Correlation and Regression

The tendency of simultaneous variation between two variable x and y is known as correlation means that whenever increment or decrement in on variable x produce any change in another variable y then x and y are said to be correlated.

→ Correlation can be two types

① Positive correlation ② Negative correlation.

$r > 0$ $r < 0$

① **Positive** when the variable moves in same direction means

$x\uparrow \quad y\uparrow$

$x\downarrow \quad y\downarrow$ $\Big]$ ⊕

Ex– Profit and investment
Crop and Rainfall
Temperature and sale of cold drinks
Temperature and electricity bill
Age and premium Amount.
Height and weight.

② **Negative** :→ when the variable moves in oppositive directions

$x\uparrow \quad y\downarrow$

$x\downarrow \quad y\uparrow$ $\Big]$ ⊖

Ex ⇒ Price and demand
Profit of Insurance company and number of claims.

Note :→ When movement in one variable doesn't produce any change in another variable then x and y all said to be uncorrelated No. correlation $r = 0$

* Spurious correlation :-

When there is no causal (कारण) relation.

ex → shoe size and Intelligence

Note :→ The amount nature of correlation coefficient be determined by correlation coefficient which denoted by r. The value of r is always is between -1 to +1

$-1 \le r \le 1$ both inclusive

$r = +1$ → Perfect positive

$r = -1$ → Perfect Negative

$r = 0$ → No correlated.

0 to 0.25 -0.25 to 0	→ Low degree (Poor)
0.25 to 0.75 -0.25 - 0.75	Moderate
0.75 to +1 -0.75 to -1	→ High degree (good)

* Methods of find r.

Qualitative Attribute — Rank ① Spearman Ran correlation cofficient.

sign ② Concurrent deviation C.C.

Quickest ③

only line or Correlation and nature both — ③ Karl Pearson C.C.

Linear
Non - Linear
Curviline

④ Scatter Diagram
only nature of correlation.

① Spearmann Rank correlation coefficient :-

$x \Rightarrow$ Rank $= R_x$

$y \Rightarrow$ Rank $\Rightarrow R_y$

$R_x - R_y = d_i$

$\Sigma d_i = 0$ Sum of difference of Rank is 0

$\Sigma d_i \neq 0$ Sum of square of different of Rand Σd_i^2

$$r = 1 - \frac{6\, \Sigma d_i}{n(n^2-1)}$$

Q.

Rank x	Rank y	d_i	d_i^2
7	1	6	36
1	6	-5	25
6	7	-1	1
2	5	-3	9
5	2	3	9
3	4	-1	1
4	3	-1	1
		0	82

Sol

$$r \Rightarrow 1 - \frac{6\, \Sigma d_i^2}{n(n^2-1)}$$

$$r \Rightarrow 1 - \frac{(6 \times 82)}{7 \times 48}$$

$$r = 1 - \frac{492}{336}$$

$$r = \frac{336 - 492}{336} = -0.46$$

$$r \Rightarrow -0.46$$

Q

R_x	R_y
1	6
2	5
3	4
4	3
5	2
6	1

When ranks are in reverse order

$r = -1$

Q.

R_x	R_y
1	1
2	2
3	3
4	4
5	5
6	6

When ranks are in same order

$r \Rightarrow +1.$

x	y	Rx	Ry	di	di^2
18	23	7	5	2	4
90	54	1	4	-3	9
55	61	3	3	0	0
60	72	2	2	0	0
25	81	5	1	4	16
40	19	4	7	-3	9
22	20	6	6	0	0
11	11	8	8	0	0
10	4	9	9	0	0
				0	38

$\Rightarrow 1 - \frac{6 \times 38}{9 \times (81-1)}$

$\Rightarrow 1 - \frac{228}{720}$

$\Rightarrow \frac{720 - 228}{720}$

$\Rightarrow +0.68$

Q. Sum of square of difference of Rank is 66 (Σd^2)
$n = 8$ find r.

Sol. $r = 1 - \frac{6 \times 66}{8 \times 63}$

$\Rightarrow 1 - \frac{396}{504}$

$\Rightarrow \frac{504 - 396}{504}$

$\Rightarrow 0.21$ Ans

Q. Rank correlation was 0.4

$6 \Sigma di^2 = 990 \times 0.6 \quad n \Rightarrow 10$

$\Sigma di^2 \Rightarrow \frac{990 \times 0.6}{6}$ by mistake one rank difference is wrongly taken 7 insted of 5

wrong $= 0.4 = 1 - \frac{\Sigma di^2}{10 \times 99}$

$\frac{6 \Sigma di^2}{990} = 1 - 0.4$

$\Sigma di^2 \Rightarrow 99$
$- 49$
$+ 25$

$\Sigma d^2 = 75$

$1 - \frac{6 \times 75}{990}$

$1 - \frac{450}{990}$ $\quad \frac{990 - 450}{990}$

$\Rightarrow 0.54$ Ans

Q. Rank correlation 0.52

$n = 8$

mistake 5 instead of 4

$0.52 = 1 - \frac{6 d_i^2}{8 \times 63}$

$\frac{6 d_i^2}{504} = 0.48$

$d_i^2 = 40.32$
$\quad - 25$
$\quad + 9$
$\quad 24.32$

$1 - \frac{6 \times 24.32}{504}$

$\Rightarrow \frac{504 - 145.92}{504}$

$\Rightarrow 0.71$ Ans

~~✱~~ observation Repeat :-

$\rightarrow$ tied Length $m = \frac{\Sigma m^3 - m}{12}$

$$r = 1 - \frac{6 \left| \Sigma d_i^2 + \frac{\Sigma m^3 - m}{12} \right|}{n (n^2 - 1)}$$

Q.

x	y	Rx	Ry	di	di²
15	12	9	8	2	4
40	16	6	7	-1	1
60	19	4	6	-2	4
40	23	6	4.5	1.5	2.25
90	50	1	2	-1	1

tied 40 = 3 = m_1
tied 85 = 2 = m_2
23 = 2 = m_3

$\frac{\Sigma m^3 - m}{12}$

85	82	2.5	1	1.5	2.25
20	23	8	4.5	3.5	12.25
40	40	6	3	3	9
85	10	2.5	9	-6.5	42.25
11	5	10	10	0	0

75 + 3 ⇒ 78

$$\frac{3^3 - 3}{12} + \frac{2^2 - 2}{12} + \frac{2^2 - 2}{15}$$

$2 + 0.5 + 0.5$

⇒ 3.

$$1 - \frac{6 \times 78}{10 \times 99}$$

⇒ $1 - 0.472$

⇒ 0.52

Q. Sum of square of diff of rank is 66. $n = 8$

$\Sigma d_i^2 = 6$ tied = 4, 3, 2

Sol. tied $= \frac{4^3 - 4}{12} + \frac{3^3 - 3}{12} + \frac{2^3 - 2}{12}$

⇒ $5 + 2 + 0.5$

⇒ 7.5

So. $1 - \frac{6 \times 73.5}{8 \times 63}$

So ⇒ $1 - 0.875$

⇒ 0.125

* Concurrent deviation. :-

$x \to$ sign $= Sx$

y = sign = Sy

Product ⇒ $Sx \times Sy$

c = number of + sign

C = number of Concurrent deviation.

n = Pair

M = n-1

$\Rightarrow r_c = \sqrt{\frac{2c - m}{m}}$

$+ + \Rightarrow +$	$= - \Rightarrow -$
$- - \Rightarrow +$	$- + \Rightarrow -$
$= = \Rightarrow +$	$+ - \Rightarrow -$
$= + \Rightarrow -$	

Q.

x	y	Sx	Sy	P
90	30	x	x	x
15	27	−	−	+
54	36	+	+	+
16	54	−	+	−
25	11	+	+	−
36	60	+	+	+
20	15	−	−	+
39	61	+	+	+
11	14	−	−	+

$c = 6$ (+ total)

$n = 9$

$m = 8$

$r = \sqrt{\frac{2 \times 6 - m}{m}}$

$r \Rightarrow \sqrt{\frac{12 - 8}{8}}$

$r \Rightarrow \sqrt{\frac{4}{8}}$

$r \Rightarrow .70$ Ans

x	y	Sx	Sy	P
15	13	x	x	x
24	10	+	−	−
90	100	+	+	+
11	23	−	−	+
99	54	+	+	+
16	61	−	+	−
100	21	+	−	−
100	21	=	=	+
24	54	−	+	−
25	10	+	−	−
25	4	=	−	−

$c \Rightarrow 4$

$n \Rightarrow 11$

$m = 10$

$r \Rightarrow \sqrt{\frac{2 \times 4 - 10}{10}}$

$r \Rightarrow \sqrt{\frac{8 - 10}{10}}$

$r \Rightarrow \sqrt{\frac{-2}{10}}$

$r \Rightarrow -0.44$ Ans

Q. Number of concurrent deviation :- 10
Pair 12
Find r

$c \Rightarrow 10$
$n = 12$
$m = 11$

$$\sqrt{\frac{2 \times 10 - 11}{11}} \Rightarrow \sqrt{\frac{9}{11}} \Rightarrow 0.90 \text{ Ans}$$

Q. $rc = \frac{1}{\sqrt{3}}$

Number of concurrent deviation $\Rightarrow 6$
Pair = P
Find = P

Solve
$$\frac{1}{\sqrt{3}} = \sqrt{\frac{2c - m}{m}} \Rightarrow \frac{1}{\sqrt{3}} = \sqrt{\frac{2 \times 6 - (P-1)}{P-1}}$$

$$\frac{1}{3} = \frac{12 - P + 1}{P - 1}$$

$$39 - 3P = P - 1$$
$$40 = 4P$$
$$P \Rightarrow 10 \text{ Ans}$$

* Karl Pearson correlation
Product moment correlation cofficient

'Table give'

$$r = \frac{n \sum xy - \sum x \cdot \sum y}{\sqrt{n \sum x^2 - (\sum x)^2} \sqrt{n \sum y^2 - (\sum y)^2}}$$

Q.

X	Y	xy	x^2	y^2
2	2	4	4	4
4	3	12	16	9
8	3	24	64	9
16	2	32	256	4
30	10	72	340	26

$r \Rightarrow \dfrac{4 \times 72 - 30 \times 10}{\sqrt{4 \times 340 - 900}\sqrt{4 \times 26 - 100}}$

$r \Rightarrow \dfrac{-12}{\sqrt{460}\sqrt{4}}$

$r \Rightarrow 0.27$

Q.10 (Book).

$n = 11$

$\Sigma dx\, \Sigma dy = 3943$

$\Sigma dx = 13$

$\Sigma dy = 42$

$\Sigma dx^2 = 2667$

$\Sigma dy^2 = 6964$

Sol

$\dfrac{11 \times 3943 - 13 \times 42}{\sqrt{11 \times 2667 - (13)^2}\sqrt{11 \times 6964 - (42)^2}}$

$\dfrac{43373 - 546}{\sqrt{29337 - 169}\sqrt{76604 - 1764}}$

$\dfrac{42827}{\sqrt{29168 \times 74840}}$

$r \Rightarrow 0.92$ Ans

Q. $Cov = 40$

$\sigma x = 4$

$\sigma y = 5$

find r

$r = \dfrac{Cov}{\sigma x \times \sigma y}$

$r = \dfrac{40}{4 \times 5} = \dfrac{40}{20} \Rightarrow 2$

(a) 0.2 (b) 2 × (c) 0.5 (d) none ✓

Q. $r = 0.5$
$Cov = 20$
$var(X) = 81$
$var(y) = 7$

$$r = \frac{Cov}{\sigma x + \sigma y}$$

$$0.5 = \frac{20}{9 \times \sigma y}$$

$$\sigma y = \frac{20}{0.5 \times 9}$$

$$\sigma y = \frac{20}{4.5}$$

$$\sigma y = 4.44$$

$V_y = 19.75$ Ans

Q. Sum of Product of deviation. 42075 find r.
$\Sigma dx\,dy = 42075$ $n = 450$

$Cov \Rightarrow \frac{\Sigma dx\,dy}{n}$ $\rightarrow$ $var(x) = 64$
$var(y) = 163$

Sol

$$\Rightarrow \frac{42075}{450} \Rightarrow 93.5$$

$$r \Rightarrow \frac{93.15}{8 \times 13}$$

$r \Rightarrow .89$ Ans

Q. $Cov = 20$
SD of x is 6 SD of y

$$r = \frac{Cov}{\sigma x \times \sigma y}$$

$$r = \frac{20}{6 \times .5}$$ (r is 0 and less than 0)

option =)
(a) More than 2 (b) More than 4 ✓
(c) More than 3 · X (d) None of these

★ Properties   Correlation coefficient - (r)

① C.C is a unit free measure
② Change of origin ×
③ Change of scale ×
④ C.C does not depend on unit
⑤ C.C is pure real number
⑥ Linear equation property →

$$u = \frac{x-a}{b} \qquad v = \frac{y-c}{d}$$

Correlation coefficient between x and y is r.
Correlation between u and v is also $\pm r$.

Q. $U = \frac{x-7}{4}$ $V = \frac{y-2}{3}$ $r_{xy} = 0.90$

Sol
+ +
+ +

then $r_{uv} = 0.90$ (No change).

$r_{xy} = 0.64$

$u = -2x + 5$
$v = -3y + 7$

$\frac{+\ +}{-\ -}$ No change

So. $r_{uv} = 0.64$

★ Sign to measures.

+ +	+ +	− −	+ −	+ +	− −	+ +
+ +	− −	+ +	+ −	+ −	+ −	− +
No	No	No	No	change	change	change.

Q.

u	v
3	7
4	2
5	9
6	4

x	y
−3	−4
−5	−2
−6	−7
−2	−3

Sol
+ +
− −

$r_{uv} = 0.64$
$r_{xy} = 0.64$

Q.

x	y
4	2
5	6
7	3

u	v
4	-3
5	-2
7	-1

Sol So + + / + −

+ r ⇒ − r

→ Same Pattern.

x	y
5	6
−4	−3
−7	−2
6	7

U	V
3	4
−5	−4
−0	−1
2	3

0 not effect

$r_{xy} = 0.22$

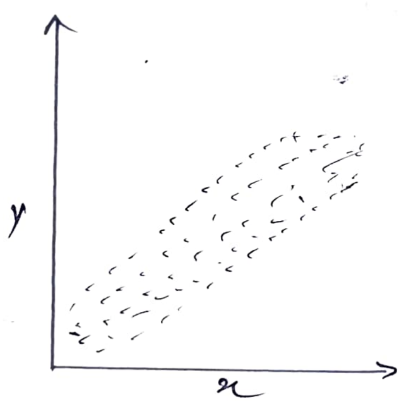
So No change

$r_{uv} = 0.22$

But the negative UV row −3 than the answer become ⇒ −0.22.

(4) Scatter Diagram or DOT Diagram :-

(1)

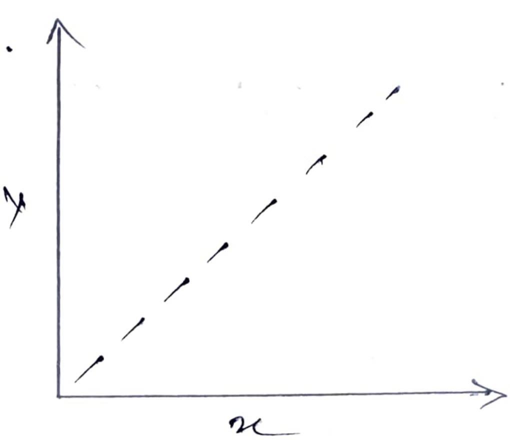


If the Plotted points moves in direction of lower left corner to upper right Corner (scatterd) there will be positive correlation.

$r > 0$

Non linear or Curvelinear.

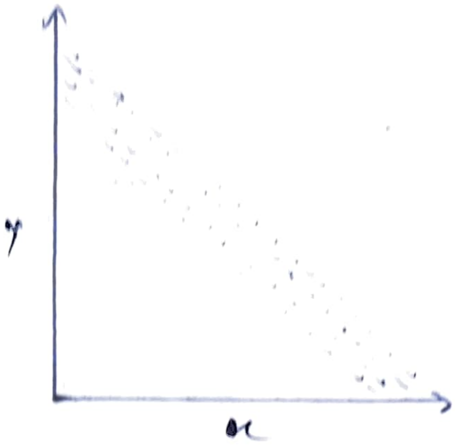
2.



If the Plotted points moves in direction of lower left to upper right in form of straight line there will be perfect positive correlation $r = +1$

Linear correlation.

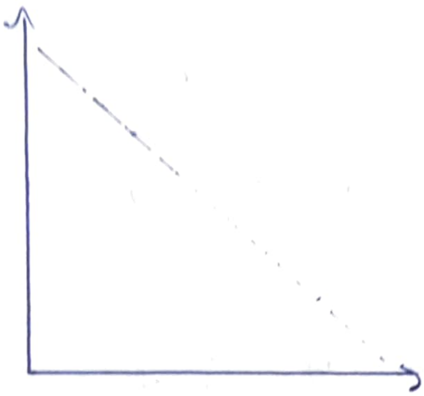
3.



If the plotted points points moves from upper left to lower right and they are dispised there will be negative correlation

$r < 0$

4.



upper left to lower right in form of straight line perfect negative $r = -1$

Regression

Regression is concerned to make a mathematical relation between x and y it also predicts the value of one variable with respect to other variable

For example:→ In profit and investment. Profit depend on investment so it is expresd as regression line or equation of Profit on investment.

So their are two staight line in Regression.

y on x regression

$$y = a + bx$$

$b = b_{yx}$ ⇒ regression cotticientof y on x

$$y - \bar{y} = b_{yx}(x - \bar{x})$$

$$b_{yx} = \frac{Cov}{\sigma x^2}$$

$$b_{yx} = \frac{r \times \sigma y}{\sigma x}$$

x on y regression

$$x = a + by$$

$b = b_{xy}$ regression cotticent of x on y

$$x - \bar{x} = b_{xy}(y - \bar{y})$$

$$b_{xy} = \frac{Cov}{\sigma y^2}$$

$$b_{xy} = \frac{r \times \sigma x}{\sigma y}$$

$$r = \sqrt{b_{yx} + b_{xy}}$$

b_{yx} + b_{xy} + r +

b_{yx} − b_{xy} − r −

b_{yx} + b_{xy} − r ×

$b_{yx} > 1$ $b_{xy} < 1$

$b_{yx} <$ · $b_{xy} < 1$

Q. $\bar{x} = 53.2$

$\bar{y} = 27.9$

$b_{yx} = -1.5$

$b_{xy} = -0.2$

find y on x line

Sol $y - \bar{y} = b_{yx}(x - \bar{x})$

$y - 27.9 = -1.5(x - 53.2)$

$y - 27.9 = -1.5x + 79.8$

$y - 27.9 + 79.8 = 1.5x$

$y - 107.7 - 1.5x$

$y = 107.7 - 1.5x$

Q. $x = 6$

$y = ?$

find y on x line

$y = 107.7 - 1.5 \times 60$

$y = 17.7$

Q. $\bar{x} = 10$

$\bar{y} = 20$

$b_{yx} = 0.4$

$b_{xy} = 0.5$

x on y line

Sol. $x - \bar{x} = b_{xy}(y - \bar{y})$

$x - 10 = 0.5(y - 20)$

$x - 10 = 0.5y - 10$

$x - 10 + 10 = 0.5y$

$x \Rightarrow 0.5y$

Q. $y = 30$

$x = ?$

$x = 0.5 \times 30$

$x = 15$

Q. $b_{yx} = 0.6$

$b_{xy} = 0.4$

$r = ?$

Sol $r = \sqrt{0.6 \times 0.4}$

$r = 0.48$

Q. $b_{yx} = -0.25$

$b_{xy} = -0.40$

$r = \sqrt{0.25 \times 0.40}$

$r = -0.31$

Q. $r = 0.5$

$b_{xy} = 0.20$

$b_{yx} = ?$

Sol $0.5 = \sqrt{0.20 \times b_{yx}}$

$0.5 \times 0.5 = 0.20 \times b_{yx}$

$\frac{0.5 \times 0.5}{0.20} = b_{yx}$

$b_{yx} \Rightarrow 1.25$ Ans

Q. $b_{yx} \Rightarrow 0.75$

$r = 0.50$

$\sigma_y = 4$

$\sigma_x \Rightarrow ?$

Q. reg coft y on x (b_{yx}) = 0.75

Coft. of correlation (r) = 0.50

Y. SD (σ_y) = 4

SD of $x = 2$
$\sigma x' = ?$

$b_{yx} = \frac{r \times \sigma y}{\sigma x}$

$0.75 = \frac{0.5 \times 4}{\sigma y}$

$0.75 \times \sigma y = 0.5 \times 4$

$\sigma y = \frac{0.5 \times 4}{0.75}$

$\sigma y = 2.66.$

Q. $Cov = 40$
$\sigma x = 12$
$b_{yx} = ?$

Sol $b_{yx} = \frac{Cov}{\sigma x^2} = \frac{40}{144} \Rightarrow 0.27.$

Q. $r = -\frac{\sqrt{3}}{2}$

$b_{yx} = -\frac{3}{4}$

$var(x) = 16$
$var(y) = ?$

Sol. Coff $= \frac{r \times \sigma y}{\sigma x}$

$-\frac{3}{\cancel{4}} = \frac{-\frac{\sqrt{3}}{2} \times \sigma y}{\cancel{4}}$

$-3 = \frac{-\sqrt{3}}{2} \times \sigma y$

$\frac{-6}{\sqrt{3}} = \sigma y$

$var(y) = \left(\frac{6}{\sqrt{3}}\right)^2 \Rightarrow \frac{36}{3} \Rightarrow 12$

$var(y) \Rightarrow 12$ Ans

Q.

	x	y
	Eco	Statics
avg.	40	50
SD	5.60	6.30

$r = 0.48$

Eco = 30
marks $x = 30$
Statics = ?
$y = ?$

Sol $y - \bar{y} = b_{yx}(x - \bar{x})$

$y - 50 = 0.54(30 - 40)$

$y - 50 = -5.4$

$y = 50 - 5.4$

$\Rightarrow 44.6$

$b_{yx} \Rightarrow \frac{r \times \sigma y}{\sigma x}$

$b_{yx} \Rightarrow \frac{0.48 \times 6.30}{5.60}$

$b_{yx} \Rightarrow 0.54$

Q.

Company	A	B
SD	10	12
Avg.	30	20

Sum of Product of dev $\Rightarrow 42075$
$n = 450$

share A price $\Rightarrow 60$
$x = 6$
Share B Price = ?
$y = ?$

Sol $y - \bar{y} = b_{yx}(x - \bar{x})$

$y - 20 = 0.935(60 - 30)$

$y = 48.05$

$\Sigma dx dy = 42075$

$Cov = \frac{\Sigma dx dy}{n}$

$Cov = \frac{42075}{450}$

$Cov = 93.5$

$b_{yx} = \frac{Cov}{\sigma x^2} \Rightarrow \frac{93.5}{100}$

$b_{yx} = 0.935$

① $a_1 x + b_1 y + c_1 \Rightarrow 0$
$a_2 x + b_2 y + c_2 \Rightarrow 0$

$\frac{a_1 b_2}{a_2 b_1} < 1$

So y on x I
x on y II

$r = -\sqrt{\frac{a_1 b_2}{a_2 b_1}}$

② $\frac{a_1 b_2}{a_2 b_1} > 1$

y on x II
x on y I

$r = -\sqrt{\frac{a_2 - b_1}{a_1 - b_2}}$

Q. $3x + 2y + 9 = 0$
$14x + 5y + 2 = 0$

Sol $\frac{15}{28} < 1$ which y on x I
x on y – II

$-\sqrt{\frac{15}{28}}$

$\Rightarrow -0.73.$

$\Rightarrow y = a + bx$ $b_{yx} =$

$3x + 2y + 9 = 0$

$-9 - 3x = 2y$ $b_{yx} \Rightarrow -\frac{3}{2}$

$2y = -3x - 9$

$y = \frac{-3x}{2} - 9$ $b_{xy} = \frac{5}{14}$

$\Rightarrow x = a + by$

$14x + 5y + 2 = 0$

$2 + 5y = 14x$

$y \Rightarrow \frac{5x}{14} + 2$

Q. $2x + 3y - 7 = 0$
$4x - 5y - 2 = 0$
+ – None of these
y on x (×)

Q. $4x + 5y - 6 = 0$
$3x + 12y - 3 = 0$

y on x – II
x on y I

$\frac{48}{15} > 1$ $r = -\sqrt{\frac{15}{48}}$

$r = -0.55$

Q. $4x + 5y + 6 = 0$ reg. line

Sol one line so sign +
than value of r is = –1

Q. $4x - 5y + 6 = 0$ reg. line

Sol One line so sign –
than value of r is +1

$r = +1$ or $\Rightarrow -1$

$2x \oplus 3y - 7 = 0$

$4x \ominus 5y + 2 = 0$

then $r = 0$

Perpendicular line

Q. $3x + 2y + 9 = 0$

$12x + 7y + 5 = 0$

$\frac{21}{24} < 1$ y on x I

x on y II

σx σy · ratio

$r_2 \sqrt{\frac{21}{24}}$

$- 0.93$

$b_{yx} = r \times \frac{\sigma y}{\sigma x}$

$-\frac{3}{2} \times 0.93 \times \frac{\sigma y}{\sigma x}$

$b_{yx} =$

$2y = -3x - 9$

$y = -\frac{3}{2}x - \frac{9}{2}$

$b_{yx} = -\frac{3}{2}$

$b_{xy} = -\frac{7}{12}$

Properties:-

1. b_{yx} and b_{xy} are called reg. coefficients
2. r, b_{yx}, b_{xy} should be of same sign.
3. b_{yx} + b_{xy} + r will be +
4. b_{yx} − b_{xy} − r will be −
5. b_{yx} + b_{xy} − r will not be determined.
6. $r = \sqrt{b_{yx} \times b_{xy}}$
7. Correlation coefficient is Geometric mean of regression coefficient
8. $r^2 = b_{yx} \times b_{xy}$
9. $r^2 \leq 1$ $r \leq 1$
10. $b_{yx} \times b_{xy} \leq 1$ The product of reg. coefficient is less than or equal to unity
11. Reg. coefficient Independent from origin.
12. Reg. coefficient dependent on change of scale.
13. A.M $\geq$ G.M $\frac{a+b}{2} \geq \sqrt{ab}$

$$\frac{b_{yx} + b_{xy}}{2} \geq \sqrt{b_{yx} \times b_{xy}}$$

14. A.M of reg. coefficient is greater or equal to r.
15. $b_{yx} > 1$ $b_{xy} < 1$

If one of the reg. coefficent is more than unity other reg. coefficent should less than unity

(16) $b_{yx} > 1$ $\quad$ $b_{yx} > 1$ ✗

(17) $b_{yx} < 1$ $\quad$ $b_{xy} < 1$

(18) Linear equation

$$U = \frac{x-a}{p} \qquad V = \frac{y-b}{q}$$

$$b_{yx} = \frac{q}{p} \times b_{vu} \qquad b_{xy} = \frac{p}{q} \times b_{uv}$$

$U = 2x+5$ $\quad$ $V = 3y+7$ $\quad$ $b_{yx} = 2.4$ $\quad$ b_{vu}

$$p = \frac{U}{x} = \frac{1}{2} \qquad b_{yx} = \frac{q}{p} \times b_{vu}$$

$$q = \frac{V}{y} = \frac{1}{3} \qquad 2.4 = \frac{\frac{1}{3}}{\frac{1}{2}} \times b_{vu}$$

$$1.2 = \frac{1}{3} \times b_{vu}$$

$$b_{vu} \Rightarrow 3.6$$

$r \Rightarrow r^2 =$ Cofficient of determination.

$$r^2 = \frac{\text{Explained variation}}{\text{Total variation.}}$$

$r^2 \Rightarrow$ Percentage of variation accounted

$1 - r^2 =$ Cofficent of Non-determination.

$$1 - r^2 = \frac{\text{Unexplained variation}}{\text{Total variation}}$$

$1 - r^2 =$ % of variation unaccounted

⇒ In regression there are two types of Errors. Errors को Residue भी कहते है।

Errors ⇒ observed value − estimated value

① Standard Errors $\quad$ ② Probable Errors

$$S.E \Rightarrow \frac{1-r^2}{\sqrt{n}} \qquad P.E \Rightarrow 0.6745 \times \frac{1-r^2}{\sqrt{n}}$$