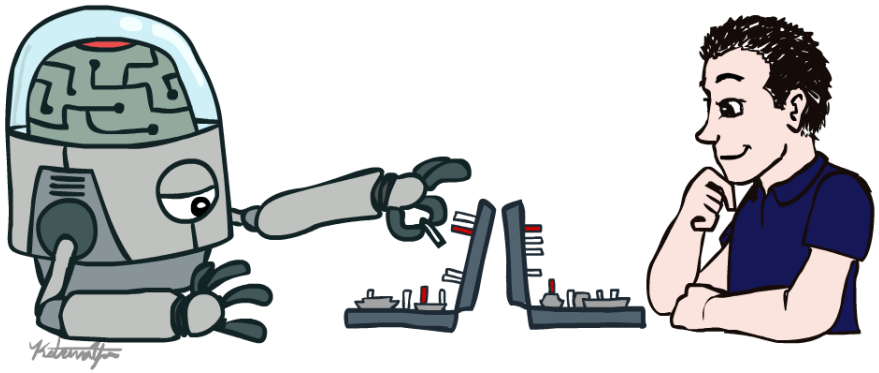
CSE 3521:
Introduction to Artificial Intelligence



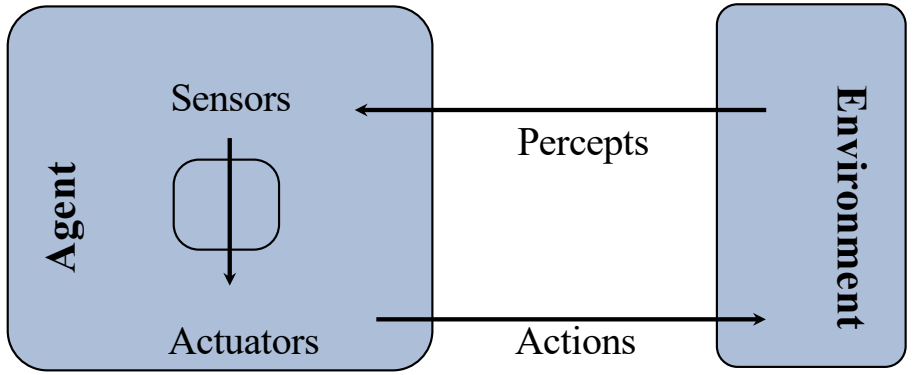
[These slides are partially adapted from the UC Berkeley. CS188 Intro to AI at UC Berkeley]

THE OHIO STATE UNIVERSITY

What makes an AI agent

- **Agent** – an entity that perceives its environment through sensors, and acts on it with effectors (actuators).

- Percepts are constrained by Sensors + Environment
- Actions are constrained by Actuators + Environment



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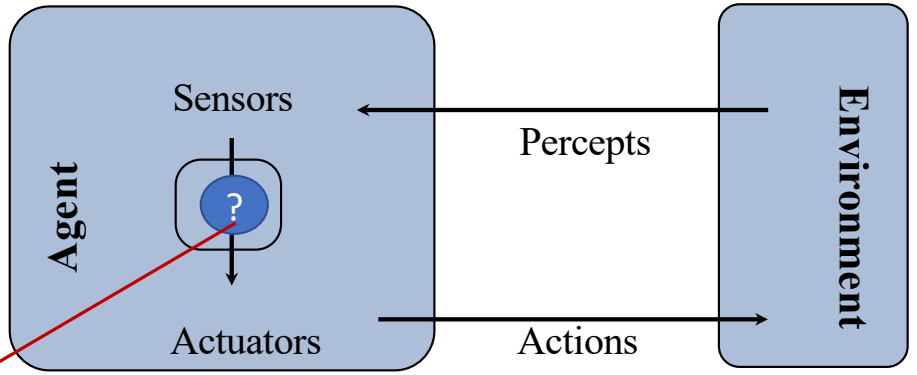
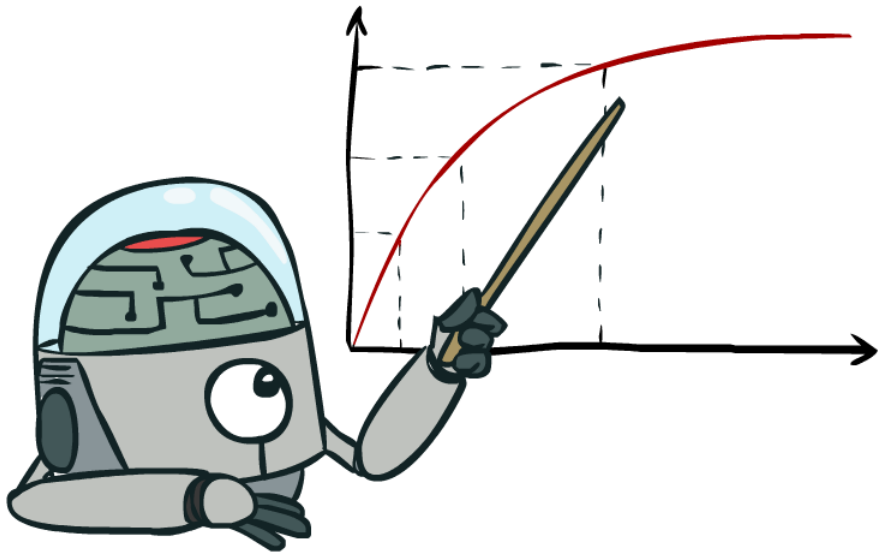


Agent Function (policy) – how does it choose the action?

What is a rational AI agent?

- A **rational agent** always acts to **maximize its expected performance measure**, given current **percept/state**

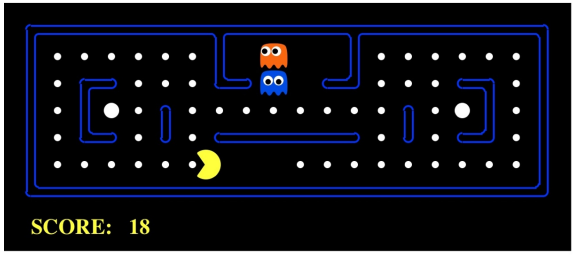
- Rationality ≠ omniscience
  - There is “uncertainty” in the environment.
  - That is why we emphasize “expected”.



Our Sample Agent

Pacman

- Percepts – squares around Pacman
- Actions – move U/D/L/R
- Environment – map with walls, dots, and ghosts

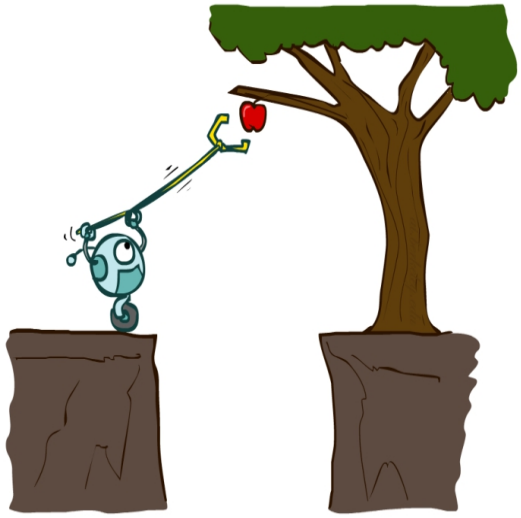


Spam Detector

- Percepts – sender, subject line, body of current email
- Actions – mark Spam/Not Spam
- Environment – your email inbox

AI – Agents and Environments

- Much (though not all!) of AI is concerned with **agents** operating in **environments.**
- **Agent –** an entity that *perceives* its environment through *sensors* and *acts* upon that environment through *effectors (actuators)*
- **Environment –** the problem setting

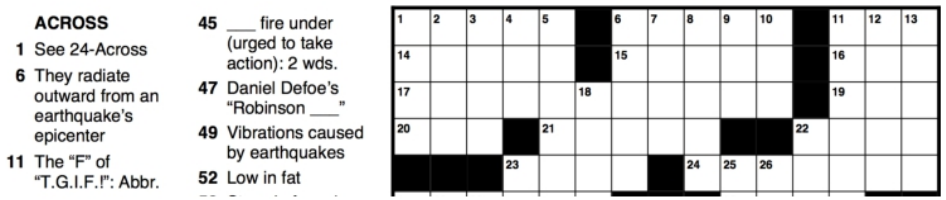


Kinds of Environments

- **Six** common properties to distinguish environments (not exhaustive)
  - Fully observable vs Partially observable
  - Single agent vs Multiagent
  - Deterministic vs Stochastic
  - Episodic vs Sequential
  - Static vs Dynamic
  - Discrete vs Continuous

Fully Observable vs Partially Observable

- Fully observable
  - Agent is able to sense everything in the environment



ACROSS

1 See 24-Across

6 They radiate outward from an earthquake's epicenter

11 The "F" of "T.G.I.F.": Abbr.

45 ___ fire under (urged to take action): 2 wds.

47 Daniel Defoe's "Robinson ___"

49 Vibrations caused by earthquakes

52 Low in fat

- Partially observable
  - noisy, inaccurate, or incomplete sensors

Single Agent vs Multiagent

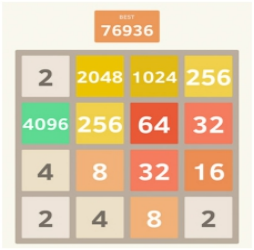
- Single Agent
  - Self-explanatory

- Multiagent
  - Task involves more than one agent
  - Each with its own performance measure
  - May be competitive (measures are opposed) or cooperative (measures are aligned)

Deterministic vs Stochastic

- Deterministic
  - Next state of the world is fully determined by current state + agent action

- Stochastic
  - it's not deterministic

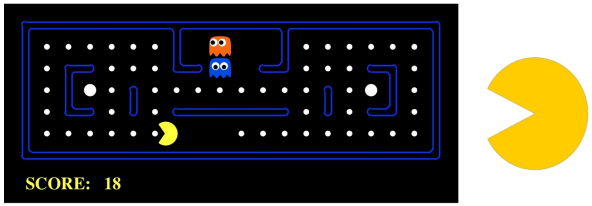


https://2048game.com/

Episodic vs Sequential

- Episodic
  - Each step's state/decision is independent of the previous ones

- Sequential
  - Each step's state/decision affects later ones



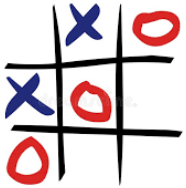
Static vs Dynamic

- Static
  - world doesn't change while agent is choosing an action

- Dynamic
  - decision time matters!

Discreet vs Continuous

- Discrete
  - Possible states/actions are distinct; world changes discretely



- Continuous
  - states/actions take on continuous values

These help to find how to approach a problem

- **Static:** focus on getting really high accuracy/utility
- **Dynamic:** trade some utility for higher efficiency (speed!)
- **Episodic:** reflex agent with a great model
- **Sequential:** need a goal oriented agent
- **Stochastic:** need robustness to uncertainty/failure (robots!)
- **Deterministic:** can focus on efficiency and exactness (Internet crawler)

Examples

	Crossword puzzle	Taxi Driving
Observability		
Deterministic vs Stochastic		
Episodic vs Sequential		
Static vs Dynamic		
Discrete vs Continuous		
Single vs Multi Agent		

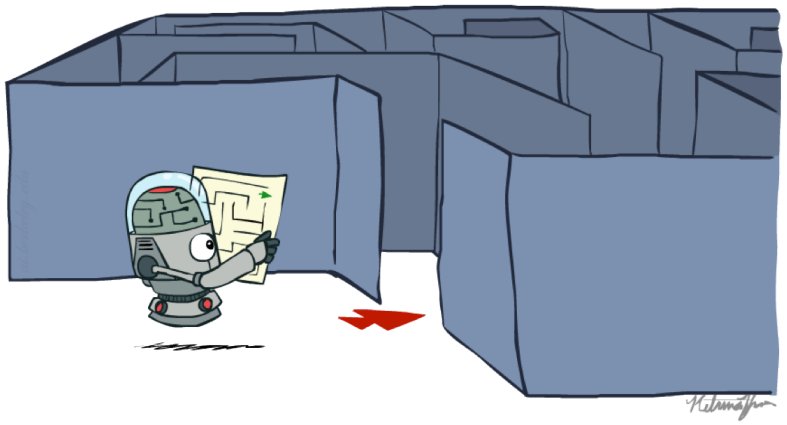
Examples

	Crossword puzzle	Taxi Driving
Observability	Fully	
Deterministic vs Stochastic	Deterministic	
Episodic vs Sequential	Sequential	
Static vs Dynamic	Static	
Discrete vs Continuous	Discrete	
Single vs Multi Agent	Single	

Examples

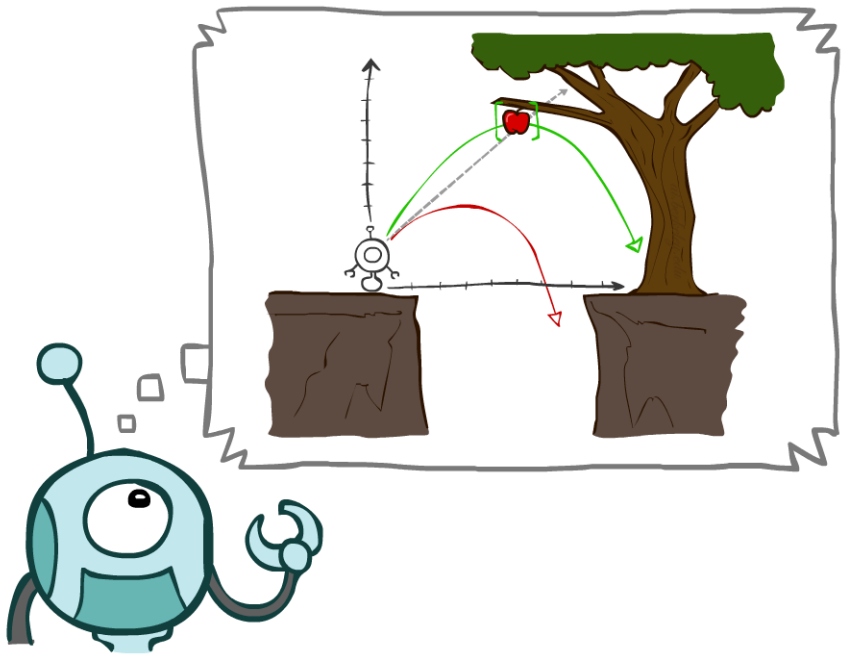
	Crossword puzzle	Taxi Driving
Observability	Fully	Partially
Deterministic vs Stochastic	Deterministic	Stochastic
Episodic vs Sequential	Sequential	Sequential
Static vs Dynamic	Static	Dynamic
Discrete vs Continuous	Discrete	Continuous
Single vs Multi Agent	Single	Multi

Search



Search Types

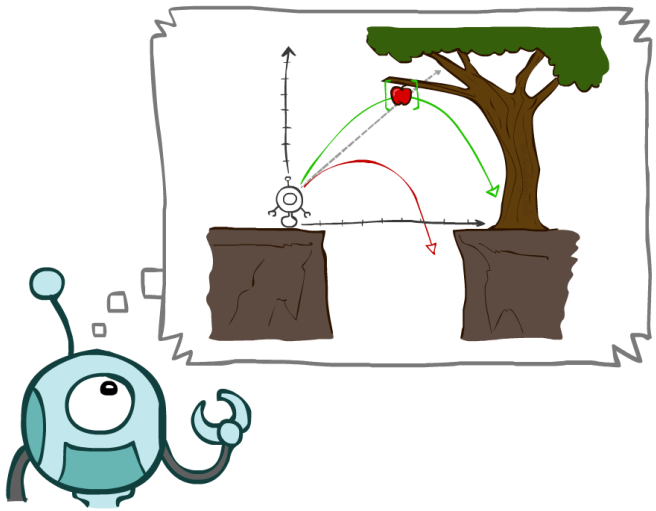
- Types
  - Uninformed Search Methods
    - Depth-First Search
    - Breadth-First Search
    - Uniform-Cost Search
  - Informed Search Methods
    - Greedy Search
    - A* Search
  - Graph searches



Agents that Plan Ahead

- Planning agents:
  - Ask “what if”
  - Decisions based on (hypothesized) consequences of actions
  - Must have a model of how the world evolves in response to actions
  - Must formulate a goal (test)
  - Consider how the world WOULD BE

- Optimal vs. complete planning



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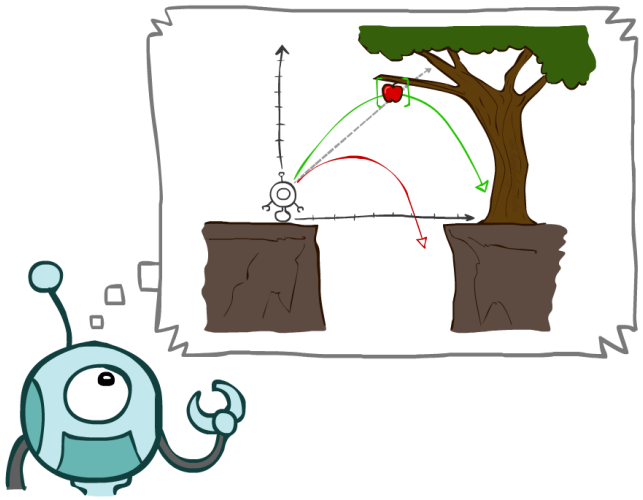
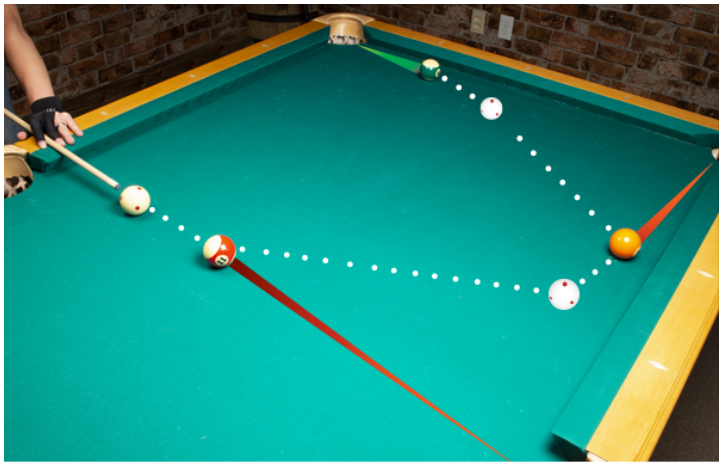


- Before taking *real* actions in the *real* environment, formulate an *off-line* problem in a *simulated/imaginary* environment (*model*).

- The off-line problem:
  - Has a goal (test)/desired state(s): not necessary the same as the real problem
  - To find *a sequence of actions* that can achieve the goal, better with optimal cost/performance measure/utility



- Execute the action sequence in the real environment
- Execute the first action in the sequence, see how to state changes, and may re-plan!

Search Problems

- A systematic way to looking for the (optimal) action sequence to reach goal
- Not the only way

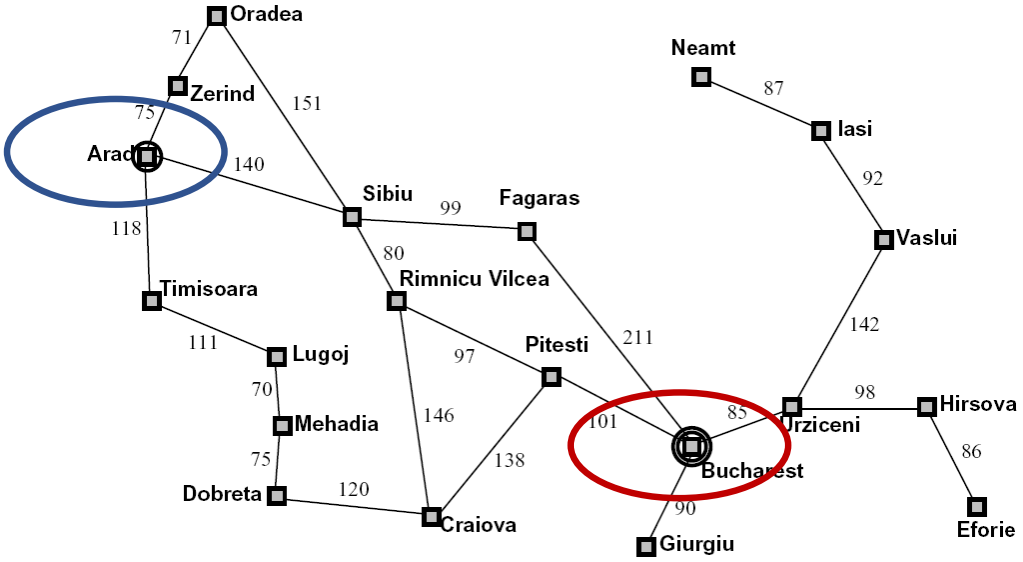
Search Problems

- A search problem consists of:
  - A state space
  - A successor function (with actions, costs)
  - A start state and a goal test

Search Problems

- A search problem consists of:
  - A state space
  - A successor function (with actions, costs)
  - A start state and a goal test
- A solution is a sequence of actions (a plan) which transforms the start state to a goal state

Example: Traveling in Romania



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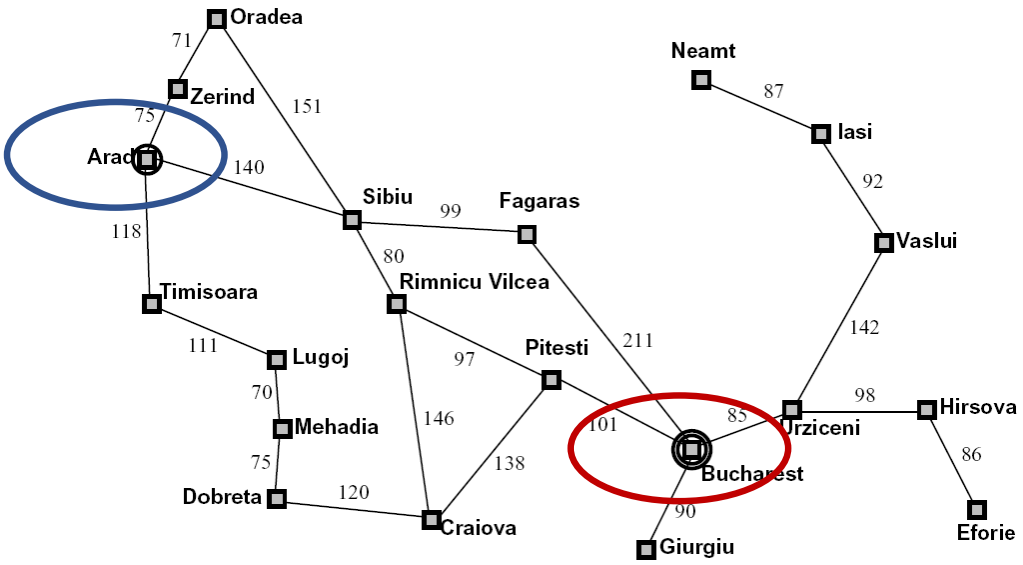

- State space:
  - Cities

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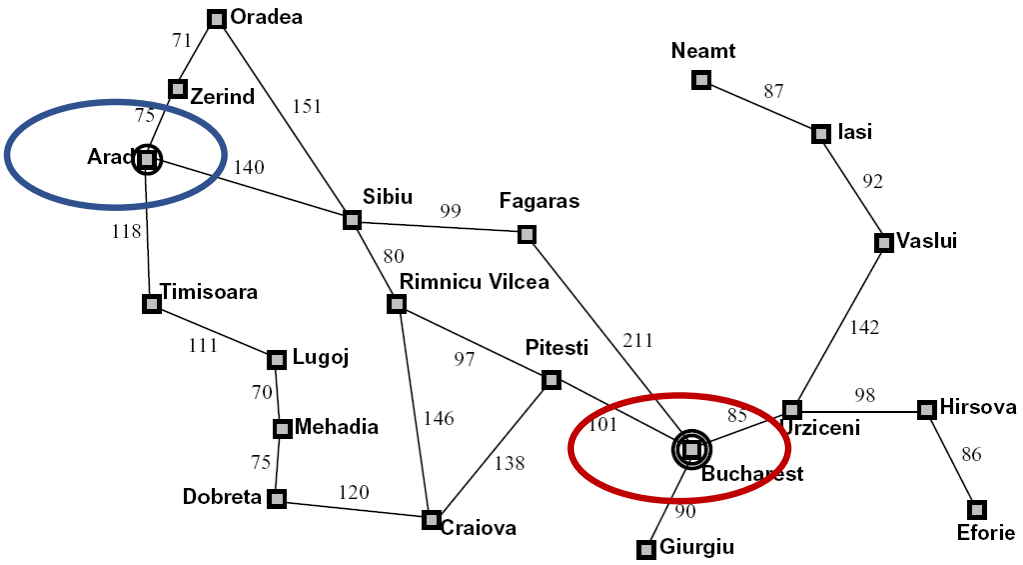

- State space:
  - Cities
- Successor function:
  - Roads: Go to adjacent city with cost = distance

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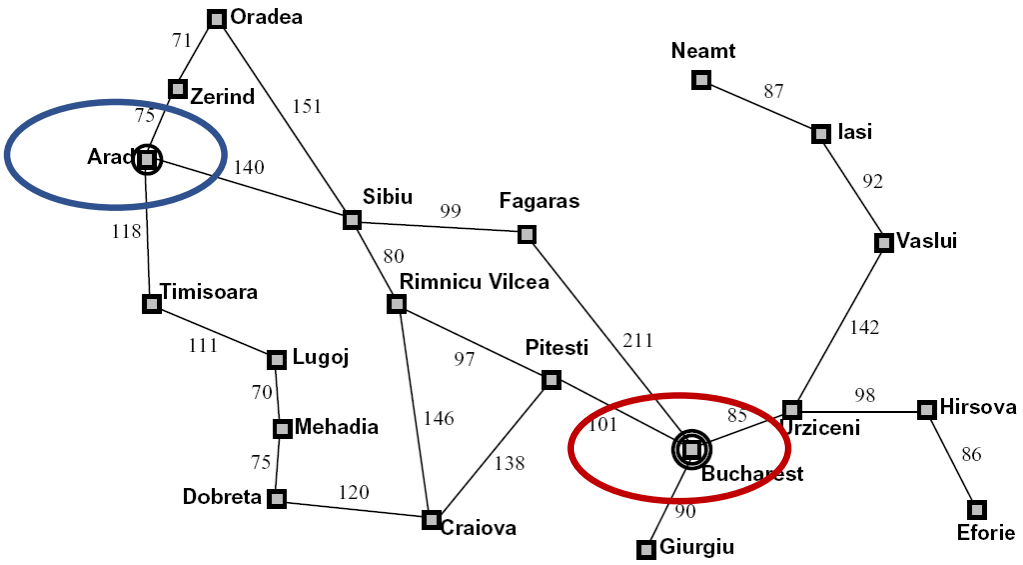

- State space:
  - Cities
- Successor function:
  - Roads: Go to adjacent city with cost = distance
- Start state:
  - Arad

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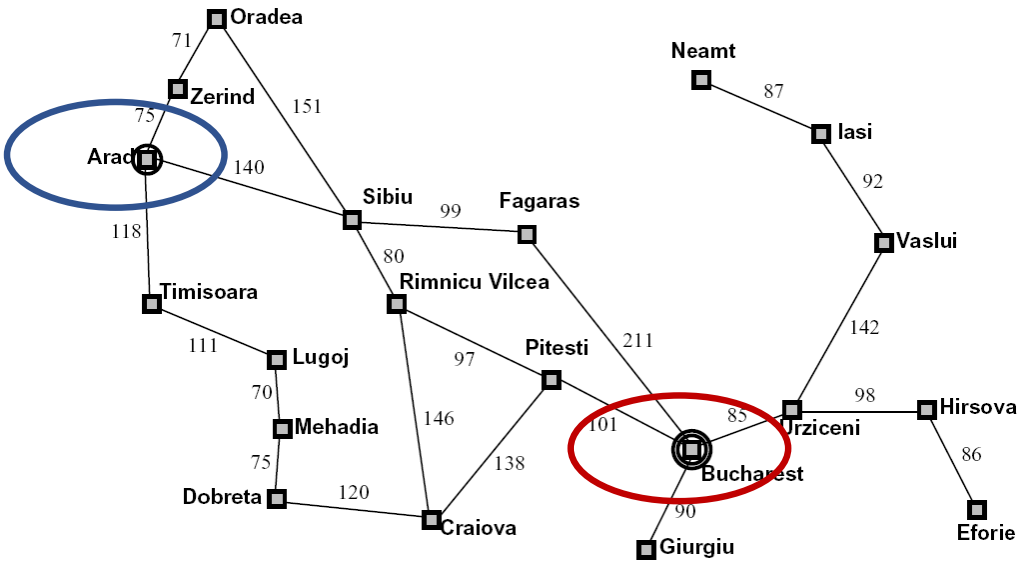

- State space:
  - Cities
- Successor function:
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- Start state:
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- Goal test:
  - Is state == Bucharest?

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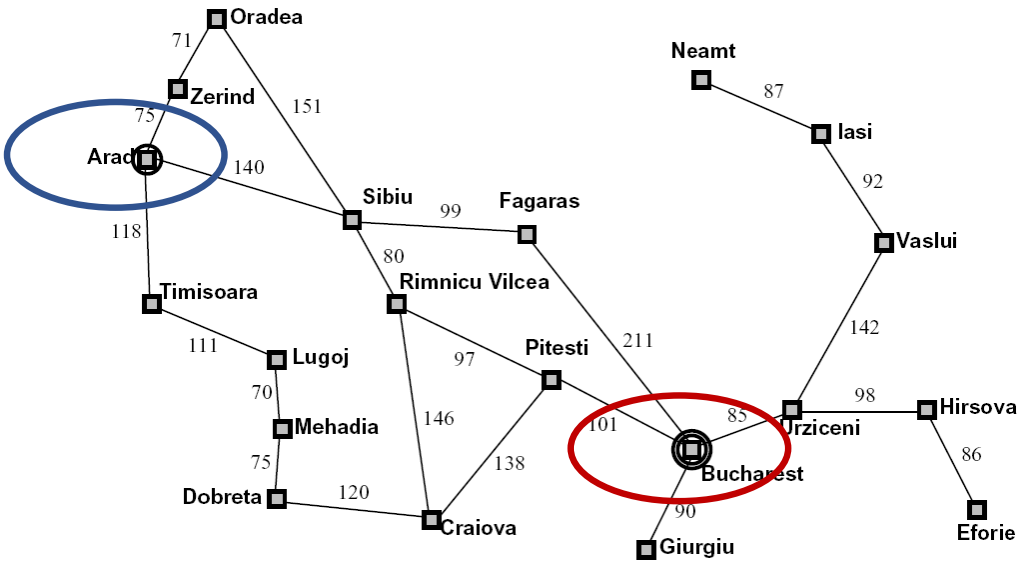

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- Solution?
  - If there exists one, it is a sequence of cities from Arad to Bucharest