Linear Algebra

Math 314 Fall 2025

Lecture 10

Today's poll code:

V4SFUZ

To do list:

- Webwork 3.1 due tomorrow
- Webwork 3.1 due Friday
- Study for the midterm!!

Office hours this week

Monday 5–6 pm and Wednesday 2–3 pm
Thursday 2—3 pm
Friday 2:30 to 3:30 pm
in Avery 339 (Dr. Grifo)

Tuesday 11–noon and Thursday 1–2 pm
in Avery 337 (Kara)

Midterm 1

in 1 week

Quiz on Friday

on inverses

Midterm 1

October 6

Material for Midterm 1: Chapters 1, 2, 3

Study materials:

- Class notes (see canvas)
- Textbook
- Slides from lecture
- Poll questions
- Quizzes
- Webwork questions
- Study guide (quick summary)

Quick Recap

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix} \qquad (i,j)\text{th entry of } A = a_{ij}$$

multiplying a matrix by a scalar: $\qquad cA = [ca_{ij}]$

$$3 \cdot \begin{bmatrix} -1 & 1 \\ -1 & 5 \end{bmatrix} = \begin{bmatrix} -3 & 3 \\ -3 & 15 \end{bmatrix}$$

always defined

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix} \qquad (i,j)\text{th entry of } A = a_{ij}$$

The sum $A + B$ is defined if

A and B have the same size $\begin{pmatrix} \#\text{ rows of } A = \#\text{ rows of } B \\ \#\text{ columns of } A = \#\text{ columns of } B \end{pmatrix}$

sum of matrices: $A + B := [a_{ij} + b_{ij}]$

$$\begin{bmatrix} 3 & -1 \\ 2 & -11 \end{bmatrix} + \begin{bmatrix} 1 & 3 \\ 4 & 5 \end{bmatrix} = \begin{bmatrix} 3+1 & -1+3 \\ 2+4 & -11+5 \end{bmatrix} = \begin{bmatrix} 4 & 2 \\ 6 & -6 \end{bmatrix}$$

product of matrices: The product AB is defined if

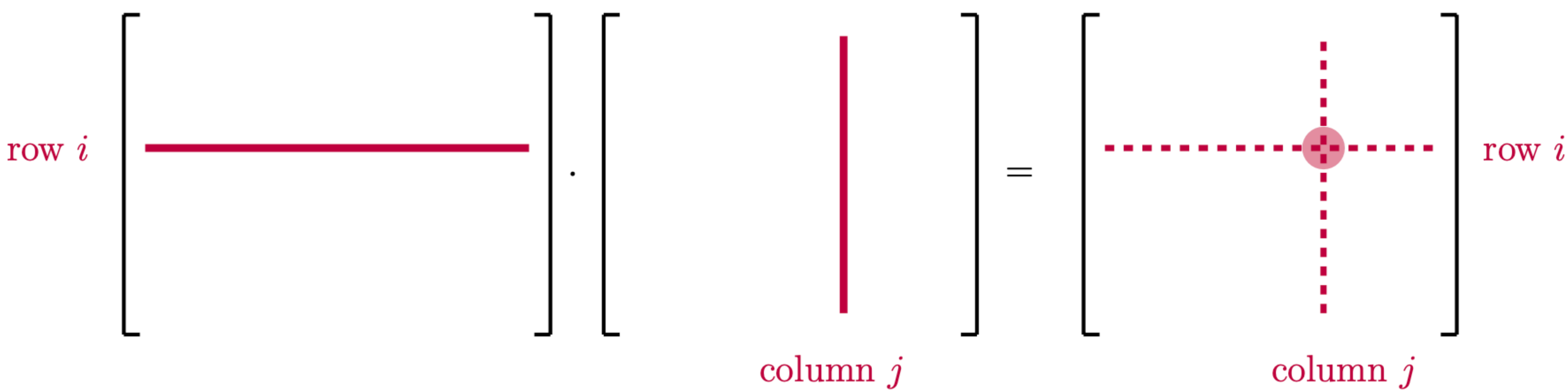
$$\# \text{ of columns of } A = \# \text{ of rows of } B$$

A $m \times n$ matrix

B $n \times p$ matrix $\longrightarrow$ AB $m \times p$ matrix

Informally: $(m \times \cancel{n)\,(n} \times p) = m \times p$

$$(i,j)\text{th entry} = a_{i1}b_{1j} + a_{i2}b_{2j} + \cdots + a_{in}b_{nj}$$



Example:

$$\begin{bmatrix} 2 & 3 \\ 1 & -5 \end{bmatrix} \begin{bmatrix} 4 & 3 & 6 \\ 1 & -2 & 3 \end{bmatrix}$$

$$= \begin{bmatrix} 2 \times 4 + 3 \times 1 & 2 \times 3 + 3 \times (-2) & 2 \times 6 + 3 \times 3 \\ 1 \times 4 - 5 \times 1 & 1 \times 3 + (-5) \times (-2) & 1 \times 6 + (-5) \times 3 \end{bmatrix}$$

$$= \begin{bmatrix} 11 & 0 & 21 \\ -1 & 13 & -9 \end{bmatrix}$$

ORDER MATTERS!!!

For example:

$$A = \begin{bmatrix} 5 & 1 \\ -1 & 3 \end{bmatrix} \qquad \text{and} \qquad B = \begin{bmatrix} 2 & 0 \\ 4 & 3 \end{bmatrix}$$

$$AB = \begin{bmatrix} 5 \cdot 2 + 1 \cdot 4 & 5 \cdot 0 + 1 \cdot 3 \\ (-1) \cdot 2 + 3 \cdot 4 & (-1) \cdot 0 + 3 \cdot 3 \end{bmatrix} = \begin{bmatrix} 14 & 3 \\ 10 & 9 \end{bmatrix}$$

$$\neq$$

$$BA = \begin{bmatrix} 2 \cdot 5 + 0 \cdot (-1) & 2 \cdot 1 + 0 \cdot 3 \\ 4 \cdot 5 + 3 \cdot (-1) & 4 \cdot 1 + 3 \cdot 3 \end{bmatrix} = \begin{bmatrix} 10 & 2 \\ 17 & 13 \end{bmatrix}$$

Powers of matrices and the transpose

A square matrix

Powers of A:

$$A^0 = I_n$$

$$A^1 = A \qquad A^2 = AA \qquad A^3 = AAA$$

$$A^k = \underbrace{A \cdot A \cdots A}_{k \text{ times}}$$

A $m \times n$ matrix

The **transpose** of A is the $n \times m$ matrix A^{T}

whose rows are the columns of A

Example:

$$A = \begin{bmatrix} 1 & 2 & 5 \\ 3 & 4 & 6 \end{bmatrix} \longrightarrow A^{\mathsf{T}} = \begin{bmatrix} 1 & 3 \\ 2 & 4 \\ 5 & 6 \end{bmatrix}$$

Theorem. Let A and B be matrices.

Assume A and B have appropriate sizes so that the following make sense.

1. $(A^\mathsf{T})^\mathsf{T} = A$.
2. $(A + B)^\mathsf{T} = A^\mathsf{T} + B^\mathsf{T}$.
3. $(\alpha A)^\mathsf{T} = \alpha A^\mathsf{T}$ for any scalar α.
4. $(AB)^\mathsf{T} = B^\mathsf{T} A^\mathsf{T}$.

A $m \times n$ matrix

The **transpose** of A is the $n \times m$ matrix A^{T}

whose rows are the columns of A

Example:

$$A = \begin{bmatrix} 1 & 2 & 5 \\ 3 & 4 & 6 \end{bmatrix} \qquad A^{\mathsf{T}} = \begin{bmatrix} 1 & 3 \\ 2 & 4 \\ 5 & 6 \end{bmatrix} \qquad (A^{\mathsf{T}})^{\mathsf{T}} = \begin{bmatrix} 1 & 2 & 5 \\ 3 & 4 & 6 \end{bmatrix}$$

A $n \times n$ (square) matrix

Powers of A:

$$A^2 = AA \qquad A^3 = AAA$$

$$A^k = \underbrace{A \cdot A \cdots A}_{k \text{ times}}$$

$$A^1 = A \qquad A^0 = I_n$$

A $m \times n$ matrix

The **transpose** of A is

the $n \times m$ matrix whose rows are the columns of A

$$A = \begin{bmatrix} v_1 & \cdots & v_n \end{bmatrix} \qquad A^{\mathsf{T}} = \begin{bmatrix} v_1 \\ \vdots \\ v_n \end{bmatrix} \begin{array}{l} \longrightarrow \text{row } 1 \\ \\ \longrightarrow \text{row } n \end{array}$$

column 1 column n

Example: $A = \begin{bmatrix} 1 & 2 & 5 \\ 3 & 4 & 6 \end{bmatrix}$ $\quad A^{\mathsf{T}} = \begin{bmatrix} 1 & 3 \\ 2 & 4 \\ 5 & 6 \end{bmatrix}$

Theorem. Let A and B be matrices whose sizes make the following make sense.

1. $(A^\top)^\top = A$.
2. $(A+B)^\top = A^\top + B^\top$.
3. $(\alpha A)^\top = \alpha A^\top$ for any scalar α.
4. $(AB)^\top = B^\top A^\top$.

A $m \times n$ matrix

The **transpose** of A is

the $n \times m$ matrix whose rows are the columns of A

A square matrix A is **symmetric** if $A = A^{\mathsf{T}}$.

In practice: if $A = [a_{ij}]$

$$a_{ij} = a_{ji} \qquad \text{for all } i,\ j$$

This imposes no conditions on the diagonal entries a_{ii}

A square matrix A is **symmetric** if $A = A^{\mathsf{T}}$.

Example: if $A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$ then $A^{\mathsf{T}} = \begin{bmatrix} a_{11} & a_{21} \\ a_{12} & a_{22} \end{bmatrix}$

If A is symmetric,

A square matrix A is **symmetric** if $A = A^{\mathsf{T}}$.

Example: if $A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$ then $A^{\mathsf{T}} = \begin{bmatrix} a_{11} & a_{21} \\ a_{12} & a_{22} \end{bmatrix}$

If A is symmetric,

we must have $a_{12} = a_{21}$

a_{11} can be anything

a_{22} can be anything

$$\longrightarrow \quad A = \begin{bmatrix} x & z \\ z & y \end{bmatrix}$$

Invertible matrices

Example:

$$A = \begin{bmatrix} 2 & 5 \\ -3 & -7 \end{bmatrix} \qquad B = \begin{bmatrix} -7 & -5 \\ 3 & 2 \end{bmatrix}$$

$$AB = \begin{bmatrix} -14+15 & -10+10 \\ 21-21 & 15-14 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} -14+15 & -35+35 \\ 6-6 & 15-14 \end{bmatrix} = BA.$$

A and B are inverses!

A $n \times n$ matrix

$I = I_n$ identity matrix

The **inverse** of A, if it exists, is an $n \times n$ matrix B such that

$$AB = I \qquad \text{and} \qquad BA = I$$

If A has an inverse, we say A is an **invertible matrix**.

Not every square matrix is invertible!

$$A = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}$$

does not have an inverse

$$\left(\begin{array}{c} \text{To see this, we can try to solve the equations we get out of} \\ \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \quad \text{and} \quad \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} a & b \\ c & d \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \\ \text{and see there is no solution} \end{array} \right)$$

But if a matrix is invertible, then its inverse is unique:

$$\text{If} \quad AB = I = BA \quad \text{and} \quad AC = I = CA$$

then

But if a matrix is invertible, then its inverse is unique:

If $\quad AB = I = BA \quad$ and $\quad AC = I = CA$

then

$$\begin{aligned} B &= BI && \text{since } BI = B \\ &= B(AC) && \text{since } AC = I \\ &= (BA)C && \text{by associativity} \\ &= IC && \text{since } BA = I \\ &= C. \end{aligned}$$

Therefore, $B = C$.

A $n \times n$ matrix

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The **inverse** of A, if it exists, is an $n \times n$ matrix B such that

$$AB = I \qquad \text{and} \qquad BA = I$$

If A has an inverse, we say A is an **invertible matrix**.

If A has an inverse B, then that inverse is unique.

We write A^{-1} for the inverse of A.

Theorem. The 2×2 matrix

$$A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

is invertible if and only if $ad - bc \neq 0$.

If $ad - bc \neq 0$, then the inverse of A is

$$A^{-1} = \frac{1}{ad - bc} \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}.$$

determinant of A $\qquad \det(A) = ad - bc$

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

Example: Is $A = \begin{bmatrix} 3 & 4 \\ 5 & 6 \end{bmatrix}$ invertible? If so, find A^{-1}.

$$\det(A) = 3 \cdot 6 - 5 \cdot 4 = 18 - 20 = -2 \neq 0$$

$$\Downarrow$$

A is invertible

$$A^{-1} = \frac{1}{-2}\begin{bmatrix} 6 & -4 \\ -5 & 3 \end{bmatrix} = \begin{bmatrix} -3 & 2 \\ \frac{5}{2} & -\frac{3}{2} \end{bmatrix}$$

Theorem (Properties of Invertible Matrices).

Let A and B be $n \times n$ matrices.

1. If A is invertible, then A^{-1} is also invertible, and
$$(A^{-1})^{-1} = A.$$

2. If A and B are invertible, then AB is invertible, with
$$(AB)^{-1} = B^{-1}A^{-1}.$$

3. If A is invertible, then A^{T} is invertible, and
$$(A^{\mathsf{T}})^{-1} = (A^{-1})^{\mathsf{T}}.$$

Theorem. If A is an invertible $n \times n$ matrix, then for each $b \in \mathbb{R}^n$ the equation

$$Ax = b$$

has a unique solution, which is given by $x = A^{-1}b$.

$Ax = b$ has a solution for every b	$\Longleftrightarrow$	A has a pivot in every row
$Ax = b$ has at most one solution	$\Longleftrightarrow$	A has a pivot in every column

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$$A \text{ is invertible} \quad \Longleftrightarrow \quad \begin{array}{c} A \text{ has a pivot in} \\ \text{every row and every column} \end{array}$$

Theorem. If A is an invertible $n \times n$ matrix, then for each $b \in \mathbb{R}^n$ the equation

$$Ax = b$$

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A is invertible $\iff$ A has a pivot in every row and every column

$\iff$ A has a pivot in every column

because A is a square matrix

$\iff$ A has a pivot in every row

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A is invertible $\iff$ A has a pivot in every row and every column

$\iff$ A has a pivot in every column

because A is a square matrix

$\iff$ A has a pivot in every row

What is the reduced row echelon form of an invertible matrix?

Theorem. If A is an invertible $n \times n$ matrix,

then for each $b \in \mathbb{R}^n$ the equation

$$Ax = b$$

has a unique solution, which is given by $x = A^{-1}b$.

Theorem. A $n \times n$ matrix

A is invertible

if and only if

the reduced row echelon form of A is the $n \times n$ identity matrix.

Example:

$$\text{Solve } \begin{bmatrix} 3 & 4 \\ 5 & 6 \end{bmatrix} x = \begin{bmatrix} 3 \\ 7 \end{bmatrix}$$

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A is invertible!

$$A^{-1} = \frac{1}{-2} \begin{bmatrix} 6 & -4 \\ -5 & 3 \end{bmatrix} = \begin{bmatrix} -3 & 2 \\ \frac{5}{2} & -\frac{3}{2} \end{bmatrix}$$

Solution: $x = A^{-1} b$

$$x = \begin{bmatrix} -3 & 2 \\ \frac{5}{2} & -\frac{3}{2} \end{bmatrix} \begin{bmatrix} 3 \\ 7 \end{bmatrix} = \begin{bmatrix} -9 + 14 \\ \frac{15}{2} - \frac{21}{2} \end{bmatrix} = \begin{bmatrix} 5 \\ -\frac{6}{2} \end{bmatrix} = \begin{bmatrix} 5 \\ -3 \end{bmatrix}$$

Algorithm. To compute the inverse of an invertible matrix:

$$[A \,|\, I] \xrightarrow{\text{row reduction}} [I \,|\, B]\,.$$

Then $B = A^{-1}$.

Example:

Find the inverse of $A = \begin{bmatrix} 0 & 1 & 2 \\ 1 & 0 & 3 \\ 4 & -3 & 8 \end{bmatrix}$

$$\left[\begin{array}{ccc|ccc} 0 & 1 & 2 & 1 & 0 & 0 \\ 1 & 0 & 3 & 0 & 1 & 0 \\ 4 & -3 & 8 & 0 & 0 & 1 \end{array}\right] \xrightarrow{R2 \leftrightarrow R1} \left[\begin{array}{ccc|ccc} 1 & 0 & 3 & 0 & 1 & 0 \\ 0 & 1 & 2 & 1 & 0 & 0 \\ 4 & -3 & 8 & 0 & 0 & 1 \end{array}\right]$$

$$\xrightarrow{R3 \leftarrow R3-4R1} \left[\begin{array}{ccc|ccc} 1 & 0 & 3 & 0 & 1 & 0 \\ 0 & 1 & 2 & 1 & 0 & 0 \\ 0 & -3 & -4 & 0 & -4 & 1 \end{array}\right]$$

$$\xrightarrow{R3 \leftarrow R3+3R2} \left[\begin{array}{ccc|ccc} 1 & 0 & 3 & 0 & 1 & 0 \\ 0 & 1 & 2 & 1 & 0 & 0 \\ 0 & 0 & 2 & 3 & -4 & 1 \end{array}\right]$$

$$\xrightarrow{R2 \leftarrow R2-R3} \left[\begin{array}{ccc|ccc} 1 & 0 & 3 & 0 & 1 & 0 \\ 0 & 1 & 0 & -2 & 4 & -1 \\ 0 & 0 & 2 & 3 & -4 & 1 \end{array}\right]$$

$$\xrightarrow{R3 \leftarrow \frac{1}{2}R3} \left[\begin{array}{ccc|ccc} 1 & 0 & 3 & 0 & 1 & 0 \\ 0 & 1 & 0 & -2 & 4 & -1 \\ 0 & 0 & 1 & \frac{3}{2} & -2 & \frac{1}{2} \end{array}\right]$$

$$\xrightarrow{R1 \leftarrow R1-3R3} \left[\begin{array}{ccc|ccc} 1 & 0 & 0 & -\frac{9}{2} & -5 & -\frac{3}{2} \\ 0 & 1 & 0 & -2 & 4 & -1 \\ 0 & 0 & 1 & \frac{3}{2} & -2 & \frac{1}{2} \end{array}\right]$$

Example:

$$\left[\begin{array}{ccc|ccc} 0 & 1 & 2 & 1 & 0 & 0 \\ 1 & 0 & 3 & 0 & 1 & 0 \\ 4 & -3 & 8 & 0 & 0 & 1 \end{array}\right] \xrightarrow{R2 \leftrightarrow R1} \left[\begin{array}{ccc|ccc} 1 & 0 & 3 & 0 & 1 & 0 \\ 0 & 1 & 2 & 1 & 0 & 0 \\ 4 & -3 & 8 & 0 & 0 & 1 \end{array}\right]$$

$$\xrightarrow{R3 \leftarrow R3 - 4R1} \left[\begin{array}{ccc|ccc} 1 & 0 & 3 & 0 & 1 & 0 \\ 0 & 1 & 2 & 1 & 0 & 0 \\ 0 & -3 & -4 & 0 & -4 & 1 \end{array}\right]$$

$$\xrightarrow{R3 \leftarrow R3 + 3R2} \left[\begin{array}{ccc|ccc} 1 & 0 & 3 & 0 & 1 & 0 \\ 0 & 1 & 2 & 1 & 0 & 0 \\ 0 & 0 & 2 & 3 & -4 & 1 \end{array}\right]$$

$$\xrightarrow{R2 \leftarrow R2 - R3} \left[\begin{array}{ccc|ccc} 1 & 0 & 3 & 0 & 1 & 0 \\ 0 & 1 & 0 & -2 & 4 & -1 \\ 0 & 0 & 2 & 3 & -4 & 1 \end{array}\right]$$

$$\xrightarrow{R3 \leftarrow \frac{1}{2} R3} \left[\begin{array}{ccc|ccc} 1 & 0 & 3 & 0 & 1 & 0 \\ 0 & 1 & 0 & -2 & 4 & -1 \\ 0 & 0 & 1 & \frac{3}{2} & -2 & \frac{1}{2} \end{array}\right]$$

$$\xrightarrow{R1 \leftarrow R1 - 3R3} \left[\begin{array}{ccc|ccc} 1 & 0 & 0 & -\frac{9}{2} & -5 & -\frac{3}{2} \\ 0 & 1 & 0 & -2 & 4 & -1 \\ 0 & 0 & 1 & \frac{3}{2} & -2 & \frac{1}{2} \end{array}\right]$$

$$\begin{bmatrix} 0 & 1 & 2 \\ 1 & 0 & 3 \\ 4 & -3 & 8 \end{bmatrix}^{-1} = \begin{bmatrix} -\frac{9}{2} & -5 & -\frac{3}{2} \\ -2 & 4 & -1 \\ \frac{3}{2} & -2 & \frac{1}{2} \end{bmatrix}$$

rank of a matrix A = number of pivot positions in A

Notation: $\mathrm{rank}(A)$

Theorem (Inverse Matrix Theorem).

Let A be any $n \times n$ matrix, and write $I = I_n$.

The following are equivalent:

1) A is invertible.
2) There exists B such that $BA = I$.
3) There exists B such that $AB = I$.
4) We have $A \sim I$.
5) The matrix A has rank n.
6) The equation $Ax = 0$ has only the trivial solution.
7) The columns of A form a linearly independent set.
8) The linear transformation $T(x) = Ax$ is injective.
9) The linear transformation $T(x) = Ax$ is surjective.
10) The equation $Ax = b$ has at least one solution for each b.
11) The transpose A^T is invertible.

rank of a matrix A = number of pivot positions in A

Theorem. The 2×2 matrix

$$A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

is invertible if and only if $ad - bc \neq 0$.

If $ad - bc \neq 0$, then the inverse of A is

$$A^{-1} = \frac{1}{ad - bc} \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}.$$

determinant of A $\quad\quad$ $\det(A) = ad - bc$

Today’s poll code:

V4SFUZ

Today’s poll code:

V4SFUZ

$$\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$$

A. is invertible

B. is not invertible

Today's poll code:

V4SFUZ

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

A. is invertible

B. is not invertible

Today’s poll code:

V4SFUZ

$$M = \begin{bmatrix} 3 & 4 & 5 \\ 6 & 7 & 8 \\ 9 & 11 & 13 \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & -1 \\ 0 & 1 & 2 \\ 0 & 0 & 0 \end{bmatrix}$$

A. is invertible

B. is not invertible

Today's poll code:

V4SFUZ

$$M = \begin{bmatrix} 3 & 4 & 5 \\ 6 & 7 & 0 \\ 9 & 11 & 13 \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

A. is invertible

B. is not invertible

Final comments on
Linear transformations

linear transformations	$T: \mathbb{R}^a \to \mathbb{R}^b$	$S: \mathbb{R}^b \to \mathbb{R}^c$	$U: \mathbb{R}^a \to \mathbb{R}^b$
standard matrices	A	B	C

$S \circ T: \mathbb{R}^a \to \mathbb{R}^c$ has standard matrix BA

$U + T: \mathbb{R}^a \to \mathbb{R}^b$ has standard matrix $A + C$

$T: \mathbb{R}^n \to \mathbb{R}^n$ linear transformation with standard matrix A

$$A \text{ invertible} \implies T \text{ invertible}$$

The standard matrix for T^{-1} is A^{-1}

$$T \text{ is bijective} \iff T \text{ is invertible}$$

$T\colon \mathbb{R}^n \to \mathbb{R}^n$ linear transformation with standard matrix A

$$A \text{ invertible} \implies T \text{ invertible}$$

The standard matrix for T^{-1} is A^{-1}

$$T \text{ is bijective} \iff T \text{ is invertible}$$

Midterm 1 a week from today!

Midterm 1

October 6

Material for Midterm 1: Chapters 1, 2, 3

Study materials:

- Class notes (see canvas)
- Textbook
- Slides from lecture
- Poll questions
- Quizzes
- Webwork questions
- Study guide (quick summary)

Midterm 1

October 6 in lecture

On the day of the midterm:

- Arrive a few minutes early if you can
- Know your NUID!
- Write your name and NUID on the cover page
- Leave one empty seat between you and the student next to you
- No calculators or notes allowed
- Write only on the front side of each page
- There are extra pages at the end of the midterm you can use
- Scratch paper will be provided for you (you can’t use your own)
- Only material you need to bring: writing utensils

Lab 1

Due Friday, October 17

To be discussed in Recitation on October 10

Groups of up to 3 students

Start early!

To do list:

- Webwork 3.1 due tomorrow
- WebworK 3.2 due Friday
- Find a team for Lab 1
- Study for the midterm!

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One week from today

Quiz on Friday

on inverses

Office hours this week:

Monday 5–6 pm and Wednesday 2–3 pm
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