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5. Inverse Matrix

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Lecture due Sep 15, 2021 20:30 IST



Explore

Inverse Matrix

There is another method that allows us to solve for \vec{x} in $A\vec{x} = \vec{b}$ without having to do elimination. One may use the **inverse matrix**.

Inverse Matrix



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2.0x

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...and, in our case, we're dealing with matrices, where the vectors are column vectors --

I mean, it's just something to remember that if you have a square matrix times a column vector --

I mean the product which makes sense is with a matrix on the left, the vector on the right. The other one just doesn't work. It's not sized. You cannot take X times A, if A and X --

if A is a square matrix, and X is a column vector, this product makes sense. The other one doesn't make sense. It's not the right size.

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The Inverse Matrix (2×2)

If $A = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$ then the inverse of A is

$$A^{-1} = \frac{1}{ad - bc} \begin{pmatrix} d & -b \\ -c & a \end{pmatrix} \tag{5.63}$$

The most important property of A^{-1} is that

$$\textbf{(Inverse Matrix Property)} \quad AA^{-1} = A^{-1}A = I. \tag{5.64}$$

(Recall that I is the identity matrix). This property can be used to define the inverse of larger matrices. To see why this property is important, imagine we want to solve for \vec{x} in the equation $A\vec{x} = \vec{b}$. We can multiply both sides by A^{-1} and simplify:

$$A^{-1}A\vec{x} = \vec{b}$$

$$\vec{x} = A^{-1}\vec{b} \quad (5.66)$$

This gives us a recipe for finding \vec{x} : we can just multiply out $A^{-1}\vec{b}$. This method is also useful if we need to solve for \vec{x} several times for different values of \vec{b} .

Example

Let $A = \begin{pmatrix} -1 & 1 \\ 1 & 3 \end{pmatrix}$. Then A^{-1} is given by

$$A^{-1} = \frac{1}{-4} \begin{pmatrix} 3 & -1 \\ -1 & -1 \end{pmatrix} \quad (5.67)$$

Suppose we want to solve for \vec{x} in $A\vec{x} = \begin{pmatrix} 1 \\ 7 \end{pmatrix}$. The solution is given by

$$\vec{x} = A^{-1} \begin{pmatrix} 1 \\ 7 \end{pmatrix} = \frac{1}{-4} \begin{pmatrix} 3 & -1 \\ -1 & -1 \end{pmatrix} \begin{pmatrix} 1 \\ 7 \end{pmatrix} = \frac{1}{-4} \begin{pmatrix} -4 \\ 8 \end{pmatrix} = \begin{pmatrix} 1 \\ -2 \end{pmatrix} \quad (5.68)$$

This agrees with the solution we found by elimination.

Find an Inverse

1/1 point (graded)

Let $A = \begin{pmatrix} 1 & 2 \\ 1 & -1 \end{pmatrix}$.

(Enter a matrix using notation such as `[[a,b],[c,d]]`.)

$A^{-1} =$ ✓ **Answer:** `[[1/3, 2/3],[1/3, -1/3]]`

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Solution:

Using the formula $A^{-1} = \frac{1}{ad-bc} \begin{pmatrix} d & -b \\ -c & a \end{pmatrix}$, we have $A^{-1} = \frac{1}{-3} \begin{pmatrix} -1 & -2 \\ -1 & 1 \end{pmatrix}$.

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You have used 2 of 3 attempts

i Answers are displayed within the problem

Solve a System

2/2 points (graded)

Let $A = \begin{pmatrix} 2 & 1 \\ 1 & 1 \end{pmatrix}$. Find A^{-1} and solve for \vec{x} in $A\vec{x} = \begin{pmatrix} 5 \\ 0 \end{pmatrix}$.

(Enter a matrix using notation such as `[[a,b],[c,d]]`.)

$A^{-1} =$ ✓ **Answer:** `[[1,-1],[-1,2]]`

(Enter a vector using notation such as `[a,b]`.)

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$\vec{x} =$

[5,-5]

✓

 Answer: [5,-5]

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Solution:

$A^{-1} = \begin{pmatrix} 1 & -1 \\ -1 & 2 \end{pmatrix}$. So $\vec{x} = A^{-1} \begin{pmatrix} 5 \\ 0 \end{pmatrix} = \begin{pmatrix} 5 \\ -5 \end{pmatrix}$.

Submit

You have used 1 of 3 attempts

i Answers are displayed within the problem

Caution

The inverse matrix method will not always work because the denominator ***ad*** — ***bc*** could equal zero. This is explored in more detail on the next page.

5. Inverse Matrix

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