The Dimension of a Vector Space

Linear Algebra MATH 2076

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Let V be a vector space.

Definition

A bunch of vectors $\mathcal{B} = \{\vec{v}_1, \ldots, \vec{v}_p\}$ is called a *basis* for $\mathbb {V}$ if and only if

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Example (Standard Basis for \mathbb{R}^n)

The set $\mathcal{S} = \{\vec{e}_1, \ldots, \vec{e}_n\}$ is the *standard basis* for \mathbb{R}^n .

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 $\mathbb{R}^n \times \mathbb{R}^n \xrightarrow{\mathbb{R}^n} \mathbb{R}^n \times \mathbb{R}^n \xrightarrow{\mathbb{R}^n} \mathbb{R}^n$

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Here t^i denotes the function that satisfies

for all numbers $t, \quad t^{i}(t) = t^{i}.$

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- \bullet β is a maximal linearly independent set in \mathbb{V} .
- \bullet β is a minimal spanning set for \mathbb{V} .

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Let V be a vector space. Then:

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Let V be a vector space. Then:

- $\bullet \mathbb{V}$ has a basis, and,
- \bullet any two bases for $\mathbb {V}$ contain the same number of vectors.

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If V has a finite basis, we call V finite dimensional;

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If V is finite dimensional, then the dimension of V is the number of vectors in any basis for V ; we write dim V for the dimension of V .

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Examples

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Examples

 \mathbb{R}^n has dimension n,

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- \bullet \mathbb{P}_n has dimension

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- If $\{\vec{a}_1, \ldots, \vec{a}_p\}$ is a LI set of vectors in \mathbb{R}^n , then $\mathbb{V} = \mathcal{S}$ pan $\{\vec{a}_1, \ldots, \vec{a}_p\}$ is a p-dimensional vector subspace of \mathbb{R}^n .

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- If $\{\vec{a}_1, \ldots, \vec{a}_p\}$ is a LI set of vectors in \mathbb{R}^n , then $\mathbb{V} = \mathcal{S}$ pan $\{\vec{a}_1, \ldots, \vec{a}_p\}$ is a p-dimensional vector subspace of \mathbb{R}^n . We call $\mathbb {V}$ a p-plane in \mathbb{R}^n .

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