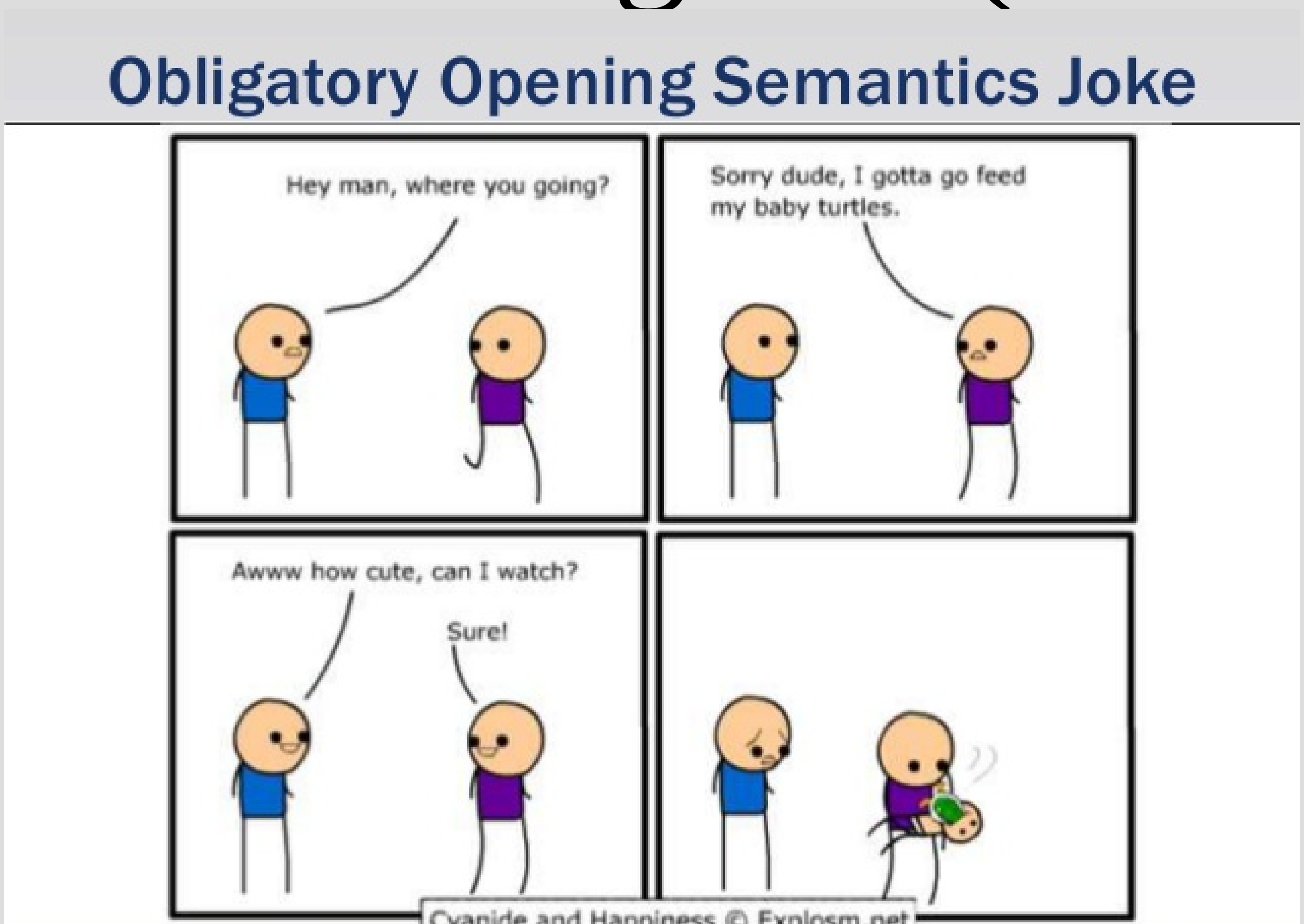
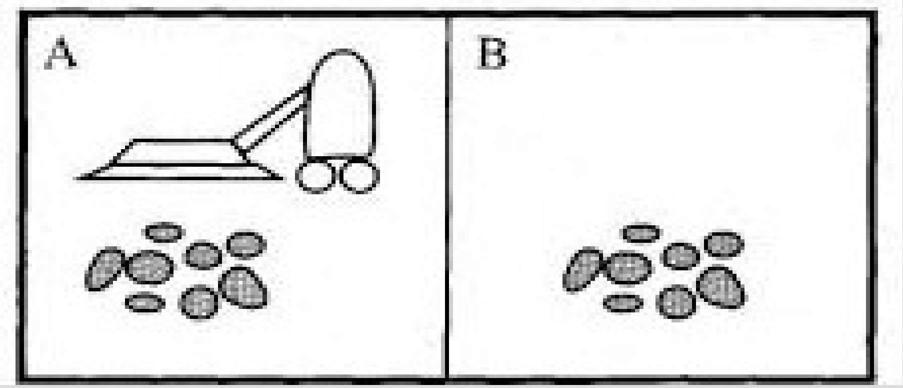
Rational Agents (Ch. 2)



Rational agent

Remember vacuum problem?



Agent program:

if [Dirty], return [Suck]
if at [room A], return [move right]
if at [room B], return [move left]

Agent models

Can also classify agents into four categories:

1. Simple reflex
2. Model-based reflex
3. Goal based
4. Utility based

Top is typically simpler and harder to adapt to similar problems, while bottom is more general representations

Agent models

A <u>simple reflex</u> agents acts only on the most recent part of the percept and not the whole history

Our vacuum agent is of this type, as it only looks at the current state and not any previous

These can be generalized as:
“if state = _____ then do action _____”
(often can fail or loop infinitely)

Agent models

A model-based reflex agent needs to have a representation of the environment in memory (called internal state)

This internal state is updated with each observation and then dictates actions

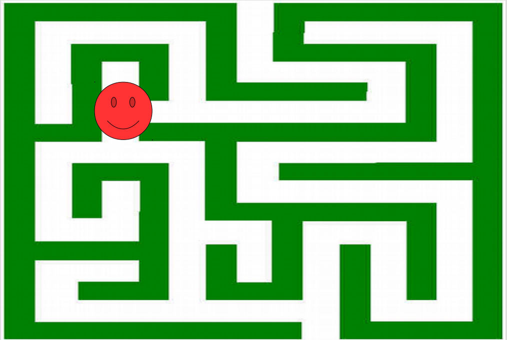
The degree that the environment is modeled is up to the agent/designer (a single bit vs. a full representation)

Agent models

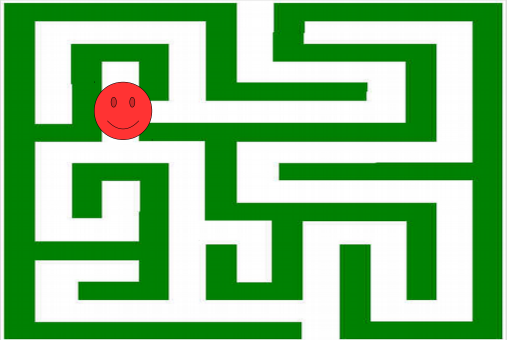
This internal state should be from the agent's perspective, not a global perspective
(as same global state might have different actions)

Consider these pictures of a maze:
Which way to go?

Pic 1



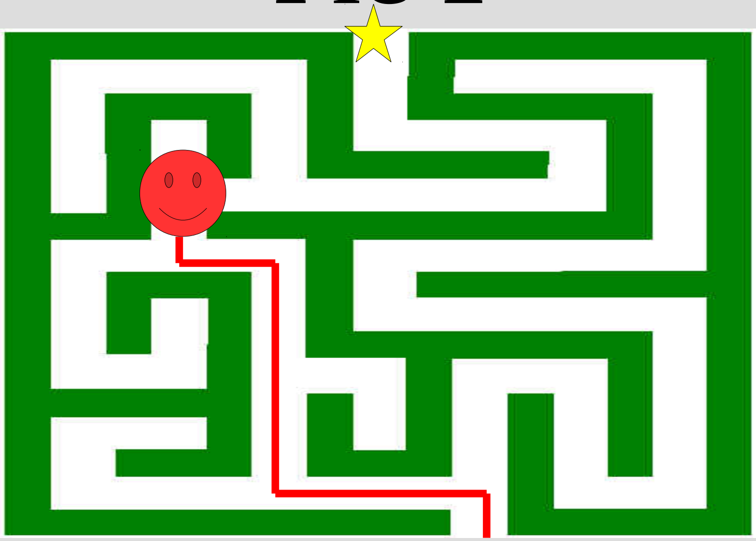
Pic 2



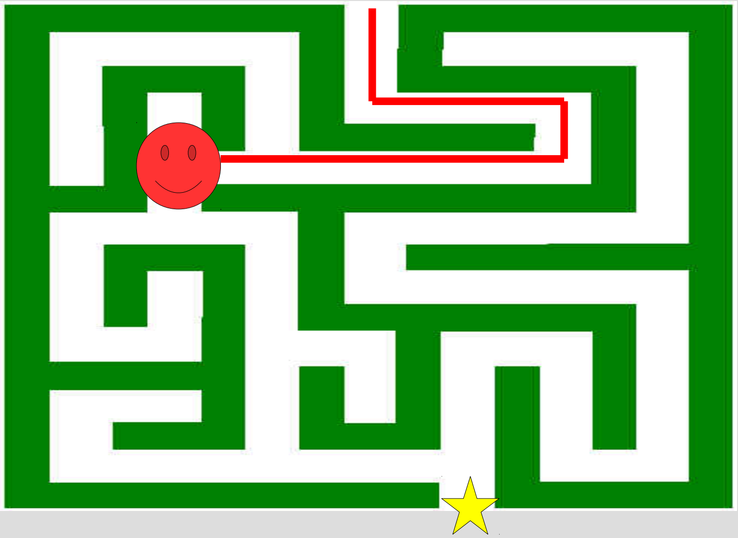
Agent models

The global perspective is the same, but the agents could have been doing different things

Pic 1



Pic 2



(Goals are not global information)

Agent models

We also saw this when we were talking about agent functions (also from agent's perspective, not global)

Percept sequence	Action
$[A, Clean]$	$Right$
$[A, Dirty]$	$Suck$
$[B, Clean]$	$Left$
$[B, Dirty]$	$Suck$
$[A, Clean]$, $[A, Clean]$	$Right$
$[A, Clean]$, $[A, Dirty]$	$Suck$
⋮	⋮

Agent models

For the vacuum agent if the dirt does not reappear, then we do not want to keep moving

The simple reflex agent program cannot do this, so we would have to have some memory (or model)

This could be as simple as a flag indicating whether or not we have checked the other state

Agent models

The <u>goal based</u> agent is more general than the model-based agent

In addition to the environment model, it has a <u>goal</u> indicating a desired configuration

Model-based reflex only use the internal state to find the immediate next action, while goal based plan multiple actions in advance

Agent models

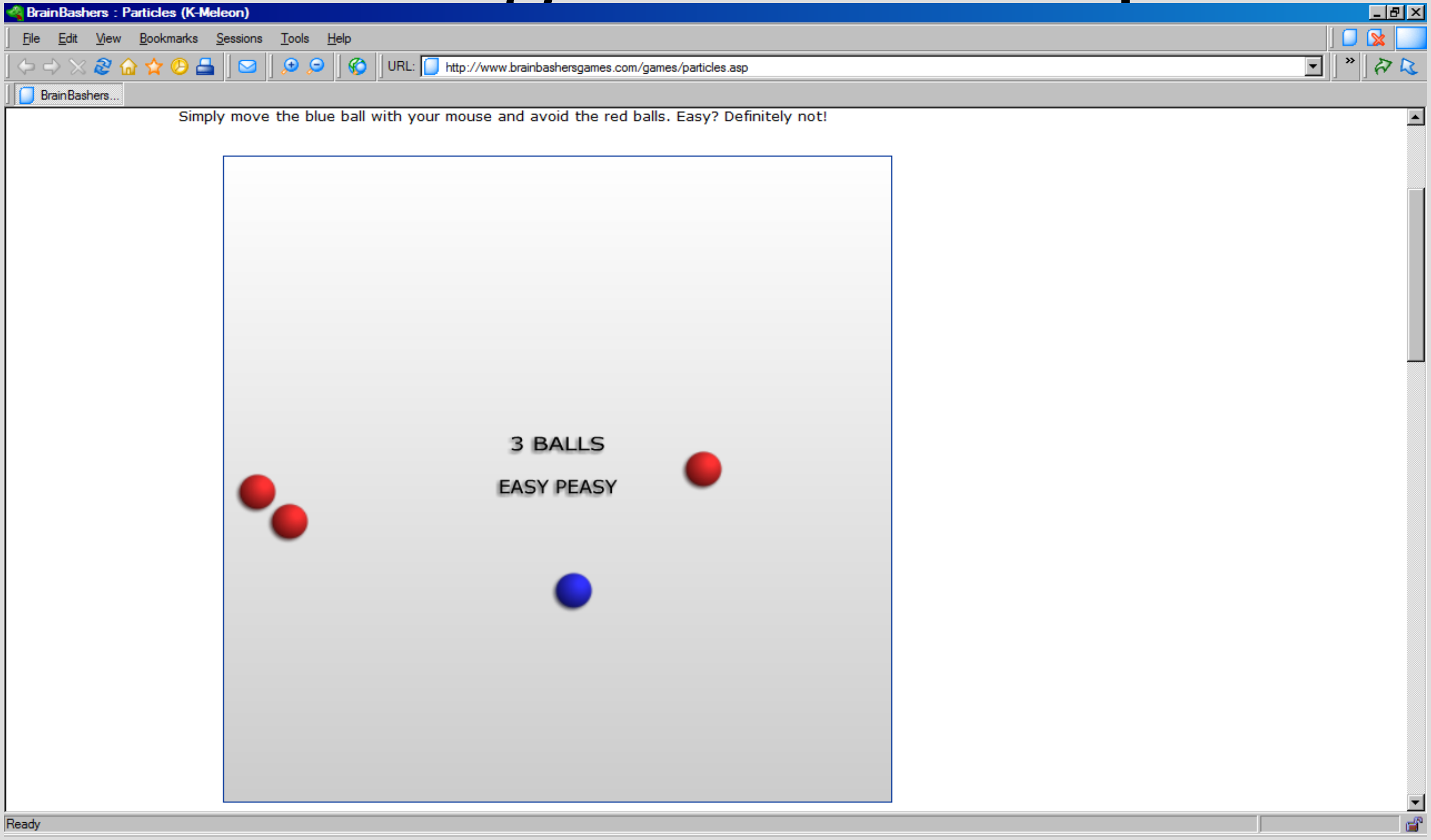
A <u>utility</u> based agent maps the sequence of states (or actions) to a real value

Goals can describe general terms as “success” or “failure”, but there is no degree of success

In the maze example, a goal based agent can find the exit. But a utility based agent can find the shortest path to the exit

Agent models

What is the agent model of particles?



Think of a way to improve the agent and describe what model it is now

Environment classification

Environments can be further classified on the following characteristics:(right side harder)

1. Fully vs. partially observable
2. Single vs. multi-agent
3. Deterministic vs. stochastic
4. Episodic vs. sequential
5. Static vs. dynamic
6. Discrete vs. continuous
7. Known vs. unknown

Environment classification

In a fully observable environment, agents can see every part.

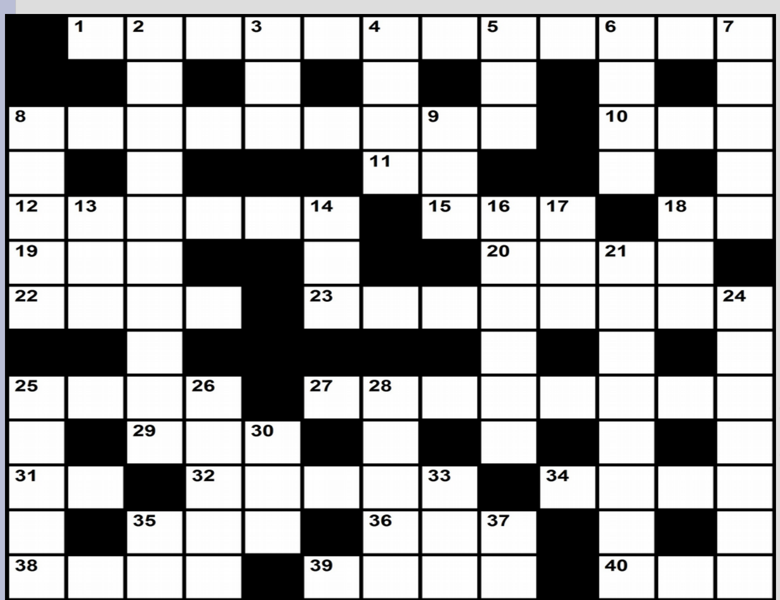
Agents can only see part of the environment if it is partially observable

Full ↗ Partial →

Environment classification

If your agent is the only one, the environment is a single agent environment

More than one is a multi-agent environment (possibly cooperative or competitive)



← single

multi →

Environment classification

If your state+action has a known effect in the environment, it is deterministic

If actions have a distribution (probability) of possible effects, it is stochastic

deterministic

stochastic

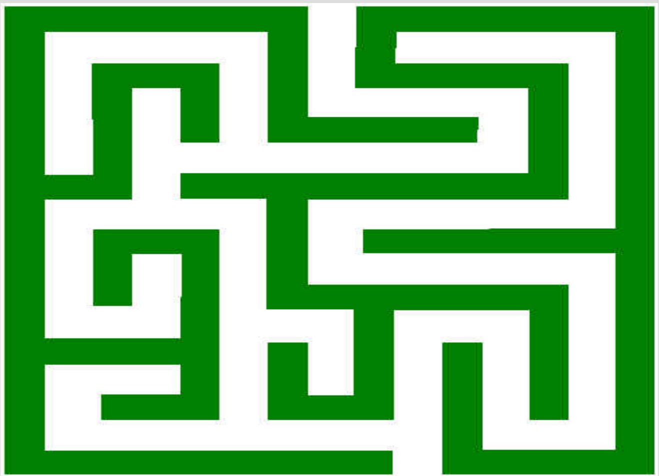
Environment classification

An <u>episodic</u> environment is where the previous action does not effect the next observation (i.e. can be broken into independent events)

If there is the next action depends on the previous, the environment is <u>sequential</u>

← episodic

sequential →



Environment classification

If the environment only changes when you make an action, it is static

a dynamic environment can change while your agent is thinking or observing

static

dynamic

Environment classification

Discrete = separate/distinct (events)
Continuous = fluid transition (between events)

This classification can applies: agent's percept and actions, environment's time and states

discrete (state)

continuous (state)

Environment classification

<u>Known</u> = agent's actions have known effects on the environment

<u>Unknown</u> = the actions have an initially unknown effect on the environment (can learn)

know how to stop

do not know how to stop

Environment classification

1. Fully vs. partially observable = how much can you see?
2. Single vs. multi-agent
   = do you need to worry about others interacting?
3. Deterministic vs. stochastic
   = do you know (exactly) the outcomes of actions?
4. Episodic vs. sequential
   = do your past choices effect the future?
5. Static vs. dynamic = do you have time to think?
6. Discrete vs. continuous
   = are you restricted on where you can be?
7. Known vs. unknown
   = do you know the rules of the game?

Environment classification

Some of these classifications are associated with the state, while others with the actions

State: Actions:

1. Fully vs. partially observable
2. Single vs. multi-agent
3. Deterministic vs. stochastic
4. Episodic vs. sequential
5. Static vs. dynamic
6. Discrete vs. continuous
7. Known vs. unknown

Environment classification

Pick a game/hobby/sport/pastime/whatever and describe both the PEAS and whether the environment/agent is:

1. Fully vs. partially observable
2. Single vs. multi-agent
3. Deterministic vs. stochastic
4. Episodic vs. sequential
5. Static vs. dynamic
6. Discrete vs. continuous
7. Known vs. unknown

Environment classification

Agent type	Performance	Environment	Actuators	Sensors
Particles	time alive	boarder, red balls	move mouse	screen-shot

Fully observable, single agent, deterministic, sequential (halfway episodic), dynamic, continuous (time, state, action, and percept), known (to me!)

State structure

An atomic state has no sub-parts and acts as a simple unique identifier

An example is an elevator:
Elevator = agent (actions = up/down)
Floor = state

In this example, when someone requests the elevator on floor 7, the only information the agent has is what floor it currently is on

State structure

Another example of an atomic representation is simple path finding:
If we start at Koffman, how
would you get to Keller's CS office?

Go E. -> Cross N @ Ford & Amundson ->
Walk to E. KHKH -> K. Stairs -> CS office

The words above hold no special meaning other than differentiating from each other

State structure

A factored state has a fixed number of variables/attributes associated with it

You can then reason on how these associated values change between states to solve problem

Can always "un-factor" and enumerate all possibilities to go back to atomic states, but might be too exponential or lose efficiency

State structure

Structured states simply describe objects and their relationship to others

Suppose we have 3 blocks: A, B and C
We could describe: A on top of B, C next to B

A factored representation would have to enumerate all possible configurations of A, B and C to be as representative

State structure

We will start using structured approaches when we deal with logic:

Summer implies Warm
Warm implies T-Shirt

The current state might be:
!Summer (¬Summer)
but the states have intrinsic relations between each other (not just actions)