
CS 232: Artificial Intelligence

Fall 2026

Prof. Carolyn Anderson
Wellesley College

Reminders

- ◆ Homework 2 will be released today
- ◆ Tutor hours:
 - Amber: Friday 1-2 in Whiteboard Alley
 - Coco: Monday 7-8 in Whiteboard Alley
- ◆ My Friday help hours will be shifted this week:
3:30-4:15pm
- ◆ Reading for next Tuesday: *Thinking Humans* Chapter 8-9
 - HW 1 notes: file types, names, path

Homework 2: Murdlebot

In Homework 2, you will build a solver for a type of logic puzzle: [Murdle puzzles](#).

Your program will build a search space of world states and eliminate them by *constraint propagation*: iteratively applying rules to eliminate impossible states.

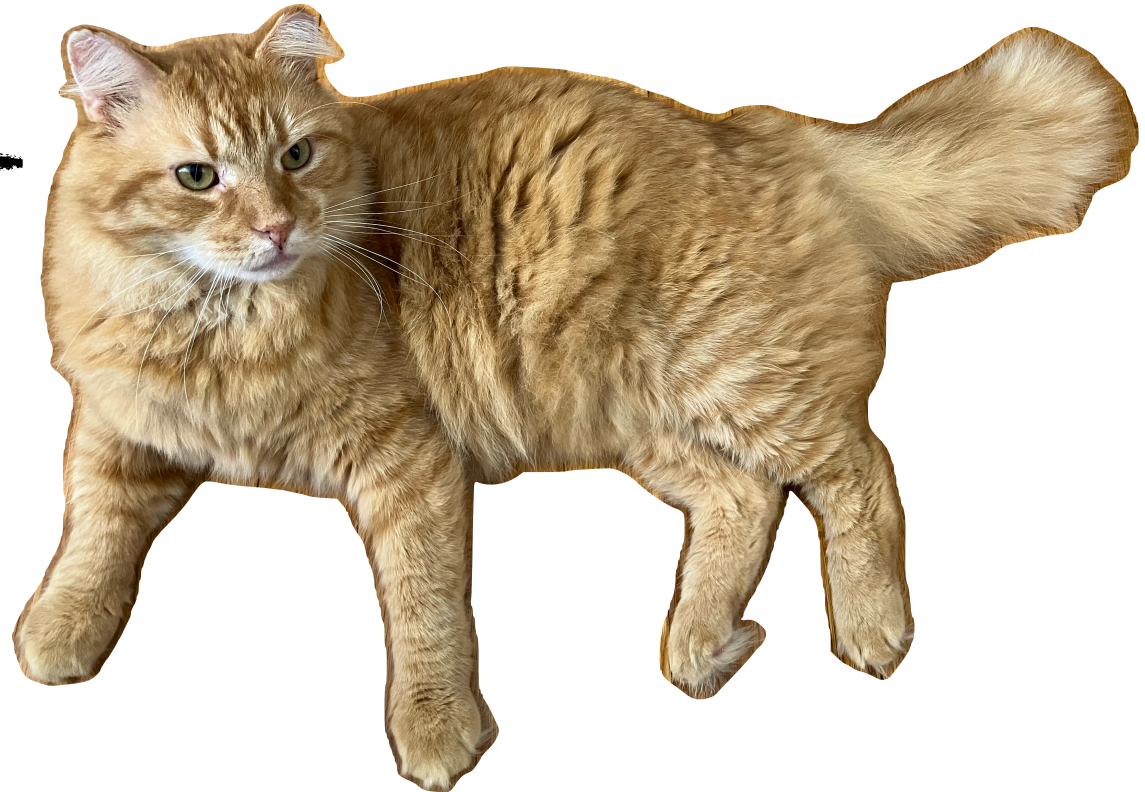
- ♦ If you eliminate all but one state, you've found the unique **solution**.
- ♦ If you run out of rules, the puzzle is **ambiguous** and can't be solved with the evidence available.
- ♦ If you eliminate all states, the puzzle is **contradictory**.

Recap

Agent Complexity

Problem-solving agent: capable of considering a sequence of actions that form a path to a goal state (planning ahead to find a solution).

if I wail, the human
might refill my bowl.
then I can eat more.

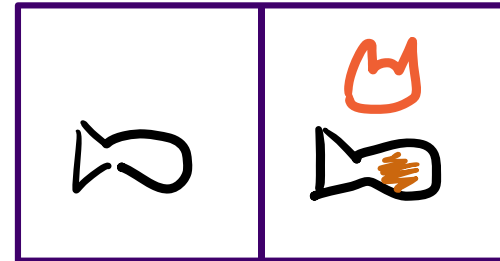


Catworld

States: A state of the world describes which objects are in which locations.

In a simple two bowl version:

- ♦ the cat can be at one bowl at a time
- ♦ each bowl can be full or empty



Catworld

States: A state of the world describes which objects are in which locations.

In a simple two bowl version:

- ♦ the cat can be at one bowl at a time
- ♦ each bowl can be full or empty



Catworld

States: A state of the world describes which objects are in which locations.

In a simple two bowl version:

- ♦ the cat can be at one bowl at a time
- ♦ each bowl can be full or empty



With n bowls, there are $n \times 2^n$ states.

2 cat positions $\times$ 2^2 bowl
configurations = 8 states.

Catworld

States: A state of the world describes which objects are in which locations.

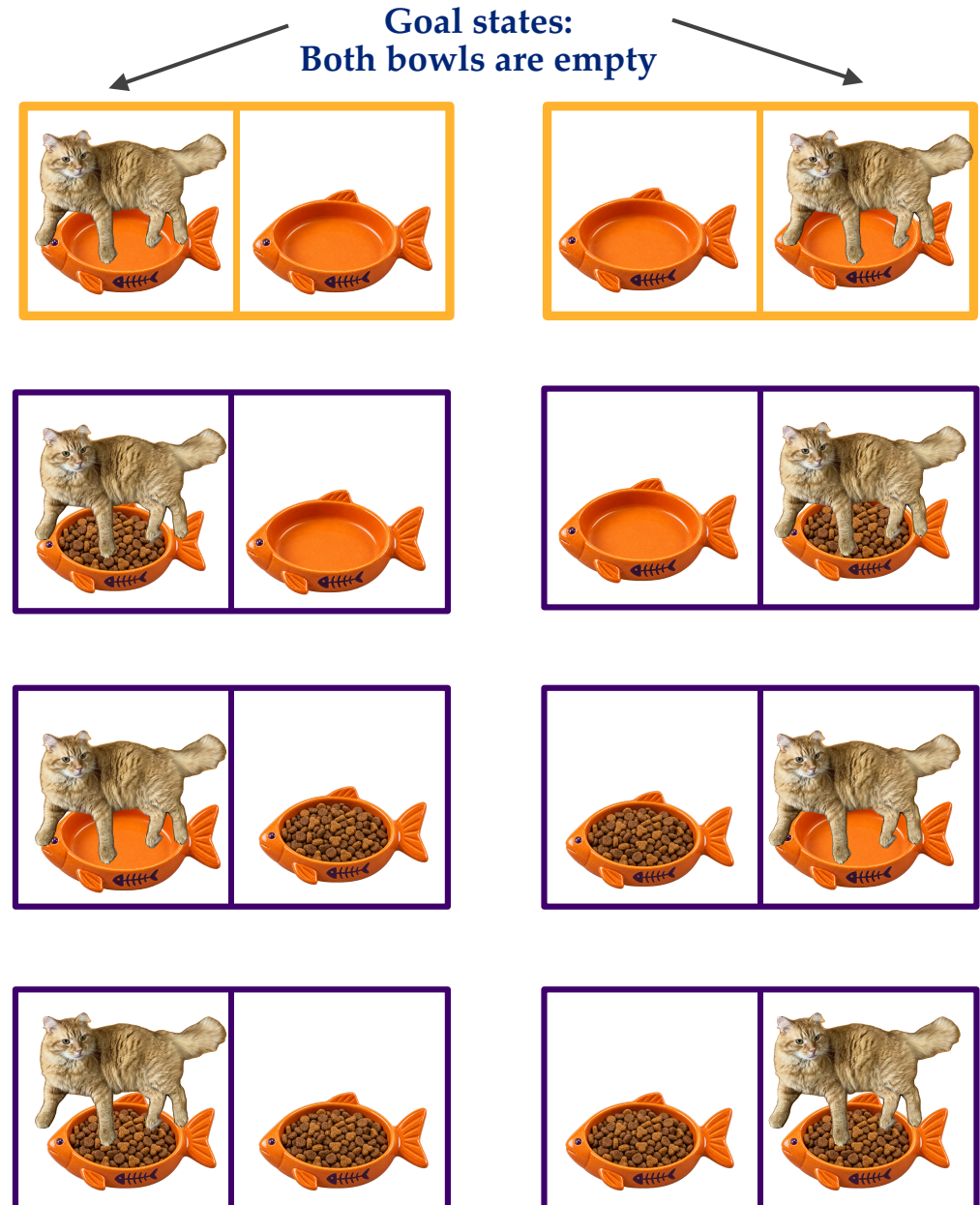
In a simple two bowl version:

- ♦ the cat can be at one bowl at a time
- ♦ each bowl can be full or empty

With n bowls, there are $n \times 2^n$ states.

2 cat positions $\times$ 2^2 bowl configurations = 8 states.

One state is designated the start state.



Catworld



Actions:

Eat

Move Left

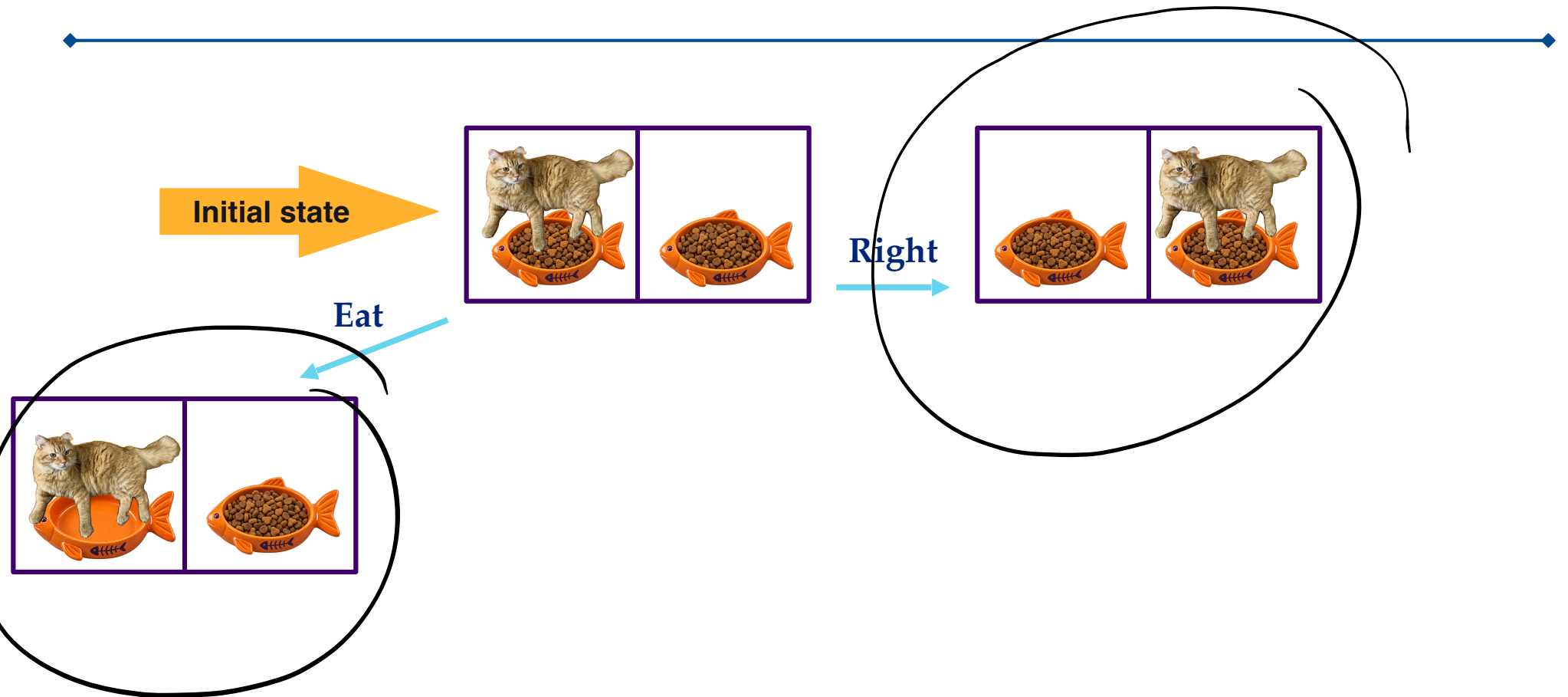
Move Right

Transition:

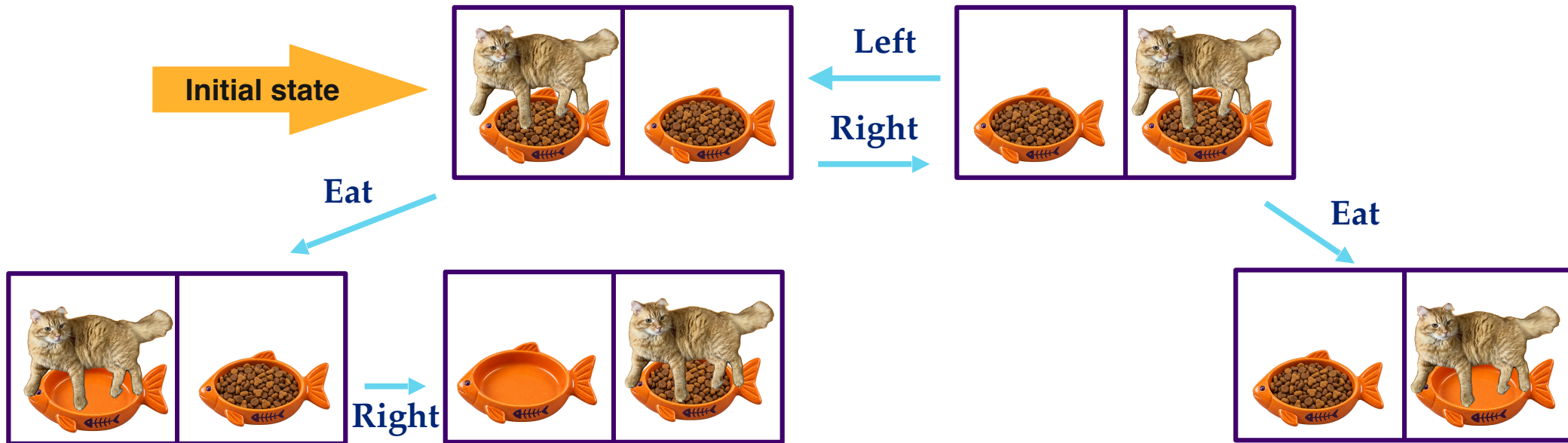
Eat $\rightarrow$ empties the current bowl

Move $\rightarrow$ moves in the given direction unless the agent hits a wall

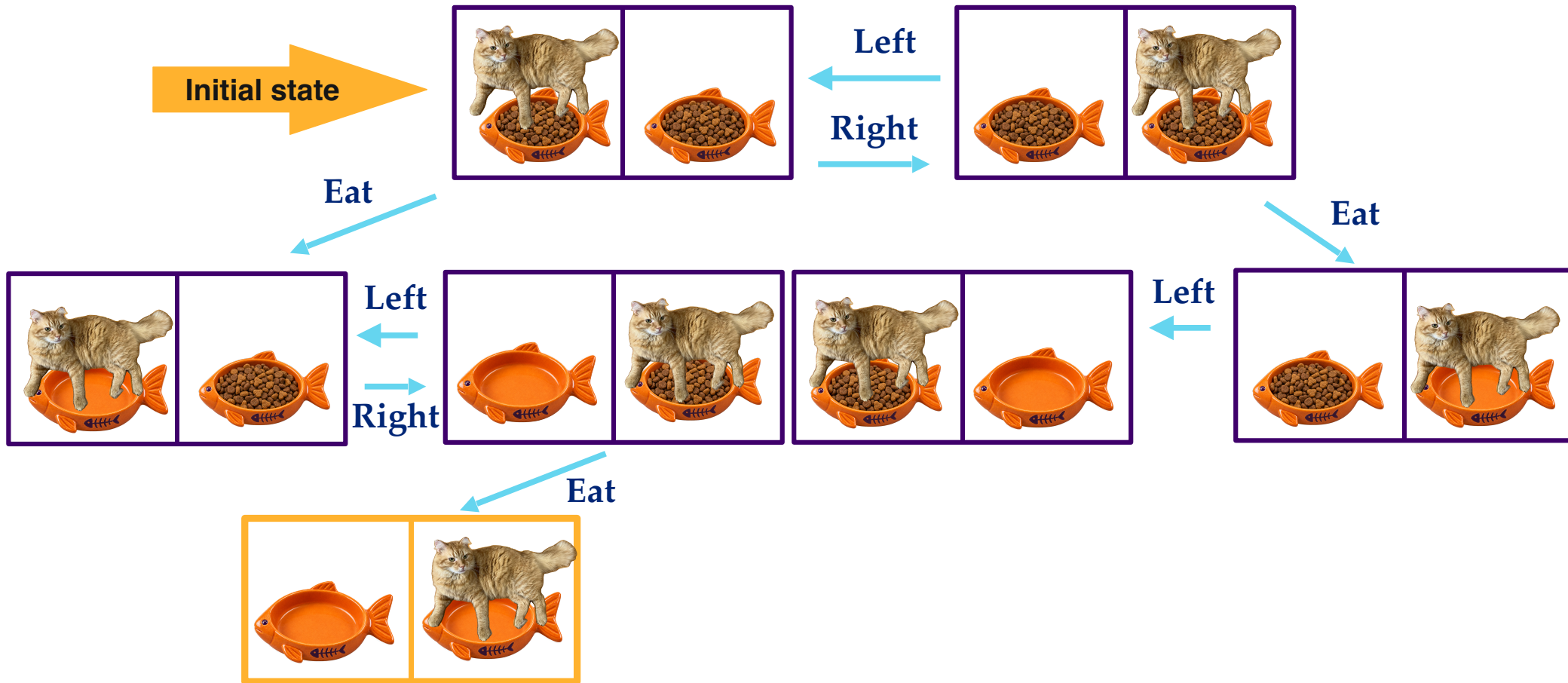
Catworld



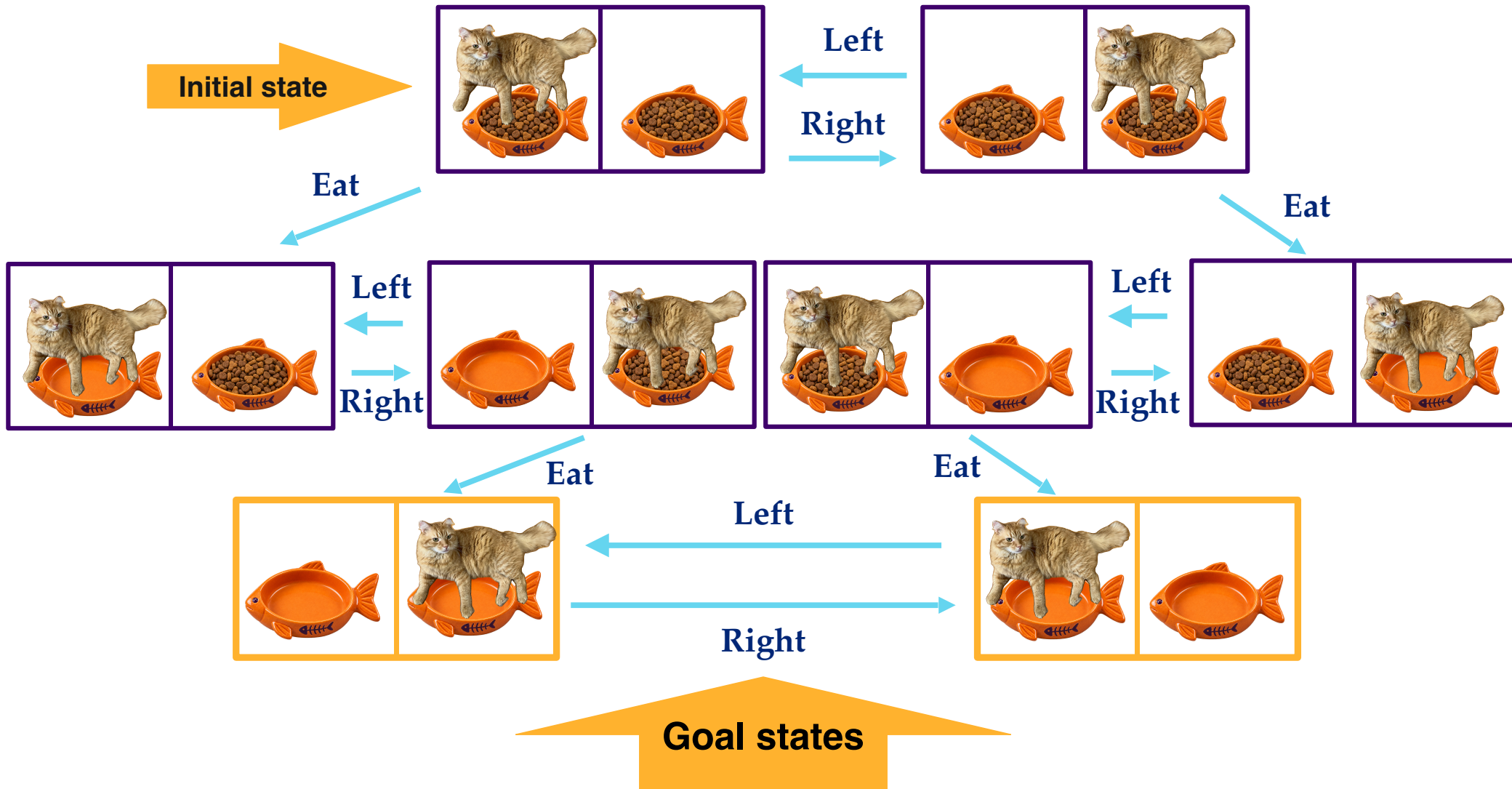
Catworld

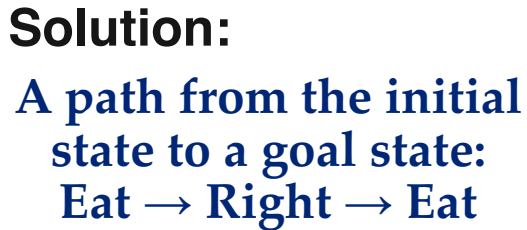


Catworld



Catworld





Useful Concepts

Solution: a path from the start state to a goal state

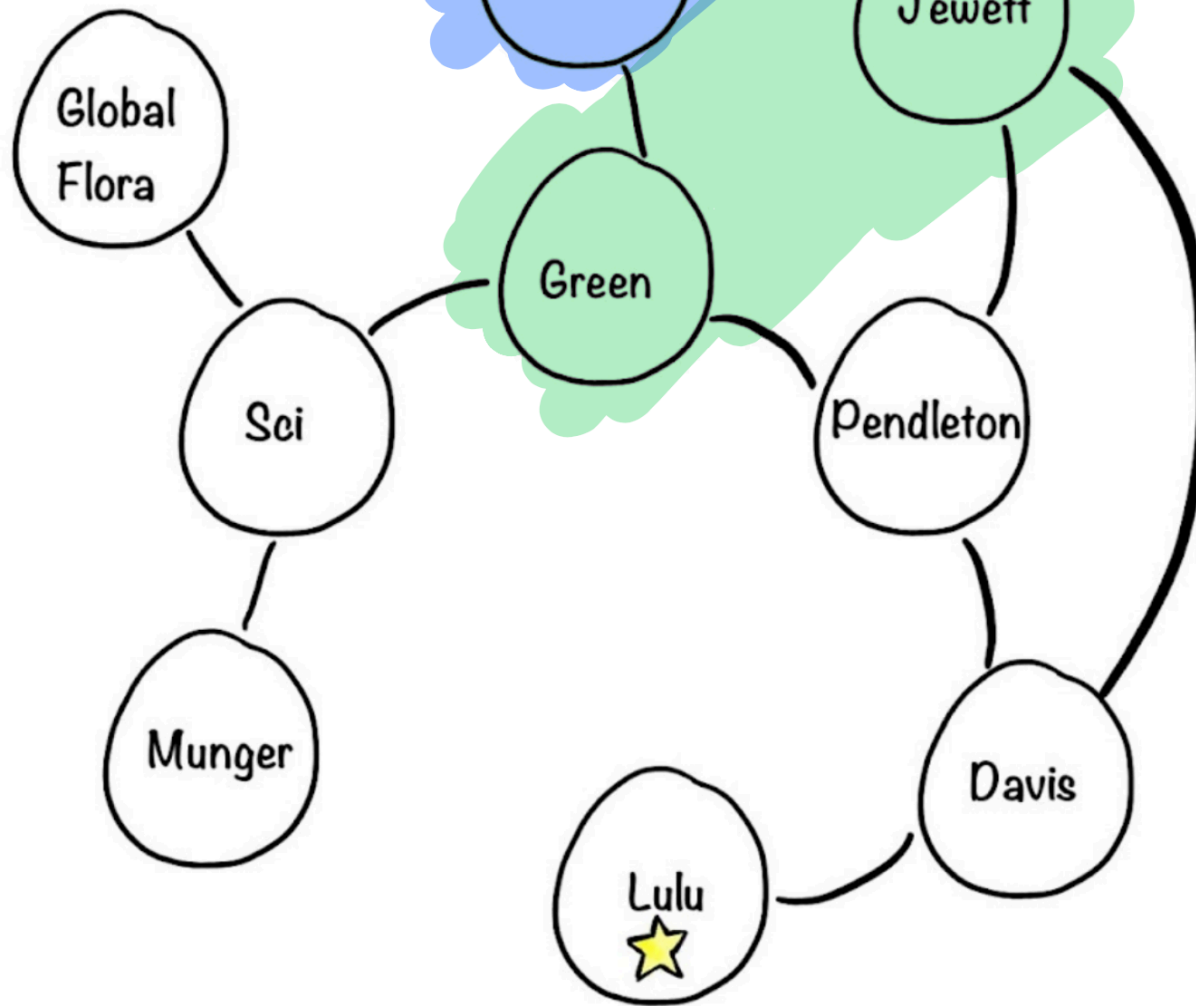
Path: a sequence of actions from one state s_i to another state s_k .

State space: the set of all states that we can reach from our start state by taking actions

Search tree: a way of representing the paths that a search algorithm has explored.
The root is the start state.

Frontier: the states available for expanding/visiting

The Frontier



Frontier = 

Current Node = 

Treasure Hunt

Looking for treasure on campus starting from Founders

Formulate Search Problem:

- ♦ States: Buildings
- ♦ Actions: walking on a path between buildings
- ♦ Cost Metric: Distance # of Buildings
Time visited
- ♦ Goal Test: Look around for treasure
- ♦ Solution: List of steps between Founders & goal

8 Puzzle

Formulate Search Problem:

7	2	4
5		6
8	3	1

Start State

	1	2
3	4	5
6	7	8

Goal State

- ♦ States: a configuration of the board
- ♦ Actions: which tile moves (where)
- ♦ Cost Metric: # of moves
- ♦ Goal Test: is the puzzle solved?
- ♦ Solution:

tile moves from start to goal

States Versus Nodes

A **state** is a (representation of a) **physical configuration**

A **node** is a data structure constituting **part of a search tree**

- Also includes *parent, children, depth, path cost $g(x)$*
- Here *node* = *<state, parent-node, children, action, path-cost, depth>*

States do not have parents, children, depth or path cost!

Solving Search Problems

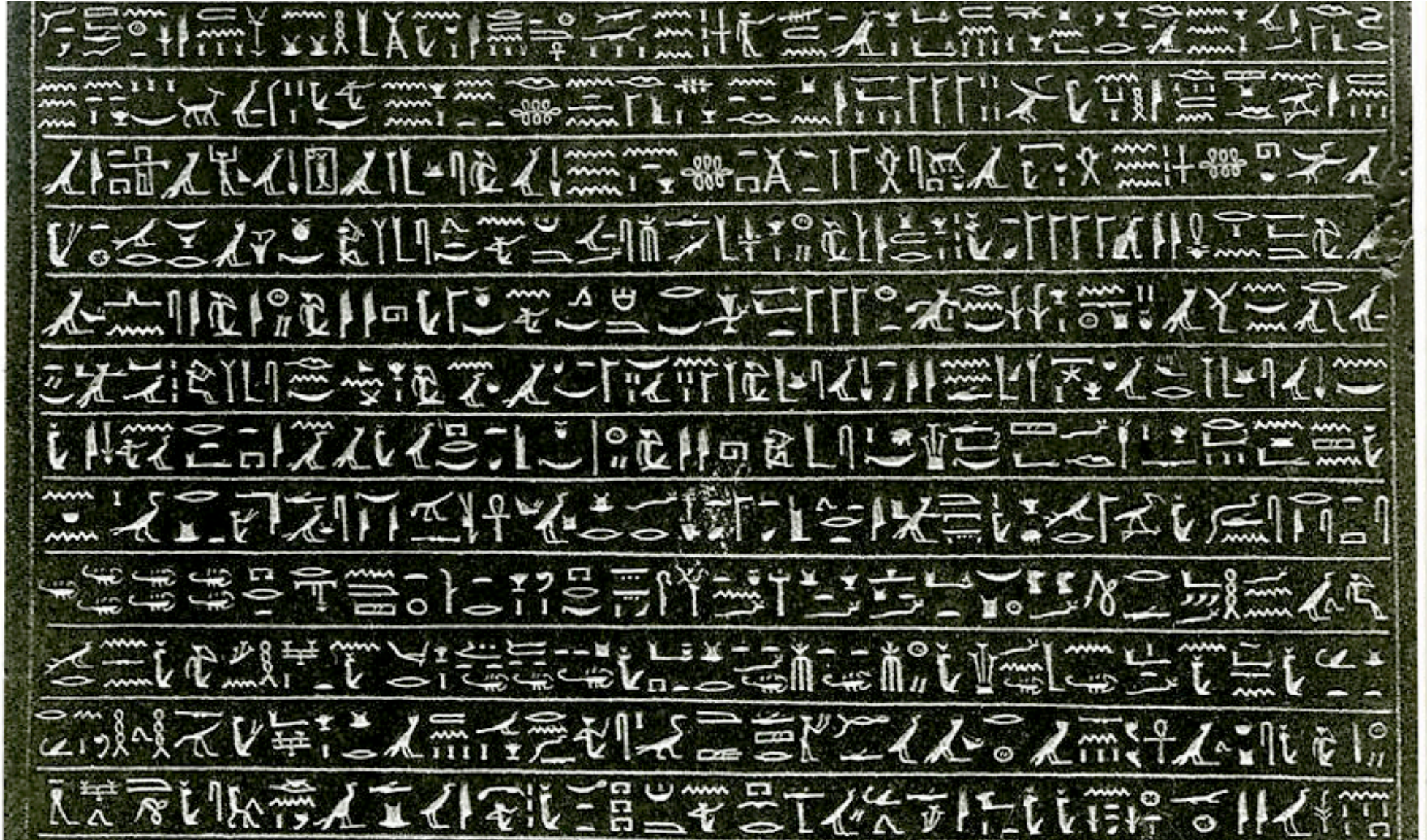
Backtracking Search

One of the simplest search strategies for puzzle-solving is **backtracking search**.

In backtracking search, we make a guess to eliminate possibilities (narrow the search space).

If we run into a logical inconsistency, we **backtrack** (undo our guess) and try out a different guess.

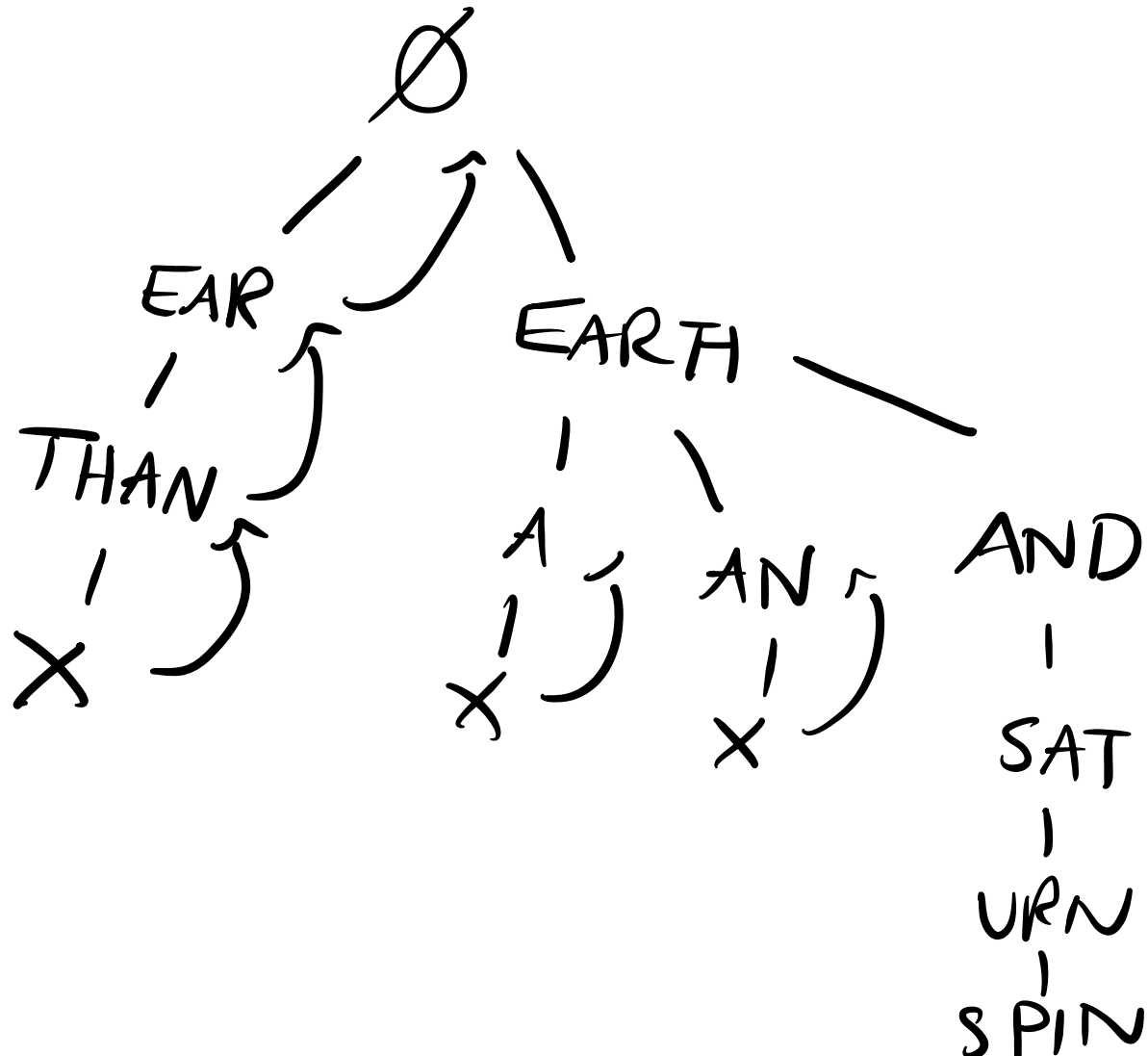
Backtracking Search Application



Magical Stela (Cippus of Horus), Metropolitan Museum of Art

Backtracking Search Application

EARTH | AND | SATURN | SPIN

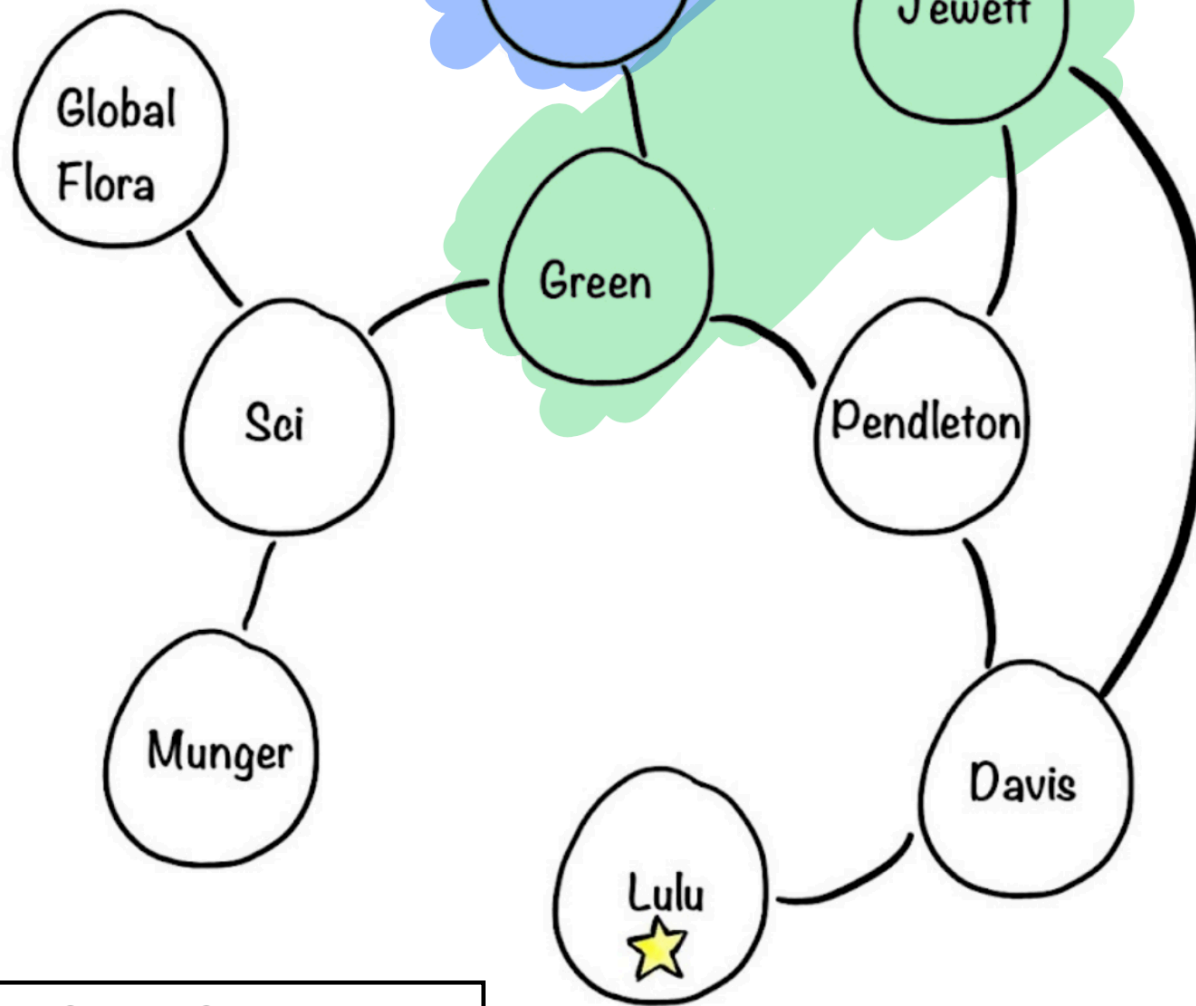


Basic Search Algorithm: Tree Search

Generalized algorithm to solve search problems

Orderly enumeration of all possible paths from the initial state

The Frontier



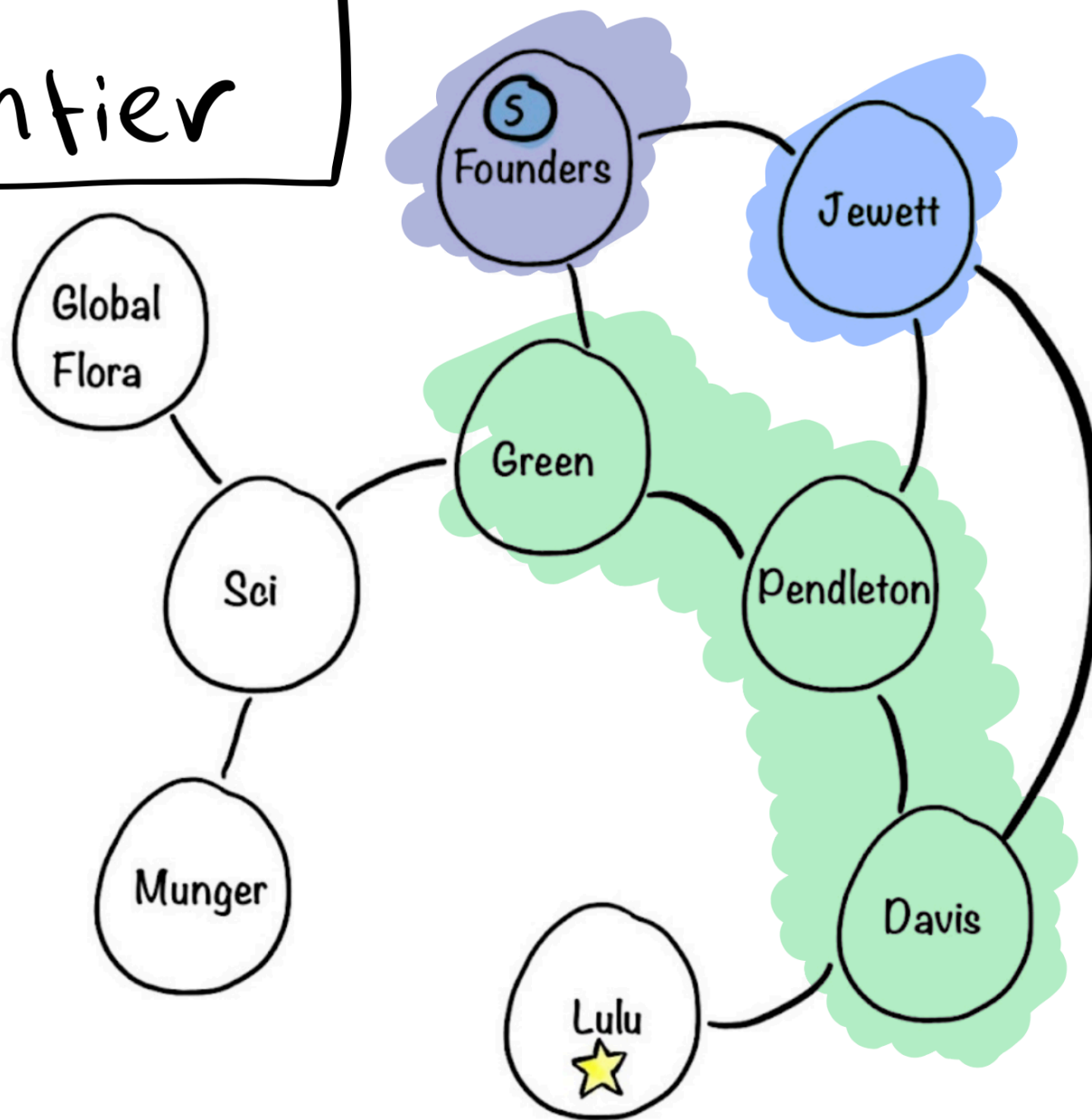
Frontier = 

Current Node = 

Choose leaf node from frontier for expansion according to the **search strategy**

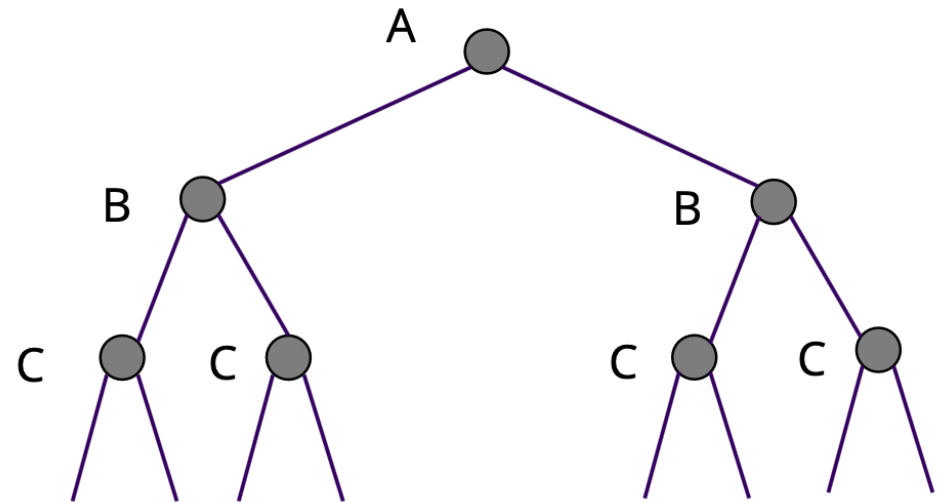
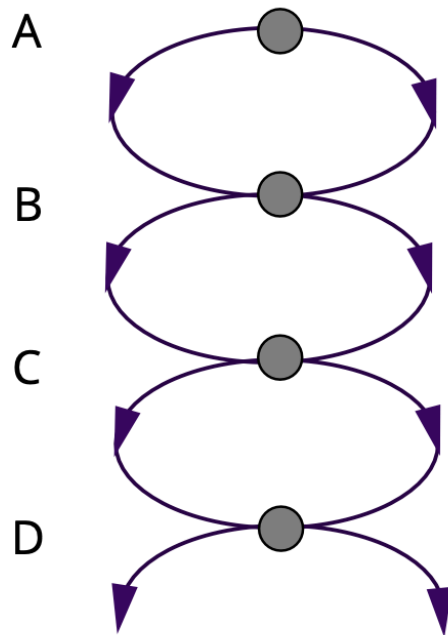
Determines the search process

The Frontier



Problem: Repeated states

Failure to detect *repeated states* can turn a linear problem into an *exponential* one!



Uninformed Search

ANY: Shadow Self

ANY: Shadow Self

What does Harding say about how to define the term *AI*?

ANY: Shadow Self

Harding writes: "*STEM skills are extremely important to our future health and prosperity but so are disciplines such as art, literature, philosophy, and history. These are just as critical to the future of technology and to the future of humanity.*"

As a liberal arts student, what are some ways that you've sought out experiences in art, literature, philosophy, and history to balance your STEM coursework?

ANY: Shadow Self

Uninformed Search

Uses only information available in problem definition

Informally:

Uninformed search: All non-goal nodes in frontier look equally good

Informed search: Some non-goal nodes can be ranked above others.