



## INTRODUCTION TO AI AND ML

EE1390

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# QUESTION IN GEOMETRIC FORM



Que. Find the tangent to the circle, at the point  $(1, -1)$  whose centre is the point of intersection of the straight lines

$$2x + y = 3 \quad (1)$$

$$x - y = 1 \quad (2)$$

# QUESTION IN MATRIX FORM



Que. Find the tangent to the circle, at the point

$$\begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

,whose centre is the point of intersection of the straight lines

$$\begin{bmatrix} 2 & 1 \end{bmatrix} X = 3$$

$$\begin{bmatrix} 1 & -1 \end{bmatrix} X = 1$$

# SOLUTION



$$\begin{bmatrix} 2 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = 3$$

$$\begin{bmatrix} 1 & -1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = 1$$

$$\begin{bmatrix} 2 & 1 \\ 1 & -1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 3 \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} x \\ y \end{bmatrix} = 1/3 \begin{bmatrix} -1 & -1 \\ -1 & 2 \end{bmatrix} \begin{bmatrix} 3 \\ 1 \end{bmatrix}$$



Let 'O' be the center of the circle and 'P' be the point at which tangent is to be drawn,

$$O = \begin{bmatrix} a \\ b \end{bmatrix} = \begin{bmatrix} 4/3 \\ 1/3 \end{bmatrix} \quad (5)$$

$$P = \begin{bmatrix} 1 \\ -1 \end{bmatrix} \quad (6)$$

$$OP = r = ||O - P|| \quad (7)$$

$$OP^2 = r^2 = (a - 1)^2 + (b + 1)^2 \quad (8)$$

$$r^2 = (1/3)^2 + (4/3)^2 = 17/9 \quad (9)$$



Equation of circle:

$$XX^T + \begin{bmatrix} -8/3 \\ -2/3 \end{bmatrix} X = 0 \quad (10)$$

Parametric form of circle:

$$\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 4/3 \\ 1/3 \end{bmatrix} + r \begin{bmatrix} \cos(\theta) \\ \sin(\theta) \end{bmatrix} \quad (11)$$

$$0 < \theta < 2\pi$$

Equation of circle:

$$x^2 + y^2 - 8/3x - 2/3y = 0 \quad (12)$$

# EQUATION OF TANGENT



Direction vector of radius = Direction of normal vector of the tangent:

$$OP = r = \begin{bmatrix} 1/3 \\ 4/3 \end{bmatrix} \quad (13)$$

Equation of tangent;

$$[\text{normal vector}] X = c \quad (14)$$

$$\begin{bmatrix} 1/3 & 4/3 \end{bmatrix} X = c \quad (15)$$

To get the value of c substitute (1,-1) in the equation, We get  $c = -1$   
Hence the equation becomes,

$$\begin{bmatrix} 1/3 & 4/3 \end{bmatrix} X = -1 \quad (16)$$

Hence, equation of tangent is:

$$x + 4y + 3 = 0 \quad (17)$$

# DIRECTION VECTOR OF TANGENT

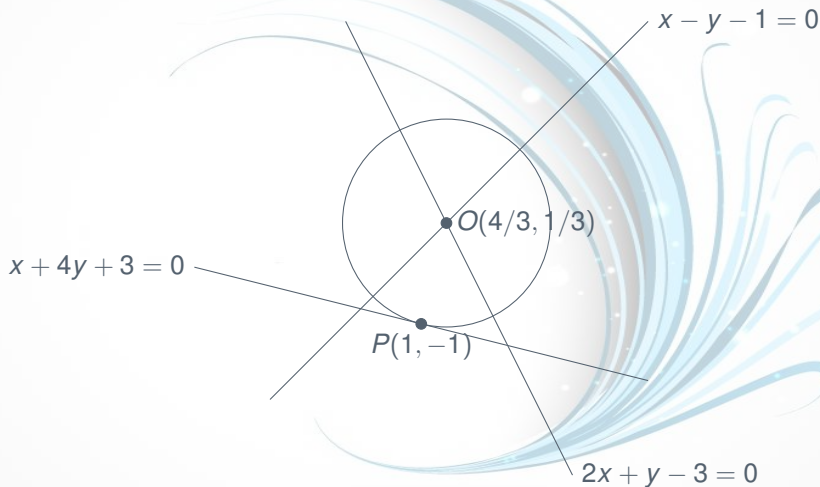


Direction vector of tangent = normal of radius vector

$$\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} 1/3 \\ 4/3 \end{bmatrix} = \begin{bmatrix} 4/3 \\ -1/3 \end{bmatrix} \quad (18)$$



# FIGURE OF SOLUTION



# FIGURE OF SOLUTION

