A MATRIX IS A 2D ARRAY

A MATRIX IS JUST A
2-DIMENSIONAL ARRAY

BUT, IN DATA ANALYSIS AND IN
R, MATRICES ARE SPECIAL

A MATRIX / MATRIX OPERATIONS CAN BE INTERPRETED IN MULTIPLE WAYS

AS A DATASET

AS A LINEAR TRANSFORMATION

AS A SET OF LINEAR EQUATIONS

AS A DATASET

EACH ROW REPRESENTS AN OBSERVATION

EACH COLUMN A VARIABLE FOR ANALYSIS

A MATRIX / MATRIX OPERATIONS CAN BE INTERPRETED IN MULTIPLE WAYS

AS A LINEAR TRANSFORMATION

AS A SET OF LINEAR EQUATIONS

1	3	0	8
0	4	6	2
1	0	5	7
0	20	11	0
4	5	0	9

AS A DATASET

A MATRIX / MATRIX OPERATIONS CAN BE INTERPRETED IN MULTIPLE WAYS
AS A LINEAR TRANSFORMATION
AS A SET OF LINEAR EQUATIONS

EACH ROW REPRESENTS AN ARTICLE

WORD 1	WORD 2	WORD 3	WORD 4
1	3	0	8
0	4	6	2
1	0	5	7
0	20	11	0
4	5	0	9

NUMBEROF TIMES A WORD APPEARS IN THE ARTICLE

AN EXAMPLE DATASET FROM NATURAL LANGUAGE PROCESSING

A MATRIX / MATRIX OPERATIONS CAN BE INTERPRETED IN MULTIPLE WAYS

AS A DATASET

AS A SET OF LINEAR EQUATIONS

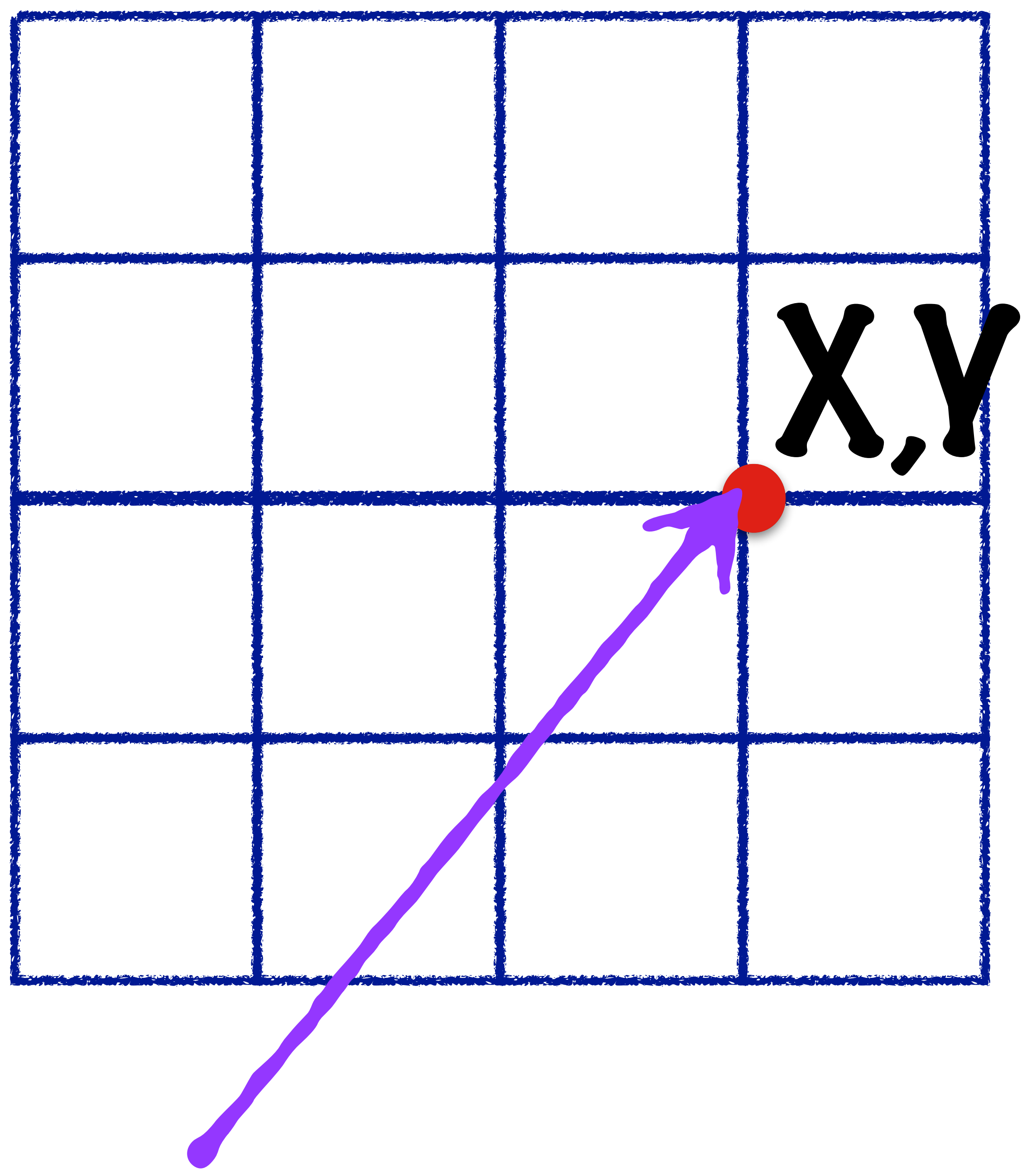
AS A LINEAR TRANSFORMATION

LET'S SAY YOU HAVE A

2 - DIMENSIONAL GRID

A LINEAR TRANSFORMATION

SCALES AND ROTATES THE GRID



EACH POINT ON THE GRID CAN BE REPRESENTED BY 2 CO-ORDINATES

A MATRIX / MATRIX OPERATIONS CAN BE INTERPRETED IN MULTIPLE WAYS

AS A DATASET

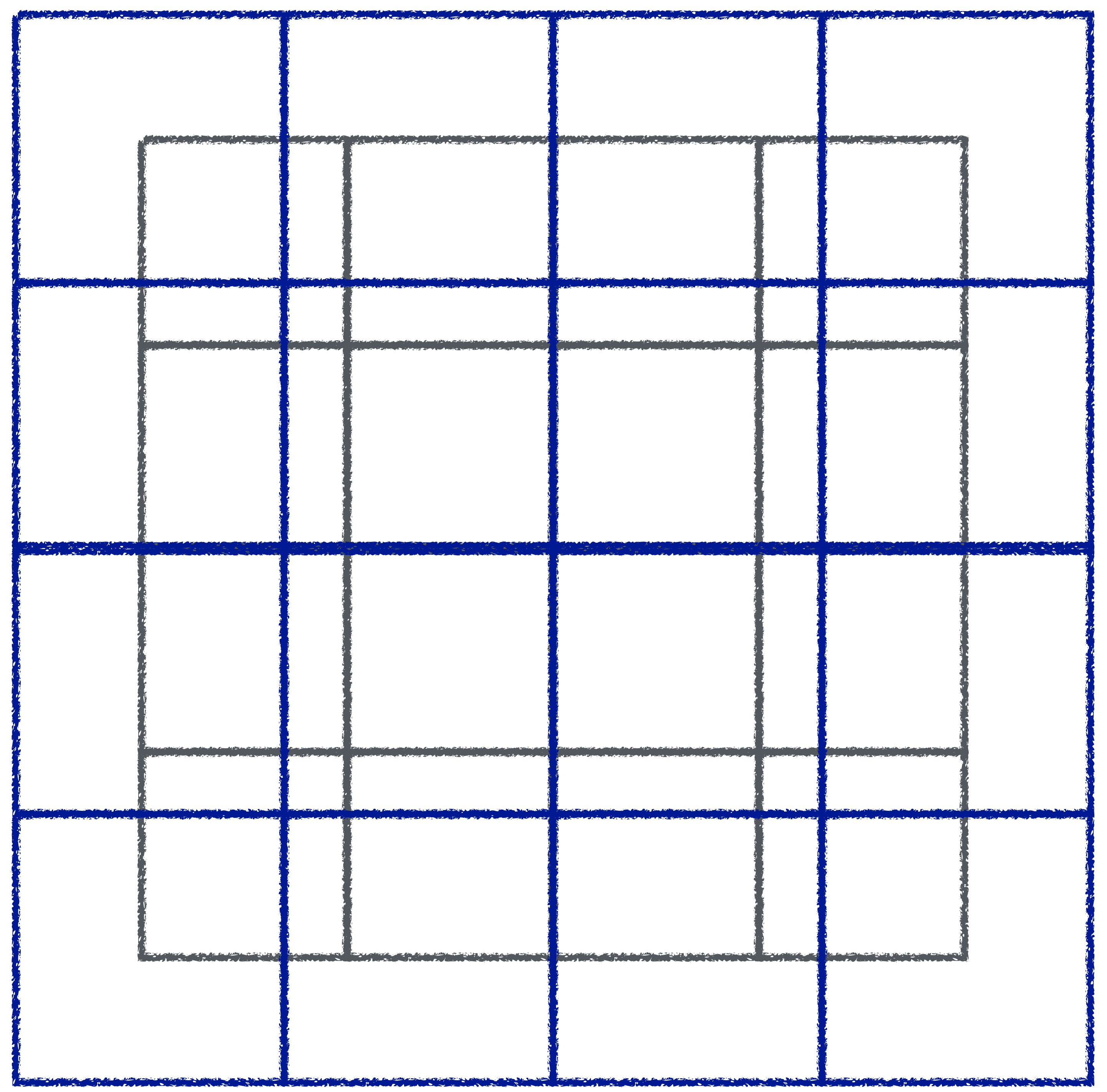
AS A SET OF LINEAR EQUATIONS

AS A LINEAR TRANSFORMATION

LET'S SAY YOU HAVE A 2 - DIMENSIONAL GRID

A LINEAR TRANSFORMATION

SCALES AND ROTATES THE GRID



A MATRIX / MATRIX OPERATIONS CAN BE INTERPRETED IN MULTIPLE WAYS

AS A DATASET

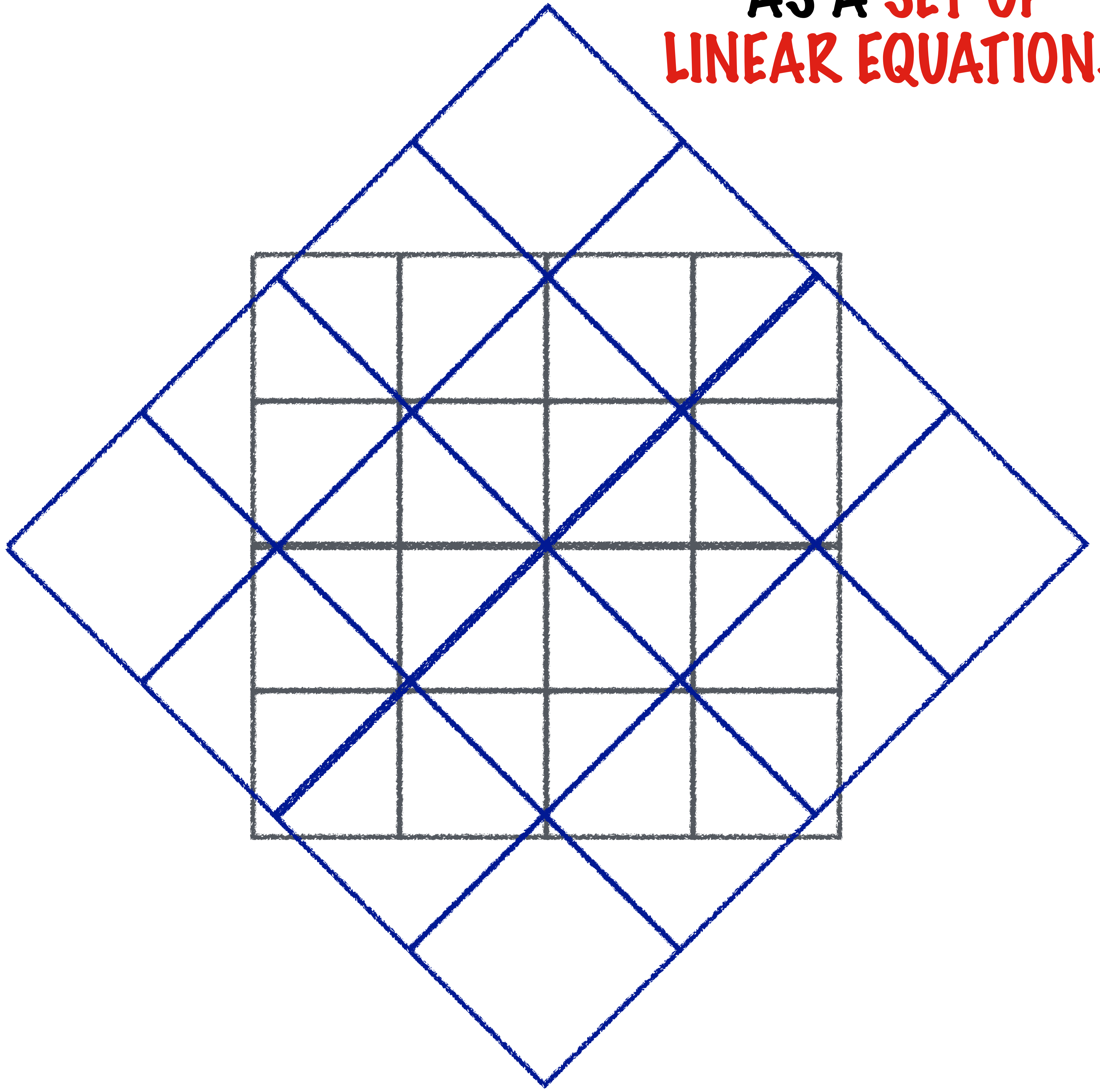
AS A SET OF LINEAR EQUATIONS

AS A LINEAR TRANSFORMATION

LET'S SAY YOU HAVE A 2 - DIMENSIONAL GRID

A LINEAR TRANSFORMATION

SCALES AND ROTATES THE GRID



AS A LINEAR TRANSFORMATION

A MATRIX / MATRIX OPERATIONS CAN BE INTERPRETED IN MULTIPLE WAYS

AS A DATASET

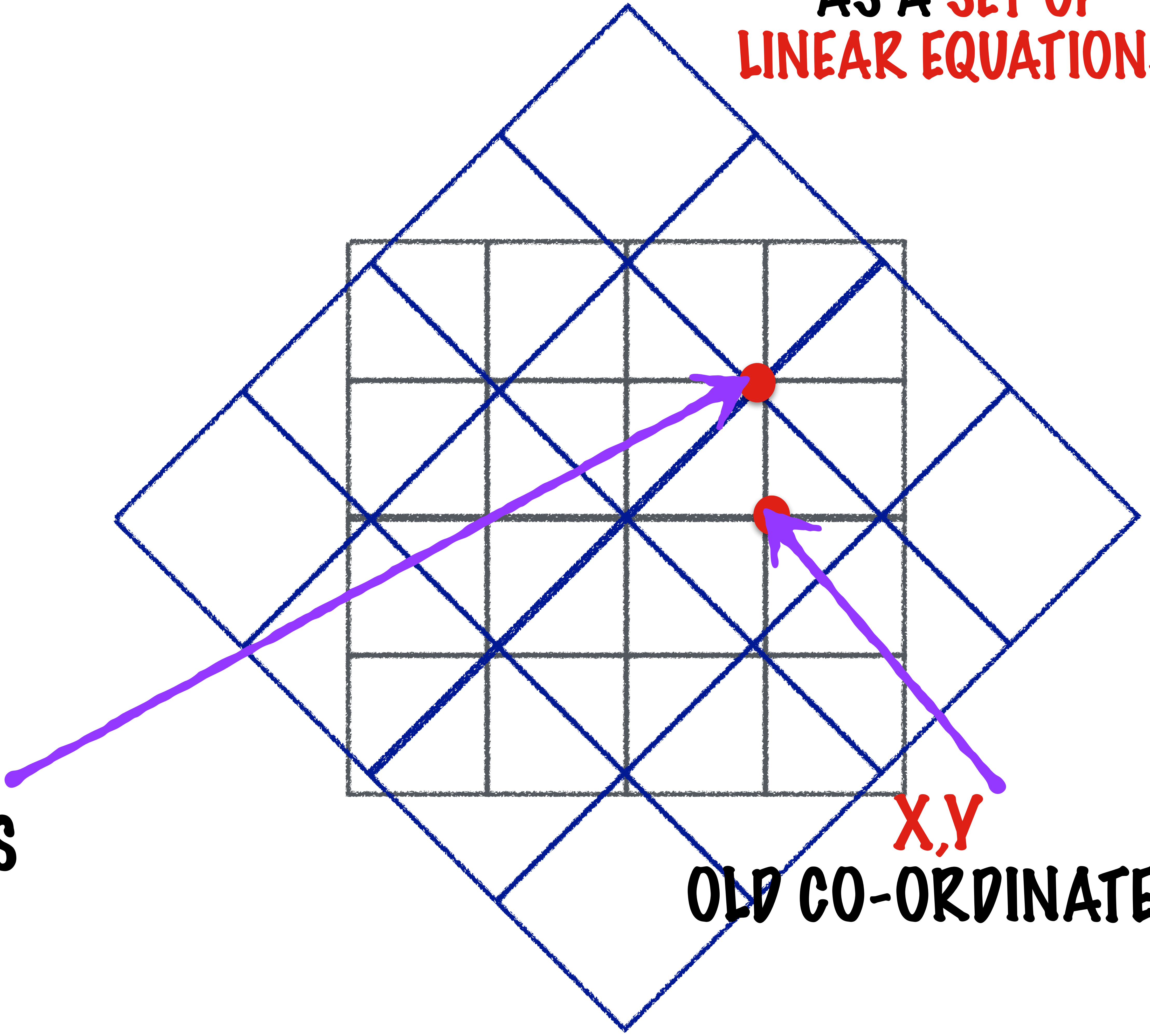
AS A SET OF LINEAR EQUATIONS

THE RELATIONSHIP BETWEEN OLD AND NEW CO-ORDINATES IS REPRESENTED BY A MATRIX

$$X' = 3X + 2Y$$
$$Y' = 2X + 4Y$$

A 2X2 MATRIX

3	2
2	4



A MATRIX / MATRIX OPERATIONS CAN BE INTERPRETED IN MULTIPLE WAYS

AS A DATASET

AS A SET OF LINEAR EQUATIONS

AS A LINEAR TRANSFORMATION

ANY NXN MATRIX CAN BE INTERPRETED AS A LINEAR TRANSFORMATION OF AN N-DIMENSIONAL GRID

A **MATRIX / MATRIX OPERATIONS** CAN BE **INTERPRETED** IN **MULTIPLE WAYS**

AS A **DATASET**

AS A **LINEAR TRANSFORMATION**

AS A SET OF LINEAR EQUATIONS

$$\boxed{a} + \boxed{b} + \boxed{c} + \boxed{d} = -3$$

$$-a + b - c + d = -1$$

$$8a + 4b + 2c + d = -13$$

$$-8a + 4b - 2c + d = -13$$

A SET OF LINEAR EQUATIONS CAN BE REPRESENTED USING MATRICES

$$\begin{bmatrix} 1 & 1 & 1 & 1 \\ -1 & 1 & -1 & 1 \\ 8 & 4 & 2 & 1 \\ -8 & 4 & -2 & 1 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} = \begin{bmatrix} -3 \\ -1 \\ -13 \\ -21 \end{bmatrix}$$

A MATRIX / MATRIX OPERATIONS CAN BE INTERPRETED IN MULTIPLE WAYS

AS A DATASET

AS A LINEAR TRANSFORMATION

AS A SET OF LINEAR EQUATIONS

BECAUSE OF ALL THE COOL THINGS YOU CAN DO WITH MATRICES, R HAS SPECIAL FUNCTIONS FOR MATRICES

EXAMPLE 25 : CREATING A MATRIX AND SOME BASICS

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```
aMatrix <- matrix(c(2*1:3, 3*1:3), nrow = 2, ncol = 3)
aMatrix
     [,1] [,2] [,3]
[1,]    2    6    6
[2,]    4    3    9
t(aMatrix)
     [,1] [,2]
[1,]    2    4
[2,]    6    3
[3,]    6    9
nrow(aMatrix)
[1] 2
ncol(aMatrix)
[1] 3
```

YOU CAN USE THE MATRIX() FUNCTION TO CREATE A MATRIX

t() WILL TRANSPOSE A MATRIX (ROWS TO COLUMNS AND VICE VERSA)

nrow() AND ncol() TO FIND THE ROWS AND COLUMNS OF A MATRIX

EXAMPLE 26 : MATRIX MULTIPLICATION

EXAMPLE 26 : MATRIX MULTIPLICATION

```
aMatrix %*% anotherMatrix
     [,1] [,2]
[1,]   76   80
[2,]   80  106
```

MATRIX MULTIPLICATION
IS A SPECIAL OPERATION

```
     [,1] [,2] [,3]
[1,]    2    6    6
[2,]    4    3    9
```

```
     [,1] [,2]
[1,]    2    4
[2,]    6    3
[3,]    6    9
```

THIS ONLY WORKS IF

NUMBER OF COLUMNS OF LEFT MATRIX = NUMBER OF ROWS OF RIGHT MATRIX

EACH ROW ON LEFT IS MULTIPLIED WITH EACH COLUMN ON THE RIGHT AND THEN SUMMED UP

EXAMPLE 26 : MATRIX MULTIPLICATION

```
crossprod(aMatrix,2*1:2)
```

CROSSPRODUCT OF 2 MATRICES A,B

t(A) %*% B

EXAMPLE 27 : MERGING MATRICES

EXAMPLE 27 : MERGING MATRICES

rbind() and cbind() CAN BE USED TO CONCATENATE MATRICES

THEY CAN ALSO BE USED TO STACK VECTORS TO CREATE A MATRIX

EXAMPLE 27 : MERGING MATRICES

```
rbind(aMatrix, 1:3)
     [,1] [,2] [,3]
[1,]    2    6    6
[2,]    4    3    9
[3,]    1    2    3
```

rbind() WILL STACK MATRICES/VECTORS VERTICALLY

```
cbind(aMatrix, 1:2)
     [,1] [,2] [,3] [,4]
[1,]    2    6    6    1
[2,]    4    3    9    2
```

cbind() WILL STACK THEM HORIZONTALLY

EXAMPLE 28 : SOLVING A SET OF LINEAR EQUATIONS

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YOU CAN SOLVE A SET A LINEAR EQUATIONS USING MATRICES

$$a + b + c + d = -3$$
$$-a + b - c + d = -1$$
$$8a + 4b + 2c + d = -13$$
$$-8a + 4b - 2c + d = -13$$

$$\begin{bmatrix} 1 & 1 & 1 & 1 \\ -1 & 1 & -1 & 1 \\ 8 & 4 & 2 & 1 \\ -8 & 4 & -2 & 1 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} = \begin{bmatrix} -3 \\ -1 \\ -13 \\ -21 \end{bmatrix}$$

```
coeffMatrix <- matrix(c(1,-1,8,-8,1,1,4,4,1,-1,2,-2,1,1,1,1), nrow = 4)
```

EXAMPLE 28 : SOLVING A SET OF LINEAR EQUATIONS

YOU CAN SOLVE A SET A LINEAR EQUATIONS USING MATRICES

$$a + b + c + d = -3$$
$$-a + b - c + d = -1$$
$$8a + 4b + 2c + d = -13$$
$$-8a + 4b - 2c + d = -13$$

$$\begin{bmatrix} 1 & 1 & 1 & 1 \\ -1 & 1 & -1 & 1 \\ 8 & 4 & 2 & 1 \\ -8 & 4 & -2 & 1 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} = \begin{bmatrix} -3 \\ -1 \\ -13 \\ -21 \end{bmatrix}$$

```r
coeffMatrix <- matrix(c(1,-1,8,-8,1,1,4,4,1,-1,2,-2,1,1,1,1), nrow = 4)
constMatrix <- c(-3, -1, -13, -21)
```

EXAMPLE 28 : SOLVING A SET OF LINEAR EQUATIONS

YOU CAN SOLVE A SET A LINEAR EQUATIONS USING MATRICES

$$a + b + c + d = -3$$
$$-a + b - c + d = -1$$
$$8a + 4b + 2c + d = -13$$
$$-8a + 4b - 2c + d = -13$$

$$\begin{bmatrix} 1 & 1 & 1 & 1 \\ -1 & 1 & -1 & 1 \\ 8 & 4 & 2 & 1 \\ -8 & 4 & -2 & 1 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} = \begin{bmatrix} -3 \\ -1 \\ -13 \\ -21 \end{bmatrix}$$

```
coeffMatrix <- matrix(c(1,-1,8,-8,1,1,4,4,1,-1,2,-2,1,1,1,1), nrow = 4)
constMatrix <- c(-3, -1, -13, -21)
solve(coeffMatrix, constMatrix)
[1]  1 -5 -2  3
```