

# AGENTS

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9/5/2023

CMSC 671

By the end of class today, you will be able to:

1. Explain whether an agent is acting rationally or not
2. Describe environments using the language of the field
3. Categorize agents based on their capabilities and behavior

*Most slides by Dr. Cassandra Kent & Dr. Mark Riedl*

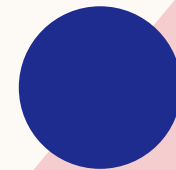
# SCHEDULE

Logistics

Recap

Types of environments

Types of agents



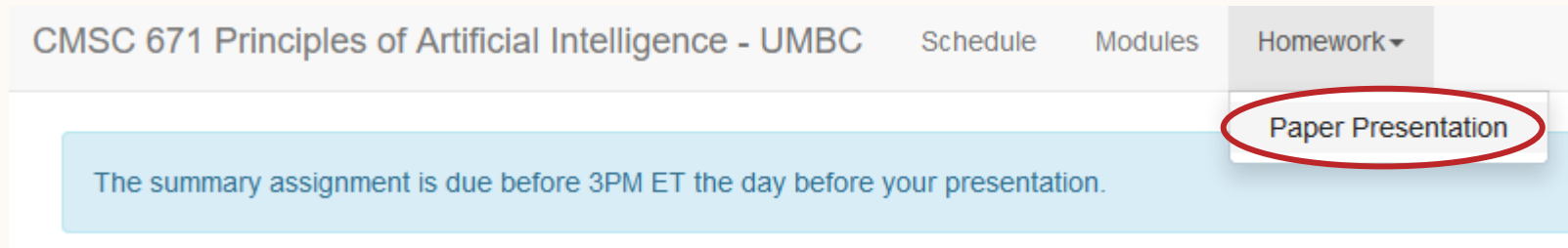
# GRADE WEIGHTS CHANGED

## Grading

- 5% Class Knowledge Checks
- 10% Paper Presentation
- 40% Homeworks (4 in total; 10% each)
- 20% Midterm
- 25% Final Project

# PAPER PRESENTATIONS

<https://laramartin.net/Principles-of-AI/homeworks/presentations.html>



The screenshot shows a navigation bar for the course "CMSC 671 Principles of Artificial Intelligence - UMBC". The menu items are "Schedule", "Modules", and "Homework". The "Homework" item is expanded, showing a sub-menu with "Paper Presentation" highlighted by a red oval. Below the navigation bar, a light blue banner contains the text: "The summary assignment is due before 3PM ET the day before your presentation."

The summary assignment is due before 3PM ET the day before your presentation.

## Paper Presentation (10%)

This assignment is to show you the modern uses of older AI methods and give you an entry point for how to critically read an academic paper.

### Learning Objectives

In this assignment, you will

- find reputable research articles from a specific AI area that you find interesting
- recognize & synthesize key points of a research paper
- communicate key findings from a research paper

### Instructions

- Pick a Module from 1-4: [sign-up sheet](#)
  - Modules will be assigned to be as evenly distributed across the class as possible, keeping in mind your preferences.
  - Once you are assigned a Module, you will be told the approximate date when your presentation will be. (Since the lecture material moves around as the course progresses, the presentation dates might move as well.)
- [1 pt] **Find a recent paper** (published within the past 5 years) from a reputable AI conference or journal. Your selection should be submitted to Lara & Aydin a week before your presentation & summary are due so that we can verify that your choice is a peer-reviewed article that is relevant to the Module. When you submit your selection, you will provide 1) the name of the article, 2) the authors of the article, 3) the link where the article can be found online, and 4) what class topic (i.e., lesson title) the article is relevant to.
- [5 pts] **Summarize** the paper in a 1-page report. Please include, *in your own words*:
  - what are the main findings of the paper?
  - how does the paper relate to the class?
  - what are the strengths of the paper?
  - what are the weaknesses of the paper?
  - are there any ethical concerns that people should consider if they were to replicate the paper or use any of the methods/data/etc. that are introduced in the paper?
- [1 pt] **Present what you learned from the paper** to small groups in class. You're welcome to create a few slides to help you present to your group, but this is not required. We will take about 10 minutes talking in separate groups and then 5 minutes coming together to share with the whole class.
- 7 points total

### Generative AI Policy

If you use ChatGPT (or similar chatbots or AI-based generation tools), you must describe exactly how you used it, including providing the prompt, the original generation, and your edits. This applies to prose, code, or any form of content creation. Not disclosing is an academic integrity violation. If you do disclose, your answer may receive anywhere from 0 to full credit, depending on the extent of substantive edits, achievement of the [learning objectives](#), and overall circumvention of those objectives.

Due this Friday!

Due a week before presentation

Due the day before presentation

Presentation day

# RECAP: KNOWN ISSUES OF GPT

- Bad reproducibility
- Copyright issues
- Can't explain what it's doing
- Can't remember things long term
- Confident bullshitter

# RECAP: WHY AI?

## Engineering

- To get machines to do a wider variety of useful things
  - Understand spoken natural language
  - Recognize individual people in visual scenes
  - Find the best travel plan for your vacation

## Cognitive Science

- Help understand how natural minds work
  - Visual perception, memory, learning, language, etc.

## Philosophy

- As a way to explore interesting (and important) philosophical questions

9/5/2023 - Agents



# **BUILDING RATIONAL AGENTS**



# DEFINITION OF AI

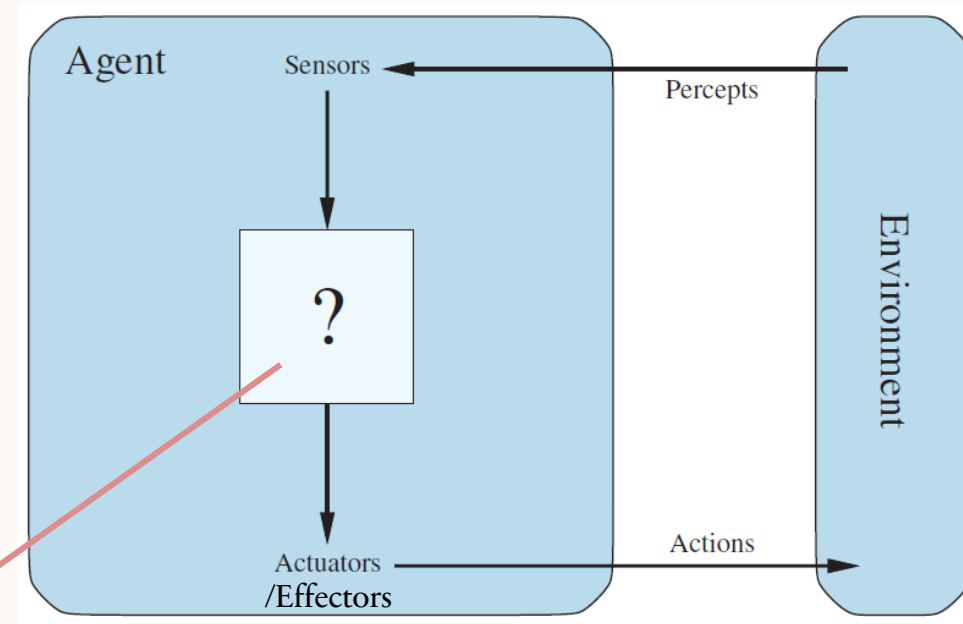
The study of intelligence – both to **understand** and **build** intelligent agents, which can:

- Act humanly
- Think humanly
- Think rationally
- *Act rationally*

Determine what action to take to achieve the best outcome.

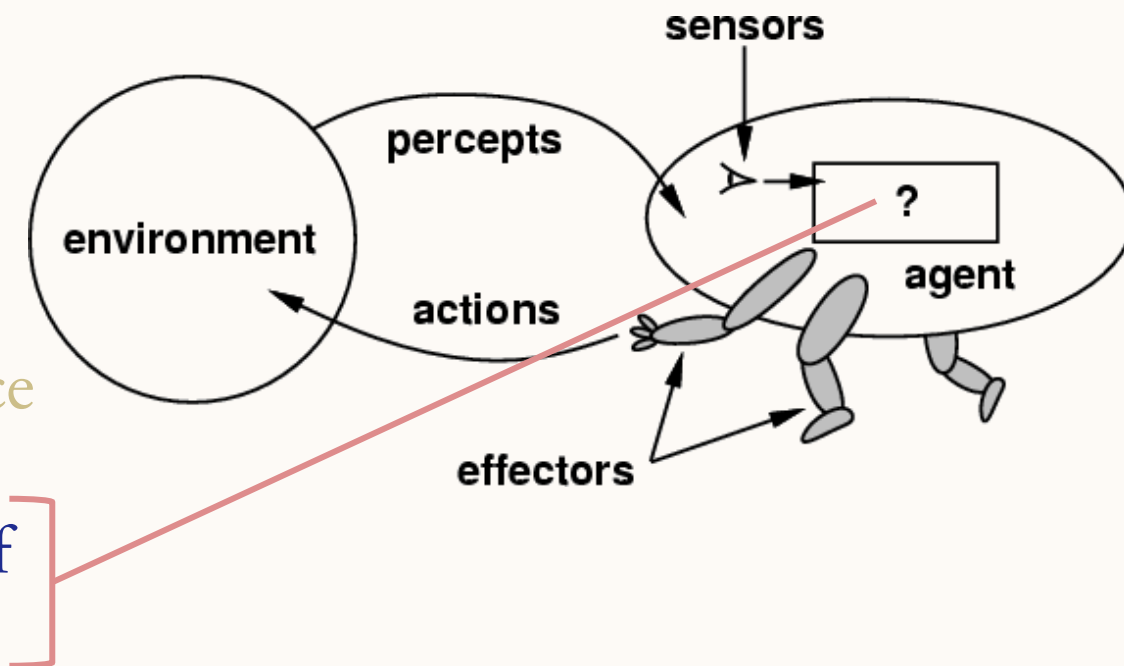
# AGENT DEFINITION

- **Agent:** anything that **perceives** its environment through **sensors**, and **acts** on its environment through **actuators**
- **Percept:** input at an instant
- **Percept sequence:** history of inputs
- **Agent function:** mapping of **percept sequence** to **action**
- **Agent program:** (concise) implementation of an agent function

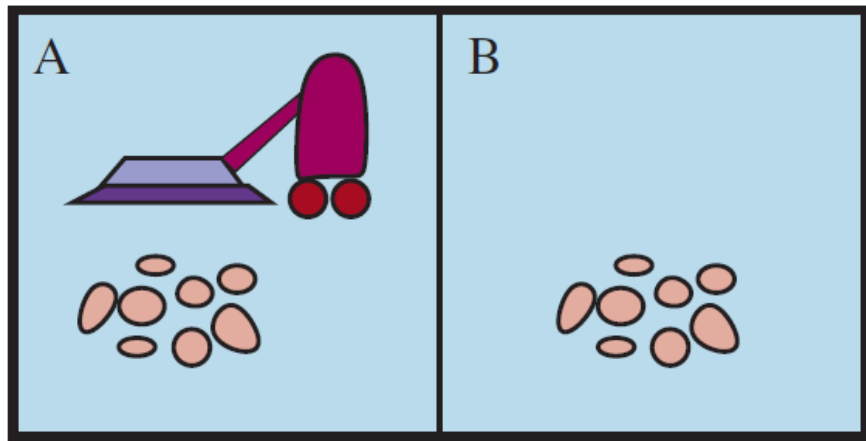


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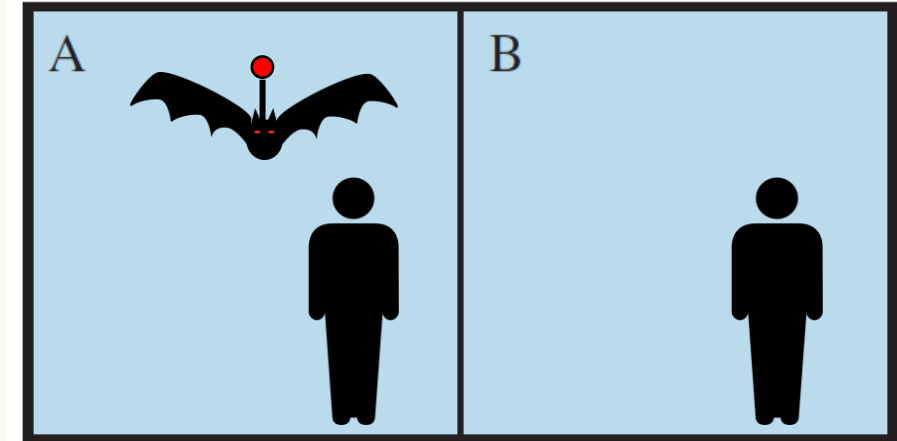
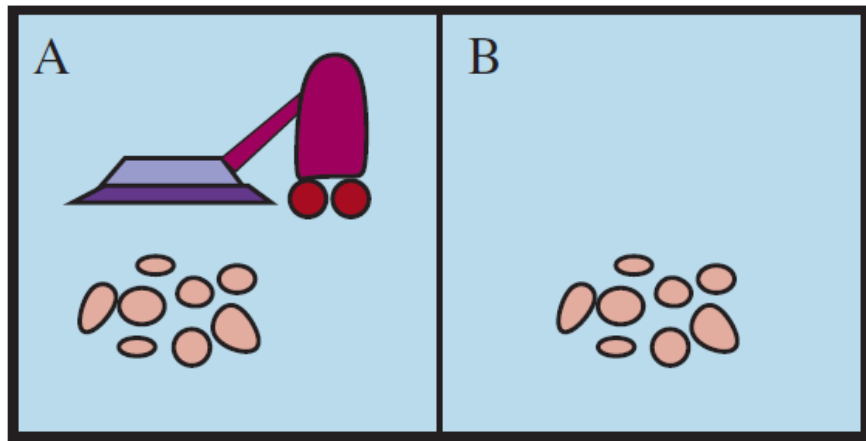
# EXAMPLE AGENT: VACUUM-CLEANER WORLD



- Agent can be in 1 of 2 locations (A or B)
- Agent's actions: [*Left, Right, Suck, Wait*]

# EXAMPLE AGENT: ~~VACUUM-CLEANER~~ WORLD

Vampire

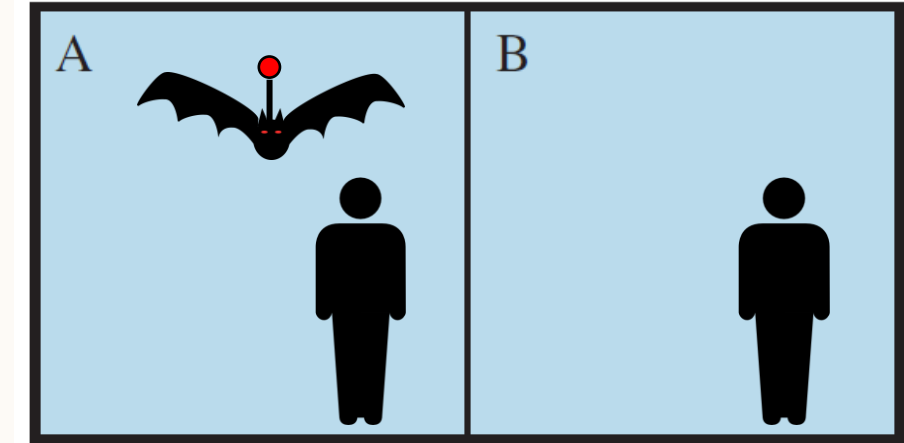


- Agent can be in 1 of 2 locations (A or B)
- Agent's actions: [*Left, Right, Suck, Wait*]

# EXAMPLE AGENT: VAMPIRE WORLD

Agent program:

Percept sequence	Action
[A, Empty]	Right
[A, Human]	Suck
[B, Empty]	Left
[B, Human]	Suck
...	...
[A, Empty], [B, Human]	Suck
[A, Empty], [B, Empty]	Left
...	...



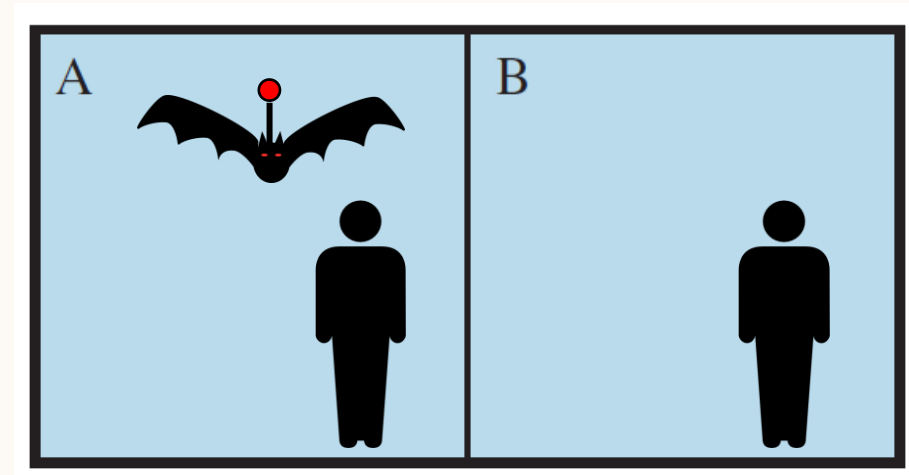
# EXAMPLE AGENT: VAMPIRE WORLD

Agent program:

```
if [A, Empty]: return Right  
if [B, Empty]: return Left  
if [A or B, Human]: return Suck
```

Is this a rational (vampire) agent?

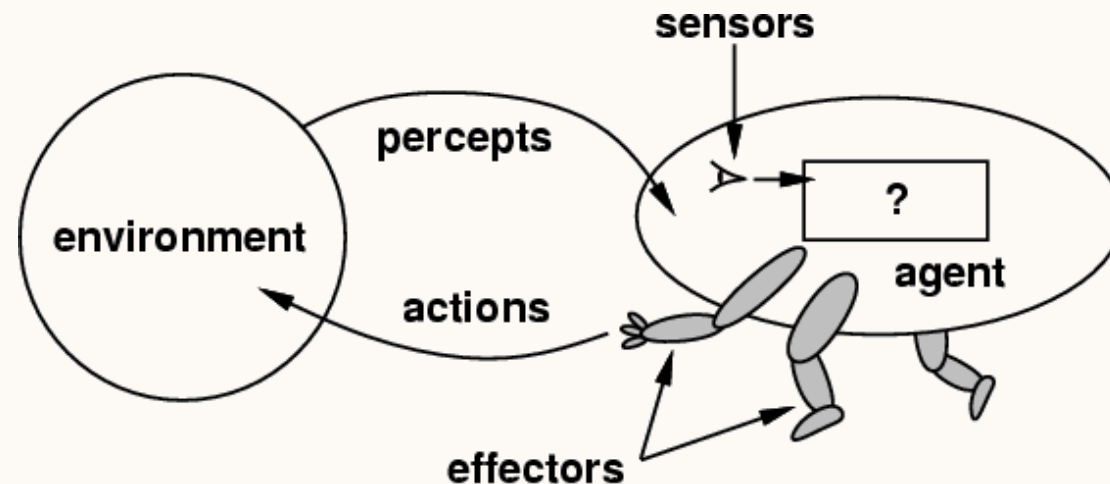
It depends.



# WHAT MAKES AN AGENT RATIONAL?

A agent is *rational* when...

it optimizes its actions based on information it gets from its environment (i.e., percepts) in order to **achieve a specific goal.**





# DEFINING THE TASK ENVIRONMENT

**Agent:** Vampire

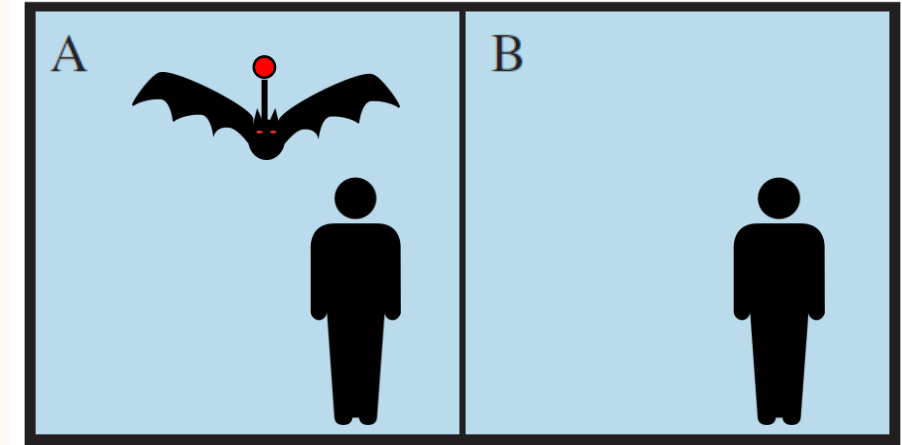
**Goal**

**Performance measure:** Suck as much blood over time as possible

**Environment:** Location, humans

**Actuators:** Flying, sucking

**Sensors:** Short-range sonar (human detection)



```
if [A, Empty]: return Right
if [B, Empty]: return Left
if [A or B, Human]: return Suck
```

Now, is this a rational (vampire) agent?

Yes.

# DEFINING THE TASK ENVIRONMENT

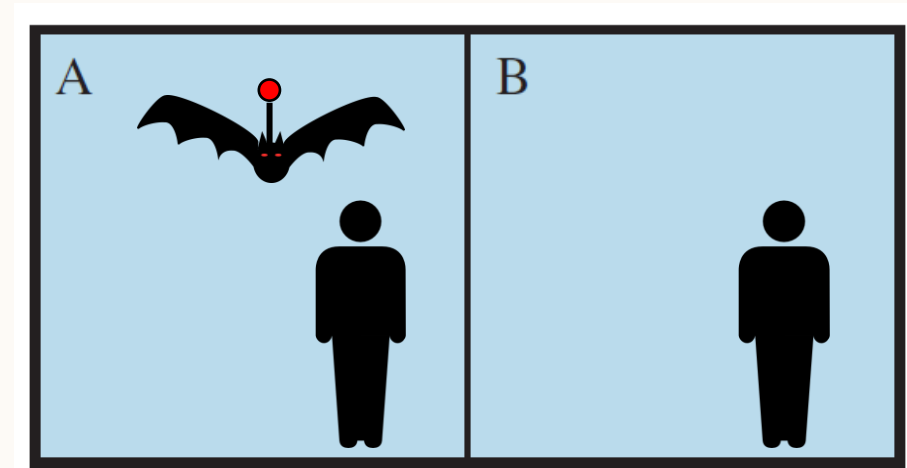
**Agent:** Vampire

**Performance measure:** Be an ethical vampire, and avoid humans

**Environment:** Location, humans

**Actuators:** Flying, sucking

**Sensors:** Short-range sonar (human detection)



```
if [A, Empty]: return Right
```

```
if [B, Empty]: return Left
```

```
if [A or B, Human]: return Suck
```

*Now, is this a rational (vampire) agent?*

**No.**

# DEFINING THE TASK ENVIRONMENT

Agent: Chess Player

Performance measure:

Environment:

Actuators:

Sensors:



Garry Kasparov vs. Deep Blue, 1997

# DEFINING THE TASK ENVIRONMENT

**Agent:** Chess Player

**Performance measure:** Checkmate the opponent before they checkmate you

**Environment:** Chess board, pieces, rules of chess

**Actuators:** Move a piece

**Sensors:** Current board state



Garry Kasparov vs. Deep Blue, 1997

# DEFINING THE TASK ENVIRONMENT

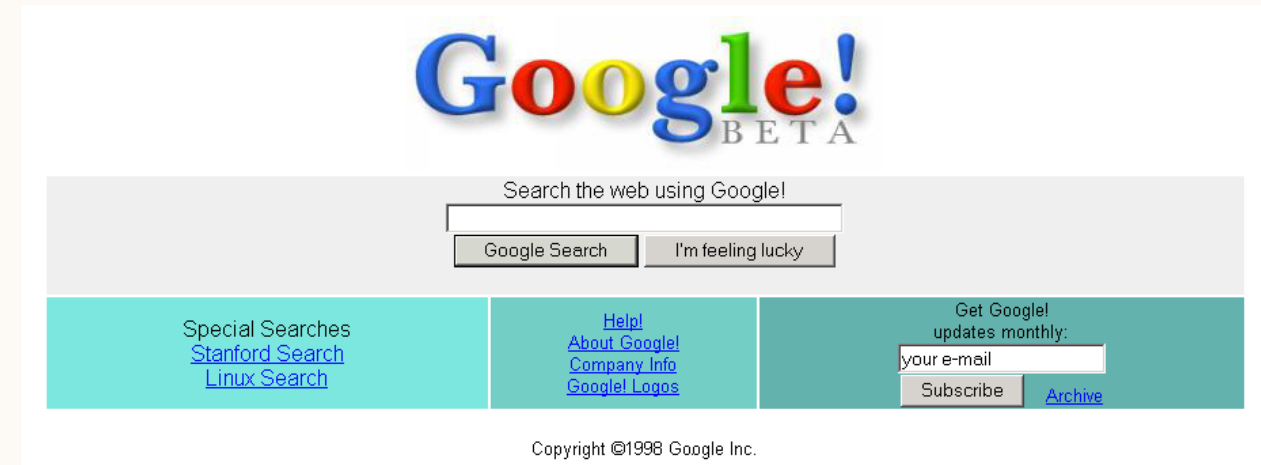
**Agent:** Search Engine

**Performance measure:**

**Environment:**

**Actuators:**

**Sensors:**



# DEFINING THE TASK ENVIRONMENT

**Agent:** Search Engine

**Performance measure:** Return relevant results, with the best results appearing earlier in the list

**Environment:** Web pages on the Internet

**Actuators:** Generate page list

**Sensors:** Read query, read page text, read page metadata





# YOUR TURN: DEFINING THE TASK ENVIRONMENT

**Agent:** Self-driving Car  
**Performance measure:**

**Environment:**

**Actuators:**

**Sensors:**



Tesla's semi-self-driving car, 2020

# YOUR TURN: DEFINING THE TASK ENVIRONMENT

**Agent:** Self-driving Car

**Performance measure:** Get passenger to destination, safely, legally, comfortably, quickly, ...

**Environment:**

**Actuators:**

**Sensors:**



Tesla's semi-self-driving car, 2020



# YOUR TURN: DEFINING THE TASK ENVIRONMENT

**Agent:** Self-driving Car

**Performance measure:** Get passenger to destination, safely, legally, comfortably, quickly, ...

**Environment:** Roads, vehicles, pedestrians, passengers, ...

**Actuators:**

**Sensors:**



Tesla's semi-self-driving car, 2020

# YOUR TURN: DEFINING THE TASK ENVIRONMENT

**Agent:** Self-driving Car

**Performance measure:** Get passenger to destination, safely, legally, comfortably, quickly, ...

**Environment:** Roads, vehicles, pedestrians, passengers, ...

**Actuators:** steering, acceleration, braking, horn, signals, lights, ...

**Sensors:**



Tesla's semi-self-driving car, 2020

# YOUR TURN: DEFINING THE TASK ENVIRONMENT

**Agent:** Self-driving Car

**Performance measure:** Get passenger to destination, safely, legally, comfortably, quickly, ...

**Environment:** Roads, vehicles, pedestrians, passengers, ...

**Actuators:** steering, acceleration, braking, horn, signals, lights, ...

**Sensors:** cameras, LIDAR, GPS, speedometer, accelerometers, ...



Tesla's semi-self-driving car, 2020

# WAYS TO DESCRIBE ENVIRONMENTS

Observability

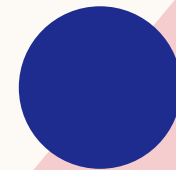
Determinism

Static

Discreteness

Episodic

Number of Agents





# DESCRIBING THE ENVIRONMENT: OBSERVABILITY

## Fully Observable

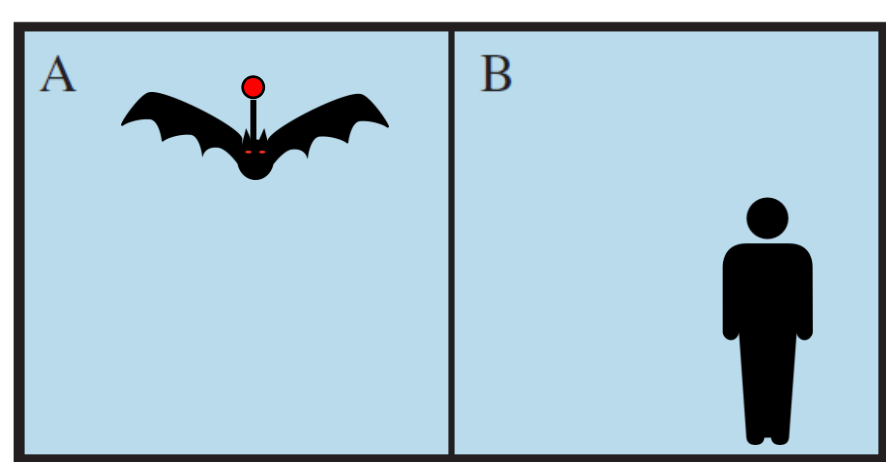
- Can sense everything in the environment without error
- *Examples:* chess, image classification

## Partially Observable

- Can only sense some information
- Two causes:
  - Incomplete data
  - Noise (sensor errors)
- *Examples:* poker, vehicle localization

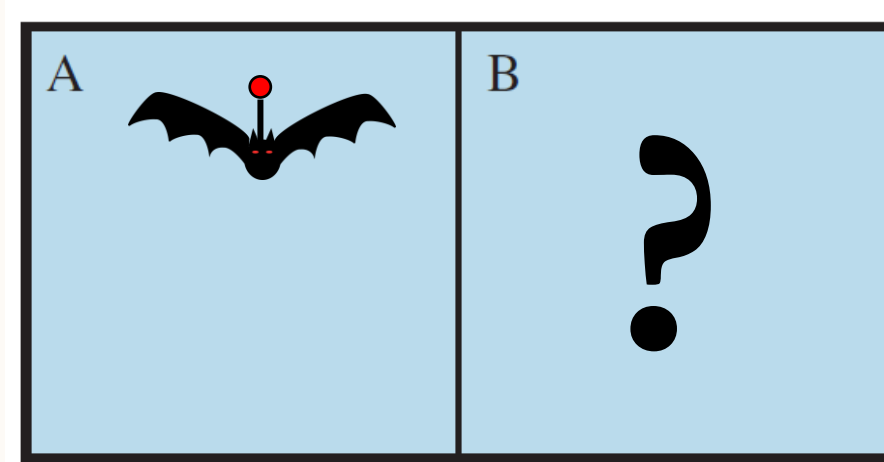
# OBSERVABILITY IN VAMPIRE WORLD

## Fully Observable



- Agent can observe the complete environment state

## Partially Observable



- Agent can only observe part of the environment

# DESCRIBING THE ENVIRONMENT: DETERMINISM

## Deterministic

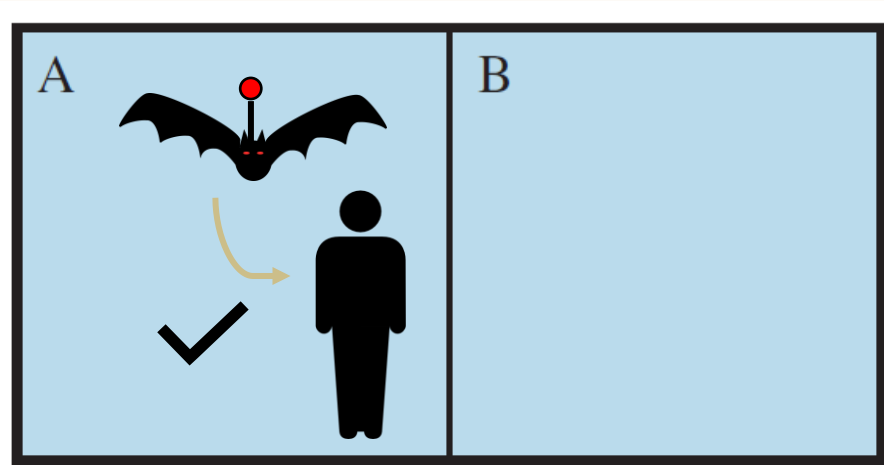
- Environment changes in exactly one way as a result of an agent's actions
- *Examples:* go, StarCraft

## Stochastic

- Randomness
- Action uncertainty
- Partial-observability
- *Examples:* rock-paper-scissors, bin picking robot

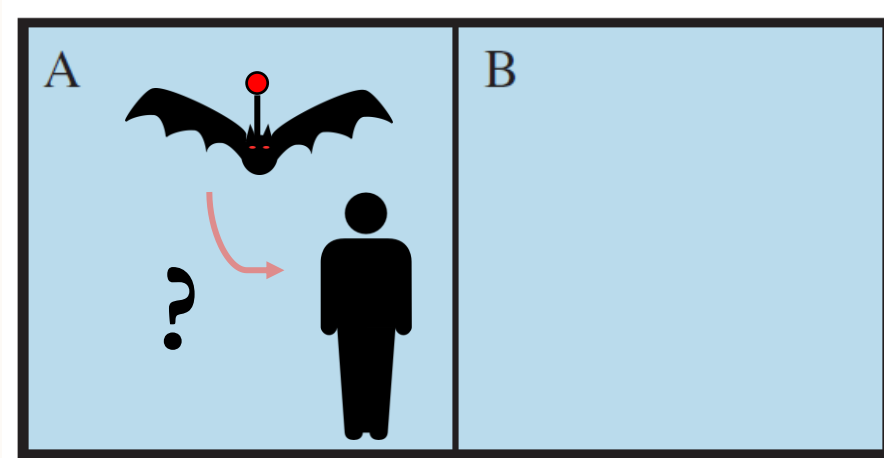
# DETERMINISM IN VAMPIRE WORLD

## Deterministic



- *Suck* action will always succeed

## Stochastic



- *Suck* action may fail, chance of human fighting off vampire agent



# DESCRIBING THE ENVIRONMENT: STATIC

## Static

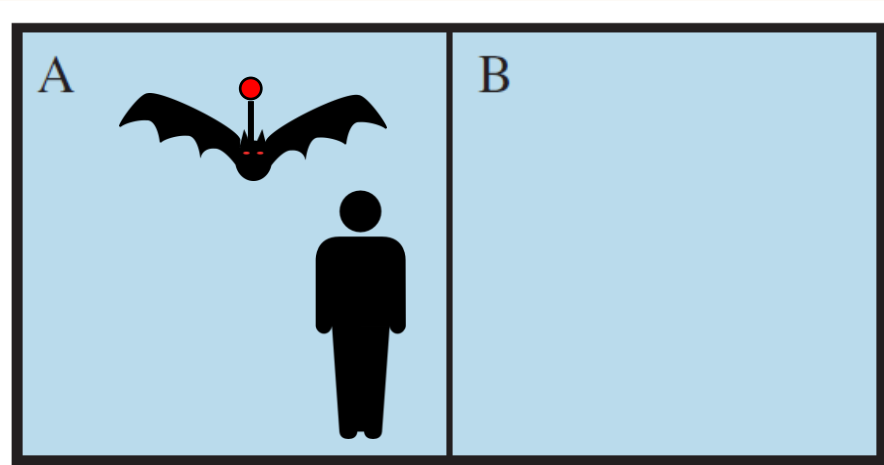
- World will not change while an agent is deliberating
- *Examples:* Sudoku, automatic character recognition

## Dynamic

- World can change while an agent is deliberating
- *Examples:* Dota, robot answering machine

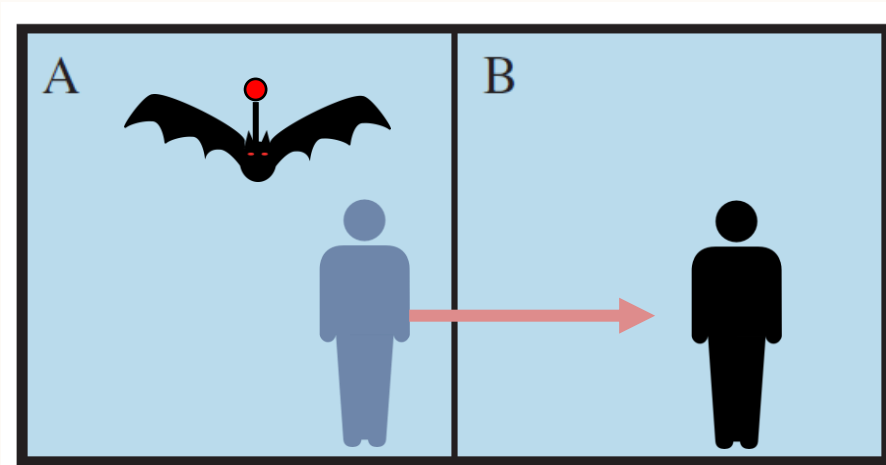
# STATIC IN VAMPIRE WORLD

## Static



- Humans will wait while vampire agent decides what to do

## Dynamic



- Humans move around independently of the decision time step

# DESCRIBING THE ENVIRONMENT: DISCRETENESS

## Discrete

- World broken up into a finite number of discrete chunks
- *Examples:* image generator, go

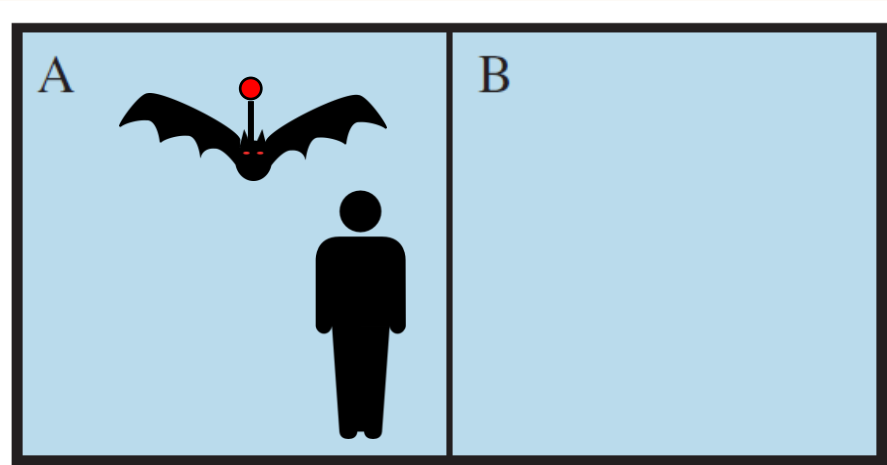
## Continuous

- Infinite number of chunks
- Infinite gradations of values
- *Examples:* image labeler, StarCraft

Can describe space, time, actions, and percepts

# DISCRETENESS IN VAMPIRE WORLD

## Discrete



- Environment divided into grid cells

## Continuous



- Environment represented as a continuous space

# DESCRIBING THE ENVIRONMENT: EPISODIC

## Episodic

- Percept sequence does not affect action selection
- History isn't required
- *Examples:* image classification, test question solver

## Sequential

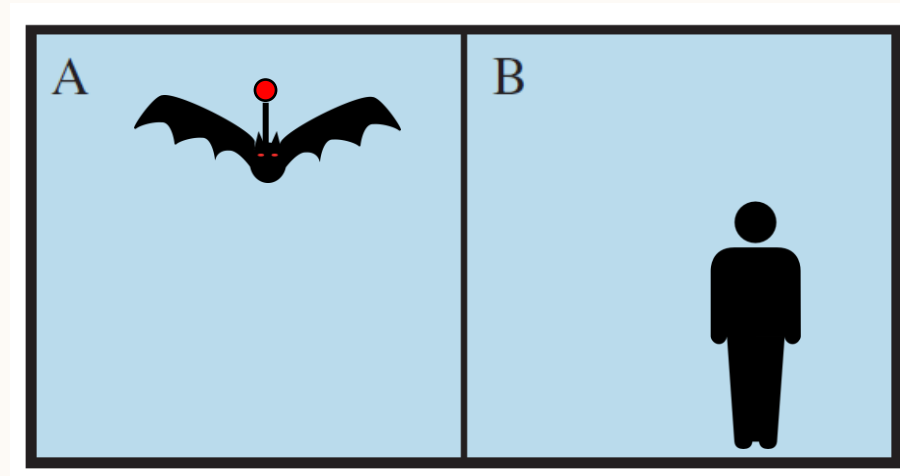
- Percept sequence matters
- Current choice of action will affect future choices
- *Examples:* video tracking, tic-tac-toe

# EPIODIC IN VAMPIRE WORLD

Episodic



Sequential



- Generally the case for physically situated agents that move through an environment

# DESCRIBING THE ENVIRONMENT: AGENTS

## Single Agent

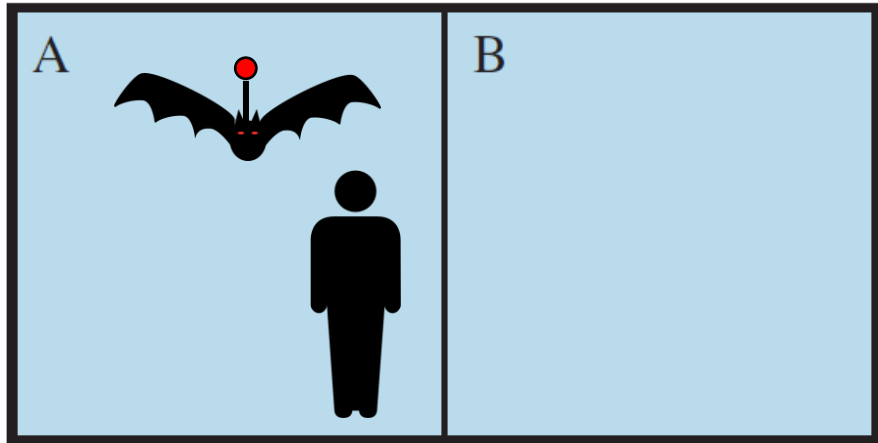
- You are the only agent in the world
- *Examples:* search engine, task scheduler

## Multi Agent

- There are other autonomous agents in the world that affect what you're trying to do
- Can be
  - Cooperative
  - Competitive
- *Examples:* chat bot, auction bidder

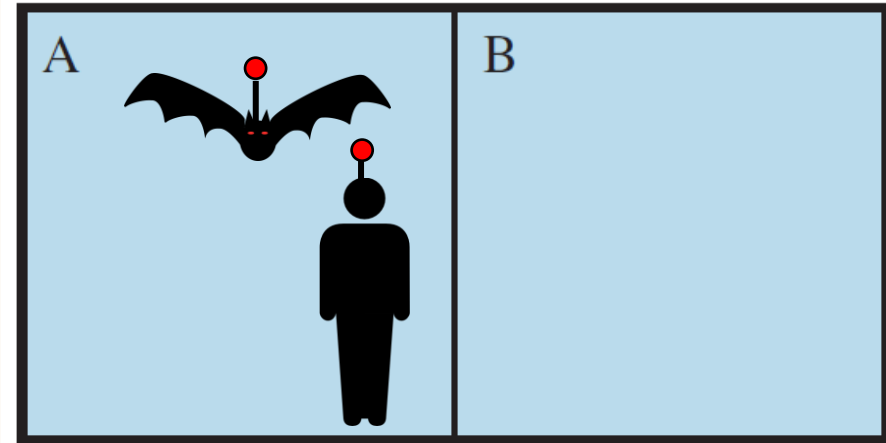
# AGENTS IN VAMPIRE WORLD

## Single Agent



- Treat human as just another feature of the environment

## Multi Agent



- Model human as another agent, with their own autonomy to interact with our agent



9/5/2023 - Agents

# DESCRIBING A SELF-DRIVING CAR ENVIRONMENT

- Partially observable
- Stochastic
- Dynamic
- Sequential
- Multi-agent



# FOR NEXT CLASS

- Fill out the paper presentation survey
- Read Chapter 3.1-3.4