

CS 162 Week 5

Kyle Dewey

Overview

- Assignment 2b pain points
- Assignment 3a

Assignment 2b Pain Points

Assignment 3a

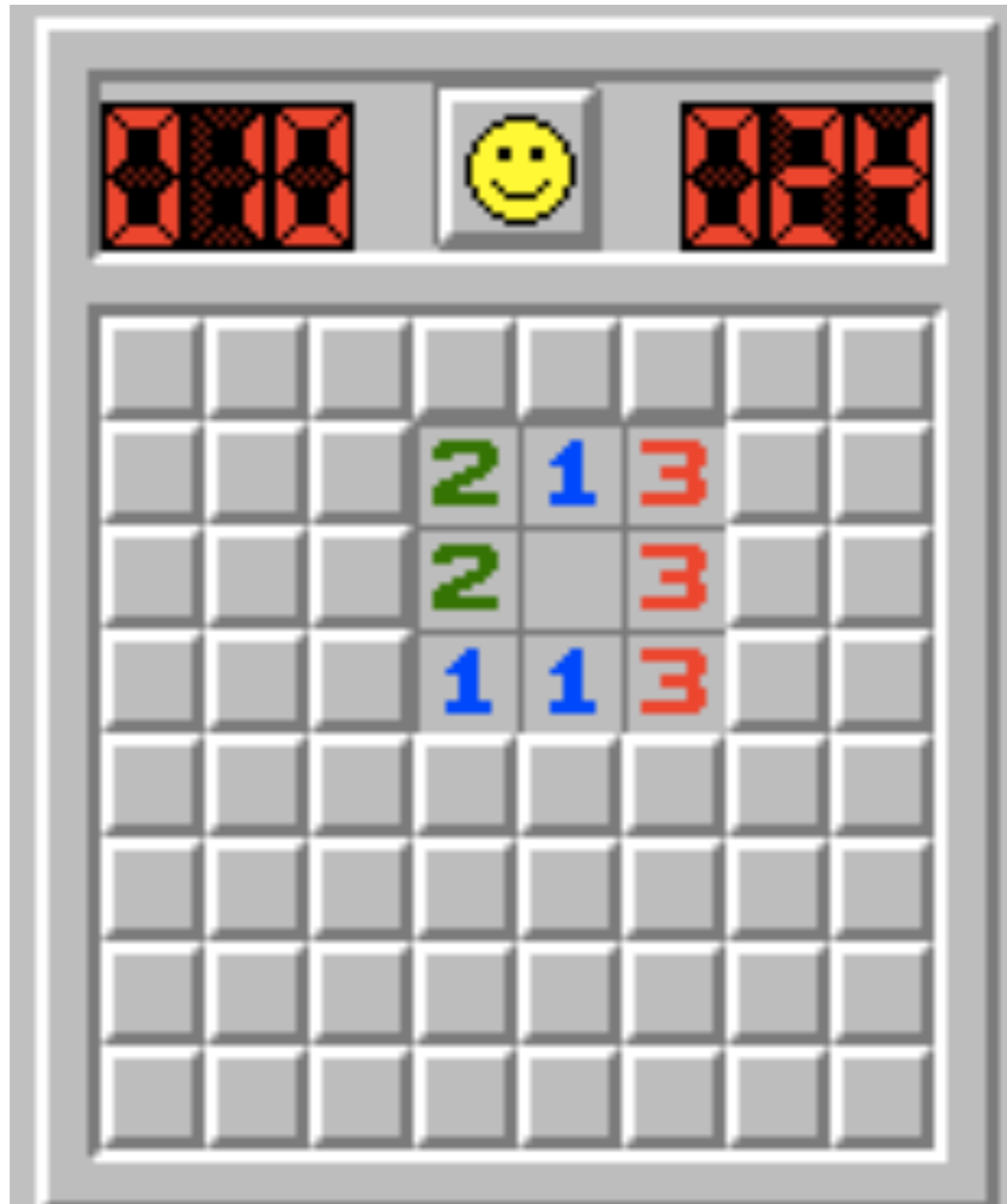
Goal

- Write a Minesweeper solver
- Given a board in some state, infer
 - Which spaces must be mines
 - Which spaces must be clear

Minesweeper

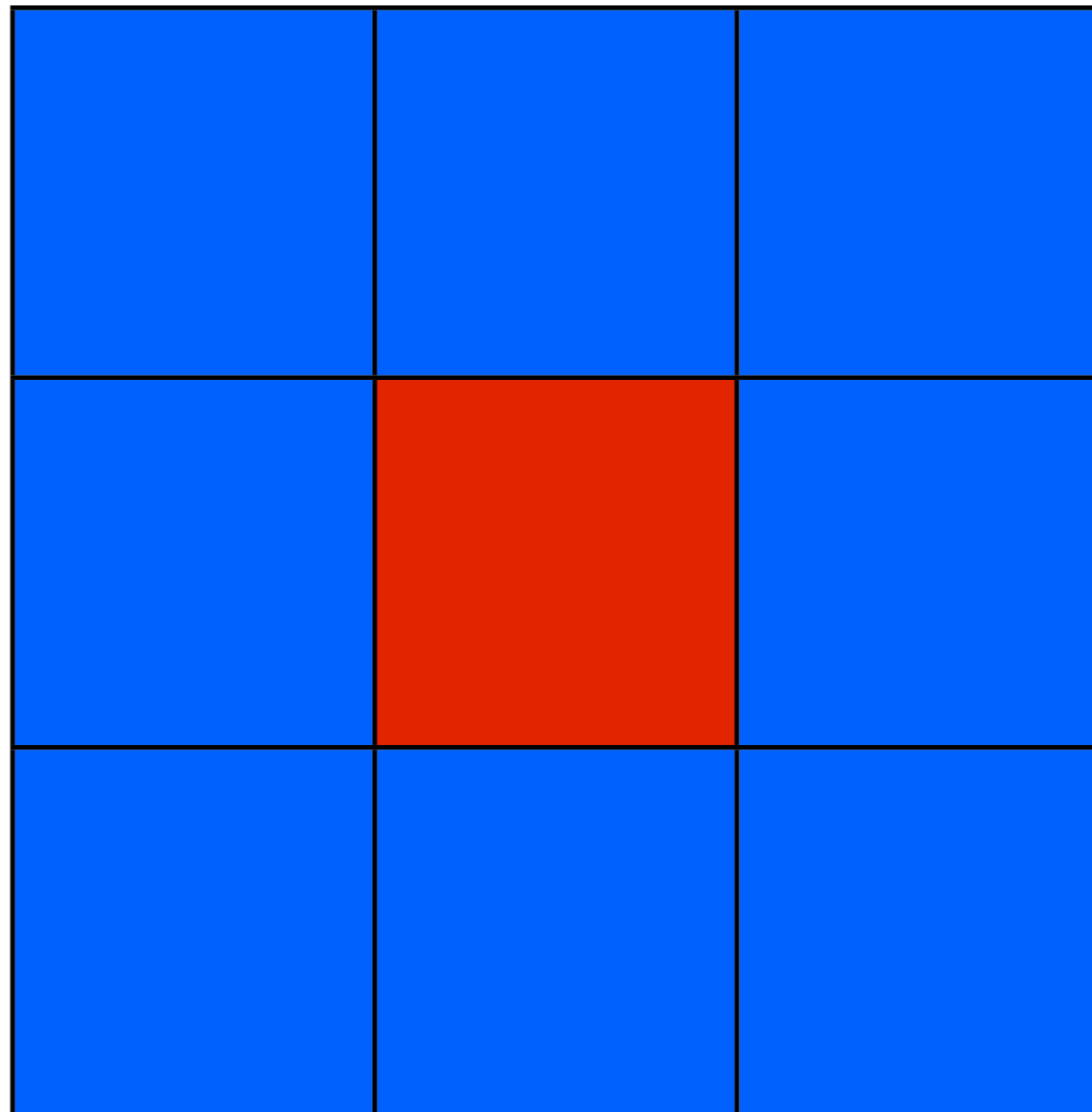
- Grid of initially unrevealed tiles
- Revealing a tile exposes:
 - A mine
 - A blank space
 - A number stating how many mines are adjacent to the revealed tile

Minesweeper



Adjacency

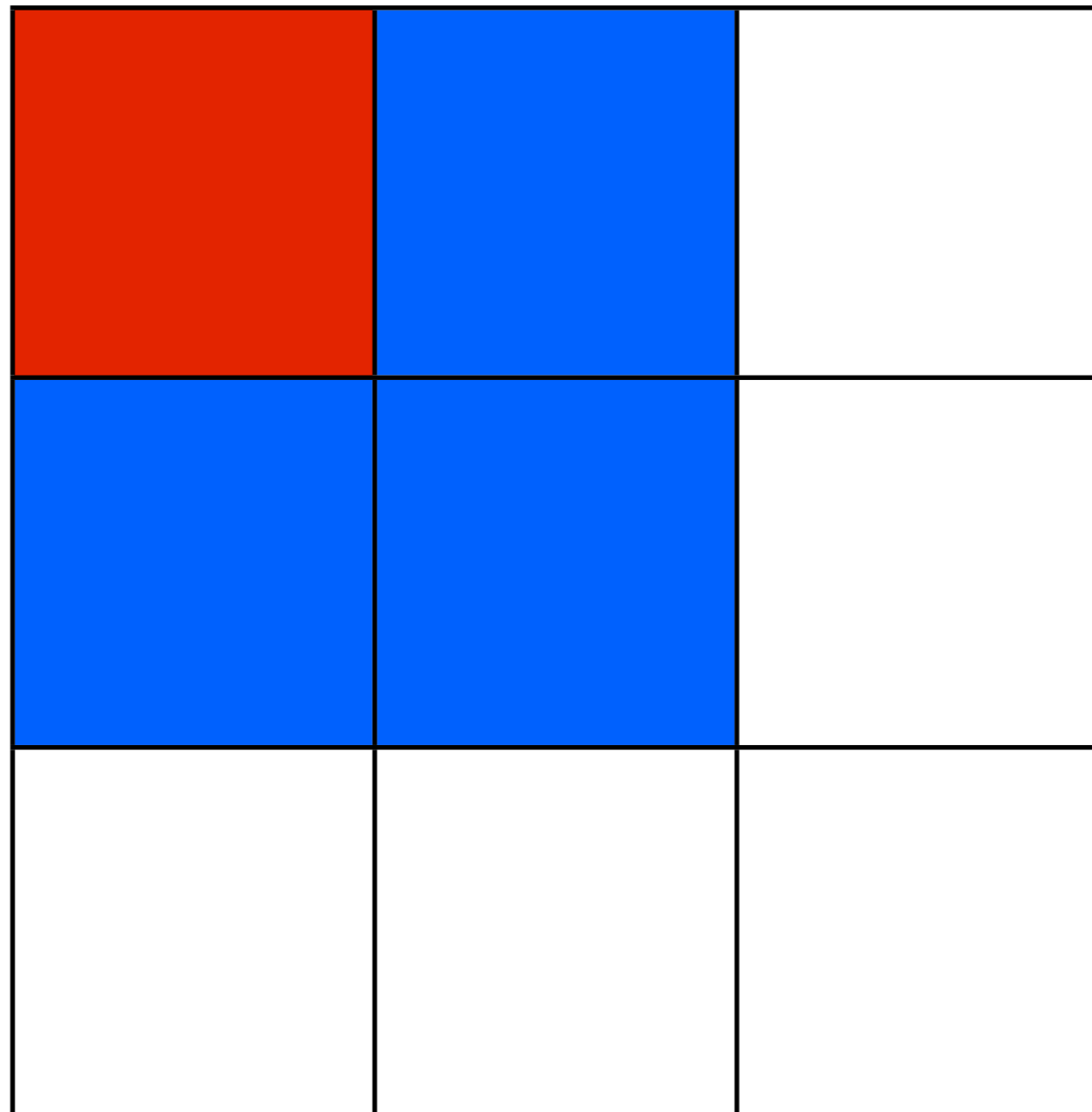
- Based on horizontal, vertical, and both diagonal axes



Blue cells are adjacent to the red cell

Adjacency

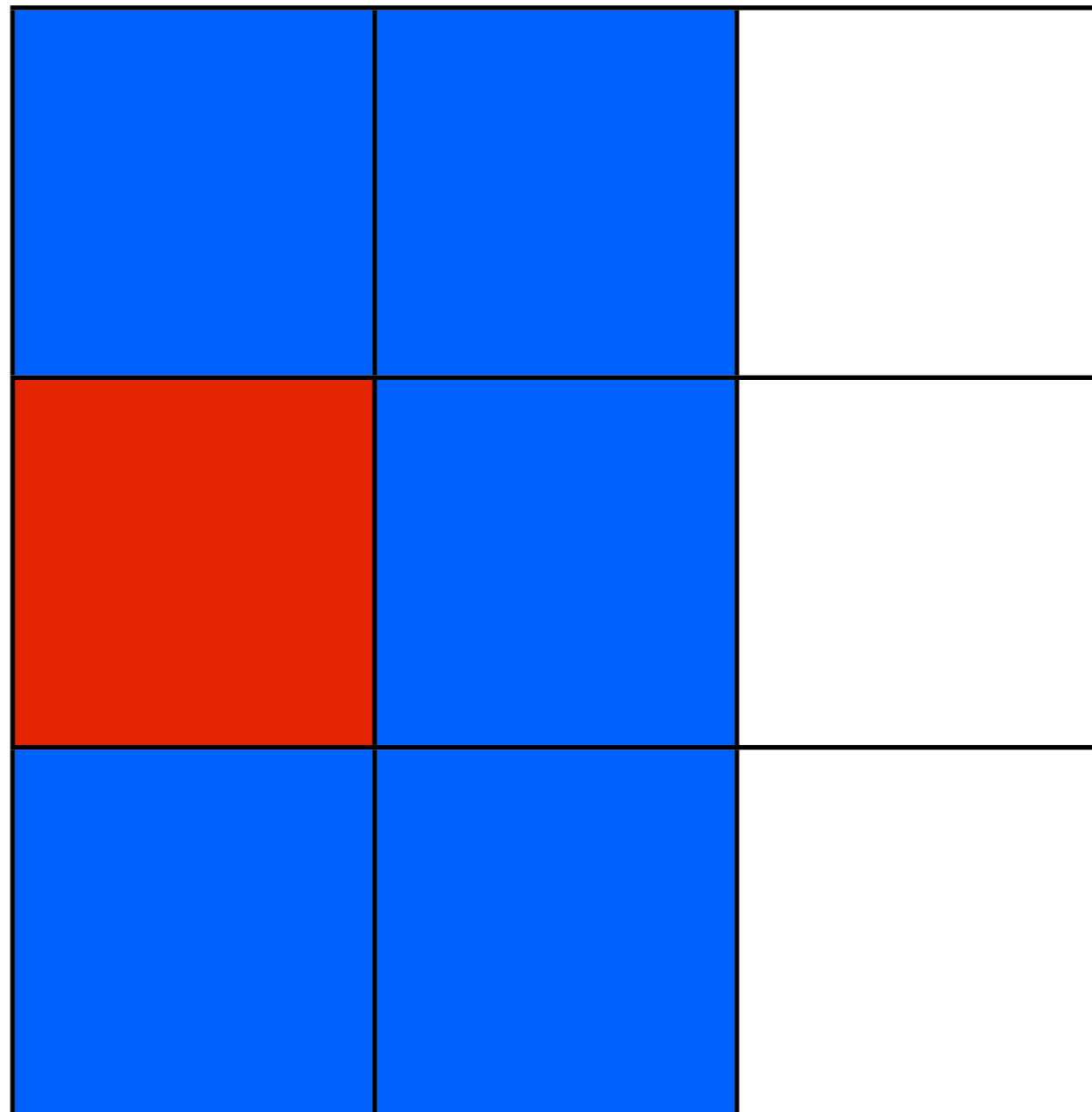
- Based on horizontal, vertical, and both diagonal axes



Blue cells are adjacent to the red cell

Adjacency

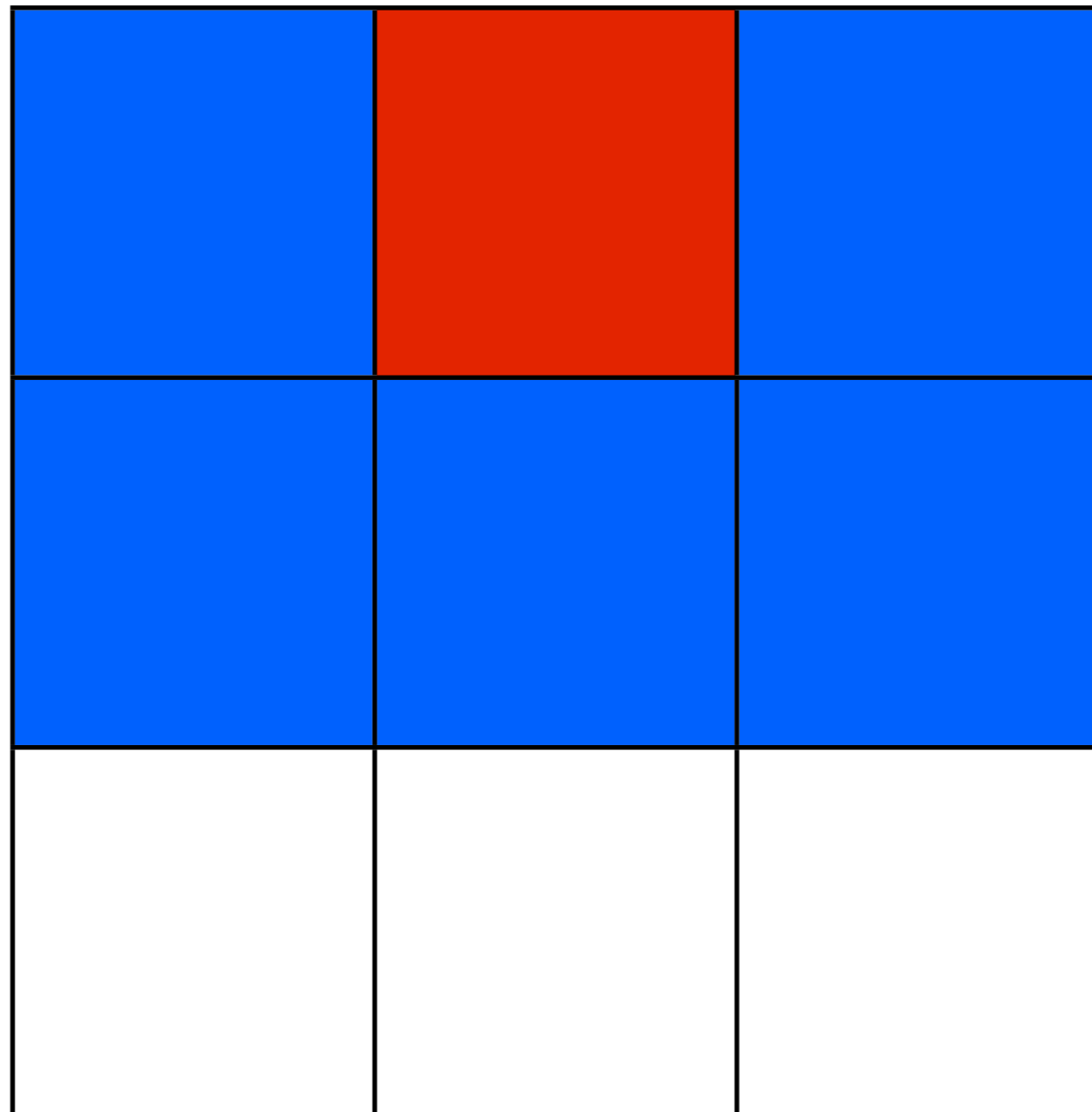
- Based on horizontal, vertical, and both diagonal axes



Blue cells are adjacent to the red cell

Adjacency

- Based on horizontal, vertical, and both diagonal axes



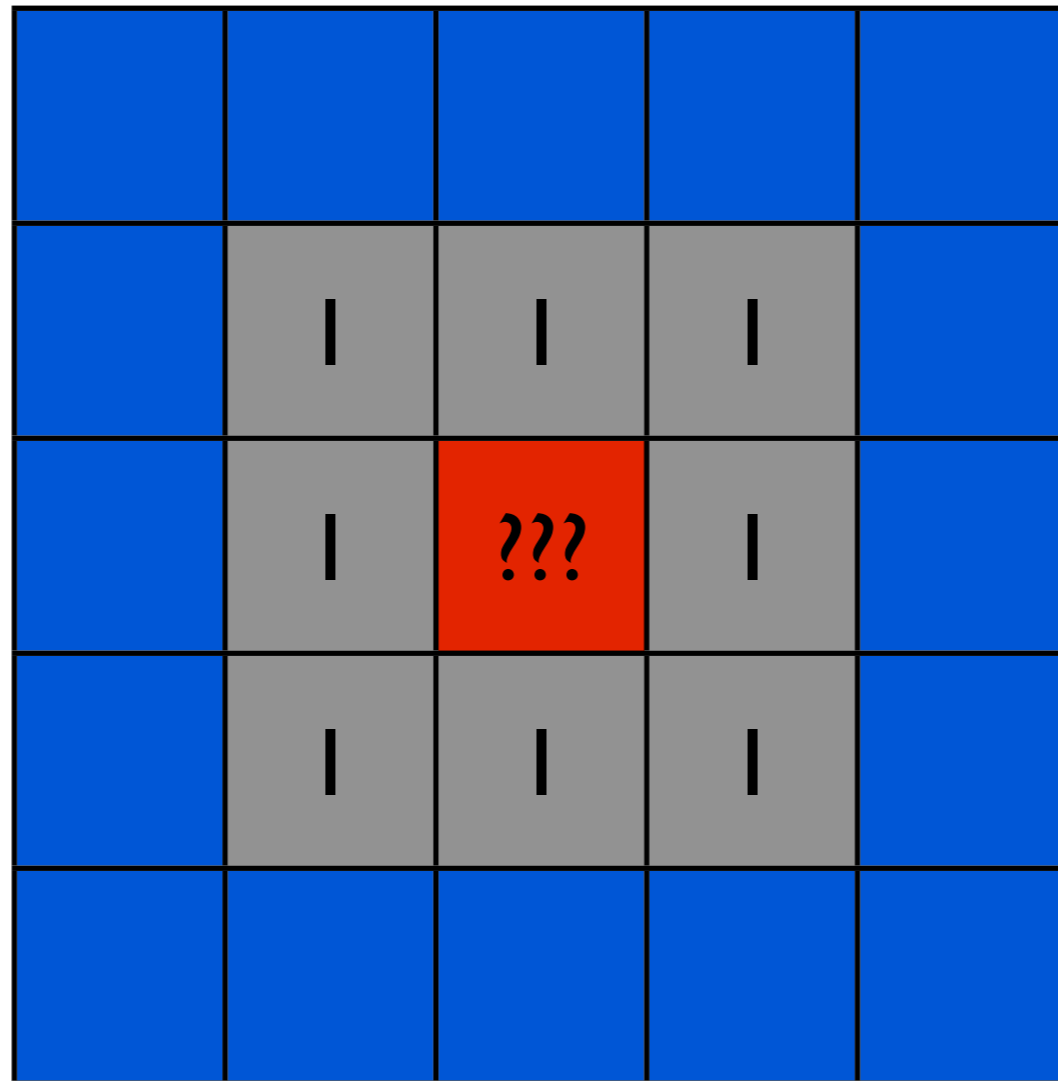
Blue cells are adjacent to the red cell

Success/Failure

- **Success:** all non-mine positions have been uncovered
- **Failure:** a cell containing a mine was uncovered

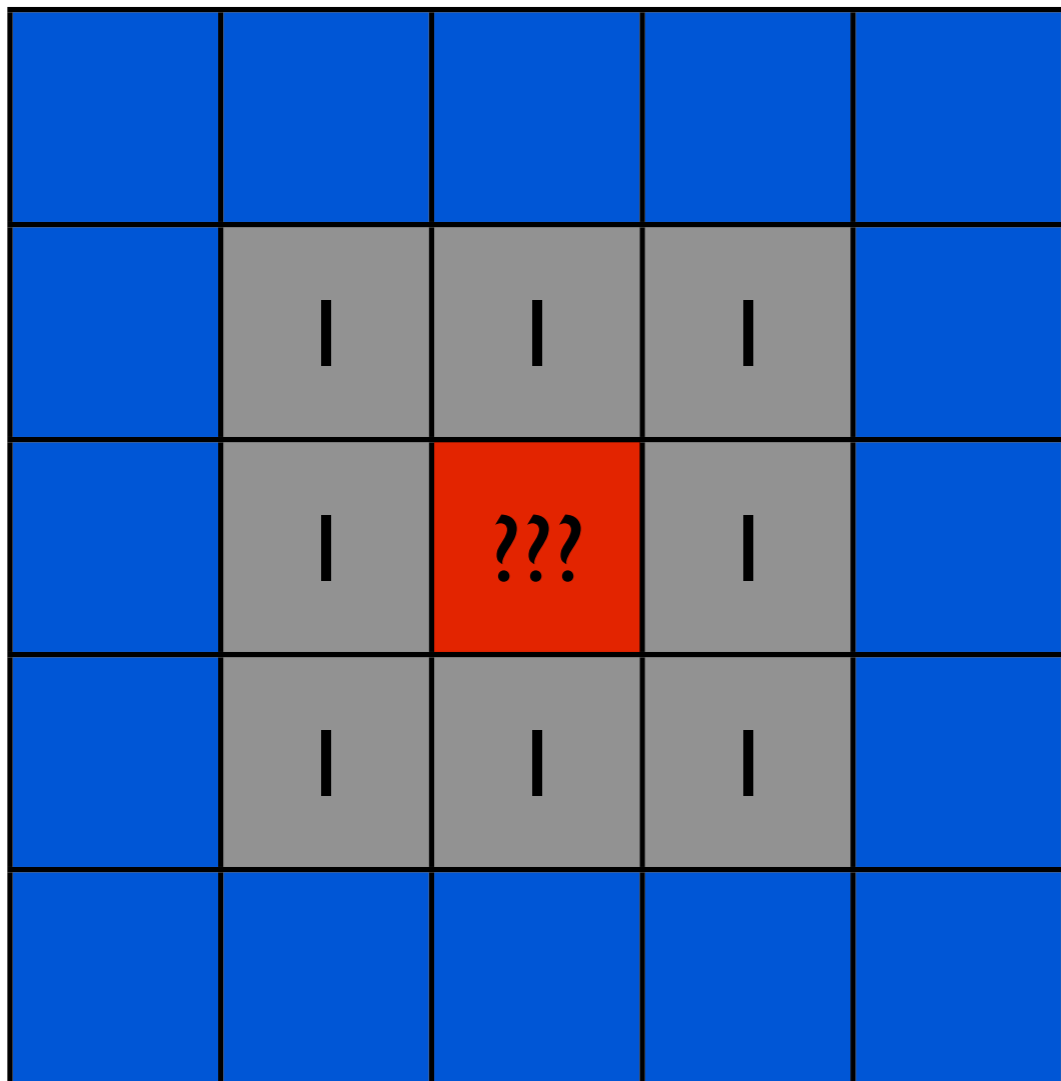
Utilizing Numbers

- In certain cases, it is possible use revealed numbers to reason about mine positions



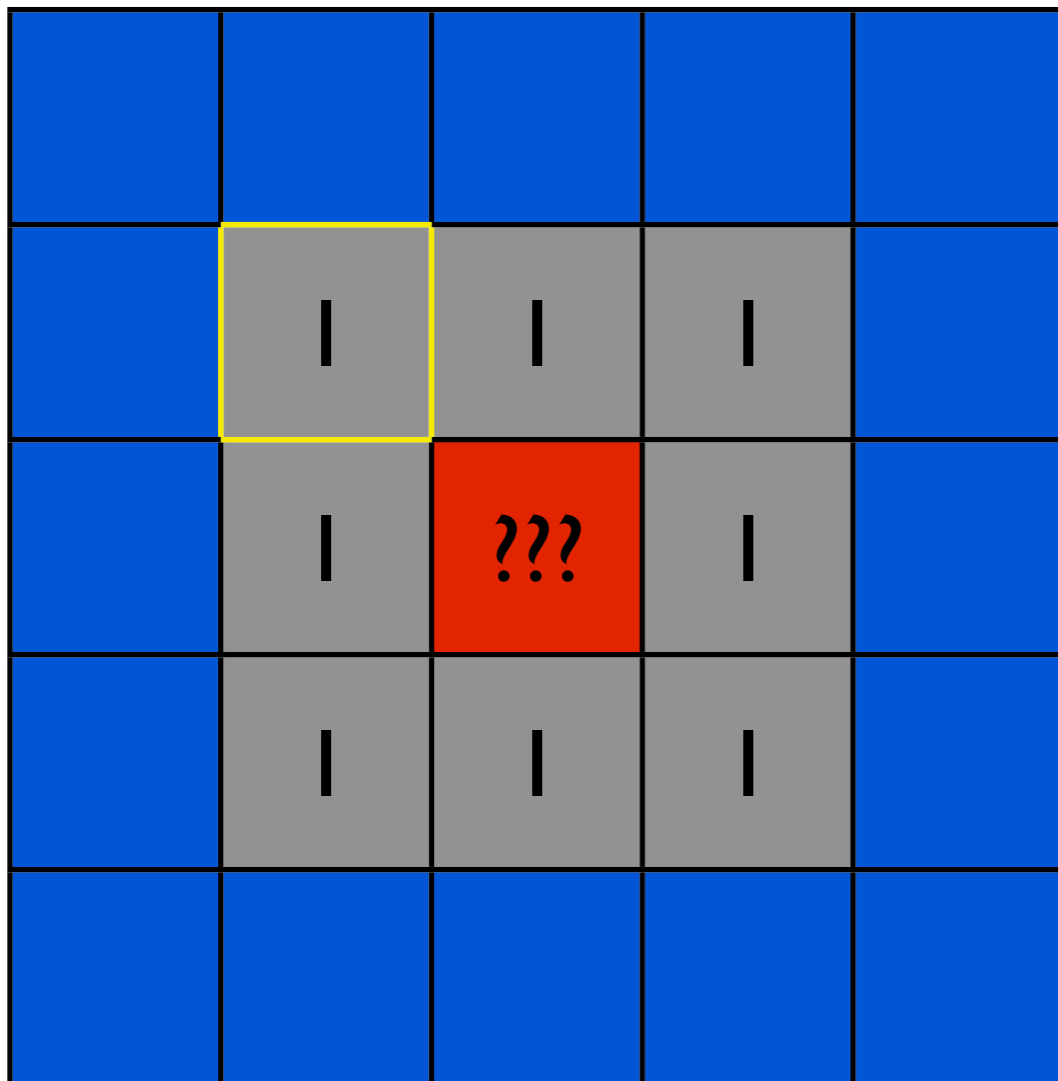
Minesweeper as a CSP

- CSP = constraint satisfaction problem
- For every number N , it must be the case that the sum of the mines in all adjacent cells is equal to N



Minesweeper as a CSP

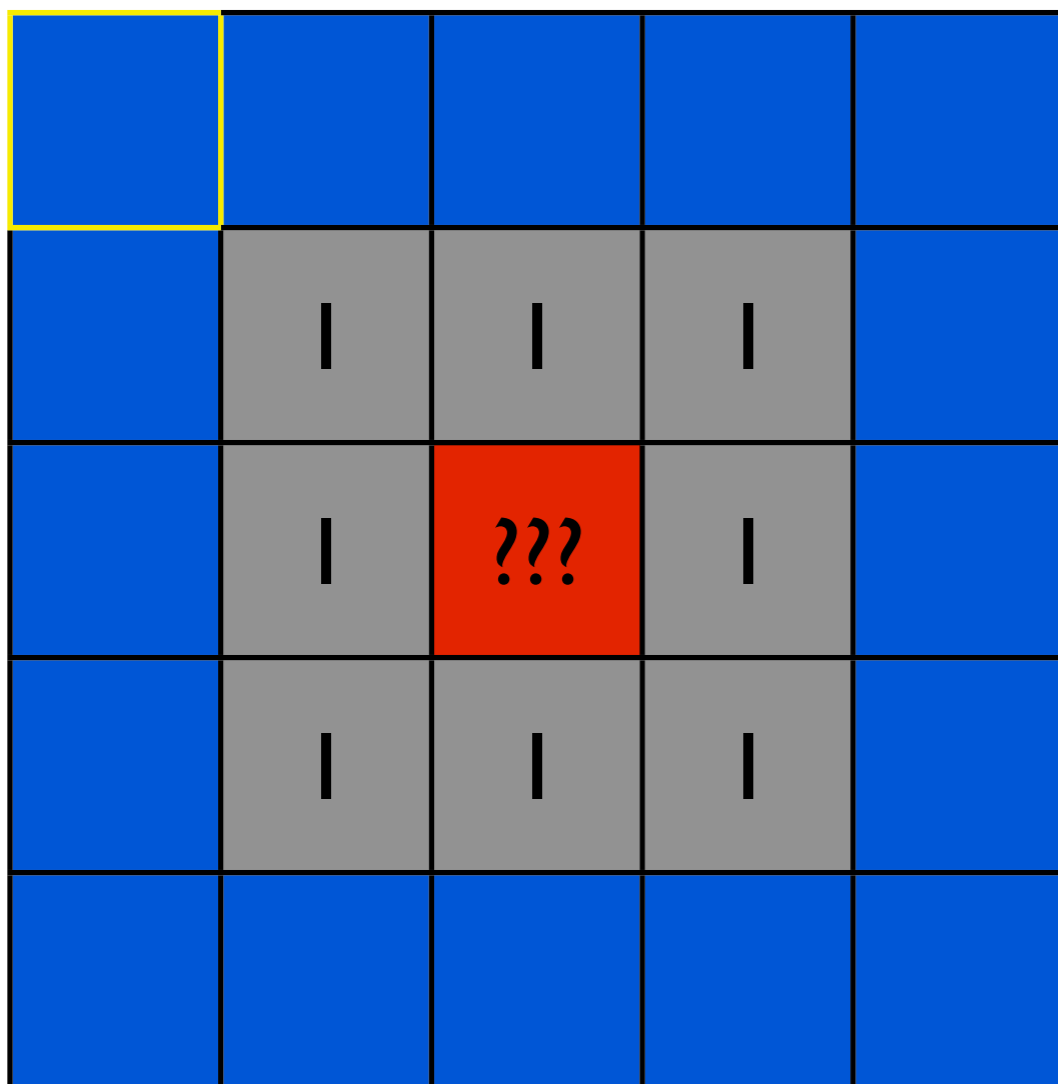
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1 = . . .

Minesweeper as a CSP

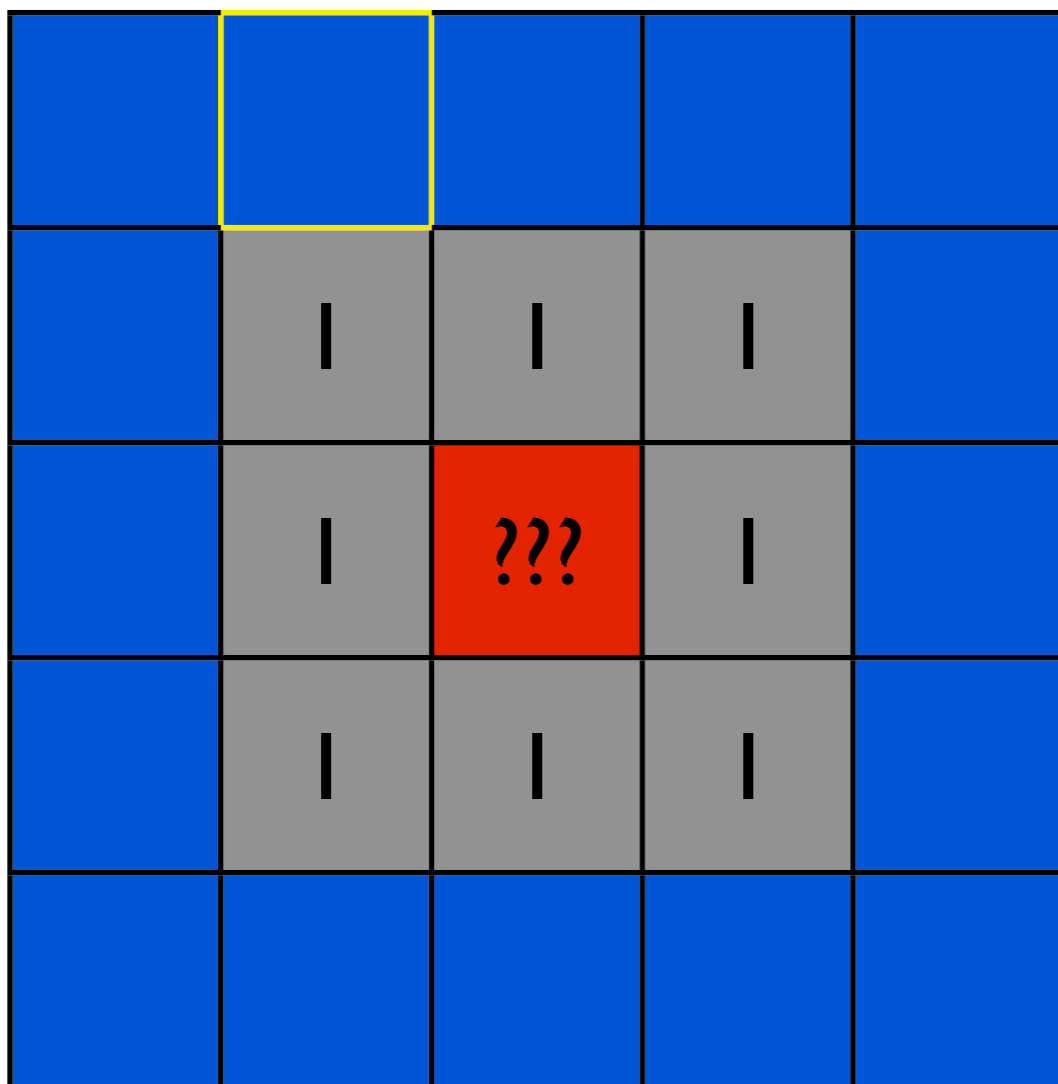
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1 = 0 ...

Minesweeper as a CSP

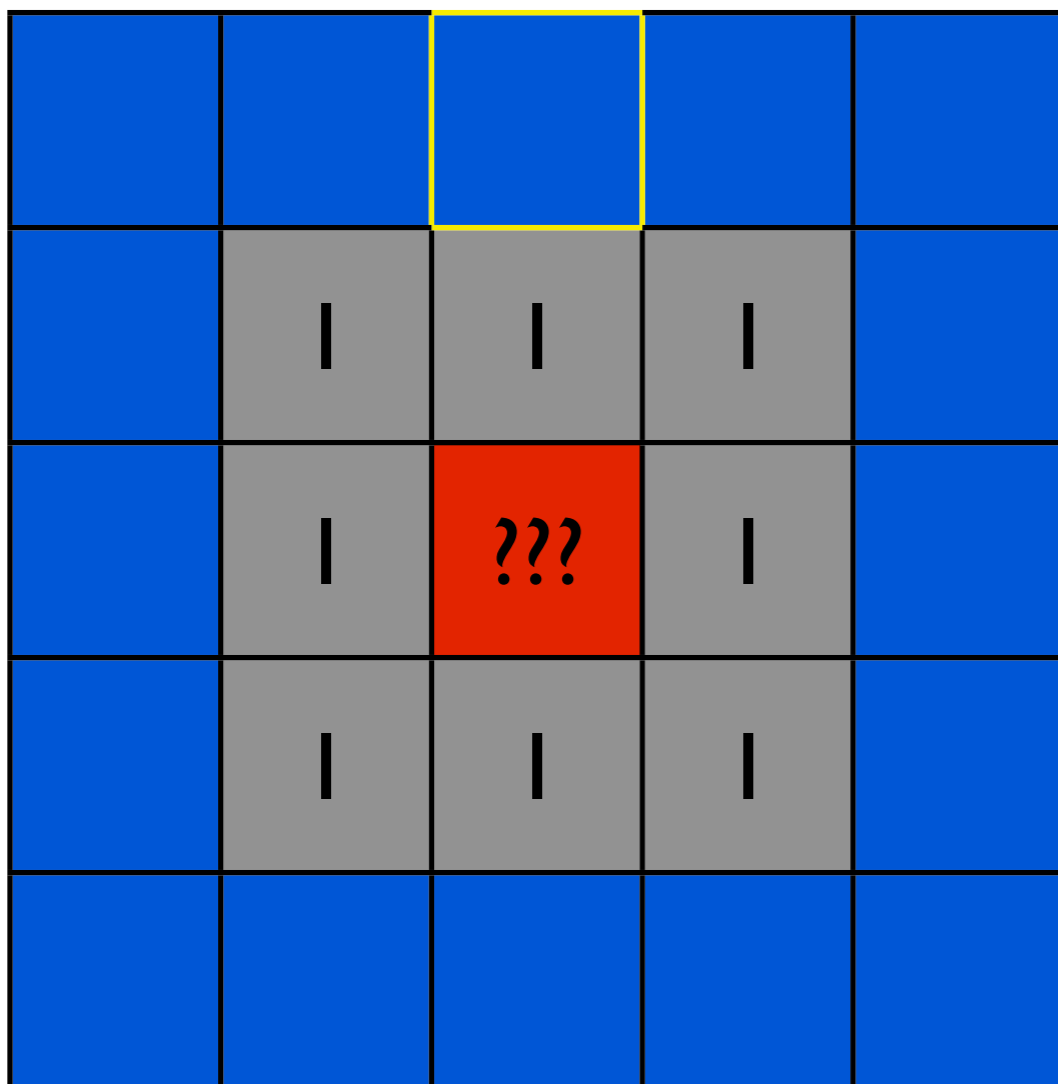
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$$1 = 0 + 0 \dots$$

Minesweeper as a CSP

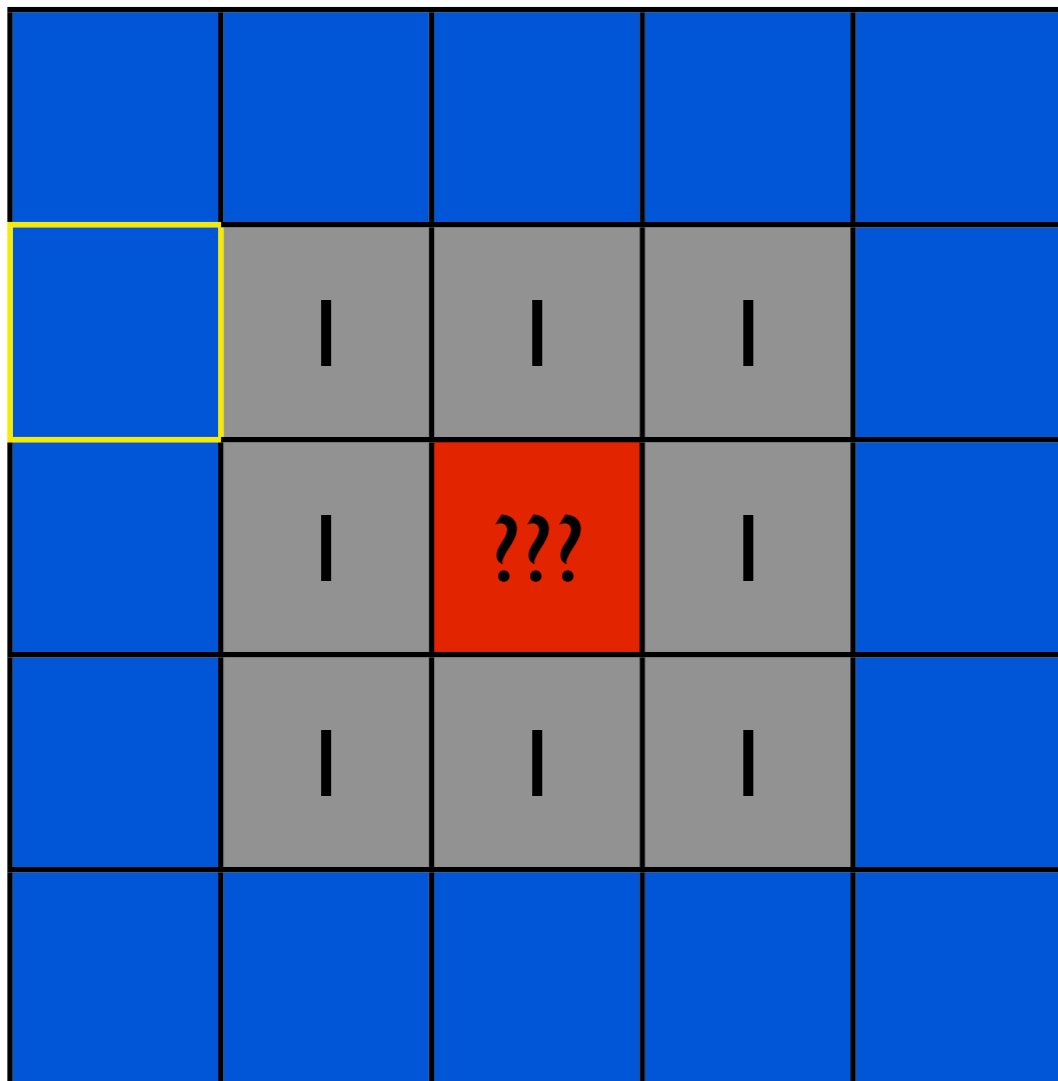
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Minesweeper as a CSP

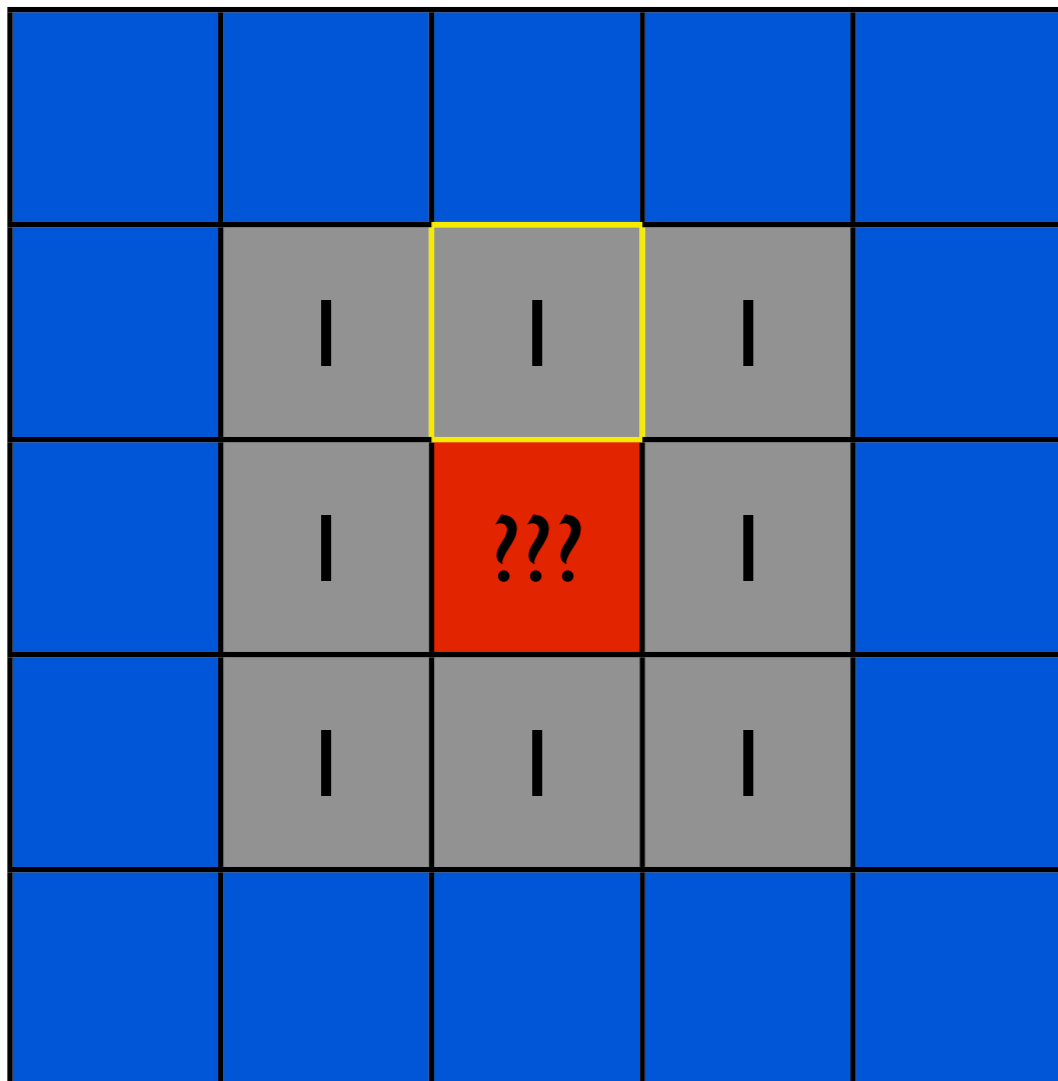
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$$1 = 0 + 0 + 0 + \\ 0 \dots$$

Minesweeper as a CSP

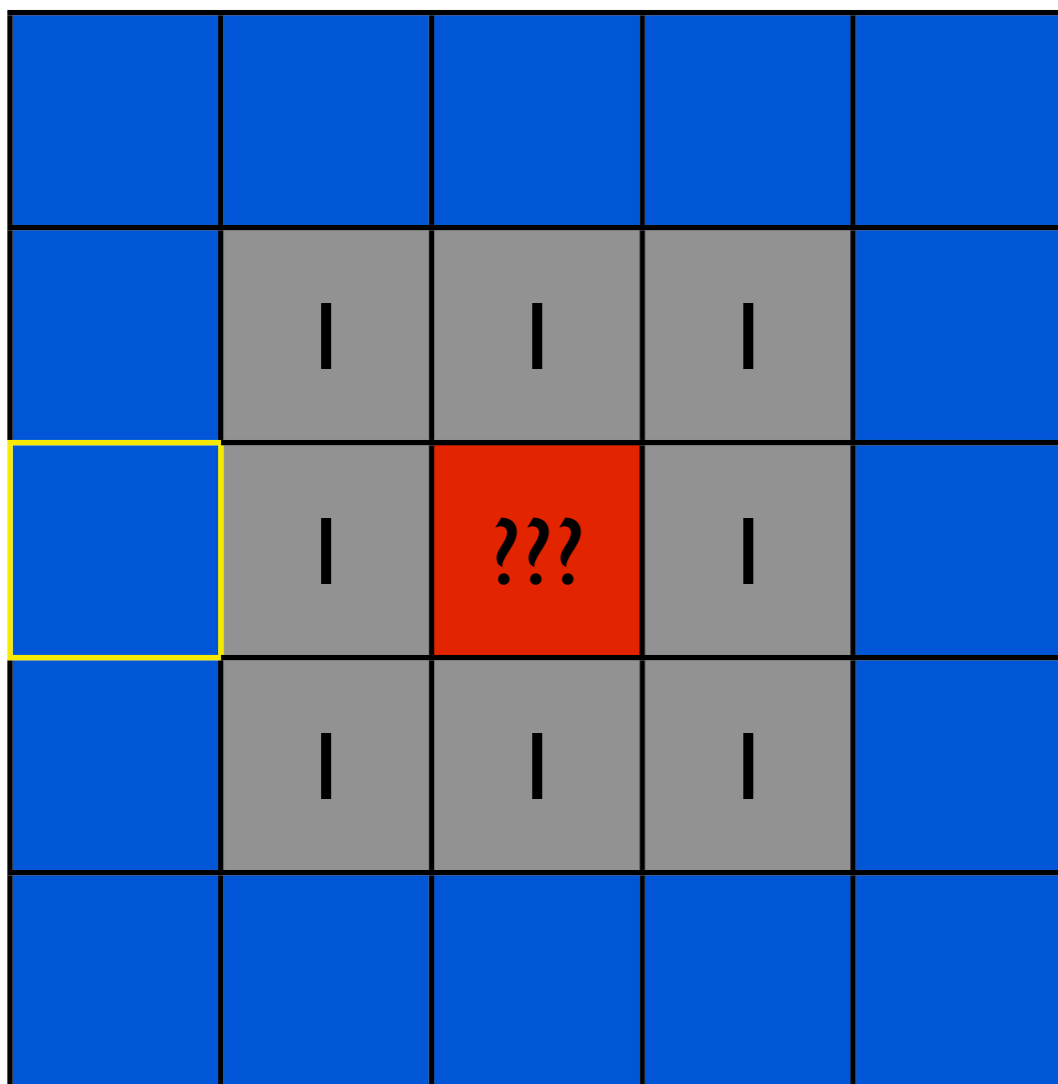
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Minesweeper as a CSP

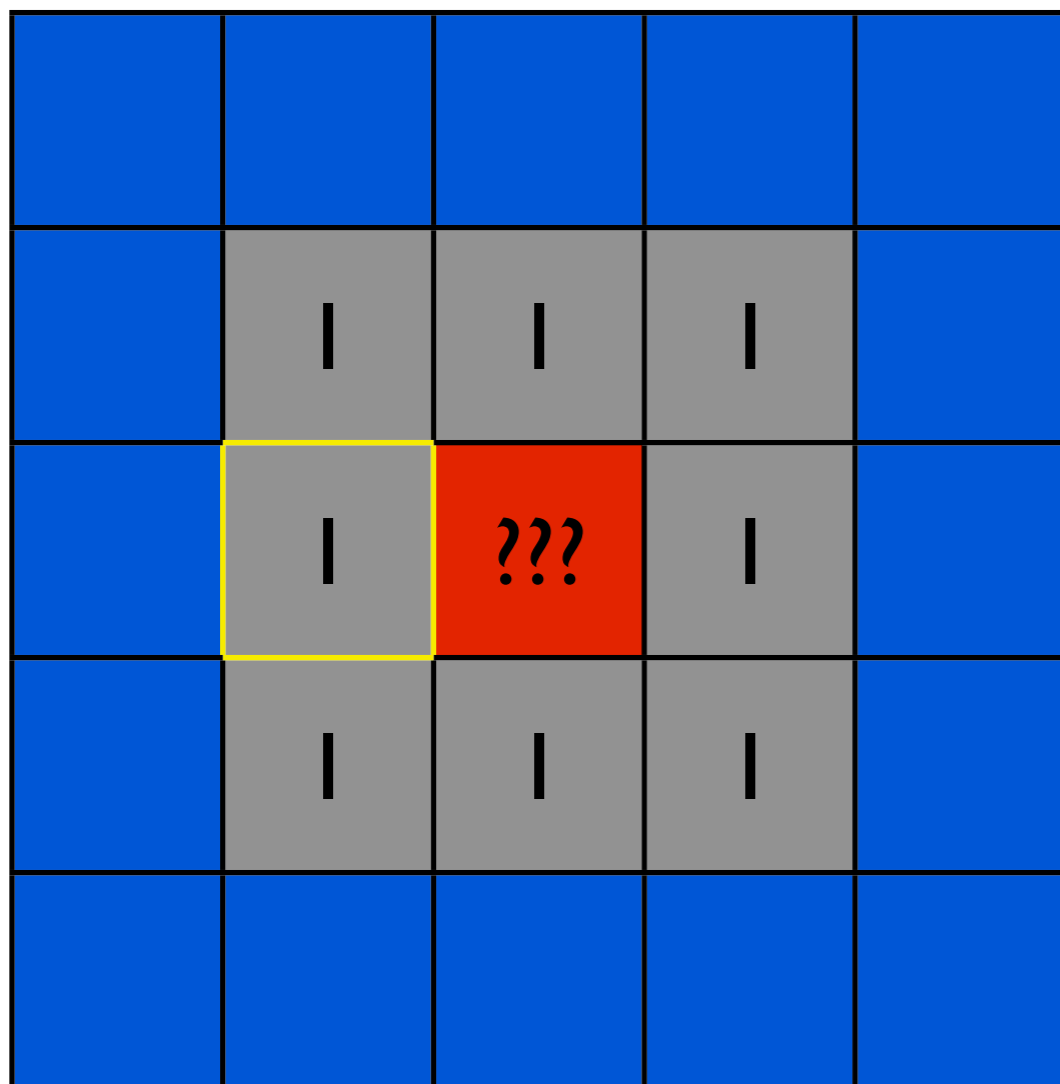
- CSP = constraint satisfaction problem
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$$\begin{array}{r} 1 = 0 + 0 + 0 + \\ 0 + 0 + \\ 0 \dots \end{array}$$

Minesweeper as a CSP

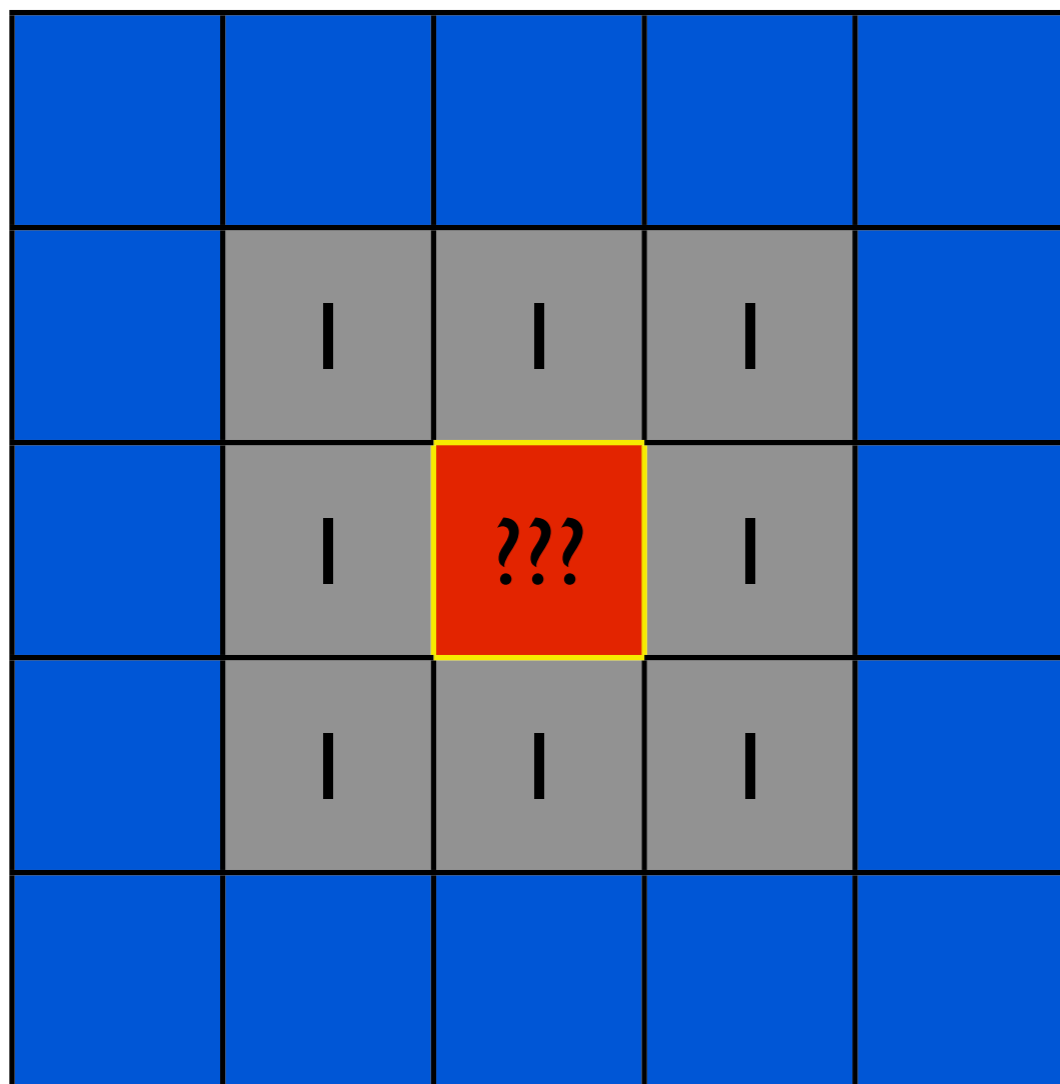
- CSP = constraint satisfaction problem
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$$\begin{array}{r} 1 = 0 + 0 + 0 + \\ 0 + 0 + \\ 0 + 0 \dots \end{array}$$

Minesweeper as a CSP

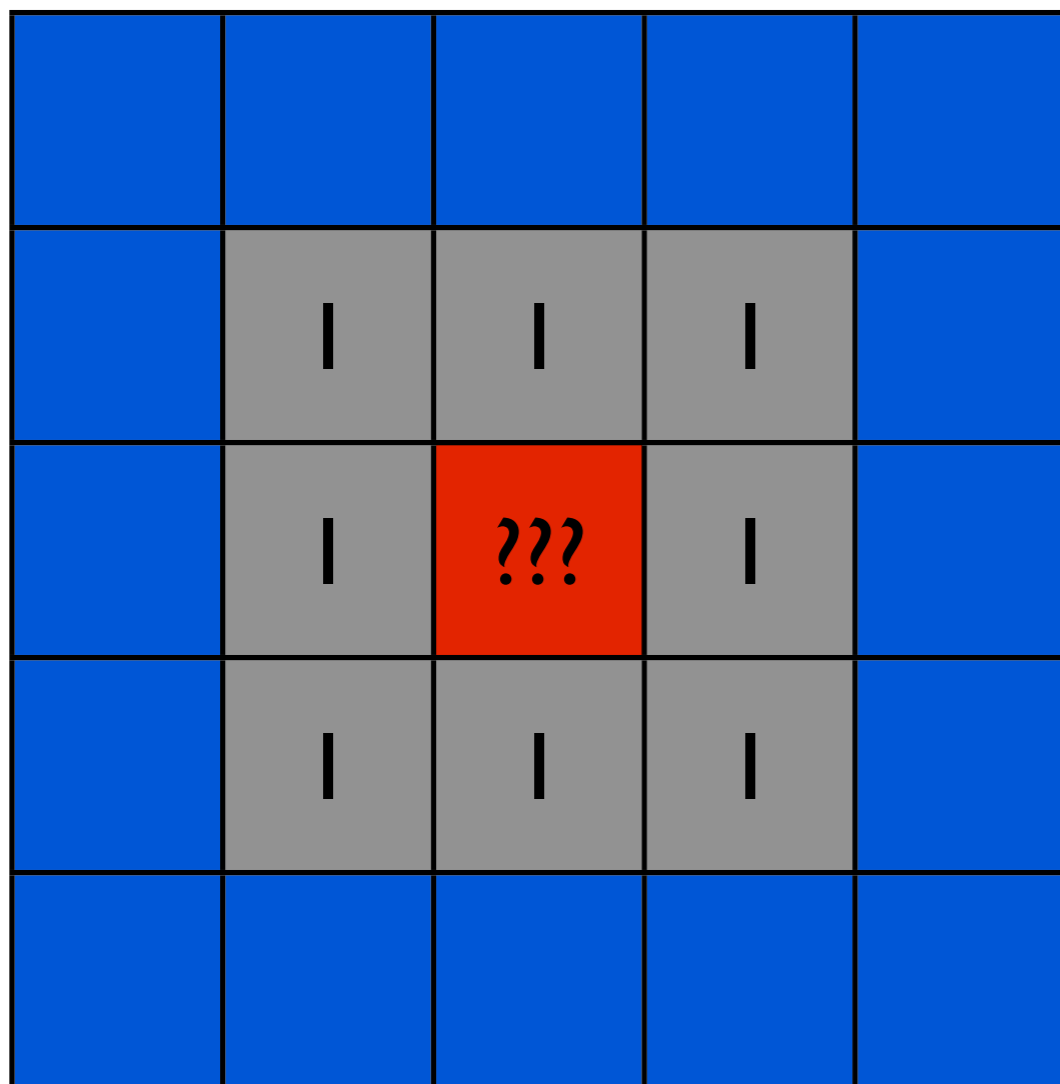
- CSP = constraint satisfaction problem
- For every number N , it must be the case that the sum of the mines in all adjacent cells is equal to N



$$\begin{array}{cccccc} 1 & = & 0 & + & 0 & + & 0 & + \\ & & & & 0 & + & 0 & + \\ & & & & 0 & + & 0 & + & X \end{array}$$

Minesweeper as a CSP

- CSP = constraint satisfaction problem
- For every number N , it must be the case that the sum of the mines in all adjacent cells is equal to N



$$\begin{array}{r} 1 = 0 + 0 + 0 + \\ 0 + 0 + \\ 0 + 0 + X \end{array}$$

simplify

$$X = 1$$

(the unknown spot has a mine)

Minesweeper as a CSP

- For each number, there is one equation
- The equations collectively form a system of equations which can be solved to derive a solution

Additional Constraints

- Each unknown square can have a value of either 0 or 1 (no mine or mine)
- The total number of mines in unknown squares + the total number of previously inferred mines = the predefined number of mines on the board

In CLP

- CLP = constraint logic programming
- The aforementioned problem can be represented and solved directly with ease
- We will provide template code which already performs most of the board manipulation
- You must implement code to add constraints

Template Code