Assignment 1

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1) Consider the following population and year graph, Find the slope of the line AB and using it, find what will be the population in the year 2010?

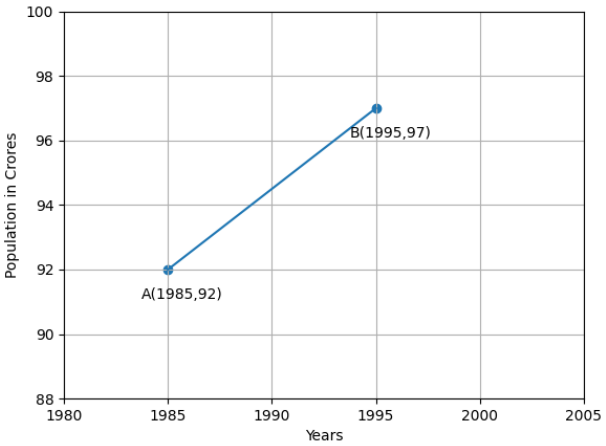

Fig. 1: Graph

Solution: Given the points

$$\mathbf{A}\begin{pmatrix}1985\\92\end{pmatrix},\mathbf{B}\begin{pmatrix}1995\\97\end{pmatrix} \tag{0.0.1}$$

The direction vector is given by,

$$\mathbf{m} = \mathbf{B} - \mathbf{A} \tag{0.0.2}$$

$$\mathbf{m} = \begin{pmatrix}1995\\97\end{pmatrix} - \begin{pmatrix}1985\\92\end{pmatrix} \tag{0.0.3}$$

$$\mathbf{m} = \begin{pmatrix}10\\5\end{pmatrix} \tag{0.0.4}$$

Direction vector,

$$\mathbf{m} = \frac{1}{5}\begin{pmatrix}10\\5\end{pmatrix} \tag{0.0.5}$$

$$\mathbf{m} = \begin{pmatrix}2\\1\end{pmatrix} \tag{0.0.6}$$

The slope of the line, m can be found by expressing the direction vector $\mathbf{m}$ in the following form

$$\mathbf{m} = \begin{pmatrix}1\\m\end{pmatrix} \tag{0.0.7}$$

$$\mathbf{m} = \begin{pmatrix}1\\\frac{1}{2}\end{pmatrix} \tag{0.0.8}$$

$$m = \frac{1}{2} \tag{0.0.9}$$

The normal of the line $\mathbf{n}$ is given by,

$$\mathbf{n} = \begin{pmatrix}5\\-10\end{pmatrix} \tag{0.0.10}$$

Any point, $\mathbf{x}$ on the line can be written as

$$\mathbf{n}^T(\mathbf{x} - \mathbf{A}) = 0 \tag{0.0.11}$$

$$\mathbf{n}^T\mathbf{x} = \mathbf{n}^T\mathbf{A} \tag{0.0.12}$$

$$\begin{pmatrix}5 & -10\end{pmatrix}\mathbf{x} = \begin{pmatrix}5 & -10\end{pmatrix}\begin{pmatrix}1985\\92\end{pmatrix} \tag{0.0.13}$$

$$\begin{pmatrix}5 & -10\end{pmatrix}\mathbf{x} = (5\times 1985) + (-10\times 92) \tag{0.0.14}$$

$$\begin{pmatrix}5 & -10\end{pmatrix}\mathbf{x} = 9005 \tag{0.0.15}$$

We need to find the population in the year 2010

$$\mathbf{x} = \begin{pmatrix}2010\\y\end{pmatrix} \tag{0.0.16}$$

$$\begin{pmatrix}5 & -10\end{pmatrix}\begin{pmatrix}2010\\y\end{pmatrix} = 9005 \tag{0.0.17}$$

$$(5\times 2010) + (-10\times y) = 9005 \tag{0.0.18}$$

$$10y = 1045 \tag{0.0.19}$$

$$y = 104.5 \tag{0.0.20}$$

Hence the population in the year 2010 is 104.5 crores.