

Course > Unit 1: ... > Part B ... > 2. Subs...

2. Subsets and subspaces

Identify the subspaces

1/1 point (graded)

Choose all of the following subsets of \mathbb{R}^4 which are vector spaces.

- lacksquare The set of vectors in \mathbb{R}^4 whose coordinates are all equal to each other. \checkmark
- The set consisting of the two vectors $\begin{pmatrix} 1 \\ 0 \\ 0 \\ 0 \end{pmatrix}$ and $\begin{pmatrix} 0 \\ 1 \\ 0 \\ 0 \end{pmatrix}$.
- ullet The set of vectors in \mathbb{R}^4 whose coordinates sum to 0.
- The set of vectors $egin{pmatrix} x_1 \ x_2 \ x_3 \ x_4 \end{pmatrix}$ such that $x_1=x_2$ and $x_1+x_2+x_3=x_4$. \checkmark



Solution:

ullet The set of vectors in \mathbb{R}^4 whose coordinates are all equal to each other is the set of vectors of the form

$$egin{pmatrix} c \ c \ c \ c \ c \end{pmatrix} = c egin{pmatrix} 1 \ 1 \ 1 \ 1 \ \end{pmatrix}.$$

Therefore it is the span of a single vector, so it is a vector space.

• The set consisting of the two vectors $\begin{pmatrix} 1 \\ 0 \\ 0 \\ 0 \end{pmatrix}$ and $\begin{pmatrix} 0 \\ 1 \\ 0 \\ 0 \end{pmatrix}$ is not a vector space, because it

does not contain the zero vector.

- The set of vectors in \mathbb{R}^4 whose coordinates sum to $\mathbf{0}$ is equivalent to the set of vectors \mathbf{x} such that $\mathbf{A}\mathbf{x}=\mathbf{0}$ where $\mathbf{A}=\begin{pmatrix} 1 & 1 & 1 \end{pmatrix}$. Thus the set in question is the nullspace of the matrix \mathbf{A} , which is a vector space. In particular, this is a 3 dimensional vector subspace of \mathbb{R}^4 .
- ullet The set of vectors $egin{pmatrix} x_1 \ x_2 \ x_3 \ x_4 \end{pmatrix}$ such that $x_1=x_2$ and $x_1+x_2+x_3=x_4$ is equal to the

set of solutions to the homogeneous system

$$x_1 - x_2 = 0$$

$$x_1 + x_2 + x_3 - x_4 = 0.$$

Therefore this set is the nullspace of the matrix

$$\mathbf{A}=egin{pmatrix}1&-1&0&0\1&1&1&-1\end{pmatrix},$$

which is a vector space. In particular this describes a two dimensional subspace of \mathbb{R}^4 .

ullet The set of vectors such that at least one coordinate is $oldsymbol{0}$ is not a vector space. For

example, the vectors
$$\begin{pmatrix} 1 \\ 1 \\ 1 \\ 0 \end{pmatrix}$$
 and $\begin{pmatrix} 0 \\ 1 \\ 1 \\ 1 \end{pmatrix}$ are in the set, but their sum $\begin{pmatrix} 1 \\ 2 \\ 2 \\ 1 \end{pmatrix}$ is not.

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You have used 2 of 3 attempts

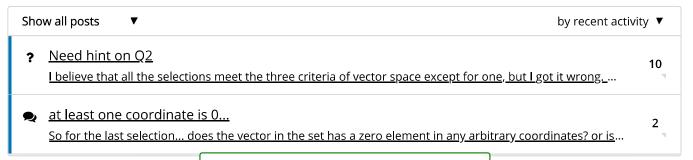
1 Answers are displayed within the problem

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