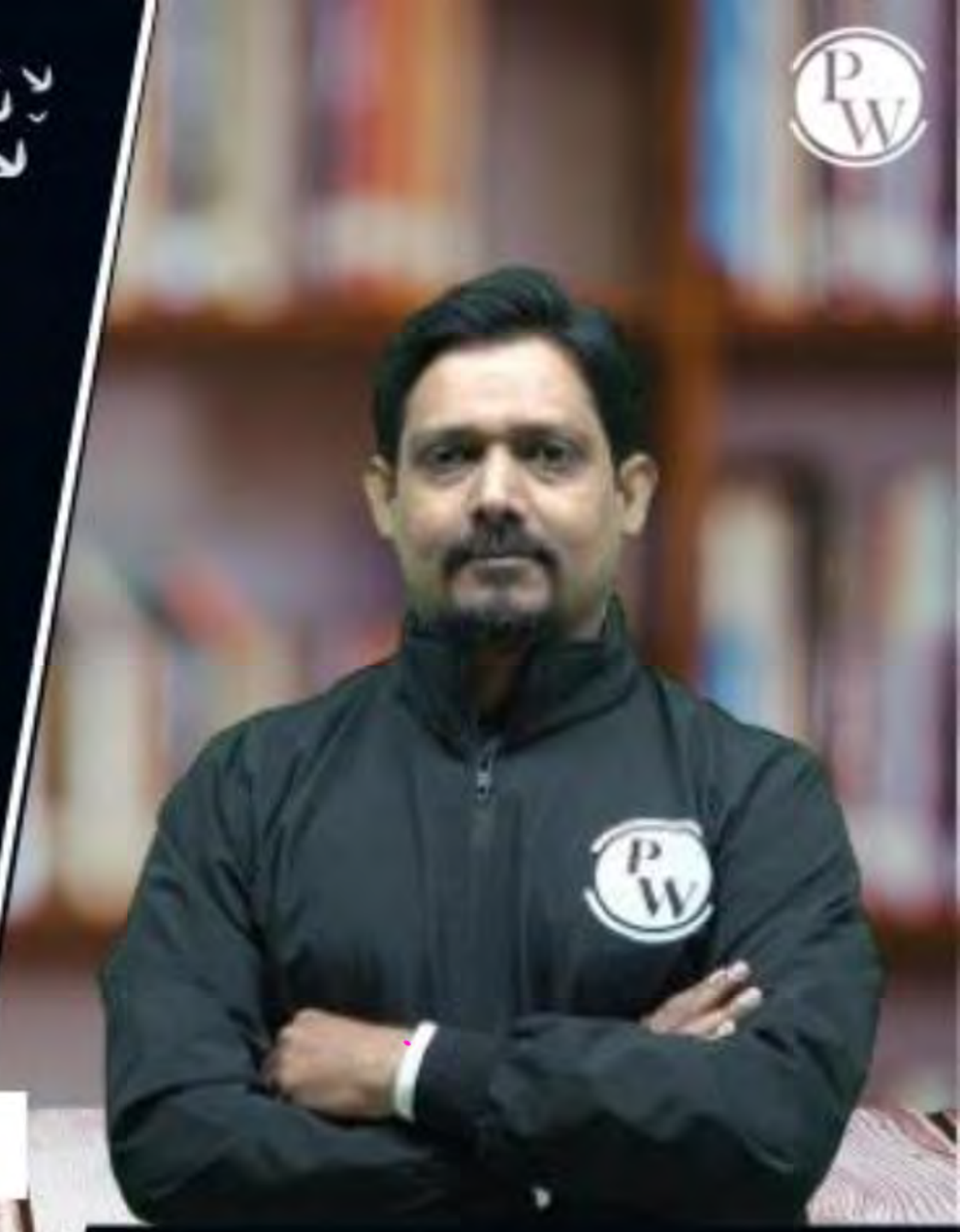
Computer Science & IT

Data Structure & Programming

Array

Lecture No. 02



By- Abhishek Sir

Recap of Previous Lecture

- Topic
- Topic
- Topic
- Topic
- Topic

1 - D array

generalized formula

2 D array

Row major order

Slide

Topics to be Covered

- Topic
- Topic
- Topic
- Topic
- Topic

Column major order

Sparse matrix

Lower Triangular Matrix.

Slide

Question : 1-D Array

Consider the above array A[-5.....100]. Base address of the array is 1000 and each element occupies 2-Bytes of space. What is the address of A[70]?

(A) 1150

(B) 1250

(C) 1200

(D) 1350

A[70]

$BA + (i - LB) \times Size$

$1000 + (70 - (-5)) \times 2$

$1000 + 75 \times 2 = 1000 + 150 = 1150$

Slide

Topic : 2-D Row major order:

A_{11} 100	A_{12} 104	A_{13} 108
A_{21} 112	A_{22} 116	A_{23} 120
A_{31} 124	A_{32} 128	A_{33} 132

$A[1..3][1..3]$

Two part calculation

$A[3][2]$

(1) Before 3rd Row

No. of Rows arranged

(2) on Third Row.

2-L6

Slide

Question : 2-D Array, MSQ

LB_1 UB_1

Consider the following array A[-23…93] [-7…31].Base address is 1000 and each element occupies 2-Bytes of space. Which of the following is TRUE ?

Rows : $UB_1 - LB_1 + 1$

$93 - (-23) + 1$

$93 + 23 + 1$

117

(A) The number of rows is 117 ~~elements in a row~~ ✓ (A)

(B) The Array B[0..116] [2..40] have same number of elements as the array declared in question

(C) Address of A[0][5] is 3538 row major order

(D) Address of A[0][0] is 3538 row major order

Slide

Question : 2-D Array, MSQ

Consider the following array A[-23…93] [-7…31].Base address is 1000 and each element occupies 2-Bytes of space. Which of the following is TRUE ?

(A) The number of rows is 117 elements in a row

(B) The Array B[0..116] [2..40] have same number of elements as the array declared in question

(C) Address of A[0][5] is 3538 row major order

(D) Address of A[0][0] is 3538 row major order

$ub_2 - lb_2 + 1$

$31 - (-7) + 1 = 32 + 7 = 39$

$A[117][39]$.

$(ub_1 - lb_1 + 1)$

$93 - (-23) + 1 = 117$

$116 - 0 + 1 = 117$ $40 - 2 + 1 = 39$

$B[117][39]$

Slide

Question : 2-D Array, MSQ

Consider the following array A[-23…93] [-7…31].Base address is 1000 and each element occupies 2-Bytes of space. Which of the following is TRUE ?

(A) The number of rows is 117 ~~elements in a row~~ ✓

(B) The Array B[0..116] [2..40] have same number of ✓ elements as the array declared in question

(C) Address of A[0][5] is 3538 row major order ✗

(D) Address of A[0][0] is 3538 row major order ✗

$1000 + [(0-(-23)) \times (31-(-7)+1) + (5-(-7)] \times 2$

$1000\,[23 \times 39 + 12] \times 2$

$= 2818$ ✓

Slide

Question : 2-D Array, MSQ

Consider the following array A[-23…93] [-7…31].Base address is 1000 and each element occupies 2-Bytes of space. Which of the following is TRUE ?

(C) Address of A[0][5] is 3538 row major order

A[0][0]

$1000 + [(0-(-23)) \times 39 + (0-(-7)]] \times 2$

$1000 + [23 \times 39 + 7] \times 2$

2808

Slide

Question : 2-D Array, MSQ

Consider the following array A[-23…93] [-7…31].Base address is 1000 and each element occupies 2-Bytes of space. Which of the following is TRUE ?

(D) Address of A[0][0] is 3538 column major order

Topic : 2-D Generalization Row major order:

$A[Lb_1 \ldots ub_1][Lb_2 \ldots ub_2]$

Row ↑ column →

Address of $A[i][j]$

Before i^{th} Row No. of Rows arranged :- $(i - Lb_1)$

No. of element in each Row :

$$uB_2 - LB_2 + 1$$

i^{th} row if we are in j^{th} colum

No. of columns arranged

$(j - Lb_2)$

Slide

Topic : 2-D Row major order

Address of A[i][j]

BA - Base Address

S - Size

$$BA + [(i - Lb_1) \times (Ub_2 - Lb_2 + 1) + (j - lb_2)] \times S$$

No of Raws arranged

No. of element in each Raw ✓

(in i^{th} raw we are in j^{th} column)

No. of element arranged

Slide

Topic : 2-D Row major order

Address of A[i][j]

BA - Base Address

S - Size

$$BA + [(i - Lb_1) \times (Ub_2 - Lb_2 + 1) + (j - lb_2)] \times S$$

- $(i - Lb_1)$: No of Raws arranged
- $(Ub_2 - Lb_2 + 1)$: No. of element in each Raw
- $(j - lb_2)$: In ith column No. of element arranged

Slide

Topic : 2-D Column Major Order

a[1..3][1..3]

Raw-1 →	a_{11}	a_{12}	a_{13}
Raw-2 →	a_{21}	a_{22}	a_{23}
Raw3 →	a_{31}	a_{32}	a_{33}

↑ Column 1 ↑ Column 2 Column 3

Column-1 Column-2 Column-3

a_{11}	a_{21}	a_{31}	a_{12}	a_{22}	a_{32}	a_{13}	a_{23}	a_{33}
100	104	108	112	116	120	124	128	132

A[3][2] ↑ column arranged

Before 2nd column No. of

$(2-Lb_2) = (2-1) = 1$

No. of element in a column =

Size of Raw = 3

total = $1 \times 3 = 3$

Slide

Topic : 2-D Column Major Order

a[1..3][1..3]

Row-1 →	a_{11}	a_{12}	a_{13}
Row-2 →	a_{21}	a_{22}	a_{23}
Row3 →	a_{31}	a_{32}	a_{33}

↑ Column 1 ↑ Column 2 Column 3

Column-1 Column-2 Column-3

a_{11}	a_{21}	a_{31}	a_{12}	a_{22}	a_{32}	a_{13}	a_{23}	a_{33}
100	104	108	112	116	120	124	128	132

A[3][2] in 2nd column we are in

↑ 3rd row

No. of element arranged = $(3 - L6_1)$

$= (3-1) = 2$

Slide

Topic : 2-D Column Major Order

a[1..3][1..3]

Row-1 →	a_{11}	a_{12} ✓	a_{13}
Row-2 →	a_{21}	a_{22} ✓	a_{23}
Row3 →	a_{31}	a_{32}	a_{33}

↑ Column 1 ↑ Column 2 Column 3

Column-1 Column-2 Column-3

a_{11}	a_{21}	a_{31}	a_{12}	a_{22}	a_{32}	a_{13}	a_{23}	a_{33}
100	104	108	112	116	120	124	128	132

Total = 3 + 2 = 5

Address of A[3][2]

= 100 + 5×4 = 100+20

= 120

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Topic : 2-D Column Major Order

$A[LB_1 \ldots UB_1][LB_2 \ldots UB_2]$ generalized formula.

Address of $A[i][j]$ =

$$BA + [(j - LB_2) \times (UB_1 - LB_1 + 1) + (i - LB_1)] \times S$$

Slide

Topic : 2-D Column Major Order

Consider the following array A[-4...100][3...100]. Base address is 1000 and each element occupies 2-Bytes of space. What is the address of A[50][48] in column major order ?

Formula / Traditional

A[-4...100][3...100]

A[50][48]

1 Before 48th column No.

of column arranged = (48 − 3)

= 45

No. of element in each column :

Size of Row = (100 − (−4) + 1) = 105

Slide

Topic : 2-D Column Major Order

Consider the following array A[-4...100][3...100]. Base address is 1000 and each element occupies 2-Bytes of space. What is the address of A[50][48] in column major order ?

In 48th column we are in 50th Row

No. of elements arranged $(50 - (-4)) = 54$

Address of A[50][48] =

$1000 + [45 \times 105 + 54] \times 2 =$

10558

Slide

Q Suppose array is declared as A[10..19][-3..20]

BA = 1000 Size = 2 B

Ans Find Address of A[15][13] in column major order.

$$BA + [(j - Lb_2) \times (Ub_1 - Lb_1 + 1) + (i - Lb_1)] \times Size$$

$$1000 + [(13 - (-3)) * (19 - 10 + 1) + (15 - 10)] \times 2B$$

$$1000 + [16 \times 10 + 5] \times 2 = 1000 + 165 \times 2$$

$$1000 + 330 = 1330$$

Topic : 2-D Column Major Order

Consider the following array A[-4…100][3…100]. Base address is 1000 and each element occupies 2-Bytes of space. What is the address of A[50][48] in column major order ?

Topic : 2-D Column Major Order

We need to find the address of A[50][48]. Before reaching to 48th column 3…47 columns i.e. 47-3+1=45 columns are already been arranged (Second way is (48- lower bound)) and each column consists of 105 elements. So total 45× 1005 =4725 elements are arranged.

For the 50th row we have already arranged -4…49 i.e. 54 (49 – (-4)+1) elements (look at the first dimension) are already arranged.

So total number of elements arranged are = 4725+55 = 4779.

The address is 1000+4779× 2=10558

Topic: Sparse Matrix

Sparse Matrix are Those matrix in which relatively few entries are Non zero.

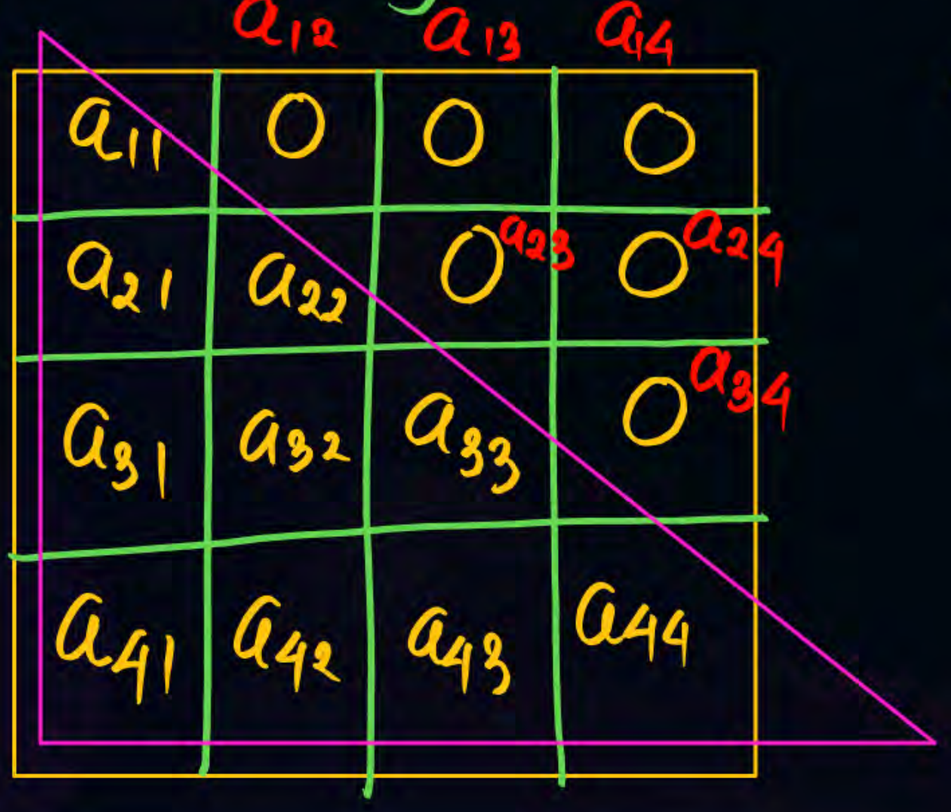
Some special spare Matrix

1. Lower Triangular Matrix

Slide

Topic: Lower Triagular Matrix

A square matrix in which elements above principle diagonals are zero. for example a_{44}



a[i][j] ←

for what condition on i & j

a[i][j] = 0 (j > i)

Slide

Topic: Lower Triagular Matrix

A square matrix in which elements above principle diagonals are zero. for example a_{44}

a_{11}	0	0	0
a_{21}	a_{22}	0	0
a_{31}	a_{32}	a_{33}	0
a_{41}	a_{42}	a_{43}	a_{44}

No. of Non Zero elements : 4×4 LTM

$1+2+3+4 = 10$

No of Non zero element in n×n LTM

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

Slide

Topic: Lower Triagular Matrix

A square matrix in which elements above principle diagonals are zero. for example a_{44}

a_{11}	0	0	0
a_{21}	a_{22}	0	0
a_{31}	a_{32}	a_{33}	0
a_{41}	a_{42}	a_{43}	a_{44}

Non Zero elements of LTM Stored in

* Row major order
* Column major order

Slide

Topic: Lower Triagular Matrix

Row major order

a[1..4][1..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

Row1 Row-2 Row-3 Row-4

a_{11}	0	0	0
a_{21}	a_{22}	0	0
a_{31}	a_{32}	a_{33}	0
a_{41}	a_{42}	a_{43}	a_{44}

A[4][3]

if we are in 4th row. No. of Rows completed := (4 - Lb1)

= (4-1) = 3

No. of elements arranged in 3 row.

1+2+3 = 6

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Topic: Lower Triagular Matrix

Befor i^{th} Row No. of Rows completed (for LB = 1)

$(i-1)$

No. of elements arrang $(i-1)$ rows

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

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2 mins Summary

Topic — 2-D column major

Topic — practice

Topic — Lower Triangular Matrix

Topic

Topic

Slide

THANK - YOU

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