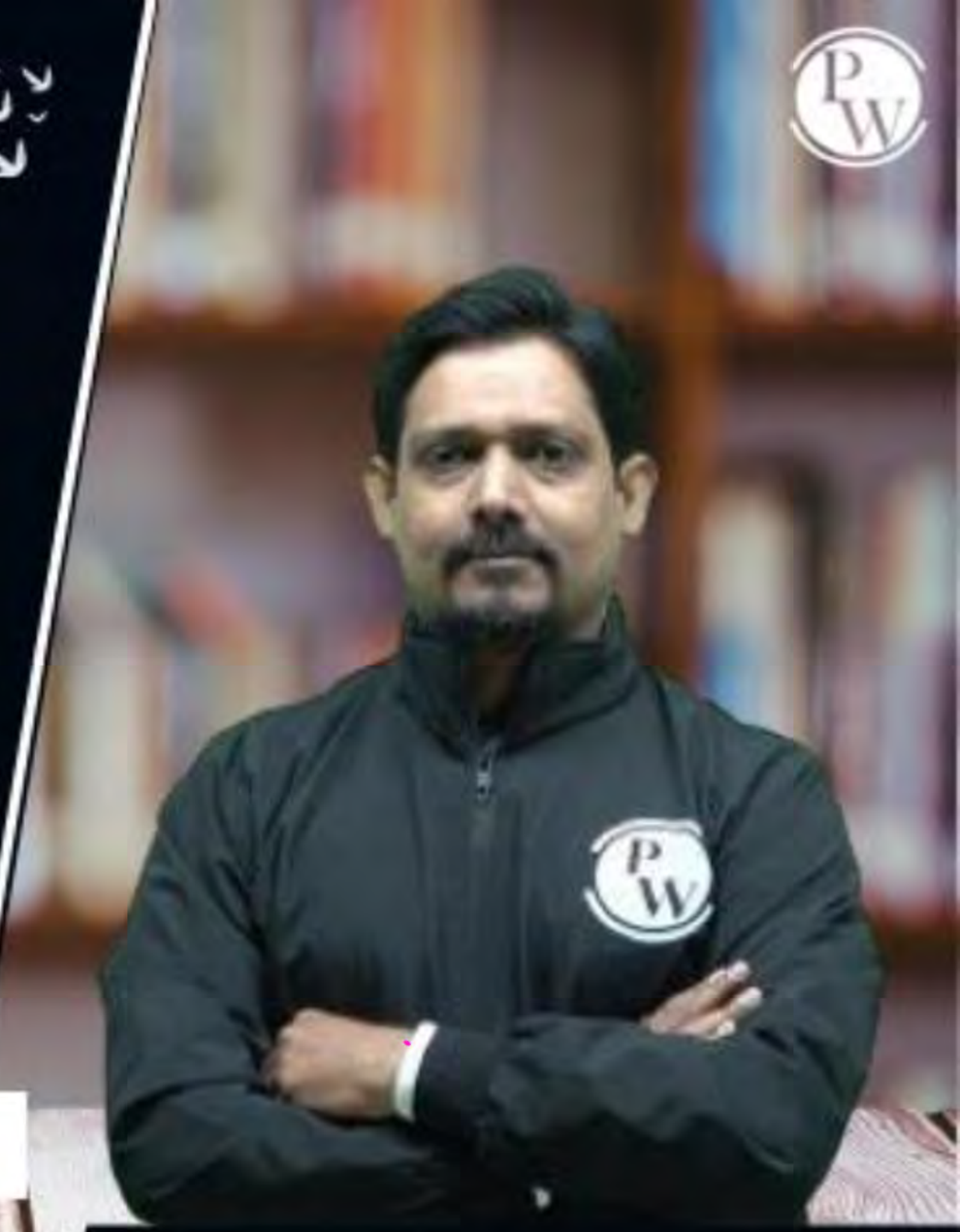
Computer Science & IT

Data Structure & Programming

Array

Lecture No. 03



By- Abhishek Sir

Recap of Previous Lecture

Topic

Topic

Topic

Topic

Topic

2D array

Column major order

Special sparse matrix Lower Triangular Matrix

Slide

Topics to be Covered

- Topic
- Topic
- Topic
- Topic
- Topic

LTM- Row major order

Column major order

UTM (Homework)

Tridiagonal Matrix ✓

Slide

Question : Lower Triangular Matrix

BA = 100 Size = 4B

A square *matrix* is called *lower triangular* if all the entries above the main diagonal are zero.

Row major order

A[1][1]	0	0	0
A[2][1]	A[2][2]	0	0
A[3][1]	A[3][2]	A[3][3]	0
A[4][1]	A[4][2]	A[4][3]	A[4][4]

a_{11}	a_{21}	a_{22}	a_{31}	a_{32}	a_{33}	a_{41}	a_{42}	a_{43}	a_{44}
100	104	108	112	116	120	124	128	132	136

Address of A[4][3]

Before 4th Row No. of Rows arranged

(4-1) = 3

No. of elements in 3 Rows

1+2+3 = 6

Slide

Question : Lower Triangular Matrix

BA = 100 Size = 4B

A square *matrix* is called *lower triangular* if all the entries above the main diagonal are zero.

Row major order

A[1][1]	0	0	0
A[2][1]	A[2][2]	0	0
A[3][1]	A[3][2]	A[3][3]	0
A[4][1]	A[4][2]	A[4][3]	A[4][4]

a_{11}	a_{21}	a_{22}	a_{31}	a_{32}	a_{33}	a_{41}	a_{42}	a_{43}	a_{44}
100	104	108	112	116	120	124	128	132	136

In 4th Row : we are in 3rd Column,

No. of elements arranged : 3-1 = 2

Total = 6+2 = 8

Address of A[4][3] = 100 + 8X4 = 132

Slide

Question : Lower Triangular Matrix

$n \times n$ - $A[1..n][1...n]$ the Address of $A[i][j]$

1. Before i^{th} Row No. of Rows arranged

$(i-1)$

No. of elements in 1 —— $(i-1)$ Rows

$$1+2+3+\cdots+(i-1) = \frac{i(i-1)}{2}$$

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Question : Lower Triangular Matrix

$n \times n$ - $A[1..n][1...n]$ the Address of $A[i][j]$

In i^{th} Row we are in j^{th} column Hence

No. of elements arranged

$(J-1)$

Lower bound 1

$$\text{Address of } A[i][j] = BA + \left[\frac{i((i-1)}{2} + (J-1) \right] \times \text{Size}$$

Slide

Question : Lower Triangular Matrix

A LTM A[1..50][1..50]

with BA = 1000 Size is 2B

Address of A[25][10] is _____

$$BA + \left[\frac{i(i-1)}{2} + (j-1) \right] \times S$$

$$1000 + \left[\frac{25 \times 24}{2} + 9 \right] \times 2 = 1000 + 309 \times 2$$

$$1000 + 618$$

$$= 1618$$

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Topic : Question

$1000 + \left[\frac{50 \times 49}{2} + 49\right] \times 2$

$= 3548$

Q A[1...100][1...100] is lower triangular matrix. Base address is 1000 and each element occupies 2-Bytes of space. What is the address of A[50][50] in row major order ?

We are at 50th row No. of Rows completed 49

$1+2+3+\cdots 49 = \frac{49 \times 50}{2} = 49 \times 25$

In 50th Row ware in 50th column. No of elements arranged is $(50-1) = 49$

$1000 + [49 \times 25 + 49] \times 2$

Slide

Topic : Answer

Before reaching 50th row, number of rows completed is 49

Total number of elements in 49 rows

1+2+3+…..+49 = (49×50)/2=1225

We are at 50th column , number of element completed is 49

Total number of element completed is 1225+49= 1274

Address of a[50][49] is = 1000+1274*2=3548

Topic : Question

Q A[1…100][1…100] is lower triangular matrix. Base address is 1000 and each element occupies 2 Bytes of space. What is the address of A[20][10] in row major order ?

Topic : Answer

A[20][10]

Before reaching 20th row, number of rows completed is 19

Total number of elements in 19 rows

1+2+3+.....+19 = (19×20)/2=190

We are at 10th column , number of element completed is 9

Total number of element completed is 190+9 = 199

Address of a[20][10] is = 1000+199*2=1398

Question : Lower Triangular Matrix

A square *matrix* is called *lower triangular* if all the entries above the main diagonal are zero. Column major order

a_{11} 100	a_{21} 104	a_{31} 108	a_{41} 112	a_{22} 116	a_{32} 120	a_{42} 124	a_{33} 128	a_{43} 132	a_{44} 136

A[1][1]	0	0	0
A[2][1]	A[2][2]	0	0
A[3][1]	A[3][2]	A[3][3]	0
A[4][1]	A[4][2]	A[4][3]	A[4][4]

4 x 4 LTM

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Topic : Lower Triangular Matrix: Column Major Order

$A[1 \ldots n][1 \ldots n]$ LTM Column major order $(n \times n)$

Address of $A[i][j]$ if we are in j^{th} column then No. of columns arranged $= (j-1)$

No. of elements arranged:

1^{st} column	n	$(n-0)$
2^{nd} column	$n-1$	$(n-1)$
3^{rd} column	$n-2$	$(n-2)$
$\vdots$	$\vdots$	
$(j-1)^{th}$ column	$n-(j-1-1)$	
	$n-(j-2)$	

Slide

Topic : Lower Triangular Matrix: Column Major Order

Total No. element

$(j-1)$ terms

$$n + n-1 + n-2 + \cdots + n-(j-2)$$

$$\frac{n(n+1)}{2}$$

$$n(j-1) - (1+2+3+\cdots(j-2))$$

$$\frac{(j-2)(j-2+1)}{2}$$

$$n(j-1) - \frac{(j-1)(j-2)}{2}$$

$$\frac{(j-2)(j-1)}{2}$$

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Topic : Lower Triangular Matrix: Column Major Order

In j^{th} column : No. of element arranged : $(i-j)$

Combining both

$$BA + \left[n(j-1) - \frac{(j-1)(j-2)}{2} + (i-j) \right] \times Size$$

Slide

Topic : Lower Triangular Matrix: Column Major Order

n = 50 n×n

#Q A LTM A[1..50][1..50] arranged Column major order (Non Zero elements)

BA = 1000

Size = 2B

Address of A[40][10]

1. n = 50
2. i, j i = 40, j = 10

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Topic : Lower Triangular Matrix: Column Major Order

$$BA + \left[n(j-1) - \frac{(j-1)(j-2)}{2} + (i-j) \right] \times Size$$

A[40][10]

$$1000 + \left[50 \times 9 - \frac{9 \times 8}{2} + 30 \right] \times 2$$

$$1000 + [450 - 36 + 30] \times 2$$

$$1000 + [450 - 6] \times 2 = 1000 + 444 \times 2 = 1888$$

Slide

Topic : Lower Triangular Matrix: Column Major Order

n = 50 n×n

#Q A LTM A[1..50][1..50] arranged Column major order (Nm Zero elements)

BA = 1000

Size = 2B

Address of A[25][10]

$$1000 + \left[50 \times 9 - \frac{9 \times 8}{2} + (25-10)\right] \times 2$$

$1000 + [450 - 36 + 15] \times 2 = 1000 + 429 \times 2$

$1000 + 858 = 1858$

Slide

Maybe ISRO

#Q Suppose a 2-D array is given & each Row consists of 4 elements, arranged in RMO. Lower Bound is 1 and Size of element is 2B. An element A[i][j] stored in 1084 Address what is the value of i+j ____?

Lower Bound (1)

1000 —— 1083 | 1084

↑ element

84 Memory Location ✓

No. of element = $\frac{84}{2}$ = 42 elements

↑ Size

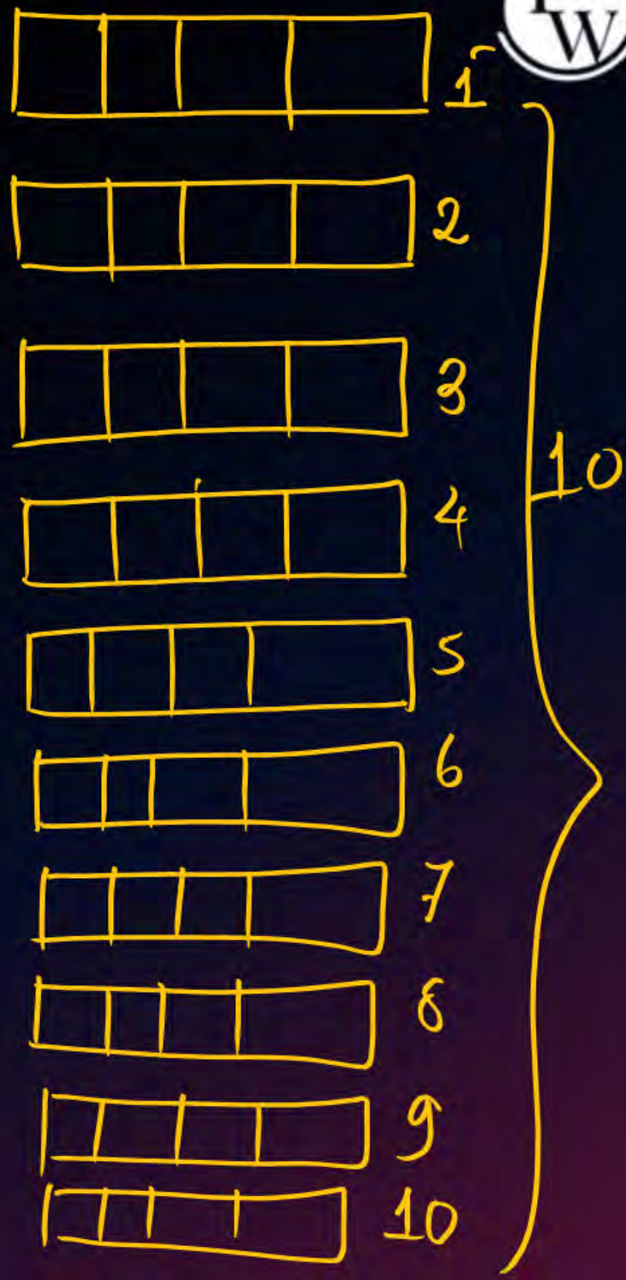
a[11][3]

(i+j = 14)

11

1084

$a_{11,1}$ $a_{11,2}$ $a_{11,3}$



Topic : Lower Triangular Matrix: Column Major Order

An LTM A[-4..0][3...7] is stored in RMO from location 1000 (Non Zero elements) Size is 2B what is the Address of A[-3][4]

$$BA + \left[\frac{i(i-1)}{2} + (j-1)\right] \times S$$

$$1000 + \left[\frac{2\times1}{2} + 1\right] \times 2$$

1004

S

A[-4..0][3...7]

+5 +5 -2 -2

A[1..5][1..5]

A[2][2]

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Topic : Lower Triangular Matrix: Column Major Order

HW : UTM (Upper triangular matrix)

a_{11}	a_{12}	a_{13}
0	a_{22}	a_{23}
0	0	a_{33}

1. Row major
2. Column major

Slide

2 mins Summary

Topic

LTM, RMO

Topic

LTM CMO

Topic

practice problem

Topic

Topic

Slide

THANK - YOU

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