Vector Definitions and Equations

Dot and Cross Products

Dot Product

Converts two vectors to a scalar value.

$\mathbf{A} \bullet \mathbf{B} = |\mathbf{A}|\,|\mathbf{B}| \cos(\theta)$ ← θ is the angle between the two vectors

If $\mathbf{A} = A_1\mathbf{i} + A_2\mathbf{j} + A_3\mathbf{k}$ and $\mathbf{B} = B_1\mathbf{i} + B_2\mathbf{j} + B_3\mathbf{k}$

$\mathbf{A} \bullet \mathbf{B} = A_1B_1 + A_2B_2 + A_3B_3$

Cross Product

Results in a new vector.

Magnitude: $\mathbf{A} \times \mathbf{B} = |\mathbf{A}|\,|\mathbf{B}| \sin(\theta)$

Direction: perpendicular to the two vectors using the right-hand rule A → B

Formal Definition

Given vectors

$\mathbf{u} = u_1\mathbf{i} + u_2\mathbf{j} + u_3\mathbf{k}$

$\mathbf{v} = v_1\mathbf{i} + v_2\mathbf{j} + v_3\mathbf{k}$

$$\mathbf{u} \times \mathbf{v} = \text{determinate of } \begin{bmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ u_1 & u_2 & u_3 \\ v_1 & v_2 & v_3 \end{bmatrix}$$

More Formulae

*Projection of **a** onto **b***

This is the component of **a** in the direction of **b**

$$\mathbf{proj_b a} = \frac{a \bullet b}{|b|^2} \cdot \mathbf{b}$$

Magnitude:

Projection of a perpendicular to b

$\mathbf{a} - \mathbf{proj_b a}$