

Search Problems

CS5491: Artificial Intelligence
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Content Credits: Prof. Wei's CS4486 Course
and Prof. Boddeti's AI Course

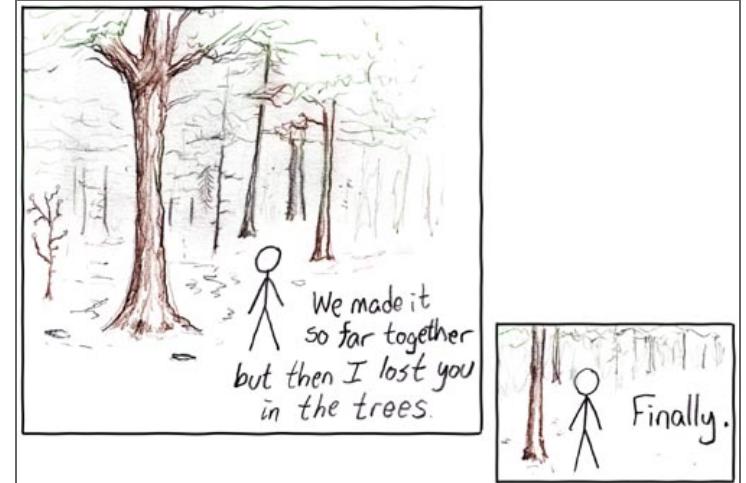
TODAY

Agents that Plan Ahead

Search Problems

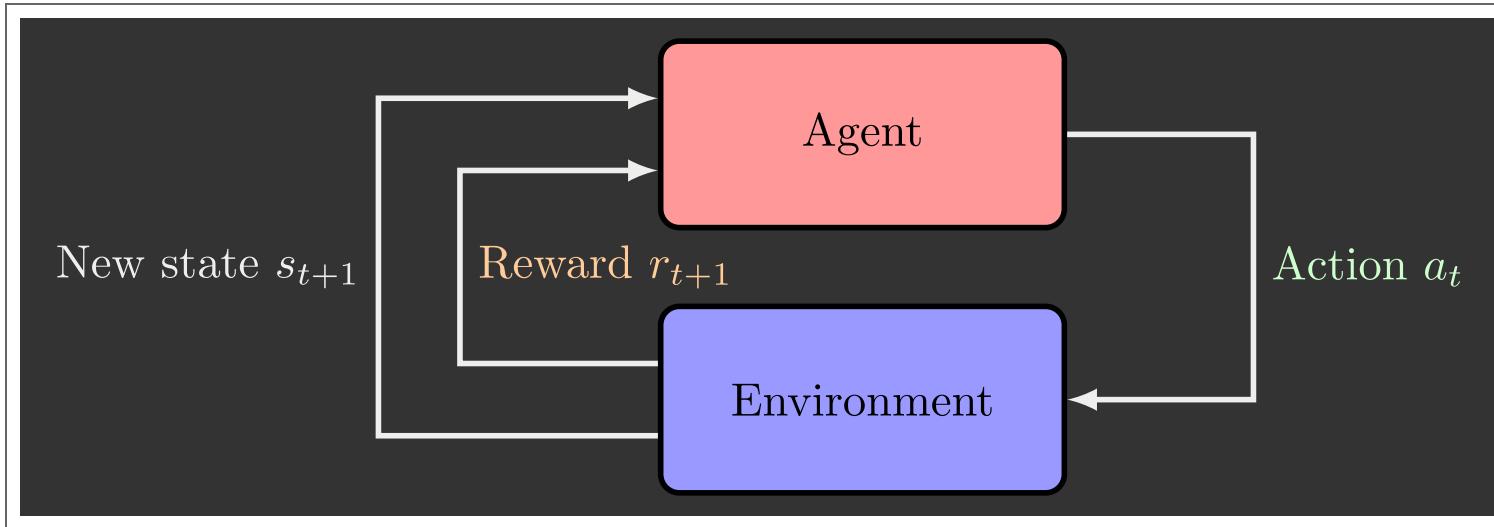
Reading

- › Today's Lecture: RN Chapter 3.1-3.4
- › Next Lecture: RN Chapter 3.1-3.4



XKCD

REMINDER: RATIONAL AGENTS



An **agent** is an entity that *perceives* and *acts*.

A **rational agent** selects actions that maximize its (expected) **utility**.

Characteristics of the **percepts**, **environment**, and **action space** dictate techniques for selecting rational actions.

RATIONAL AGENTS

Are rational agents **omniscient**?

- › No - they are limited by what they can perceive

Are rational agents **clairvoyant**?

- › No - they lack knowledge of environment dynamics

Do rational agents **explore** and **learn**?

- › Yes - essential qualities required in unknown environments

So, rational agents are not necessarily successful, but they are **autonomous**.

RATIONAL AGENTS

Performance Measure

- 1 per time step; +10 food; +500 win; -500 die;
+200 hit scared ghost

Environment

- Pacman dynamics + ghost behavior

Actuators

- North, West, East, South, Stop (idle)

Sensors

- entire state is visible



ROBOTAXI - PEAS

Performance Measure

- › income, happy customer, vehicle costs, fines, car, insurance

Environment

- › streets, other drivers, customers, etc.

Actuators

- › steering, brake, gas, display/speaker

Sensors

- › cameras, lidar, radar, ultrasonic, accelerometer, mechanical sensors, microphone, etc.



ENVIRONMENT CATEGORIZATION

	Pacman	Robotaxi
Fully or Partially Observable	fully	partial
Single or Multi Agent	multi	multi
Deterministic or Stochastic	deterministic	stochastic
Static or Dynamic	static	dynamic
Discrete or Continuous	discrete	continuous

ENVIRONMENT CATEGORIZATION

Reflex agents:

- › Choose actions based on current observation (and maybe memory)
- › May have memory or a model of the world's current state.
- › Do not consider future consequences of actions
- › Consider how the world IS as opposed to how it would be.

Can a reflex agent be rational?

AGENTS THAT PLAN AHEAD

Planning Agents:

- › Decision based on predicted consequences of actions
- › Must have a transition model : how the world evolves in responses to actions
- › Must formulate a goal
- › Consider how the world WOULD BE as opposed to how it is

Spectrum of Deliberativeness:

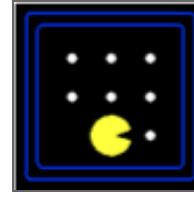
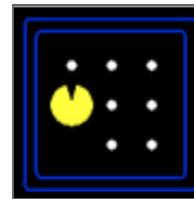
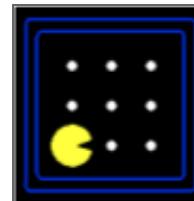
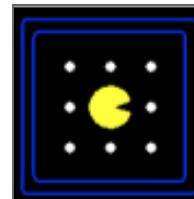
- › Generate complete, optimal plan offline, then execute
- › Generate simple, greedy plan, start executing, replan if necessary

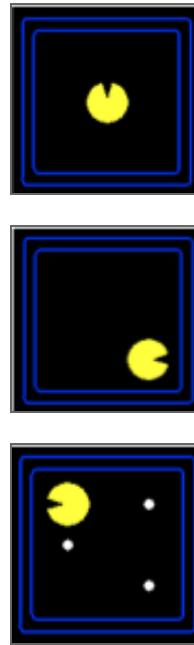
SEARCH PROBLEMS

WHAT ARE SEARCH PROBLEMS?

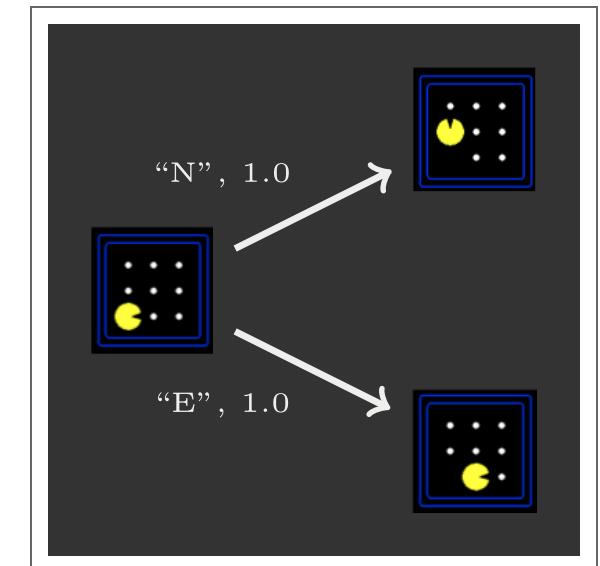
A **search problem** consists of:

- › A state space:





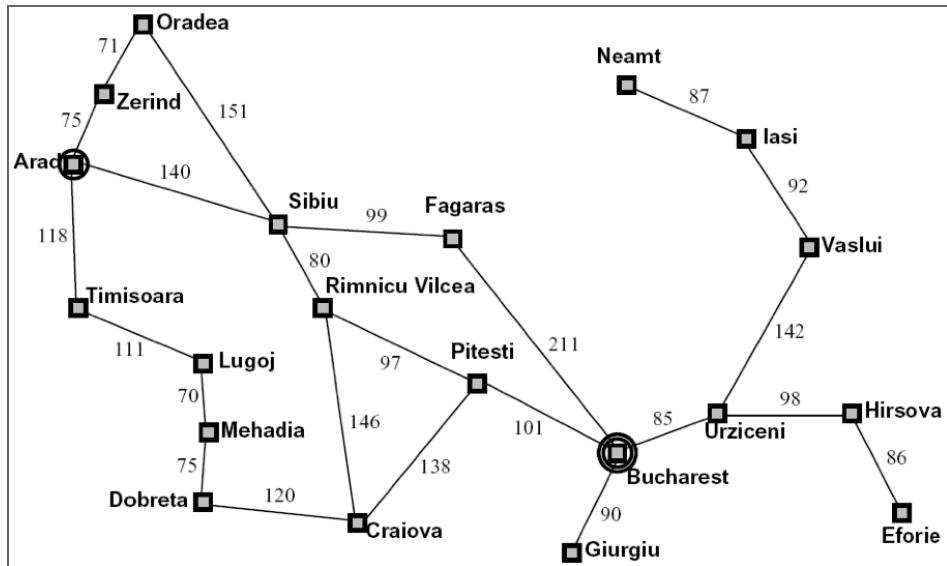
- › A successor function (actions, costs):
 - › A start state and goal test
- A **solution** is a sequence of actions (a plan) which transforms the start state to the goal test.



SEARCH PROBLEMS ARE MODELS



EXAMPLE: TRAVELING IN ROMANIA



State Space:

- Cities

Successor Function:

- Roads: travel to adjacent city with cost=distance

Start Space:

- Arad

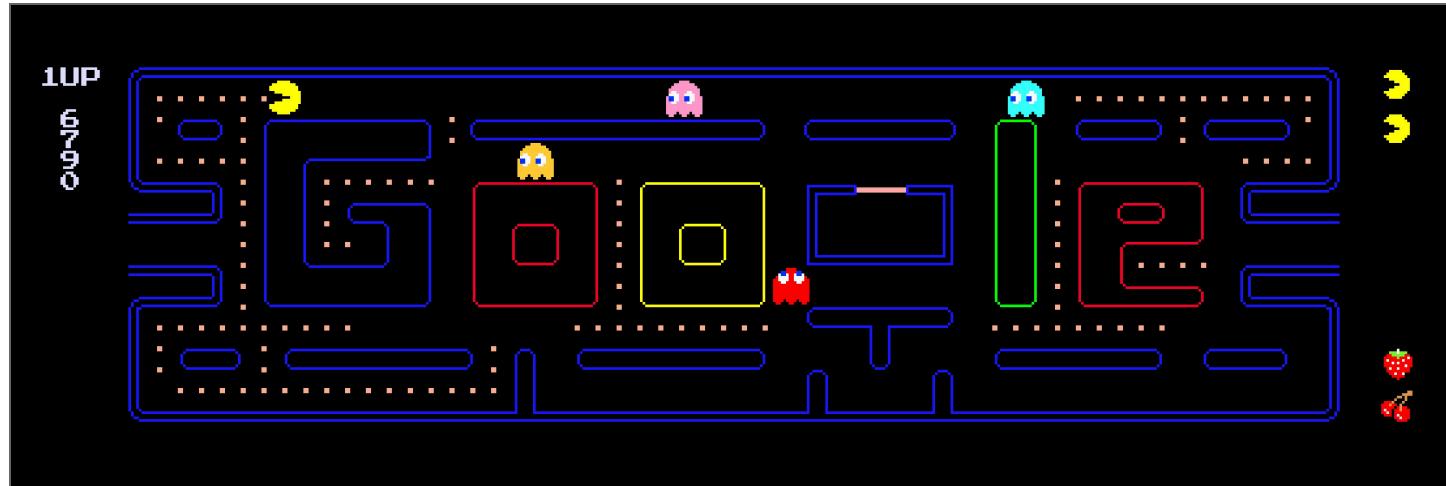
Goal Test:

- Is state == Bucharest?

Solution?

WHAT IS IN A STATE SPACE?

World State: Includes every last detail of the environment



Search State: Keeps only details necessary for planning

Problem: Pathing

- States: (x,y) position
- Actions: NEWS
- Successor: update location

Problem: Eat-All-Dots

- States: (x,y), boolean for each dot
- Actions: NEWS
- Successor: update location, boolean for dots

- Goal Test: Is $(x,y) == \text{END}$

- Goal Test: All dot booleans are false

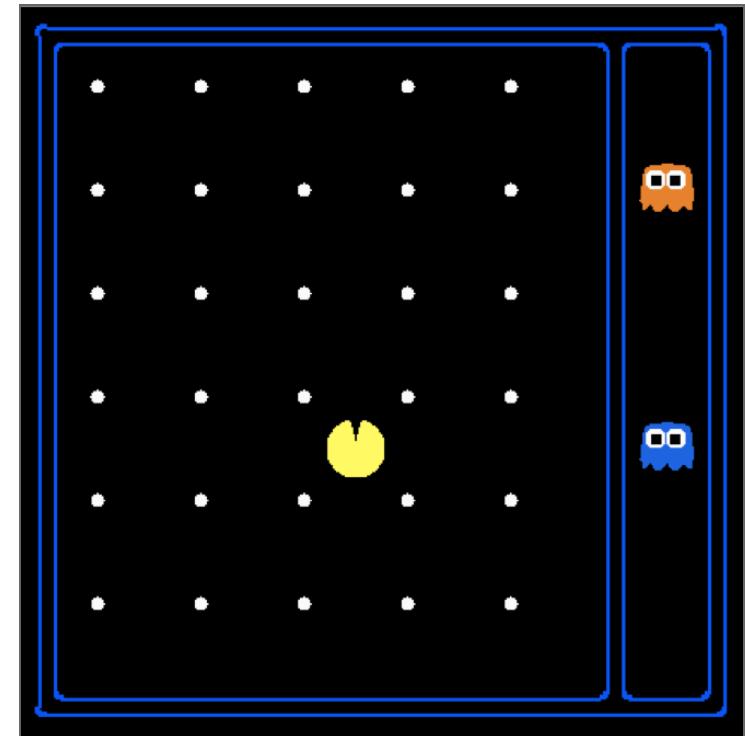
SEARCH SPACE SIZE

World State

- Agent Positions: 120
- Food Count: 30
- Ghost Positions: 12
- Agent Orientation: NEWS

Size

- World States: $120 \times 2^{30} \times 12^2 \times 4$
- States for Pathing: 120
- States for Eat-All-Dots: 120×2^{30}



Q & A



XKCD

Speaker notes

