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SCALAR PRODUCT OF TWO VECTORS AND ITS PROPERTIES

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Abstract

Underlying concepts: projection, scalar product, angle between vectors, parallel vectors, perpendicular vectors.

Scalar product of vectors Is a scalar product of two and vectors, which is said to be the number that is formed by visualizing the lengths of the vectors and the cosine of the angle between them, and $(\bar{a},\bar{b})=|\bar{a}||\bar{b}|\cos\varphi$ it is written in visual notation. Here φ, $\bar{a}$ va $\bar{b}$ angle between vectors.

From the definition of a scalar product follows the following facts:

Hut 1. In order for the scalar product of two vectors to be zero, their mutual perpendicular is weak and sufficient. $(\bar{a},\bar{b})=0 \Leftrightarrow \varphi=\frac{\pi}{2},\ \bar{a}\perp\bar{b}$

Hut 2. Is the self-scalar product of any vector, which is the vector length of squared: $(\bar{a},\bar{a})=|\bar{a}|^2$

House 3. Scalar multiplicative substitution (commutativity) paints the rule: $(\bar{a}\ ,\bar{b})=(\bar{b}\ ,\bar{a})$.

Hospice 4. Scalar multiplication, gruppering rule with respect to scalar multiplication: $(\lambda\bar{a}\ ,\bar{b})=\lambda(\bar{a}\ ,b)$, $\lambda\in R$

Hut 5. $(\bar{a}+\bar{b},\bar{c})=(\bar{a},\bar{c})+(\bar{b},\bar{c})$

The proof of the fifth property follows from the second property of the projection:

$$(\bar{a}+\bar{b},\bar{c})=|\bar{a}+\bar{b}||\bar{c}|\cos\varphi=\text{ï ð}_{\bar{c}}(\bar{a}+\bar{b})|\bar{c}|=\text{ï ð}_l(\bar{a}+\bar{b})|\bar{c}|=\text{ï ð}_l\bar{a}\cdot|\bar{c}|+\text{ï ð}_l\bar{b}\cdot|\bar{c}|=$$

$$=|\bar{a}|\cdot|\bar{c}|\cos\alpha+|\bar{b}|\cdot|\bar{c}|\cos\varphi$$

$$(\bar{e}_1,\bar{e}_2,\bar{e}_3)$$

$$\bar{e}_i\bar{e}_j=\begin{cases}0, & i\neq j\\ 1, & i=j\end{cases}\quad i,j=1,2,3.$$

Representation of a scalar product in coordinates

Orthonormalized in Vector Space $(\bar{e}_1,\bar{e}_2,\bar{e}_3)$ take some. $\bar{a},\bar{b}$ vectors with respect to this basis $\{x_1,y_1,z_1\}$ va $\{x_2,y_2,z_2\}$ have coordinates:

$\bar{a} = x_1\bar{e_1} + y_1\bar{e_2} + z_1\bar{e_3}$

$\bar{b} = x_2\bar{e_1} + y_2\bar{e_2} + z_2\bar{e_3}$

Based on properties 4 and 5 of the scalar product

$$(a,b) = \left(x_1\bar{e_1} + y_1\bar{e_2} + z_1\bar{e_3}\right)\left(x_2\bar{e_1} + y_2\bar{e_2} + z_2\bar{e_3}\right) =$$

$$= x_1x_2\bar{e_1^2} + y_1y_2\bar{e_2^2} + z_1z_2\bar{e_3^2} + (x_2y_1 + x_1y_2)\bar{e_1}\bar{e_2} +$$

$$+ (z_1y_2 + y_1z_2)\bar{e_2}\bar{e_3} + (x_1z_2 + z_1x_2)\bar{e_1}\bar{e_3}$$

we can write the ratio, where we use the 7-hossatan,

$$(a,b) = x_1x_2\bar{e_1^2} + y_1y_2\bar{e_2^2} + z_1z_2\bar{e_3^2}$$

Hence, the scalar product of two vectors given by their coordinates is equal to the sum of the products of the corresponding coordinates of these vectors.

From this case, the result thus follows: $\bar{a}\{x, y, z\}$ the space of a vector is equal to the arithmetic square root obtained from the sum of the squares of its coordinates:

$$\left|\bar{a}\right| = \sqrt{x^2 + y^2 + z^2}$$

Angle between two vectors

The angle between two vectors is calculated by the following formula:

$$\cos\left(\bar{a},\bar{b}\right) = \frac{x_1x_2\bar{e_1^2} + y_1y_2\bar{e_2^2} + z_1z_2\bar{e_3^2}}{\sqrt{x_1^2 + y_1^2 + z_1^2}\sqrt{x_2^2 + y_2^2 + z_2^2}}.$$

$\bar{a}\{x_1, y_1, z_1\}$ va $\bar{b}\{x_2, y_2, z_2\}$ the perpendicularity condition of vectors is:

$$x_1x_2 + y_1y_2 + z_1z_2 = 0$$

Example-2. $\bar{a}\{1,-1,0\}$, $\bar{b}\{1,-2,2\}$ find the angle between the vectors.

Decilishii. we put the coordinates of the vectors in the formula for finding the angle between two vectors: $\cos\left(\bar{a},\bar{b}\right) = \frac{1+2+0}{\sqrt{1+1+0}\sqrt{1+4+4}} = \frac{3}{3\sqrt{2}} = \frac{\sqrt{2}}{2}$

This is the case $\left(\bar{a},\bar{b}\right) = 45^0$

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