Department of Computer Science
Undergraduate Events for Sept 10-14

More details @
https://www.cs.ubc.ca/students/undergrad/life/upcoming-events

TELUS Info Session
Date: Mon. Sept. 10
Time: 5:30 – 7:30 pm
Location: Wesbrook 100

Deloitte Info Session
Date: Tues. Sept. 11
Time: 6:00 – 8:00 pm
Location: Henry Angus Room 098

Capgemini Info Session
Date: Fri. Sept. 14
Time: 2:00 – 5:00 pm
Location: Downtown Vancouver
(RSVP req'd by Sept. 12)

Tri-Mentoring Student Orientation
Date: Tues. Sept. 11
Time: 5:15 – 6:30 pm
Location: DMP 110

Resume Writing Workshop (for non-coops)
Date: Thurs. Sept. 13
Time: 12:30 – 1:45 pm
Location: DMP 101

Women in Games Panel
Date: Wed. Sept 12
Time: 5:30 – 9:00 pm
Location: EA Burnaby Studios

AI Applications

Computer Science cpsc322, Lecture 3

Sept, 10, 2012

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

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

Representation
Reasoning Technique

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

Environment

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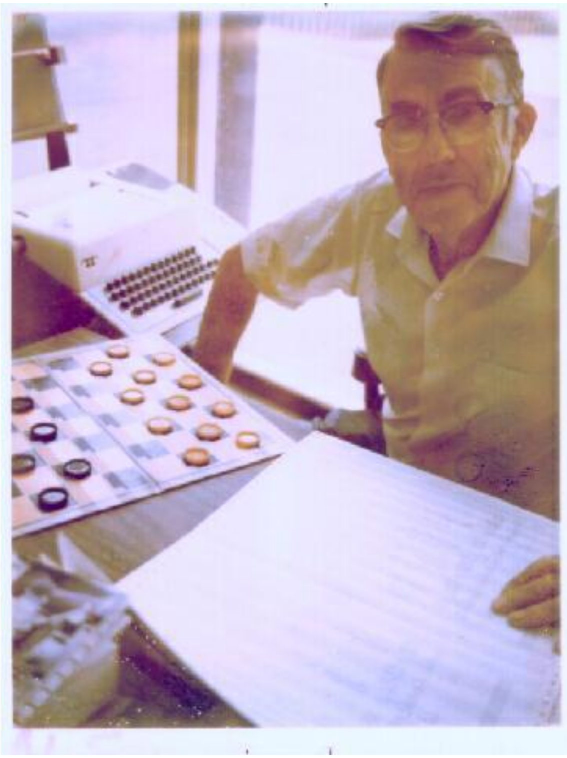
Sequential	Planning	*STRIPS* actions, preconds, effects Search	*Decision Nets* Var. Elimination *Markov Processes* Value Iteration

(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

Sample A* applications

- **An Efficient A* Search Algorithm For Statistical** Machine Translation. 2001
- **The Generalized A* Architecture**. Journal of Artificial Intelligence Research (2007)
  - Machine Vision … Here we consider a new compositional model for finding salient curves.
- **Factored A*search for models over sequences and trees** International Conference on AI. 2003…. It starts saying… *The primary challenge when using A* search is to find heuristic functions that simultaneously are admissible, close to actual completion costs, and efficient to calculate…* applied to NLP and BioInformatics

(Natural Language Processing)

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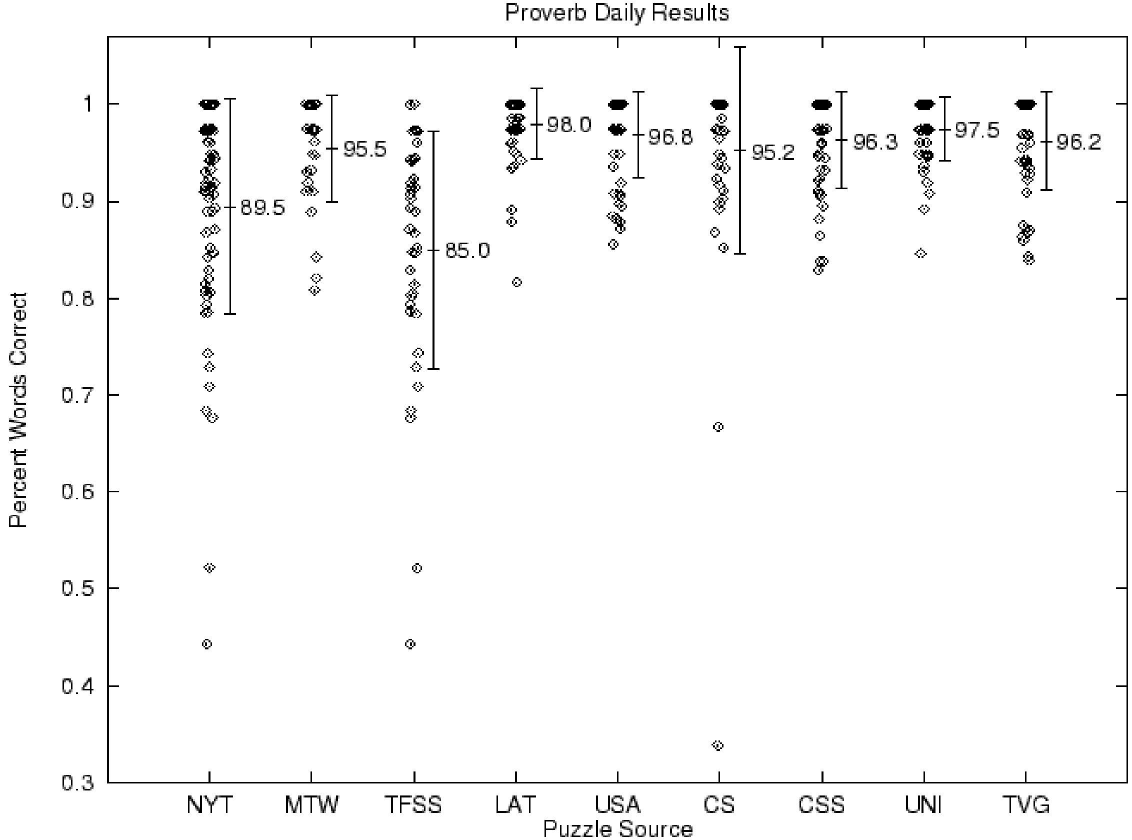
CSPs: Crossword Puzzles

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



P	O	L	O	N	E		P	A	L	O	M	I	N	O
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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
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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
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A	B	E	R	D	E	E	N		E	S	C	H	E	R
J	U	N	K	Y	A	R	D		S	M	E	A	R	S

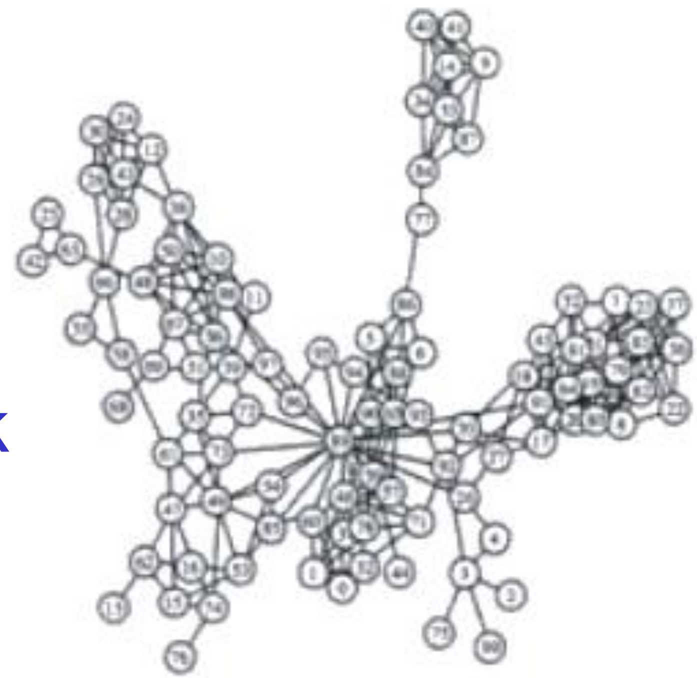
Source: *Michael Littman*

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

Example: SLS for RNA secondary structure design

RNA strand made up of four bases: cytosine (C), guanine (G), adenine (A), and uracil (U)

2D/3D structure RNA strand folds into is important for its function

Predicting structure for a strand is “easy”: $O(n^3)$

But what if we want a strand that folds into a certain structure?

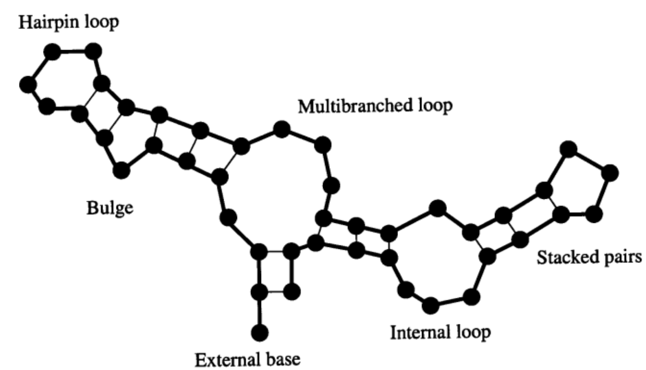
RNA strand

GUCCCAUAGGAUGUCCCAUAGGA

Easy

Hard

Secondary structure



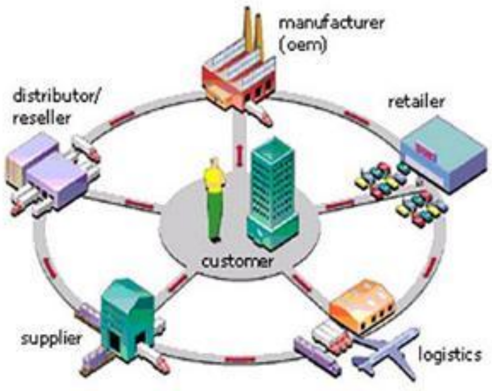
On of the Best algorithm to date: Local search algorithm RNA-SSD developed at UBC [Andronescu, Fejes, Hutter, Condon, and Hoos, Journal of Molecular Biology, 2004]

Constraint optimization problems

Optimization under side constraints (similar to CSP)

E.g. mixed integer programming (software: IBM CPLEX)

- Linear program: max $c^T x$ such that $Ax \leq b$
- Mixed integer program: additional constraints, $x_i \in \mathbb{Z}$ (integers)
- NP-hard, widely used in operations research and in industry



Transportation/Logistics:
SNCF, United Airlines
UPS, United States Postal Service, …

Supply chain management software:
Oracle, SAP,…

Production planning and optimization:
Airbus, Dell, Porsche, Thyssen Krupp, Toyota, Nissan, ...

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

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CSP/logic: formal verification

Hardware verification
(e.g., IBM)

Software verification
(small to medium programs)

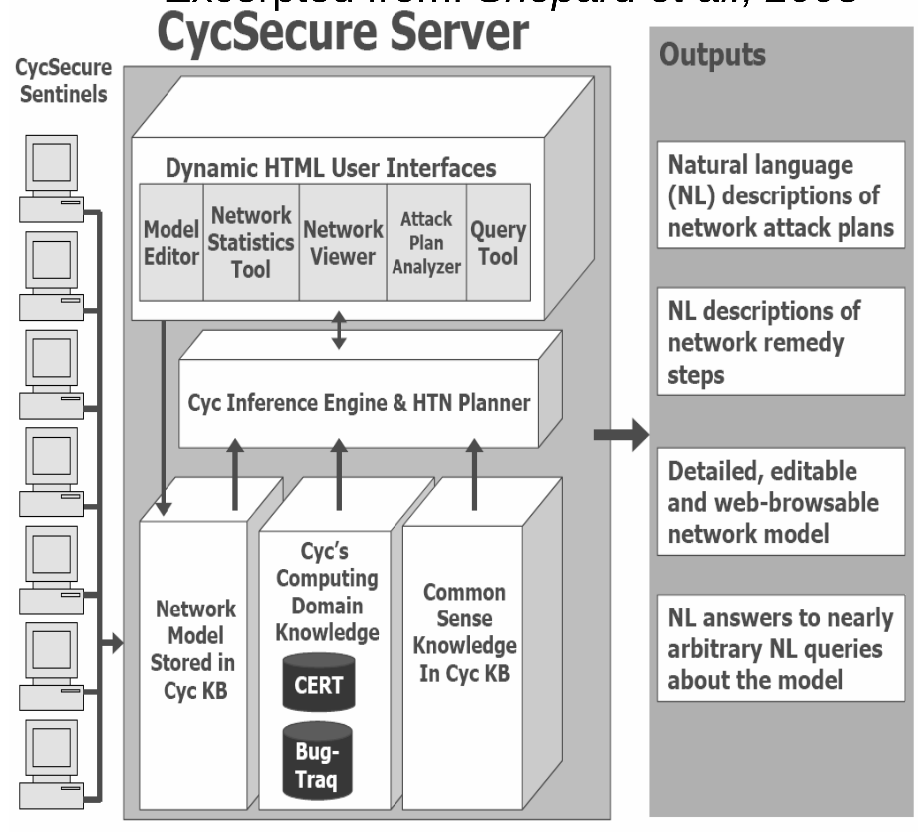
Most progress in the last 10 years based on:
Encodings into propositional satisfiability (SAT)

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 !

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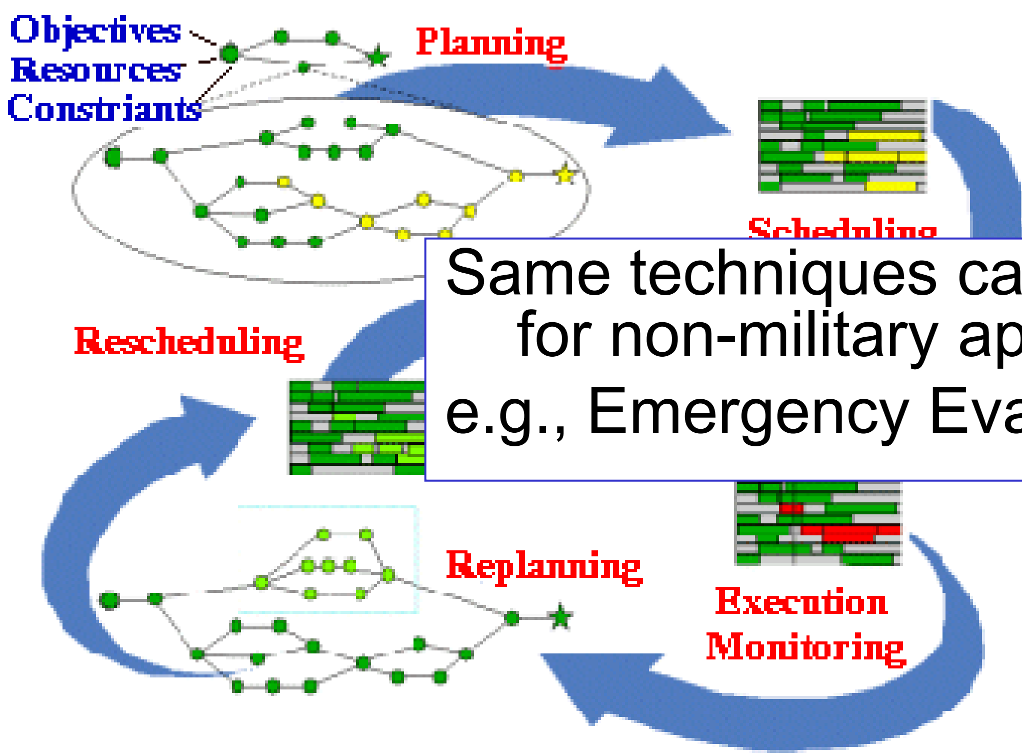
Planning & Scheduling: Logistics

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 used for non-military applications:

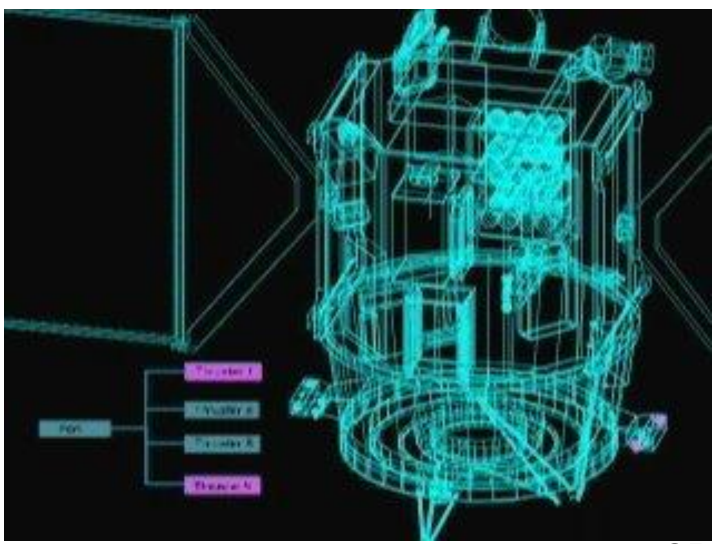
e.g., Emergency Evacuation

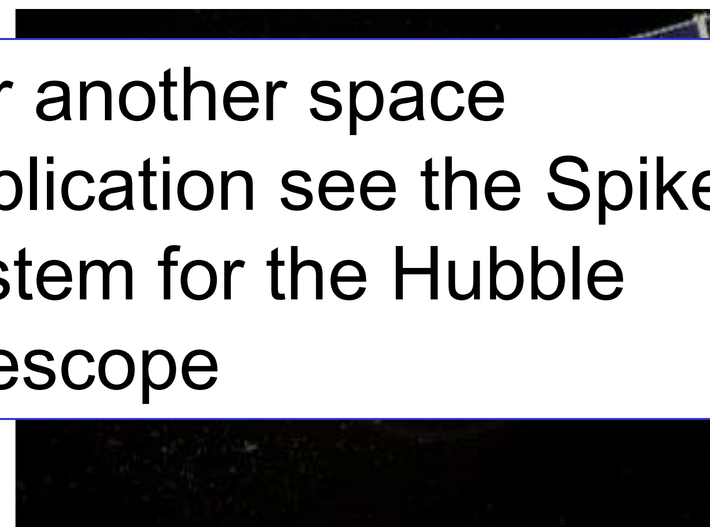
Source: *DARPA*

Planning: Spacecraft Control

NASA: Deep Space One spacecraft
operated autonomously for two days in May, 1999:

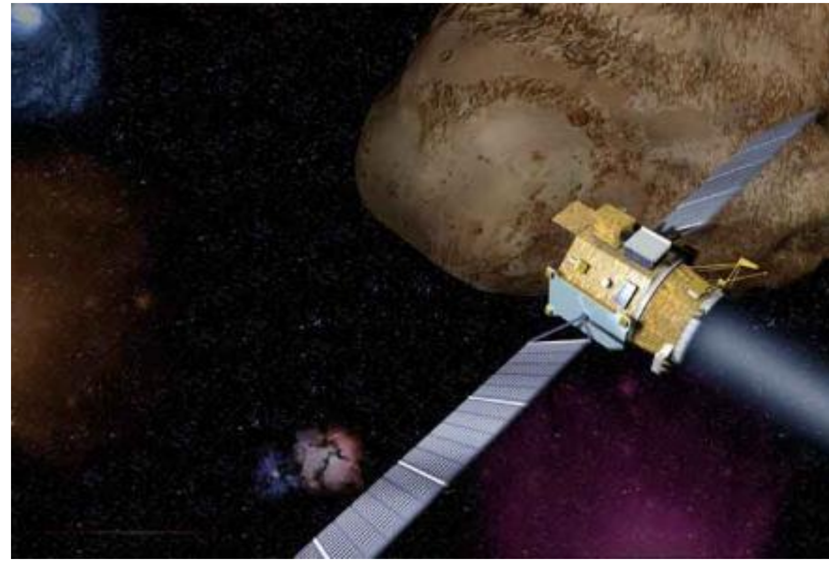
- determined its precise position using stars and asteriods
  - ✓ despite a malfunctioning ultraviolet detector
- planned the necessary course adjustment
- fired the ion propulsion system to make this adjustment

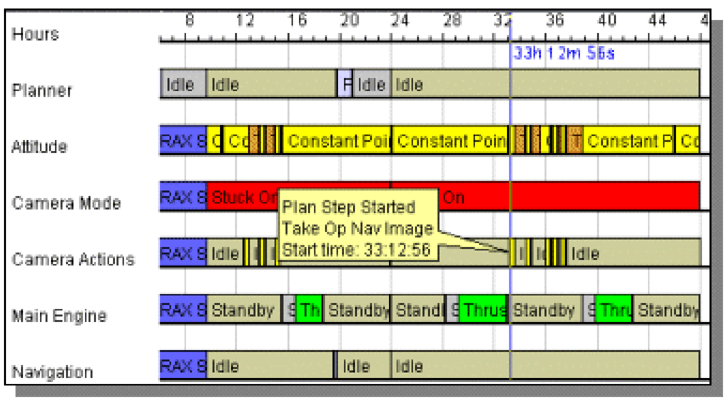


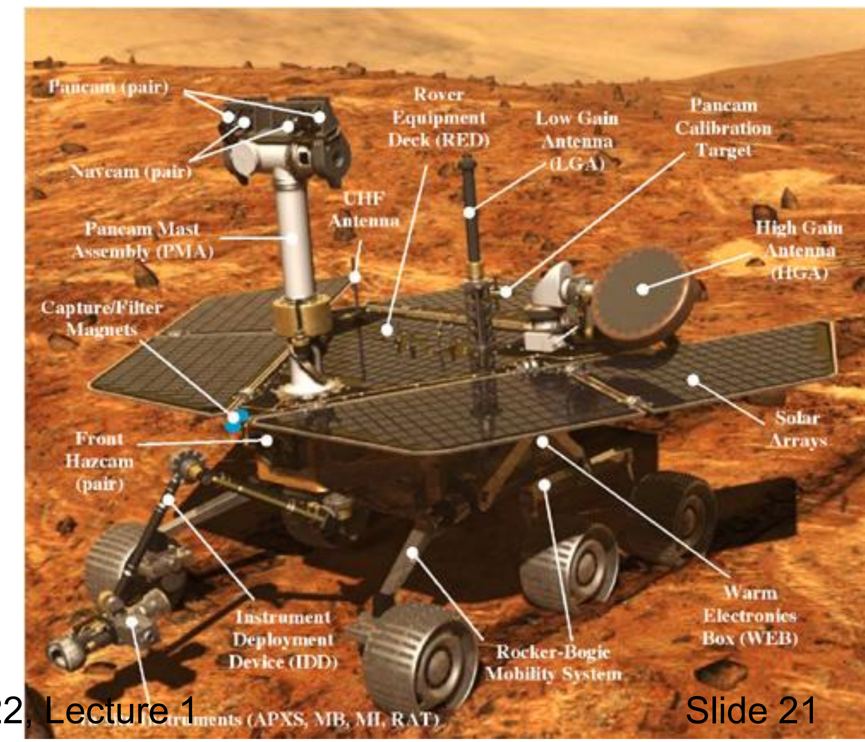


For another space application see the Spike system for the Hubble telescope

Source: *NASA*







Source:
cs221 stanford

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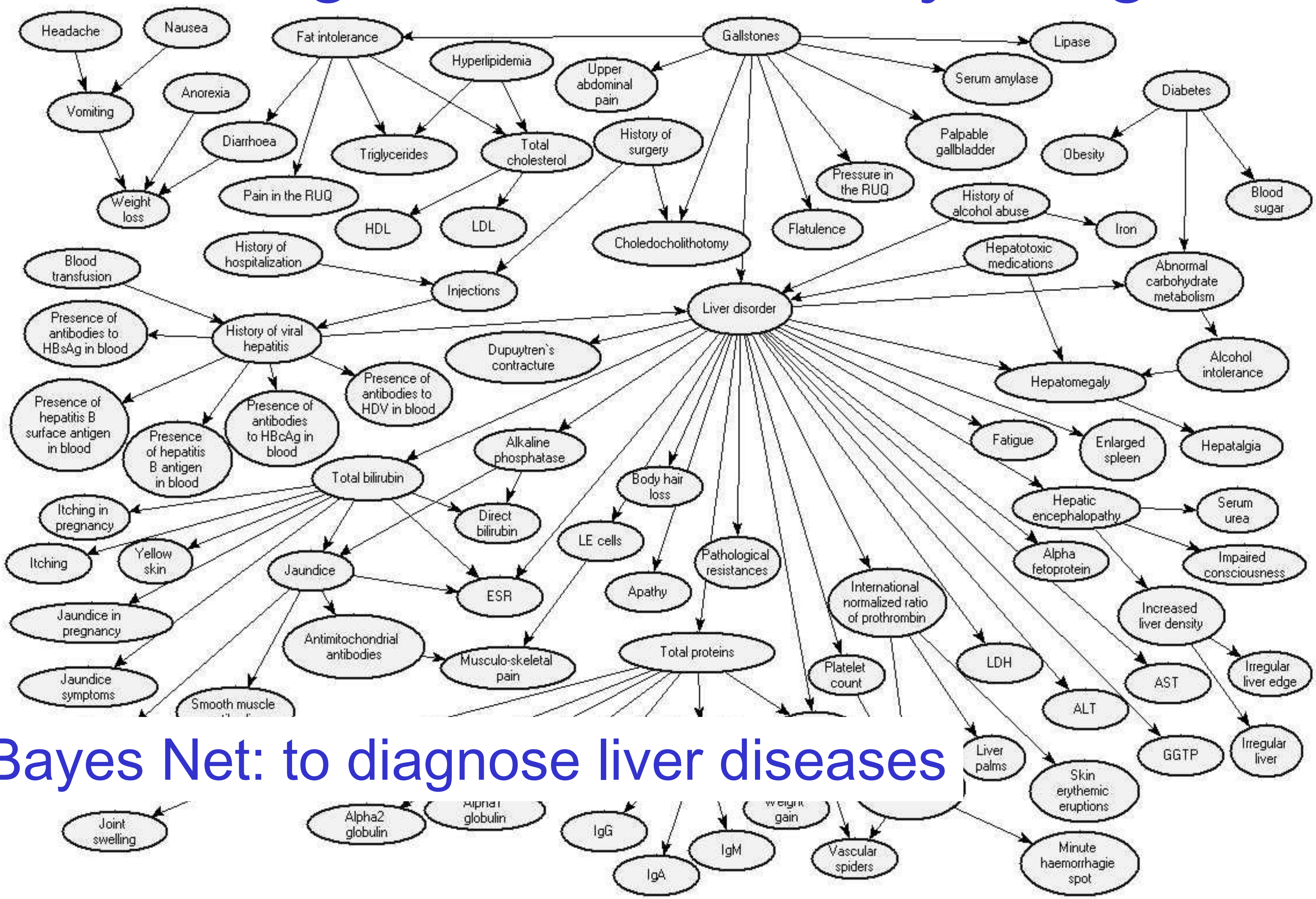
Reasoning under Uncertainty: Diagnosis



Bayes Net: to diagnose liver diseases

Reasoning Under Uncertainty

Texture classification using Support Vector Machines

- foliage, building, sky, water

Source: *Mike Cora, UBC*

Reasoning Under Uncertainty

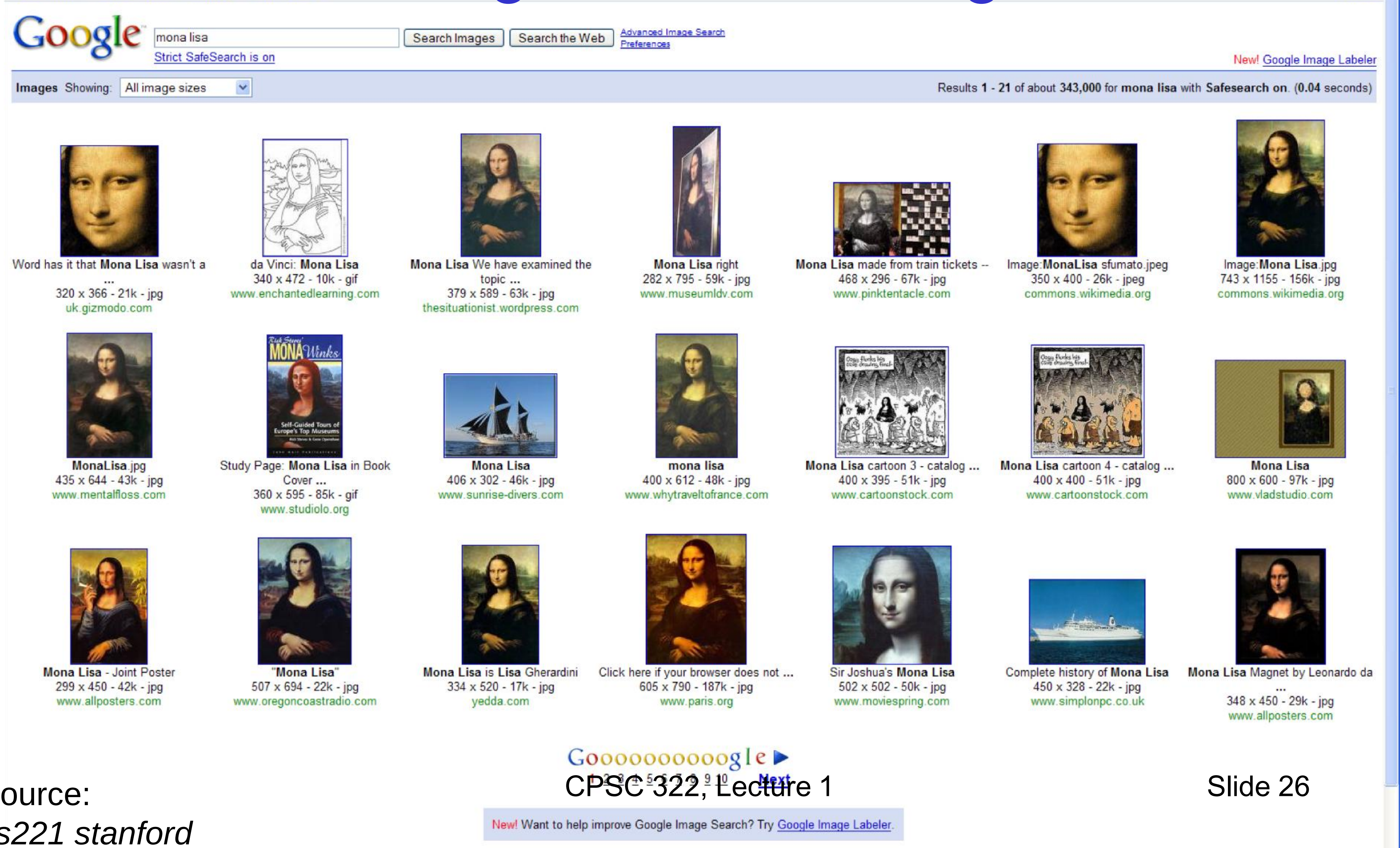
E.g. motion tracking: track a hand and estimate activity:

- drawing, erasing/shading, other

Source: *Kevin Murphy, UBC*

Computer Vision (not just for robots!)

Jing, Baluja, Rowley, Google: Finding Canonical Images



Source:
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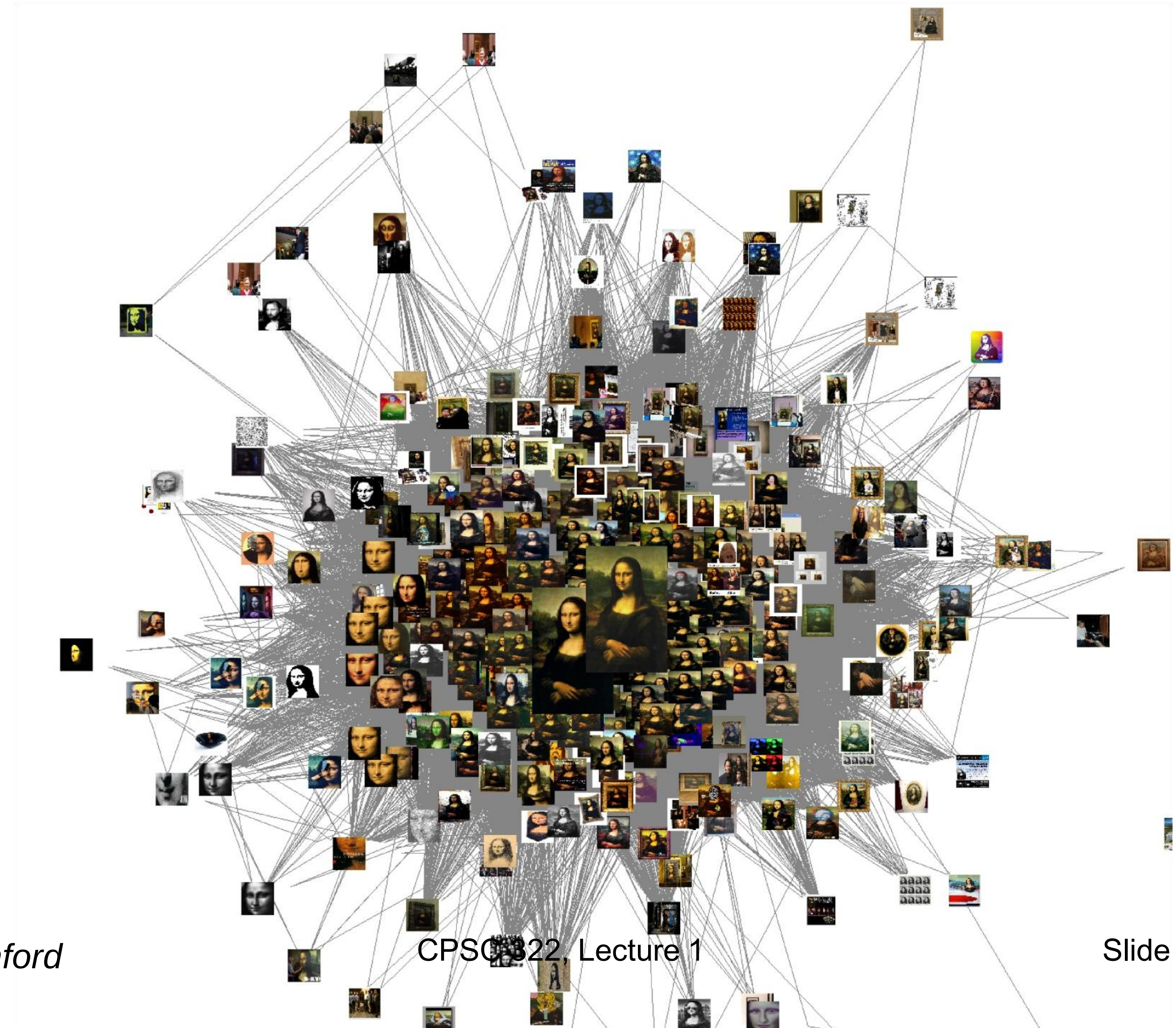
Compare low level features

(a) A v.s. B (b) A v.s. C

(c) A v.s. D (d) B v.s. C

Source:
cs221 stanford

Induced Graph



Source:
cs221 stanford

AI - Machine Learning @google

- Spam/Porn Detection
- Which ad to place given a query
- Train Speech to search on mobile
- Machine Translation
- …..

- Highly Parallelizable EM + Map Reduce (simple code to write)
- Stochastic Gradient Descent

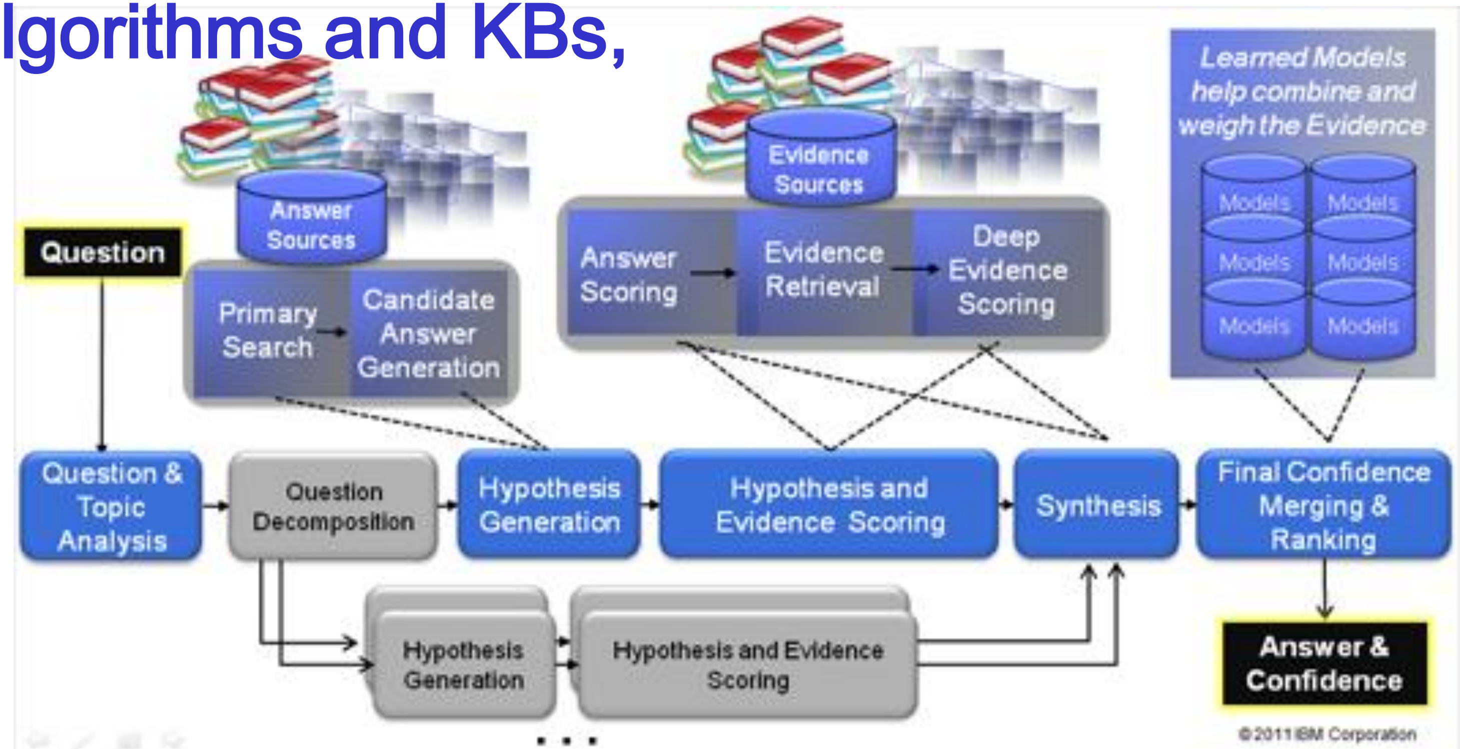
JEOPARDY! The IBM Challenge

Watson : analyzes natural language questions and content well enough and fast enough to compete and win against champion players at Jeopardy!

"This Drug has been shown to relieve the symptoms of ADD with relatively few side effects."

- 3 secs

- 1000s of algorithms and KBs,



Source: *IBM*

Statistical Machine Translation

SEHR GEEHRTER GAST!
KUNST, KULTUR UND
KOMFORT IM HERZEN
BERLIN.

DEAR GUESTS,
ART, CULTURE AND
LUXURY IN THE HEART
OF BERLIN.

DIE ÖRTLICHE
NETZSPANNUNG
BETRÄGT 220/240 VOLT
BEI 50 HERTZ.

THE LOCAL VOLTAGE
IS 220/240 VOLTS 50 HZ.

EN

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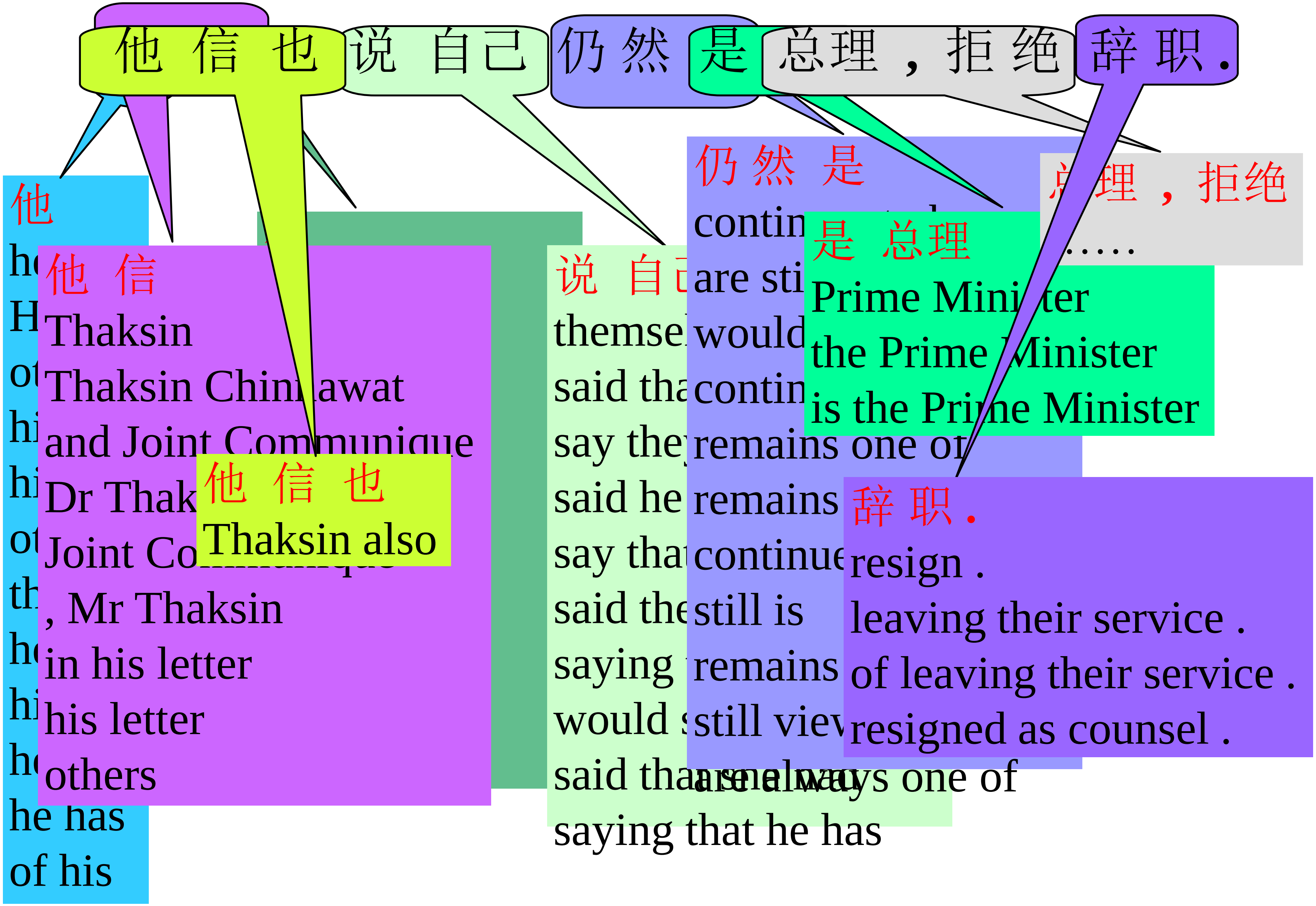
cs221 Stanford



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cs221 stanford

Zite: a personalized magazine

… that gets smarter as you use it

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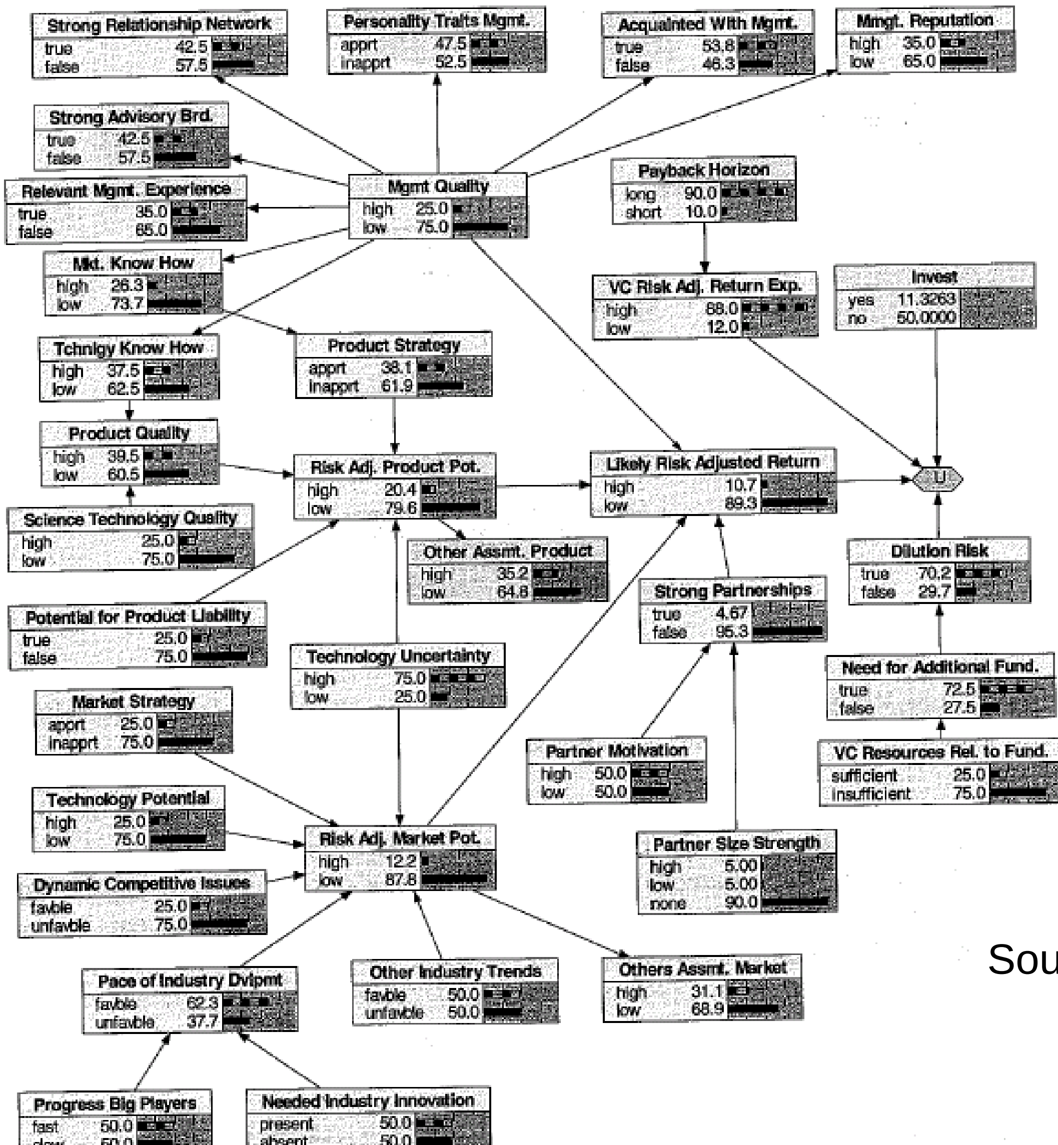
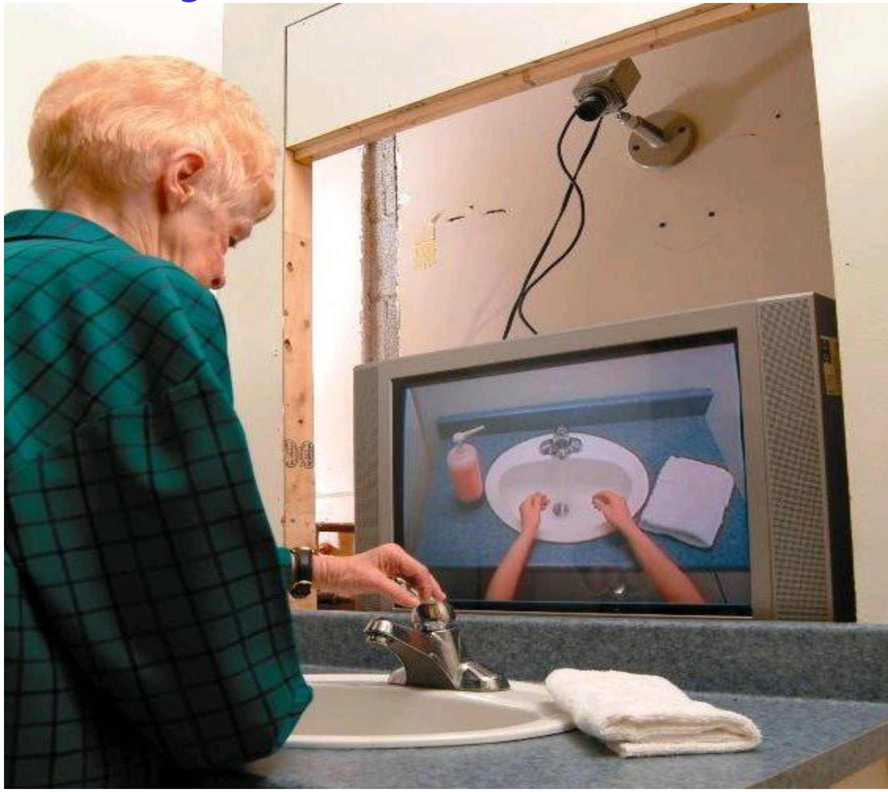
Decision Network in Finance for venture capital decision



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*

Military applications: ethical issues

- Robot soldiers
  - Existing: robot dog carrying heavy
    materials for soldiers in the fie
  - The technology is there
- Unmanned airplanes
- Missile tracking
- Surveillance
- …

Decision Theory: Decision Support Systems

E.g., Computational Sustainability

New interdisciplinary field, AI is a key component

- Models and methods for decision making concerning the management and allocation of resources
- to solve most challenging problems related to sustainability

Often constraint optimization problems. E.g.

- Energy: when are where to produce green energy most economically?
- Which parcels of land to purchase to protect endangered species?
- Urban planning: how to use budget for best development in 30 years?

Source: http://www.computational-sustainability.org/

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

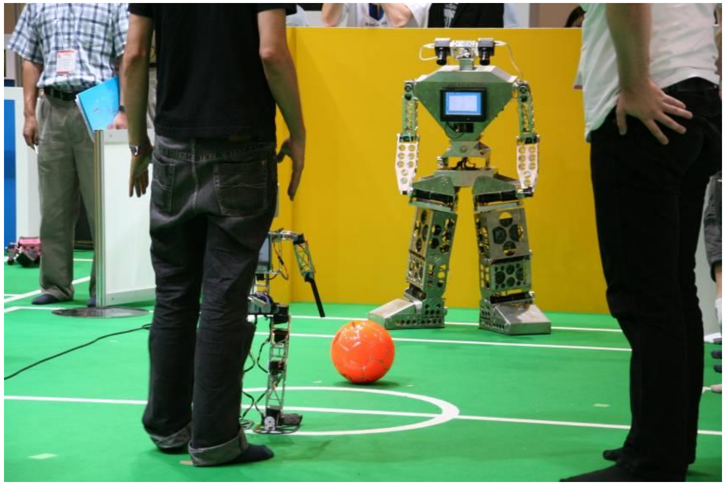
Search Space: 1.2 quintillion nodes

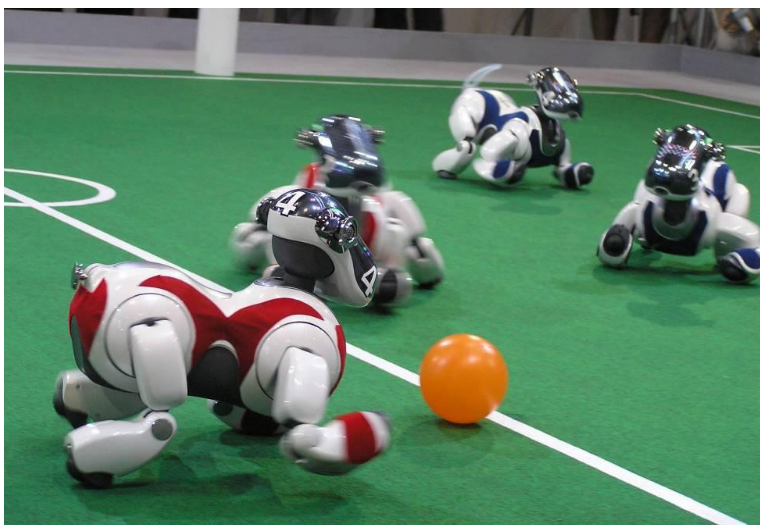
"In full 10-player games Poki is **better than a typical low-limit casino player** and wins consistently; however, **not as good as most experts**

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*

TO DO for Next class

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

- **If your student ID is below come and talk to me**
- **22019095, 13301114**