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Some Example Problems

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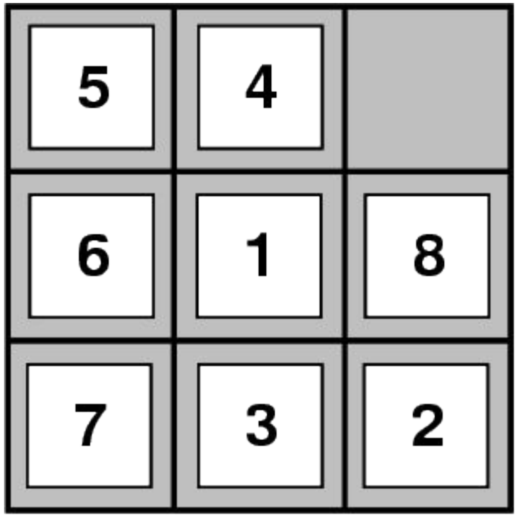
Some example problems

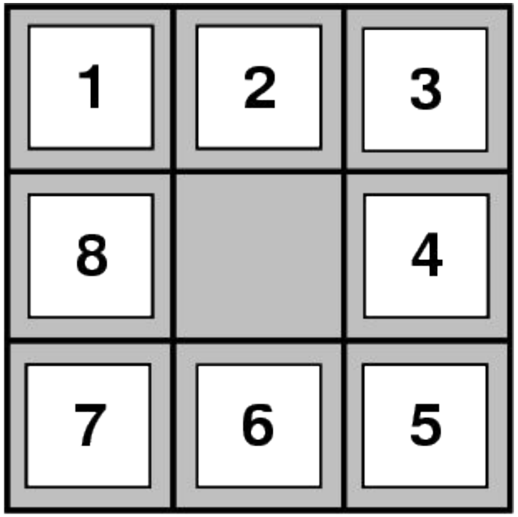
- Toy problems and micro-worlds
  - 8-Puzzle
  - Missionaries and Cannibals
  - Cryptarithmetic
  - Remove 5 Sticks
  - Water Jug Problem
  - Black and White tiles
- Real-world problems

8-Puzzle

Given an initial configuration of 8 numbered tiles on a 3 x 3 board, move the tiles in such a way so as to produce a desired goal configuration of the tiles.



Start State



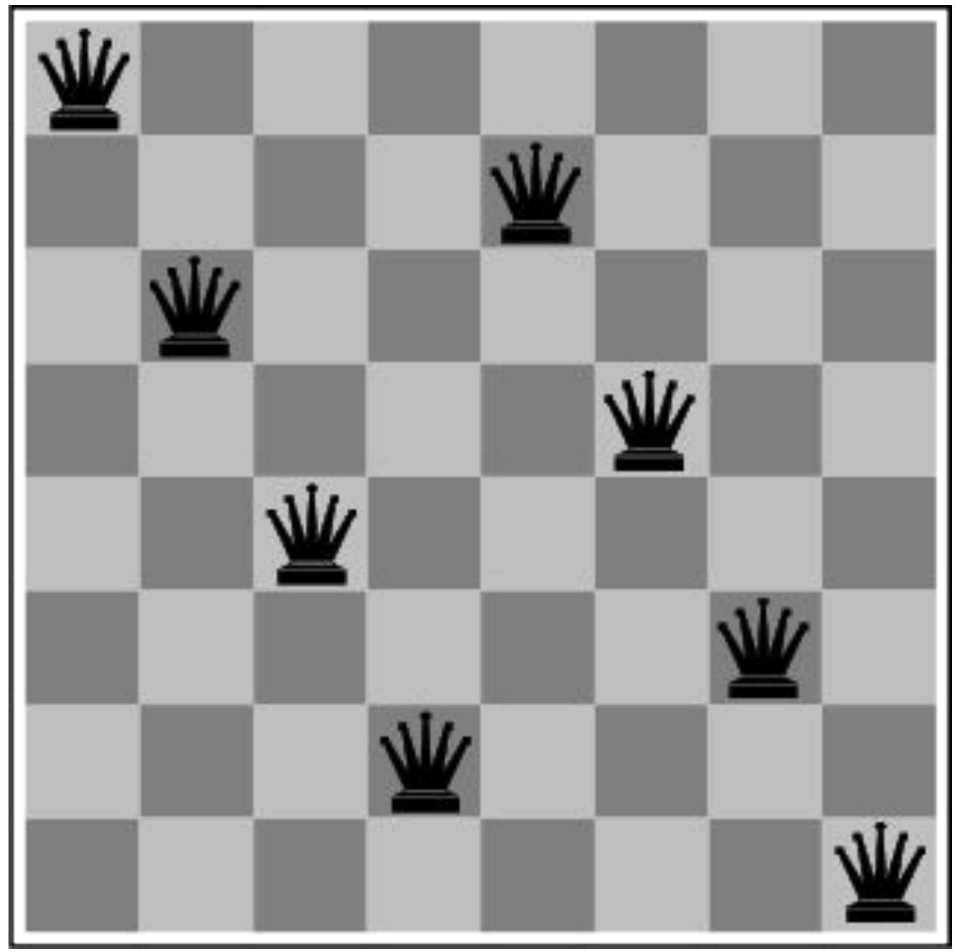
Goal State

8 puzzle

- **State:** 3 x 3 array configuration of the tiles on the board.
- **Operators:** Move Blank Square Left, Right, Up or Down.
  - This is a more efficient encoding of the operators than one in which each of four possible moves for each of the 8 distinct tiles is used.
- **Initial State:** A particular configuration of the board.
- **Goal:** A particular configuration of the board.

The 8-Queens Problem

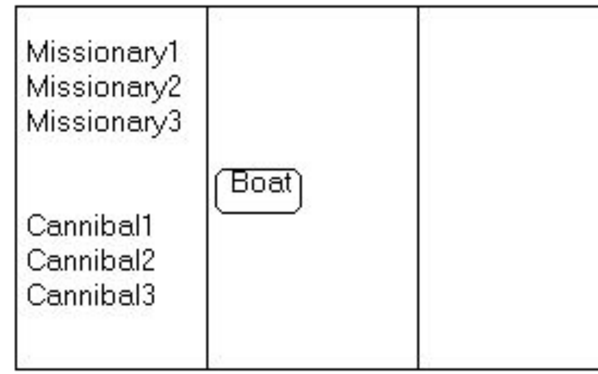
Place eight queens on a chessboard such that no queen attacks any other!



Missionaries and Cannibals

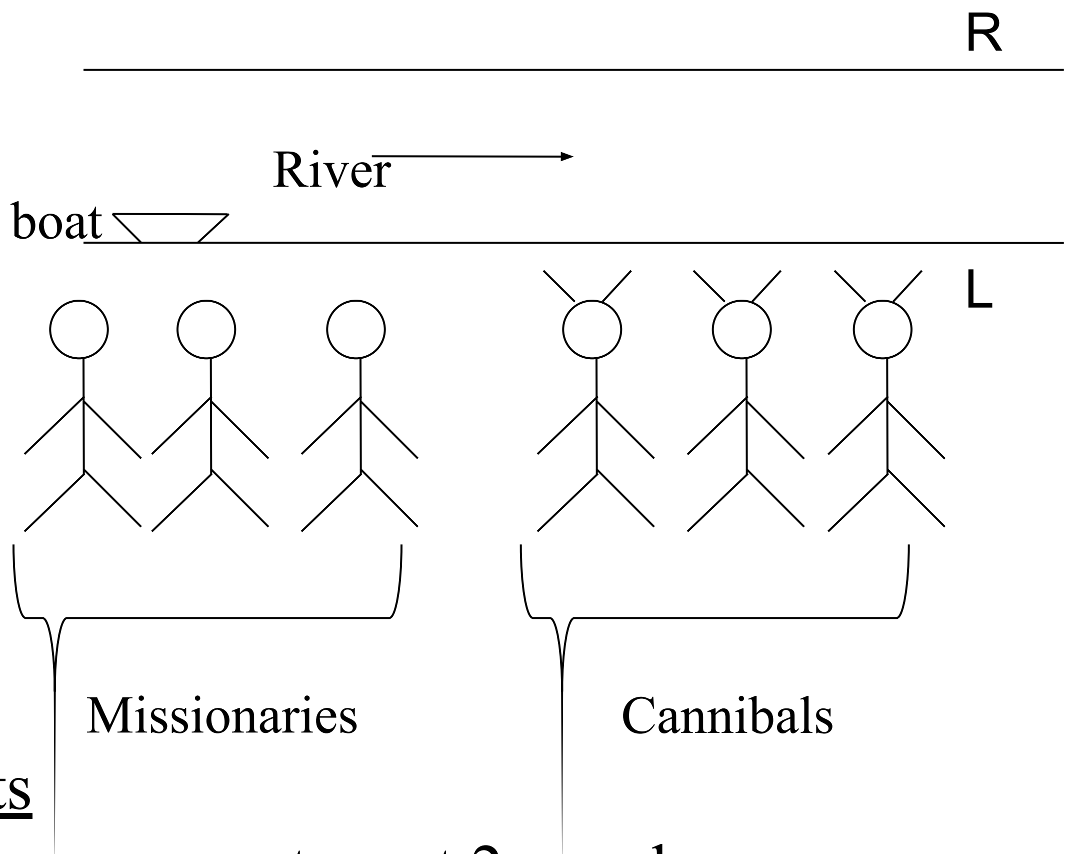
There are 3 missionaries, 3 cannibals, and 1 boat that can carry up to two people on one side of a river.

- **Goal**: Move all the missionaries and cannibals across the river.
- **Constraint:** Missionaries can never be outnumbered by cannibals on either side of river, or else the missionaries are killed.
- **State:** configuration of missionaries and cannibals and boat on each side of river.
- **Operators:** Move boat containing some set of occupants across the river (in either direction) to the other side.



3 Missionaries and 3 Cannibals wish to cross the river. They have a boat that will carry two people. Everyone can navigatethe boat. If at any time the Cannibals outnumber the missionaries on either bank of the river, they will eat the Missionaries. Find the smallest number of crossings that will allow everyone to cross the river safely.
The problem can be solved in 11 moves. But people rarely get the optimal solution, because the MC problem contains a 'tricky' state at the end, where two people move back across the river.

Problem 2: Missionaries and Cannibals



<u>Constraints</u>

- The boat can carry at most 2 people
- On no bank should the cannibals outnumber the missionaries

Missionaries and Cannibals Solution

	Near side	***Far side***
0 Initial setup:	MMMCCC B	-
1 Two cannibals cross over:	MMMC	B CC
2 One comes back:	MMMCC B	C
3 Two cannibals go over again:	MMM	B CCC
4 One comes back:	MMMC B	CC
5 Two missionaries cross:	MC	B MMCC
6 A missionary & cannibal return:	MMCC B	MC
7 Two missionaries cross again:	CC	B MMMC
8 A cannibal returns:	CCC B	MMM
9 Two cannibals cross:	C	B MMMCC
10 One returns:	CC B	MMMC
11 And brings over the third:	-	B MMMCCC

Cryptarithmetic

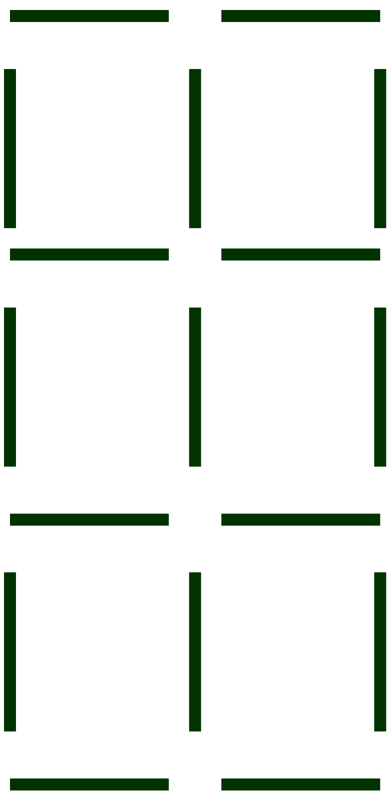
- Find an assignment of digits (0, ..., 9) to letters so that a given arithmetic expression is true. examples: SEND + MORE = MONEY and

```
  FORTY     Solution:  29786
+  TEN                   850
+  TEN              850
  -----              -----
  SIXTY             31486
F=2, O=9, R=7, etc.
```

- Note: In this problem, the solution is NOT a sequence of actions that transforms the initial state into the goal state; rather, the solution is a goal node that includes an assignment of digits to each of the distinct letters in the given problem.

Remove 5 Sticks

- Given the following configuration of sticks, remove exactly 5 sticks in such a way that the remaining configuration forms exactly 3 squares.



Water Jug Problem

Given a full 5-gallon jug and an empty 2-gallon jug, the goal is to fill the 2-gallon jug with exactly one gallon of water.

- State = (x,y), where x is the number of gallons of water in the 5-gallon jug and y is # of gallons in the 2-gallon jug
- Initial State = (5,0)
- Goal State = (*,1), where * means any amount

Operator table

Name	Cond.	Transition	Effect
Empty5	–	$(x,y) \rightarrow (0,y)$	Empty 5-gal. jug
Empty2	–	$(x,y) \rightarrow (x,0)$	Empty 2-gal. jug
2to5	$x \leq 3$	$(x,2) \rightarrow (x+2,0)$	Pour 2-gal. into 5-gal.
5to2	$x \geq 2$	$(x,0) \rightarrow (x-2,2)$	Pour 5-gal. into 2-gal.
5to2part	$y < 2$	$(1,y) \rightarrow (0,y+1)$	Pour partial 5-gal. into 2-gal.

Problem 3

B	B	B	W	W	W	

3 black and 3 white tiles are given in some initial configuration. Aim is to arrange the tiles such that all the white tiles are to the left of all the black tiles. The cost of a translation is 1 and cost of a jump is 2.

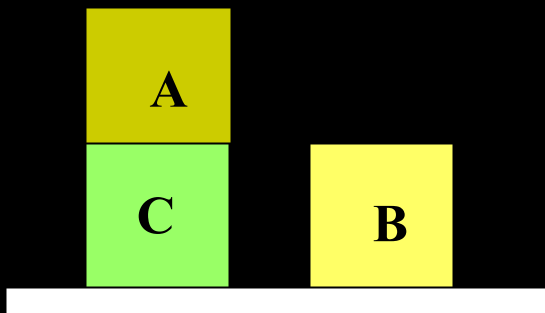
G: States where no **B** is to the left of any **W**

Operators:

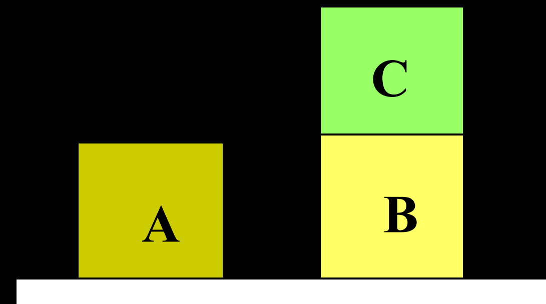
1) A tile jumps over another tile into a blank tile with cost 2
2) A tile translates into a blank space with cost 1

All the three problems mentioned above are to be solved using A*

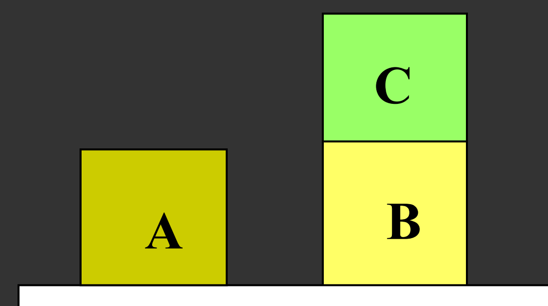
Block world problem :STRIPS



initial state



Goal state



Stato corrente

Some more real-world problems

- Route finding
- Touring (traveling salesman)
- Logistics
- VLSI layout
- Robot navigation
- Learning