Demo

CSR to CVR

Matrix

- 15 * 15
- nnz = 51

	1		1	2		3						5		
8			1	3			2	1		3				4
	5				5					8				
											9	1		
	4	4				2							3	
3							3				7		7	6
	10		9								8			
				7										
			1				5			9				7
2			5		8	4	4				1			
		8												1
				6			7					6		
			5			10		9						
								4		6				11

Matrix

Thread_0
nnz = 26

	1		1	2		3						5		
8			1	3			2	1		3				4
	5				5					8				
											9	1		
	4	4				2							3	
3							3				7		7	6

Thread_1
nnz = 25

	10		9								8			
				7										
			1				5			9				7
2			5		8	4	4				1			
		8												1
				6			7					6		
			5			10		9						
								4		6				11

Thread_0

	1		1	2		3						5		
8			1	3			2	1		3				4
	5				5					8				
											9	1		
	4	4				2							3	
3							3				7		7	6

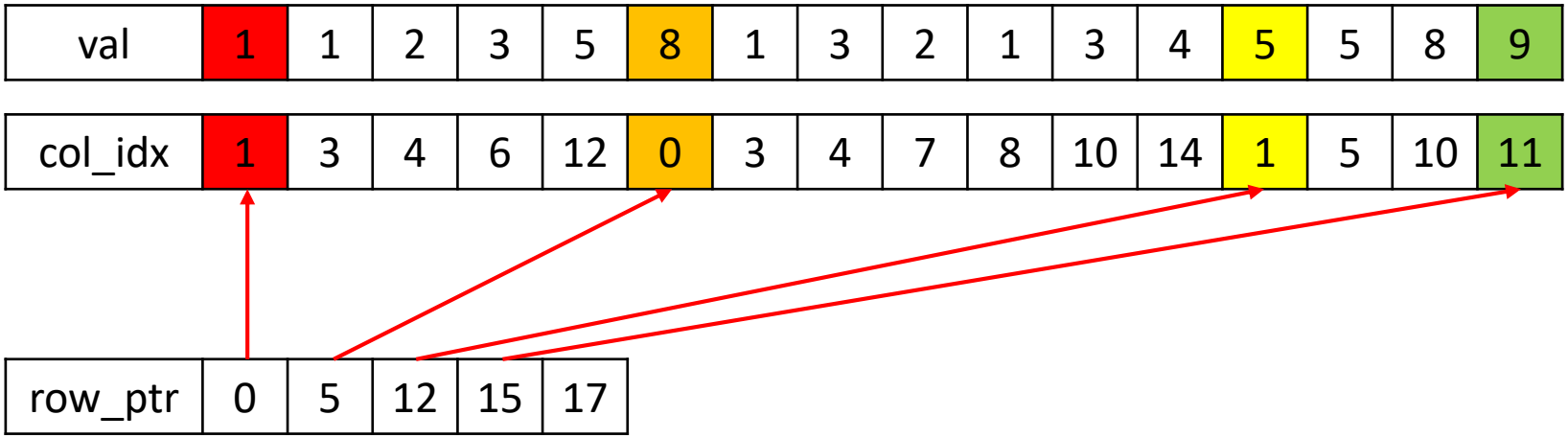
CVR

lane	val							tail	col_idx						
0	1	1	2	3	5	7	7	0	1	3	4	6	12	11	13
1	8	1	3	2	1	3	4	1	0	3	4	7	8	10	14
2	5	5	8	3	3	6	0	6	1	5	10	0	7	14	14
3	9	1	4	4	2	3	0	5	11	12	1	2	6	13	14

rec	pos	7	10	16	22	23	24	25
	wb	4	2	0	2	3	2	1

lr_rec = 16

Thread_0, initialize



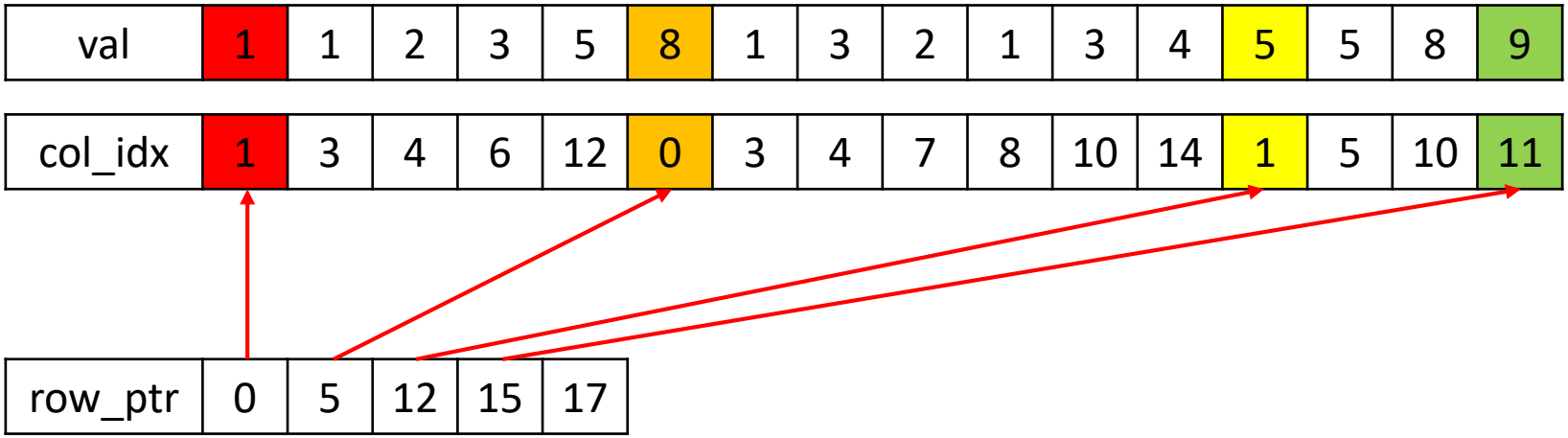
lane	val		col_idx		tail	tracker		
						valID	rowID	count
0	-	-	-	-	-	0	0	5
1	-	-	-	-	-	5	1	7
2	-	-	-	-	-	12	2	3
3	-	-	-	-	-	15	4	2

rowID = row

valID = row_ptr[row]

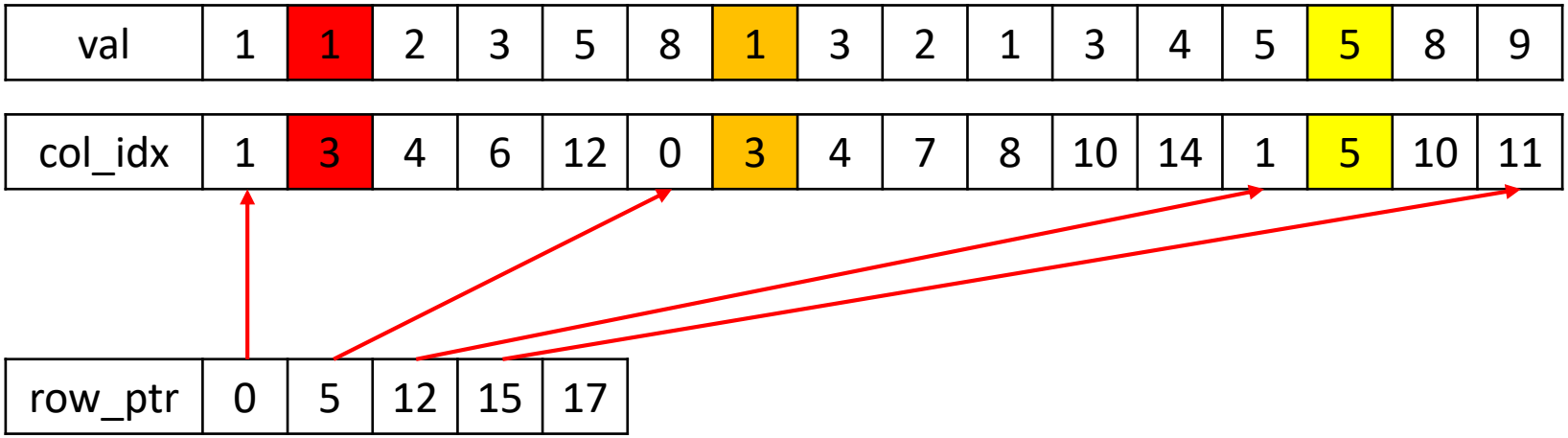
count = row_ptr[row+1] – row_ptr[row]

Convert



lane	val		col_idx		tail	tracker		
						valID	rowID	count
0	1	-	1	-	-	0	0	5
1	8	-	0	-	-	5	1	7
2	5	-	1	-	-	12	2	3
3	9	-	11	-	-	15	4	2

Convert



lane	val		col_idx		tail	tracker		
						valID	rowID	count
0	1	-	1	-	-	1	0	4
1	8	-	0	-	-	6	1	6
2	5	-	1	-	-	13	2	2
3	9	-	11	-	-	16	4	1

valID++

count--

Convert

	1		1	2		3						5		
8			1	3			2	1		3				4
	5				5					8				
											9	1		
	4	4				2							3	
3							3				7		7	6

lane	val			col_idx			tail	tracker		
								valID	rowID	count
0	-	-	-	-	-	-	-	0	0	5
1	-	-	-	-	-	-	-	5	1	7
2	-	-	-	-	-	-	-	12	2	3
3	-	-	-	-	-	-	-	15	4	2

Convert

	1		1	2		3						5		
8			1	3			2	1		3				4
	5				5					8				
											9	1		
	4	4				2							3	
3							3				7		7	6

lane	val			col_idx			tail	tracker		
								valID	rowID	count
0	1	-	-	1	-	-	-	1	0	4
1	8	-	-	0	-	-	-	6	1	6
2	5	-	-	1	-	-	-	13	2	2
3	9	-	-	11	-	-	-	16	4	1

Trigger recording

	1		1	2		3						5		
8			1	3			2	1		3				4
	5				5					8				
											9	1		
	4	4				2							3	
3							3				7		7	6

lane	val			col_idx			tail	tracker		
								valID	rowID	count
0	1	1	-	1	3	-	-	2	0	3
1	8	1	-	0	3	-	-	7	1	5
2	5	5	-	1	5	-	-	14	2	1
3	9	1	-	11	12	-	-	17	4	0

Record

lane	val			col_idx			tail	tracker		
	i = 0	i = 1						valID	rowID	count
0	1	1	-	1	3	-	-	2	0	3
1	8	1	-	0	3	-	-	7	1	5
2	5	5	-	1	5	-	-	14	2	1
lane = 3	3	9	1	-	11	12	-	-	17	4	0

pos = i * n_lanes + lane

wb = rowID

rec			
	pos	7	-
	wb	4	-

Feed

	1		1	2		3						5		
8			1	3			2	1		3				4
	5				5					8				
											9	1		
	4	4				2							3	
3							3				7		7	6

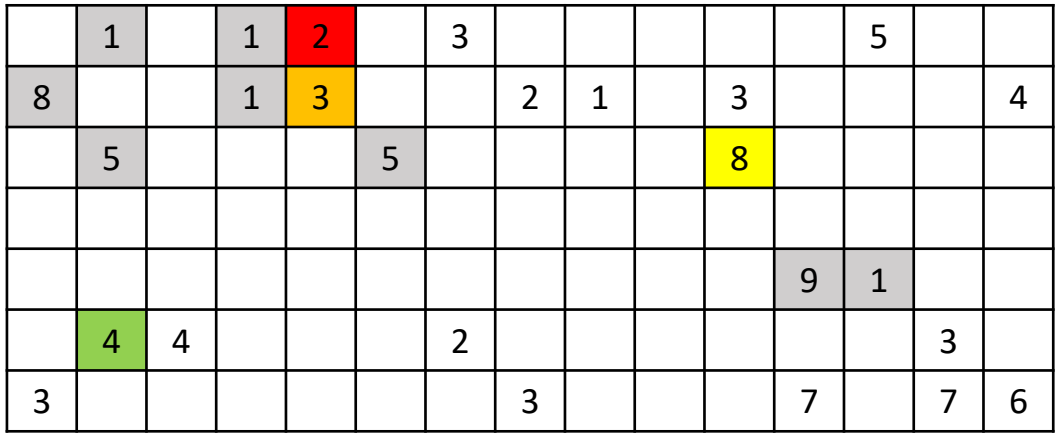
lane	val			col_idx			tail	tracker		
								valID	rowID	count
0	1	1	-	1	3	-	-	2	0	3
1	8	1	-	0	3	-	-	7	1	5
2	5	5	-	1	5	-	-	14	2	1
3	9	1	-	11	12	-	-	17	5	4

Convert

	1		1	2		3						5		
8			1	3			2	1		3				4
	5				5					8				
											9	1		
	4	4				2							3	
3							3				7		7	6

lane	val			col_idx			tail	tracker		
								valID	rowID	count
0	1	1	-	1	3	-	-	2	0	3
1	8	1	-	0	3	-	-	7	1	5
2	5	5	-	1	5	-	-	14	2	1
3	9	1	-	11	12	-	-	17	5	4

Convert

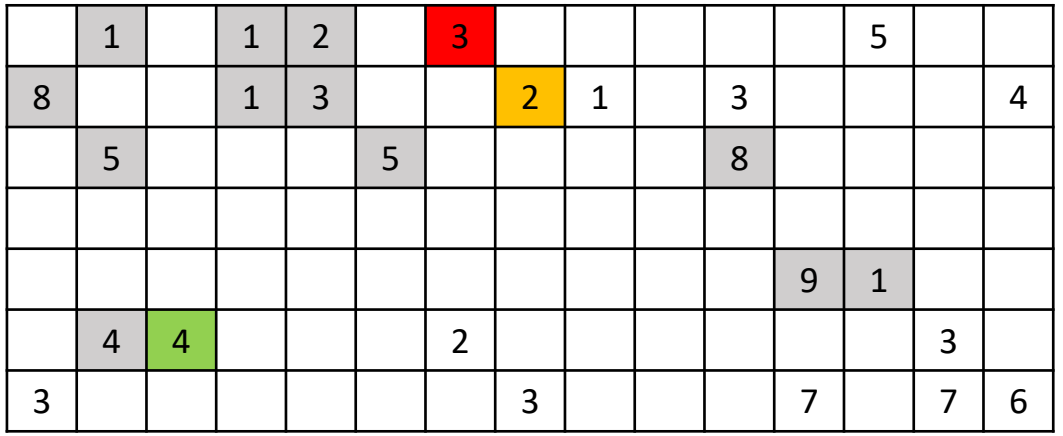


lane	val							tail	tracker		
									valID	rowID	count
0	1	1	-	-	-	-	-	-	2	0	3
1	8	1	-	-	-	-	-	-	7	1	5
2	5	5	-	-	-	-	-	-	14	2	1
3	9	1	-	-	-	-	-	-	17	5	4

col_idx						
1	3	-	-	-	-	-
0	3	-	-	-	-	-
1	5	-	-	-	-	-
11	12	-	-	-	-	-

rec					
	pos	7	-	-	-
	wb	4	-	-	-
	pos	-	-	-	-
	wb	-	-	-	-

Record



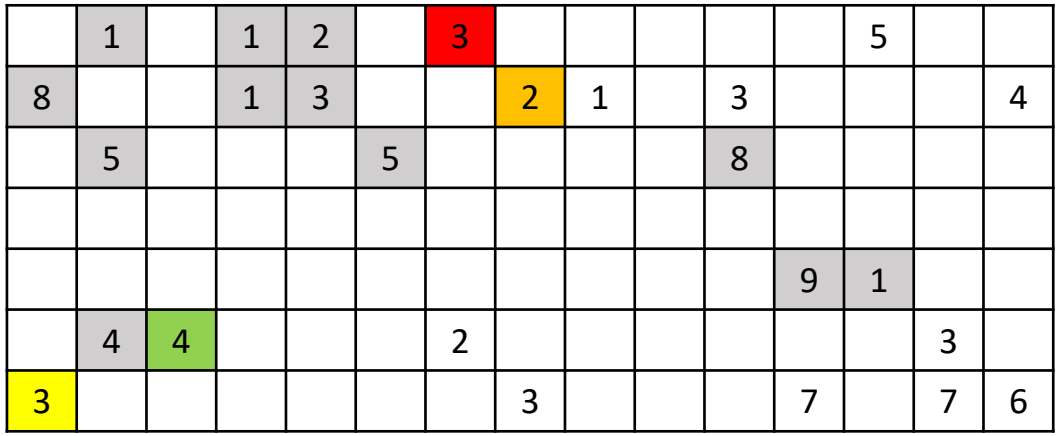
	1		1	2		3						5		
8			1	3			2	1		3				4
	5				5					8				
											9	1		
	4	4				2							3	
3							3				7		7	6

lane	val							tail	tracker		
									valID	rowID	count
0	1	1	2	-	-	-	-	-	3	0	2
1	8	1	3	-	-	-	-	-	8	1	4
2	5	5	8	-	-	-	-	-	15	2	0
3	9	1	4	-	-	-	-	-	18	5	3

col_idx						
1	3	4	-	-	-	-
0	3	4	-	-	-	-
1	5	10	-	-	-	-
11	12	1	-	-	-	-

rec					
	pos	7	10	-	-
	wb	4	2	-	-
	pos	-	-	-	-
	wb	-	-	-	-

Feed

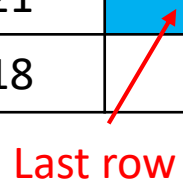


lane	val							tail	tracker		
									valID	rowID	count
0	1	1	2	-	-	-	-	-	3	0	2
1	8	1	3	-	-	-	-	-	8	1	4
2	5	5	8	-	-	-	-	-	21	6	5
3	9	1	4	-	-	-	-	-	18	5	3

col_idx						
1	3	4	-	-	-	-
0	3	4	-	-	-	-
1	5	10	-	-	-	-
11	12	1	-	-	-	-

rec					
	pos	7	10	-	-
	wb	4	2	-	-
	pos	-	-	-	-
	wb	-	-	-	-

lane	val							tail	tracker		
									valID	rowID	count
0	1	1	2	-	-	-	-	-	3	0	2
1	8	1	3	-	-	-	-	-	8	1	4
2	5	5	8	-	-	-	-	-	21	6	5
3	9	1	4	-	-	-	-	-	18	5	3

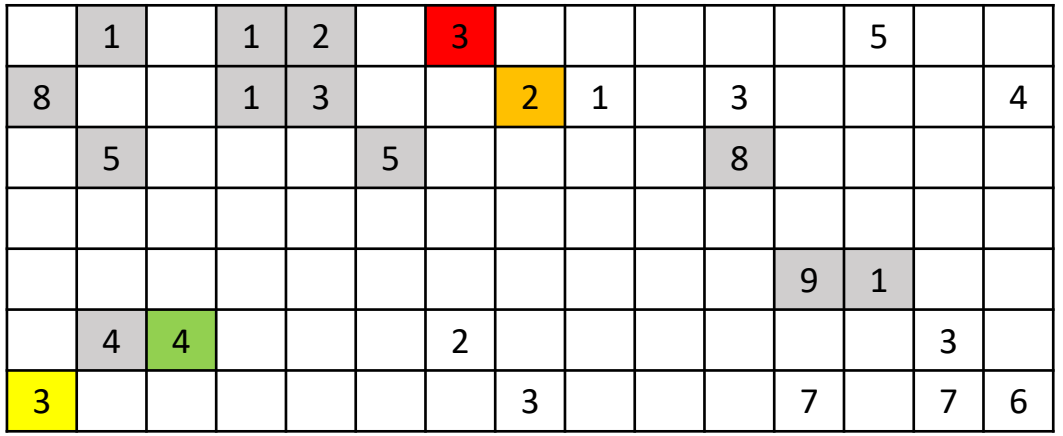


lane	val							tail	tracker		
									valID	rowID	count
0	1	1	2	-	-	-	-	0	3	0	2
1	8	1	3	-	-	-	-	1	8	1	4
2	5	5	8	-	-	-	-	6	21	2	5
3	9	1	4	-	-	-	-	5	18	3	3

tail[] = rowID[]
rowID[] = lane

Feeding will be replaced by stealing since then.

Convert

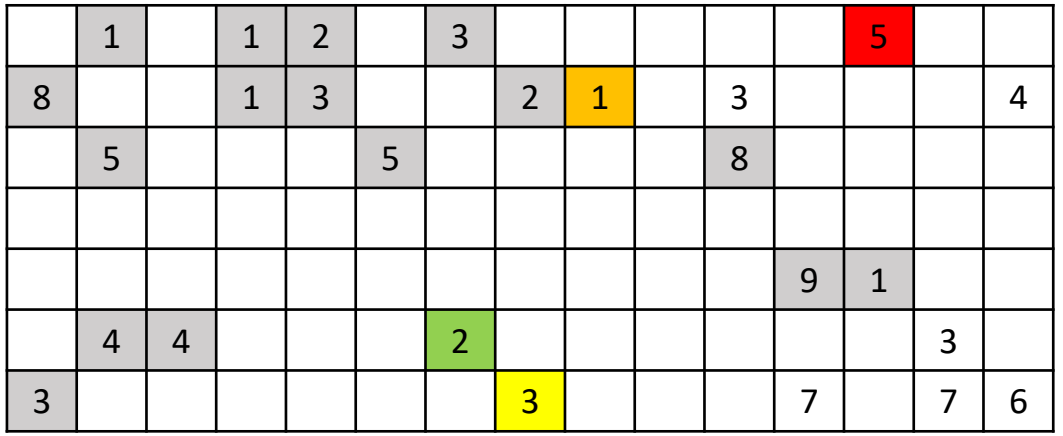


lane	val							tail	tracker		
									valID	rowID	count
0	1	1	2	-	-	-	-	0	3	0	2
1	8	1	3	-	-	-	-	1	8	1	4
2	5	5	8	-	-	-	-	6	21	2	5
3	9	1	4	-	-	-	-	5	18	3	3

col_idx						
1	3	4	-	-	-	-
0	3	4	-	-	-	-
1	5	10	-	-	-	-
11	12	1	-	-	-	-

rec					
	pos	7	10	-	-
	wb	4	2	-	-
	pos	-	-	-	-
	wb	-	-	-	-

Convert

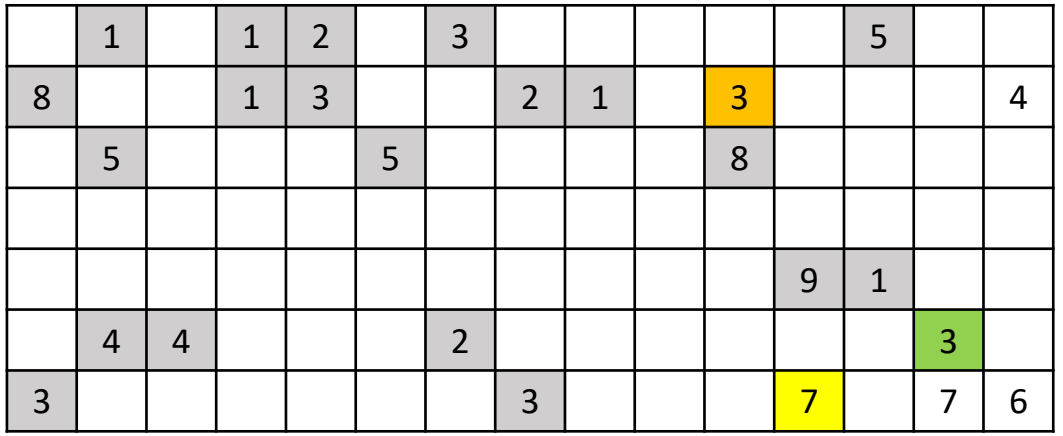


lane	val							tail	tracker		
									valID	rowID	count
0	1	1	2	3	-	-	-	0	4	0	1
1	8	1	3	2	-	-	-	1	9	1	3
2	5	5	8	3	-	-	-	6	22	2	4
3	9	1	4	4	-	-	-	5	19	3	2

col_idx						
1	3	4	6	-	-	-
0	3	4	7	-	-	-
1	5	10	0	-	-	-
11	12	1	2	-	-	-

rec					
	pos	7	10	-	-
	wb	4	2	-	-
	pos	-	-	-	-
	wb	-	-	-	-

Record



lane	val							tail	tracker		
									valID	rowID	count
0	1	1	2	3	5	-	-	0	5	0	0
1	8	1	3	2	1	-	-	1	10	1	2
2	5	5	8	3	3	-	-	6	23	2	3
3	9	1	4	4	2	-	-	5	20	3	1

col_idx						
1	3	4	6	12	-	-
0	3	4	7	8	-	-
1	5	10	0	7	-	-
11	12	1	2	6	-	-

lr_rec = 16

rec					
	pos	7	10	16	-
	wb	4	2	0	-
	pos	-	-	-	-
	wb	-	-	-	-

Steal

lane	val							tail	tracker		
									valID	rowID	count
0	1	1	2	3	5	-	-	0	5	0	0
1	8	1	3	2	1	-	-	1	10	1	2
2	5	5	8	3	3	-	-	6	23	2	3
3	9	1	4	4	2	-	-	5	20	3	1

average = (2 + 3 + 1 + n_lanes - 1) / n_lanes = 2

Steal

lane	val							tail	tracker		
									valID	rowID	count
0	1	1	2	3	5	-	-	0	5	0	0
1	8	1	3	2	1	-	-	1	10	1	2
2	5	5	8	3	3	-	-	6	23	2	3
3	9	1	4	4	2	-	-	5	20	3	1

average = 2

count[2] > average
candidate = 2

Steal

lane	val							tail	tracker		
									valID	rowID	count
0	1	1	2	3	5	-	-	0	23	2	2
1	8	1	3	2	1	-	-	1	10	1	2
2	5	5	8	3	3	-	-	6	25	2	1
3	9	1	4	4	2	-	-	5	20	3	1

average = 2

count[2] > average

candidate = 2

valID = valID[candidate]

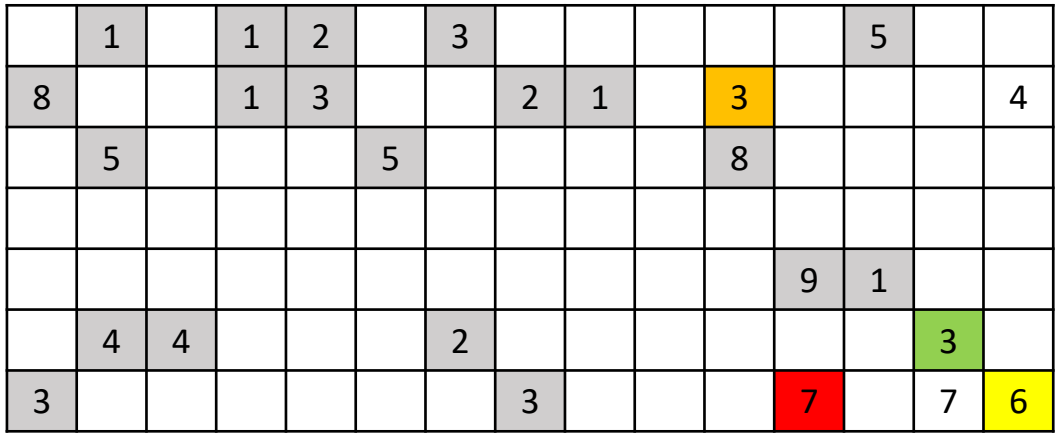
rowID = candidate

count = average

valID[candidate] += average

count[candidate] -= average

Convert



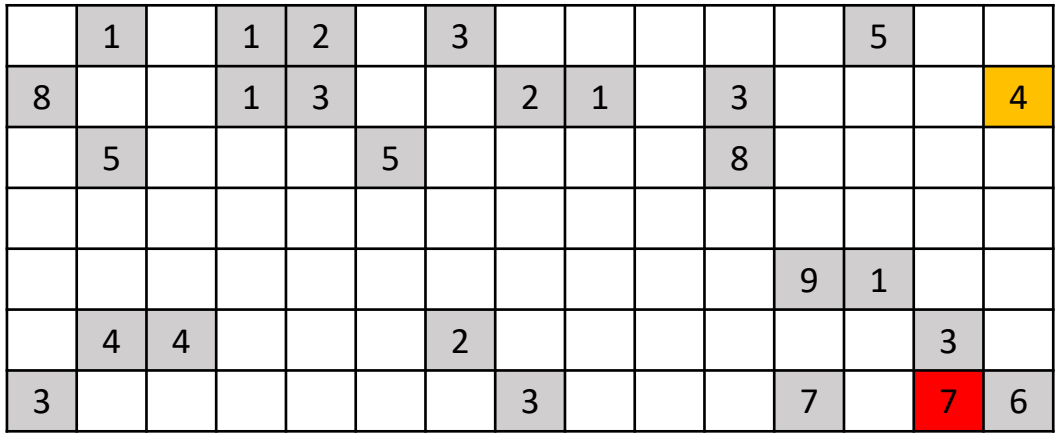
lr_rec = 16

lane	val							tail	tracker		
									valID	rowID	count
0	1	1	2	3	5	-	-	0	23	2	2
1	8	1	3	2	1	-	-	1	10	1	2
2	5	5	8	3	3	-	-	6	25	2	1
3	9	1	4	4	2	-	-	5	20	3	1

col_idx						
1	3	4	6	12	-	-
0	3	4	7	8	-	-
1	5	10	0	7	-	-
11	12	1	2	6	-	-

rec					
	pos	7	10	16	-
	wb	4	2	0	-
	pos	-	-	-	-
	wb	-	-	-	-

Record



lr_rec = 16

lane	val							tail	tracker		
									valID	rowID	count
0	1	1	2	3	5	7	-	0	24	2	1
1	8	1	3	2	1	3	-	1	11	1	1
2	5	5	8	3	3	6	-	6	26	2	0
3	9	1	4	4	2	3	-	5	21	3	0

col_idx						
1	3	4	6	12	11	-
0	3	4	7	8	10	-
1	5	10	0	7	14	-
11	12	1	2	6	13	-

rec					
	pos	7	10	16	22
	wb	4	2	0	2
	pos	23	-	-	-
	wb	3	-	-	-

Steal(the last round)

lane	val							tail	tracker		
									valID	rowID	count
0	1	1	2	3	5	7	-	0	24	2	1
1	8	1	3	2	1	3	-	1	11	1	1
2	5	5	8	3	3	6	-	6	26	2	0
3	9	1	4	4	2	3	-	5	21	3	0

average = (1 + 1 + n_lanes - 1) / n_lanes = 1
count[] <= average

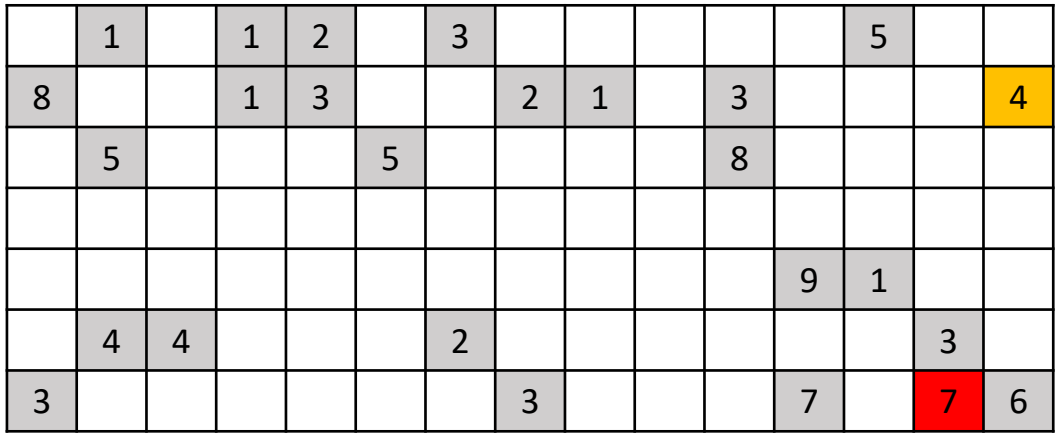
Steal(the last round)

lane	val							tail	tracker		
									valID	rowID	count
0	1	1	2	3	5	7	-	0	24	2	1
1	8	1	3	2	1	3	-	1	11	1	1
2	5	5	8	3	3	6	-	6	-1	2	1
3	9	1	4	4	2	3	-	5	-1	3	1

average = 1
count[] <= average

valID = -1
count = 1
(padding)

Convert



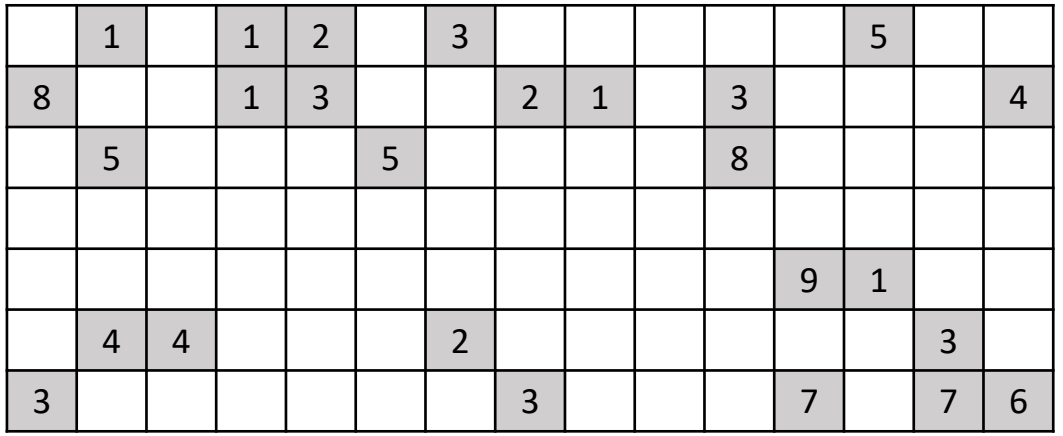
lr_rec = 16

lane	val							tail	tracker		
									valID	rowID	count
0	1	1	2	3	5	7	-	0	24	2	1
1	8	1	3	2	1	3	-	1	11	1	1
2	5	5	8	3	3	6	-	6	-1	2	1
3	9	1	4	4	2	3	-	5	-1	3	1

col_idx						
1	3	4	6	12	11	-
0	3	4	7	8	10	-
1	5	10	0	7	14	-
11	12	1	2	6	13	-

rec					
	pos	7	10	16	22
	wb	4	2	0	2
	pos	23	-	-	-
	wb	3	-	-	-

Record



lr_rec = 16

lane	val							tail	tracker		
									valID	rowID	count
0	1	1	2	3	5	7	7	0	25	2	0
1	8	1	3	2	1	3	4	1	12	1	0
2	5	5	8	3	3	6	0	6	0	2	0
3	9	1	4	4	2	3	0	5	0	3	0

col_idx						
1	3	4	6	12	11	13
0	3	4	7	8	10	14
1	5	10	0	7	14	14
11	12	1	2	6	13	14

rec					
	pos	7	10	16	22
	wb	4	2	0	2
	pos	23	24	25	-
	wb	3	2	1	-

Thread_0

	1		1	2		3						5		
8			1	3			2	1		3				4
	5				5					8				
											9	1		
	4	4				2							3	
3							3				7		7	6

CVR

lane	val							tail	col_idx						
0	1	1	2	3	5	7	7	0	1	3	4	6	12	11	13
1	8	1	3	2	1	3	4	1	0	3	4	7	8	10	14
2	5	5	8	3	3	6	0	6	1	5	10	0	7	14	14
3	9	1	4	4	2	3	0	5	11	12	1	2	6	13	14

rec	pos	7	10	16	22	23	24	25
	wb	4	2	0	2	3	2	1

lr_rec = 16