

ANOVA ~ Analysis of Variance :

→ The total variance in the joint sample is partitioned into 2 parts :

- i) Between Samples variances (Var for diff treatments)
- ii) Within Samples Variances - (Random Unexplained Disturbance).

$$\rightarrow F_c = \frac{\text{b/w samples variance}}{\text{within samples variance}}.$$

→ H_0 : All population means are same .

→ H_1 : All population means are not same .

-> One-Way ANOVA

- i) obtain mean of each sample $\sim \bar{x}_1, \bar{x}_2, \bar{x}_3 \dots \bar{x}_k$
- ii) Workout the mean of sample means :

$$\overline{\bar{x}} = \frac{\bar{x}_1 + \bar{x}_2 + \bar{x}_3 + \dots + \bar{x}_k}{k}$$

$$\overline{\bar{x}} = \frac{\bar{x}_1 + \bar{x}_2 + \bar{x}_3 + \dots + \bar{x}_k}{\text{no. of samples } (k)}$$

- iii) Take deviations of sample means from the mean of sample means & calculate the square of such deviations (Sum of Squared Between) SSB

$$SSB = n_1(\bar{x}_1 - \overline{\bar{x}})^2 + n_2(\bar{x}_2 - \overline{\bar{x}})^2 + n_3(\bar{x}_3 - \overline{\bar{x}})^2 + \dots + n_k(\bar{x}_k - \overline{\bar{x}})^2$$

- iv) Divide result of iii) by D-O-F between samples to obtain variance or mean squared between.

$$\rightarrow MSB = \frac{SSB}{(k-1)}$$

- v) Deviation within (SSW) \sim Sum of Squared Within.

v) Deviation within (SSW) ~ Sum of Squared Within

$$SSW = \sum (x_{1i} - \bar{x}_1)^2 + \sum (x_{2i} - \bar{x}_2)^2 + \dots + \sum (x_{ki} - \bar{x}_k)^2$$
$$i = 1, 2, 3, \dots, n$$

vi) Calculate MS Within = $\frac{SSW}{(n-k)}$ \approx MSW

Where $(n-k)$ represents D.O.F

n : Total no. of items in all samples
i.e. $n_1 + n_2 + \dots + n_k$

k : No. of samples.

vii) Sum of Squared Total Variance

$$SST = SSB + SSW$$

$$DOF = (n-1) = (k-1) + (n-k)$$

viii) F-Ratio = $\frac{MSB}{\underline{\underline{MSW}}}$

For rice prod data

Plot of land

Yield of wheat

A

B

C

1	6	5	5
2	7	5	4
3	3	3	3
4	8	7	4

H_0 : All wheat varieties are same or effects of different varieties on wheat production are same.

H_1 : All varieties are not the same.

$$i) \bar{x}_1 = \frac{6+7+3+8}{4} = \underline{\underline{6}} \quad \bar{x}_2 = \frac{5+5+3+7}{4} = \underline{\underline{5}}$$

$$\bar{x}_3 = \frac{5+4+3+4}{4} = \underline{\underline{4}}$$

$$ii) \text{ Mean of sample means : } \bar{\bar{x}} = \frac{\bar{x}_1 + \bar{x}_2 + \bar{x}_3}{k} \\ = \frac{6+5+4}{3} = \underline{\underline{5}}$$

$$iii) SS_B = 4(6-5)^2 + 4(5-5)^2 + 4(4-5)^2 \\ = \underline{\underline{8}}$$

$$v) SS_W = \{ (6-6)^2 + (7-6)^2 + (3-6)^2 + (8-6)^2 \} \\ + \{ (5-5)^2 + (5-5)^2 + (3-5)^2 + (7-5)^2 \} + \{ (5-4)^2 + (4-4)^2 + (3-4)^2 + (4-4)^2 \}$$

$$\begin{aligned}
 \text{vi) } SSW &= \{ (10-5)^2 + (10-5)^2 + (10-5)^2 + (10-5)^2 \} \\
 &+ \{ (5-5)^2 + (5-5)^2 + (3-5)^2 + (7-5)^2 \} \\
 &+ \{ (5-4)^2 + (4-4)^2 + (3-4)^2 + (2-4)^2 \} \\
 &= \underline{\underline{24}}
 \end{aligned}$$

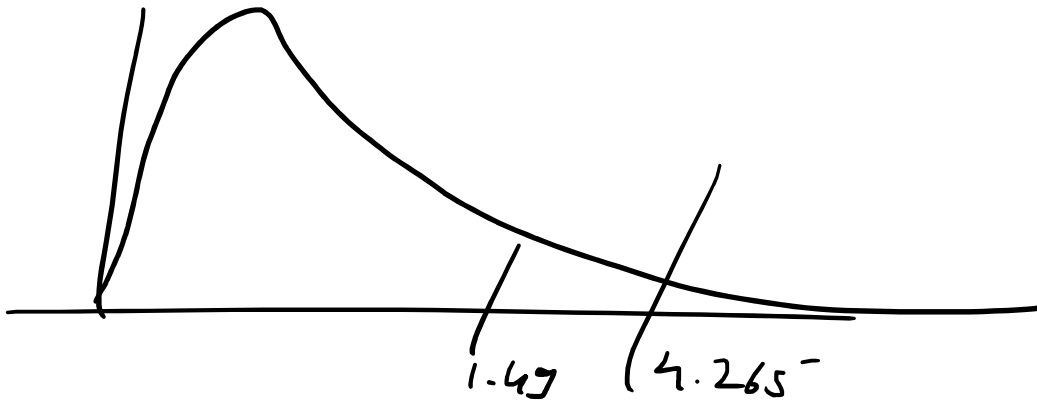
$$\begin{aligned}
 \text{vii) } SST &= (6-5)^2 + (7-5)^2 + (3-5)^2 + (8-5)^2 \\
 &+ (5-5)^2 + (5-5)^2 + (1-5)^2 + (7-5)^2 \\
 &+ (1-5)^2 + (2-5)^2 + (3-5)^2 + (4-5)^2 \\
 &= \underline{\underline{32}}
 \end{aligned}$$

→ ANOVA Table:

Source	<u>SS</u>	df	MS	F-ratio	Critical V ₀
<u>B/w Sample</u>	8	(3-1) = 2	8/2 = 4	4/2.67	F(2, 9)
<u>Within Sample</u>	24	(12-3) = 9	24/9 = 2.67	<u>= 1.47</u>	<u>= 4.265</u>
<u>Total</u>	32	(12-1) = 11			

	DF1	$\alpha = 0.05$																	
DF2	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	Inf
1	161.45	199.5	215.71	224.58	230.16	233.99	236.77	238.88	240.54	241.88	243.91	245.95	248.01	249.05	250.1	251.14	252.2	253.25	254.31
2	18.513	19	19.164	19.247	19.296	19.33	19.353	19.371	19.385	19.396	19.413	19.429	19.446	19.454	19.462	19.471	19.479	19.487	19.496
3	10.128	9.5521	9.2766	9.1172	9.0135	8.9406	8.8867	8.8452	8.8123	8.7855	8.7446	8.7029	8.6602	8.6385	8.6166	8.5944	8.572	8.5494	8.5264
4	7.7086	6.9443	6.5914	6.3882	6.2561	6.1631	6.0942	6.041	5.9988	5.9644	5.9117	5.8578	5.8025	5.7744	5.7459	5.717	5.6877	5.6581	5.6281
5	6.6079	5.7861	5.4095	5.1922	5.0503	4.9503	4.8759	4.8183	4.7725	4.7351	4.6777	4.6188	4.5581	4.5272	4.4957	4.4638	4.4314	4.3985	4.365
6	5.9874	5.1433	4.7571	4.5337	4.3874	4.2839	4.2067	4.1468	4.099	4.06	3.9999	3.9381	3.8742	3.8415	3.8082	3.7743	3.7398	3.7047	3.6689

	DF1	$\alpha = 0.05$																	
DF2	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	Inf
1	161.45	199.5	215.71	224.58	230.16	233.99	236.77	238.88	240.54	241.88	243.91	245.95	248.01	249.05	250.1	251.14	252.2	253.25	254.31
2	18.513	19	19.164	19.247	19.296	19.33	19.353	19.371	19.385	19.396	19.413	19.429	19.446	19.454	19.462	19.471	19.479	19.487	19.496
3	10.128	9.5521	9.2766	9.1172	9.0135	8.9406	8.8867	8.8452	8.8123	8.7855	8.7446	8.7029	8.6602	8.6385	8.6166	8.5944	8.572	8.5494	8.5264
4	7.7086	6.9443	6.5914	6.3882	6.2561	6.1631	6.0942	6.041	5.9988	5.9644	5.9117	5.8578	5.8025	5.7744	5.7459	5.717	5.6877	5.6581	5.6281
5	6.6079	5.7861	5.4095	5.1922	5.0503	4.9503	4.8759	4.8183	4.7725	4.7351	4.6777	4.6188	4.5581	4.5272	4.4957	4.4638	4.4314	4.3985	4.365
6	5.9874	5.1433	4.7571	4.5337	4.3874	4.2839	4.2067	4.1468	4.099	4.06	3.9999	3.9381	3.8742	3.8415	3.8082	3.7743	3.7398	3.7047	3.6689
7	5.5914	4.7374	4.3468	4.1203	3.9715	3.866	3.787	3.7257	3.6767	3.6365	3.5747	3.5107	3.4445	3.4105	3.3758	3.3404	3.3043	3.2674	3.2298
8	5.3177	4.459	4.0662	3.8379	3.6875	3.5806	3.5005	3.4381	3.3881	3.3472	3.2839	3.2184	3.1503	3.1152	3.0794	3.0428	3.0053	2.9669	2.9276
9	5.1174	4.2565	3.8625	3.6331	3.4817	3.3738	3.2927	3.2296	3.1789	3.1373	3.0729	3.0061	2.9365	2.9005	2.8637	2.8259	2.7872	2.7475	2.7067
10	4.9646	4.1028	3.7083	3.478	3.3258	3.2172	3.1355	3.0717	3.0204	2.9782	2.913	2.845	2.774	2.7372	2.6996	2.6609	2.6211	2.5801	2.5379
11	4.8443	3.9823	3.5874	3.3567	3.2039	3.0946	3.0123	2.948	2.8962	2.8536	2.7876	2.7186	2.6464	2.609	2.5705	2.5309	2.4901	2.448	2.4045
12	4.7472	3.8853	3.4903	3.2592	3.1059	2.9961	2.9134	2.8486	2.7964	2.7534	2.6866	2.6169	2.5436	2.5055	2.4663	2.4259	2.3842	2.341	2.2962
13	4.6672	3.8056	3.4105	3.1791	3.0254	2.9153	2.8321	2.7669	2.7144	2.671	2.6037	2.5331	2.4589	2.4202	2.3803	2.3392	2.2966	2.2524	2.2064
14	4.6001	3.7389	3.3439	3.1122	2.9582	2.8477	2.7642	2.6987	2.6458	2.6022	2.5342	2.463	2.3879	2.3487	2.3082	2.2664	2.2229	2.1778	2.1307
15	4.5431	3.6823	3.2874	3.0556	2.9013	2.7905	2.7066	2.6408	2.5876	2.5437	2.4753	2.4034	2.3275	2.2878	2.2468	2.2043	2.1601	2.1141	2.0658
16	4.494	3.6337	3.2389	3.0069	2.8524	2.7413	2.6572	2.5911	2.5377	2.4935	2.4247	2.3522	2.2756	2.2354	2.1938	2.1507	2.1058	2.0589	2.0096
17	4.4513	3.5915	3.1968	2.9647	2.81	2.6987	2.6143	2.548	2.4943	2.4499	2.3807	2.3077	2.2304	2.1898	2.1477	2.104	2.0584	2.0107	1.9604
18	4.4139	3.5546	3.1599	2.9277	2.7729	2.6613	2.5767	2.5102	2.4563	2.4117	2.3421	2.2686	2.1906	2.1497	2.1071	2.0629	2.0166	1.9681	1.9168
19	4.3807	3.5219	3.1274	2.8951	2.7401	2.6283	2.5435	2.4768	2.4227	2.3779	2.308	2.2341	2.1555	2.1141	2.0712	2.0264	1.9795	1.9302	1.878
20	4.3512	3.4928	3.0984	2.8661	2.7109	2.599	2.514	2.4471	2.3928	2.3479	2.2776	2.2033	2.1242	2.0825	2.0391	1.9938	1.9464	1.8963	1.8432
21	4.3248	3.4668	3.0725	2.8401	2.6848	2.5727	2.4876	2.4205	2.366	2.321	2.2504	2.1757	2.096	2.054	2.0102	1.9645	1.9165	1.8657	1.8117
22	4.3009	3.4434	3.0491	2.8167	2.6613	2.5491	2.4638	2.3965	2.3419	2.2967	2.2258	2.1508	2.0707	2.0283	1.9842	1.938	1.8894	1.838	1.7831
23	4.2793	3.4221	3.028	2.7955	2.64	2.5277	2.4422	2.3748	2.3201	2.2747	2.2036	2.1282	2.0476	2.005	1.9605	1.9139	1.8648	1.8128	1.757
24	4.2597	3.4028	3.0088	2.7763	2.6207	2.5082	2.4226	2.3551	2.3002	2.2547	2.1834	2.1077	2.0267	1.9838	1.939	1.892	1.8424	1.7896	1.733
25	4.2417	3.3852	2.9912	2.7587	2.603	2.4904	2.4047	2.3371	2.2821	2.2365	2.1649	2.0889	2.0075	1.9643	1.9192	1.8718	1.8217	1.7684	1.711
26	4.2252	3.369	2.9752	2.7426	2.5868	2.4741	2.3883	2.3205	2.2655	2.2197	2.1479	2.0716	1.9898	1.9464	1.901	1.8533	1.8027	1.7488	1.6906
27	4.21	3.3541	2.9604	2.7278	2.5719	2.4591	2.3732	2.3053	2.2501	2.2043	2.1323	2.0558	1.9736	1.9299	1.8842	1.8361	1.7851	1.7306	1.6717
28	4.196	3.3404	2.9467	2.7141	2.5581	2.4453	2.3593	2.2913	2.236	2.19	2.1179	2.0411	1.9586	1.9147	1.8687	1.8203	1.7689	1.7138	1.6541
29	4.183	3.3277	2.934	2.7014	2.5454	2.4324	2.3463	2.2783	2.2229	2.1768	2.1045	2.0275	1.9446	1.9005	1.8543	1.8055	1.7537	1.6981	1.6376
30	4.1709	3.3158	2.9223	2.6896	2.5336	2.4205	2.3343	2.2662	2.2107	2.1646	2.0921	2.0148	1.9317	1.8874	1.8409	1.7918	1.7396	1.6835	1.6223
40	4.0847	3.2317	2.8387	2.606	2.4495	2.3359	2.249	2.1802	2.124	2.0772	2.0035	1.9245	1.8389	1.7929	1.7444	1.6928	1.6373	1.5766	1.5089
60	4.0012	3.1504	2.7581	2.5252	2.3683	2.2541	2.1665	2.097	2.0401	1.9926	1.9174	1.8364	1.748	1.7001	1.6491	1.5943	1.5343	1.4673	1.3893
120	3.9201	3.0718	2.6802	2.4472	2.2899	2.175	2.0868	2.0164	1.9588	1.9105	1.8337	1.7505	1.6587	1.6084	1.5543	1.4952	1.429	1.3519	1.2539
Inf	3.8415	2.9957	2.6049	2.3719	2.2141	2.0986	2.0096	1.9384	1.8799	1.8307	1.7522	1.6664	1.5705	1.5173	1.4591	1.394	1.318	1.2214	1



∴ Null Hypothesis is accepted since
conclude the wheat samples in all
perspectives are the same.