next week
mxn matrix Mondays, 5:30-7:30
Blocker 166

Section 1.1: Basic Matrix Operations

- Size (Dimensions): rows × columns
- Entries: Labeled based on row and column position, a_{ij}
- Addition/Subtraction:
  - Matrices must be the same size for the operation to be performed
  - Combined corresponding entries based on operation given
- Scalar Product: multiplying a matrix by a constant results in a matrix of the same size
- Transpose of a matrix A: A^T
- Matrix Equality: two matrices are equal if they are the same size AND corresponding entries are equal
- Operations of matrices which contain variables must be done by hand

Pr 1. Use the given matrices A, B, C, D, and E below, to Determine the dimensions of the resulting matrices, if possible. If the given operation is not possible, explain why.

A is a 1×2, B is a 1×2, C is a 2×3, D is a 2×3, E is a 3×2

a. $\frac{1}{2}B$.

scalar multiplication
$\frac{1}{2}B$ is 1×2

1 row
2 columns $\begin{bmatrix} 1 & 3 \end{bmatrix}$

$2 \times 3 \rightarrow \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \end{bmatrix}$

b. $(B + C)^T$.

1×2 2×3
the operation is not defined.

If A has size $m \times n$
then A^T has size $n \times m$

c. $E^T - D + 2C$.

3×2 2×3 2×3 → $2C$ has dimension 2×3

E^T has dimension 2×3

$E^T - D + 2C$ has dimension 2×3

Pr 2. Use the given matrices A, B, C, D, E, and F below, to compute each operation, if possible.

$$A = \begin{bmatrix} 5 & 2 & 6 \\ 6 & \frac{1}{5} & 0 \end{bmatrix} \quad 2\times 3$$

$$B = \begin{bmatrix} -9 & 0 & 3 \end{bmatrix} \quad 1\times 3$$

$$C = \begin{bmatrix} -3 & w \\ -y & 0 \\ 5 & (x+1) \end{bmatrix} \quad 3\times 2$$

$$D = \begin{bmatrix} 1.6 & 3 \\ 5 & 15p \end{bmatrix} \quad 2\times 2$$

$$E = \begin{bmatrix} v & 10 \\ 6m & -1 \end{bmatrix} \quad 2\times 2$$

$$F = \begin{bmatrix} -3r \\ 6z \end{bmatrix} \quad 2\times 1$$

a. State the dimensions of each matrix. ✓

b. State the value of c_{32}.

matrix C 3rd row 2nd column

$c_{32} = (x+1)$

c. State the value of b_{21}.

b_{21} matrix B 2nd row 1st column

b_{21} is undefined

d. Given $M = B^T$, state the value of m_{21}.

$B = [-9 \quad 0 \quad 3]$

$M = B^T = \begin{bmatrix} -9 \\ 0 \\ 3 \end{bmatrix}$

$m_{21} = 0$

M is 3×1

e. Compute $D + E$.

D is 2x2

E is 2x2

D + E is 2x2

$$\begin{bmatrix} 1.6 & 3 \\ 5 & 15p \end{bmatrix} + \begin{bmatrix} v & 10 \\ 6m & -1 \end{bmatrix}$$

$$= \begin{bmatrix} 1.6+v & 3+10 \\ 5+6m & 15p+(-1) \end{bmatrix}$$

$$= \begin{bmatrix} v+1.6 & 13 \\ 6m+5 & 15p-1 \end{bmatrix}$$

f. Compute $C^T - 6A$.

3x2 ⇝ 2x3 ⇝ 2x3

$$C^T = \begin{bmatrix} -3 & -y & 5 \\ w & 0 & x+1 \end{bmatrix}$$

$$\begin{bmatrix} -3 & -y & 5 \\ w & 0 & x+1 \end{bmatrix} - 6 \begin{bmatrix} 5 & 2 & 6 \\ 6 & \frac{1}{5} & 0 \end{bmatrix}$$

$$= \begin{bmatrix} -3 & -y & 5 \\ w & 0 & x+1 \end{bmatrix} + \begin{bmatrix} -6\cdot 5 & -6\cdot 2 & -6\cdot 6 \\ -6\cdot 6 & -6\cdot\frac{1}{5} & -6\cdot 0 \end{bmatrix}$$

$$= \begin{bmatrix} -3 & -y & 5 \\ w & 0 & x+1 \end{bmatrix} + \begin{bmatrix} -30 & -12 & -36 \\ -36 & -\frac{6}{5} & 0 \end{bmatrix}$$

$$= \begin{bmatrix} -3+(-30) & -y-12 & 5-36 \\ w-36 & 0-\frac{6}{5} & x+1-0 \end{bmatrix}$$

$$= \begin{bmatrix} -33 & -y-12 \\ w-36 & -\frac{6}{5} \end{bmatrix}$$

g. Compute $2D - 3E$.

$$A = \begin{bmatrix} 5 & 2 & 6 \\ 6 & \frac{1}{5} & 0 \end{bmatrix} \qquad B = \begin{bmatrix} -9 & 0 & 3 \end{bmatrix} \qquad C = \begin{bmatrix} -3 & w \\ -y & 0 \\ 5 & (x+1) \end{bmatrix}$$

$$D = \begin{bmatrix} 1.6 & 3 \\ 5 & 15p \end{bmatrix} \qquad E = \begin{bmatrix} v & 10 \\ 6m & -1 \end{bmatrix} \qquad F = \begin{bmatrix} -3r \\ 6z \end{bmatrix}$$

h. ~~Compute $(B^T + C)^T$~~ g) $2D - 3E$ — $2D-3E$ is 2×2 matrices

$$2\begin{bmatrix} 1.6 & 3 \\ 5 & 15p \end{bmatrix} - 3\begin{bmatrix} v & 10 \\ 6m & -1 \end{bmatrix}$$

$$= \begin{bmatrix} 2 \cdot 1.6 & 2 \cdot 3 \\ 2 \cdot 5 & 2 \cdot 15p \end{bmatrix} - \begin{bmatrix} 3 \cdot v & 3 \cdot 10 \\ 3 \cdot 6m & 3 \cdot (-1) \end{bmatrix}$$

i. If $D = 3E$, solve for m, v and p.

$$= \begin{bmatrix} 3.2 & 6 \\ 10 & 30p \end{bmatrix} - \begin{bmatrix} 3v & 30 \\ 18m & -3 \end{bmatrix}$$

3. Solve the matrix equation for the matrix X.

$$3X - \begin{bmatrix} 260 & 165 \\ 130 & 60 \end{bmatrix} = \begin{bmatrix} 120 & 165 \\ 320 & -30 \end{bmatrix} - 3X$$

$$= \begin{bmatrix} 3.2 - 3v & 6 - 30 \\ 10 - 18m & 30p - (-3) \end{bmatrix}$$

$$= \begin{bmatrix} -3v + 3.2 & -24 \\ -18m + 10 & 30p + 3 \end{bmatrix}$$

4. Solve the matrix equation $6X - 3A = 6B + A$, for matrix X, assuming that the matrices A, B and X are the same size.

$$A = \begin{bmatrix} 5 & 2 & 6 \\ 6 & \frac{1}{5} & 0 \end{bmatrix} \qquad B = \begin{bmatrix} -9 & 0 & 3 \end{bmatrix} \qquad C = \begin{bmatrix} -3 & w \\ -y & 0 \\ 5 & (x+1) \end{bmatrix}$$

$$D = \begin{bmatrix} 1.6 & 3 \\ 5 & 15p \end{bmatrix} \qquad E = \begin{bmatrix} v & 10 \\ 6m & -1 \end{bmatrix} \qquad F = \begin{bmatrix} -3r \\ 6z \end{bmatrix}$$

h. Compute $(B^T + C)^T$

$(B^T + C)^T$ is not defined

B is 1x3

B^T is 3x1 3x2

$B^T + C$ is not defined

i. If $D = 3E$, solve for m, v and p.

$$\begin{bmatrix} 1.6 & 3 \\ 5 & 15p \end{bmatrix} = 3 \begin{bmatrix} v & 10 \\ 6m & -1 \end{bmatrix} = \begin{bmatrix} 3v & 30 \\ 18m & -3 \end{bmatrix}$$

2x2 2x2

no solution

$1.6 = 3v$

$3 = 30$ ← not possible

$5 = 18m$

$15p = -3$

assume $3 = 30$ didn't exist

$\frac{1.6}{3} = \frac{3v}{3}$

$v = \frac{1.6}{3}$

$\frac{18m}{18} = \frac{5}{18}$

$m = 5/18$

$\frac{15p}{15} = \frac{-3}{15}$

$p = -3/15$

Pr 3. Solve the matrix equation for the matrix X.

$$3X - \begin{bmatrix} 260 & 165 \\ 130 & 60 \end{bmatrix} = \begin{bmatrix} 120 & 165 \\ 320 & -30 \end{bmatrix} - 3X$$

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Pr 4. Solve the matrix equation $6X - 3A = 6B + A$, for matrix X, assuming that the matrices A, B and X are the same size.

"unknown"

Goal $X =$ stuff with A, B

A, B are "constants"

$6X - 3A = 6B + A$

$+3A \qquad +3A$

$\frac{1}{6} \cdot 6X = 6B + A + 3A = \frac{1}{6}(6B + 4A)$

$X = \frac{1}{6} \cdot 6B + \frac{1}{6} \cdot 4A$

$= B + \frac{4}{6}A = 1$

$X = B + \frac{2}{3}A$

$$A = \begin{bmatrix} 5 & 2 & 6 \\ 6 & \frac{1}{5} & 0 \end{bmatrix} \qquad B = \begin{bmatrix} -9 & 0 & 3 \end{bmatrix} \qquad C = \begin{bmatrix} -3 & w \\ -y & 0 \\ 5 & (x+1) \end{bmatrix}$$

$$D = \begin{bmatrix} 1.6 & 3 \\ 5 & 15p \end{bmatrix} \qquad E = \begin{bmatrix} v & 10 \\ 6m & -1 \end{bmatrix} \qquad F = \begin{bmatrix} -3r \\ 6z \end{bmatrix}$$

h. Compute $(B^T + C)^T$

B is 1x3

B^T is 3x1 3x2

$B^T + C$ is not defined

$(B^T + C)^T$ is not defined

i. If $D = 3E$, solve for m, v and p.

2x2 2x2

no solution

$$\begin{bmatrix} 1.6 & 3 \\ 5 & 15p \end{bmatrix} = 3\begin{bmatrix} v & 10 \\ 6m & -1 \end{bmatrix} = \begin{bmatrix} 3v & 30 \\ 18m & -3 \end{bmatrix}$$

$1.6 = 3v$

$3 = 30$ ← not possible

$5 = 18m$

$15p = -3$

assume $3 = 30$ didn't exist

$\frac{1.6}{3} = \frac{3v}{3}$ $\quad v = \frac{1.6}{3}$

$\frac{18m}{18} = \frac{5}{18}$ $\quad m = 5/18$

$\frac{15p}{15} = \frac{-3}{15}$ $\quad p = -3/15$

Pr 3. Solve the matrix equation for the matrix X.

what is the size of X? $3X - \begin{bmatrix} 260 & 165 \\ 130 & 60 \end{bmatrix} = \begin{bmatrix} 120 & 165 \\ 320 & -30 \end{bmatrix} - 3X$

+3X 2x2 +3X

X is 2x2

$6X - \begin{bmatrix} 260 & 165 \\ 130 & 60 \end{bmatrix} = \begin{bmatrix} 120 & 165 \\ 320 & -30 \end{bmatrix}$

$+ \begin{bmatrix} 260 & 165 \\ 130 & 60 \end{bmatrix} + \begin{bmatrix} 260 & 165 \\ 130 & 60 \end{bmatrix}$

Pr 4. Solve the matrix equation $6X - 3A = 6B + A$, for matrix X, assuming that the matrices A, B and X are the same size.

$$6X = \begin{bmatrix} 120 & 165 \\ 320 & -30 \end{bmatrix} + \begin{bmatrix} 260 & 165 \\ 130 & 60 \end{bmatrix}$$

$$6X = \begin{bmatrix} 380 & 330 \\ 450 & 30 \end{bmatrix}$$

$$X = \frac{1}{6}\begin{bmatrix} 380 & 330 \\ 450 & 30 \end{bmatrix}$$

$$X = \begin{bmatrix} \frac{190}{3} & 55 \\ 75 & 5 \end{bmatrix} \checkmark$$

Section 1.2: Matrix Multiplication

- For the matrix product AB to exist the number of columns of matrix A must be the same as the number of rows of matrix B.
- Matrix multiplication is not commutative.

Pr 1. Use the given matrices A, B, C, D, E, and F below, to compute each matrix product, if possible.

$$A = \begin{bmatrix} 5 & 2 & 6 \\ 6 & \frac{1}{5} & 0 \end{bmatrix} \qquad B = \begin{bmatrix} -9 & 0 & 3 \end{bmatrix} \qquad C = \begin{bmatrix} -3 & w \\ -y & 0 \\ 5 & (x+1) \end{bmatrix}$$

$$D = \begin{bmatrix} 1.6 & 4.8 \\ 5 & 15p \end{bmatrix} \qquad E = \begin{bmatrix} v & 10 \\ 6m & -1 \end{bmatrix} \qquad F = \begin{bmatrix} -3r \\ 6z \end{bmatrix}$$

a. DA

$$\begin{bmatrix} 1.6 & 4.8 \\ 5 & 15p \end{bmatrix} \begin{bmatrix} 5 & 2 & 6 \\ 6 & \frac{1}{5} & 0 \end{bmatrix} = \begin{bmatrix} 1.6\cdot 5 + 4.8\cdot 6 & 1.6\cdot 2 + 4.8\cdot\frac{1}{5} & 1.6\cdot 6 + 4.8\cdot 0 \\ 5\cdot 5 + 15p\cdot 6 & 5\cdot 2 + 15p\cdot\frac{1}{5} & 5\cdot 6 + 15p\cdot 0 \end{bmatrix}$$

$$= \begin{bmatrix} 8 + 28.8 & 3.2 + .96 & 9.6 + 0 \\ 25 + 90p & 10 + 3p & 30 + 0 \end{bmatrix}$$

b. FC

$$= \begin{bmatrix} 36.8 & 4.16 & 9.6 \\ 90p + 25 & 3p + 10 & 30 \end{bmatrix}$$

c. $F^T E$

d. $-6BC$

Section 1.2: Matrix Multiplication

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Pr 1. Use the given matrices A, B, C, D, E, and F below, to compute each matrix product, if possible.

$$A = \begin{bmatrix} 5 & 2 & 6 \\ 6 & \frac{1}{5} & 0 \end{bmatrix} \qquad B = \begin{bmatrix} -9 & 0 & 3 \end{bmatrix} \qquad C = \begin{bmatrix} -3 & w \\ -y & 0 \\ 5 & (x+1) \end{bmatrix}$$

$$D = \begin{bmatrix} 1.6 & 4.8 \\ 5 & 15p \end{bmatrix} \qquad E = \begin{bmatrix} v & 10 \\ 6m & -1 \end{bmatrix} \qquad F = \begin{bmatrix} -3r \\ 6z \end{bmatrix}$$

a. ~~DA~~

b. FC is not defined!

c. $F^T E$

$$= \begin{bmatrix} -3r & 6z \end{bmatrix} \cdot \begin{bmatrix} v & 10 \\ 6m & -1 \end{bmatrix}$$

$$= \begin{bmatrix} -3r \cdot v + 6z \cdot 6m & -3r \cdot 10 + 6z(-1) \end{bmatrix}$$

$$= \begin{bmatrix} -3rv + 36zm & -30r - 6z \end{bmatrix}$$

d. $-6BC$ → skip

$$A = \begin{bmatrix} 5 & 2 & 6 \\ 6 & \frac{1}{5} & 0 \end{bmatrix} \qquad B = \begin{bmatrix} -9 & 0 & 3 \end{bmatrix} \qquad C = \begin{bmatrix} -3 & w \\ -y & 0 \\ 5 & (x+1) \end{bmatrix}$$

$$D = \begin{bmatrix} 1.6 & 4.8 \\ 5 & 15p \end{bmatrix} \qquad E = \begin{bmatrix} v & 10 \\ 6m & -1 \end{bmatrix} \qquad F = \begin{bmatrix} -3r \\ 6z \end{bmatrix}$$

e. FBA^T

$(FB)A^T = F(BA^T)$

$2\times3 \quad 3\times2 \qquad 2\times1 \quad 1\times2$

$2\times1 \quad 1\times3 \quad 3\times2$ is 2×2

$A \to 2\times3$

$B \cdot A^T$

$$\begin{bmatrix} -9 & 0 & 3 \end{bmatrix} \begin{bmatrix} 5 & 6 \\ 2 & \frac{1}{5} \\ 6 & 0 \end{bmatrix}$$

$$= \begin{bmatrix} -9\cdot5+0\cdot2+3\cdot6 & 9\cdot6+0\cdot\frac{1}{5}+3\cdot0 \end{bmatrix}$$

$$= \begin{bmatrix} -45+0+18 & 54+0+0 \end{bmatrix}$$

$$BA^T = \begin{bmatrix} -27 & 54 \end{bmatrix}$$

f. $BC + 10F^T$

Skipped

g. $CE - A^TD$

$$F \cdot (BA^T) = \begin{bmatrix} -3r \\ 6z \end{bmatrix} \cdot \begin{bmatrix} -27 & 54 \end{bmatrix}$$

$$= \begin{bmatrix} -3r\cdot-27 & -3r\cdot54 \\ 6z\cdot-27 & 6z\cdot54 \end{bmatrix}$$

$$= \begin{bmatrix} 81r & -162r \\ -162z & 324z \end{bmatrix}$$

h. If $L = CD$, determine l_{32}.

Skipped

i. Find the value of each variable, given $Q = \begin{bmatrix} -33.8 & -6 \\ -5 & -15 \\ 52.8 & 21 \end{bmatrix}$ and $CD = Q$.

$$A = \begin{bmatrix} 5 & 2 & 6 \\ 6 & \frac{1}{5} & 0 \end{bmatrix} \qquad B = \begin{bmatrix} -9 & 0 & 3 \end{bmatrix} \qquad C = \begin{bmatrix} -3 & w \\ -y & 0 \\ 5 & (x+1) \end{bmatrix}$$

$$D = \begin{bmatrix} 1.6 & 4.8 \\ 5 & 15p \end{bmatrix} \qquad E = \begin{bmatrix} v & 10 \\ 6m & -1 \end{bmatrix} \qquad F = \begin{bmatrix} -3r \\ 6z \end{bmatrix}$$

e. FBA^T ✓

f. $BC + 10F^T$

g. $CE - A^TD$

3x2 2x2 → 3x2 → Compute $C \cdot E$, A^TD → 3x2 3x2

A^T 3x2 2x2

$C \cdot E =$

$$\begin{bmatrix} -3 & w \\ -y & 0 \\ 5 & x+1 \end{bmatrix} \begin{bmatrix} v & 10 \\ 6m & -1 \end{bmatrix} = \begin{bmatrix} -3 \cdot v + w \cdot 6m & -3 \cdot 10 + w \cdot (-1) \\ -y \cdot v + 0 \cdot 6m & -y\,10 + 0(-1) \\ 5v + (x+1)6m & 5 \cdot 10 + (x+1)(-1) \end{bmatrix}$$

$$= \begin{bmatrix} -3v + 6wm & -w - 30 \\ -yv & -10y \\ 5v + 6(x+1)m & -(x+1) + 50 \\ & -x + 49 \end{bmatrix}$$

h. If $L = CD$, determine l_{32}.

$$A^TD = \begin{bmatrix} 5 & 6 \\ 2 & 1/5 \\ 6 & 0 \end{bmatrix} \begin{bmatrix} 1.6 & 4.8 \\ 5 & 15p \end{bmatrix}$$

$$= \begin{bmatrix} 5 \cdot 1.6 + 6 \cdot 5 & 5 \cdot 4.8 + 6 \cdot 15p \\ 2 \cdot 1.6 + 1/5 \cdot 5 & 2 \cdot 4.8 + 1/5 \cdot 15p \\ 6 \cdot 1.6 + 0 \cdot 5 & 6 \cdot 4.8 + 0 \cdot 15p \end{bmatrix}$$

i. Find the value of each variable, given $Q = \begin{bmatrix} -33.8 & -6 \\ -5 & -15 \\ 52.8 & 21 \end{bmatrix}$ and $CD = Q$.

$$A^TD = \begin{bmatrix} 8 + 30 & 24 + 90p \\ 4.2 & 9.6 + 3p \\ 9.6 & 28.8 \end{bmatrix}$$

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$$C \cdot E - A^TD = \begin{bmatrix} -3v + 6wm - 38 & -w - 30 - 24 - 90p \\ -yv - 4.2 & -10y - 9.6 - 3p \\ 5v + 6(x+1)m - 9.6 & -x + 49 - 28.8 \end{bmatrix}$$

$$= \begin{bmatrix} -3v + 6wm - 38 & -w - 54 - 90p \\ -yv - 4.2 & -10y - 9.6 - 3p \\ 5v + 6(x+1)m - 9.6 & -x + 20.2 \end{bmatrix}$$ ✓

$$A = \begin{bmatrix} 5 & 2 & 6 \\ 6 & \frac{1}{5} & 0 \end{bmatrix} \qquad B = \begin{bmatrix} -9 & 0 & 3 \end{bmatrix} \qquad C = \begin{bmatrix} -3 & w \\ -y & 0 \\ 5 & (x+1) \end{bmatrix}$$

$$D = \begin{bmatrix} 1.6 & 4.8 \\ 5 & 15p \end{bmatrix} \qquad E = \begin{bmatrix} v & 10 \\ 6m & -1 \end{bmatrix} \qquad F = \begin{bmatrix} -3r \\ 6z \end{bmatrix}$$

e. FBA^T

Let $CD = \begin{bmatrix} -33.8 & -6 \\ -5 & -15 \\ 52.8 & 21 \end{bmatrix}$, solve for variables

f. $BC + 10F^T$

$$C \cdot D = \begin{bmatrix} -3 & w \\ -y & 0 \\ 5 & x+1 \end{bmatrix} \begin{matrix} 1 & 2 \\ \end{matrix} \begin{bmatrix} 1.6 & 4.8 \\ 5 & 15p \end{bmatrix}$$

g. $CE - A^T D$

$$= \begin{bmatrix} -3 \cdot 1.6 + w \cdot 5 & -3 \cdot 4.8 + w \cdot 15p \\ -y \cdot 1.6 + 0 \cdot 5 & (-y)4.8 + 0 \cdot 15p \\ 5 \cdot 1.6 + (x+1)5 & 5 \cdot 4.8 + (x+1)15p \end{bmatrix}$$

$$= \begin{bmatrix} -4.8 + 5w & -14.4 + 15wp \\ -1.6y & -4.8y \\ 8 + 5(x+1) & 24 + 15(x+1)p \end{bmatrix}$$

$$= \begin{matrix} \\ \\ 13 + 5x \end{matrix}$$

$$= \begin{bmatrix} -33.8 & -6 \\ -5 & -15 \\ 52.8 & 21 \end{bmatrix}$$

h. If $L = CD$, determine l_{32}.

i. Find the value of each variable, given $Q = \begin{bmatrix} -33.8 & -6 \\ -5 & -15 \\ 52.8 & 21 \end{bmatrix}$ and $CD = Q$.

i. Find the value of each variable, given $Q = \begin{bmatrix} -33.8 & -6 \\ -5 & -15 \\ 52.8 & 21 \end{bmatrix}$ and $CD = Q$.

1) ★ $-4.8 + 5w = -33.8$

2) $-14.4 + 15wp = -6$

3) ★ $-1.6y = -5$

4) ★ $-4.8y = -15$

5) ★ $13 + 5x = 52.8$

6) $24 + 15(x+1)p = 21$

1) $-4.8 + 5w = -33.8 \rightarrow \frac{5w}{5} = \frac{-29}{5}$

$+4.8 \quad +4.8$

$w = -\frac{29}{5}$ ✓

3) $\frac{-1.6y}{-1.6} = \frac{-5}{-1.6}$

$y = \frac{5}{1.6} = 3.125$ no fraction

4)

5) $13 + 5x = 52.8$

$-13 \quad -13$

$\frac{5x}{5} = \frac{39.8}{5}$

$x = 7.96$

$-14.4 + 15\left(-\frac{29}{5}\right)p = -6$

$-14.4 - 87p = -6$

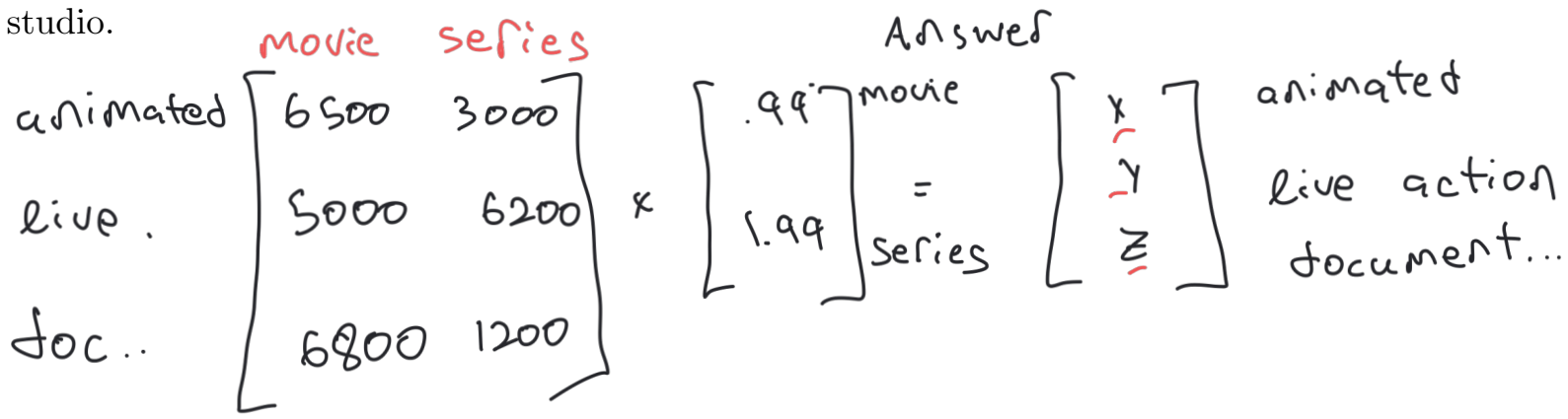
$+14.4 \quad +14.4$

$-87p = 8.4$

$p = \frac{-8.4}{87}$

Pr 2. An online streaming service records the number of downloads of movies and series based upon which studio produced the movie or series. During the month of January 3000 animated series, 6500 animated movies, 6200 live action series, 5000 live action movies, 1200 documentary series, and 6800 documentary movies were downloaded, while in February the downloads were 3800, 2900, 2600, 5100, 6500, and 9500 respectively.

a. The streaming service is considering charging per film or series download, instead of the traditional subscription service. If the online streaming service charges \$.99 per movie download and \$1.99 per series download, write a matrix equation that would allow the service to compute how much they make for each studio.



b. How much income does the online streaming service bring in, in January, from each studio?

c. How much income does the online streaming service bring in, for January and February combined, from each studio?