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ノ-E103BN MADE IN JAPAN

表紙・中紙に再生紙を使用していますので、以下の点を
ご理解の上ご使用ください。
●黒っぽい異物や汚れに見えるものが入ることがあります。
●筆記具によってはインクがにじむ場合があります。
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No.

Date

TABLE of CONTENTS

No.

Date

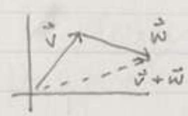
No. 1

Date 9 4 24

VECTORS

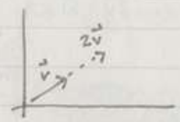
- rooted @ origin (for lin alg) $\Rightarrow$ vectors & endpoints ("heads") interchangeable
  - useful for sets of $\rightarrow$s

ADDITION:



$$\begin{bmatrix} x_1 \\ y_1 \\ z_1 \end{bmatrix} + \begin{bmatrix} x_2 \\ y_2 \\ z_2 \end{bmatrix} = \begin{bmatrix} x_1 + x_2 \\ y_1 + y_2 \\ z_1 + z_2 \end{bmatrix}$$

SCALING:



Parallel

$$\underset{\text{"scalar"}}{n} \cdot \begin{bmatrix} x_1 \\ y_1 \\ z_1 \end{bmatrix} = \begin{bmatrix} nx_1 \\ ny_1 \\ nz_1 \end{bmatrix}$$

Standard Base Vectors:

$\hat{i}$: $\rightarrow$

$\hat{j}$: $\uparrow$

$\vec{e}_i = \begin{bmatrix} 0 \\ 0 \\ \vdots \\ 1 \\ \vdots \\ 0 \end{bmatrix}$ ← ith comp

column vector (default): $\begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix}$ ← in $\mathbb{R}^4$

row vector: $[a \ b \ c \ d]$

- <u>Vector space</u> ($\mathbb{R}^n$): set of all col vectors w/ n components

MAGNITUDE:

$$\|\vec{x}\| = \sqrt{\vec{x} \cdot \vec{x}} = \sqrt{x_1^2 + x_2^2 \cdots + x_n^2}$$

also called length or norm

- unit vector $u = \frac{v}{|v|}$

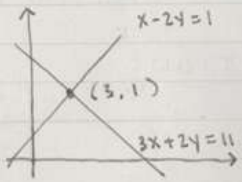
No. 2
Date 9 · 4 · 24

REPRESENTATIONS

ROW PICTURE:

$$\begin{bmatrix} (1,-2)\cdot(x,y) \\ (3,2)\cdot(x,y) \end{bmatrix} = \begin{bmatrix} 1 \\ 11 \end{bmatrix}$$

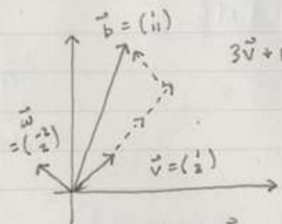
↑ for 3D, use the plane's normal vector! — constant matrix



COLUMN PICTURE:

$$x\begin{bmatrix} 1 \\ 3 \end{bmatrix} + y\begin{bmatrix} -2 \\ 2 \end{bmatrix} = \begin{bmatrix} 1 \\ 11 \end{bmatrix}$$

coefficient matrix of x — coefficient matrix of y — constant matrix



$3\vec{v}+\vec{w}=\vec{b}$ ↑ linear combo!

MATRIX PICTURE:

$$A\vec{x}=\vec{b}$$

$$\begin{bmatrix} 1 & -2 \\ 3 & 2 \end{bmatrix} \times \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 1 \\ 11 \end{bmatrix}$$

coefficient matrix — variable matrix — constant matrix

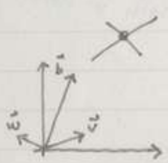
$A\vec{v}=\vec{b} \Rightarrow \vec{v}=A^{-1}\vec{b}$

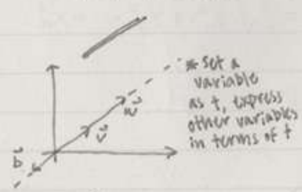
UNIQUE SOL:
- 1 intersection pt.

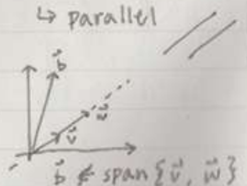
INFINITE SOLs:
- intersection line

NO SOLs:
- no intersection
  - ↳ parallel

ROW PIC







COL PIC

"consistent" — "inconsistent"

No. 3
Date 9 · 6 · 24

MATRICES

upper case for matrices!

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \end{bmatrix}$$

← $\underset{row}{3} \times \underset{col}{4}$ matrix

a_{ij} : i^{th} row, j^{th} column

$n =$ # of rows (# of equations) $m =$ # of cols (# of unknowns) $r = \text{rank}(A)$ $n[\ ]^m$

- <u>square matrix</u>: A is $n \times n$
  - ↳ <u>diagonal</u>: $a_{11}, a_{22}, a_{33}, \ldots a_{nn}$
    - A is diagonal if all values outside diagonal are 0
  - if diagonal, ALSO
    - ↳ <u>upper triangular</u>: all below diagonal are 0
    - ↳ <u>lower triangular</u>: all above diagonal are 0
  - ↳ <u>zero</u>: all are 0 (denoted by 0)

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

upper △ — lower △ — diagonal

rectangular: anything not square ($m \times n$, $m \neq n$)

ADDITION:

$$\begin{bmatrix} a_{11} & \cdots & a_{1m} \\ \vdots & & \vdots \\ a_{n1} & \cdots & a_{nm} \end{bmatrix} + \begin{bmatrix} b_{11} & \cdots & b_{1m} \\ \vdots & & \vdots \\ b_{n1} & \cdots & b_{nm} \end{bmatrix} = \begin{bmatrix} a_{11}+b_{11} & \cdots & a_{1m}+b_{1m} \\ \vdots & & \\ a_{n1}+b_{n1} & \cdots & a_{nm}+b_{nm} \end{bmatrix}$$

*need to have same dimensions!

SCALAR MULTIPLICATION:

$$k\cdot\begin{bmatrix} a_{11} & \cdots & a_{1m} \\ \vdots & & \vdots \\ a_{n1} & \cdots & a_{nm} \end{bmatrix} = \begin{bmatrix} k\cdot a_{11} & \cdots & k\cdot a_{1m} \\ \vdots & & \vdots \\ k\cdot a_{n1} & \cdots & k\cdot a_{nm} \end{bmatrix}$$

COEFFICIENT MATRIX (A):

$$\begin{bmatrix} 2 & 8 & 4 \\ 2 & 5 & 1 \\ 4 & 10 & -1 \end{bmatrix}$$

AUGMENTED MATRIX ($A \vdots \vec{b}$):

$$\left[\begin{array}{ccc|c} 2 & 8 & 4 & 2 \\ 2 & 5 & 1 & 5 \\ 4 & 10 & -1 & 1 \end{array}\right]$$

$$n\overset{m}{[\ \ ]}$$

No. 4
Date 9 · 6 · 24

REDUCED ROW ECHELON FORM (RREF)

- Must satisfy 3 conditions:
  1.) first nonzero entry of a nonzero row must be 1 ("leading 1", "pivot")
  2.) All other entries in a pivot column (has a leading 1) must be 0
  3.) Leading 1s go left to right (upper triangular) (rows of 0s must go to bottom)

"free variable" (unknown has no lead)
"free column"

$$M = \left[\begin{array}{ccccc|c} 2 & 4 & -2 & 2 & 4 & 2 \\ 1 & 2 & -1 & 2 & 0 & 4 \\ 3 & 6 & -2 & 1 & 9 & 1 \\ 5 & 10 & -4 & 5 & 9 & 9 \end{array}\right] \qquad E = \left[\begin{array}{ccccc|c} 1 & 2 & 0 & 0 & 3 & 2 \\ 0 & 0 & 1 & 0 & -2 & 4 \\ 0 & 0 & 0 & 1 & -1 & 3 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{array}\right] = \text{rref}(M)$$

"pivot columns"

- <u>Rank</u>: # of leading 1s in RREF
  $r = \text{rank}(A) \leftarrow r \leq n,\ r \leq m$

<u>1 SOL</u>:
- no free variables
- $r = m$ (each unknown gets a lead)
- $m \leq n$ (more equations than unknowns)

$$\left[\begin{array}{ccc|c} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 2 \\ 0 & 0 & 1 & 3 \end{array}\right] \begin{array}{l} n=3 \\ m=3 \\ r=3 \end{array}$$

<u>INF. SOLs</u>:
- at least 1 free variable
- $r < m$ (unknowns have free(s))

$$\left[\begin{array}{ccc|c} 1 & \boxed{2} & 0 & 1 \\ 0 & 0 & 1 & 2 \end{array}\right] \begin{array}{l} n=2 \\ m=3 \\ r=2 \end{array}$$

underconstrained

<u>NO SOLs</u>:

$$[\,0\ 0\ \dots\ 0 \mid 1\,]$$

- $r < n$ (has a row of zeros)

$$\left[\begin{array}{ccc|c} 1 & 2 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{array}\right] \begin{array}{l} n=4 \\ m=3 \\ r=2 \end{array}$$

overconstrained

No. 5
Date 9 · 6 · 24

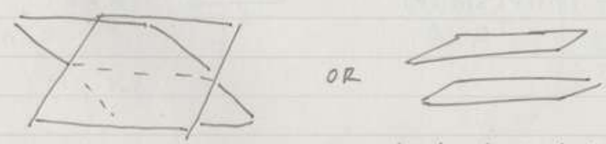
GAUSS - JORDAN ELIMINATION

- get to RREF using:
  - divide rows by scalars
  - subtract multiples of rows from other rows
  - swap rows

<u>if $n < m$:</u>

# of equations < # of unknowns

Ex. 2 equations, 3 unknowns
2 planes



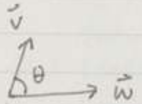
intersect @ line (inf.) OR don't intersect (none)

No. 6
Date 9 . 10 . 24

DOT PRODUCT

also a linear transform → $\begin{bmatrix} v_1 \\ v_2 \\ \vdots \\ v_n \end{bmatrix} \cdot \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix} = v_1 w_1 + v_2 w_2 + \dots + v_n w_n$ ← scalar

must be same length!



$$\boxed{\vec{v} \cdot \vec{w} = \|\vec{v}\| \cdot \|\vec{w}\| \cdot \cos(\theta)}$$

⇒ if $\vec{v} \cdot \vec{w} = 0$, the vectors are orthogonal

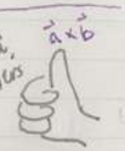
CROSS PRODUCT:

★ only exists in $\mathbb{R}^3$ (and $\mathbb{R}^7$?)

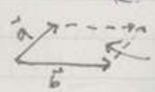
$$\begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ x_a & y_a & z_a \\ x_b & y_b & z_b \end{vmatrix} = \begin{vmatrix} y_a & z_a \\ y_b & z_b \end{vmatrix} \hat{\imath} - \begin{vmatrix} x_a & z_a \\ x_b & z_b \end{vmatrix} \hat{\jmath} + \begin{vmatrix} x_a & y_a \\ x_b & y_b \end{vmatrix} \hat{k}$$

anticommutative: $\vec{a} \times \vec{b} = -\vec{b} \times \vec{a}$

hand → $\vec{a}$, curl fingers → $\vec{b}$



- $\vec{a} \times \vec{b}$ is orthogonal to $\vec{a}$ and $\vec{b}$
- $|\vec{a} \times \vec{b}| = |\vec{a}||\vec{b}| \sin(\theta)$



No. 7
Date 9 . 10 . 24

"matrix operates on a vector"

MATRIX - VECTOR MULTIPLICATION ($A\vec{x}$)

for all matrix multiplication:

$r_1 \overset{c_1}{[\;]} \times r_2 \overset{c_2}{[\;]} = r_1 \overset{c_2}{[\;]}$ $\quad$ c_1 MUST EQUAL r_2!

↳ if $c_2 = 1$ (vector), result is a vector

ROWS:

$$A\vec{x} = \begin{bmatrix} - \vec{w}_1 - \\ \vdots \\ - \vec{w}_n - \end{bmatrix} \vec{x} = \begin{bmatrix} \vec{w}_1 \cdot \vec{x} \\ \vdots \\ \vec{w}_n \cdot \vec{x} \end{bmatrix}$$ ← vector in $\mathbb{R}^n$!

COLS:

$$A\vec{x} = \begin{bmatrix} | & & | \\ \vec{v}_1 & \cdots & \vec{v}_m \\ | & & | \end{bmatrix} \begin{bmatrix} x_1 \\ \vdots \\ x_m \end{bmatrix} = x_1 \vec{v}_1 + \dots + x_m \vec{v}_m$$

"linear combination"

For $[A \,|\, \vec{b}]$: $A\vec{x} = \vec{b}$ ← linear combo

Homogenous : $A\vec{x} = \vec{0}$

IDENTITY MATRIX:

$$I_n = \begin{bmatrix} 1 & 0 & \cdots & 0 \\ 0 & 1 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & & 1 \end{bmatrix}$$

SYMMETRIC MATRIX:

ex.

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

No. 8

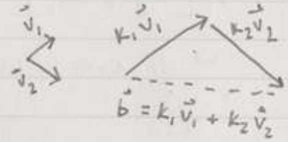
Date 9 . 10 . 24

LINEAR COMBINATIONS & SPAN

$\vec{b} = k_1 \cdot \vec{v}_1 + \dots + k_m \vec{v}_m$ — ks are scalars; $\vec{b}$ and $\vec{v}$s are in $\mathbb{R}^n$

"linear combination of $\vec{v}_1, \dots, \vec{v}_m$"

$$\vec{b} = A\vec{x} = \begin{bmatrix} | & & | \\ \vec{v}_1 & \cdots & \vec{v}_m \\ | & & | \end{bmatrix} \cdot \begin{bmatrix} k_1 \\ \vdots \\ k_m \end{bmatrix}$$



<u>Span</u> : set of all linear combinations (let scalars vary for all real numbers)

$\text{span}(\{v_1, v_2, \dots, v_n\}) = c_1v_1 + c_2v_2 + \dots + c_nv_n$

2D VECTORS:

- if they line up: span is a line
- else: span is all 2D space

3D VECTORS:

- 2 non-similar vectors: span is a plane
  - ↳ add a vector not on the plane: span is all 3D space
  - ↳ add a vector in span: span doesn't change (redundant, linearly dependent)

LINEARLY DEPENDENT:

- a vector could be removed w/o changing span
  - ↳ linear combo of other vectors

LINEARLY INDEPENDENT:

- each vector adds to span

No.

Date 9 . 18 . 24

LINEAR TRANSFORMATIONS

<u>Transformation</u> : function T

input vector → output vector

domain ($\mathbb{R}^m$) → target space ($\mathbb{R}^n$)

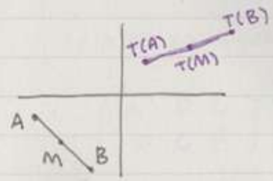
specify dimensions of in/out

actual vector outputs : "images"

<u>Linear</u> :

- Lines map to lines w/o getting curvy (parallel, evenly spaced)
- Origin stays fixed ($T(\vec{0}) = \vec{0}$)
- $T(\vec{v}) = A \cdot \vec{v}$ (for $n \times m$ matrix A)
- Behaves w/ sums & scalar transformation:
  - $T(\vec{v} + \vec{w}) = T(\vec{v}) + T(\vec{w})$
  - $T(k \cdot \vec{v}) = k \cdot T(\vec{v})$

all equivalent!



Ex. x^2 and $mx+b$ aren't linear :(

has +b, affine

★ <u>MATRICES = SPACE TRANSFORM:</u>

transforming, matrix-vector multiplication!

A: coefficient matrix

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

where $\hat{i}$ gets transformed; where $\hat{j}$ goes

$$T = A \cdot \begin{bmatrix} x \\ y \end{bmatrix} = \overbrace{\begin{bmatrix} a & b \\ c & d \end{bmatrix}}^{A} \cdot \begin{bmatrix} x \\ y \end{bmatrix}$$

$$= \begin{bmatrix} a \\ c \end{bmatrix} \cdot x + \begin{bmatrix} b \\ d \end{bmatrix} \cdot y$$

linear combination of transformed basis vectors!

$$= \begin{bmatrix} ax + by \\ cx + dy \end{bmatrix}$$

only need where basis vectors land!

INVERSES

$$\begin{tikzcd} \vec{x} \arrow[r, bend left, "A"] & \vec{y} \arrow[l, bend left, "A^{-1}"] \end{tikzcd}$$ "inverse"

- not all matrices are invertible!
  - ↳ ex. squish onto x-axis

$$\boxed{R \cdot R^{-1} = I}$$
&
$$\boxed{R^{-1} \cdot R = I}$$

2 × 2 MATRICES:

- invertible only if $ad - bc \neq 0$

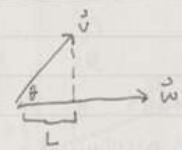
$$\begin{bmatrix} a & b \\ c & d \end{bmatrix}^{-1} = \frac{1}{ad - bc} \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$$

$$\boxed{(AB)^{-1} = B^{-1}A^{-1}} \quad \boxed{(A^T)^{-1} = (A^{-1})^T}$$

- only square matrices have inverses
  - ↳ has an inverse if and only if it has a determinant

PROJECTION

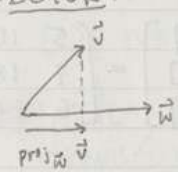
SCALAR:



$$L = |\vec{v}| \cdot \cos\theta$$
$$= |\vec{v}| \cdot \vec{v} \cdot \vec{w} \cdot \frac{1}{|\vec{v}||\vec{w}|}$$
$$= \boxed{\frac{\vec{v} \cdot \vec{w}}{|\vec{w}|}}$$

↓ magnitude

VECTOR:



direction ($\vec{w}$ unit vector)

$$= \frac{\vec{v} \cdot \vec{w}}{|\vec{w}|} \cdot \frac{\vec{w}}{|\vec{w}|}$$
$$= \boxed{\frac{\vec{v} \cdot \vec{w}}{|\vec{w}|^2} \cdot \vec{w}}$$

TRANSPOSE:

- swaps rows and columns

$$\begin{bmatrix} a & b & c \\ d & e & f \end{bmatrix}^T = \begin{bmatrix} a & d \\ b & e \\ c & f \end{bmatrix}$$

- for correctly sized vectors:

$$w^T v = w \cdot v$$

ex.

$$v = \begin{bmatrix} 1 \\ 2 \end{bmatrix} \quad w = \begin{bmatrix} -3 \\ 1 \end{bmatrix}$$
$$w^T v = \begin{bmatrix} -3 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 2 \end{bmatrix}$$

$$\boxed{(Av)^T = v^T A^T}$$

Date 9 5 25

MULTIPLYING MATRICES

$$\begin{array}{c}c_1\\ r_1\end{array}\!\left[\;\right] \times \begin{array}{c}c_2\\ \end{array}\!\left[\;\right] r_2 = r_1 \begin{array}{c}c_2\\ \end{array}\!\left[\;\right] \qquad c_1 = r_2 \text{ !!!}$$

$$r_1 \times (c_1 \times r_2) \times c_2$$

$$=$$

Transformation Matrix*

A set of 2 points (each point is a column) can add more, all get transformed

ex.

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 2 \\ 4 & 1 \end{bmatrix} \qquad B = \begin{bmatrix} 1 & 4 \\ 2 & 3 \end{bmatrix}$$

$$C = AB = \begin{bmatrix} [1\ 2]\cdot[1\ 2] & [1\ 2]\cdot[4\ 3] \\ [3\ 2]\cdot[1\ 2] & [3\ 2]\cdot[4\ 3] \\ [4\ 1]\cdot[1\ 2] & [4\ 1]\cdot[4\ 3] \end{bmatrix} = \begin{bmatrix} 5 & 10 \\ 7 & 18 \\ 6 & 19 \end{bmatrix}$$

$$AB = A[B_1, B_2, \dots] = [AB_1, AB_2, \dots]$$

Commutative

$$\boxed{AB \neq BA}$$

Distributive

$$\boxed{A(B+C) = AB + AC}$$

Associative

$$\boxed{A(BC) = (AB)C}$$

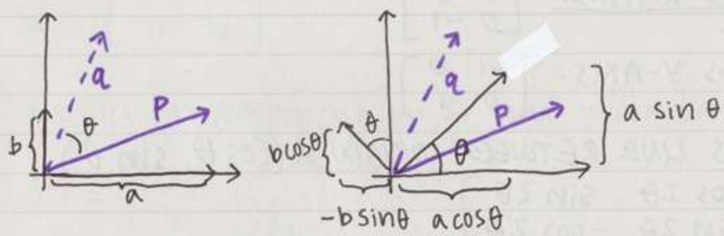
$$\boxed{(A+B)^2 = A^2 + AB + BA + B^2}$$

$$\boxed{A \cdot A^2 = A^2 \cdot A}$$

* This was a bad example, since it transforms 2D vectors into 3D vectors. To be simple, keep transformation matrices square.

Date 9 10 25

MATRIX ROTATIONS



p is rotated by θ to become q

ROTATION MATRIX:

- transforms vectors by rotating them

$$R(\theta) = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$$

- rotates counter-clockwise around the origin

commutative

$$\boxed{R(\theta_1)R(\theta_2) = R(\theta_2)R(\theta_1)}$$

$$\boxed{R(\theta_1)R(\theta_2) = R(\theta_1 + \theta_2)}$$

INVERSE ROTATION:

$$R \cdot R^{-1} = I$$

$$R^{-1}(\theta) = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$$

- rotates clockwise about the origin

Date 9 14 25

REFLECTION

ACROSS X-AXIS: $\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$

ACROSS Y-AXIS: $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$

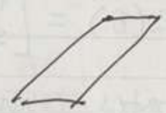
ACROSS LINE BETWEEN ORIGIN & $(\cos\theta, \sin\theta)$:

$$\begin{bmatrix} \cos 2\theta & \sin 2\theta \\ \sin 2\theta & -\cos 2\theta \end{bmatrix}$$

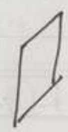
INVERSE: $R = R^{-1}$ (for reflection)

SHEARING

SHEAR TOP TO RIGHT: $\begin{bmatrix} 1 & K \\ 0 & 1 \end{bmatrix}$



SHEAR RIGHT UP: $\begin{bmatrix} 1 & 0 \\ K & 1 \end{bmatrix}$



INVERSE: make K negative

(ex. $\begin{bmatrix} 1 & -K \\ 0 & 1 \end{bmatrix}$ or $\begin{bmatrix} 1 & 0 \\ -K & 1 \end{bmatrix}$

Date 9 15 25

SCALING

$$S = \begin{bmatrix} S_1 & 0 \\ 0 & S_2 \end{bmatrix}$$

- scales x-component by S_1 and y-component by S_2

$$S^{-1} = \begin{bmatrix} 1/S_1 & 0 \\ 0 & 1/S_2 \end{bmatrix}$$

ROTATION ABOUT POINT

$$T(x_c, y_c)\, R(\theta)\, T(-x_c, -y_c)$$

- rotates around (x_c, y_c)

TRANSFORMING

- when doing multiple transformations on D, go to the left of D and go right to left

ex. Rotate, then scale, then translate

↳ TSRD

transformation matrices must be on the left!

- inverse: $R^{-1}S^{-1}T^{-1}N$

Date 9 15 25

TRANSLATION

$$T = \begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{bmatrix}$$

↑ translates $\begin{bmatrix} x \\ y \end{bmatrix}$ to $\begin{bmatrix} x + t_x \\ y + t_y \end{bmatrix}$

↑ actually $\begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$, the result lives on the plane $z = 1$ (just ignore z)

$$T^{-1} = \begin{bmatrix} 1 & 0 & -t_x \\ 0 & 1 & -t_y \\ 0 & 0 & 1 \end{bmatrix}$$

<u>ADJUST OTHER TRANSFORMATIONS:</u>

- if translating AND doing another transformation, need to make it 3×3

$$R = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad S = \begin{bmatrix} s_1 & 0 & 0 \\ 0 & s_2 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\text{reflection} = \begin{bmatrix} \cos 2\theta & \sin 2\theta & 0 \\ \sin 2\theta & -\cos 2\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\text{shearing} = \begin{bmatrix} 1 & k & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

MATLAB INTRO

- size(x) for matrix size

INDEXING:
- starts from 1
- x(3) = 1 or x(2:4) ← range
- x (row #, col #)
- entire row: x(1, :)
- end: last element

ARRAY OPERATIONS:
- add arrays of same size
- adding scalar adds to all values in array
  - ↳ also multiplying/dividing, sqrt, round
- max() of an array
- * ← matrix multiplication
- .* ← element-wise multiplication (same size)
- x = A\b ← x = inv(A)*b but faster

No.

Date 9 . 3 . 25

MATLAB INTRO

- command w/o ; : displays result
  - ↳ w/o ; : hides result
- recall previous commands w/ ↑
- variables must start w/ a letter
- save all variables using save filename.mat
  - ↳ clear w/ clear ← for variables
  - ↳ clear command window w/ clc
  - ↳ save/load just k w/ load myData k
- use Live Script to run many commands at once
- create array : y = [7 9] ← row vector
  z = [7;9] ← column vector
  c = [5 6 7 ; 8 9 10] ← matrix
- evenly spaced : z = 1 : 0.5 : 5
  start : spacing : end
  linspace (start, end, # of elements)
- transpose row v → col v : b = b' or c = (5:2:9)'
- random matrix : v = rand (row, col) (default is square)
  or zeros or ones