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9.4.3 The Column Space

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Week 9 due Dec 9, 2023 18:12 IST Completed

9.4.3 The Column Space

Video

[Start of transcript. Skip to the end.](#)



Dr. Robert van de Geijn: So now we have arrived at a very important topic, and that's the notion of a column space. What's the column space? Well, first of all, let's just start by asking the following question. Is the set S described by all vectors that



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Reading Assignment

0 points possible (ungraded)
Read Unit 9.4.3 of the notes. [\[LINK\]](#)

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✓ Correct

Discussion

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<div> Homework 9.4.3.2 #2 and #5</div> <div>Why is #2 c and why is #5 a and not b?</div>	2
<div> Homework 9.4.3.2</div> <div>I don't understand how to do Homework 9.4.3.2. Any hints? Which unit should I be looking at? "By examination" implies that it should be straig</div>	

Calculator

Homework 9.4.3.1

1/1 point (graded)
The set $\mathcal{S} \subset \mathbb{R}^m$ described by

$$\{Ax \mid x \in \mathbb{R}^n\},$$

where $A \in \mathbb{R}^{m \times n}$, is a subspace.

TRUE

✓ Answer: TRUE

- $0 \in \mathcal{S}$: (pick $x = 0$).
- If $v, w \in \mathcal{S}$ then $(v + w) \in \mathcal{S}$: Pick $v, w \in \mathcal{S}$. Then for some $x, y \in \mathbb{R}^n$, $v = Ax$ and $w = Ay$. But then $v + w = Ax + Ay = A(x + y)$, which is also in \mathcal{S} .
- If $\alpha \in \mathbb{R}$ and $v \in \mathcal{S}$ then $\alpha v \in \mathcal{S}$: Pick $\alpha \in \mathbb{R}$ and $v \in \mathcal{S}$. Then for some $x \in \mathbb{R}^n$, $v = Ax$. But then $\alpha v = \alpha(Ax) = A(\alpha x)$, which is also in \mathcal{S} since $\alpha x \in \mathbb{R}^n$.

What this means is that the set of all linear combinations of two vectors is a subspace, except expressed even more explicitly as a matrix-vector multiplication. In other words, this exercise is simply a restatement of the previous two exercises. Now we are getting somewhere!

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Answers are displayed within the problem

In the below question (and in some future questions like it) matrices don't render correctly when I use Chrome. If this happens, try Firefox instead.

Homework 9.4.3.2

9/9 points (graded)
Match the matrices on the left to the column space on the right. (You should be able to do this “by examination.”)

1.

$\begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}$

f

▼

✓ Answer: f

2.

$\begin{pmatrix} 0 & 1 \\ 0 & 0 \end{pmatrix}$

c

▼

✓ Answer: c

3.

$\begin{pmatrix} 0 & -2 \\ 0 & 0 \end{pmatrix}$

c

▼

✓ Answer: c

4.

$\begin{pmatrix} 0 & 0 \\ 1 & -2 \end{pmatrix}$

d

▼

✓ Answer: d

5.

$\begin{pmatrix} 0 & 1 \\ 2 & 0 \end{pmatrix}$

a

▼

✓ Answer: a

6.

$\begin{pmatrix} 1 & 0 \\ 2 & 3 \end{pmatrix}$

a

▼

✓ Answer: a

7.

$\begin{pmatrix} 1 \\ 2 \end{pmatrix}$

e

▼

✓ Answer: e

(a) \mathbb{R}^2 .

(b) $\left\{ \begin{pmatrix} \chi_0 \\ \chi_1 \end{pmatrix} \middle| \begin{matrix} \chi_0 \\ \chi_1 \end{matrix} = 0 \right\}$

(c) $\left\{ \begin{pmatrix} \alpha \\ 0 \end{pmatrix} \middle| \alpha \in \mathbb{R} \right\}$

(d) $\left\{ \begin{pmatrix} 0 \\ \alpha \end{pmatrix} \middle| \alpha \in \mathbb{R} \right\}$

Calculator

8. $\begin{pmatrix} 1 & -2 \\ 2 & -4 \end{pmatrix}$ ✓ Answer: e (e) $\left\{ \alpha \begin{pmatrix} 1 \\ 2 \end{pmatrix} \middle| \alpha \in \mathbb{R} \right\}$

9. $\begin{pmatrix} 1 & -2 & -1 \\ 2 & -4 & -2 \end{pmatrix}$ ✓ Answer: e (f) $\left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix} \right\}$

(Recall that \vee is the logical “or” operator.)

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i Answers are displayed within the problem

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