9.4.4 The Null Space

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

9.4.4 The Null Space

Video

Start of transcript. Skip to the end.

Robert van de Geijn: The second really important subspace of Rn

is known as the null space.

Recall.

We're interested in the solution of Ax equals b.

You've seen that if we have a specific solution

0:00 / 0:00 2.0x

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Reading Assignment

0 points possible (ungraded)

Read Unit 9.4.4 of the notes. [LINK]

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Calculator

Homework 9.4.4.1

1/1 point (graded)

Let $A \in \mathbb{R}^{m\times n}$. The null space of A, $\mathcal{N}(A)$, is a subspace

TRUE ✔ Answer: TRUE

- $0 \in \mathcal{N}(A)$: $A0 = 0$.
- If $x, y \in \mathcal{N}(A)$ then $x + y \in \mathcal{N}(A)$: Let $x, y \in \mathcal{N}(A)$ so that $Ax = 0$ and $Ay = 0$. Then $A(x + y) = Ax + Ay = 0 + 0 = 0$ which means means that $x + y \in \mathcal{N}(A)$.
- If $\alpha \in \mathbb{R}$ and $x \in \mathcal{N}(A)$ then $\alpha x \in \mathcal{N}(A)$: Let $\alpha \in \mathbb{R}$ and $x \in \mathcal{N}(A)$ so that $Ax = 0$. Then $A(\alpha x) = A\alpha x = \alpha Ax = \alpha 0 = 0$ which means means that $\alpha x \in \mathcal{N}(A)$.

Hence $\mathcal{N}(A)$ is a subspace.

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Answers are displayed within the problem

Homework 9.4.4.2

8/8 points (graded)

Note: This exercise (and some in future units) does not seem to render right in Chrome. You may want to try another browser.

For each of the matrices on the left match the set of vectors on the right that describes its null space. (You should be able to do this "by examination.")

1. $\begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}$ a ✔ Answer: a
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. $\begin{pmatrix} 0 & 0 \\ 1 & -2 \end{pmatrix}$ i ✔ Answer: i
5. $\begin{pmatrix} 0 & 1 \\ 2 & 0 \end{pmatrix}$ f ✔ Answer: f
6. $\begin{pmatrix} 1 & 0 \\ 2 & 3 \end{pmatrix}$ f ✔ Answer: f
7. $\begin{pmatrix} 1 \\ 2 \end{pmatrix}$ g ✔ Answer: g
8. $\begin{pmatrix} 1 & -2 \end{pmatrix}$

(a) $\mathbb{R}^2$.

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

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

(d) $\varnothing$

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

(f) $\left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix} \right\}$

(g) $\{(0)\}$

Calculator

8. $\begin{pmatrix} \\ 2 & -4 \end{pmatrix}$ i ✔ Answer: i

(h) $\left\{ \alpha \begin{pmatrix} 1 \\ 2 \end{pmatrix} \middle| \alpha \in \mathbb{R} \right\}$

(i) $\left\{ \alpha \begin{pmatrix} 2 \\ 1 \end{pmatrix} \middle| \alpha \in \mathbb{R} \right\}$

(Recall that $\vee$ is the logical "or" operator.)

1. $\begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}$ **Answer:** (a) Any vector in $\mathbb{R}^2$ maps to the zero vector.

2. $\begin{pmatrix} 0 & 1 \\ 0 & 0 \end{pmatrix}$ **Answer:** (c) $\begin{pmatrix} 0 & 1 \\ 0 & 0 \end{pmatrix} \begin{pmatrix} \chi_0 \\ \chi_1 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$ means $\chi_1 = 0$ with no restriction on χ_0.

3. $\begin{pmatrix} 0 & -2 \\ 0 & 0 \end{pmatrix}$ **Answer:** (c) $\begin{pmatrix} 0 & -2 \\ 0 & 0 \end{pmatrix} \begin{pmatrix} \chi_0 \\ \chi_1 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$ means $-2\chi_1 = 0$ with no restriction on χ_0.

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