4.2.15

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Question:
Find the direction and normal vectors of $y = 2x$.
Solution:

The line can be written as:

$$-2x + 1y = 0 \tag{0.1}$$

This equation can be expressed in terms of matrices as:

$$\mathbf{n}^\top \mathbf{x} = c \tag{0.2}$$

$$\mathbf{n}^\top = \begin{pmatrix} -2 & 1 \end{pmatrix} \tag{0.3}$$

$$\mathbf{x} = \begin{pmatrix} x \\ y \end{pmatrix} \tag{0.4}$$

$$c = 0 \tag{0.5}$$

where $\mathbf{n}$ is normal vector of the given line.

The direction vector is:

$$\mathbf{m} = \begin{pmatrix} 1 \\ 2 \end{pmatrix}. \tag{0.6}$$

This is true because, if the direction vector is represented as

$$\mathbf{m} = \begin{pmatrix} 1 \\ m \end{pmatrix} \tag{0.7}$$

then the normal vector can be expressed as

$$\mathbf{n} = \begin{pmatrix} -m \\ 1 \end{pmatrix} \tag{0.8}$$

$$\mathbf{n}^\top \mathbf{m} = 0 \tag{0.9}$$

$$\begin{pmatrix} -2 & 1 \end{pmatrix} \begin{pmatrix} 1 \\ 2 \end{pmatrix} = 0 \tag{0.10}$$

Hence, normal vector $\mathbf{n} = \begin{pmatrix} -2 \\ 1 \end{pmatrix}$ and direction vector $\mathbf{m} = \begin{pmatrix} 1 \\ 2 \end{pmatrix}$.

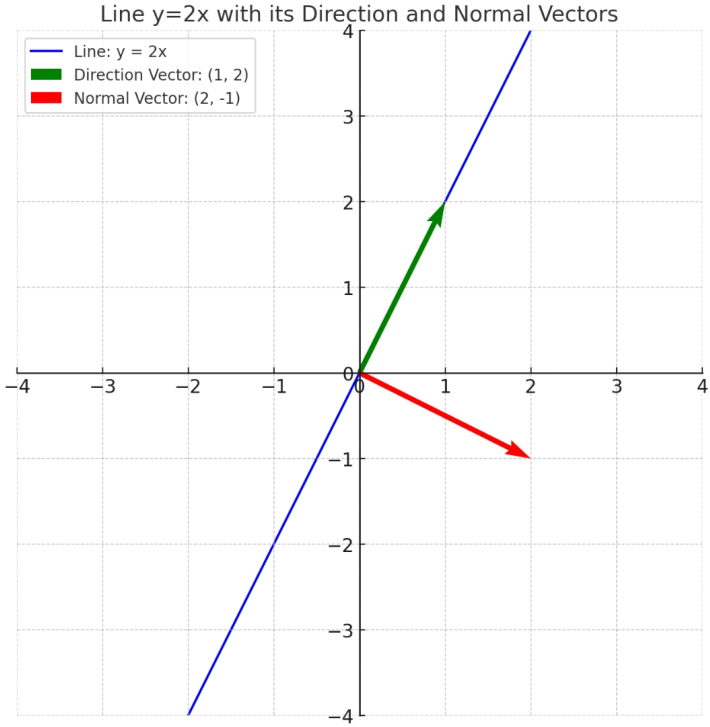

Fig. 0.1: line y=2x