Linear Algebra
review (optional)
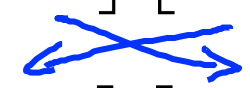
Matrix multiplication
properties

Machine Learning

$$3 \times 5 = 5 \times 3 \qquad \text{``Commutative''}$$

Let A and B be matrices. Then in general,
$$A \times B \neq B \times A. \quad (\text{not commutative.})$$

E.g. $\begin{bmatrix} 1 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 \\ 2 & 0 \end{bmatrix} = \begin{bmatrix} 2 & 0 \\ 0 & 0 \end{bmatrix}$

$$\begin{bmatrix} 0 & 0 \\ 2 & 0 \end{bmatrix} \begin{bmatrix} 1 & 1 \\ 0 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 2 & 2 \end{bmatrix}$$

$\neq$

$$A \times B$$
$$m \times n \qquad n \times m$$

$A \times B$ is $m \times m$

$B \times A$ is $n \times n$

$3 \times 5 \times 2$

$3 \times 10 = 30 = 15 \times 2$

$3 \times (5 \times 2) = (3 \times 5) \times 2$

"Associative"

$A \times (B \times C)$
$(A \times B) \times C$

$A \times B \times C.$

Let $D = B \times C.$ Compute $A \times D.$

Let $E = A \times B.$ Compute $E \times C.$

$A \times (B \times C)$
$(A \times B) \times C$
$\rightarrow$ Some answer.

Identity Matrix

Denoted I (or $I_{n \times n}$).

Examples of identity matrices:

$[1]$
1×1

$\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$
2 x 2

$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$
3 x 3

$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$
4 x 4

For any matrix A,
$$A \cdot I = I \cdot A = A$$

$m \times n$ $n \times n$ $m \times m$ $m \times n$ $m \times n$

1 is identity

$1 \times z = z \times 1 = z$
for any z

Informally:
$\begin{bmatrix} 1 & & & & \\ & 1 & & & \\ & & 1 & & \\ & & & \ddots & \\ & & & & 1 \end{bmatrix}$

$I_{n \times n}$

Note:
$AB \neq BA$ in general
$AI = IA$ ✓

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