

Artificial Intelligence

CSC 665

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Administrivia

- Who in this room is not enrolled?
- Office hours are in effect: before class on Tuesdays, after class on Thursdays @ Thornton 434
- Homework 0 due tomorrow at 11:59 pm — earn extra credit and calibrate your level of preparation
- All homeworks can be submitted up to 5 days late, with a 10% penalty per day
- You get one late waiver during the semester to apply (retroactively) to any late homework, eliminating the late penalty
- Midterms are in-person and cannot be made up

Search I

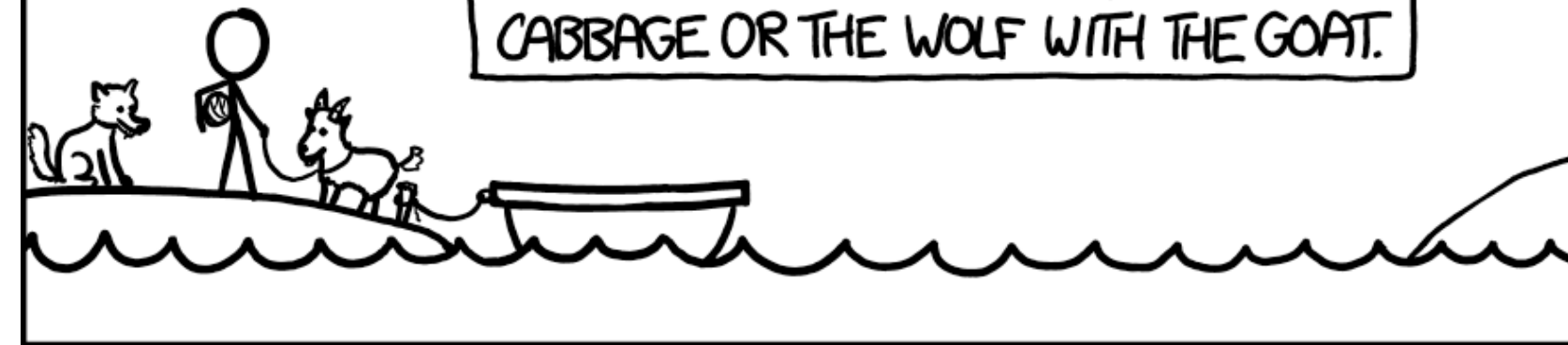
2.6.2024

- **Search:** make decisions by looking ahead
- **Logic:** deduce new facts from existing facts
- **Constraints:** find a way to satisfy a given specification
- **Probability:** reason quantitatively about uncertainty
- **Learning:** make future predictions from past observations

Goat example

PROBLEM:

THE BOAT ONLY HOLDS TWO, BUT YOU CAN'T LEAVE THE GOAT WITH THE CABBAGE OR THE WOLF WITH THE GOAT.



SOLUTION:

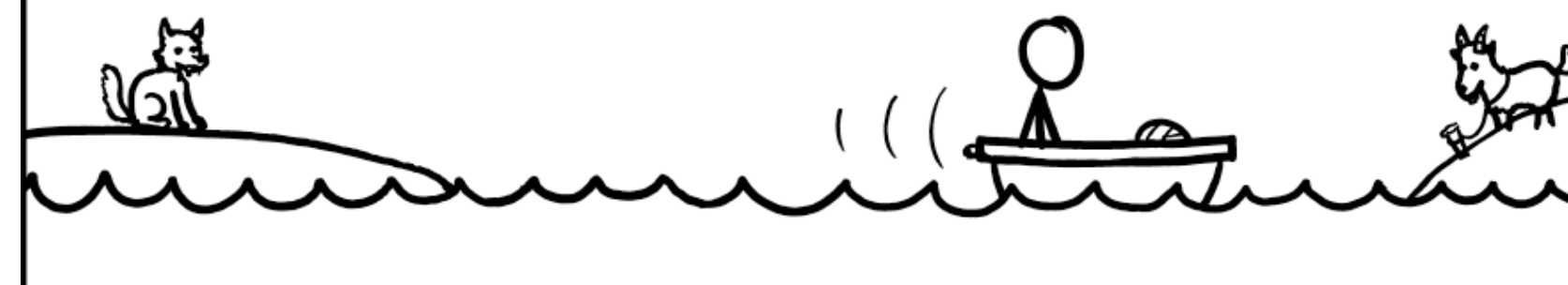
1. TAKE THE GOAT ACROSS.



2. RETURN ALONE.

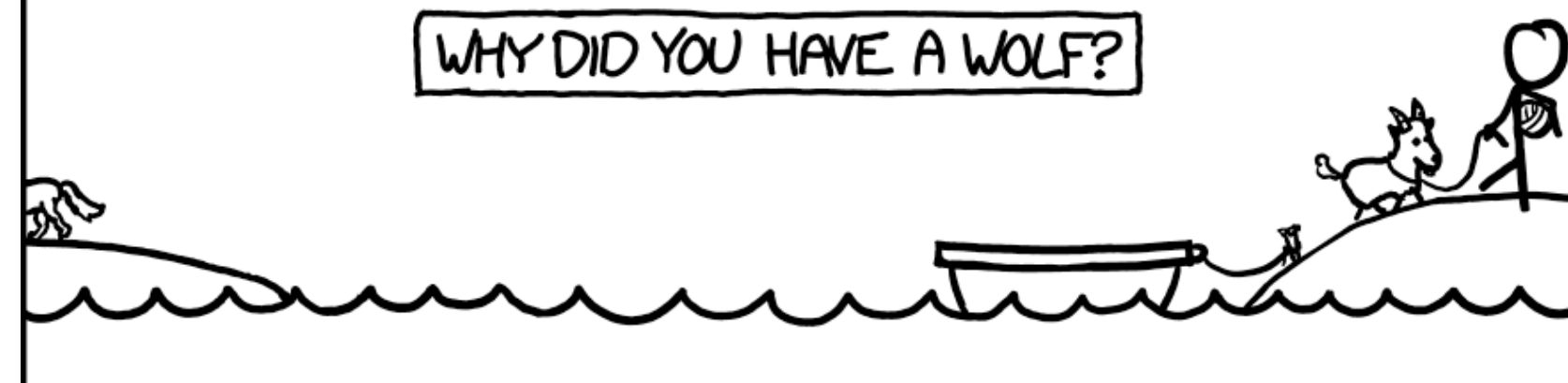


3. TAKE THE CABBAGE ACROSS.

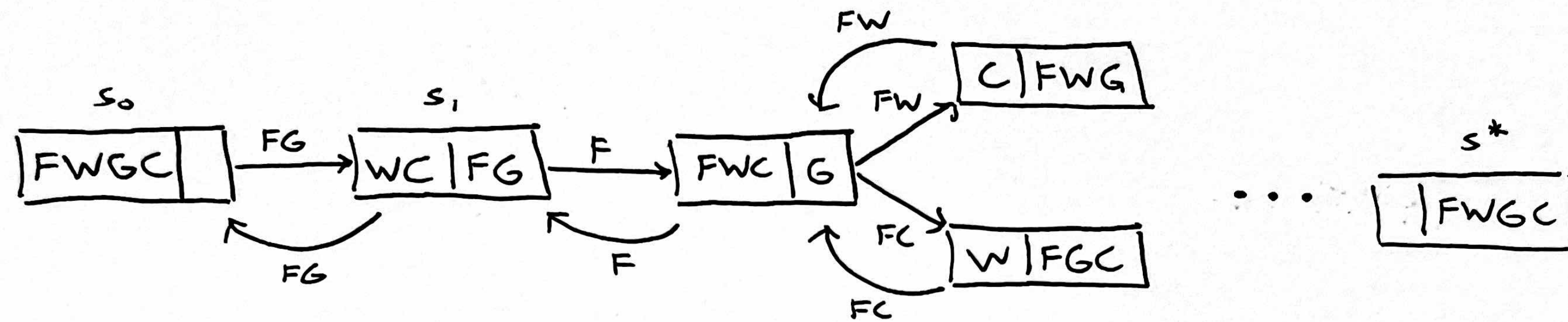


4. LEAVE THE WOLF.

WHY DID YOU HAVE A WOLF?



[search tree for goat problem on board]



$$\text{Actions}(s_0) = \{FG\}$$

$$\text{Succ}(s_0, FG) = s_1 = WC|FG$$

$$\text{Actions}(s_1) = \{F, FG\}$$

$$\text{Succ}(s_1, FG) = s_0 = FWGC|$$

$$\text{Succ}(s_1, F) = FWC|G$$

$$\text{Cost}(s, a) = 1 \quad \forall s, a$$

$$\text{IsEnd}(s) = \begin{cases} \text{True} & \text{if } s = s^* \\ \text{False} & \text{otherwise} \end{cases}$$

Modeling

Modeling a search problem

Start state: s_0

Possible actions: $\text{Actions}(s)$

Action cost: $\text{Cost}(s, a)$

Transition model: $\text{Succ}(s, a)$

Goal test: $\text{IsEnd}(s)$

Modeling a search problem

Start state: $s_0 \in S$

Possible actions: $\text{Actions}(s) \subseteq A$

Action cost: $\text{Cost}(s, a) \in \mathbb{R}_{\geq 0}$

Transition model: $\text{Succ}(s, a) \in S$

Goal test: $\text{IsEnd}(s) \in \{\text{True}, \text{False}\}$

state space S , action set A , non-negative real numbers $\mathbb{R}_{\geq 0}$

Search graph

- The functions of the search problem induce a **graph**
- **Nodes** are states in S
- There is a **directed edge** $s \rightarrow s'$ if $\text{Succ}(s, a) = s'$ for some action $a \in \text{Actions}(s)$
- **Edges are labeled** with the costs given by $\text{Cost}(s, a)$
- **Goal nodes** are determined by $\text{IsEnd}(s)$

[live coding: modeling search]

Inference

The inference problem

Given: a search graph

Find: a minimum cost path from start to finish in the graph

Backtracking search

Global state: minimum cost path, set of explored (node, cost) pairs

function search(s , path) :

- **if** IsEnd(s) :
 - update the minimum cost path
- **for each** action $a \in \text{Actions}(s)$:
 - **if** Succ(s, a) hasn't been explored at Cost(s, a) yet:
 - add (Succ(s, a), Cost(s, a)) to the explored set
 - extend path with Succ(s, a) and Cost(s, a)
 - recurse: search(Succ(s, a), path)