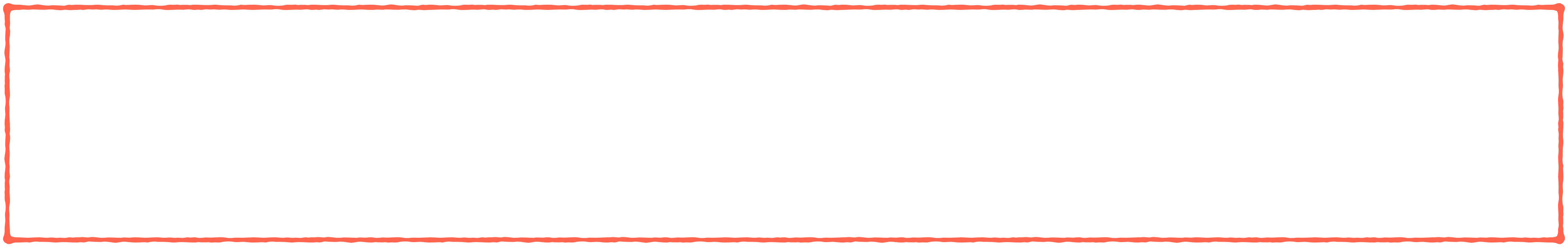


what is a vector space?



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A set V is called a vector space, if it is equipped with the operations of addition and scalar multiplication in such a way that the 'usual rules' of arithmetic hold.
The elements of V are generally regarded as vectors.

The 'rules' (axioms) to hold true for all vectors $\vec{u}, \vec{v}, \vec{w} \in V$ and scalars a, b are the following

- Closure: $\vec{u} + \vec{v} \in V, a\vec{v} \in V$
- Commutative: $\vec{u} + \vec{v} = \vec{v} + \vec{u}$
- Associativity: $(\vec{u} + \vec{v}) + \vec{w} = \vec{u} + (\vec{v} + \vec{w})$
- Identity for Addition: There is a zero vector $\vec{0} \in V$ such that $\vec{u} + \vec{0} = \vec{u}$
- Distributive Property: $a(\vec{u} + \vec{v}) = a\vec{u} + a\vec{v}$ and $(a + b)\vec{u} = a\vec{u} + b\vec{u}$
- Associativity of Scalars: $(ab)\vec{u} = a(b\vec{u})$
- Multiplicative Identity: $1\vec{u} = \vec{u}$

what is a vector space?

Vector spaces are the foundation for:

- Linear transformations and matrices
- Eigenvalues, eigenvectors, and diagonalization
- Applications in
 - physics (e.g., quantum mechanics)
 - engineering (signal processing)
 - computer science (machine learning, graphics)