

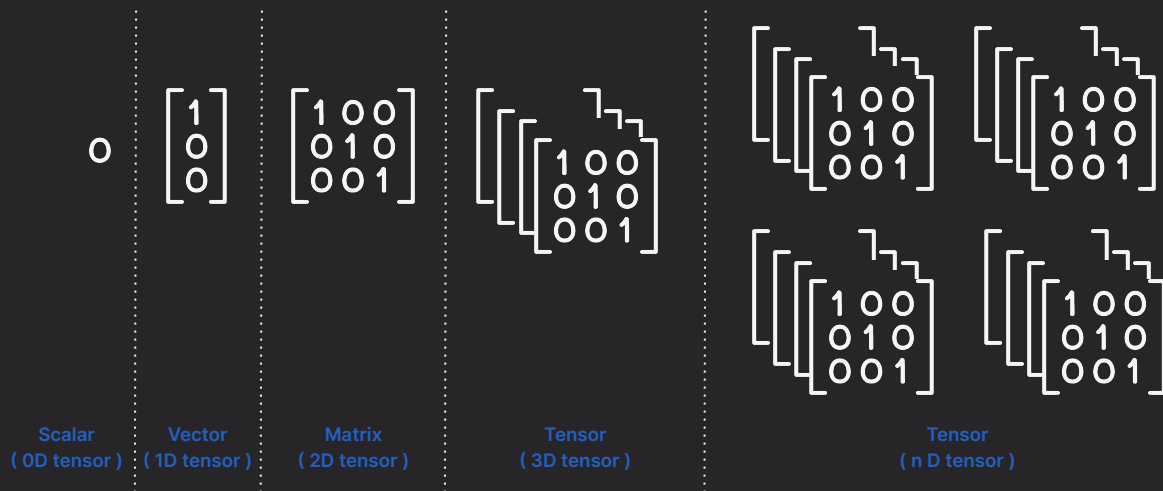


Introduction to Deep Learning

Video 6: Scalars and Vectors

Tensors

Tensors are mathematical objects that generalize scalars, vectors, and matrices to higher dimensions.



Scalars

Scalars : Single digit matrix.

1

Scalar

Vectors : Either one row or one column.

$$\begin{bmatrix} 1 \\ 4 \\ 6 \end{bmatrix}$$

1 Row Vector

$$\begin{bmatrix} 2 & 7 & 1 \end{bmatrix}$$

1 Column Vector

Matrices

A matrix is a **two dimensional array of scalars** with one or more columns and rows.

Uppercase Letter

A

=

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ 1 & 0 & 0 \\ a_{31} & a_{32} & a_{33} \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Referred by two
dimensional subscript
of row and column

Example: a_{11} , a_{32}

Matrices

A matrix is a **two dimensional array of scalars** with one or more columns and rows.

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

m = number of rows

n = number of columns

Matrix Addition

Two **matrices with same dimensions** can be added together to create a new third matrix.

$$\begin{bmatrix} 3 & 5 & 2 \\ 0 & 0 & 4 \\ 0 & 1 & 5 \end{bmatrix} + \begin{bmatrix} 1 & 1 & 2 \\ 1 & 0 & 1 \\ 0 & 0 & 2 \end{bmatrix} = \begin{bmatrix} 4 & 6 & 4 \\ 1 & 0 & 5 \\ 0 & 1 & 7 \end{bmatrix}$$

Diagram illustrating matrix addition. A blue curved arrow connects the element 5 in the first row, second column of the first matrix to the element 6 in the first row, second column of the resulting matrix. Above this arrow, the calculation $5 + 1 = 6$ is shown, indicating the addition of the corresponding element from the second matrix (1).

Matrix Subtraction

Two **matrices with same dimensions** can be subtracted together to create a new third matrix.

$$\begin{bmatrix} 3 & 5 & 2 \\ 0 & 0 & 4 \\ 0 & 1 & 5 \end{bmatrix} - \begin{bmatrix} 1 & 1 & 2 \\ 1 & 0 & 1 \\ 0 & 0 & 2 \end{bmatrix} = \begin{bmatrix} 2 & 4 & 0 \\ 0 & 0 & 3 \\ 0 & 0 & 3 \end{bmatrix}$$

Diagram illustrating matrix subtraction. A blue curved arrow connects the element 5 in the first row, second column of the first matrix to the element 4 in the first row, second column of the result matrix. Above this arrow, the calculation $5 - 1 = 4$ is shown, indicating the subtraction of the corresponding element (1) from the second matrix.

Matrix Multiplication

Multiplication of a scalar with *m*×*n* matrix.

$$\begin{bmatrix} 1 & 2 \\ 3 & 4 \\ 5 & 6 \end{bmatrix}_{3 \times 2} \times 2 = \begin{bmatrix} 2*1 & 2*2 \\ 2*3 & 2*4 \\ 2*5 & 2*6 \end{bmatrix}_{3 \times 2}$$

Matrix Multiplication

The number of columns in the 1st matrix should be same the number of rows of the 2nd matrix.

$$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}_{2 \times 3} \begin{bmatrix} 1 & 2 \\ 3 & 4 \\ 5 & 6 \end{bmatrix}_{3 \times 2} = \begin{bmatrix} a & b \\ c & d \end{bmatrix}_{2 \times 2}$$

Transpose of a Matrix

Transposing a matrix means **rows become columns** and **columns become rows**.

$$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}^T = \begin{bmatrix} 1 & 4 \\ 2 & 5 \\ 3 & 6 \end{bmatrix}$$

2×3 3×2

Matrix Multiplication

Multiplication of two matrices that have matching rows and columns.

$$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}_{2 \times 3} \begin{bmatrix} 1 & 2 \\ 3 & 4 \\ 5 & 6 \end{bmatrix}_{3 \times 2} = \begin{bmatrix} a_{11} & a_{21} \\ a_{12} & a_{22} \end{bmatrix}_{2 \times 2}$$

Dot Product

Matrices Operations



Addition



Subtraction



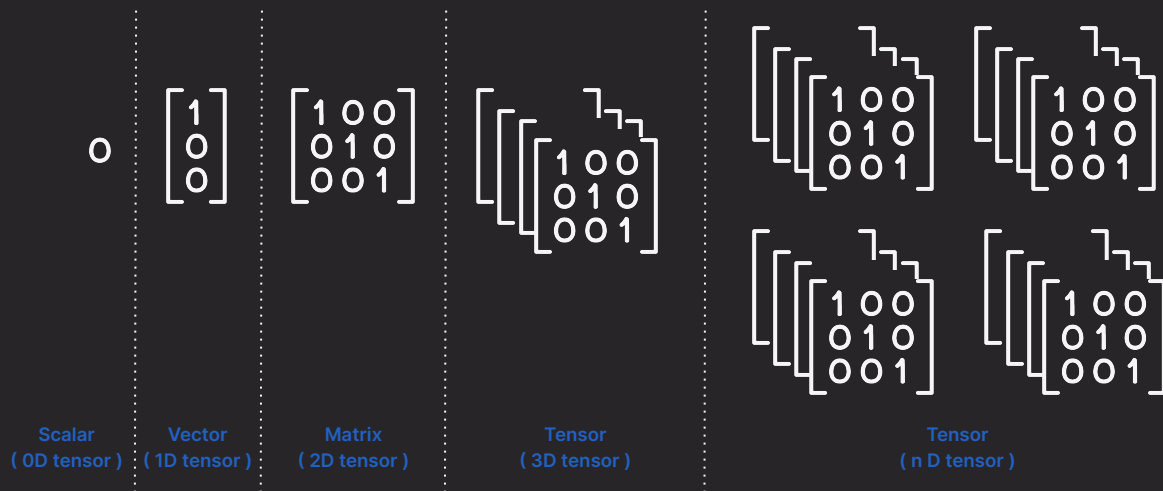
Transpose



Multiplication

Tensors

Tensors are mathematical objects that generalize scalars, vectors, and matrices to higher dimensions.





Introduction to Deep Learning

Video 7: Building a neuron with PyTorch