Representational Dimensions

Computer Science cpsc322, Lecture 2

(Textbook Chpt1)

January, 7, 2009

Announcement (1) : Need to talk at the end of lecture (missing prereqs for 322)

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Announcement (2): Industry Panel

Date: Thursday, Jan 15, 5:30-7:30

Time: 5:30 – 6:30 pm : Panel Discussion

6:30 – 7:30 pm : Networking Session

Place: DMP 110 : Panel Discussion

X-wing Student Lounge : Networking Session

Theme: How to Prepare Yourself to be Leaders in IT

Speakers:

David Fracchia, VP Technology, Radical Entertainment

David Hunter, VP Operations and Academic Research Centre, SAP

Gail Murphy, COO, Tasktop Technologies, Prof., UBC CS Dept.

Sheri Plewes, VP Planning & Engineering, Translink

Tim Richards, Manager, IS Operations, TELUS

Food and beverages will be provided!

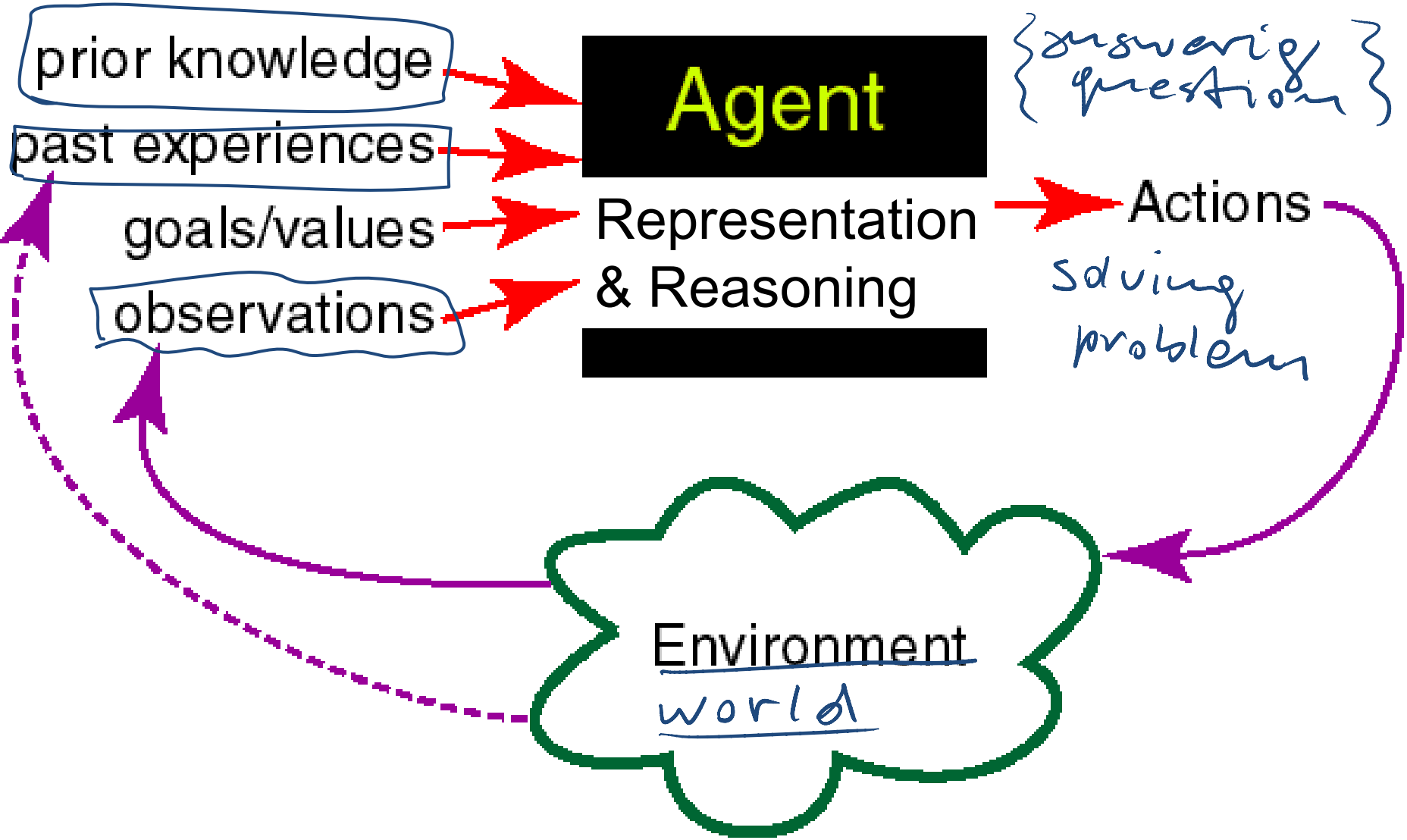
Lecture Overview

- **Recap from last lecture**
- Representation and Reasoning
- An Overview of This Course
- Further Dimensions of Representational Complexity

Course Essentials

- **Course web-page :** CHECK IT OFTEN!
- **Textbook**: Available on WebCT (wait to print all Chps… they may change a little!)
  - We will cover at least Chapters: 1, 3, 4, 5, 6, 8, 9
- **WebCT:** used for textbook, discussion board….
- **Aispace** : online tools for learning Artificial Intelligence http://aispace.org/
- **Lecture slides…**
- **Midterm exam,** Wed, Mar 4 (1.5 hours, regular room)

Agents acting in an environment



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- Further Dimensions of Representational Complexity

What do we need to represent ?

- **The environment /world :** What different configurations (**states / possible worlds**) can the world be in, and how do we denote them?

Chessboard, Info about a patient, Robot Location

- **How the world works** ***(we will focus on)***
  - **Constraints:** *sum of current into a node = 0*
  - **Causal:** *what are the causes and the effects of brain disorders?*
  - **Actions** preconditions and effects: *when can I press this button? What happens if I press it?*

Corresponding Reasoning Tasks / Problems

- **Constraint Satisfaction – Find state that satisfies set of constraints.** *E.g., What is a feasible schedule for final exams?*
- **Inference – Is a given proposition true/likely given what is known?** *E.g., Does this patient suffers from viral hepatitis?*
- **Planning – Find sequence of actions to reach a goal state.** *E.g., Navigate through and environment to reach a particular location*

Representation and Reasoning System

- A (**representation**) **language** in which the environment and how it works can be described

- Computational (**reasoning**) **procedures** to compute a solution to a problem in that environment (an answer, a sequence of actions)

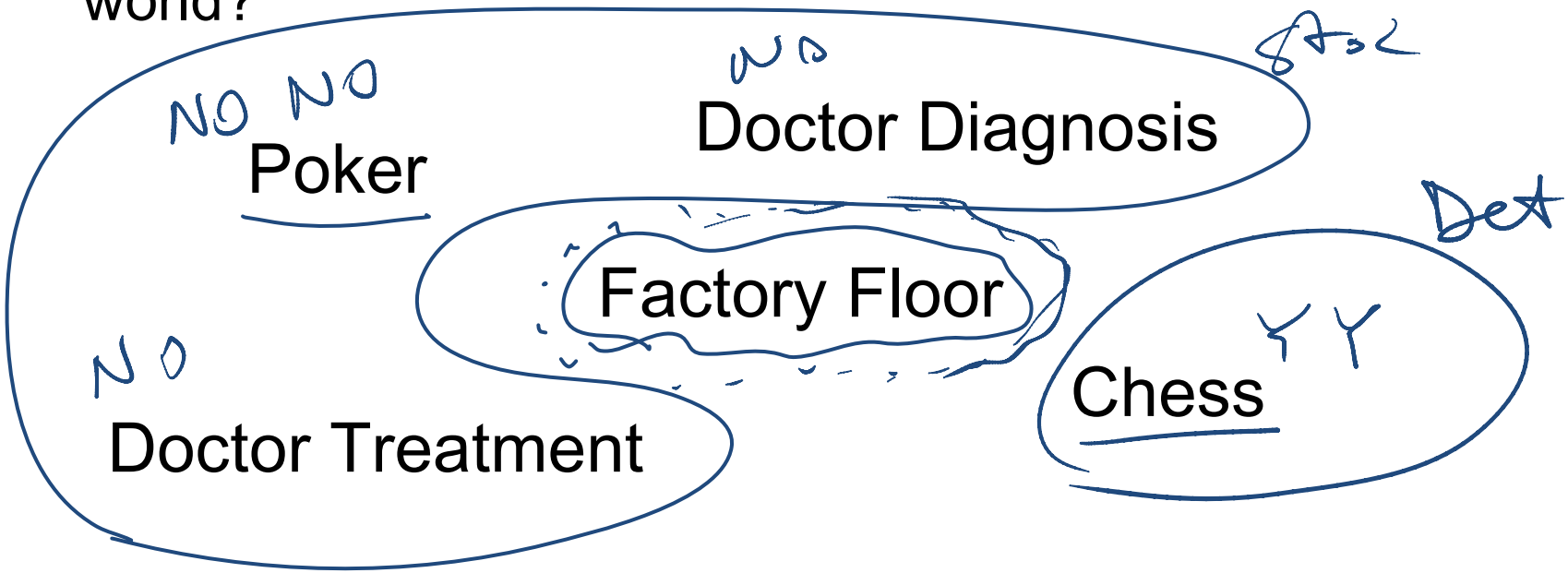
But the choice of an appropriate R&R system depends on a key property of the environment and of the agent's knowledge

Deterministic vs. Stochastic Domains

- Is the environment **deterministic** or **stochastic**?
- Is the agent's knowledge **certain** or **uncertain**?

A. Does the agent knows for sure what the effects of its actions are?

B. Can the agent fully observe the current state of the world?



Deterministic vs. Stochastic Domains

Historically, AI has been divided into two camps: those who prefer representations based on **logic** and those who prefer **probability**.

A few years ago, CPSC 322 covered logic, while CPSC 422 introduced probability:

- now we introduce both representational families in 322, and 422 goes into more depth
- this should give you a better idea of what's included in AI

Note: Some of the most exciting current research in AI is actually building bridges between these camps.

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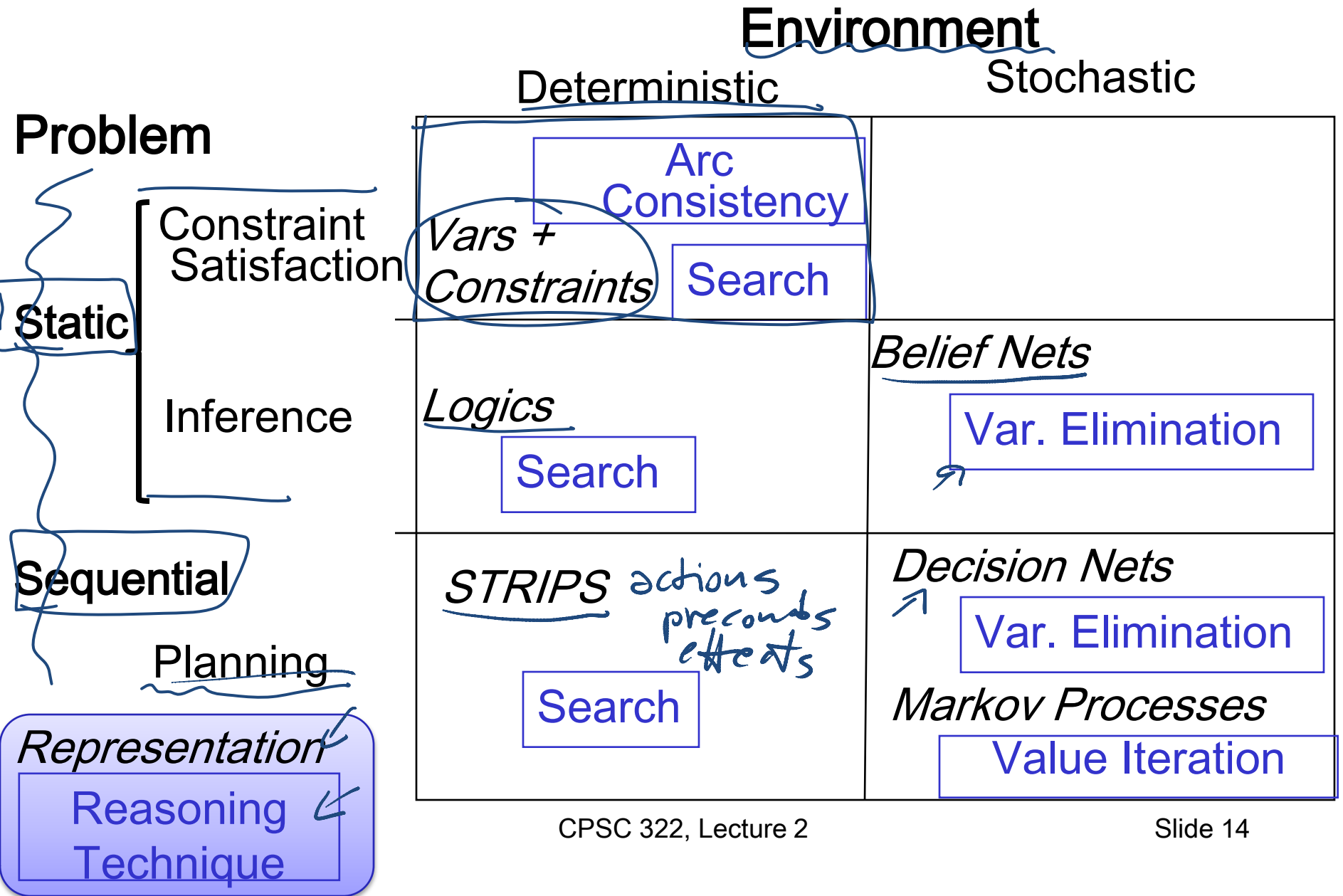
Modules we'll cover in this course: R&Rsys



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- Recap from last lecture
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- **Further Dimensions of Representational Complexity**

Dimensions of Representational Complexity

We've already discussed:

- Reasoning tasks (Static vs. Sequential)
- Deterministic versus stochastic 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

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.

Mars Explorer Example

Weather {S, C} (sunny, cloudy)

Temperature {-40 .. +40}

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

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

$2 * 81 * 360 * 180$ = 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

1 relationship

Registred(S,C) → $(s_1 c_1)$ $(s_2 c_3)$ ... 12 propositions, 2^{12} states

Students (S) = { s_1 s_2 s_3 s_4 }

Courses (C) = { c_1 c_2 c_3 }

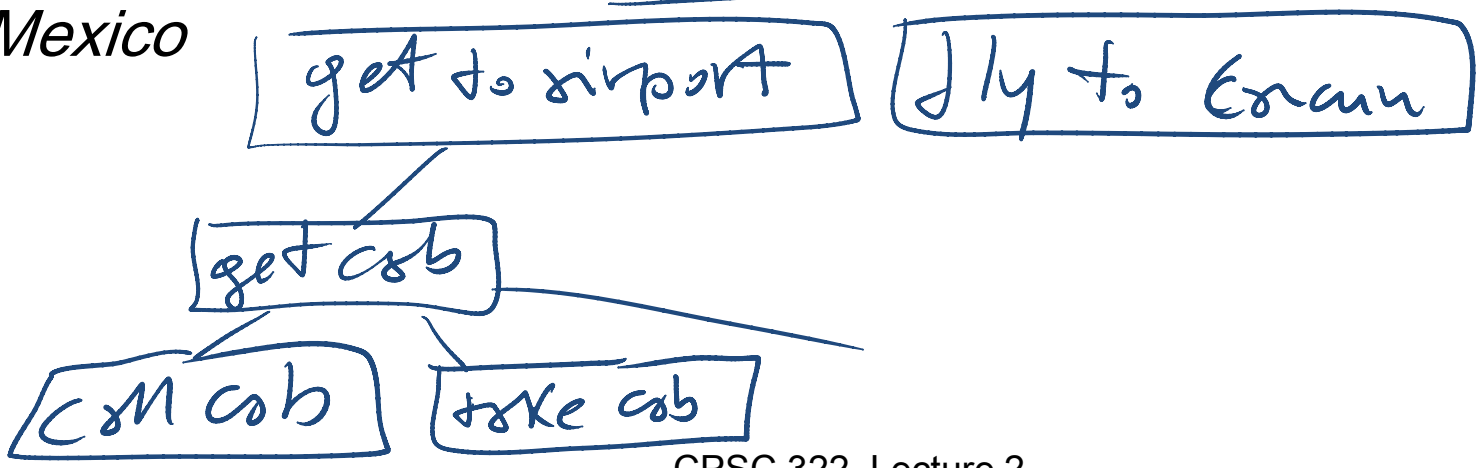
individuals/objects

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

Flat or hierarchical

Is it useful to model the whole world at the same level of abstraction?

- You can model the world at one level of abstraction: **flat**
- You can model the world at multiple levels of abstraction: **hierarchical**
- *Example: Planning a trip from here to a resort in Cancun, Mexico*



Knowledge given vs. knowledge learned from experience

The agent is provided with a model of the world once and far all

- The agent can learn how the world works based on experience
  - in this case, the agent often still does start out with some **prior knowledge**

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Machine Learning

Goals versus complex preferences

An agent may have a **goal** that it wants to achieve

- e.g., there is some **state or set of states** of the world that the agent wants to be in
- e.g., there is some **proposition or set of propositions** that the agent wants to make true

An agent may have complex **preferences**

- e.g., there is some **preference function** that describes how happy the agent is in each state of the world; the agent's task is to put the world into a state which makes it as happy as possible

What beverage to order?

- *The sooner I get one the better*
- *Cappuccino better than Espresso*

Single-agent vs. Multiagent domains

Does the environment include other agents?

Everything we've said so far presumes that there is only one agent in the environment.

- If there are other agents whose actions affect us, it can be useful to **explicitly model their goals and beliefs** rather than considering them to be part of the environment

- Other Agents can be: **cooperative**, **competitive**, or **a bit of both**

Dimensions of Representational Complexity in CPSC322

- Reasoning tasks (Constraint Satisfaction / Logic&Probabilistic Inference / Planning)
- Deterministic versus stochastic 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~~

Next class

- Assignment 0 due: **submit electronically** and **you can't use late days**
- Come to class ready to discuss the **two examples of fielded AI agents** you found
- I'll show some pictures of cool applications in that class
- Read carefully Section 1.6 on textbook: "Example Applications"
  - The Tutoring System
  - The trading agent
  - The autonomous delivery robot
  - The diagnostic assistant

David Poole, Indiana University, Poster Development Committee Chair
Poster Design: Giacomo Marchesi www.GiacomoMarchesi.com