CSSS BBQ
Date: Tues., Sept 10
Time: 12 – 1:30 pm
Location: Outside Reboot Cafe

Microsoft Resume Clinic
Date: Tues., Sept 10
Time: 5:30 pm
Location: DMP 110

Tri-mentoring Orientation
Date: Wed., Sept 11
Time: 5:15 pm
Location: DMP 110

TELUS Info Session
Date: Thurs., Sept 12
Time: 5:30 pm
Location: DMP 110
AI Applications

Computer Science cpsc322, Lecture 3

Sept, 9, 2013
## CPSC 322, Lecture 2

### Slide 3

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

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**CPSC 322, Lecture 2**
Modules we'll cover in this course: R&Rsys

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CPSC 322, Lecture 2
(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

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

… and completely solved by a program in 2007!

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

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

- Deterministic Environment
  - Arc Consistency
  - Search
- Stochastic Environment
  - Belief Nets
    - Var. Elimination
- Static
  - Constraint Satisfaction
  - Logics
    - Search
  - STRIPS
- Sequential
  - Query
  - Planning
  - Decision Nets
    - Markov Processes
      - Value Iteration
  - Markov Processes
    - Value Iteration
CSPs: Crossword Puzzles

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

Daily Puzzles
370 puzzles from 7 sources.

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: 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?

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 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

- **Problem**
  - Static
    - Constraint Satisfaction
    - Query
  - Sequential
    - Planning

- **Environment**
  - Deterministic
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CPSC 322, Lecture 2
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:

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

- Knowledge Representation
- Web Mining & Semantic Web!
Modules we'll cover in this course: R&Rsys

- Problem
  - Constraint Satisfaction
  - Query

- Static
- Sequential

Environment

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  - Markov Processes
    - Value Iteration

- Logics
  - Search
  - STRIPS
    - actions
    - preconditions
    - effects

CPSC 322, Lecture 2
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 asteroids
  - 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
## Modules we'll cover in this course: R&Rsyst

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*CPSC 322, Lecture 2*
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
Reasoning Under Uncertainty

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

- drawing, erasing/shading, other
**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,
DEAR GUESTS,
ART, CULTURE AND LUXURY IN THE HEART OF BERLIN.

THE LOCAL VOLTAGE IS 220/240 VOLTS 50 HZ.

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

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

Source:
cs221 Stanford
Thaksin also said that he has not resigned as counsel.

Prime Minister, the Prime Minister remains one of the main areas, saying that he has always viewed by others, saying that he has not resigned.
Zite: a personalized magazine

... that gets smarter as you use it
Modules we'll cover in this course: R&Rsys

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Decision Network in Finance for venture capital decision

Source: R.E. Neapolitan, 2007
Planning Under Uncertainty

Learning and Using PO\textit{MDP} models of Patient-Caregiver Interactions During Activities of Daily Living

\textbf{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 field
  - 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?
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
“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)
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.