COMPUTING : i) Encode information

ii) Process information [Computation]

iii) Read / Obtain the result [read-out]

True for all forms of Computation

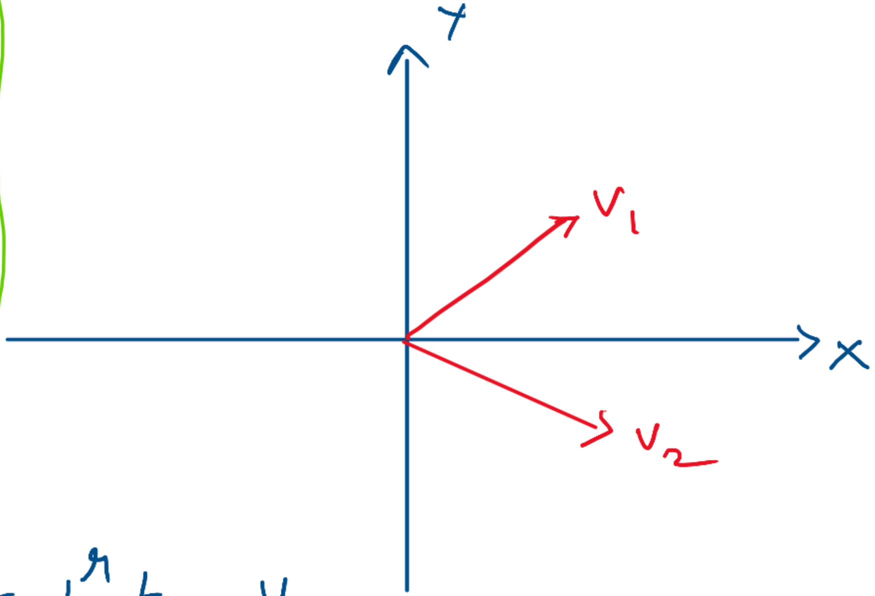
The Need for Orthogonal Basis Vectors

Real - 2D Plane

Perpindicularity

$\Updownarrow$

Distinguishability



$V_1 \neq k V_2$; k is a number

any 2 distinct vectors are linearly independent

i) If V_1 is not $\perp^r$ to V_2
then it is not always possible to distinguish between them

ii) However, if $V_1 \perp V_2$ then they <u>can always be distinguished</u>

On the representation of the Y gate

$$\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} = Y \qquad - \text{ Y Gate}$$

$$\begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} = \sigma_Y \qquad - \text{ Pauli Y matrix}$$

$$Y = i\,\sigma_Y$$

$$Y|\psi\rangle = i\,\underbrace{\sigma_Y|\psi\rangle}_{|\phi\rangle} = \boxed{i}\,|\phi\rangle$$

$e^{i\pi/2} \rightarrow$ unit complex no. $\Rightarrow$ Global Phase

Reversibility in Quantum Computing

→ All Quantum gates are unitary tranformations

→ If U is unitary, the $UU^{\dagger} = U^{\dagger}U = \mathbb{1}$

(Identity matrix)

$\dagger$ - tranposed conjugate or Hermitian Conjugate.

$|\psi\rangle$: $U|\psi\rangle = |\phi\rangle$

$U^{\dagger}|\phi\rangle = |\psi\rangle$

$\because U^{\dagger}|\phi\rangle = \underbrace{U^{\dagger}U}_{\text{Identity}}|\psi\rangle$

True for any unitary transformation

$\boxed{\text{Every gate operation performed in Quantum Computing is reversible}}$

ORDERING IN TENSOR PRODUCTS

$|\psi\rangle_1 = \begin{pmatrix}1\\0\end{pmatrix} \equiv |0\rangle \in V_1$ (space of all single qubit states for qubit "1")

$|\phi\rangle_2 \equiv \begin{pmatrix}1\\0\end{pmatrix} \equiv |0\rangle \in V_2$ (" " " " " " " qubit "2")

$$|0\rangle_1 \otimes |0\rangle_2 = \begin{pmatrix} 1\begin{pmatrix}1\\0\end{pmatrix} \\ 0\begin{pmatrix}1\\0\end{pmatrix}\end{pmatrix} = \begin{pmatrix}1\\0\\0\\0\end{pmatrix} \in V_1 \otimes V_2$$

$$|0\rangle_2 \otimes |0\rangle_1 = \begin{pmatrix}1\\0\\0\\0\end{pmatrix} \in V_2 \otimes V_1$$

$$\boxed{V_1 \otimes V_2 \not\equiv V_2 \otimes V_1}$$