

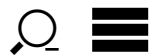
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## Linear Algebra

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### The Nullspace of a Matrix



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Subject







$$A = \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$$

By definition, the nullspace of  $A$  consists of all vectors  $\mathbf{x}$  such that  $A\mathbf{x} = \mathbf{0}$ . Perform the following elementary row operations on  $A$ ,

$$\begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix} \xrightarrow{r_1 \leftrightarrow r_2} \begin{bmatrix} 1 & 2 \\ 2 & 1 \end{bmatrix} \xrightarrow{-2r_1 \text{ added to } r_2} \begin{bmatrix} 1 & 2 \\ 0 & -3 \end{bmatrix}$$

to conclude that  $A\mathbf{x} = \mathbf{0}$  is equivalent to the simpler system

$$\begin{bmatrix} 1 & 2 \\ 0 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

The second row implies that  $x_2 = 0$ , and back-substituting this into the first row implies that  $x_1 = 0$  also. Since the only solution of  $A\mathbf{x} = \mathbf{0}$  is  $\mathbf{x} = \mathbf{0}$ , the nullspace of  $A$  consists of the zero vector alone. This subspace,  $\{\mathbf{0}\}$ , is called the **trivial subspace** (of  $\mathbb{R}^2$ ).

**Example 4:** Find the nullspace of the matrix

$$B = \begin{bmatrix} 2 & 1 \\ -4 & -2 \end{bmatrix}$$

## Subspaces of $\mathbb{R}^n$

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