

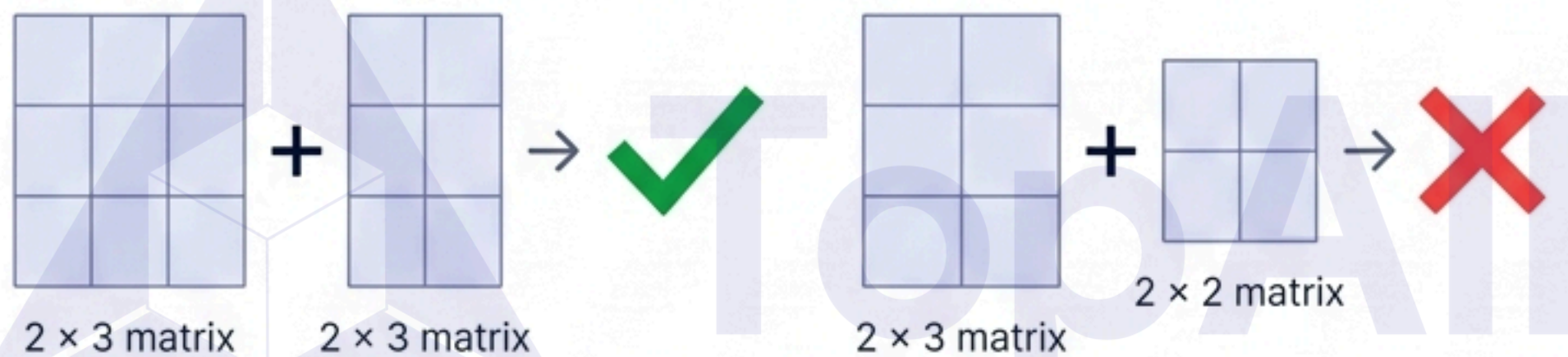
4 Core Matrix Operations

Addition, Scalar Multiplication,
Difference, and Multiplication

1. Matrix Addition ($A + B$)

Same Order Needed

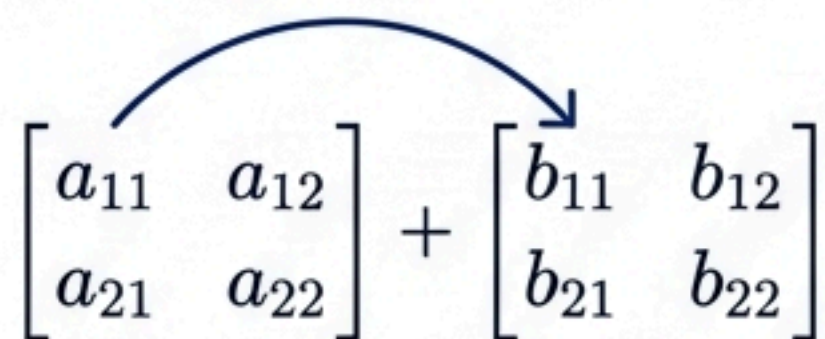
Matrices **MUST** have the **exact same dimensions** ($m \times n$).



Add Corresponding Elements

Add Corresponding Elements

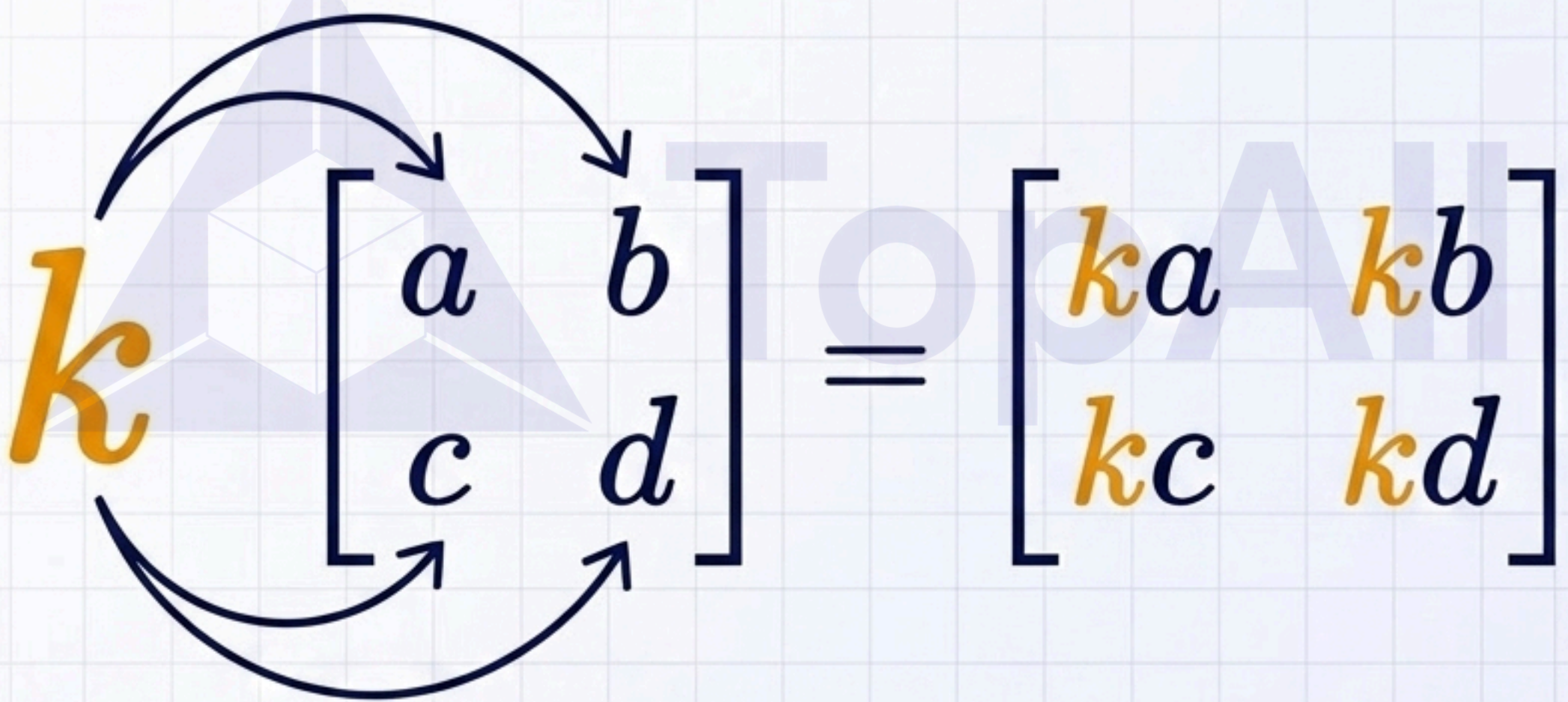
$$C = [a_{ij} + b_{ij}]$$



$$\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}$$

2. Scalar Multiplication (kA)

Multiply every single entry by the scalar k .



$$k \begin{bmatrix} a & b \\ c & d \end{bmatrix} = \begin{bmatrix} ka & kb \\ kc & kd \end{bmatrix}$$

$$kA = k[a_{ij}]_{m \times n} = [k(a_{ij})]_{m \times n}$$



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$$E=mc^2$$



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3. Matrix Difference (A - B)

$$A - B = A + (-1)B$$

Step 1: Treat as the addition of a negative matrix.

Step 2: Apply scalar multiplication of $k = -1$ to matrix B. $B \rightarrow -B$

Step 3: Add the corresponding elements. $a_{\{ij\}} - b_{\{i\}}$

Inherits the rule of Addition: Matrices must be the exact same order ($m \times n$).

4. Matrix Multiplication (AB)

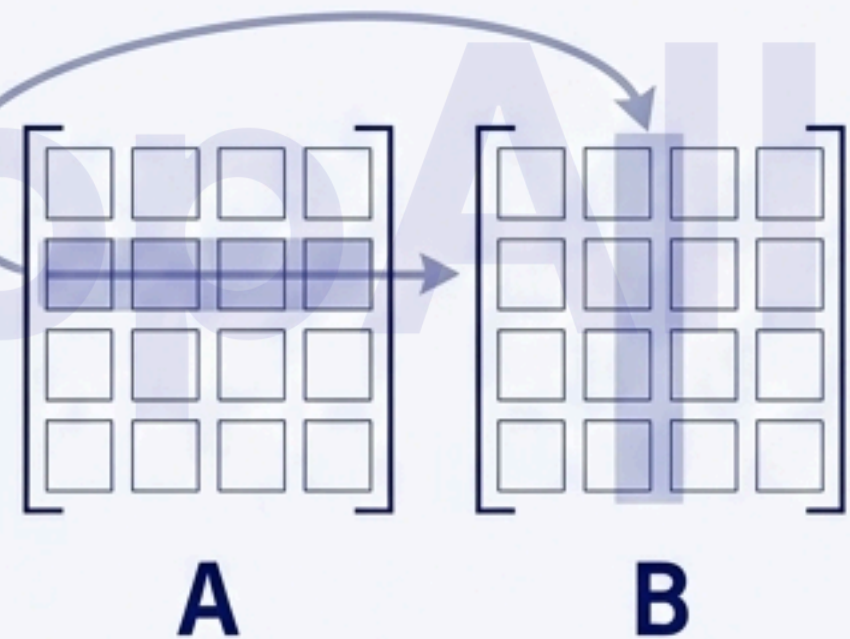


Inner dimensions must match!

$$(\mathbf{m} \times \mathbf{n}) \times (\mathbf{n} \times \mathbf{p}) \rightarrow (\mathbf{m} \times \mathbf{p}) \text{ matrix}$$

Row × Column. Multiply elements of the **i**-th row of **A** with the **j**-th column of **B**, then sum them.

$$c_{ik} = \sum a_{ij} b_{jk}$$



Non-Commutative!

Do not assume order doesn't matter.

$$\mathbf{AB} \neq \mathbf{BA}$$

Key Takeaways: The Matrix Workflow

Identify operation → check condition → calculate.

Operation	Condition Check	Calculate
Addition / Difference	Same Order ($m \times n$)	$a_{ij} \pm b_{ij}$
Scalar Mult (kA)	None	$k \cdot a_{ij}$
Matrix Mult (AB)	Columns of 1st = Rows of 2nd	Row $\times$ Column ($\sum a_{ij}b_{jk}$)



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