How to solve Minesweeper In 3 minutes

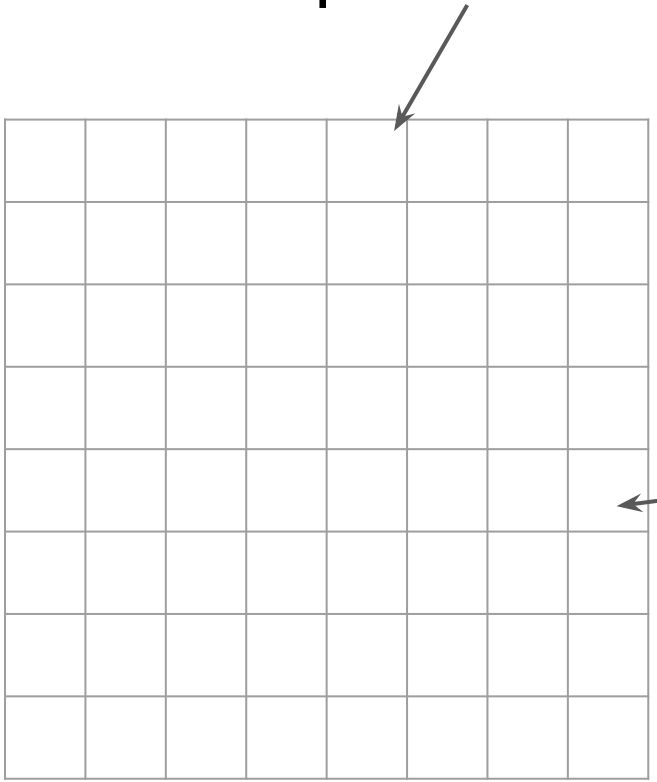
Steven Waterman

LOOK HERE IF YOU DON'T KNOW WHAT MINESWEEPER IS

Basics

LOOK HERE IF YOU'VE PLAYED MINESWEEPER BEFORE

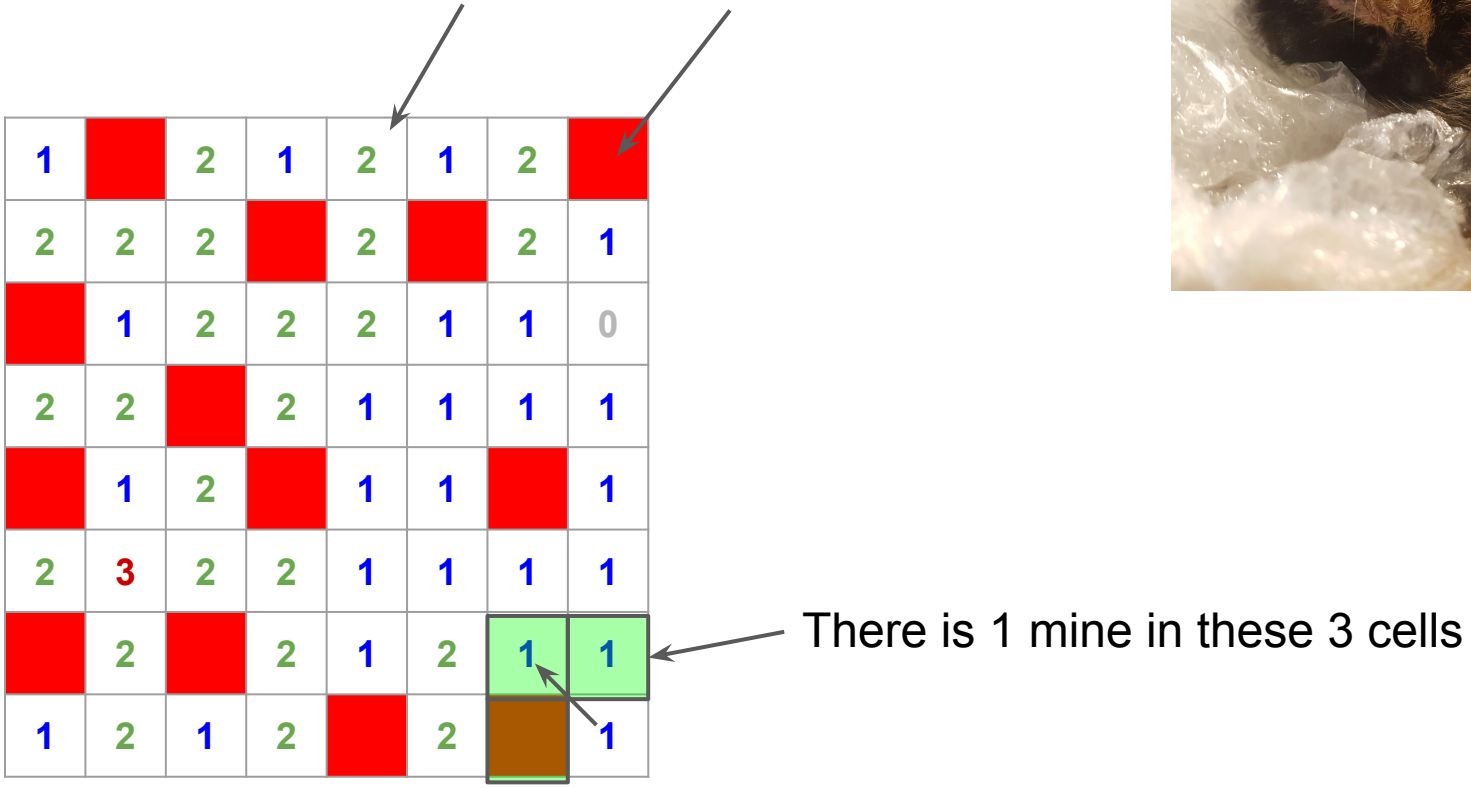
Minesweeper Board!



Rectangular!

Cells!

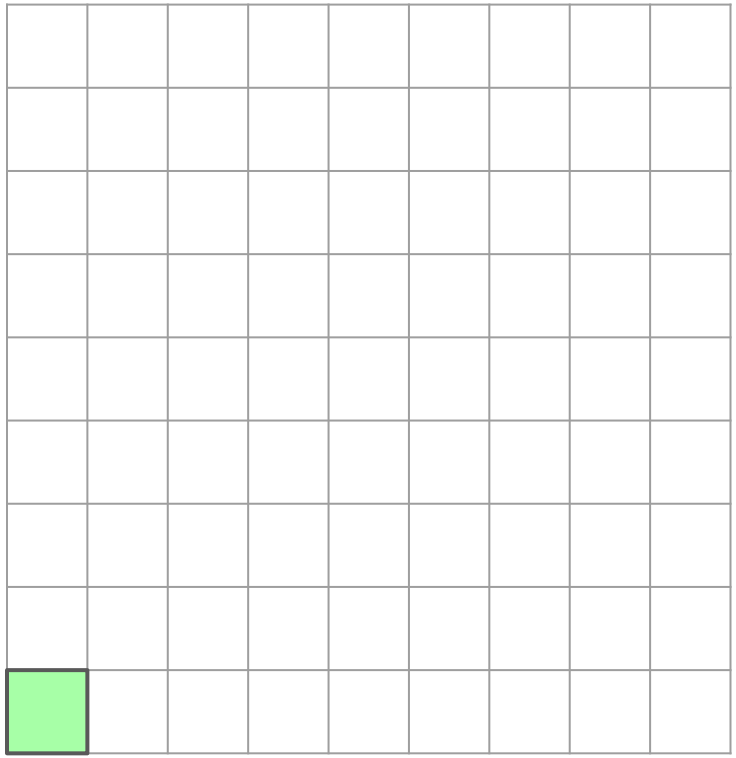
Cells can be *clear* or *mines*

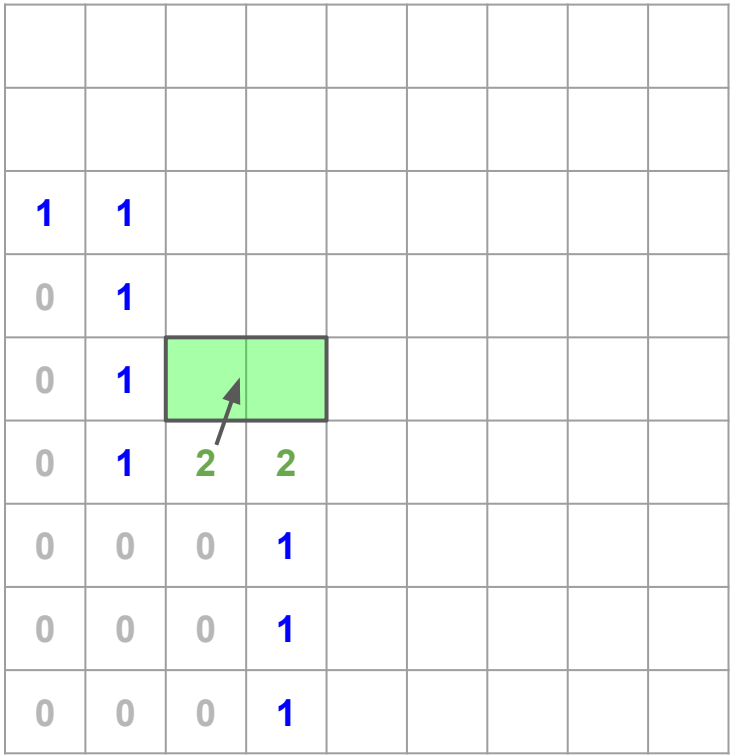


There is 1 mine in these 3 cells

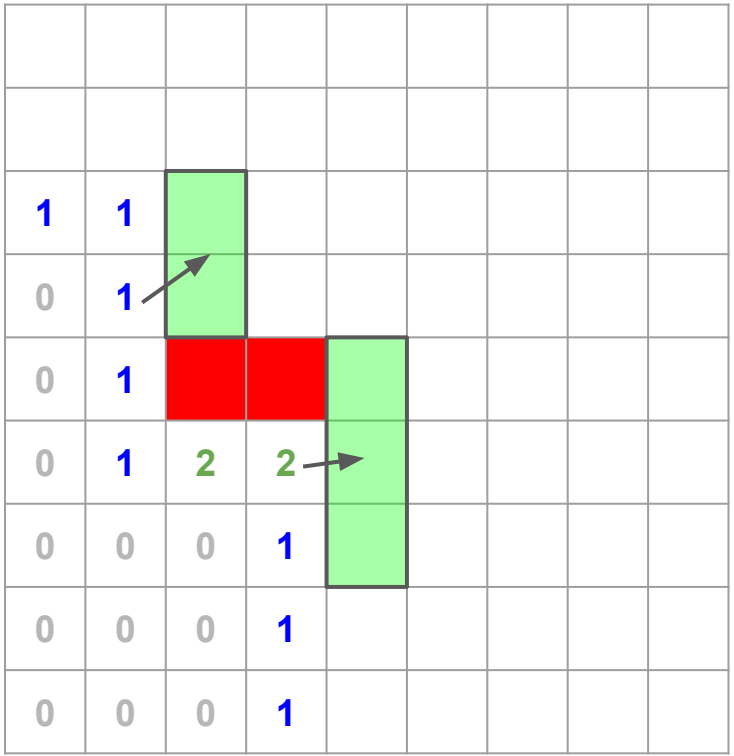
Let’s Play!

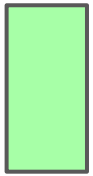
9x9 board, 15 bombs





2 mines / 2 unknowns
All are mines
Can flag

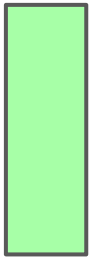




0 / 2

None are mines

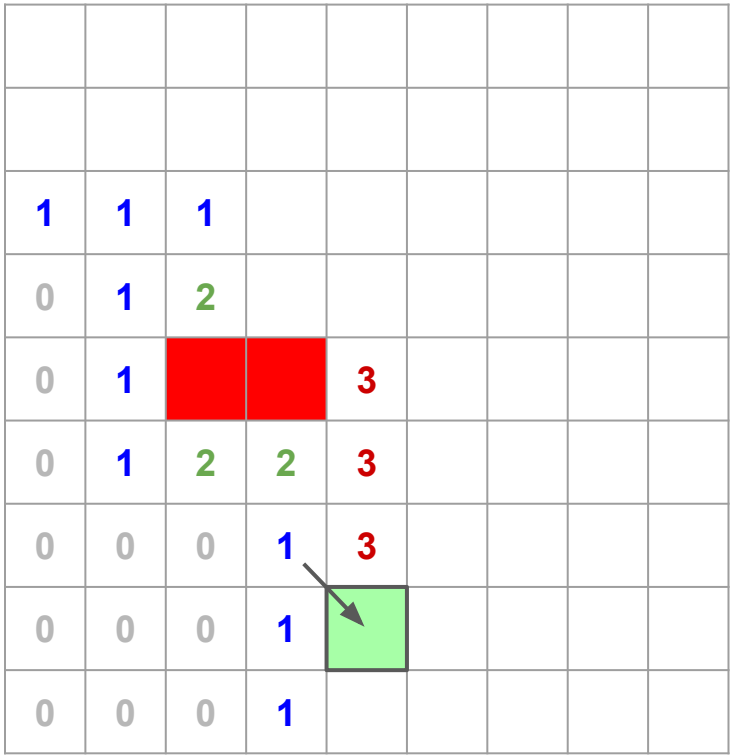
Can Clear



0 / 3

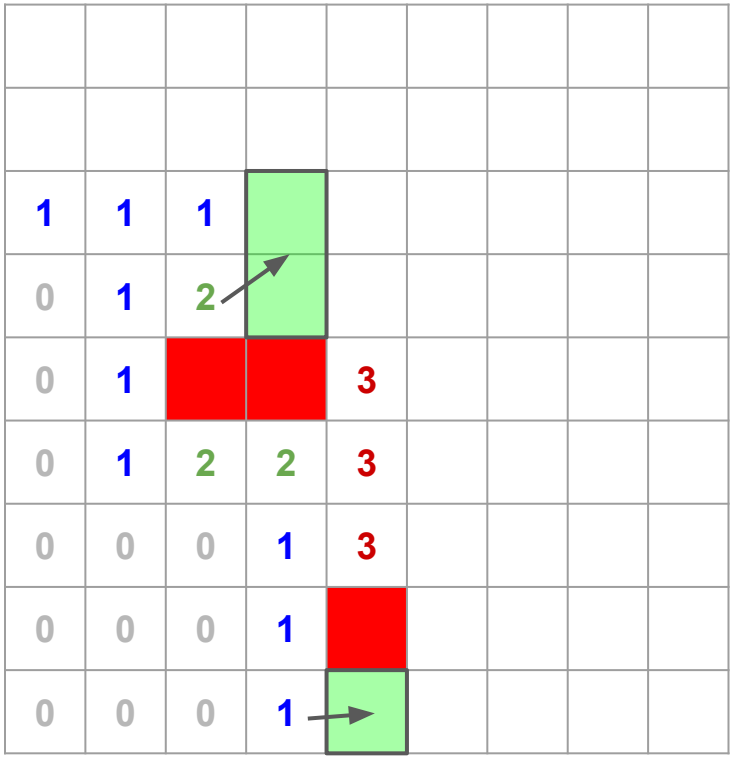
None are mines

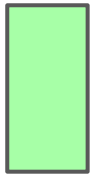
Can Clear



1 / 1

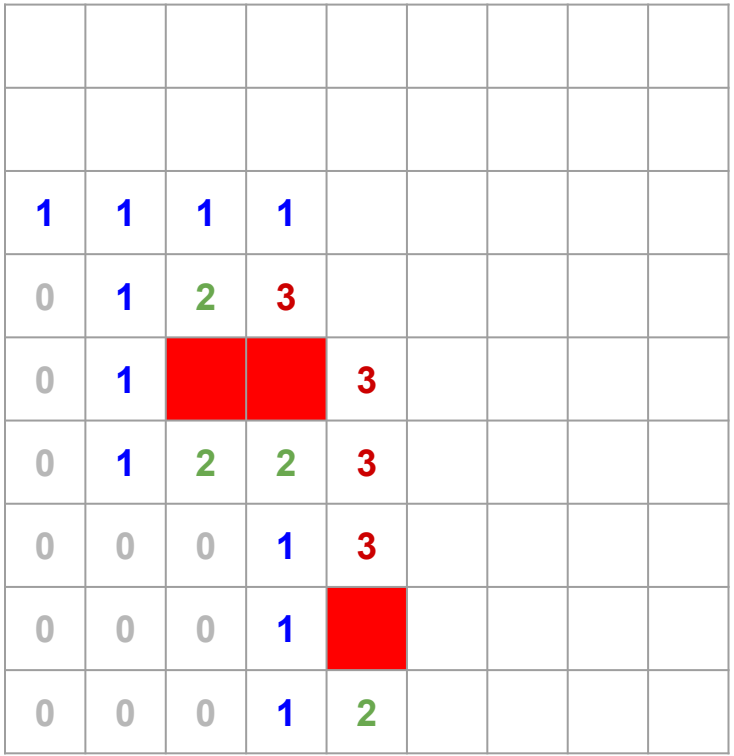
Can Flag



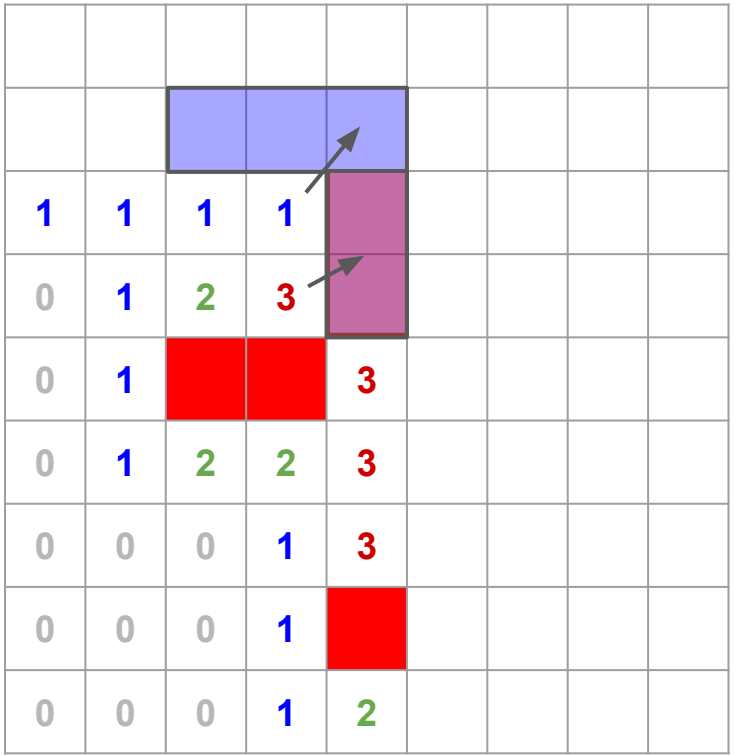


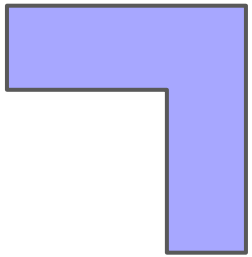
0 / 2
Can Clear

0 / 1
Can Clear

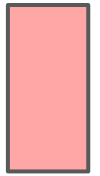


Stuck :(

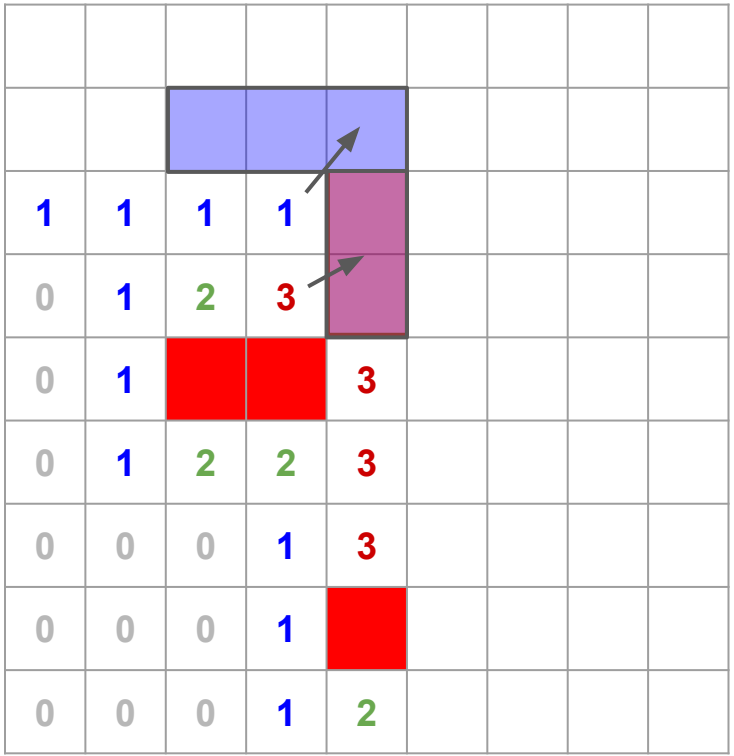


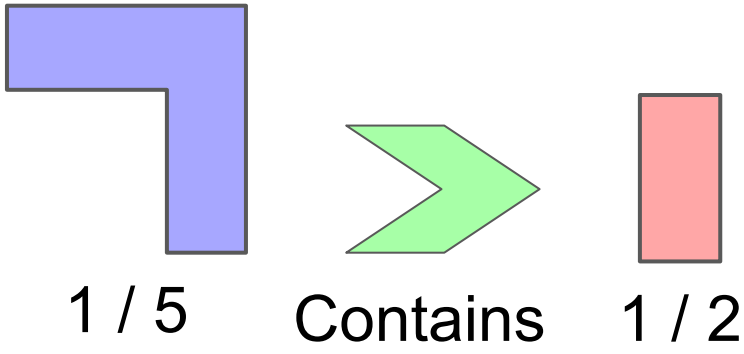


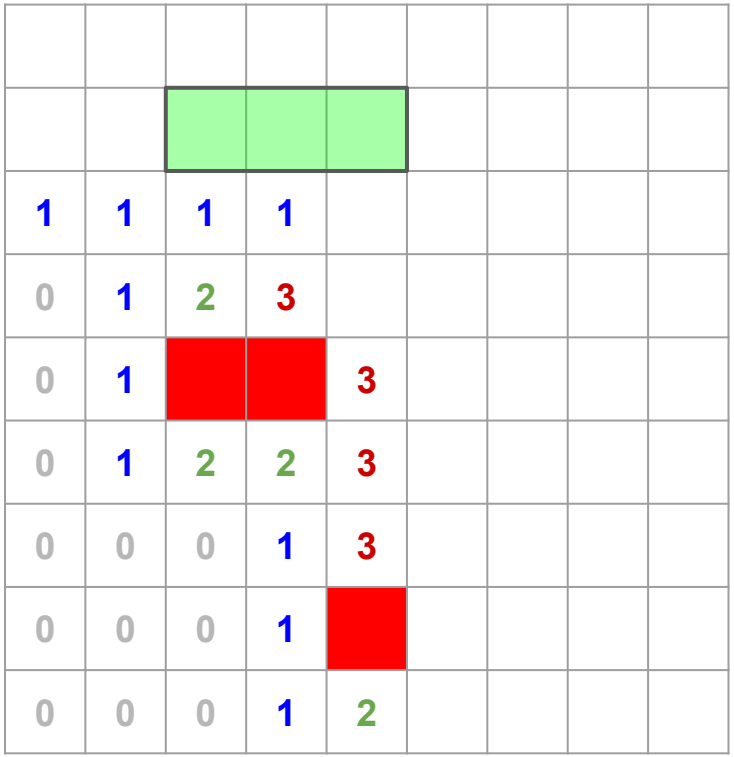
1 / 5

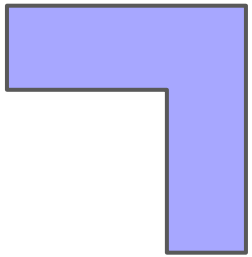


1 / 2


1 1 1 1
0 1 2 3
0 1 3
0 1 2 2 3
0 0 0 1 3
0 0 0 1
0 0 0 1 2

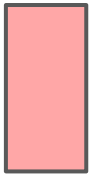

1 / 5
Contains
1 / 2





1 / 5

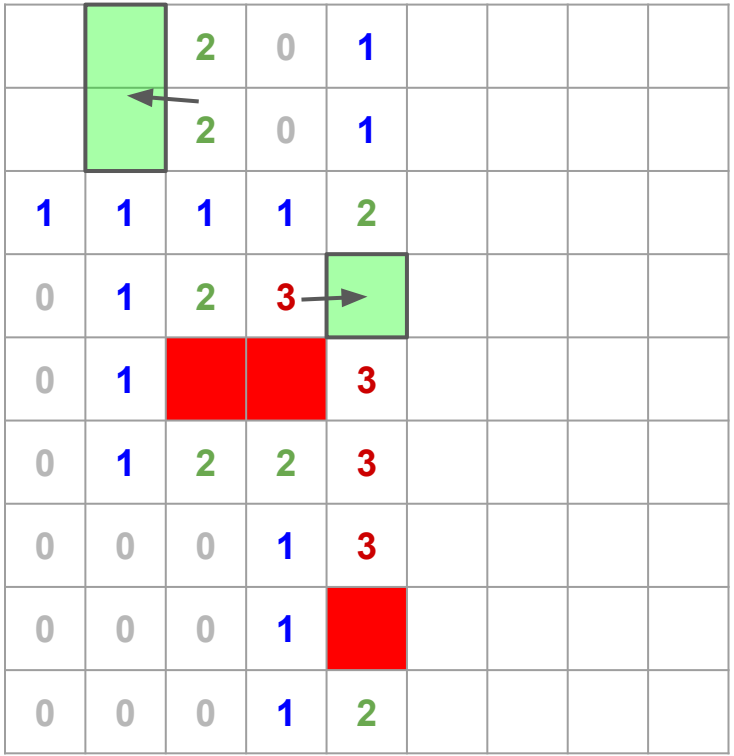
minus

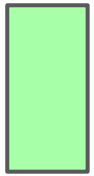


1 / 2

1-1 mines
5-2 cells
0 / 3

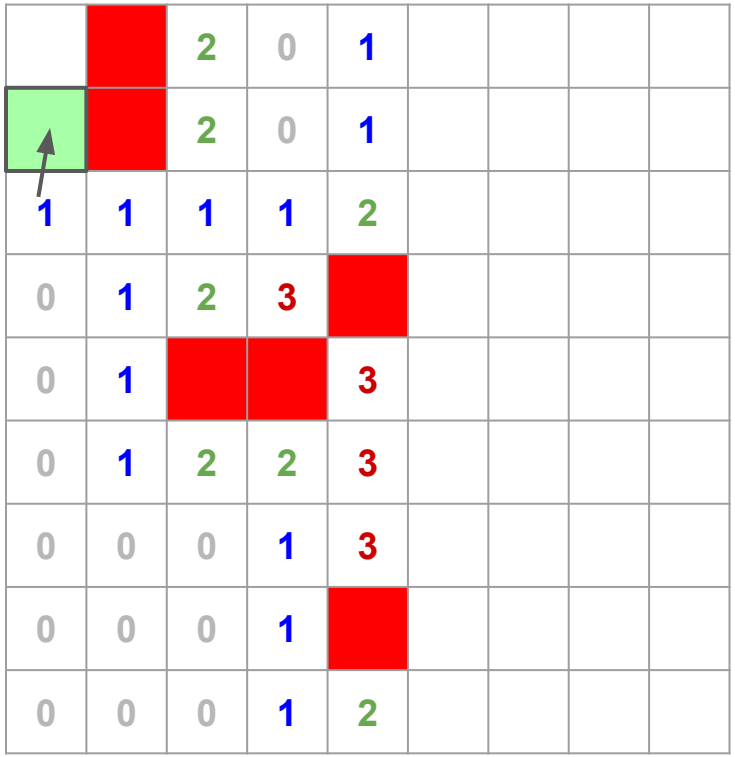
0 / 3
Can Clear



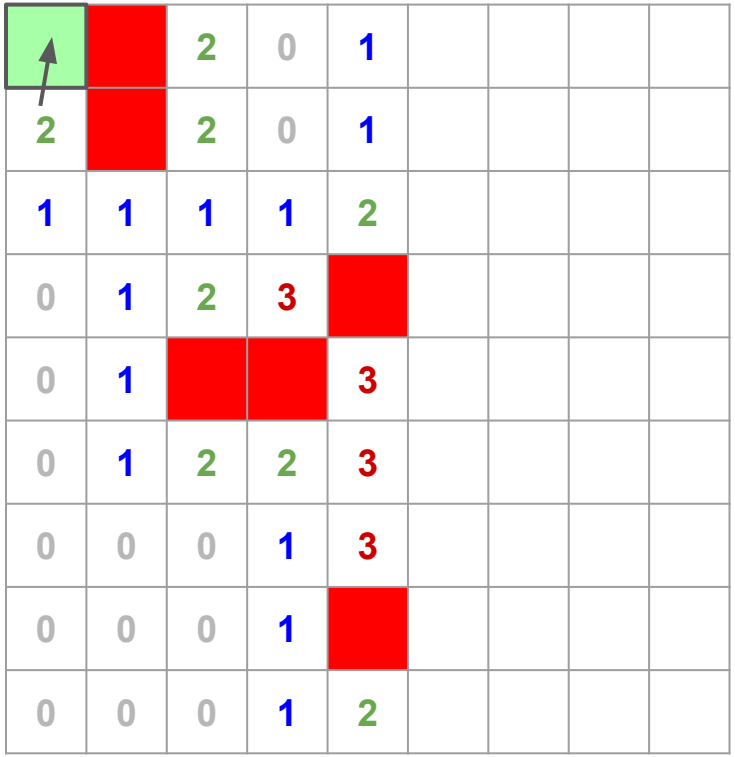


2 / 2
Can Flag

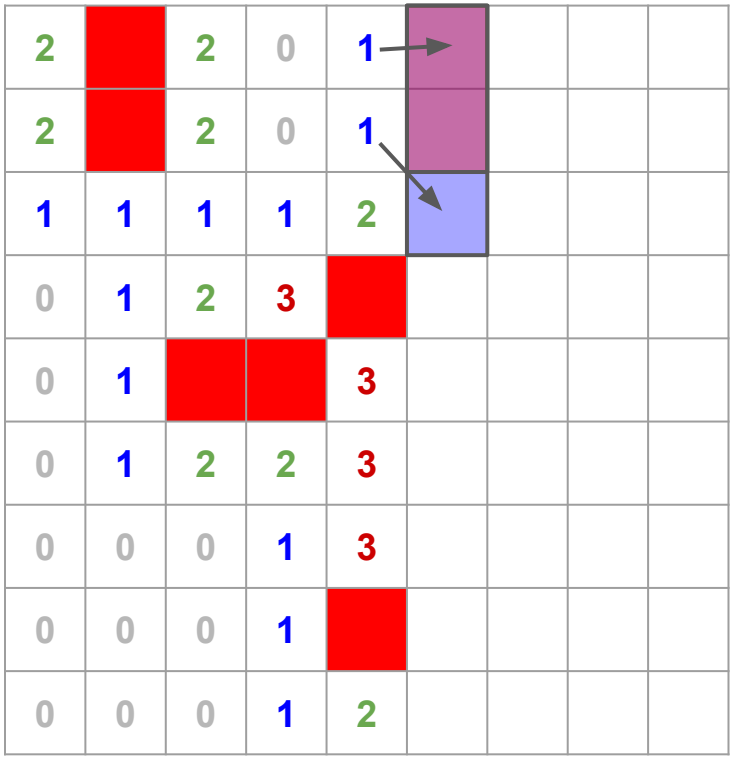
1 / 1
Can Flag



0 / 1
Can Clear



0 / 1
Can Clear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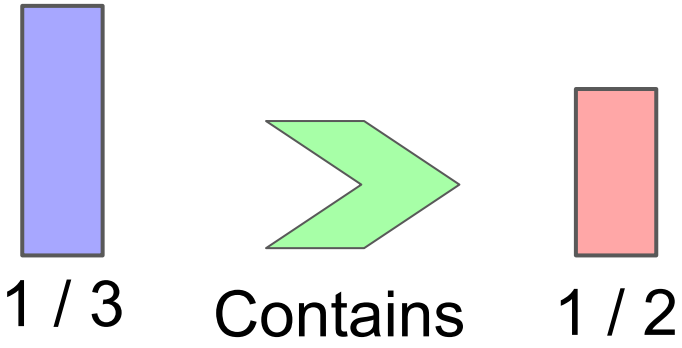
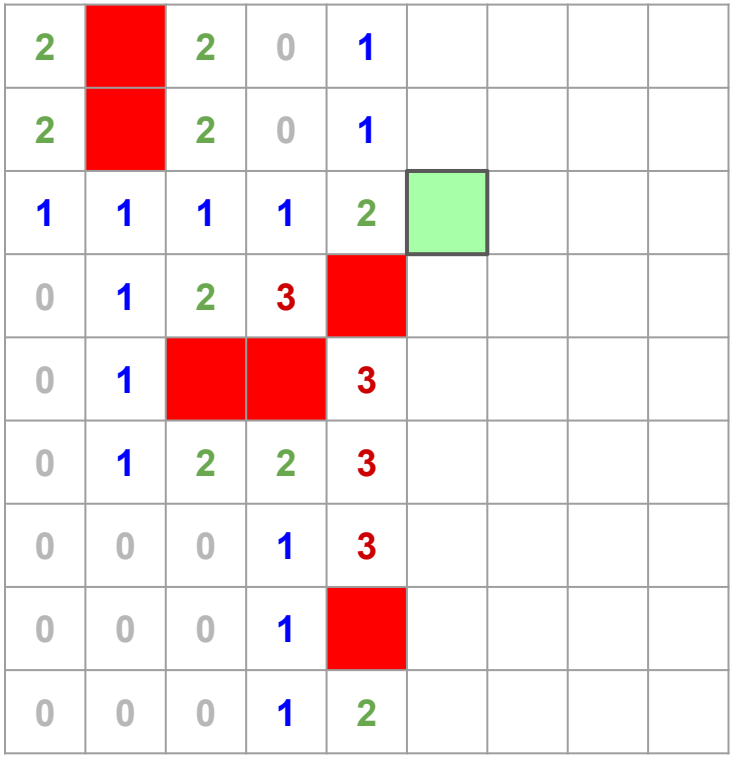
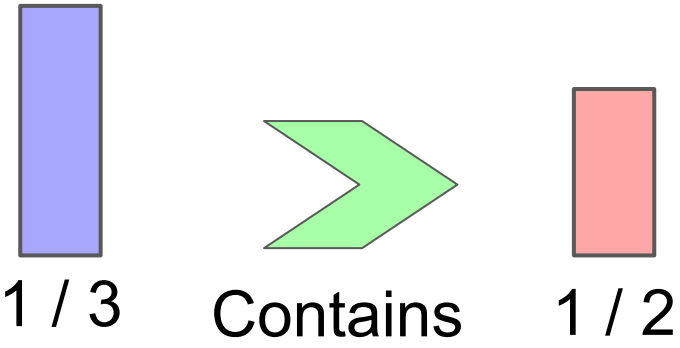
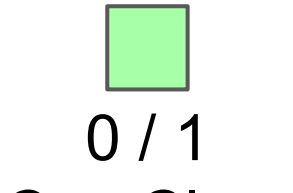
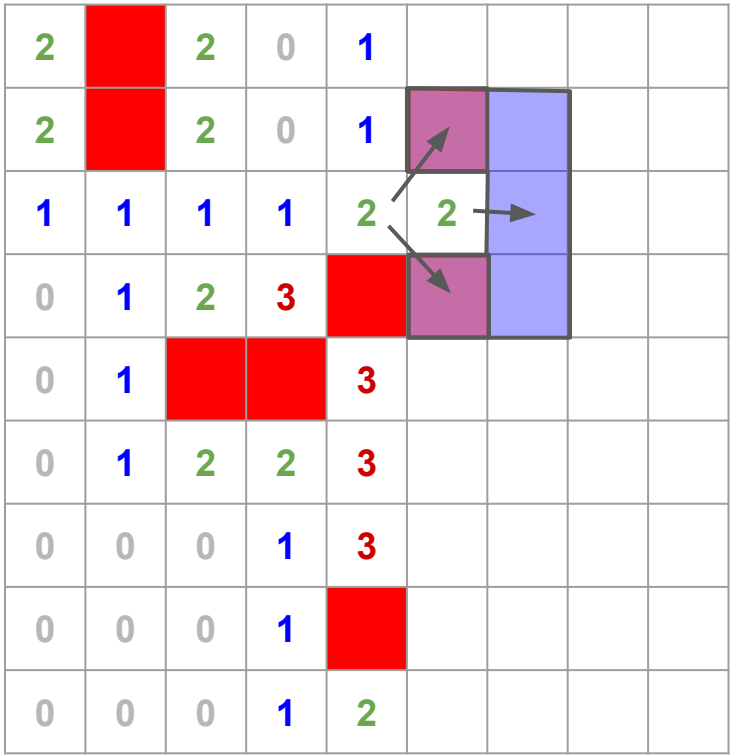
1 1 1 1 2
0 1 2 3
0 1 3
0 1 2 2 3
0 0 0 1 3
0 0 0 1
0 0 0 1 2


1 / 3
Contains
1 / 2


2 2 0 1
2 2 0 1
1 1 1 1 2
0 1 2 3
0 1 3
0 1 2 2 3
0 0 0 1 3
0 0 0 1
0 0 0 1 2


1 / 3
Contains
1 / 2


0 / 1
Can Clear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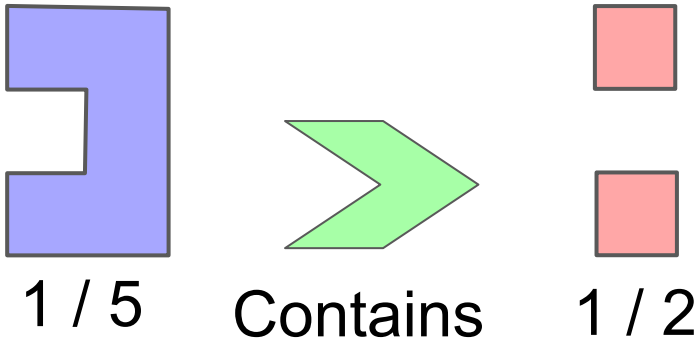
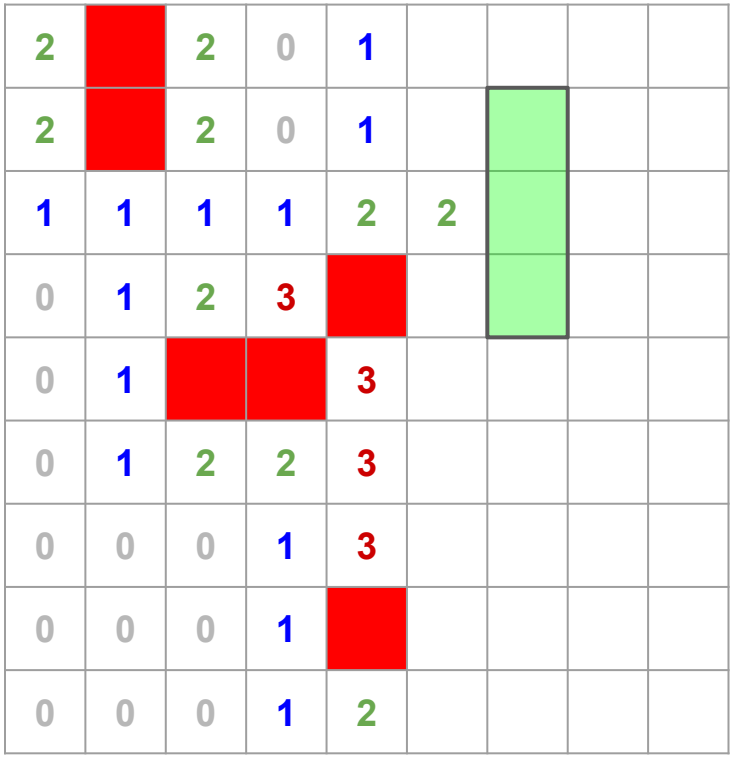
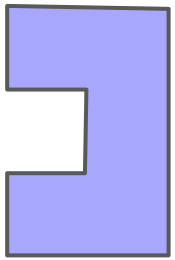
2 2 0 1
1 1 1 1 2 2
0 1 2 3
0 1 3
0 1 2 2 3
0 0 0 1 3
0 0 0 1
0 0 0 1 2

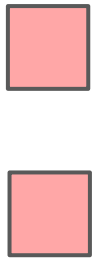

1 / 5
Contains
1 / 2



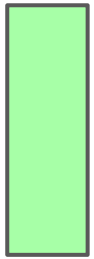


1 / 5

Contains



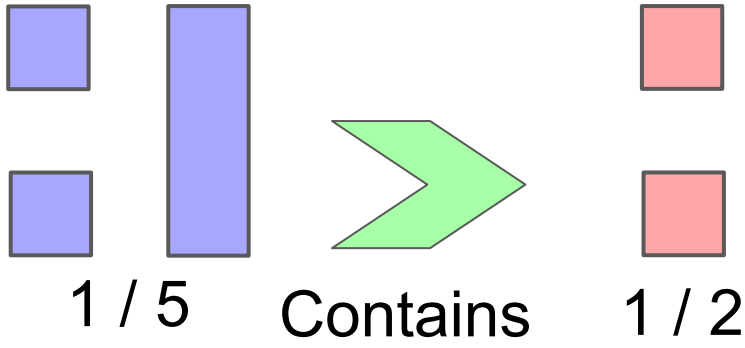
1 / 2



0 / 3

Can Clear

2 2 0 1
2 2 0 1 1
1 1 1 1 2 2 1
0 1 2 3 1
0 1 3
0 1 2 2 3
0 0 0 1 3
0 0 0 1
0 0 0 1 2


1 / 5
Contains
1 / 2

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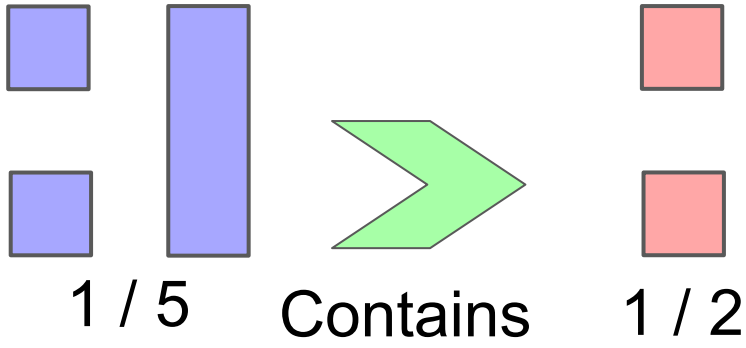
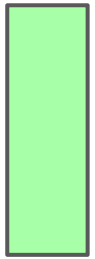
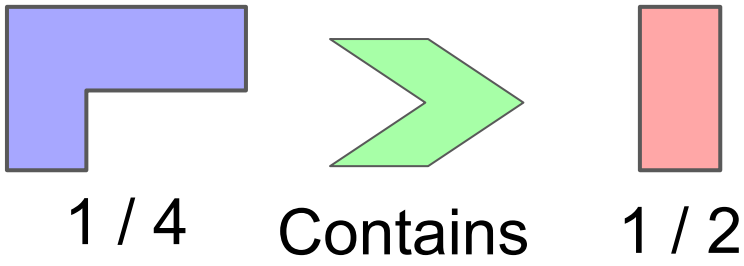
2		2	0	1		1		
1	1	1	1	2	2	1		
0	1	2	3			1		
0	1			3				
0	1	2	2	3				
0	0	0	1	3				
0	0	0	1					
0	0	0	1	2				



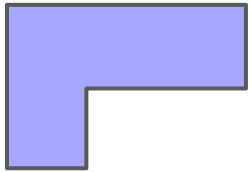


0 / 3
Can Clear

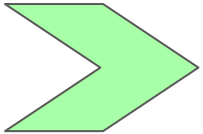
2		2	0	1			
2		2	0	1		1	1
1	1	1	1	2	2	1	1
0	1	2	3			1	2
0	1			3			
0	1	2	2	3			
0	0	0	1	3			
0	0	0	1				
0	0	0	1	2			



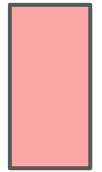
2		2	0	1				
2		2	0	1		1	1	
1	1	1	1	2	2	1	1	
0	1	2	3			1	2	
0	1			3				
0	1	2	2	3				
0	0	0	1	3				
0	0	0	1					
0	0	0	1	2				



1 / 4

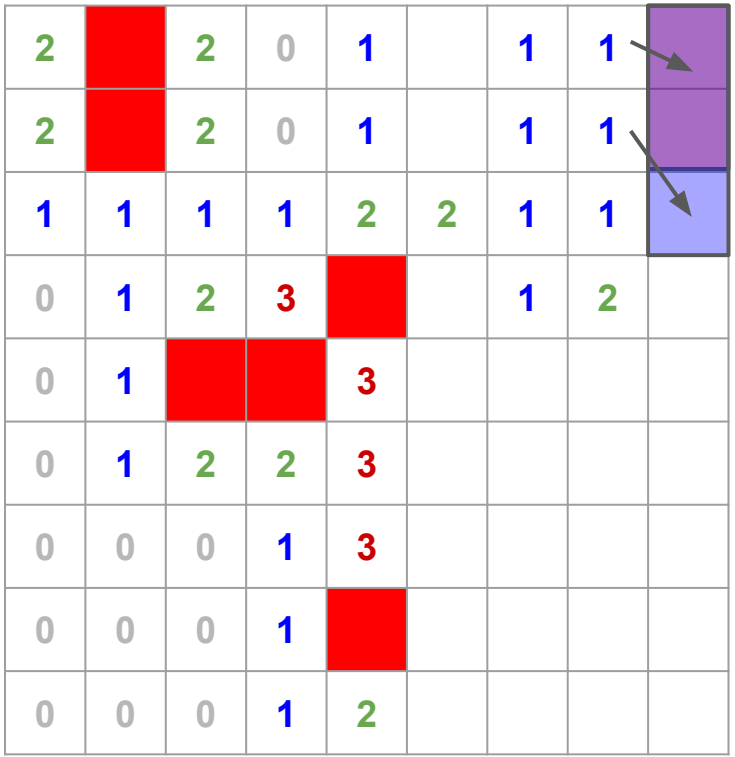


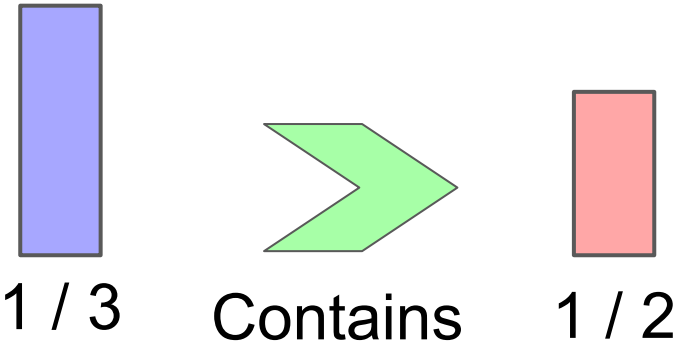
Contains



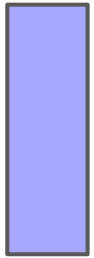
1 / 2

0 / 2
Can Clear

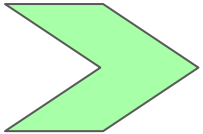

2 2 0 1 1 1
2 2 0 1 1 1
1 1 1 1 2 2 1 1
0 1 2 3 1 2
0 1 3
0 1 2 2 3
0 0 0 1 3
0 0 0 1
0 0 0 1 2


1 / 3
Contains
1 / 2

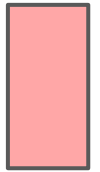
2		2	0	1		1	1	
2		2	0	1		1	1	
1	1	1	1	2	2	1	1	
0	1	2	3			1	2	
0	1			3				
0	1	2	2	3				
0	0	0	1	3				
0	0	0	1					
0	0	0	1	2				



1 / 3



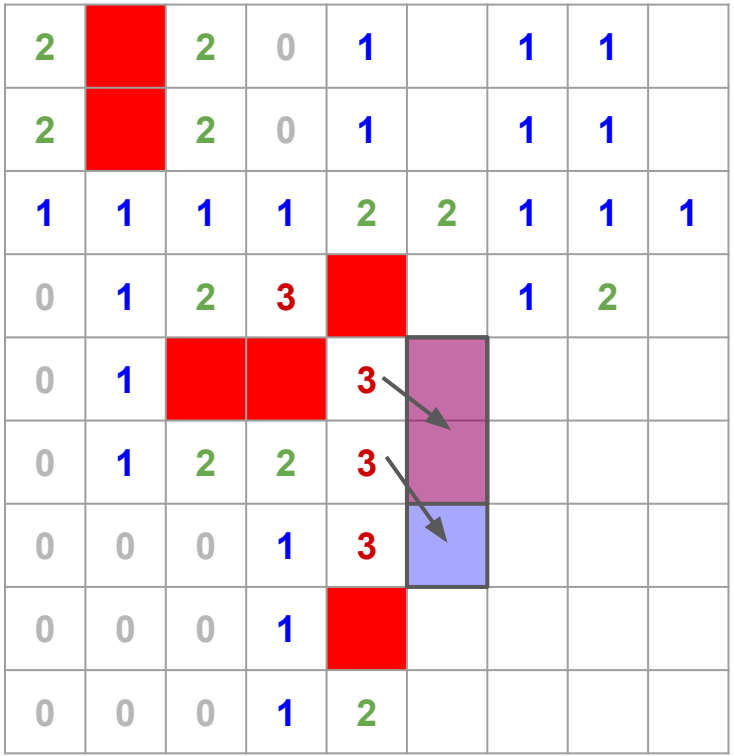
Contains

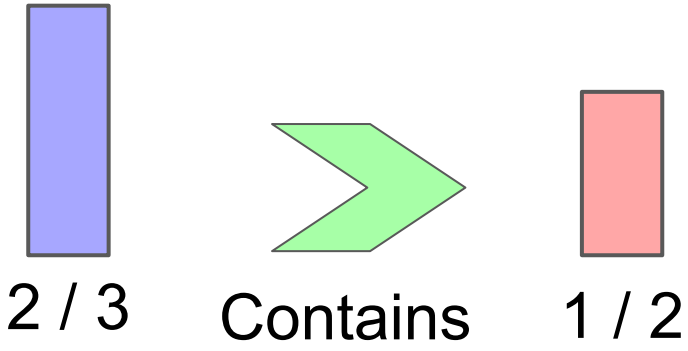


1 / 2

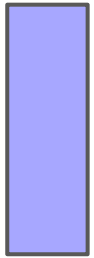
0 / 2

Can Clear

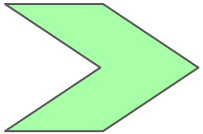

2 2 0 1 1 1
2 2 0 1 1 1
1 1 1 1 2 2 1 1 1
0 1 2 3 1 2
0 1 3
0 1 2 2 3
0 0 0 1 3
0 0 0 1
0 0 0 1 2


2 / 3
Contains
1 / 2

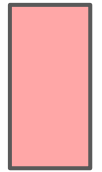
2		2	0	1		1	1	
2		2	0	1		1	1	
1	1	1	1	2	2	1	1	1
0	1	2	3			1	2	
0	1			3				
0	1	2	2	3				
0	0	0	1	3				
0	0	0	1					
0	0	0	1	2				



2 / 3



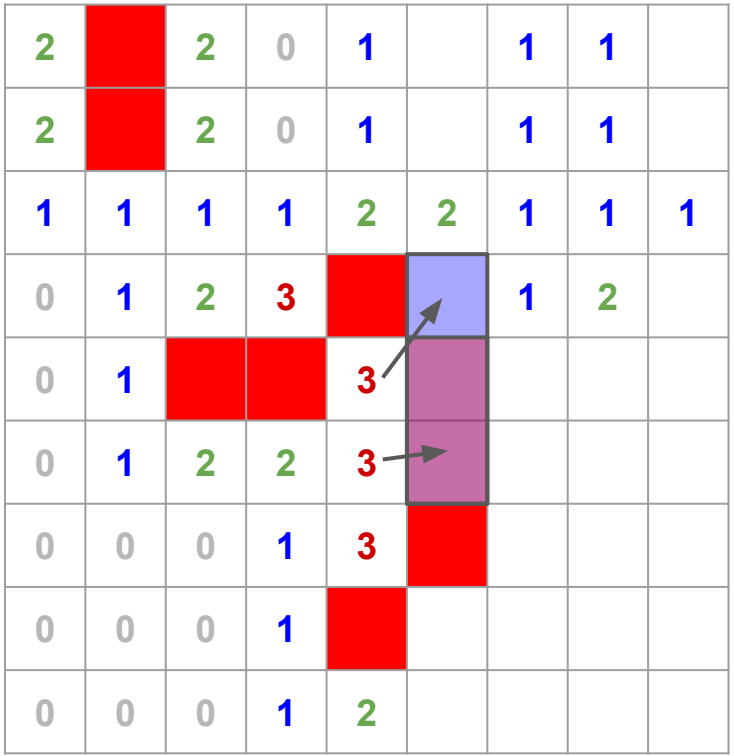
Contains

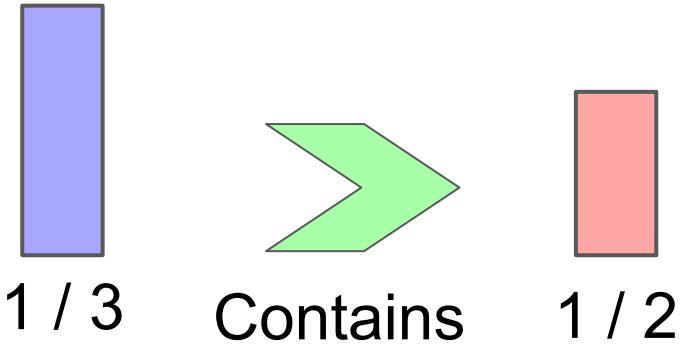


1 / 2

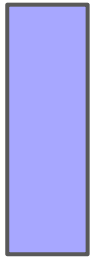
1 / 1

Can Flag

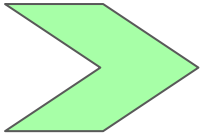

2 2 0 1 1 1
2 2 0 1 1 1
1 1 1 1 2 2 1 1 1
0 1 2 3 1 2
0 1 3
0 1 2 2 3
0 0 0 1 3
0 0 0 1
0 0 0 1 2


1 / 3
Contains
1 / 2

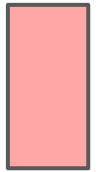
2		2	0	1		1	1	
2		2	0	1		1	1	
1	1	1	1	2	2	1	1	1
0	1	2	3			1	2	
0	1			3				
0	1	2	2	3				
0	0	0	1	3				
0	0	0	1					
0	0	0	1	2				



1 / 3



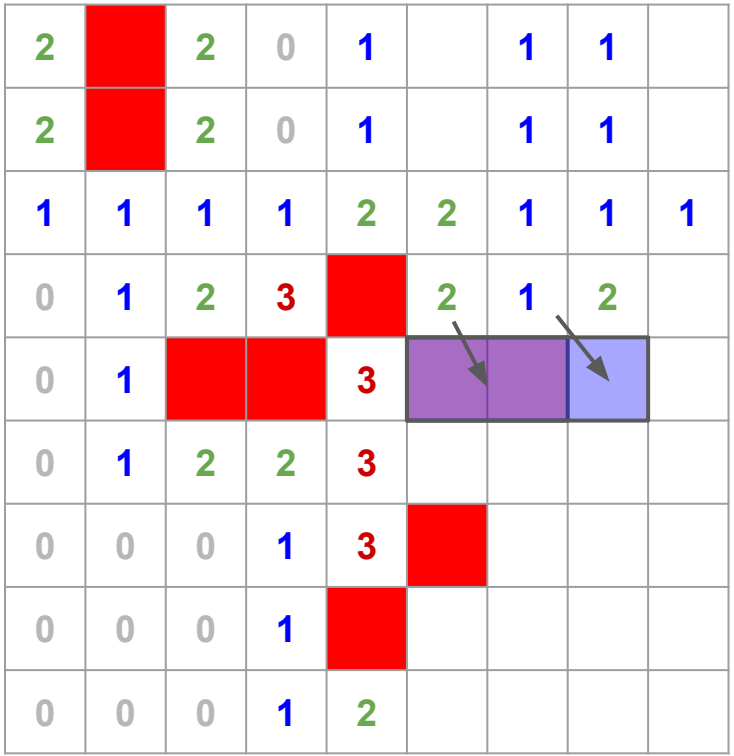
Contains

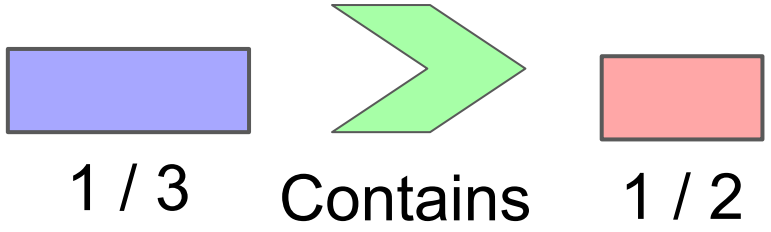


1 / 2

0 / 1

Can Clear

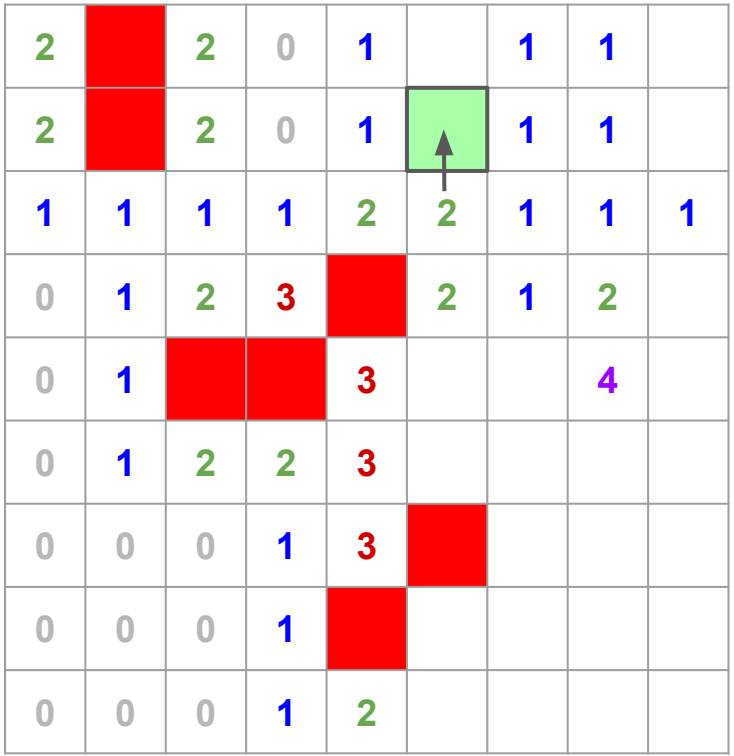

2 2 0 1 1 1
2 2 0 1 1 1
1 1 1 1 2 2 1 1 1
0 1 2 3 2 1 2
0 1 3
0 1 2 2 3
0 0 0 1 3
0 0 0 1
0 0 0 1 2


1 / 3
Contains
1 / 2

2		2	0	1		1	1	
2		2	0	1		1	1	
1	1	1	1	2	2	1	1	1
0	1	2	3		2	1	2	
0	1			3				
0	1	2	2	3				
0	0	0	1	3				
0	0	0	1					
0	0	0	1	2				

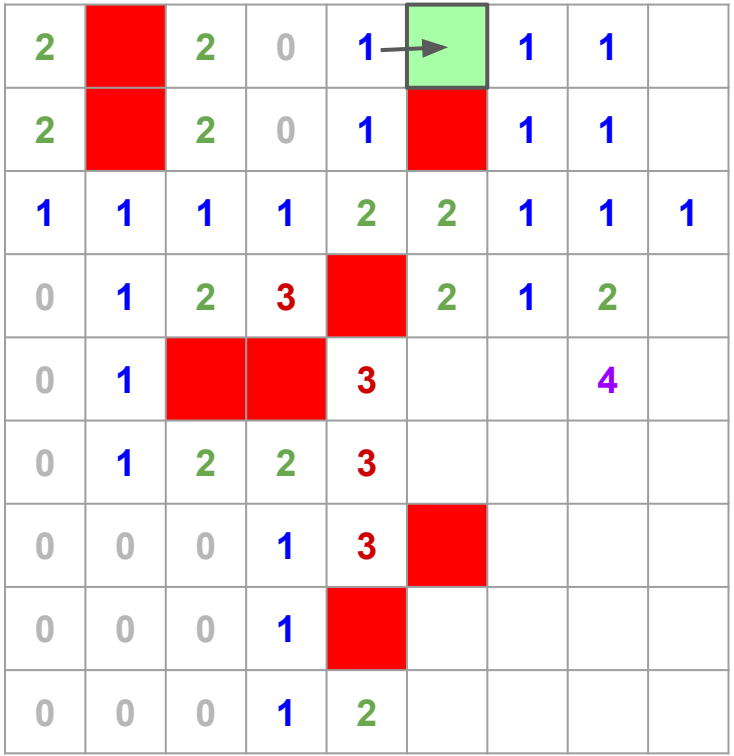
0 / 1

Can Clear


2 2 0 1 1 1
2 2 0 1 1 1
1 1 1 1 2 2 1 1 1
0 1 2 3 2 1 2
0 1 3 4
0 1 2 2 3
0 0 0 1 3
0 0 0 1
0 0 0 1 2

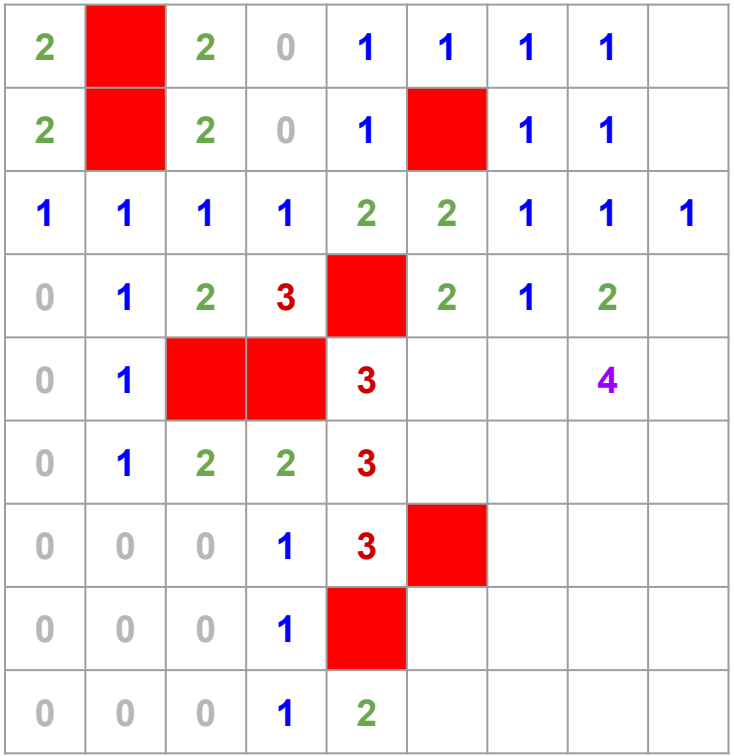
1 / 1

Can Flag


2 2 0 1 1 1
2 2 0 1 1 1
1 1 1 1 2 2 1 1 1
0 1 2 3 2 1 2
0 1 3 4
0 1 2 2 3
0 0 0 1 3
0 0 0 1
0 0 0 1 2

0 / 1

Can Clear


2 2 0 1 1 1 1
2 2 0 1 1 1
1 1 1 1 2 2 1 1 1
0 1 2 3 2 1 2
0 1 3 4
0 1 2 2 3
0 0 0 1 3
0 0 0 1
0 0 0 1 2

Stuck :(

Let’s Play!

9x9 board, 15 bombs

Let’s Play!

9x9 board, 15 bombs

Let’s Play!

9x9 board, 15 bombs

15 bombs

15 bombs

15 bombs

Let’s Play!

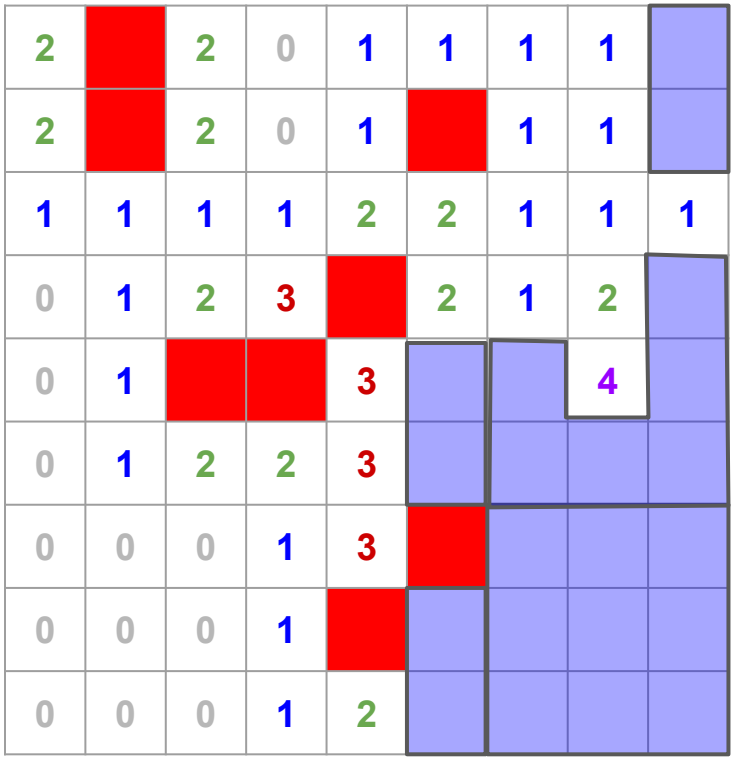
15 bombs

9x9 board, 15 bombs

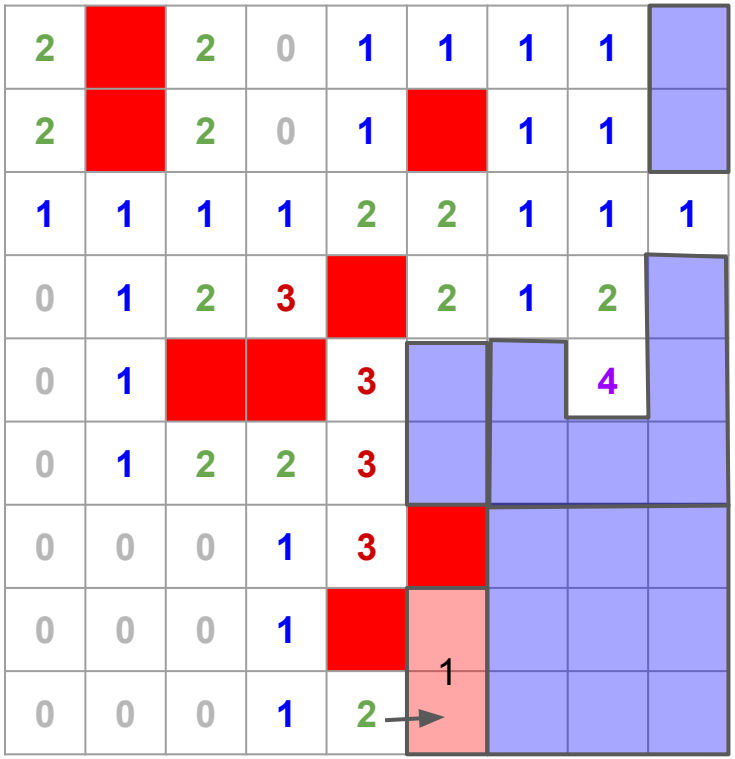
15 bombs

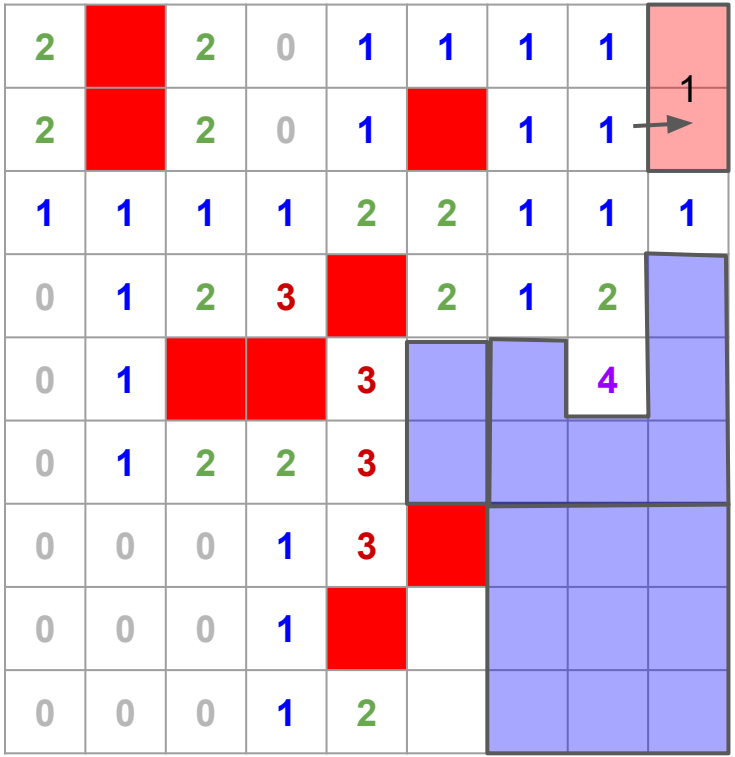
2 2 0 1 1 1 1
2 2 0 1 1 1
1 1 1 1 2 2 1 1 1
0 1 2 3 2 1 2
0 1 3 4
0 1 2 2 3
0 0 0 1 3
0 0 0 1
0 0 0 1 2

15 / 81

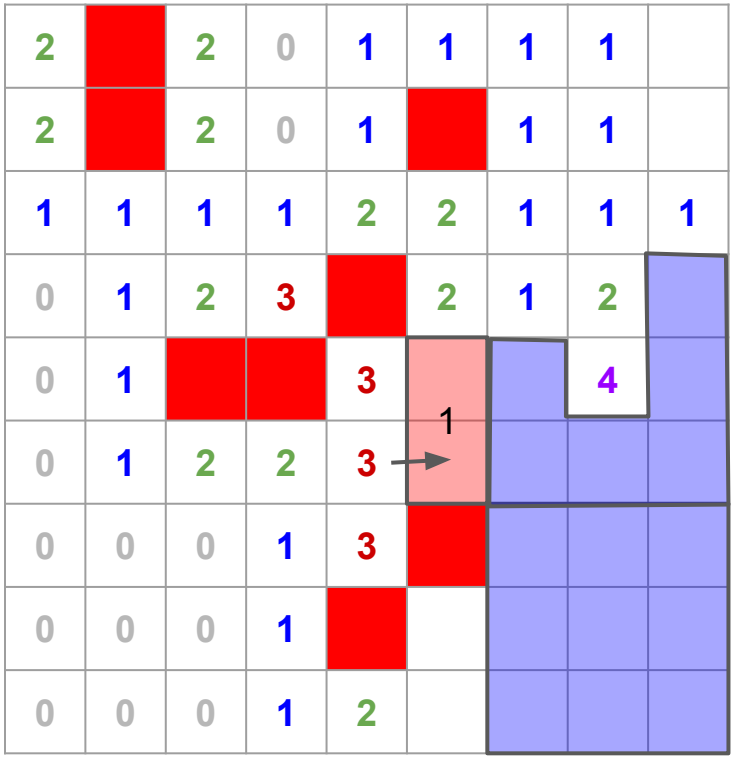

2 2 0 1 1 1 1
2 2 0 1 1 1
1 1 1 1 2 2 1 1 1
0 1 2 3 2 1 2
0 1 3 4
0 1 2 2 3
0 0 0 1 3
0 0 0 1
0 0 0 1 2

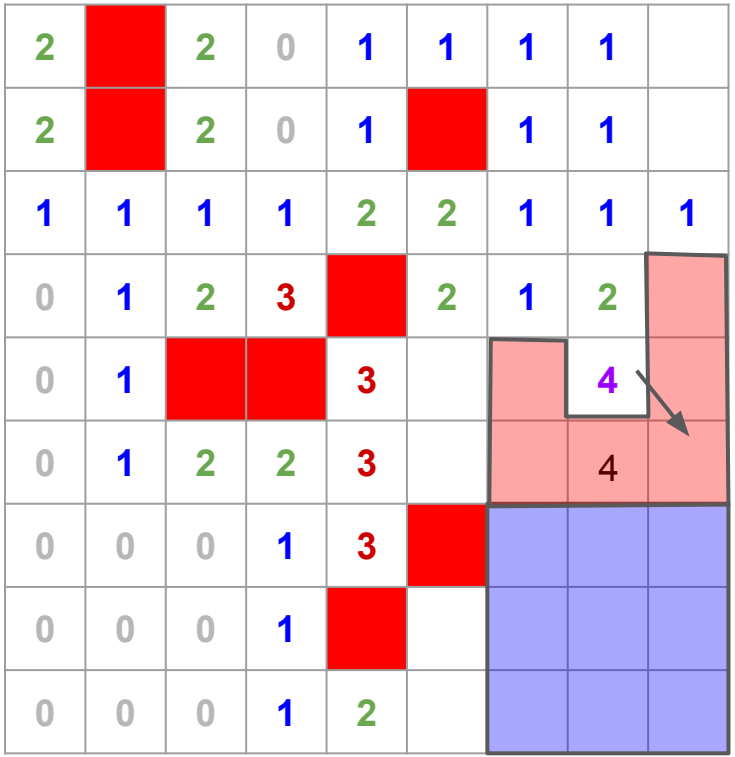
7 / 20


2 2 0 1 1 1 1
2 2 0 1 1 1
1 1 1 1 2 2 1 1 1
0 1 2 3 2 1 2
0 1 3 4
0 1 2 2 3
0 0 0 1 3
0 0 0 1
0 0 0 1 2
1


2 2 0 1 1 1 1
2 2 0 1 1 1
1 1 1 1 2 2 1 1 1
0 1 2 3 2 1 2
0 1 3 4
0 1 2 2 3
0 0 0 1 3
0 0 0 1
0 0 0 1 2
1

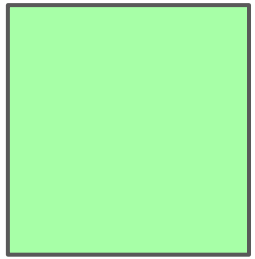
5 / 18


2 2 0 1 1 1 1
2 2 0 1 1 1
1 1 1 1 2 2 1 1 1
0 1 2 3 2 1 2
0 1 3 4
1
0 1 2 2 3
0 0 0 1 3
0 0 0 1
0 0 0 1 2


2 2 0 1 1 1 1
2 2 0 1 1 1
1 1 1 1 2 2 1 1 1
0 1 2 3 2 1 2
0 1 3 4
0 1 2 2 3 4
0 0 0 1 3
0 0 0 1
0 0 0 1 2

0 / 18

2		2	0	1	1	1	1	
2		2	0	1		1	1	
1	1	1	1	2	2	1	1	1
0	1	2	3		2	1	2	
0	1			3			4	
0	1	2	2	3				
0	0	0	1	3				
0	0	0	1					
0	0	0	1	2				

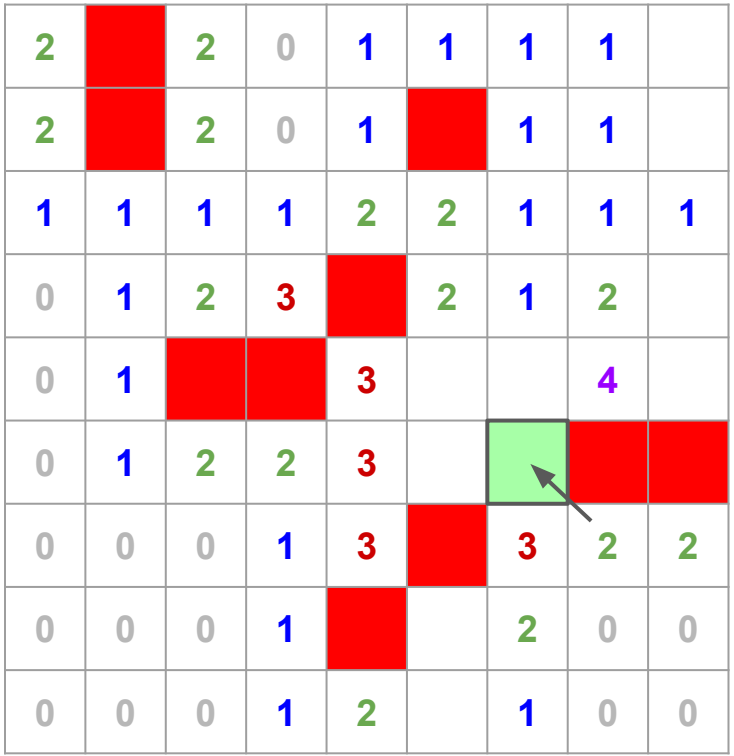


0 / 9
Can Clear

2		2	0	1	1	1	1	
2		2	0	1		1	1	
1	1	1	1	2	2	1	1	1
0	1	2	3		2	1	2	
0	1			3			4	
0	1	2	2	3				
0	0	0	1	3		3	2	2
0	0	0	1			2	0	0
0	0	0	1	2		1	0	0

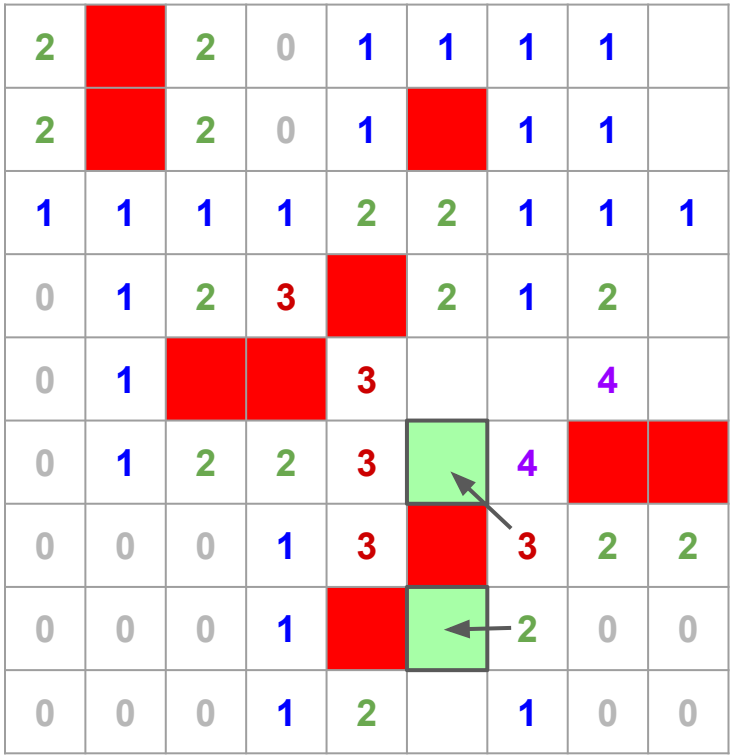
2 / 2

Can Flag

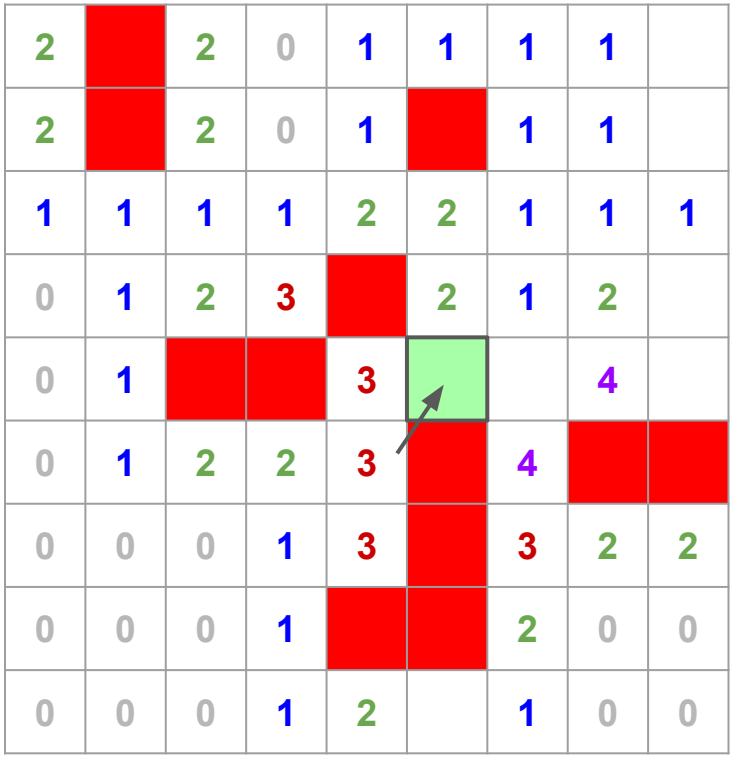

2 2 0 1 1 1 1
2 2 0 1 1 1
1 1 1 1 2 2 1 1 1
0 1 2 3 2 1 2
0 1 3 4
0 1 2 2 3
0 0 0 1 3 3 2 2
0 0 0 1 2 0 0
0 0 0 1 2 1 0 0

0 / 1

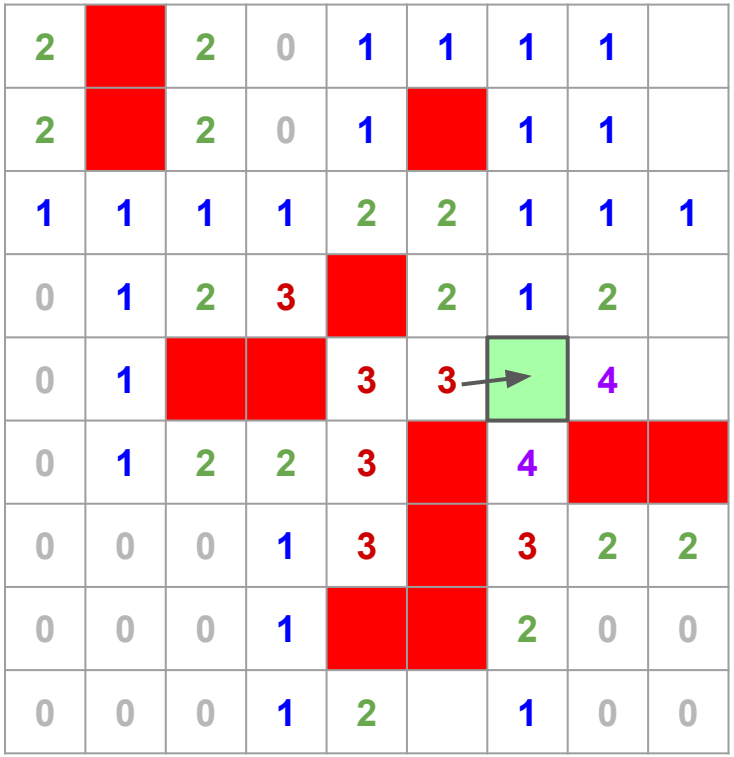
Can Clear


2 2 0 1 1 1 1
2 2 0 1 1 1
1 1 1 1 2 2 1 1 1
0 1 2 3 2 1 2
0 1 3 4
0 1 2 2 3 4
0 0 0 1 3 3 2 2
0 0 0 1 2 0 0
0 0 0 1 2 1 0 0

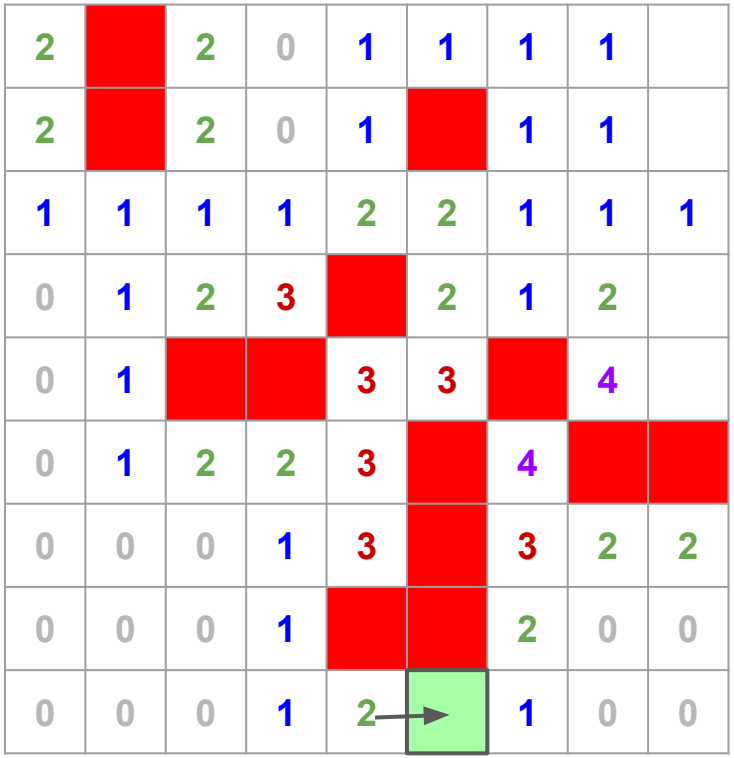
2 / 2
Can Flag


2 2 0 1 1 1 1
2 2 0 1 1 1
1 1 1 1 2 2 1 1 1
0 1 2 3 2 1 2
0 1 3 4
0 1 2 2 3 4
0 0 0 1 3 3 2 2
0 0 0 1 2 0 0
0 0 0 1 2 1 0 0

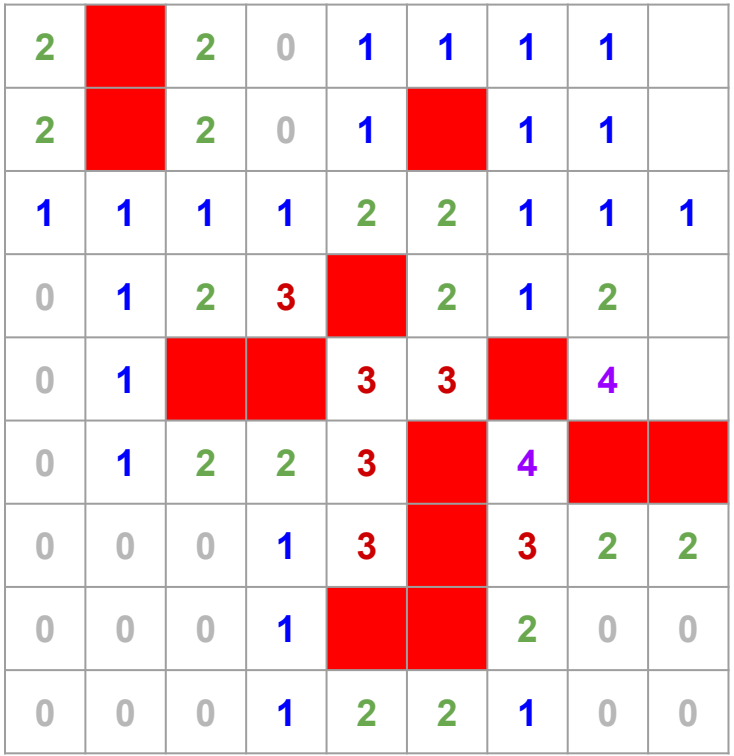
0 / 1
Can Clear


2 2 0 1 1 1 1
2 2 0 1 1 1 1
1 1 1 1 2 2 1 1 1
0 1 2 3 2 1 2
0 1 3 3 4
0 1 2 2 3 4
0 0 0 1 3 3 2 2
0 0 0 1 2 0 0
0 0 0 1 2 1 0 0

1 / 1
Can Flag


2 2 0 1 1 1 1
2 2 0 1 1 1
1 1 1 1 2 2 1 1 1
0 1 2 3 2 1 2
0 1 3 3 4
0 1 2 2 3 4
0 0 0 1 3 3 2 2
0 0 0 1 2 0 0
0 0 0 1 2 1 0 0

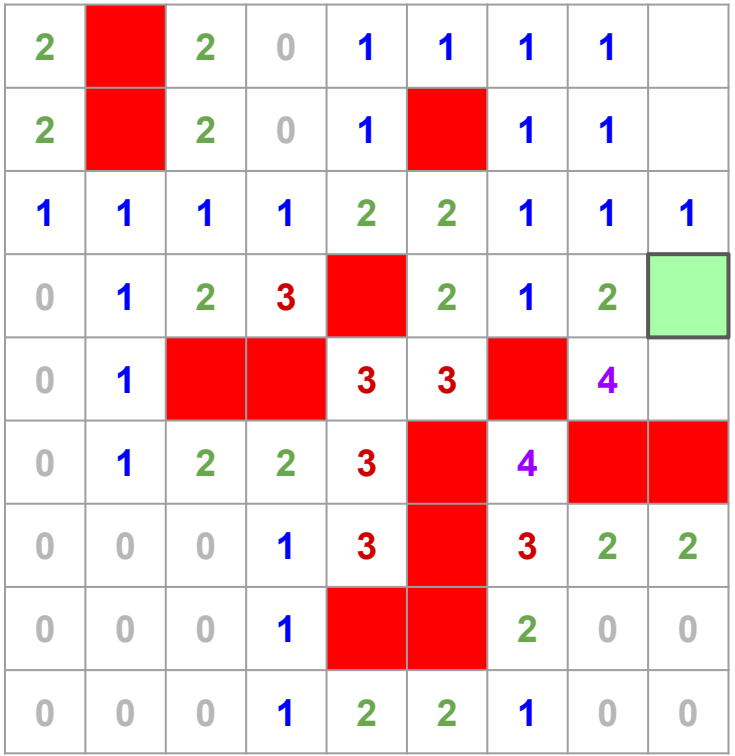
0 / 1
Can Clear



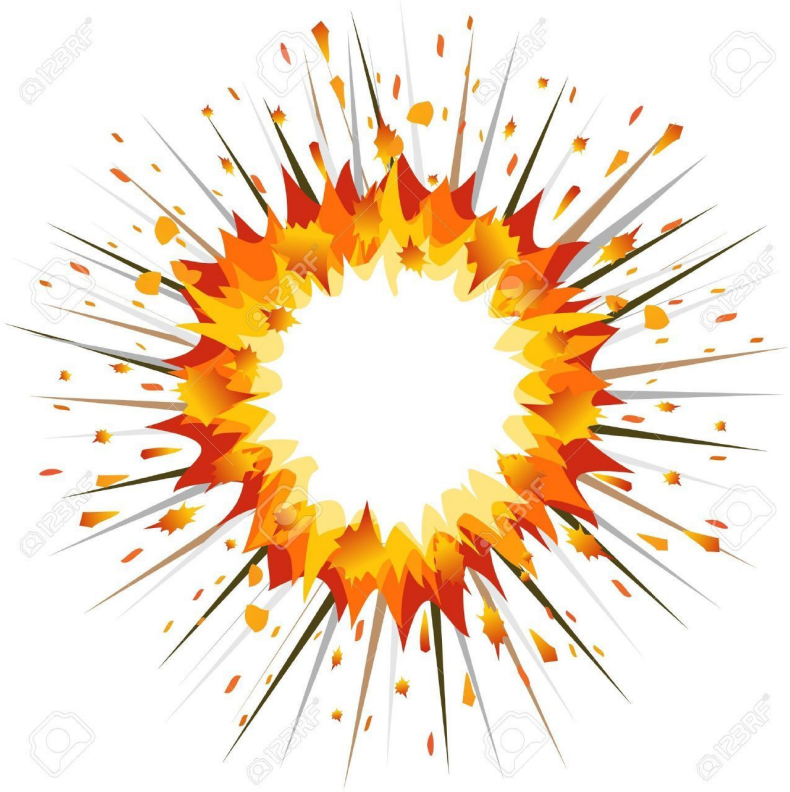
...What now?

It’s time for...

Super Advanced Technique


2 2 0 1 1 1 1
2 2 0 1 1 1
1 1 1 1 2 2 1 1 1
0 1 2 3 2 1 2
0 1 3 3 4
0 1 2 2 3 4
0 0 0 1 3 3 2 2
0 0 0 1 2 0 0
0 0 0 1 2 2 1 0 0

Guessing



:(

(bad solver code on github @stevenwaterman)

Next time:

- Constraint Reduction
- Inexact Constraints
- Proof of Completeness
- How to actually implement it
- How to do it without taking exponential time

So get excited for *How to solve minesweeper in a series of 20 hour-long lectures!*