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OPERATION RESEARCH:-

The course deals use of mathmetical model for corporate & governmental activities. Most of the planning problem consists of an economic objective. which we want to maximize under scare resource OR consist of.

- Limiting & defining the correct problem.
- Formulating a mathmetical.
- Calculating an optimized solution of problem
- Interpreting & Implement the find solution.
- Deterministic problem.
- Statistic / Stochastic problem.
- Linear & non-linear programming.
- Integer programming.
- Network model.
- Simple queuing theory +
- Simulation.

OR is also called quantities techniques of managment or quantities analysis of managment. It is probability nature.

APPLICATION OF O.R:-

Forecasting
Product scheduling
Inventary contrd managment
Budgeting
Transportation.

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4. Building block or core of O.R.
Statistics & probability theory.

5. **Note:-**
Advance spred sheet will be used to find numerical solution for some of analyzed problem.

Characteristics Of O.R:-

1. Applied scientific method to solve problem.
For e.g. certain algo, predefine steps used for reaching to an optimal research.

2. It is uncover or exhibit problem.
For e.g: while looking a problem finding a solution, one take find some new problem. for instance, while consumer spend more time comparitivly other, we will look at some resources are.
For e.g: for more shops are free.

3. It improve quality of decision biggest we used numerical method, analysis & quantitative method. Since we using numerical & quantitative method it we used computer extensively.

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4. Since qualitative method, we have only qualitative solution, no quantitative solution.

5. It allows to take a real world problem & focus or put this into a mathmetical model For e.g: I have certain amount & I have to perform five task which required this amount in this month. Now it is art to pick some basic task more & more to be accomplished using a same amount in a month. That is how best I can optimized upon a required amount I have.

Q What is model?

A The model implies to deals with math and statistic.

Mathematical Model:- $Y = mx + b$

Statistics Model:- $Y = b_0 + b_1 x_1 + \epsilon$

Basically the model (equation) is explain of real data.
For e.g.
Mathematical model: Integration $\int_a^b f x$.
Approximation method (Trapezioidal).

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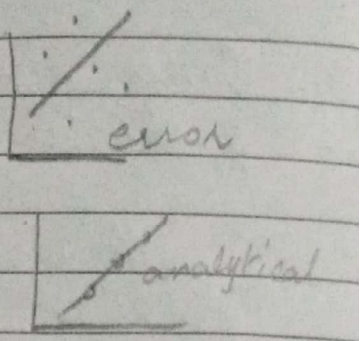
Here the denoted lines shows the distance (error) from the model of actual data.

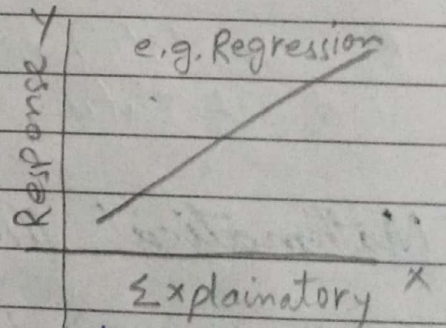


We used model to explore relationship
For e.g.
I might be interested relationship height & age of student.
We use statistic to determine how useful & how reliable our model is.

Types Of Statistics Model:-

1. **Continous Data:-**

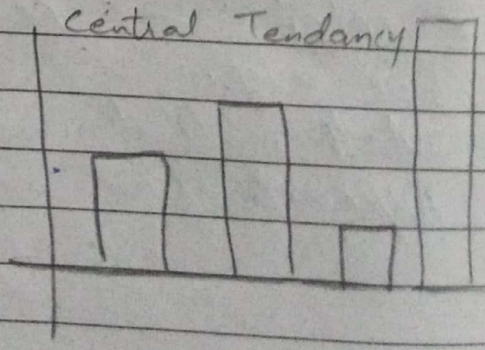
It depends on continous data.
e.g Regression,
Explainatory: how many unit change & effect on response.
ex



2. **Integer Data:-**

It depends on discrete

e.g. ANOVA.



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Weight of Popul of 2 samples diff

ANALYSIS OF VARIANCE (ANOVA):-

originated by

The technique ANOVA is r.a. fisher. The analysis of method which seprate the variation refer able to one set of causes from the variation to other set.

For e.g. We are interested in testing the null hypothesis that the three variety of wheat produce equal yeild on the average.

H_0: $\mu_A = \mu_B = \mu_C$

H_A: $\mu_A \neq \mu_B \neq \mu_C$

We conduct experiment by planting different varities of wheat on plotting on land. there might be difference in the mean of various variety due to experimental error. also there might be variation dueto experimental error + any variation due to the different variety of wheat.

The analysis of variance is a method of splitting the total variation of our data into constitutent which measure different sources of variation. The total variation is split up into the following meaningful component.

1. Variance with in the sub group of sample.

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2. Variance between the subgroup of sample.

After this, the two variances are tested for their significant by the variance ratio or the f-test.

"Also analysts use the ANOVA test to determine the influence that independent variables have on the dependent variable in a regression study".

VARIANCE:-

The distance between the random variable to the mean. $(x - \bar{x})$

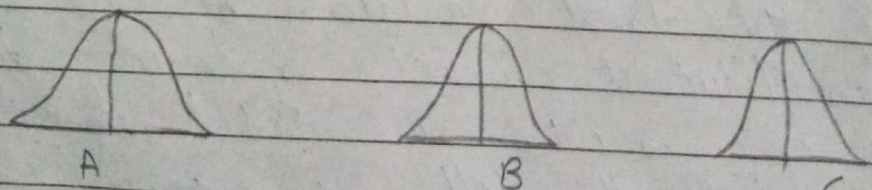
OR

It is define as the expectation of S.D. of the random variable from its mean.

$(x - \bar{x})^2$

Basically, we do anova for comparision of more than two population or population having more than two sub group.

Consider the example.



between the column

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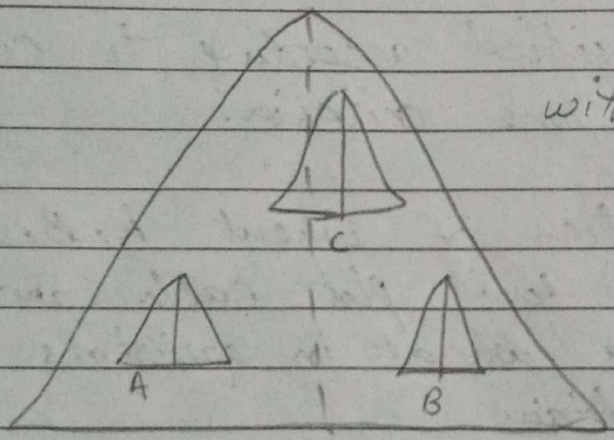
If we want to know all above three mean are coming from the same populations than we can apply ANOVA test. because

∴ ANOVE = variability b/w the means / variability within the distribution

than we have total variance = variability b/w the means + variability within distribution.

than graphically concept says.



within column

Assumption:-

Each population having normal dist.
The population from which the sample are drawn have the equal variance that is

$$S_1^2 = S_2^2 = S_3^2 \ldots\ldots S_k^2$$

Each sample is drawn randomly and other are independent.

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Hypothesis test for F-Distribution:-

H_0: $\mu_1 = \mu_2 = \mu_3 \ldots$

H_A $\mu_1 \neq \mu_2 \neq \mu_3 \ldots$

We define ANOVA into two classes.

One way ANOVA (one factor)
Two way ANOVA (two factor).

Q. It is classified according to one factor or one criteria.

Three varieties of wheat A, B, C sown in (4) four plot each and the following wheat in quintals per acre ~~one~~ were obtain

Plot	Varities		
	A	B	C
1	10	9	4
2	6	7	7
3	7	7	7
4	9	5	6
Total	32	28	24

Set of table of ANOVA and find out whether there is a significant of

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mean of yield of the three variety.

Solution:-

Step 1:-

H_0 : $\bar{X}_A = \bar{X}_B = \bar{X}_C$

H_A : $\bar{X}_A \neq \bar{X}_B \neq \bar{X}_C$

Step 2:

Calculate the variance b/w the sample.

a) Calculate mean of each sample.

$\bar{X}_A = 32/4 = 8$

$\bar{X}_B = 28/4 = 7$

$\bar{X}_C = 24/4 = 6$

b) Calculate the grand mean.

$$\bar{\bar{X}} = \frac{\bar{X}_A + \bar{X}_B + \bar{X}_C}{3} = \frac{32 + 28 + 24}{3}$$

$$\boxed{\bar{\bar{X}} = 7}$$

c) The difference b/w the mean of variance sample and grand mean and square it

$\bar{X}_A - \bar{\bar{X}}$	$(\bar{X}_A - \bar{\bar{X}})^2$	$(\bar{X}_B - \bar{\bar{X}})^2$	$(X_C - \bar{\bar{X}})^2$	$(\bar{X}_C - \bar{\bar{X}})$	$(X_C - \bar{\bar{X}})^2$
8 - 7	1	7 - 7	0	6 - 7	-1
8 - 7	1	7 - 7	0	6 - 6	-1
8 - 7	1	7 - 7	0	6 - 7	-1
8 - 7	1	7 - 7	0	6 - 7	-1
	4		0		4

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Sum of square b/w samples

$\Sigma(\bar{x} - \bar{\bar{x}})^2 = 4+0+4 = 8$

Step 3:-

Calculate the variance within the sample.

a) Calculate the mean for each sample.

b) Take the deviation from variance item in a sample from the mean value of respective sample & square it.

$(A-\bar{X}_A)$	$(A-\bar{X}_A)^2$	$(B-\bar{X}_B)$	$(B-\bar{X}_B)^2$	$(C-\bar{X}_C)$	$(C-\bar{X}_C)^2$
10-8	4	9-7	4	4-6	4
6-8	4	7-7	0	7-6	1
7-8	1	7-7	0	7-6	1
9-8	1	5-7	4	6-6	0
Total	10		8		6

Sum of square within the sample.

$(\Sigma(x-\bar{x})^2) = 10+8+6 = 24$

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Step 4:-

Calculate the value of F-ratio:-

Sum of variance	Sum of square	D.F	Mean sum of square	F-Test
Between the sample	SSC = 8	$n_1 = c-1$ $3-1=2$	MSC = SSC/c-1 $8/2 = 4$	F = MSC/MSE
Within the sample	SSE = 24	$n_2 = n-c$ $12-3=9$	MSE = SSE/n-c $24/9 = 2.66$	F = 4/2.66 F = 1.50

M.S.E = error.

$F_{cal} = 1.50$, $F_{tab} = 8.0215$

Step 5:-

$F_{cal} < F_{tab}$

$1.50 < 8.0215$

Result:-

We accept null hypothesis and Hence, prove that there is a significant difference b/w the mean of varities of wheat.

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Replicates:- Rows in ANOVA table

Factors:- Column in ANOVA table also called method.

Within OR Within the Columns:-
Difference between the rows

Between OR Between the Columns-
Difference between the column.

SS (method):- Sum of square between the column. Also called "ANOVA test". Difference by the "mean"
↙ column.

SS (error):- Sum of square within the column.
↙ row

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Q A rifle club perform an experiment on a randomly selected group of first time shooter. The purpose of the exp was to determine whether shooting accuracy is affected by the method of sighting used:
Only right eye open, only left eye open or both eyes open. 15 shooter were selected & split into three group. Each group experience the same training and practising procedures with one exception; the method of sighting used. After completing training, each student was given the same. $\therefore \alpha = 0.05$

Method Of Sighting

Right Eye	Left Eye	Both Eyes
12	10	16
10	17	14
18	16	16
12	13	11
14		20
		21

Solution:-

Step 1:-

$H_0 : \mu_R = \mu_L = \mu_B$
$H_0 : \mu_R \neq \mu_L \neq \mu_B$

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Replicant (K)	Right Eye	Left Eye	Both Eyes
1	12	10	16
2	10	17	14
3	18	16	16
4	12	13	11
5	14		20
6			21
Total	$C_R = 66$	$C_L = 56$	$C_B = 98$

$$\Sigma x = C_R + C_L + C_B = 66 + 56 + 98 = 220$$

$$\Sigma x^2 = 12^2 + 10^2 + 16^2 + 10^2 + 17^2 + \ldots = 3392$$

Step 2:-

Sum Of Square Among/Between The Factors:-

$$SS(\text{method}) = \left(\frac{C_R^2}{K_1} + \frac{C_L^2}{K_2} + \frac{C_B^2}{K_3}\right) - \frac{(\Sigma x)^2}{N}$$

$$SS(\text{method}) = \left(\frac{66^2}{5} + \frac{56^2}{4} + \frac{98^2}{6}\right) - \frac{(220)^2}{15}$$

$$SS(\text{method}) = 3255.87 - 3226.67$$

$$SS(\text{method}) = 29.2.$$

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Step 3:-

Sum Of Square Within The Factors:-

$$SS(error) = \Sigma x^2 - \left(\frac{C_0}{K_1} + \frac{C_1}{K_2} + \frac{C_2}{K_3}\right)$$

$$SS(error) = 3392 - 3255.87$$

$$SS\ error) = 136.13.$$

Step 4:-

Sum Of Square Total:-

$$SS(total) = \Sigma x^2 - \frac{(\Sigma x)^2}{N}$$

$$SS(total) = 3392 - \frac{(220)^2}{15}$$

$$SS(total) = 165.33.$$

Verification:-

$$SS(method) + SS(error) = SS(total)$$

$$29.20 + 136.13 = 165.33$$

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Step 5:-

MSSC:- Mean Sum Of Square Between the factor:-

$$MSSC = \frac{SS(method)}{c-1} = \frac{29.20}{2} \quad \therefore df(method) = c-1$$

$$MSSC = 14.6$$

Step 6:-

MSSE:- Mean Sum Of Square Within the factor:-

$$M.SSE = \frac{S.S(error)}{n-c} = \frac{136.13}{15-3}$$

$\therefore df(error) = n-c.$

$$MSSE = 11.33$$

Step 7:-

F-Ratio:-

$$F_{cal} = \frac{MSSC}{M.SSE} = \frac{14.6}{1.22.} = 1.288$$

Step 8:-

$$F_{tab} = F_{(2,12,0.05)} = 3.89$$

Step 9:-

$F_{cal} < F_{tab}$

$1.288 < 3.89$

Conclusion:-

Accept null hypothesis. There is a significant difference b/w the mean of method of sighting.

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