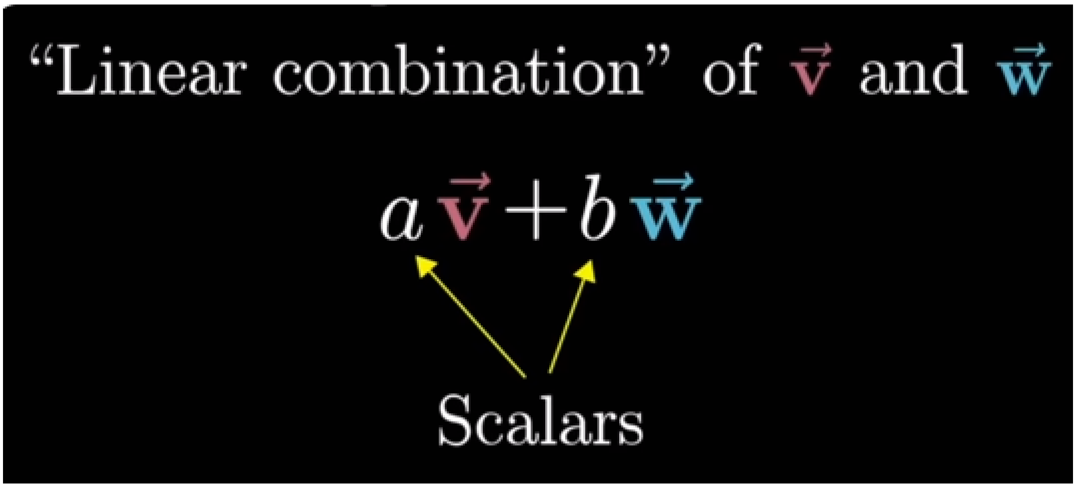
Linear Combination

Prereq: Vector addition, Vector multiplication



In mathematics, a linear combination is an expression constructed from a set of terms by multiplying each term by a constant (coefficient) and adding the results. The coefficients are real or complex numbers, and the terms can be variables, vectors, or any mathematical objects that support addition and scalar multiplication.

The general form of a linear combination is given by:

$$c_1 \cdot a_1 + c_2 \cdot a_2 + \ldots + c_n \cdot a_n$$

where:

- $c_1, c_2, \ldots, c_n$ are constants (coefficients),
- $a_1, a_2, \ldots, a_n$ are the terms (variables, vectors, or other mathematical objects),
- n is the number of terms.

Linear combinations are fundamental in various branches of mathematics, including linear algebra. Here are some specific examples:

1. **Linear Combination of Numbers:**
   $3x + 2y - 5z$
   In this example, x, y, z are variables, and $3, 2, -5$ are coefficients.
2. **Linear Combination of Vectors:**
   $\mathbf{v} = 2\mathbf{u} - 3\mathbf{w}$
   Here, $\mathbf{u}$ and $\mathbf{w}$ are vectors, and 2 and -3 are coefficients.
3. **Linear Combination of Functions:**
   $f(x) = 2\sin(x) - 3\cos(x)$
   In this case, $\sin(x)$ and $\cos(x)$ are functions, and 2 and -3 are coefficients.

Linear combinations play a crucial role in defining vector spaces, span, and linear independence in linear algebra. They are also fundamental in expressing solutions to systems of linear equations and in understanding the structure of vector spaces.

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