





DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)

Times Product

Dot Product:

Dot product of 2 vectors 2= <2, -37 & y= (5,1) 2.4= 2.5+ (-3.1)=7

Dot product can also be expressed as, $2^{T}y = [2, -3] \begin{bmatrix} 5 \\ 1 \end{bmatrix} = 7$

Length:

The length of vector x is denoted as 11211. Example: $x = [3, 4]^T$ Men,

11 X11= \J32+42 = 125

Note that this is same as

$$X^{T} X = [3 \ 4] \begin{bmatrix} 3 \\ 4 \end{bmatrix} = \sqrt{3^{2} + 4^{2}} = 5$$

/:. || X || = \[\sqrt{xT} \sqrt{}



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Inner Product

Dot Product:

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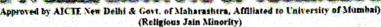
$$x^{7} \times = [3 \ 4] [\frac{3}{4}] = \sqrt{3^{2} + 4^{2}} = 5$$

[:. 11×11= VXTX]



Same Samuel Charles

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General Inner Products

Inner Product:

Let V be a vector space and $n: V \times V \rightarrow R$ be a bilinear mapping that takes 2 vectors and maps them onto a real number. Then,

· A positive definite, symmetric bilinear mapping on: VXV >> R is called an inner product on V.

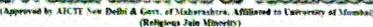
we typically write <2,47 instead of or (2,47).

- · The part (V, <.,.7) is called inner product space or vector space of inner product.
- · vi is called symmetric if su (214)= SU (4,2) for all 2,4 ex order of the agguments doesn't matter.
- · us is called positive definite if

V2 € V \{03: (1(0)) > 0, (V(0,0)=0

. The positive definiteness of the inner product implies that,

42E Y 403: 2 A2 70





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Example:

$$A_1 = \begin{bmatrix} 9 & 6 \\ 6 & 5 \end{bmatrix} \qquad A_2 = \begin{bmatrix} 9 & 6 \\ 6 & 3 \end{bmatrix}$$

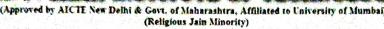
Ai is symmetric as, AI = AT Now check for the positive definiteness.

$$a^{T}A_{1}2 = [2, 22] \begin{bmatrix} 9 & 6 \\ 6 & 5 \end{bmatrix} \begin{bmatrix} 21 \\ 22 \end{bmatrix}$$



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... At is symmetric and positive definite. Also Az is symmetric but not positive definite.

If A ER is symmetric, positive definite

(2147=-2TA4

<2147 = 2TAY

defines inner product where 2 and y are the coordinate representations of 214 EV.

Note: Not every norm is id induced by an inner product. (1, norm)

Inner product induces a norm

1/211= Jata = Jeans Cle norm