

- a) $\text{proj}_{\vec{u}}(\vec{v}) = \frac{2}{3} \langle 1, 2, 2 \rangle$
 b) $\vec{v} - \text{proj}_{\vec{u}}(\vec{v}) = \frac{1}{3} \langle 4, -7, 5 \rangle$
 c) scalar projection of \vec{v} onto \vec{u} , $|\text{proj}_{\vec{u}}\vec{v}| = 2$

Summary

- A vector can be written as

$$\vec{V} = \langle v_1, v_2, v_3 \rangle = v_1\hat{i} + v_2\hat{j} + v_3\hat{k}$$

- Direction angle

$$\cos \alpha = \frac{v_1}{\|\vec{v}\|}, \quad \cos \beta = \frac{v_2}{\|\vec{v}\|}, \quad \cos \gamma = \frac{v_3}{\|\vec{v}\|},$$

satisfying the relation $\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$.

- If $\vec{u} = \langle u_1, u_2, u_3 \rangle$, $\vec{v} = \langle v_1, v_2, v_3 \rangle$

- Dot Product

$$\vec{u} \cdot \vec{v} = u_1v_1 + u_2v_2 + u_3v_3$$

$$\vec{u} \cdot \vec{v} = \|\vec{u}\|\|\vec{v}\|\cos \theta$$

- Orthogonal projections

A vector \vec{v} can be decomposed into two vectors, one vector parallel to \vec{u}

$$\text{proj}_{\vec{u}}\vec{v} = \frac{\vec{v} \cdot \vec{u}}{\|\vec{u}\|^2} \vec{u}$$

and another vector perpendicular to \vec{u}

$$\vec{v} - \text{proj}_{\vec{u}}\vec{v}$$

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