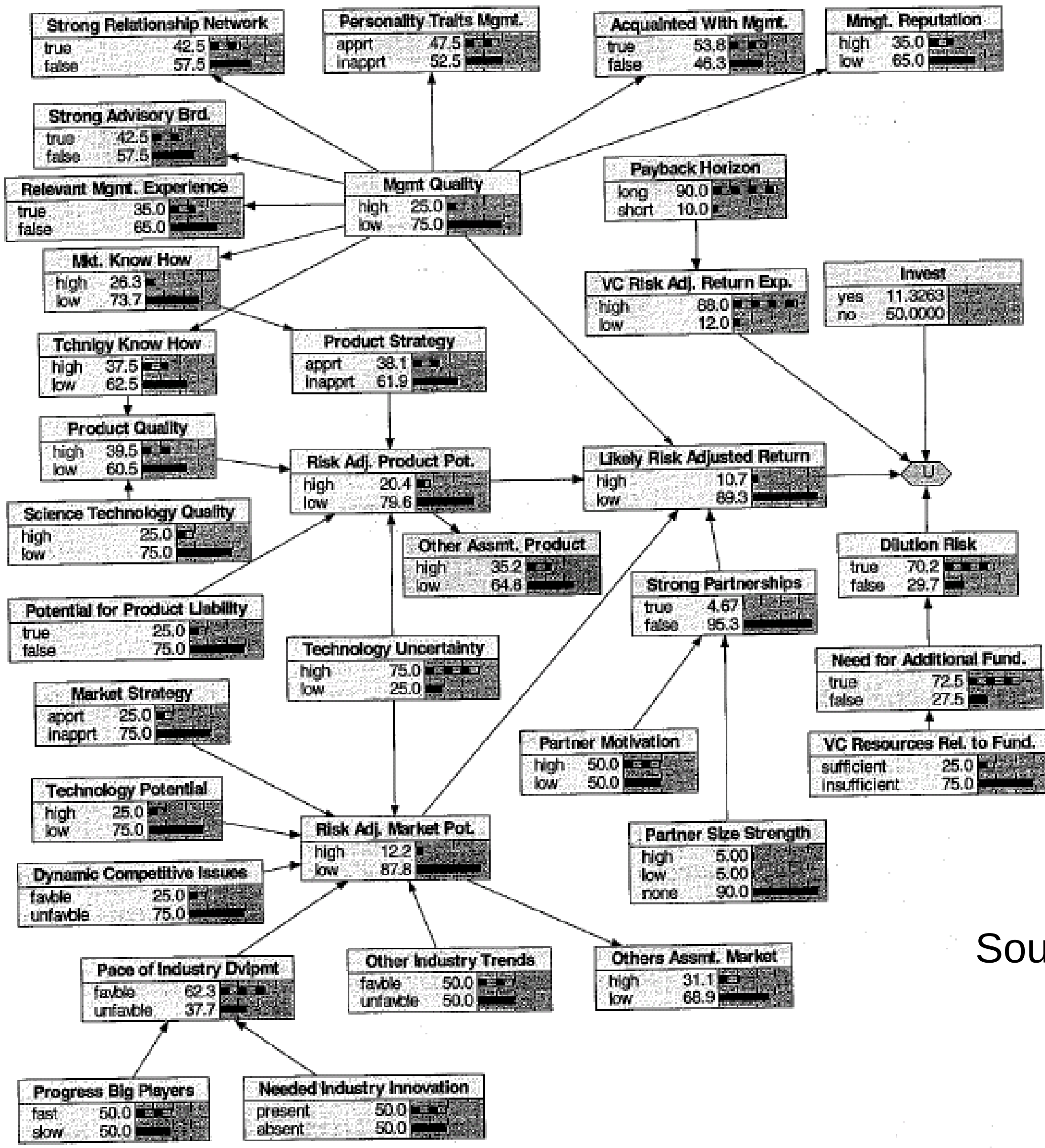
- foliage, building, sky, water

Source: *Mike Cora, UBC*

Modules we'll cover in this course: R&Rsys

Problem		Environment: Deterministic	Environment: Stochastic
Static	Constraint Satisfaction	*Vars + Constraints*: Arc Consistency, Search	
Static	Inference	*Logics*: Search	*Belief Nets*: Var. Elimination
Sequential	Planning	*STRIPS* (actions, preconds, effects): Search	*Decision Nets*: Var. Elimination; *Markov Processes*: Value Iteration

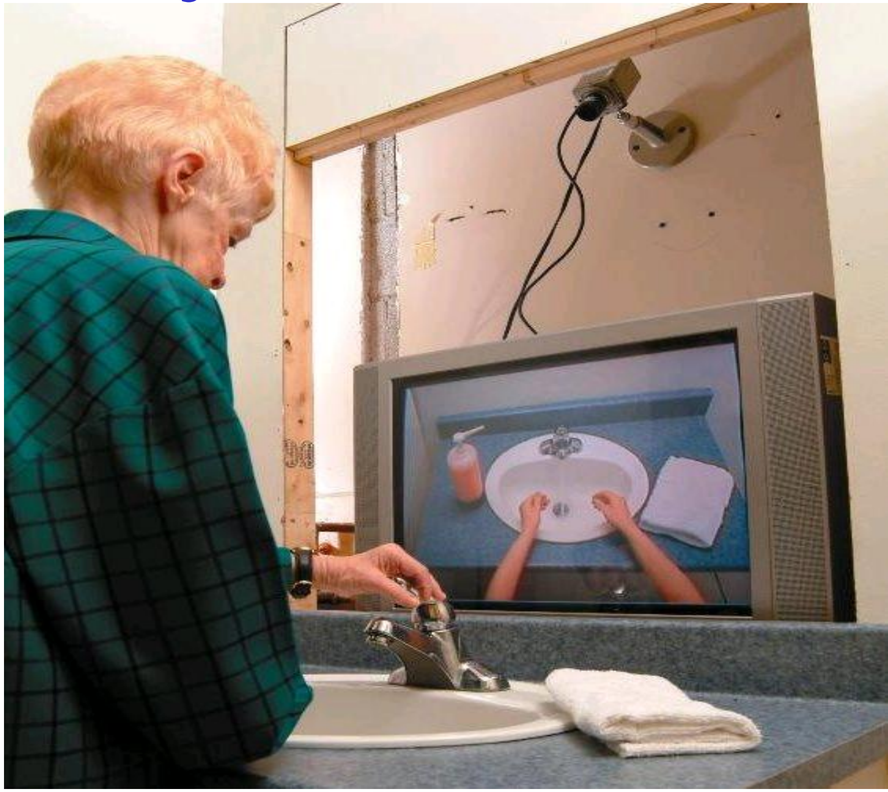
Decision Network in Finance for venture capital decision



Source: *R.E. Neapolitan, 2007*

Planning Under Uncertainty

Learning and Using POMDP models of Patient-Caregiver Interactions During Activities of Daily Living



Goal: Help Older adults living with cognitive disabilities (such as Alzheimer's) when they:

- **forget the proper sequence of tasks** that need to be completed
- **they lose track of the steps** that they have already completed.

Source: *Jesse Hoey UofT 2007*

Planning Under Uncertainty

Helicopter control: MDP, reinforcement learning

States: all possible positions, orientations, velocities and angular velocities

Final solution involves

Deterministic **search**!

Source: *Andrew Ng 2004*

Dimensions of Representational Complexity in CPSC322

We've already discussed:

- Deterministic versus stochastic domains
- Static versus sequential domains

Some other important dimensions of complexity:

- Explicit state or propositions or relations
- Flat or hierarchical
- Knowledge given versus knowledge learned from experience
- Goals versus complex preferences
- **Single-agent vs. multi-agent**

Multiagent Systems: Poker

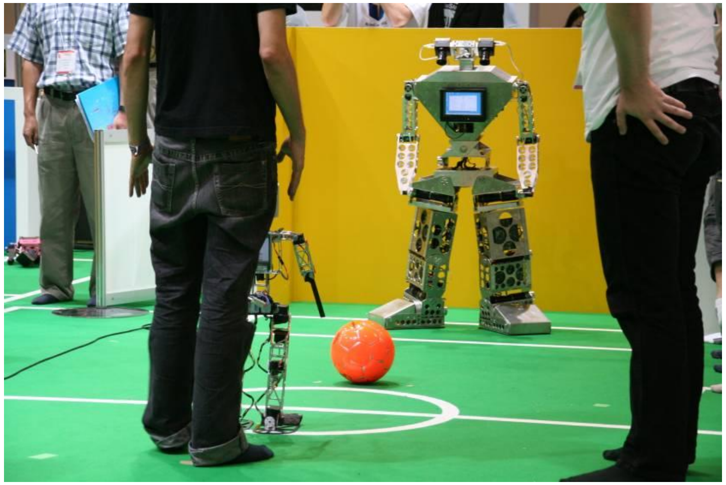
Search Space: 1.2 quintillion nodes

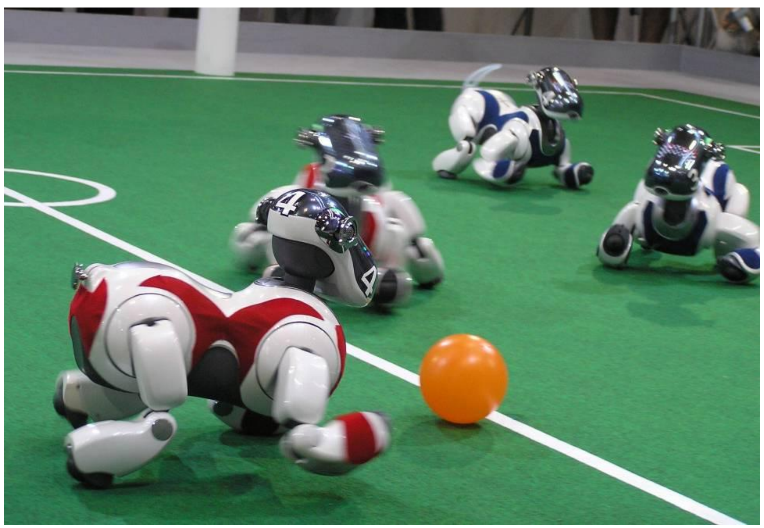
"In full 10-player games Poki is better than a typical low-limit casino player and wins consistently; however, not as good as most experts

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





Extremely complex

- Stochastic
- Sequence of actions
- Multiagent

robotic soccer competition was proposed by LCI (UBC) in 1992

(which became *Robocup* in 1997).

Source: *RoboCup web site*

Natural Language Processing

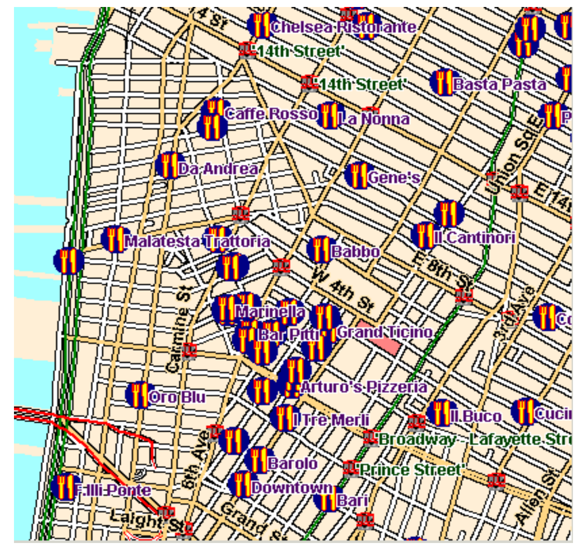
Multimodal Access to City Help (MATCH)

Multimodal interface

Portable Fujitsu tablet

Input: Pen for deictic gestures and Speech input

Output: Text, Speech and graphics



Source:
M. Walker (ex. AT&T) 2002

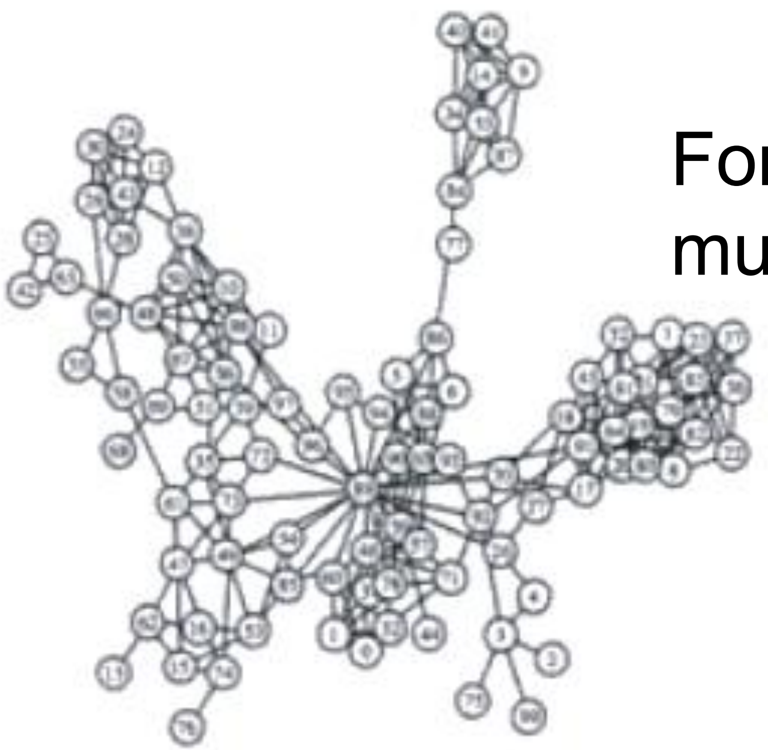
TO DO for Next class

- Search: Start reading (Chpt 3 – sec 3.1 – 3.3)

CSPs: Radio link frequency assignment

Assigning frequencies to a set of radio links defined between pairs of sites in order to avoid interferences.

Source: *INRIA*



For each link two frequencies must be assigned