



# Arrays - Part IV

Course on Data Structure



# CS & IT Engineering

Data Structure

Arrays- IV



Lecture Number- 05

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# Topics

*to be covered*

1

Arrays



## Sparse matrix

- (i) Lower triangular matrix
- (ii) Upper triangular matrix
- (iii) Tri-diagonal matrix



# Lower triangular matrix

✓ A LTM is a square matrix  
( $n \times n$ )

$$A_{12} = 0$$

$$A_{13} = 0$$

$$A_{14} = 0$$

row  $\rightarrow$  col

$$A_{23} = 0$$

$$A_{24} = 0$$

$$A_{34} = 0$$

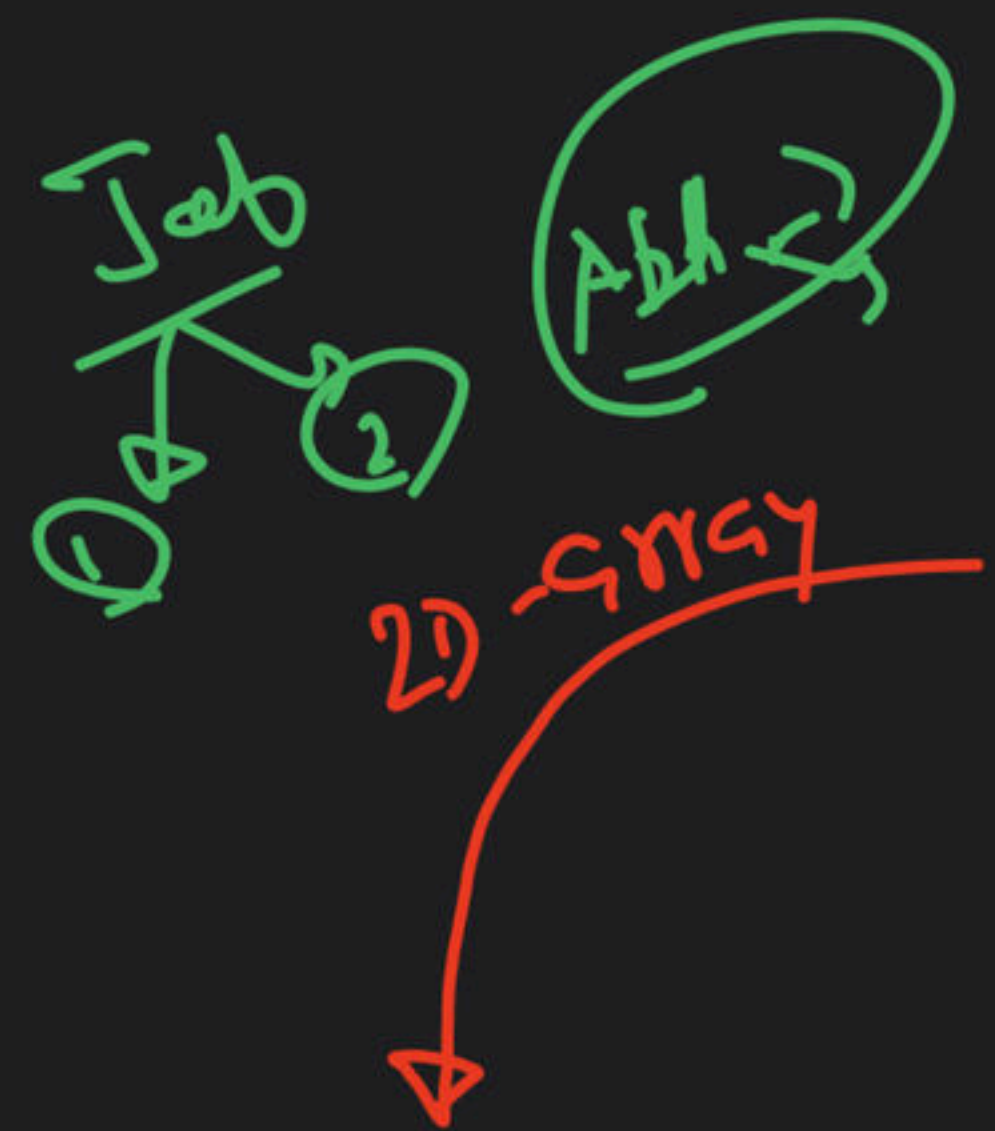
$$A_{ij} = 0 \quad i < j$$

	1	2	3	4
1	$A_{11}$	$A_{12}$	$A_{13}$	$A_{14}$
2	$A_{21}$	$A_{22}$	$A_{23}$	$A_{24}$
3	$A_{31}$	$A_{32}$	$A_{33}$	$A_{34}$
4	$A_{41}$	$A_{42}$	$A_{43}$	$A_{44}$



Non-zero entries

RMO



	1	2	3	4
1	$A_{11}$	0	0	0
2	$A_{21}$	$A_{22}$	0	0
3	$A_{31}$	$A_{32}$	$A_{33}$	0
4	$A_{41}$	$A_{42}$	$A_{43}$	$A_{44}$

Memory

{ non-zeros } fill

Diagram illustrating the structure of a 4x4 matrix  $A$  with row labels and column indices:

1st Row	2nd row	3rd row	4th row
$A_{11}$	$A_{21}$	$A_{31}$	$A_{41}$
	$A_{22}$	$A_{32}$	$A_{42}$
		$A_{33}$	$A_{43}$
			$A_{44}$

Annotations:

- 1st Row: Points to the first row of the matrix.
- 2nd row: Points to the second row of the matrix.
- 3rd row: Points to the third row of the matrix.
- 4th row: Points to the fourth row of the matrix.

Additional note:  $\{non-zeros\}$  till (indicated by a bracket above the matrix).



Odd( $A_{43}$ )

row 1, 2, 3

rows already filled

= 1 to 3

= 3 - 1 + 1 = 3 rows

$[1 + 2 + 3] = 6$  ele

within row index  
3, ele. already  
filled before

$A_{43} = 1$  to 2

= 2 - 1 + 1 = 2

Total = 6 + 2 = 8 ele.

	1	2	3	4	5
1	$A_{11}$	0	0	0	0
2	$A_{21}$	$A_{22}$	0	0	0
3	$A_{31}$	$A_{32}$	$A_{33}$	0	0
4	$A_{41}$	$A_{42}$	$A_{43}$	$A_{44}$	0
5	$A_{51}$	$A_{52}$	$A_{53}$	$A_{54}$	$A_{55}$

$A_{11}$	$A_{21}$	$A_{22}$	$A_{31}$	$A_{32}$	$A_{33}$	$A_{41}$	$A_{42}$	$A_{43}$	$A_{44}$	$A_{51}$	$A_{52}$	$A_{53}$	$A_{54}$	$A_{55}$
1000	1004	1008	1012	1016	1020	1024	1028	1032						



$$\begin{aligned}
 & * (a+1)[1] \\
 \Rightarrow & * * (a+1+1) \\
 = & * * (a+2) \\
 \Rightarrow & a[2][0] \\
 & \quad \quad \quad \hookrightarrow 15
 \end{aligned}$$

$A \Rightarrow LTM$   
 $N \times N$

$add(A_{ij})$

within row  
 whose index is  $i$

rows already filled

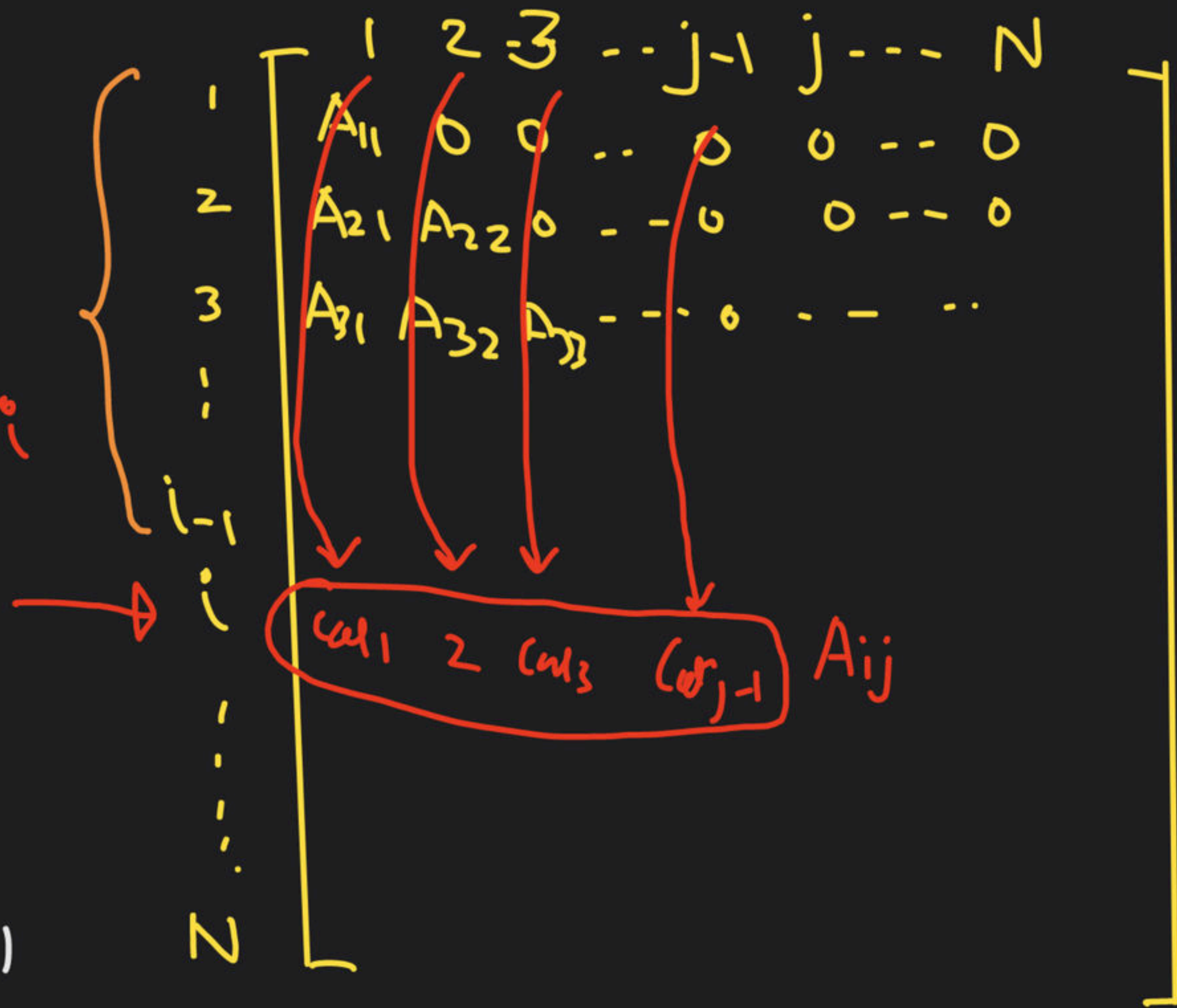
= index 1 to  $(i-1)$

=  $i-1 - 1 + 1 = (i-1)$  rows

rows with index 1, 2, 3, ...,  $(i-1)$

$1 + 2 + 3 + \dots + (i-1)$

$$= \frac{(i-1)(i)}{2}$$





total elem. already filled before  $A_{ij} = \frac{(i-1)(i)}{2} + (j-1)$

Memory already filled =  $\left[ \frac{(i-1)(i)}{2} + (j-1) \right] w$

$$\text{Add}(A_{ij}) = \text{DA} + \left[ \frac{(i-1)(i)}{2} + (j-1) \right] w$$

Ratna Nahi hai

LTM Academy  $A[-5..5][-7..3]$ ,  $w = 2 \text{ bytes}$   $BA = 1000$

$\text{add}(A[.][E_2])$

6 rows

$-5 + 2 + \dots + 5$

$$\frac{6 \times 7}{2} = 21$$

$-7 \text{ to } -3$

$$-3 - (-7) + 1 = 5$$

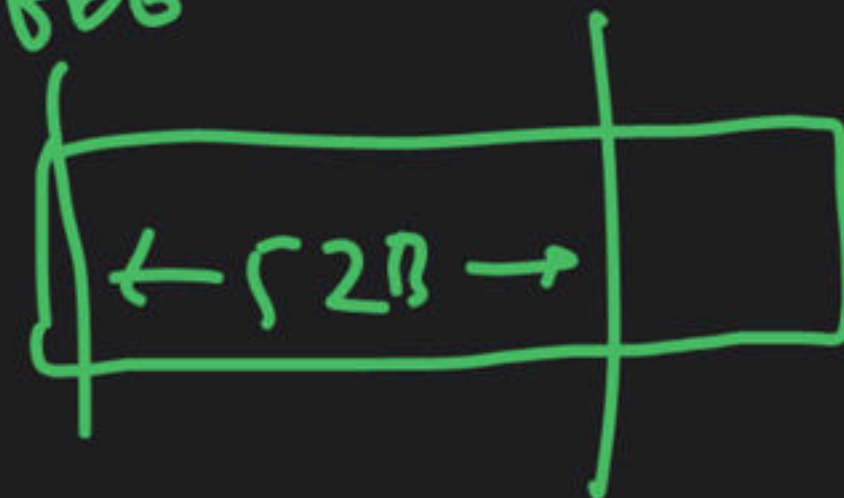
$$\text{Total} = 21 + 5 = 26 \text{ elements}$$

$$\text{Total memory} = 26 \times 2 = 52 \text{ Bytes}$$

$$1000 + 52 = 1052$$

	-7	-6	-5	-4	-3	-2	-1	0	1	2	3
-5	x										
-4	x	x									
-3	x	x	x								
-2	x	x	x	x							
-1	x	x	x	x	x						
0	x	x	x	x	x	x					
1	x	x	x	x	x	x	x				
2	x	x	x	x	x	x	x	x			
3	x	x	x	x	x	x	x	x	x		
5	x	x	x	x	x	x	x	x	x	x	...

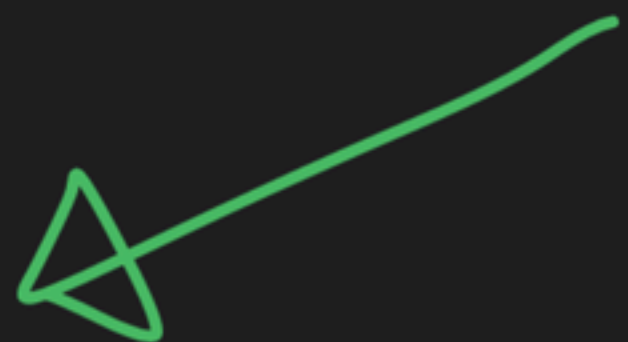
1000





$$A[-5..5]$$

$$A[1][2]$$



$$-5 \text{ to } 0$$

$$-5, -4, -3, -2, -1, 0$$

$$0 - (-5) + 1$$

$$0 + 5 + 1$$

$$= 6 \text{ rows}$$

LTM  $\rightarrow$  CMO

UTM  $\rightarrow$  RMO, CMO





Total Elements already filled before

$$A_{43} = 8 \text{ ele.}$$

$$w = 4 \text{ Bytes}$$

Memory already filled =  $8 \times 4 = 32 \text{ Bytes}$



$$= 1632$$



# THANK YOU!

Here's to a cracking journey ahead!