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

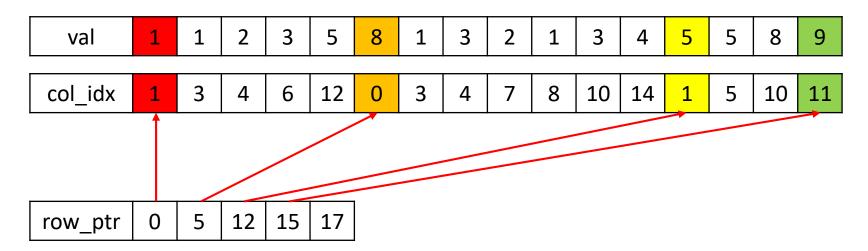
	10		9							8		
				7								
			1				5		9			7
2			5		8	4	4			1		
		8										1
				6			7				6	
			5			10		9				
								4	6			11

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

lano		al	col	idy	+ail		tracker	
lane	V	dI	COI_	_idx	tail	valID	rowID	count
0	-	-	ı	-	1	0	0	5
1	-	-	-	-	-	5	1	7
2	-	-	-	-	-	12	2	3
3	-	-	-	-	-	15	4	2

Initialize



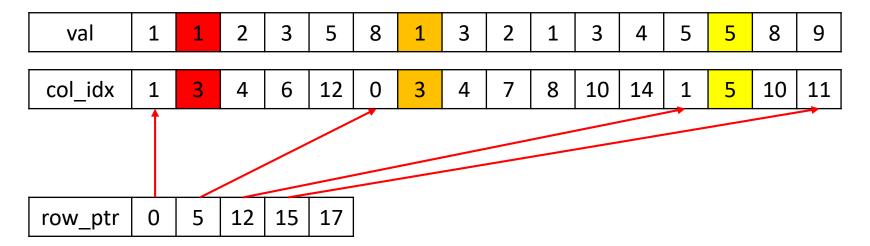
lano		al	col	idv	+ail		tracker	
lane 0	V	dI	COI_	_idx	tail	valID	rowID	count
0	-	-	-	-	-	0	0	5
1	-	-	-	-	-	5	1	7
2	-	-	-	-	-	12	2	3
3	-	-	-	-	-	15	4	2

rowID = row
valID =
row_ptr[row]

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

val	1	1	2	3	5	8	1	3	2	1	3	4	5	5	8	9
col_idx	1	3	4	6	12	0	3	4	7	8	10	14	1	5	10	11
	1															
				_												
row_ptr	0	5	12	15	17											

lano	2.0	al	sol	idy	+ail		tracker	
lane	V	dI	COI_	_idx	tail	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



lano		al	col	idv	+ail		tracker	
lane	V	al	COI_	_idx	tail	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--

	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

lano		val			cal idy		+ail		tracker	
lane		val			col_idx		tail	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

lano	ane val				cal idy	,	+ail	tracker			
lane		Vai			col_idx		tail	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

	lano		val			cal idy	,	tail.		tracker	
	lane	i = 0	val i = 1			col_idx		tail	valID	rowID	count
	0	1	1	ı	1	3	1	1	2	0	3
	1	8	8 1 -		0	3	1	1	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 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

lano	lane val				cal idy	,	+ail	tracker			
lane		Vai			col_idx		tail	valID	rowID	count	
0	1	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	

	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

lano		val		col_idx					tracker	
lane		val			coi_iux		tail	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

	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

lano				val				+ail		tracker	
lane				val				tail	valID	rowID	count
0	1	1	-	1	_	-	-	1	2	0	3
1	8	1	-	1	_	-	-	1	7	1	5
2	5	5	_	-		-	-	-	14	2	1
3	9 1							ı	17	5	4

		(col_id	(
1	3	-	ı	ı	ı	ı
0	3	-	-	-	ı	-
1	5	-	-	-	-	-
11	12	-	-	-	-	-

	pos	7	ı	ı	ı
ro c	wb	4	-	-	-
rec	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

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

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

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

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

lano	nne val						tail		tracker		
lane		VdI						lali	valID	rowID	count
0	1	1	2	-	-	-	1	1	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	ı	ı	ı	ı						
0	3	4	1	ı	ı	1						
1	5	10	1	1	1	ı						
11	12	1	-	-	-	-						

pos	7	10	ı	ı
wb	4	2	1	1
pos	-	-	-	-
wb	-	-	-	-
	wb pos	wb 4 pos -	wb 4 2 pos	wb 4 2 - pos

lano				ادير				+ail		tracker	
lane		val						tail	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

Last row

lano				ادير				+ail		tracker	
lane	val						tail	valID	rowID	count	
0	1	1	2	1	_	-	-	0	3	0	2
1	8	1	3	-	_	-	-	1	8	1	4
2	5	5	8	-	-	-	-	6	21	2	5
3	9	1	4	ı	-	_	-	5	18	3	3

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

Feeding will be replaced by stealing since then.

	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

lano	val							+ail		tracker	
lane		VdI						tail	valID	rowID	count
0	1	1	2	-	-	-	-	0	3	0	2
1	8	1	3	-	-	-	ı	1	8	1	4
2	5	5	8	-	_	-	ı	6	21	2	5
3	9	1	4	-	-	-	-	5	18	3	3

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

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

	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

lano				val				+3:1		tracker	
lane				val				tail	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_id	(
1	3	4	6	ı	-	-
0	3	4	7	1	-	-
1	5	10	0	1	-	-
11	12	1	2	-	-	-

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

Record

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

lano				val				+ail		tracker	
lane				val				tail	valID	rowID	count
0	1	1	2	3	5	-	1	0	5	0	0
1	8	1	3	2	1	-	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_id	<								
1	3 4 6 12											
0	3	4	7	8	-	-						
1	5	10	0	7	-	-						
11	12	1	2	6	-	-						

		lr_r	ec = 1	6	
	pos	7	10	16	ı
roc	wb	4	2	0	ı
rec	pos	1	-	ı	ı
	wb	-	-	-	-

Steal

lano				val				+ail		tracker			
lane				val				tail	valID	rowID	C	count	
0	1	1	2	3	5	ı	-	0	5	0		0	
1	8	1	3	2	1	1	-	1	10	1		2	
2	5	5	8	3	3	1	-	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

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

average = 2 count[2] > average candidate = 2

Steal

lano				val				+ail		tracker	
lane				val				tail	valID	rowID	count
0	1	1	2	3	5	-	ı	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

	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

lano				val				+ail	tracker			
lane				val				tail	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	-	ı	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	-	-							

	pos	7	10	16	ı
KO 0	wb	4	2	0	-
rec	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

lano				val				tail	tracker			
latte	lane val								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	ı						
0	3	4	7	8	10	1						
1	5	10	0	7	14	1						
11	12	1	2	6	13	-						

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

Steal(the last round)

lano				val				tail	tracker			
lane				val				laii	valID	rowID	(count
0	1	1	2	3	5	7	ı	0	24	2		1
1	8	1	3	2	1	3	1	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</pre>

Steal(the last round)

lano				ادير				+ail	tracker			
lane val								tail	valID	rowID	count	
0	1	1	2	3	5	7	ı	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</pre>

valID = -1
count = 1
(padding)

	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

lano				val				tail	tracker			
lane		val							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

	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

lano	val						tail	tracker			
lane				Val				tan	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						e 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

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