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Question: Consider an unknown linear transformation T that maps vecto...

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2. Consider an unknown linear transformation T that maps vectors from R^4 to vectors in R^4 .

The following information is provided:

$$T(e_1) = \begin{bmatrix} 1 \\ 2 \\ 0 \\ 1 \end{bmatrix}, \quad T(e_2) = \begin{bmatrix} 1 \\ 0 \\ 0 \\ 4 \end{bmatrix}$$

Here, $e_1 = \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}$, $e_2 = \begin{bmatrix} 0 \\ 1 \\ 1 \\ 2 \end{bmatrix}$

- Find the image of the vector $x = \begin{bmatrix} 3 \\ 2 \\ 2 \\ 4 \end{bmatrix}$ under this linear transformation.
- Can we find the image of the vector $x = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{bmatrix}$ under this transformation?
- Do we have enough information to find the matrix A such that $T(x) = Ax$?
- Now, we are further given $T(e_3) = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$, where $e_3 = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$. Can we determine the transformation matrix A ?

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Expert Answer



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$$\text{Let } x = ae_1 + be_2$$

$$\begin{bmatrix} 3 \\ 2 \\ 2 \\ 4 \end{bmatrix} = a \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix} + b \begin{bmatrix} 0 \\ 1 \\ 1 \\ 2 \end{bmatrix}$$

$$\begin{bmatrix} 3 \\ 2 \\ 2 \\ 4 \end{bmatrix} = \begin{bmatrix} a \\ b \\ b \\ 2b \end{bmatrix}$$

$$a = 3, b = 2$$

$$\text{Hence } x = 3e_1 + 2e_2$$

$$T(x) = T(3e_1 + 2e_2)$$

$$= 3T(e_1) + 2T(e_2)$$

$$= 3 \begin{bmatrix} 1 \\ 2 \\ 0 \\ 1 \end{bmatrix} + 2 \begin{bmatrix} 1 \\ 0 \\ 0 \\ 4 \end{bmatrix}$$

$$= \begin{bmatrix} 5 \\ 6 \\ 0 \\ 11 \end{bmatrix}$$

$$T(x) = \begin{bmatrix} 5 \\ 6 \\ 0 \\ 11 \end{bmatrix}$$

Which is the image of x under T .

(b)

$$\text{Let } x = ae_1 + be_2$$

$$\begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{bmatrix} = a \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix} + b \begin{bmatrix} 0 \\ 1 \\ 1 \\ 2 \end{bmatrix}$$

$$\begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{bmatrix} = \begin{bmatrix} a \\ b \\ b \\ 2b \end{bmatrix}$$

$$a = 1, b = 2, b = 3$$

Therefore b has two different values hence

Hence we can not find the image of x under T

$$T \begin{bmatrix} 5 \\ 2 \\ 2 \\ 4 \end{bmatrix} = A \begin{bmatrix} 3 \\ 2 \\ 2 \\ 4 \end{bmatrix}$$

$$\begin{bmatrix} 5 \\ 6 \\ 0 \\ 11 \end{bmatrix} = A_{4 \times 4} \begin{bmatrix} 3 \\ 2 \\ 2 \\ 4 \end{bmatrix}$$

$$\begin{bmatrix} 5 \\ 6 \\ 0 \\ 11 \end{bmatrix} = \begin{bmatrix} a_1 & a_2 & a_3 & a_4 \\ b_1 & b_2 & b_3 & b_4 \\ c_1 & c_2 & c_3 & c_4 \\ d_1 & d_2 & d_3 & d_4 \end{bmatrix} \begin{bmatrix} 3 \\ 2 \\ 2 \\ 4 \end{bmatrix}$$

From this we cannot find A

(d)

Here $\{e_1, e_2, e_3\}$ does not form a basis, since $\dim R^4 = 4$

Hence we can't find transformation matrix.

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Consider an unknown linear transformation T that maps

vectors from R^4 to

vectors in R^4 . Although the transformation is unknown, we have been given its results when applied to the standard basis:

$$T(e_1) = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{bmatrix}, \quad T(e_2) = \begin{bmatrix} 2 \\ 3 \\ 4 \\ 5 \end{bmatrix}, \quad T(e_3) = \begin{bmatrix} 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}, \quad T(e_4) = \begin{bmatrix} 4 \\ 5 \\ 6 \\ 7 \end{bmatrix}$$

Given:

$$T(v_1) = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{bmatrix}, \quad T(v_2) = \begin{bmatrix} 2 \\ 3 \\ 4 \\ 5 \end{bmatrix}, \quad T(v_3) = \begin{bmatrix} 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}, \quad T(v_4) = \begin{bmatrix} 4 \\ 5 \\ 6 \\ 7 \end{bmatrix}$$

a. Find a matrix A such that $T(v) = AV$ for all vectors V in R^4 .

b. Find $T(v)$ for the case $V = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{bmatrix}$.

[See answer](#)

Give an example where homogenous transformations are commutative

[See answer](#)

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Q: Homogenous Coordinates

A: [See answer](#) 100% (4 ratings)

Q: 3. Consider an unknown linear transformation T that maps vectors from R^4 to vectors in R^4 . Although the transformation is unknown, we have been given its results when applied to this non-standard basis: The following information is provided: $T(b_1) = \begin{bmatrix} 1 \\ 0 \\ 7 \\ 0 \end{bmatrix}$, $T(b_2) = \begin{bmatrix} 0 \\ 1 \\ 0 \\ 7 \end{bmatrix}$. Find the image of the vector $v = \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{bmatrix}$ under this linear transformation. Hint: $v = b_1 + b_2$. a. b. Find...

A: [See answer](#)

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