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3. Solve by elimination

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Solve by elimination

We start with an example that can be solved with the method of "elimination."

Example 3.1 Let
$$A=egin{pmatrix} -1 & 1 \ 1 & 3 \end{pmatrix}$$
 . We will use $ec{b}=egin{pmatrix} 1 \ 7 \end{pmatrix}$.

Goal: solve for $ec{x}$ in $Aec{x}=inom{1}{7}$.

Let's break this problem down. There are two unknowns, x_1 and x_2 :

$$\vec{x} = \begin{pmatrix} x_1 \\ x_2 \end{pmatrix}. \tag{5.55}$$

We also have two equations, which result from doing the matrix multiplication:

$$A\vec{x} = \begin{pmatrix} 1 \\ 7 \end{pmatrix}$$
 equivalent to $\begin{pmatrix} -x_1 + x_2 \\ x_1 + 3x_2 \end{pmatrix} = \begin{pmatrix} 1 \\ 7 \end{pmatrix}$ (5.56)

Thus we need to solve the linear system:

$$(1): -x_1 + x_2 = 1 \ (2): x_1 + 3x_2 = 7$$

One common method is to "solve by elimination."

Solve by Elimination

The idea behind elimination is to successively replace the equations in a linear system by simpler equations without losing any information. In this example, we can add equation (1) to equation (2) to obtain

$$(1)+(2): 4x_2 = 8 (5.57)$$

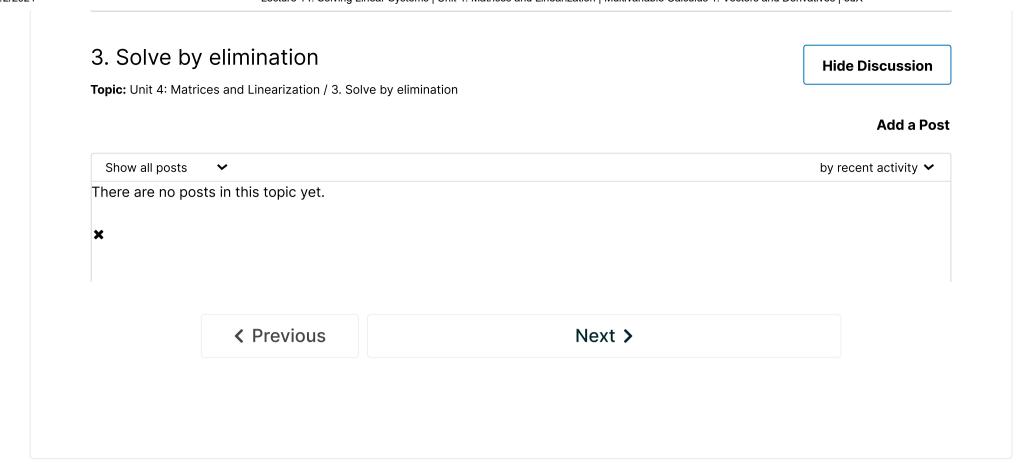
From this equation, we see $x_2=2$. Substituting $x_2=2$ in equation (1) we obtain

$$-x_1 + 2 = 1 (5.58)$$

Therefore, $x_1 = 1$. In conclusion,

$$\vec{x} = \begin{pmatrix} 1 \\ 2 \end{pmatrix}$$
 solves $\begin{pmatrix} -1 & 1 \\ 1 & 3 \end{pmatrix} \vec{x} = \begin{pmatrix} 1 \\ 7 \end{pmatrix}$ (5.59)

In general, the method of elimination may involve further steps, such as multiplying an equation by a constant before adding it to the other equation. In summary: **To solve for** $ec{x}$ in $Aec{x}=ec{b}$, we can use elimination.



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