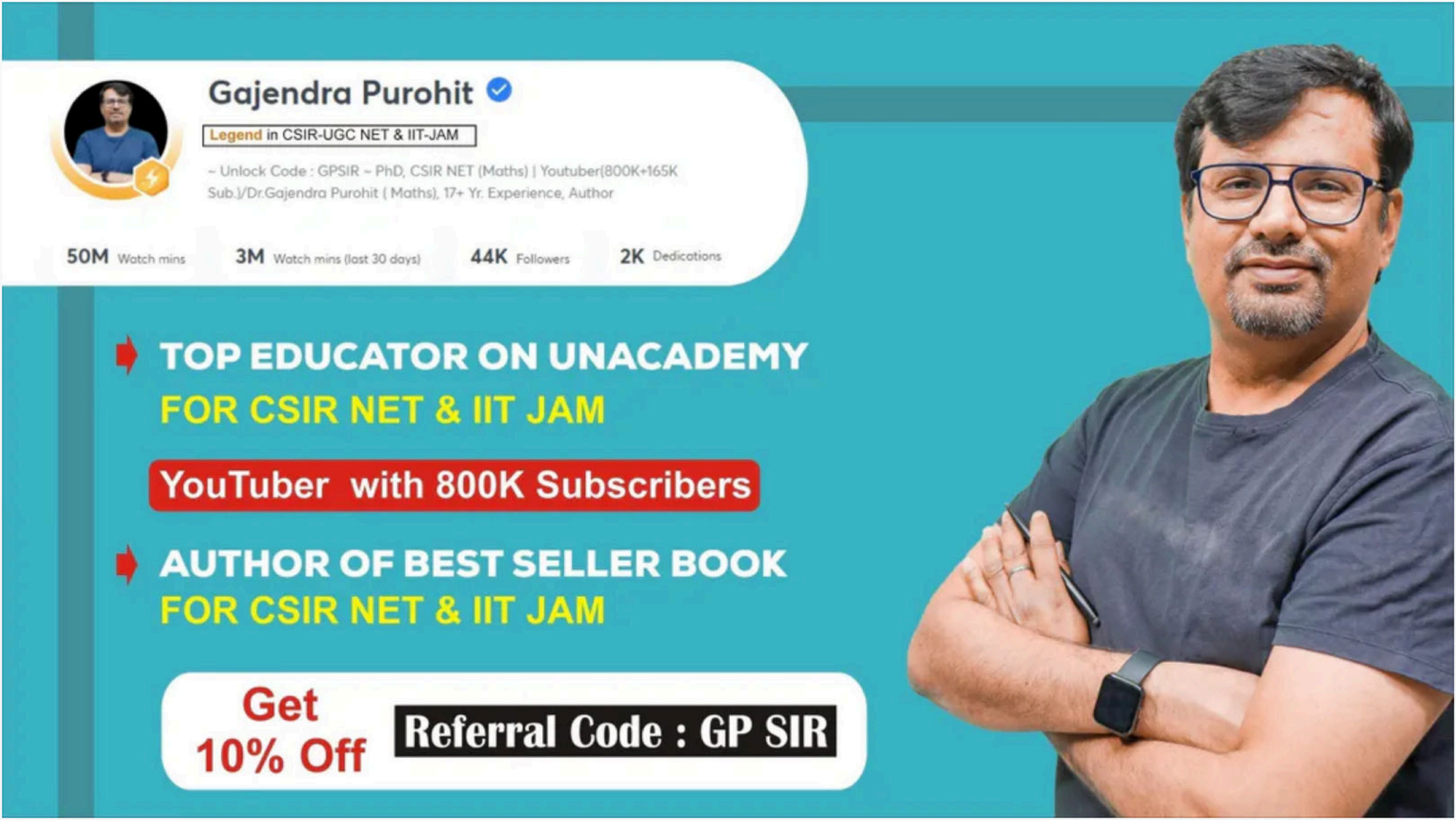
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Eigen value &eigen vector

Characteristic polynomial : Let A be square matrix of order n then $C_A(x) = \det(xI - A) = \det(A - xI)$ is a polynomial of degree n called the characteristic polynomial of A and the equation $C_A(x) = \det(A - xI) = 0$ is called characteristic equation.

Eigen value and Eigen vector : Let A be any matrix of order n then roots of characteristic equation is called eigen value.

i.e. If A is matrix and $[A - \lambda I]X = 0$ then λ is eigen value and X is eigen vector corresponding to λ

Note : Eigen vector corresponding to distinct eigen value are LI

Result : If λ is eigen value of A then

(1) Eigen value of αA is $\alpha\lambda$

(2) Eigen value of A^n is λ^n.

(3) Sum of all eigen value = Trace (A)

(4) Product of all eigen value = det(A)

(5) Eigen value of A^{-1} is λ^{-1}.

(6) Eigen value of Adj(A) is $\frac{|A|}{\lambda}$

(7) If sum of each row in A is equal to k then k must be eigen value and it is largest eigen value.

$\frac{|A|}{\lambda}$

A   1, 2, 3

2A   2, 4, 6

A^2 1, 4, 9

I   1, 1, 1

A^2+2A+I 2, 8, 15

$|A^2+2A+I| = 2\times 8\times 15$

$Tr(A^2+2A+I) = 2+8+15$

A^2+2A+I

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

$\lambda_1 = 1, \ \lambda_2 = 1$

$2v_1 = \cancel{2}v_2$

$\lambda_1 = 1$

$$\begin{pmatrix} 0 & 1 \\ 0 & 0 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$$

$x_2 = 0$

$x_1 = k$

$$k \begin{pmatrix} 1 \\ 0 \end{pmatrix}$$

$$\begin{pmatrix} 1 \\ 0 \end{pmatrix} \quad \begin{pmatrix} 2 \\ 0 \end{pmatrix}$$

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

$$A = \begin{bmatrix} 1 & 1 \\ 0 & 2 \end{bmatrix} \qquad \lambda_1 = 1, \quad \lambda_2 = 2$$

$\lambda_1 = 1$

$$\begin{bmatrix} 0 & 1 \\ 0 & 1 \end{bmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$$

$x_2 = 0$

$x_1 = k$

$$k \begin{pmatrix} 1 \\ 0 \end{pmatrix}$$

$$\begin{bmatrix} -1 & 1 \\ 0 & 0 \end{bmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$$

$-x_1 + x_2 = 0$

$x_2 = k$

$x_1 = k$

$$\begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = k \begin{pmatrix} 1 \\ 1 \end{pmatrix}$$

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

Q.1. Let A be a 3 × 3 matrix with eigen value 1, -1, 0. Then the determinant of $I + A^{100}$ is

(a) 6 (b) 4

(c) 9 (d) 100

$I \begin{pmatrix} 1 & & \\ & 1 & \\ & & 1 \end{pmatrix}$

$A^{100} \begin{pmatrix} 1 & & \\ & 1 & \\ & & 0 \end{pmatrix}$

$\det(I + A^{100}) = 2 \times 2 \times 1 = 4$

$A_{3\times 3}$ Eigen Values are $1, -1, 3$

(a) $A^2 + A$ is non singular

(b) $A^2 - A$ is non-singular

(c) $A^2 + 3A$ is non singular

(d) $A^2 - 3A$ is non singular

$A^2 = 1, 1, 9$

$3A = 3, -3, 9$

$A^2 + 3A$ $4, -2, 18$

$A^2 - 3A = -2, 4, 0$

A

$A^2 = 1, 1, 9$

$A = 1, -1, 3$

$A^2 + A$ $2, 0, 12$

$A^2 - A = 0, 2, 6$

Q.2. Let $A = \begin{array}{c}\begin{pmatrix} 2 & -1 & 3 \\ 2 & -1 & 3 \\ 3 & 2 & -1 \end{pmatrix}\end{array} \begin{array}{c} 4 \\ 4 \\ 4 \end{array}$. Then the largest eigenvalue of A is

(a) 1 (b) 2

(c) 3 (d) 4

$$A = \begin{bmatrix} a & 1 & 4 \\ 0 & b & 7 \\ 0 & 0 & 3 \end{bmatrix}$$

(a) 29 (b) 40

(c) 58 (d) 65

Sum of Eigen value of A = 10

Product of Eigen value of A = 30

$a^2 + b^2 = 4 + 25 = 29$

$a + b + 3 = 10$

$3ab = 30$

$ab = 10$

$a + b = 7$

$a = 2$

$b = 5$

Eigen value for different type of matrix

(1) Eigen values of symmetric matrix and hermitian matrix are real.

(2) Eigen value of skew-symmetric and skew-hermitian matrix are either zero or purely imaginary.

(3) Eigen values of involutory matrix are either 1 or -1 or both.

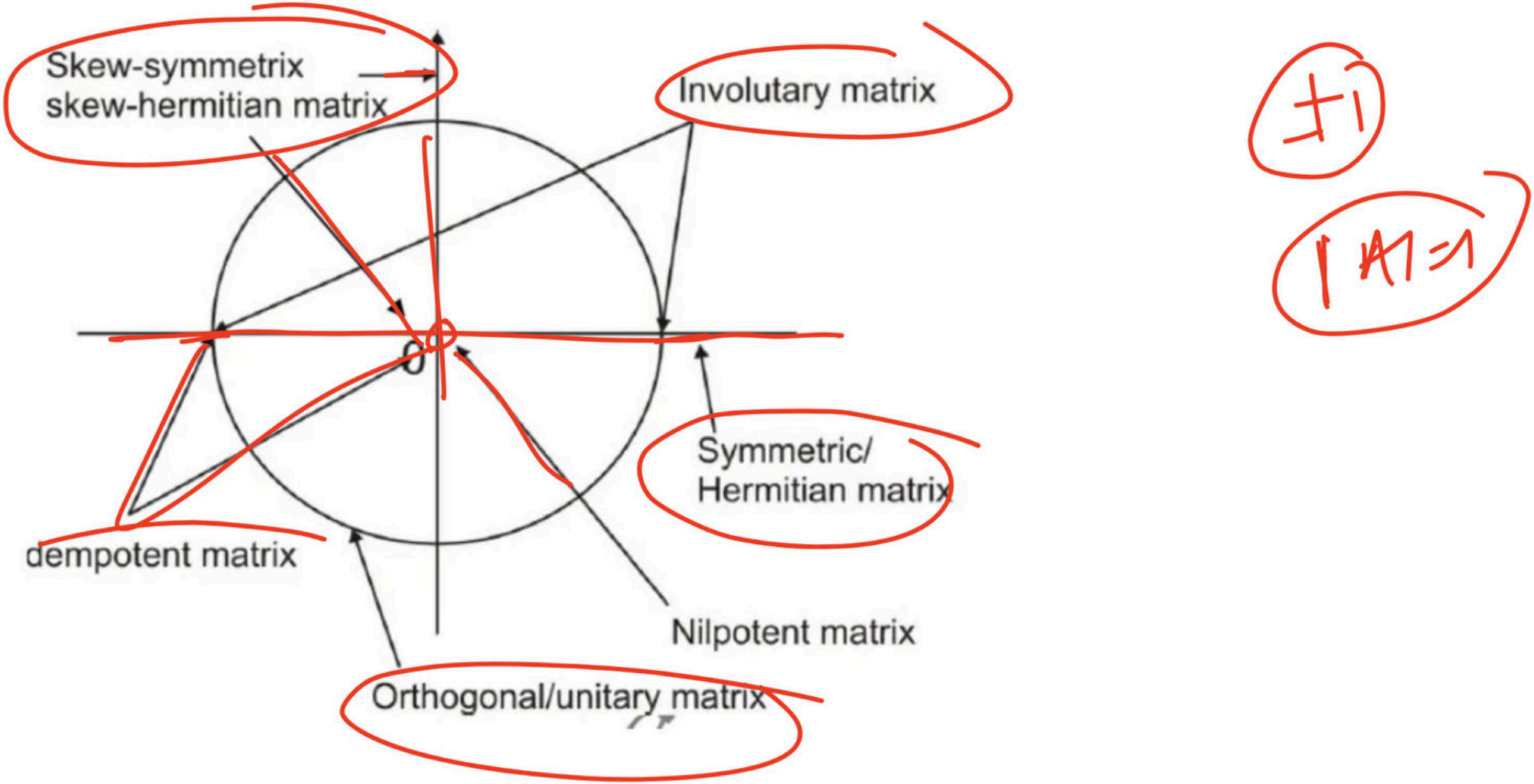
(4) Eigen values of idempotent matrix are either 0 or 1 or both.

(5) Eigen values of nilpotent matrix are 0.

(6) Eigen values of orthogonal matrix and unitary matrix are unit modulus.

$AA^T = I$

$A^2 = I$



Skew-symmetrix
skew-hermitian matrix
Involutary matrix
0
Symmetric/
Hermitian matrix
dempotent matrix
Nilpotent matrix
Orthogonal/unitary matrix
±1
|A|=1

(7) Eigen value of permutation matrix.

Let $\sigma = c_1.c_2. \ldots.. c_k$ product of disjoint cycles such that $l(c_i) = r_i$ where $l(c_i)$ = length of c_i.

Then characteristic of A is $c(x) = \prod_{ri} (x^{r_i} - 1)$

i.e. $\sigma = (12)\,(3) \in S_3$

$c_1 = (12)$ and $l(c_1) = 2 = r_1$

$c_2 = (3)$ and $l(c_2) = 1 = r_2$ then $c(x) = (x^2 - 1)(x - 1)$

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

$$\begin{pmatrix} 1 & 2 & 3 & 4 \\ 3 & 1 & 4 & 2 \end{pmatrix}$$

(1342)

$(x^4 - 1) = 0$

$x = \pm 1, \pm i$

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

$$(\lambda^2 - 5\lambda - 2)(\lambda^2 - 3\lambda - 33)$$

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Q.3. Which of the following properties are true?

(a) If λ is an eigen value of A then 2λ is an eigen value of A^{-1}.

(b) If λ is an eigen value of A then $1/\lambda$ is an eigen value of A^{-1}.

(c) If λ is an eigen value of an orthogonal matrix, then $1/\lambda$ is also its eigen value.

(d) All of the above.

Q.4. The square matrix A is said to be an idempotent if $A^2 = A$.

An idempotent matrix is non-singular iff

(a) All E.V. are real

(b) All E.V. are real non-negative

(c) All E.V. are either 0 or 1

(d) All E.V. are 1

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

a c
b d
c b
d a

Q.5 The trace of the matrix $A = \begin{bmatrix} 3 & 2 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}^{15}$ is

(a) $1 + 3^{15}$

(b) $2 + 3^{15}$

(c) 3^{15}

(d) 0

$3^{15} =$

1^{15}

1^{15}

3^{15}

1

1

$2 + 3^{15}$

Q.6. Let A be 3 × 3 matrix with real entries such that 1, -1, 2 are its eigenvalues if $B = A^3 + 2A^2 + I$, then

(a) det (B) = 50 (b) det (B) = 136

(c) det (B) = 23 T (d) det(B) = 17 T

(a) a, c
(b) b, c
(c) a, d
(d) b, d

$A = 1, -1, 2$

$A^2 \quad 1, 1, 4$

$2A^2 \quad 2 \quad 2 \quad 8$

$I \quad 1 \quad 1 \quad 1$

$A^3 \quad 1, -1, 8$

$A^3 + 2A^2 + I = 4 \quad 2 \quad 17$

Q.7.. Let A and B be $n \times n$ real matrices and let $C = \begin{pmatrix} A & B \\ B & A \end{pmatrix}$

.Which of the following statements are true?

(a) If λ is an eigenvalue of $A + B$ then λ is an eigen value of C

(b) If λ is an eigenvalue of $A - B$ then λ is an eigen value of C

(c) If λ is an eigen value of A or B then λ is an eigen value of C

(d) All eigen values of C are real

$$C = \begin{bmatrix} 0 & 0 & 0 & 1 \\ 0 & 0 & -1 & 0 \\ 0 & 1 & 0 & 0 \\ -1 & 0 & 0 & 0 \end{bmatrix}$$

Q.8. Which of the following eigen values of the matrix.

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

(a) 1 (b) -1

(c) i (d) –i

Q.1. Let $M_n(R)$ be the set of $n \times n$ matrices with real entries.

Which of the following is true?

(a) Any matrix $A \in M_4(R)$ has a real eigen value.

(b) Any matrix $A \in M_5(R)$ has a real eigen value.

(c) Any matrix $A \in M_2(R)$ has a real eigen value

(d) None of these


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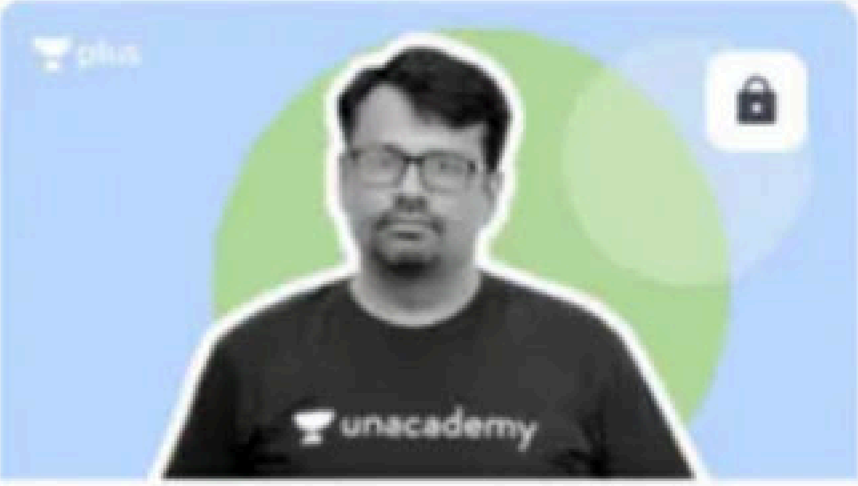

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