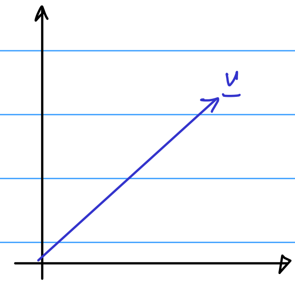
Length of a vector $\underline{v}$



$$\underline{v} = \begin{pmatrix} x_1 \\ x_2 \end{pmatrix}$$

$$\|\underline{v}\| = \sqrt{x_1^2 + x_2^2}$$

$$\|\underline{v}\|^2 = x_1^2 + x_2^2 = \underline{v} \cdot \underline{v}$$

Matrix

* Rectangular array of numbers.

$$\begin{array}{c|cc} & \text{feature 1} & \text{feature 2} \\ \hline \text{eg 1} & & \\ \text{eg 2} & & \end{array}$$

$$A = \begin{pmatrix} 1 & 0 & 3 \\ -2 & 1 & 2 \end{pmatrix}.$$

Size 2×3 python $(2, 3)$

$A : m \times n$

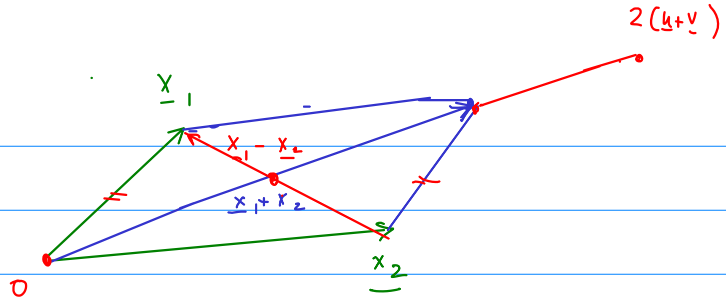
$$\underline{\alpha_1 \begin{pmatrix} 1 \\ -2 \end{pmatrix} + \alpha_2 \begin{pmatrix} 0 \\ 1 \end{pmatrix} + \alpha_3 \begin{pmatrix} 3 \\ 2 \end{pmatrix}} = \underbrace{\begin{pmatrix} 1 & 0 & 3 \\ -2 & 1 & 2 \end{pmatrix}} \begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{pmatrix} \quad *$$

$$\beta_1 \begin{pmatrix} 1 \\ -2 \end{pmatrix} + \beta_2 \begin{pmatrix} 0 \\ 1 \end{pmatrix} + \beta_3 \begin{pmatrix} 3 \\ 2 \end{pmatrix} = \begin{pmatrix} 1 & 0 & 3 \\ -2 & 1 & 2 \end{pmatrix} \begin{pmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \end{pmatrix}$$

$$\begin{pmatrix} 1 & 0 & 3 \\ -2 & 1 & 2 \end{pmatrix} \begin{pmatrix} \alpha_1 & \beta_1 \\ \alpha_2 & \beta_2 \\ \alpha_3 & \beta_3 \end{pmatrix} = \left[\begin{matrix} \alpha_1 \begin{pmatrix} 1 \\ -2 \end{pmatrix} + \alpha_2 \begin{pmatrix} 0 \\ 1 \end{pmatrix} \\ + \alpha_3 \begin{pmatrix} 3 \\ 2 \end{pmatrix} \end{matrix} \quad \begin{matrix} \beta_1 \begin{pmatrix} 1 \\ -2 \end{pmatrix} + \beta_2 \begin{pmatrix} 0 \\ 1 \end{pmatrix} \\ + \beta_2 \begin{pmatrix} 3 \\ 2 \end{pmatrix} \end{matrix} \right]$$

Is $\begin{pmatrix} -1 \\ 3 \end{pmatrix}$ a linear combination of $\begin{pmatrix} 1 \\ -2 \end{pmatrix}, \begin{pmatrix} 0 \\ 1 \end{pmatrix}, \begin{pmatrix} 3 \\ 2 \end{pmatrix}$?

$$\begin{pmatrix} 1 & 0 & 3 \\ -2 & 1 & 2 \end{pmatrix} \begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{pmatrix} \stackrel{?}{=} \begin{pmatrix} -1 \\ 3 \end{pmatrix}$$



$$\|\underline{x}_1 + \underline{x}_2\|^2 + \|\underline{x}_1 - \underline{x}_2\|^2 = 2\|\underline{x}_1\|^2 + 2\|\underline{x}_2\|^2$$