Test of Consistency and Solution of **Simultaneous Linear Equation** in two and three variables using **determinants** and matrices.

Course Outline

- Basics of Consistency and solution.
- Introduction to Cramer's Rule for two variables.
- Introduction to Cramer's Rule for three variables.
- Application of Cramer's Rule to higher order thinking questions.

Part I

Simultaneous: Operations at the same time

Linear Equation: A equation that would give a **straight line** when its variables are plotted on a plane or a graph, such that each variable is assigned a unique axis.

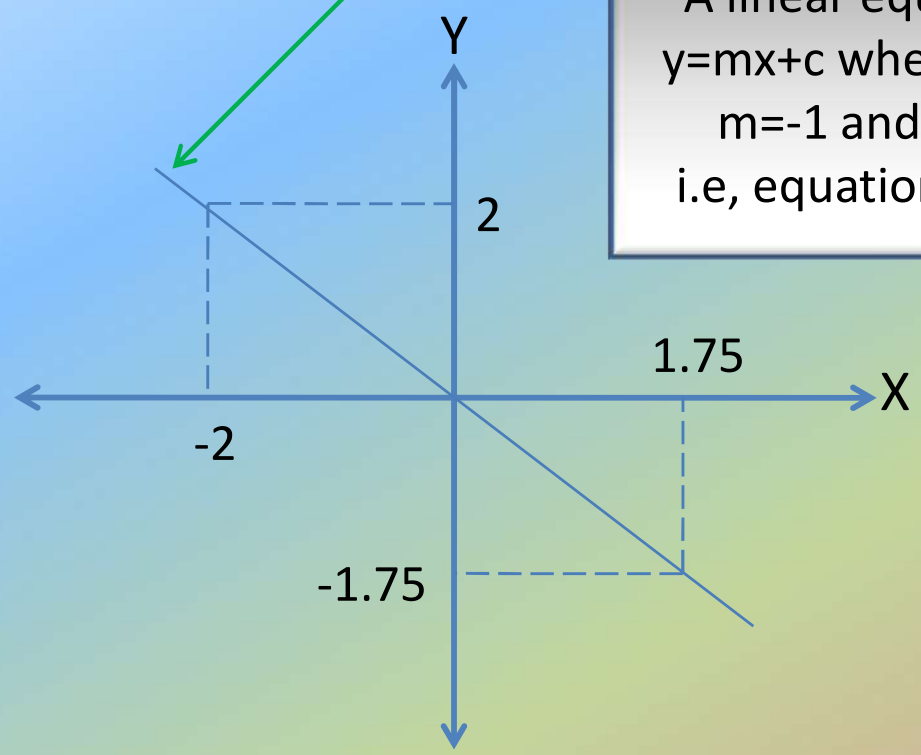
Determinant of a matrix: A value computed for a matrix (ANY MATRIX-**NO!** ONLY SQUARE MATRIX).

Solution: Value of variable(s) or unknown(s) for a equation or set of equations.

Visualisation

1

A linear equation
y=mx+c where c=0,
m=-1 and x=y
i.e, equation, y=-x



2

Solution of simultaneous equation y=-x and y=0.50

or

1x+1y=0

0x+1y=0.50

Comparing with standard equations:

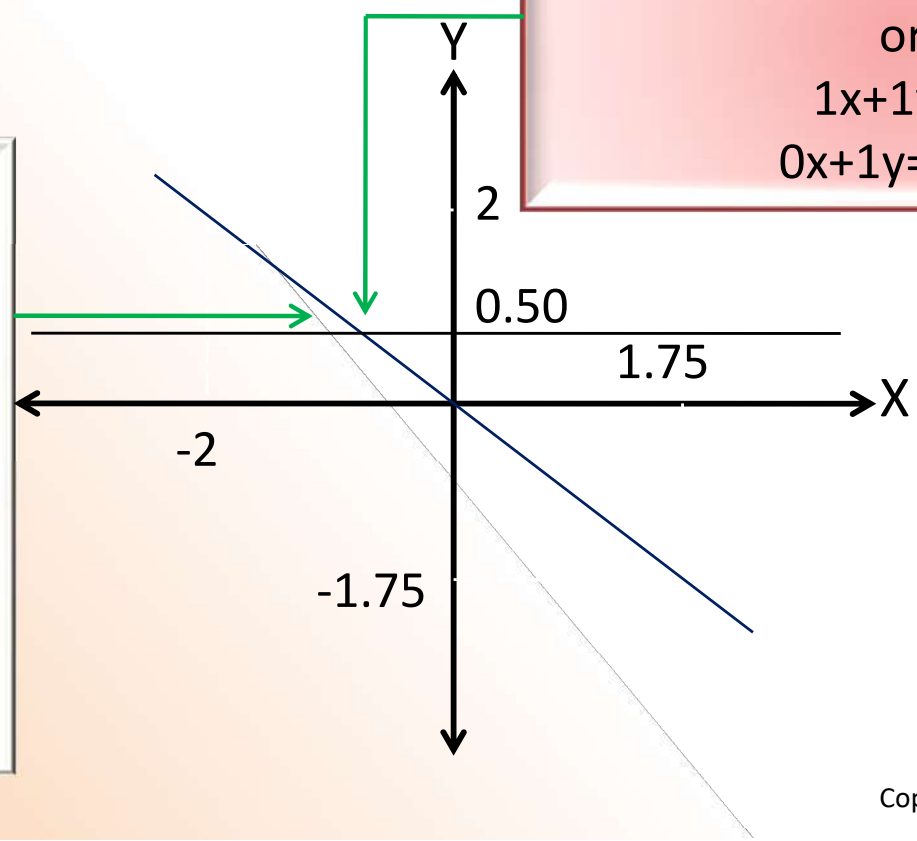
$a_1 x + b_1 y = c_1$

$a_2 x + b_2 y = c_2$

$$\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$$

we get the system is **consistent** (i.e., has at least one solution).

The solution is unique, i.e., **(x,y)=(-0.50,0.50)**



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Set of Simultaneous Linear Equations

Consistent

Consistent independent
i.e., set of equations has a **unique solution,** in graphical representation these lines **intersect each other at a single point**.

Consistent dependent
i.e., set of equations has **infinitely many solution**, in graphical representation these lines overlap each other at every point i.e., **coincide** with each other.

Inconsistent

Set of equations has **no solution**, i.e., these lines do not have any point in common, in graphical representation these lines are **parallel** to each other.

Part II

Solution of Simultaneous Linear Equation-**2 Variables**

Consider the set of equations:

$$2x - 1y = -1$$
$$5x - 4y = 3$$

Applying **Cramer's Rule**

Step 1: Assign **coefficients of x and y to a matrix**, say A and **constants to matrix B**

Cramer's Rule

- Checks Consistency
- Gives Solution
- Prerequisites: Knowledge of determinant and basic mathematics

Thus we get,

Coefficients of x

Coefficients of y

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

$$\begin{aligned} 2x - 1y &= -1 \\ 5x - 4y &= 3 \end{aligned}$$

Constants

Step 2: Find determinant of Matrix A as follows:

$$\begin{vmatrix} 2 & -1 \\ 5 & -4 \end{vmatrix} = \boxed{(2 \times -4)} - \boxed{(5 \times -1)}$$

$$= -8 - (-5) = -8 + 5 = -3$$

$$|A| = -3$$

Step 3: Calculate $|A_x|$ by replacing column **of coefficients of x** by constants:

$$|A_x| = \begin{vmatrix} -1 & -1 \\ 3 & -4 \end{vmatrix} = 4-(-3) = 7$$

$$\begin{aligned} 2x - 1y &= -1 \\ 5x - 4y &= 3 \end{aligned}$$

Replace coefficients of x by constants

Step 4: Calculate $|A_y|$ by replacing **column of coefficients of y** by constants:

$$|A_y| = \begin{vmatrix} 2 & -1 \\ 5 & 3 \end{vmatrix} = 6-(-5) = 6+5 = 11$$

$$\begin{aligned} 2x - 1y &= -1 \\ 5x - 4y &= 3 \end{aligned}$$

Replace coefficients of y by constants

Step 5: Find the **value of x and y** as follows:

Determinant
and **NOT MODULUS!**

$$x = \frac{|A_x|}{|A|} = \frac{7}{-3} = -\frac{7}{3}$$

$$y = \frac{|A_y|}{|A|} = \frac{11}{-3} = -\frac{11}{3}$$

Solutions

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