CS301
Data Structure and Algorithms
Lecture 4: Multidimensional Arrays

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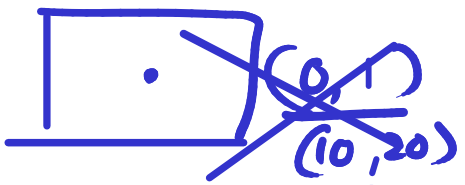
Objective

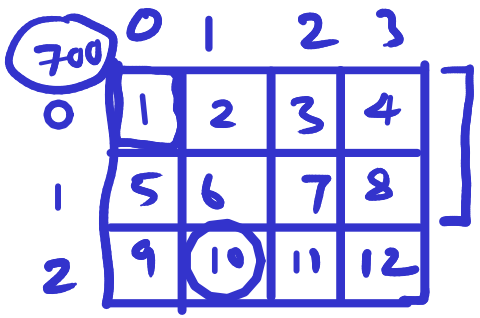
- Understand multidimensional array
- Learn to represent multidimensional array as one dimensional array
- understand row-major vs column-major order
- Learn to efficiently represent sparse matrices



700 — 4 bytes int 0 1 2 . . . .

Logical

int arr[3][4]; C Language



Memory

row-major

column-major

Other

arr[2][1]

row major 736

column major 720

$(2 \times 4) + 1 = 9 \times 4 = 36$

$700 + 36 = 736$

$(1 \times 3) + 2 = 5 \times 4 = 20$

$700 + 20 = 720$

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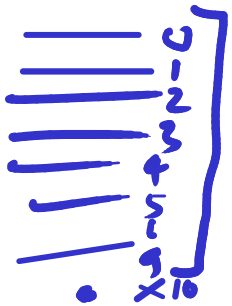
double arr[32][16] —— sizeof(double) – 8 bytes

Base add^{n} = 1000



arr[10][5]

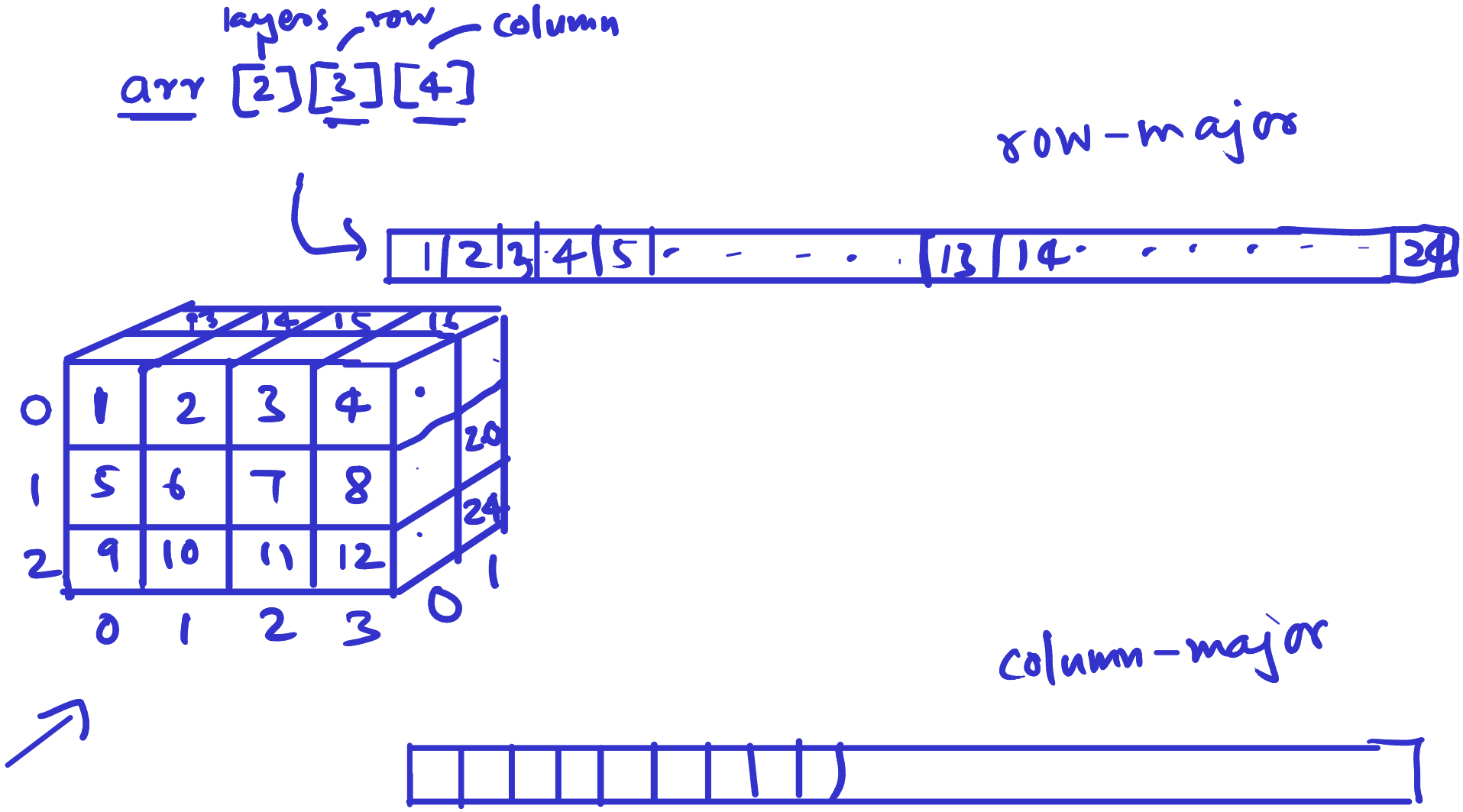
row-major: $(10 \times 16 + 5) \times 8$

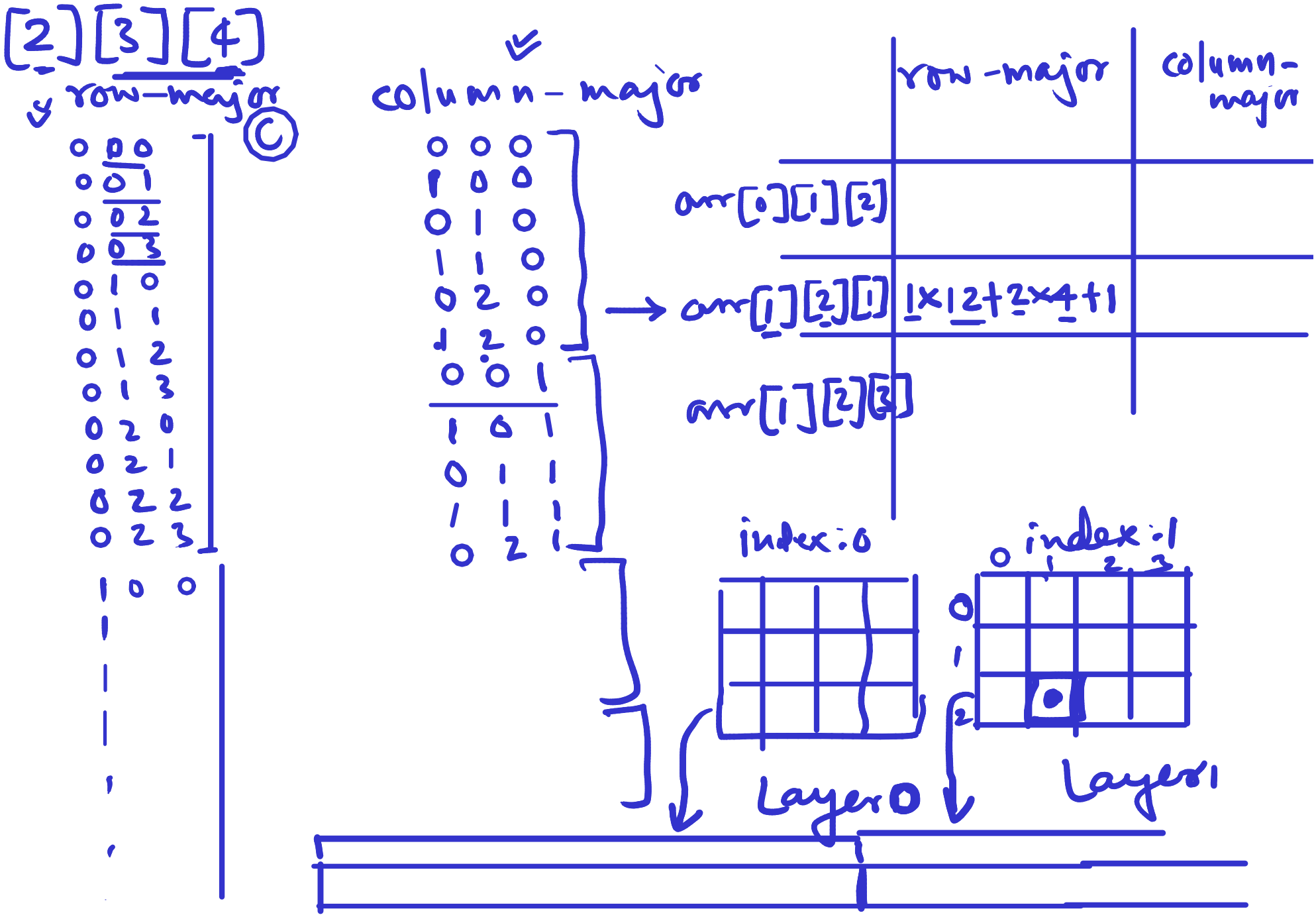
column-major: $(5 \times 32 + 10) \times 8$

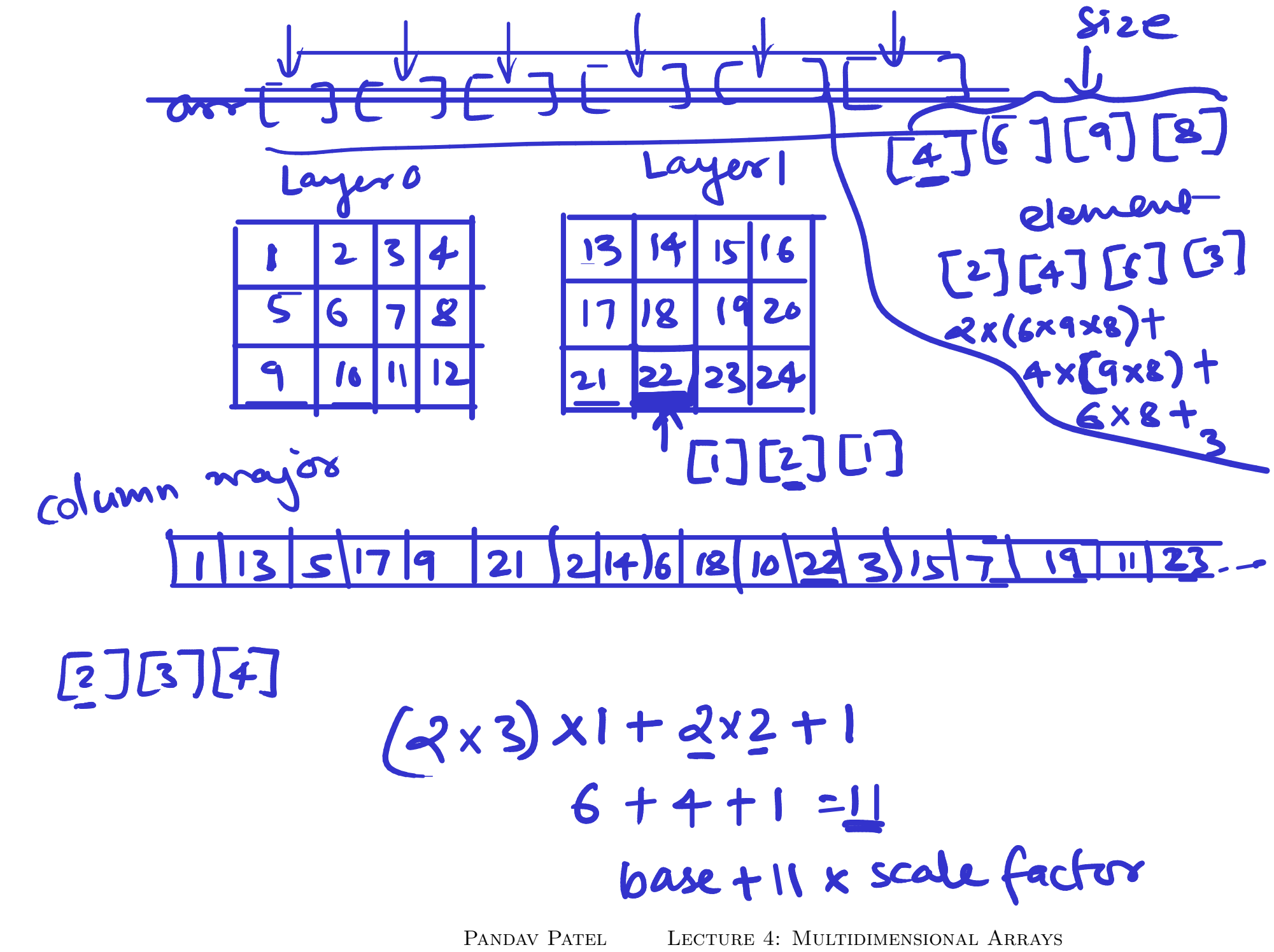
arr[5][10]

row-major: $(5 \times 16 + 10) \times 8$

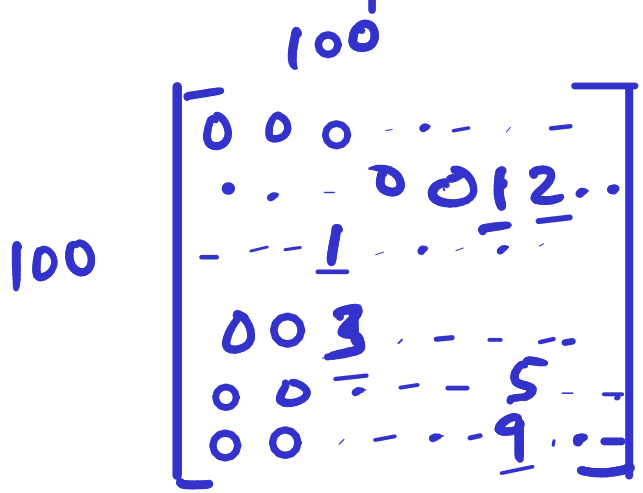
column-major: $(10 \times 32 + 5) \times 8$


layers
row
column
arr [2][3][4]
row-major
1 2 3 4 5 13 14 24
13 14 15 16
0
1
2
1 2 3 4
5 6 7 8
9 10 11 12
20
24
0 1 2 3
0 1
column-major


[2][3][4]
row-major
column-major
row-major
column-major
arr[0][1][2]
arr[1][2][1]
1x12+2x4+1
arr[1][2][3]
index:0
index:1
Layer 0
Layer 1


Size
[4][6][9][8]
Layer 0
1 2 3 4
5 6 7 8
9 10 11 12
Layer 1
13 14 15 16
17 18 19 20
21 22 23 24
[1][2][1]
element
[2][4][6][3]
2x(6x9x8)+
4x(9x8)+
6x8+
3
column major
1 13 5 17 9 21 2 14 6 18 10 22 3 15 7 19 11 23
[2][3][4]
(2x3)x1+2x2+1
6+4+1=11
base+11 x scale factor

Sparse matrix

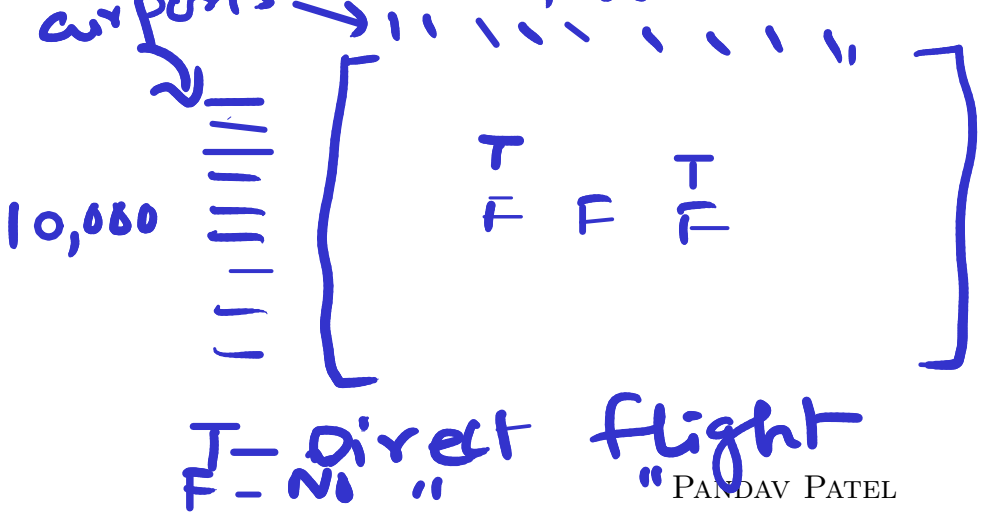


space occupied for $100 \times 100 = 10,000$

How many elements stored? 6

No. of airports in world $\sim 17,000$

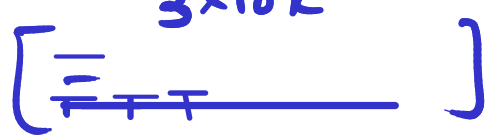
— Want to store true/false for connectivity b/w each airport



10^8 elements

100 million elements

10K



Dense matrix Vs sparse matrix

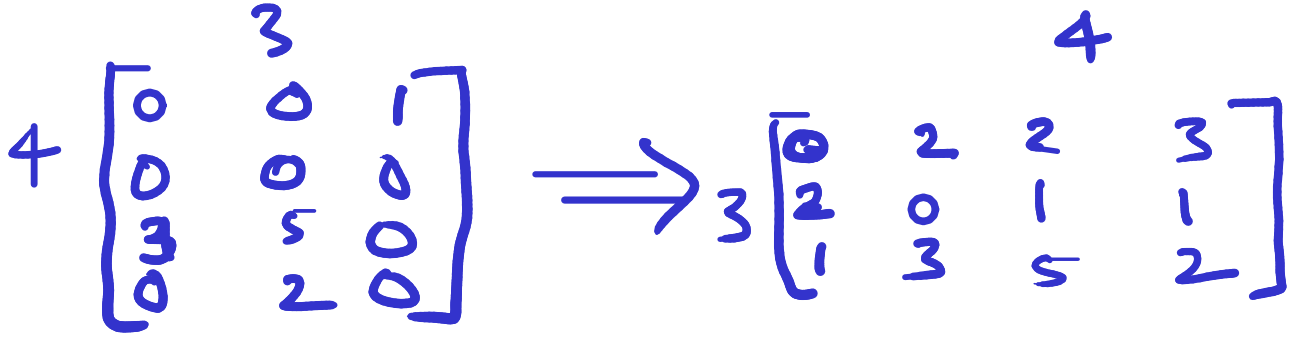
most Diff^n element

most elements are same

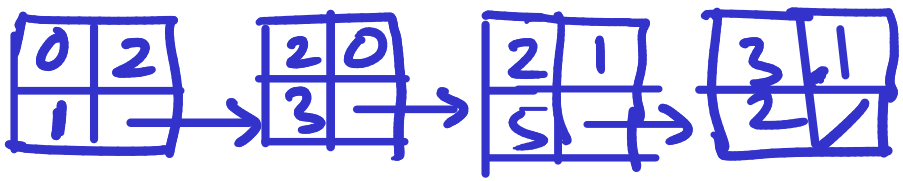
1000 — size of each dimention

5 — dimentions

$1000^5 = (10^3)^5 = 10^{15}$



⇒ Simple example
⇒ Not achieving much
⇒ But for complex example, it will make difference



Trade-off

Time Vs Space

extra reading ① skip list