SAPIENZA
UNIVERSITÀ DI ROMA

Artificial Intelligence I

2017/2018 Prof: Daniele Nardi

Exercises 2:

Search in the State Space*

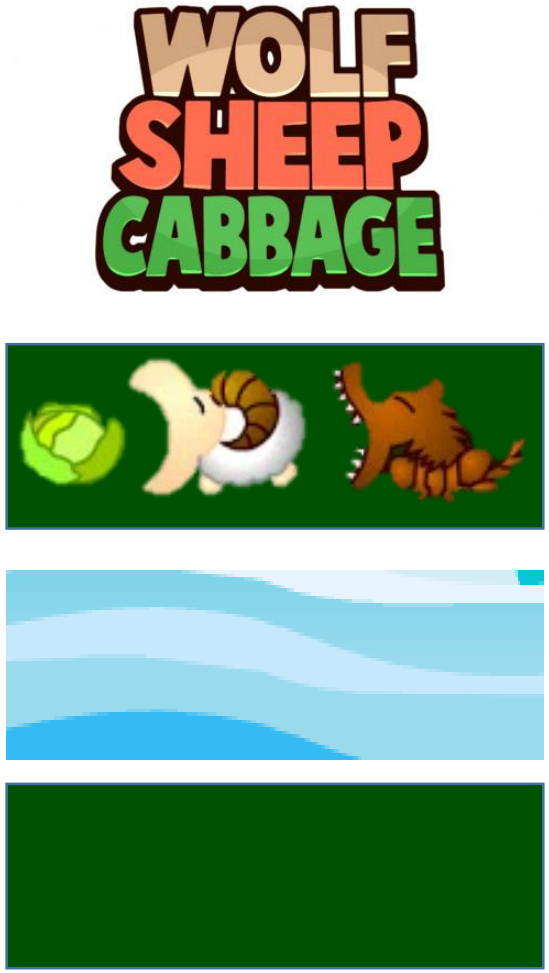
Solutions

Francesco Riccio
email: riccio@diag.uniroma1.it

*The slides have been prepared using the textbook material available on the web, and the slides of the previous editions of the course by Prof. Luigia Carlucci Aiello, Prof. Daniele Nardi, Dott. Fabio Previtali and Andrea Vanzo.

Example: Crossing the river

A man has a **wolf**, a **sheep** and a **cabbage**. He is on a river bench with a **boat**, whose maximum **load** for a single trip is the man **plus one of his 3 goods**. The man wants to cross the river with his goods, but he must avoid that - when he is far away - **the wolf eats the sheep** and that, **the sheep eats the cabbage**. How can the man reach is goal?



1. Characterize the **state space**
2. Specify the **operators**
3. Find a minimal sequence of moves to **solve the problem**
4. Find a good **heuristics** to be used by A∗
5. Draw the **search tree generated by A∗**. For each node indicate: the number (state), *f*, *g*, and *h* and an integer indicating the expansion order

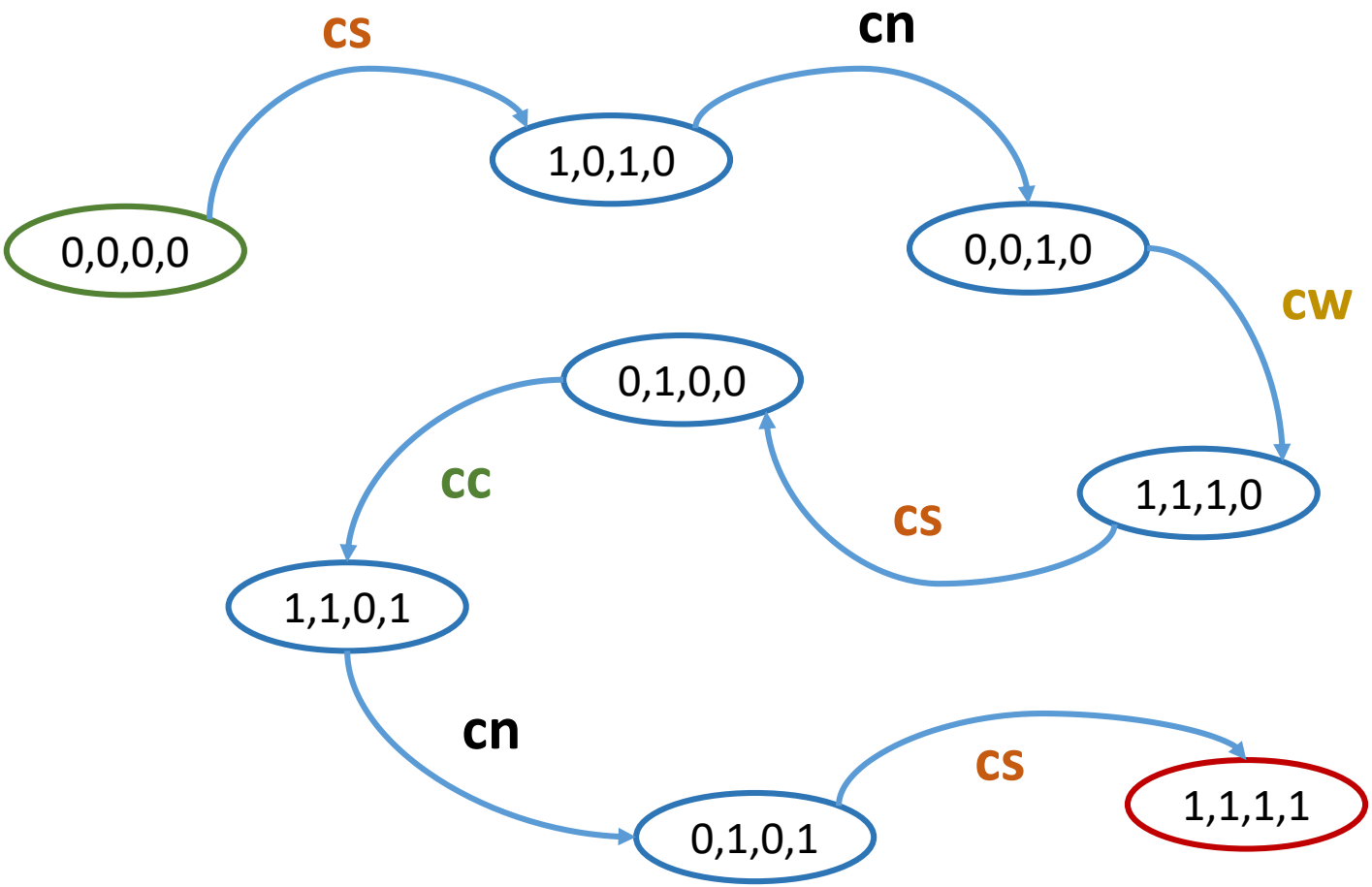
State space

A man has a **wolf**, a **sheep** and a **cabbage**. He is on a river bench with a **boat**, whose maximum **load** for a single trip is the man **plus one of his 3 goods**. The man wants to cross the river with his goods, but he must avoid that - when he is far away - **the wolf eats the sheep** and that, **the sheep eats the cabbage**. How can the man reach is goal?

1. Characterize the **state space**

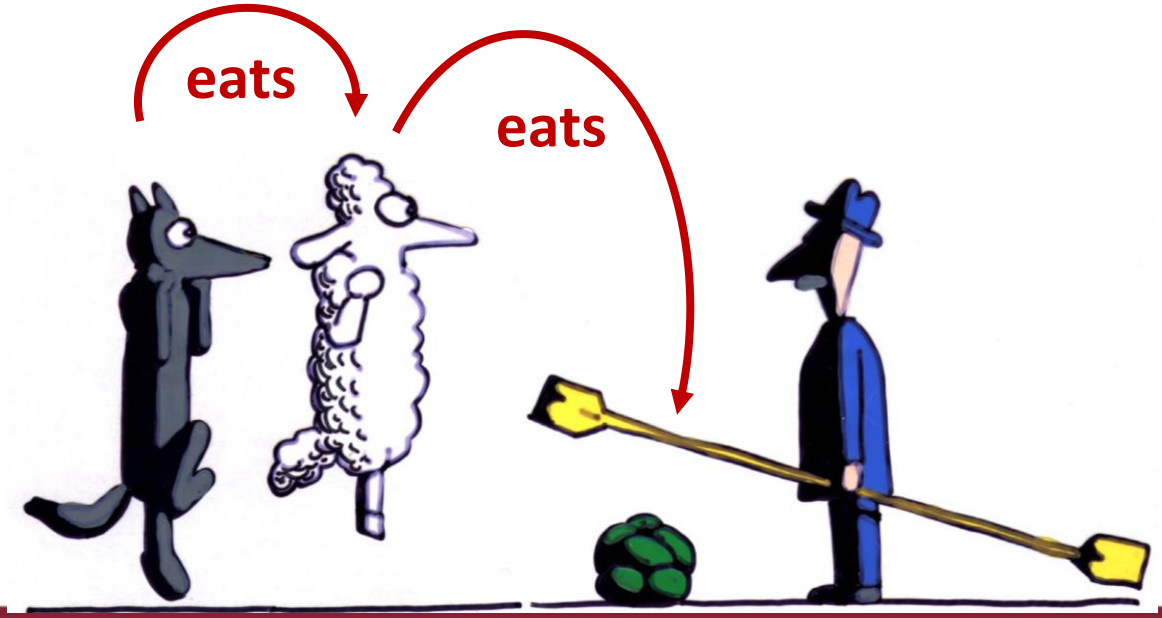
- Let $S = D \text{ x } D \text{ x } D \text{ x } D$ where $D = \{0,1\}$ and *0* and *1* are represent the river benches
- $\langle M, W, S, C \rangle \in S$ represents the position of the man, the wolf, the sheep and the cabbage
- **Initial state**: $\langle 0,0,0,0 \rangle$, and **Goal state**: $\langle 1,1,1,1 \rangle$

Possible solution



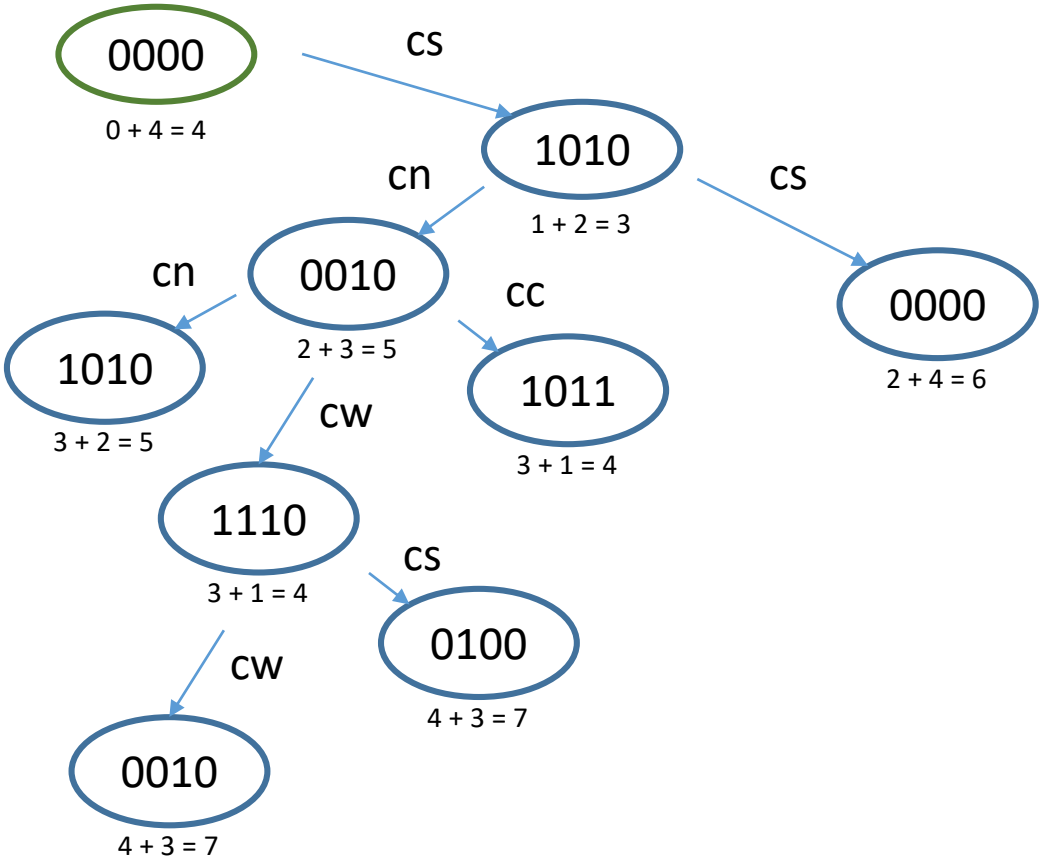
Operators

Name	Conditions	from State	to State
carryNothing (cn)	$W \neq S, S \neq C$	$\langle M, W, S, C \rangle$	$\langle \bar{M}, W, S, C \rangle$
carryWolf (cw)	$M = W, S \neq C$	$\langle M, W, S, C \rangle$	$\langle \bar{M}, \bar{W}, S, C \rangle$
carrySheep(cs)	$M = S$	$\langle M, W, S, C \rangle$	$\langle \bar{M}, W, \bar{S}, C \rangle$
carryCabbage(cc)	$M = C, W \neq S$	$\langle M, W, S, C \rangle$	$\langle \bar{M}, W, S, \bar{C} \rangle$



Heuristics & A*

cost = 1 for each trip, $h(s) = |4 - M - W - S - C|$



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