UNIT - IV

TWO DIMENSIONAL RANDOM VARIABLE

Two random variables x and y are defined on same prob space called as Joint prob distribution Function

1) Let x be the R.V with value $x_1, x_2 \cdots x_n$ and y be the R.V with value $y_1, y_2 \cdots y_n$

then the sample $S = S_x \times S_y$

2) Joint prob mass function is

$$P_{xy}(x = x_i, y = y_i) = P_{xy}(x = x_i \cap y = y_i)$$

$X \backslash Y$	y_1	y_2	y_j	y_m	
x_1	P_{11}	P_{12}	P_{1j}	P_{1m}	$P_{1\cdot}$
x_2	P_{21}	P_{22}	P_{2j}	P_{2m}	$P_{2\cdot}$
x_i	P_{i1}	P_{i2}	P_{ij}	P_{im}	$P_{i\cdot}$
x_n	P_{n1}	P_{n2}	P_{nj}	P_{nm}	$P_{n\cdot}$
	P_1	P_2	P_j	P_m	1

Total probability $\sum_{i=1}^{n} \sum_{j=1}^{m} P(x_i, y_j) = 1$

Marginal distribution function of X

$P(X = x_i) = \sum_{j=1}^{m} P(x_i, y_j)$ i is fixed

MARGINAL DISTRIBUTION FUNCTION OF Y

$P(y = y_j) = \sum_{i=1}^{?} P(x_i, y_j)$ (j is fixed)

For the following probability distribution find the marginal distribution of x and y

i) $P(X \leq 1, Y = 2)$

ii) $P(X \leq 1)$

iii) $P(Y = 3)$

iv) $P(Y \leq 3)$

v) $P(X < 3, y \leq 4)$

CONDITIONAL PROBABILITY DISTRIBUTION OF X given Y = y

$$P\, X/y = \frac{P(X = x_i, y = y_i)}{P(y = y_i)}$$

$$= \frac{P(X = x_i \cap Y = y_i)}{P(Y = y_i)}$$

Conditional probability distribution of Y given X = x

$$P\, Y/x = \frac{P(x = x_i, y = y_i)}{P(x = x_i)}$$

$$= \frac{P(x = x_i \cap y = y_i)}{P(x = x_i)}$$

1) If X & Y are 2 random variables having the Join density fn $f(x, y) = \frac{1}{27}(2x + y)$

for $x = 0, 1, 2$
$y = 0, 1, 2$

Verify that $f(x, y)$ is a joint density function and find the marginal & conditional distribution of X and Y given that $Y = 1$

X \ Y	0	1	2	
0	0	$\frac{1}{27}$	$\frac{2}{27}$	$\frac{3}{27}$
1	$\frac{2}{27}$	$\frac{3}{27}$	$\frac{4}{27}$	$9/27$
2	$\frac{4}{27}$	$\frac{5}{27}$	$\frac{6}{27}$	$15/27$
	$6/27$	$9/27$	$12/27$	1

conditional probability

$$\frac{P(X=0, Y=1)}{P(Y=1)} = \frac{\frac{1}{27}}{9/27} = \frac{1}{9}$$

$$P(X=1, Y=1) = \frac{3/27}{9/27} = \frac{1}{3}$$

$$P(X=2, Y=1) = \frac{5/27}{9/27} = \frac{5}{9}$$

6) A Fair coin is tossed 250 times Find the prob that heads will appear between 120 and 140 times using C.L.M

SOL

$n = 250$

$p = \frac{1}{2} = \mu$ [Bernoulli distribution]

$var = pq = \frac{1}{2} \cdot \frac{1}{2} = \frac{1}{4}$

S.D $\sigma = \frac{1}{2}$

$P(120 < S_n < 140)$

$= P\left(\frac{120 - 250(\frac{1}{2})}{\sqrt{250} \cdot \frac{1}{2}} < z < \frac{140 - 250(\frac{1}{2})}{\sqrt{250} \cdot \frac{1}{2}}\right)$

$= P(1.89) - P(-0.63)$

$= 0.7063$

7) Based on data us census the mean age of college students in 2011 was 25 years with the standard deviation of 9.5 years. A random sample of 125 students is drawn, what is the prob that the sample mean age of students > 26 years

SOL

$\mu = 25 \quad \sigma = 9.5$

$n = 25$

$P(X>26)$

$= 1 - P(X<26)$

$= 1 - P\left(Z < \dfrac{26-25}{\frac{9.5}{\sqrt{125}}}\right)$

$= 1 - P(Z<1.18)$

$= 0.119$

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8) Students of a class were given aptitude test and their marks have mean $= 60$ and $\sigma = 5$. What % students have scored

(i) > 60 marks

(ii) < 56 marks

(iii) btw 45 and 66

SOL

$P(x>60)$

$= 1 - P(x<60)$

$= 1 - P\left(Z < \dfrac{60-60}{5}\right)$

$= 1 - P(Z<0)$

$= 0.5000$

(ii) $P(<56)$

$= P\left(X < \dfrac{56-60}{5}\right)$

$= P(X < \cancel{-0.8}) = \cancel{0.0228}$ 0.2119

(iii) $P(45 < x < 65)$

$= P\left(\frac{45-60}{5} < x < \frac{65-60}{5}\right)$

$= \cancel{P(1 < x}$

$\phi(1) - \phi(-3)$

$\cancel{= 0.9974}$ $= 0.84.$

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9) The Avg. age of a vehicle registered in US is 8 years and $\sigma = 16$ months. If a Random sample of 36 vehicles is selected. Find the prob that mean of their age is btw 90 and 100 months

SOL

$\mu = 8 \times 12 = 96$

$\sigma = 16$

$n = 36$

$P(90 < x < 100)$

$= P\left(\frac{90-96}{16/6} < x \quad \frac{100-96}{16/6}\right)$

$= \phi(7.5) - \phi(-2.25)$

$= 0.9332 - 0.0122$

$= 0.921$

1) The Joint probability distribution function of X & Y is $P(x, y) = K(2x + 3y)$ for $x = 0, 1, 2$, $y = 1, 2, 3$

find (i) K

(ii) Marginal distribution of X and Y

(iii) conditional distr of Y given X

X \ Y	1	2	3	
0	3K	6K	9K	18K
1	5K	8K	11K	24K
2	7K	10K	13K	30K
	15K	24K	33K	1

$K = \frac{1}{72}$

(ii)

X	0	1	2
$P(X = x)$	$\frac{8}{72}$	$24/72$	$30/72$

Y	1	2	3
$P(Y = y)$	$15/72$	$24/72$	$33/72$

(iii) $X = 0$

$$\frac{P(x=0, y=1)}{P(X=0)} = \frac{\frac{3}{72}}{18/72} = \frac{1}{6}$$

$$\frac{P(x=0, y=2)}{P(x=0)} = \frac{6/72}{18/72} = \frac{1}{3}$$

$$\frac{P(x=0, y=3)}{P(x=0)} = \frac{9/72}{18/72} = \frac{1}{2}$$

$x=1$

$$\frac{P(x=1, y=1)}{P(x=1)} = \frac{5/72}{24/72} = \frac{5}{24}$$

$$\frac{P(x=1, y=2)}{P(x=1)} = \frac{8/72}{24/72} = \frac{1}{3}$$

$$\frac{P(x=1, y=3)}{P(x=1)} = \frac{11/72}{24/72} = \frac{11}{24}$$

x \ y	1	2	3
0	1/6	1/3	1/2
1	5/24	1/3	11/24
2	7/30	1/3	13/30

v) Find prob distribution of $X+Y$

$X+Y$	$P(X+Y)$
1	$P_{01} = 3K = 3/72$
2	$P_{11} + P_{02} = 5K + 6K = 11/72$
3	$P_{03} + P_{12} + P_{21} = 9K + 8K + 7K = 24K = 24/72$
4	$P_{13} + P_{22} = 11K + 10K = 21K = 21/72$
5	$P_{23} = 13K = 13/72$
	1

Cumulative Joint distribution function of X & Y is given by

$$F_{XY}(x, y) = P(X \le x, Y \le y)$$

Independency : Two Random Variable X and Y are independent if

$$\underline{P(X = x, Y = y) = P(X = x) \cdot P(Y = y)}$$

for all x & y

marginal dist can be found only if it is

2) The R.V.s X and Y are <u>independent</u> and given as

$P(X=1) = 2/3$ $P(X=0) = 1/3$ $P(Y=1)$ $1/4$ $P(Y=-1)$ $3/4$

find the joint dist of X & Y

X \ Y	-1	1
0	1/4	1/12
1	1/2	2/6

3)

Y \ X	0	1	2	
0	1/16	1/8	1/8	5/16
1	1/16	1/8	1/16	1/4
2	1/8	1/4	1/16	7/16
	1/4	1/2	1/4	1

Find

(i) $P(X=1, Y\leq 0) = \frac{1}{8}$

(ii) $P(X=2, Y\leq 0) = 1/8$

(iii) $P(X=2, X+Y=4) = 1/16$

(iv) $P(1\leq X<3, Y\geq 1) = 1/2 \quad (1/8 + 1/16 + 1/16 + \frac{1}{4})$

(v) $P(X\leq 2) = 1$

(vi) $F(1,1) = P(X\leq 1, Y\leq 1) = 3/8$

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4) $$P(x,y) = \begin{cases} k(x^2+y^2), & \text{if } (x,y) = (1,1)(1,2) \\ & (2,3)(3,3) \\ 0 & \text{elsewhere} \end{cases}$$

Sol

x \ y	1	2	3	
1	2K	5K	0	7K
2	0	0	13K	13K
3	0	0	18K	18K
	2K	5K	31K	1

P(1, 2)

P(1, 3)

P(2, 3)

P(3

K = 1/38

ii) $P(Y>X) = P(1,2) + P(1,3) + P(2,3)$

$= 5K + 13K + 0 = 18/38$

iii) $P(X+Y \le 4) = 7/38$

(iii) $P(Y \ge X) = 1$

$E(XY) = \sum xy \, P(X=x, Y=y)$

Covariance of joint probability distribution

measures the joint variance of two random variables denoted by

$cov(x,y) = \sigma_{xy} = E(XY) - E(X)E(Y)$

$= E((x - E(x))(Y - E(Y)))$

$= \sum (X - E(X))(Y - E(Y)) \, P(X,Y)$

$= E(XY - XE(Y) - YE(X) + E(X)E(Y))$

$= E(XY) - E(X)E(Y) - E(Y)E(X) + E(X)E(Y) = E(XY) - E(X)E(Y)$

$E(x) = \sum x_i P(X=x_i)$ - (Marginal distr of X)

$E(y) = \sum y_i P(Y=y_i)$ (Marginal distribution of Y)

$E(XY) = \sum XY \, P(X,Y) = \sum\sum x_i y_i \, P(X=x_i, Y=y_i)$

	y_1	y_2	
x_1	P_{11}	P_{12}	P_1
x_2	P_{21}	P_{22}	P_2
	$P_{.1}$	$P_{.2}$	

$E(x) = x_1 P_1 + x_2 P_2$

$E(y) = y_1 P_1 + y_2 P_2$

$E(XY) = x_1 y_1 P_{11} + x_2 y_1 P_{21} + x_1 y_2 P_{12} + x_2 y_2 P_{22}$

Correlation coefficient : measures strength of relationship b/w two Random variable

$$corr(X,Y) = \rho_{xy} = \frac{cov(X,Y)}{\sigma_X \sigma_Y}$$

Properties

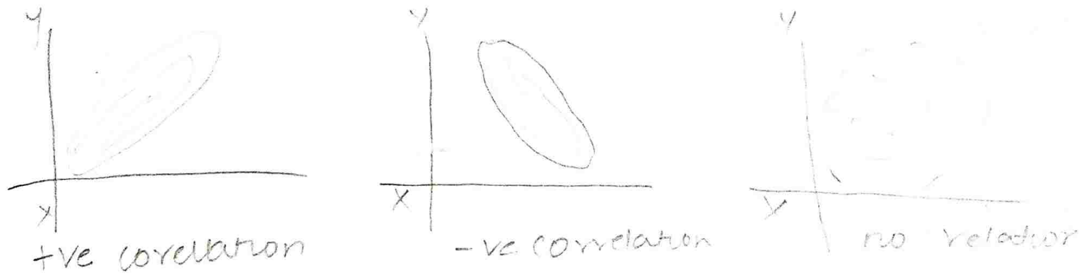
1) $-1 \le \rho_{xy} \le 1$

2) $\rho_{xy} = 1 \rightarrow$ perfect positive correlation

3) $\rho_{xy} = -1 \rightarrow$ perfect negative correlation

4) $\rho_{xy} > 0 \rightarrow$ +ve correlation

5) $\rho_{xy} < 0 \rightarrow$ -ve correlation



1)

X \ Y	0	1	2	3	
0	h	2h	3h	4h	10h
1	4h	6h	8h	2h	20h
2	9h	12h	3h	6h	30h
	14h	20h	14h	12h	1

Find h, $E(x)$, $E(x^2)$, $E(Y)$, $E(Y^2)$, $E(XY)$, σ_x, σ_y, σ_{xy}, ρ_{xy}

SOL

$60h = 1$

$h = 1/60$

$E(X) = 0(\cancel{10h}) + 1(20h) + 2(30h)$

$= \cancel{20}\cdot\frac{1}{\cancel{60}_{3}} + \cancel{2}\cdot\cancel{30}^{1}\frac{1}{\cancel{60}_{2}} = 1 + \frac{1}{3} = 4/3$

$E(Y) = 1(20h) + 2(14h) + 3(12h)$

$= \frac{20}{60} + \frac{2\times 14}{60} + \frac{3\times 12}{60} =$

$E(XY) = 5/3$

$\sigma(x) = \sqrt{5/9}$

$\sigma_y = \sqrt{\frac{23}{75}}$

$\sigma_{xy} = -1/5$

$\rho_{xy} = -0.255$

PROPERTIES OF COVARIANCE

1) $cov(X,Y) = cov(Y,X)$

2) $cov(X,Y) = 0$, if X & Y are independent

3) $cov(aX, bY) = ab\ cov(X,Y)$

4) $cov(aX+c, bY+d) = ab\ cov(X,Y)$

5) $cov(X,X) = Var(X)$

6) $Var(X+Y) = Var(X) + Var(Y) + 2cov(XY)$

7) $Var(aX+bY) = a^2 Var(X) + b^2 Var(Y) + 2ab\ cov(X,Y)$

$Var = \sigma^2$

1) Let x and y be two R.V. $\rho_{xy} = 1/2$, $\sigma_x = 2$, $\sigma_y = 3$ find $var(2X - 4Y)$

SOL

$$\sigma_{XY} = \frac{cov(X,Y)}{\sigma_X \cdot \sigma_Y} = \rho_{XY} \cdot \sigma_X \cdot \sigma_Y$$

$$= \frac{1}{2} \cdot 2 \cdot 3 = 3$$

$$Var(2X-4Y) = 2^2 \cdot var(X) + 4^2 \cdot var(Y) - 2 \cdot 2 \cdot 4 \cdot \sigma_{xy}$$

$$= 4 \cdot 2^2 + 16 \cdot 3^2 - 16 \cdot 3$$

$$= 112$$

2) $Var(X) = Var(Y) = 3$

find $Var(X+3Y)$ if X & Y are independent

SOL

$var(2x+3y) = 2^2 \cdot var(x) + 3^2 \cdot var(y) + 2\sigma_{xy}$

$= 2^2 \cdot 3 + 3^2 \cdot 3 + 0$

$= 39$

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3) $var(x) = var(y) = \frac{11}{144}$

$\sigma_{xy} = cov(x,y) = \frac{-1}{144}$ find $var(\frac{1}{2}x + y) = ?$

SOL

$var(\frac{1}{2}x+y) = \frac{1}{4} \cdot \frac{11}{144} + 1 \cdot \frac{11}{144} - 0 \cdot \frac{1}{2} \cdot \frac{1}{144}$

$= \frac{53}{576}$

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4) $y = -5x+2$ find ρ_{xy}

SOL

$\rho_{xy} = \frac{cov(x, -5x+2)}{\sigma_x \cdot \sigma_y} = \frac{-5\,cov(x,x)}{\sqrt{var(x)}\sqrt{var(y)}}$

$var(y) = var(-5x+2) = 25\,var(x)$

$var(ax+b) = a^2\,var(x)$

$= \frac{-5\,var(x)}{\sqrt{var\,x}\,\sqrt{25\,var(x)}} = \frac{-5}{5} = -1$

(5)

$X \backslash Y$	0	100	200	
100	0.20	0.10	0.20	0.50
250	0.05	0.15	0.30	0.50
	0.25	0.25	0.50	1

find $\rho_{XY} = ?$

also Verify if X & Y are independent

$(P(X,Y) = P(X)\,P(Y)$

Var(X)

<u>SOL</u>

$$\rho_{XY} = \frac{\mathrm{cov}(X,Y)}{\sigma_X \cdot \sigma_Y}$$

$\mathrm{cov}(X,Y) = E(X\cdot Y) - E(X)E(Y)$

$E(X^2) =$

$E(X) = 100(0.50) + 250(0.50) = 175$ $\quad E(x^2) = 36250$

$E(Y) = 0(0.25) + 100(0.25) + 200(0.50) = 125$ $\quad E(Y^2) = 22500$

$E(XY) = 100(100)(0.10) + (100)(200)(0.20) + 250(100)(0.15)$
$\quad + 250(200)(0.30)$

$= 23750$

$\mathrm{cov}(XY) = E(XY) - E(X)E(Y)$

$= 23750 - (175)(125) = 1875$

$\mathrm{Var}(X) = E(X^2) - (E(x))^2 = 5625$ $\quad \sigma_X = 75$

$\mathrm{Var}(Y) = 6875$ $\quad \sigma_Y = 82.91$

$$\rho_{xy} = \frac{1875}{75 \times 82.91} = 0.30$$

Regression line is best estimate of value of one variable for specific value of another variable

Regression line of y on x (y is dependent, x is independent)

Regression line of x on y (x is dependent , y is independent)

consider $y = a + bx$

$$\sum_{i=1}^{n} y_i = \sum_{i=1}^{n} a + b \sum_{i=1}^{n} x$$

$$\Rightarrow \sum y_i = na + b \sum x_i \rightarrow (1)$$

multiply by x_i & take Σ,

$$\sum_{i=1}^{n} x_i y_i = a \sum_{i=1}^{n} x_i + b \sum_{i=1}^{n} x_i^2 \rightarrow (2)$$

from (1)

$$a = \frac{\sum y_i - b \sum x_i}{n}$$

$a = \bar{y} - b\bar{x} \Rightarrow \bar{y} = a + b\bar{x}$ → regression line passes through $(\bar{x}, \bar{y})$

substitute a in (2)

$$\sum x_i y_i = \left(\frac{\sum y_i - b \sum x_i}{n} \right) \sum x_i + b \sum x_i^2$$

$$\cancel{b_{yx} = n \sum x_i y_i - \sum x_i \sum y_i}$$

$$\sum x_i y_i = \sum y_i \sum x_i - b(\sum x_i)^2 + bn \sum x_i^2$$

$$b = \frac{n \sum x_i y_i - \sum x_i \sum y_i}{n \sum x_i^2 - (\sum x_i)^2}$$

$$b_{yx} = \frac{\frac{1}{n^2}(n \sum x_i y_i - \sum x_i \sum y_i)}{\frac{1}{n^2}(n \sum x_i^2 - (\sum x_i)^2)}$$

$$= \frac{\frac{\sum x_i y_i}{n} - \frac{\sum x_i}{n} \cdot \frac{\sum y_i}{n}}{\frac{\sum x_i^2}{n} - \left(\frac{\sum x_i}{n}\right)^2} = \frac{cov(x,y)}{var(x)} = b_{yx}$$

$\hookrightarrow E(xy) - E(x)E(y)$ $\qquad \frac{cov(x,y)}{Var(y)} = b_{xy}$

$$cov(x,y) = \frac{\sum x_i y_i}{n} - \bar{x} \cdot \bar{y}$$

$$var(x) = \sum x_i^2 - (\bar{x})^2$$

$$var(y) = \frac{\sum y_i^2}{n} - (\bar{y})^2$$

$$b_{yx} b_{xy} = \left(\frac{cov(x,y)}{\sigma_x \sigma_y}\right)^2 = \rho_{xy}^2 = r^2$$

$$b_{yx} = \frac{cov(x,y)}{var(x)} = \frac{r \sigma_x \sigma_y}{\sigma_x^2} = \frac{r \sigma_y}{\sigma_x}$$

$$= b_{xy} = \frac{r \sigma_x}{\sigma_y}$$

$$b_{yx} = \frac{r \sigma_y}{\sigma_x} \qquad b_{xy} = \frac{r \sigma_x}{\sigma_y}$$

1) The two regression lines y on x & x on y are given respectively as $8x - 10y + 66 = 0$, $40x - 18y = 214$. and variance of $x = 9$. Find

i) $\bar{x}$ & $\bar{y}$

ii) ρ_{xy} or $r(x, y)$

(iii) σ_y

<u>Sol</u>

$$8x - 10y + 66 = 0$$
$$40x - 18y = 214$$

$$40x - 50y = -330$$
$$\underset{(-)}{}40x \overset{(+)}{-} 18y = \overset{(-)}{214}$$

$$\cancel{-68y = -116}$$
$$-32y = -544$$
$$\boxed{y = 17}$$

$$8x - 170 + 66 = 0$$
$$8x = 104$$
$$\boxed{x = 13}$$

1) $\bar{x} = 13 \quad \bar{y} = 17$

(ii) ρ_{xy} or $r(x, y) = \sqrt{b_{yx}\, b_{xy}}$

$$y = a + b_{yx}$$
$$x = a + b_{xy}$$

$$y = \frac{66}{10} + \frac{8}{10}x$$

$$x = \frac{214}{40} + \frac{18}{40}y$$

$$b_{yx} = \frac{8}{10}$$

$$b_{xy} = \frac{18}{40}$$

$$r = \sqrt{\frac{8}{10} \times \frac{18}{40}} = 0.6$$

ii) $\sigma_x = 3$, $r = 0.6$, $b_{yx} = \frac{8}{10} = \frac{4}{5}$

$$b_{yx} = r \cdot \frac{\sigma_y}{\sigma_x} \Rightarrow \frac{8}{10} = \frac{0.6 \cdot \sigma_y}{3}$$

$$\sigma_y = 4$$

1) Find 2 regression lines y on x & x on y for the following

x	1	2	3	4	5	6	7
y	9	8	10	12	11	13	14

Sol

y on x

$$y = a + bx$$

$$b_{yx} = \frac{cov(x,y)}{Var(x)} = \frac{\frac{\Sigma x_i y_i}{n} - \frac{\Sigma x_i}{n}\frac{\Sigma y_i}{n}}{\frac{\Sigma x_i^2}{n} - \left(\frac{\Sigma x_i}{n}\right)^2} = \frac{\frac{\Sigma x_i y_i}{n} - \bar{x}\bar{y}}{\frac{\Sigma x_i^2}{n} - (\bar{x})^2}$$

$$y = a + bx$$

$$a = \bar{y} - b\bar{x} \Rightarrow y = \bar{y} - b\bar{x} + bx$$

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

x on y

$$b_{xy} = \frac{cov(x,y)}{Var(y)} = \frac{\frac{\Sigma x_i y_i}{n} - \frac{\Sigma x_i}{n}\frac{\Sigma y_i}{n}}{\frac{\Sigma y_i^2}{n} - \left(\frac{\Sigma y_i}{n}\right)^2} = \frac{\frac{\Sigma x_i y_i}{n} - \bar{x}\bar{y}}{\frac{\Sigma y_i^2}{n} - (\bar{y})^2}$$

$$x = a + by$$

$$a = \bar{x} - b\bar{y}$$

$$x = \bar{x} - b\bar{y} + by$$

$$x - \bar{x} = b(y - \bar{y})$$

x	y	x^2	y^2	xy
1	9	1		
2	8	4		
3	10	9		
4	12	16		
5	11	25		
6	13	36		
7	14	49		

$\Sigma x_i = 28$ $\Sigma y_i = 77$ $\Sigma x_i^2 = 140$ $\Sigma y_i^2 = 875$ $\Sigma x_i y_i = 384$

$\bar{x} = \frac{28}{7} = 4$ $\bar{y} = \frac{77}{7} = 11$

$$b_{yx} = \frac{\frac{334}{7} - 4(11)}{\frac{140}{7} - (4)^2} = 0.929$$

Line y on x

$$y - 11 = 0.929 (x - 4)$$

$$y = 7.284 + 0.929 x$$

Line x on y

$$b_{xy} = \frac{\frac{334}{7} - 4.11}{\frac{875}{7} - (11)^2} = 0.929$$

$$(x - 4) = 0.929 (y - 11)$$

$$x = -0.6219 + 0.929 y$$

What is the most likely value of y at x = 10

y on x $\Rightarrow y = 7.284 + 0.929(x)$

$x = 10 \Rightarrow y = 16.574$

2) find the most likely price in bombay corresponding to the price of ₹ 70 at calcutta from the following

SOL

Cal	Calcutta	Bombay
Average Price	65	67
standard deviation	2.5	3.5

and $r(x, y) = 0.8$

SOL

y on x $\Rightarrow y - \bar{y} = b_{yx}(x - \bar{x})$ $\qquad b_{yx} = \dfrac{r\sigma_y}{\sigma_x}$

at $x = 70$, $y - 67 = 0.8 \dfrac{3.5}{2.5}(70 - 65) = 72.6$

find the price of calcutta corresponding to Price of 68 at bombay

X on y :-

$x - \bar{x} = b_{xy}(y - \bar{y})$ $\qquad b_{xy} = \dfrac{r\sigma_x}{\sigma_y}$

$x - 65 = \cancel{bx} \cdot 0.8\left(\dfrac{2.5}{3.5}\right)(68 - 67)$

$x = 65.5$

Can $y = 5 + 2.8x$

$x = 3 - 0.5y$ be the estimated regression

of y on x and x on y respectively

Sol

b_{xy} and b_{yx} are of different signs so its not possible

The following data relates to the expenditure on ad in thousands of rupees and the corresponding sales in Lakhs of rupees. Find an appropriate regression equation

Sol

Expenditure	8	10	10	12	15
sales	18	20	22	25	28

Sol

$$b_{yx} = \frac{cov(x, y)}{var(x)} = \frac{n \sum x_i y_i - \sum x_i \sum y_i}{n \sum x_i^2 - (\sum x_i)^2}$$

$y =$