

Text Example of One-Way ANOVA & Kruskal-Wallis

Group #1	Group #2	Group #3	Group #1	Group #2	Group #3
3	6	9	(1)	(3.5)	(10)
5	7	10	(2)	(5.5)	(13)
6	8	11	(3.5)	(7.5)	(15.5)
7	9	12	(5.5)	(10)	(17)
8	10	15	(7.5)	(13)	(18)
9	10		(10)	(13)	
	11			(15.5)	

$$R_1 = 29.5$$

$$R_2 = 68$$

$$R_3 = 73.5$$

ANOVA

$$n_1 = 6 \quad n_2 = 7 \quad n_3 = 5$$

$$\sum x_{1i} = 38 \quad \sum x_{2i} = 61 \quad \sum x_{3i} = 57$$

$$\sum (x_{1i})^2 = 264 \quad \sum (x_{2i})^2 = 551 \quad \sum (x_{3i})^2 = 671$$

$$SS_{TOT} = (264 + 551 + 671) - \frac{(38 + 61 + 57)^2}{18} = 134$$

$$SS_{BET} = \frac{38^2}{6} + \frac{61^2}{7} + \frac{57^2}{5} - \frac{(38 + 61 + 57)^2}{18} = 70.038$$

$$SS_W = \left[264 - \frac{38^2}{6} \right] + \left[551 - \frac{61^2}{7} \right] + \left[671 - \frac{57^2}{5} \right] = 63.962$$

Source of Variation	SS	DF	MS	F Ratio	F critical value	Test Decision
Between Groups	70.038	2	35.019	8.213	3.68	Reject H_0
Within Groups	63.962	15	4.264			
Total	134.000	17				

Kruskal-Wallis

$$H = \frac{12}{18(18+1)} \left[\frac{29.5^2}{6} + \frac{68^2}{7} + \frac{73.5^2}{5} \right] - 3(18+1)$$

$$H = 66.18 - 57 = 9.18$$

$$\chi_{0.05,2}^2 = 5.99, \therefore \text{reject } H_0$$

Two Way ANOVA - example from Freund

	Machine 1	Machine 2	Machine 3	
Operator A	16	9	22	← # of defective pieces produced by each machine by 4 different operators
	13	15	25	
	19	11	17	
Operator B	18	15	14	
	17	13	16	
	21	12	12	
Operator C	14	7	11	
	16	12	14	
	13	9	12	
Operator D	13	3	13	
	14	1	17	
	16	9	14	

Anova: Two-Factor With Replication

SUMMARY	Machine 1	Machine 2	Machine 3	Total
<i>Operator A</i>				
Count	3	3	3	9
Sum	48	35	64	147
Average	16	11.666667	21.333333	16.333333
Variance	9	9.333333	16.333333	26.25

<i>Operator B</i>				
Count	3	3	3	9
Sum	56	40	42	138
Average	18.666667	13.333333	14	15.333333
Variance	4.333333	2.333333	4	9

<i>Operator C</i>				
Count	3	3	3	9
Sum	43	28	37	108
Average	14.333333	9.333333	12.333333	12
Variance	2.333333	6.333333	2.333333	7.5

<i>Operator D</i>				
Count	3	3	3	9
Sum	43	13	44	100
Average	14.333333	4.333333	14.666667	11.111111
Variance	2.333333	17.333333	4.333333	31.861111

<i>Total</i>				
Count	12	12	12	
Sum	190	116	187	
Average	15.833333	9.666667	15.583333	
Variance	6.696969	18.969697	17.719697	

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Sample	172.75	3	57.583333	8.6016598	0.0004705	3.0087861
Columns	292.38889	2	146.194444	21.838174	3.956E-06	3.4028318
Interaction	143.83333	6	23.972222	3.5809129	0.0112091	2.5081874
Within	160.66667	24	6.6944444			
Total	769.63889	35				

keep Mr. A from machine #3

reserve Machine#2 for Mr. D.

all reject H_0
at 5% level