Application of Statistics in Educational Research I

MPU1034

One-Way ANOVA*

Prof. Dr. Mohd Salleh Abu
Dr. Hamidreza Kashefi

main source: Vernoy & Vernoy (1997)

The General Idea About One-Way Analysis of Variance (ANOVA)

- ✓ z test is applicable for testing hypothesis of any normally distributed data generated from a large n and involved with one independent variable
- ✓ *t* tests are applicable for testing hypothesis of data generated from:
  - one independent variable involving a single group of sample
  - one independent variable involving two independent groups of sample
  - one two-level independent variable involving two correlated groups of sample
- ✓ Strictly speaking, one-way ANOVA is an extended version of a *t* test; it lets you perform a *t* test for one independent variable with 3 or more levels at a time

Strong Notes:

If you were to conduct hypothesis testing of a specific independent variable involving 3 or more levels….

- ☑ You cannot draw a directly-transitive conclusion from multiple *t* tests among the different groups (as permitted by *t* tests)!
- ☑ Instead, you have to employ a one-way ANOVA (sometime called *F* test) for this purpose.
- ☑ As for *t* tests, the aim of one-way ANOVA is to determine whether the null hypothesis (H_o) can be safely rejected

Essential Steps in Performing One-Way ANOVA

- Setting The Hypotheses
- Estimating MSs*
- Finding *F* Value*
- Finding Degree of Freedom*
- Finding Critical *F* Value*
- Drawing up a Conclusion
- Finding *p* Value (optional)*
- Conducting *post hoc* Test*
- Drawing up a Conclusion

* *Executable by SPSS*

The Example:

You are to study the factor of unintended acceleration that cause road accident. It is hypothesised that the distance between the brake and the accelerator pedals plays a contributing factor in driver error that cause road accident. To test this hypothesis, you design an experiment in which subjects use one of three driving simulators, each with a different pedal arrangement. In the close-pedal arrangement, the distance between pedals is only 1 inch; in the moderate-pedal arrangement, it's 2 inches; and in the far-pedal arrangement, 3 inches.

You assign ten subjects to each condition and instruct them to drive their simulators for 4 hours. During these 4 hours, the number of errors made by each driver is recorded.

	Pedal arrangement	
Type 1 X_1	Type 2 X_2	Type 3 X_3
3	4	6
2	3	4
4	4	3
1	3	4
0	5	7
2	4	6
3	2	5
2	5	8
1	4	5
2	4	6

The Hypotheses

The null hypothesis:

H_o : There is no difference between the sample means of any of the level

$H_o : \mu_1 = \mu_2 = \ldots\ldots\ldots\ldots = \mu_k$

where k is the number of levels of the independent variable

The alternative hypothesis:

H_1 : At least one of the sample means comes from a population different from that of the other sample means.

(Refer to Example)

H_o : There is no difference between the sample means of any of the three level

$H_o : \mu_1 = \mu_2 = \mu_3$

H_1 : At least one of the three sample means comes from a population different from that of the other sample means.

Estimating The Mean Square (MS)

- ✓ The MS is the mean (the average) of the *squared* deviation scores used to calculate the variation.

- ✓ MS is equivalent to variance estimate (est. σ) for the *t* tests

- ✓ The are two types of MS:

  - ☑ mean square within groups (MS_{wg})
  - ☑ mean square between groups (MS_{bg})

Mean Square Within Group

$$MS_{wg} = \frac{\Sigma(X_1 - \overline{X}_1)^2 + \Sigma(X_2 - \overline{X}_2)^2 + \cdots + \Sigma(X_k - \overline{X}_k)^2}{(n_1 - 1) + (n_2 - 1) + \cdots + (n_k - 1)}$$

where

$\overline{X}_k$ is the mean for k^{th} group

k is the total number of different groups

Mean Square Between Group

$$MS_{bg} = \frac{n_1(\overline{X}_1 - \overline{\overline{X}})^2 + n_2(\overline{X}_2 - \overline{\overline{X}})^2 + \cdots + n_k(\overline{X}_k - \overline{\overline{X}})^2}{k - 1}$$

where

$\overline{X}_k$ is the mean for k^{th} group

$$\overline{\overline{X}} = \frac{\Sigma\overline{X}}{k} = \frac{\overline{X}_1 + \overline{X}_2 + \cdots + \overline{X}_k}{k}$$

k is the total number of different groups

note: MS_{bg} is always bigger or equal to MS_{wg}

(Refer to Example)

Pedal arrangement		
Type 1 X_1	Type 2 X_2	Type 3 X_3
3	4	6
2	3	4
4	4	3
1	3	4
0	5	7
2	4	6
3	2	5
2	5	8
1	4	5
2	4	6

$\Sigma X_1 = 20$ $\quad \Sigma X_2 = 38$ $\quad \Sigma X_3 = 54$

$\bar{X}_1 = 2$ $\quad \bar{X}_2 = 3.8$ $\quad \bar{X}_3 = 5.4$

$$\bar{\bar{X}} = \frac{\bar{X}_1 + \bar{X}_2 + \bar{X}_3}{k} = \frac{2 + 3.8 + 5.4}{3} = \frac{11.2}{3} = 3.733$$

or

$$\bar{\bar{X}} = \frac{\Sigma X_1 + \Sigma X_2 + \Sigma X_3}{N_{\text{total}}} = \frac{20 + 38 + 54}{30} = \frac{112}{30} = 3.733$$

(Refer to Example)

$$MS_{bg} = \frac{n_1(\bar{X}_1 - \bar{\bar{X}})^2 + n_2(\bar{X}_2 - \bar{\bar{X}})^2 + n_3(\bar{X}_3 - \bar{\bar{X}})^2}{k - 1}$$

$$= \frac{10(2 - 3.733)^2 + 10(3.8 - 3.733)^2 + 10(5.4 - 3.733)^2}{3 - 1}$$

$$= \frac{10(-1.733)^2 + 10(0.067)^2 + 10(1.667)^2}{2}$$

$$= \frac{10 \cdot 3.003 + 10 \cdot 0.004 + 10 \cdot 2.779}{2}$$

$$= \frac{30.03 + 0.04 + 27.79}{2} = \frac{57.86}{2} = 28.93$$

(Refer to Example)

Table 13.3 Calculations of Deviations and Squared Deviations for the Number of Pedal Errors with Three Pedal Arrangements

Pedal arrangement								
Type 1			Type 2			Type 3		
X_1	$X_1 - \bar{X}_1$	$(X_1 - \bar{X}_1)^2$	X_2	$X_2 - \bar{X}_2$	$(X_2 - \bar{X}_2)^2$	X_3	$X_3 - \bar{X}_3$	$(X_3 - \bar{X}_3)^2$
3	1	1	4	0.2	0.04	6	0.6	0.36
2	0	0	3	−0.8	0.64	4	−1.4	1.96
4	2	4	4	0.2	0.04	3	−2.4	5.76
1	−1	1	3	−0.8	0.64	4	−1.4	1.96
0	−2	4	5	1.2	1.44	7	1.6	2.56
2	0	0	4	0.2	0.04	6	0.6	0.36
3	1	1	2	−1.8	3.24	5	−0.4	0.16
2	0	0	5	1.2	1.44	8	2.6	6.76
1	−1	1	4	0.2	0.04	5	−0.4	0.16
2	0	0	4	0.2	0.04	6	0.6	0.36
$\Sigma(X_1 - \bar{X}_1)^2 = 12$			$\Sigma(X_2 - \bar{X}_2)^2 = 7.60$			$\Sigma(X_3 - \bar{X}_3)^2 = 20.40$		

(Refer to Example)

$$MS_{wg} = \frac{\Sigma(X_1 - \overline{X}_1)^2 + \Sigma(X_2 - \overline{X}_2)^2 + \Sigma(X_3 - \overline{X}_3)^2}{(n_1 - 1) + (n_2 - 1) + (n_3 - 1)}$$

$$= \frac{12 + 7.60 + 20.40}{(10 - 1) + (10 - 1) + (10 - 1)} = \frac{40}{9 + 9 + 9}$$

$$= \frac{40}{27} = 1.481$$

Finding The *F* Value

- ✓ *F* test is used to decide whether to reject the H_o or fail to reject H_o (for one independent variable with 3 or more levels at a time).
- ✓ It is done by comparing the MS_{bg} and MS_{wg} using the following formula:

$$\boxed{F = \frac{MS_{bg}}{MS_{wg}}}$$

- ✓ Observe that $F \geq 1$ as MS_{bg} is always bigger or equal to MS_{wg}

  If MS_{bg} and MS_{wg} are similar, then $F = 1$

(Refer to Example)

- ✓ In the example,

$$F = \frac{MS_{bg}}{MS_{wg}} = 28.930/1.481 = 19.534$$

Finding Degree of Freedom (*df*)

✓ There are two types of degree of freedom:

a. degree of freedom for the mean square between group (df_{bg})

b. degree of freedom for the mean square within groups (df_{wg})

$$df_{bg} = k - 1$$

$$df_{wg} = (n_1 - 1) + (n_2 - 1) + \ldots\ldots + (n_k - 1)$$

where

k is the total number of different groups

n_m is the number of observations for the m^{th} group

(Refer to Example)

- ✓ In the example,

$$df_{bg} = 3 - 1 = 2$$

$$df_{wg} = (10 - 1) + (10 - 1) + (10 - 1) = 27$$

Drawing Up A Conclusion

- ☑ The hypothesis testing for ANOVA is concluded in a similar way as we do for *t* tests.
- ☑ In ANOVA, we refer to Table *F* to identify the critical value of *F* (denoted by F_{cv})
- ☑ Table *F* is arranged so that we look for the computed degrees of freedom between groups (i.e. df_{bg}) in the row at the top of the table (denoted by df_N).

  The corresponding degrees of freedom within groups (i.e. df_{wg}) is in the most left column of the table (denoted by df_D)

(Refer to Example)

- ☑ In the example, with $\alpha = 0.05$ ($df_N = 2$ and $df_D = 27$) the critical F value is

$$F_{cv} = 3.35$$

- ☑ Conclusion:

  Observe that, with $\alpha = 0.05$, the $F = 19.534$ lies in the rejection region (as $F > F_{cv}$).

  Thus, we can reject H_0 and accept H_1 (i.e. there is a difference between at least two of the pedal arrangements and the difference is sigificant)

(This is vital if you use SPSS to perform ANOVA)

Finding The *p* Value (optional)

☑ Note that F is the ratio of two estimates i.e.

$$F = \frac{MS_{bg}}{MS_{wg}}$$

with $F \geq 1$

If the estimates are very different (i.e. the F value is <u>large</u>), then at least one of the samples probably comes from a population different from the other samples, so the H_1 is true (i.e. we can safely reject H_o)

☑ Recall that, in the example, using the Table F with $\alpha = 0.05$, $df_N = 2$ and $df_D = 27$, the critical value of F value is $F_{cv} = 3.35$

The computed $F = 19.354$ is large as compared to F_{cv} (i.e. much larger than 3.35 that we get from the Table F at $\alpha = 0.05$!!). Therefore, it is very probable for H_1 to occur (i.e. very unlikely for H_o to occur!).

In this case, if $\boldsymbol{p}$ is the probability for H_o to occur, then $\boldsymbol{p}$ is small with $\boldsymbol{p < 0.05}$ (in fact, $\boldsymbol{p}$ is smaller than 0.01 as the F_{cv} with $\alpha = 0.01$ is 5.49)

This tells us that the probability for H_o to occur is very small (i.e. less than the prescribed α).Thefore we reject H_o and accept H_1

The Source Table

- ☑ You will find a <u>source table</u> useful for the purpose of drawing up conclusion and reporting of ANOVA analysis.
- ☑ A <u>source table</u> displays the vital information of the ANOVA performed on the data; sum squares, degree of freedom, mean squares, F value and $\boldsymbol{p}$.

Source Table ($\alpha = 0.05$)

Source	***SS***	***df***	***MS***	***F***	***p***
Between groups	SS_{bg}	df_{bg}	MS_{bg}	F	< or > 0.05
Within group	SS_{wg}	df_{wg}	MS_{wg}		
Total	SS_{total}	df_{total}			

note: a. Reject H_o if $p < 0.05$

b. The exact *p* value can be found if you have very detailed Table *F* with various values of α (like the one adopted by SPSS)

Source Table (α = 0.01)

Source	***SS***	***df***	***MS***	***F***	***p***
Between groups	SS_{bg}	df_{bg}	MS_{bg}	F	< or > 0.01
Within group	SS_{wg}	df_{wg}	MS_{wg}		
Total	SS_{total}	df_{total}			

note: a. Reject H_o if $p < 0.01$

b. The exact *p* value can be found if you have very detailed Table *F* with various values of α (like the one adopted by SPSS)

(Refer to Example)

Source Table (α = 0.05)

Table 13.5 Source Table for Analysis of Variance of Pedal Error Data

Source	Sum of squares	*df*	Mean square	*F*	*p*
Between	57.867	2	28.934	19.537	<.05
Within	40.000	27	1.481		
Total	97.867	29			

Post Hoc Test

- ☑ The *F* test tells us whether we can safely reject the H_o. In the case where we reject H_o, it indicates that there is some difference between at least two and possibly more of the groups, but it does not reveal where that difference lies.

  However, there are several tests that can do so. These are called *post hoc* tests. *Post hoc is* Latin for *after the fact.*

- ☑ These tests are only conducted *after you* have determined that you have an *F* ratio that is significant.

- ☑ The one we discuss next is called the Tukey's HSD, which stands for *Tukey's honestly significant difference.*

Performing One-Way ANOVA Tests Using SPSS

Group	Type	Group	Type
1	3	2	4
1	2	2	2
1	4	2	5
1	1	2	4
1	0	2	4
1	2	3	6
1	3	3	4
1	2	3	3
1	1	3	4
1	2	3	7
2	4	3	6
2	3	3	5
2	4	3	8
2	3	3	5
2	4	3	6

```
ONEWAY
  Type BY Group
  /MISSING ANALYSIS
  /POSTHOC = TUKEY ALPHA(.05).
```

SPSS Generated One-Way ANOVA

Type	ANOVA				
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	57.8667	2	28.9333	19.530	0.000
Within Groups	40.000	27	1.4815		
Total	97.8667	29			

Sig. = *p*

How to Draw A Conclusion About The Test?

Method 1	Check the value of significant p ; Reject H_0 if $p < \alpha$
Method 2	Check the value of F ; Reject H_o if F falls in the rejection region (refer to $F_{c.v}$ identified from the Table F)

Conclusion: Reject H_o (i.e. there is significant difference between the means)

Post Hoc : Tukey's HSD

Multiple Comparisons

Dependent Variable: Type
Tukey HSD

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Group 1	Group 2	-1.800*	.544	.007	-3.15	-.45
	Group 3	-3.400*	.544	.000	-4.75	-2.05
Group 2	Group 1	1.800*	.544	.007	.45	3.15
	Group 3	-1.600*	.544	.018	-2.95	-.25
Group 3	Group 1	3.400*	.544	.000	2.05	4.75
	Group 2	1.600*	.544	.018	.25	2.95

*. The mean difference is significant at the .05 level.

Conclusion: There exists significant difference for each pair!

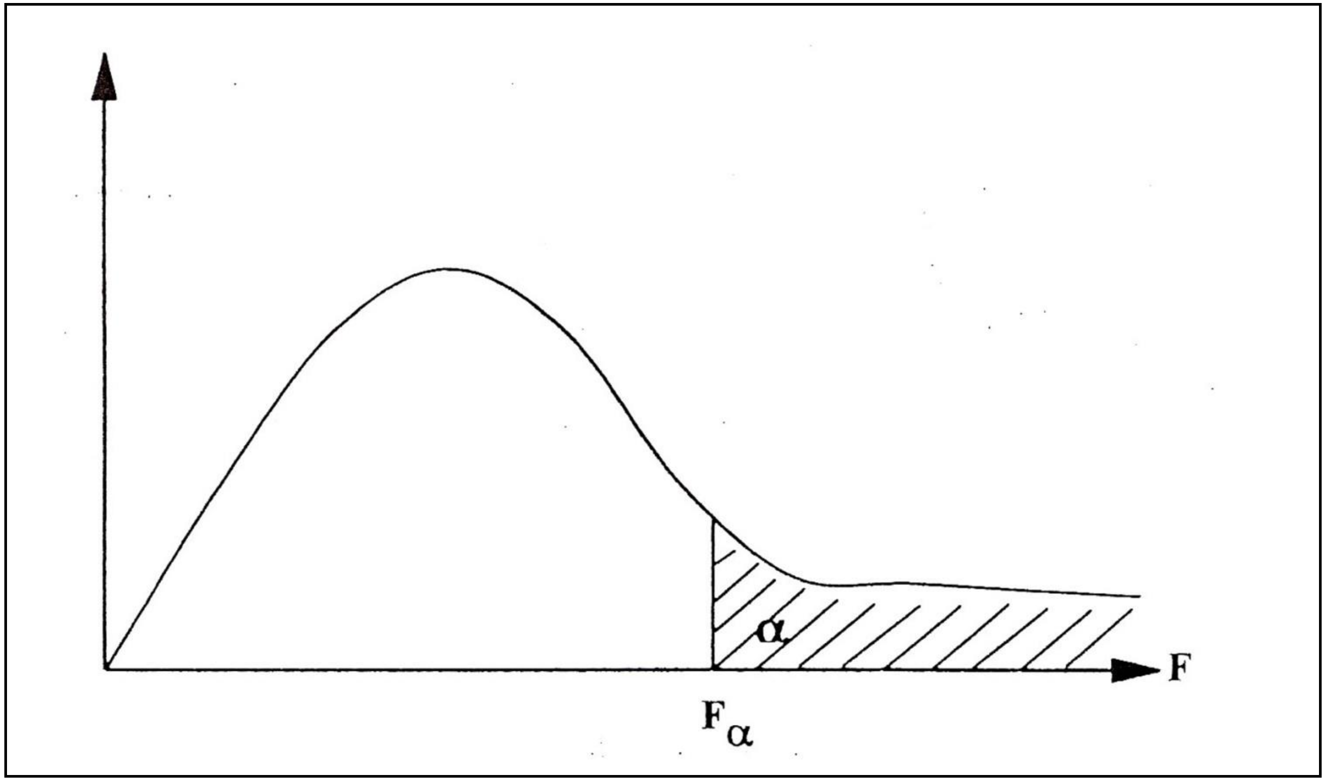
Observe that $p < \alpha$ for:

Group 1 vs Group 2 (with p = 0.007)

Group 1 vs Group 3 (with p = 0.000)

Group 2 vs Group 3 (with p = 0.018)

The *F* Distribution



- There are different set of formulas to solve ANOVA questions. In the next slides, you can seed the 4 steps solving ANOVA questions based on other formulas.

- <u>source</u>: Gravetter (2012)

G1 Walk-in shopping		G2 Online shopping		G3 Sales day shopping	
X_1	X_1	x_2	x_2	x_3	x_3
5	$5^2 = 25$	0	$0^2 = 0$	4	$4^2 = 16$
6	$6^2 = 36$	0	$0^2 = 0$	9	$9^2 = 81$
7	$7^2 = 49$	2	$2^2 = 4$	1	$1^2 = 1$
8	$8^2 = 64$	1	$1^2 = 1$	5	$5^2 = 25$
26	25 + 36 + 49 + 6	3	0 + 0 + 4 + 1	19	6 + 81 + 1 + 25
					123

T_1 : 5 + 6 + 7 + 8 = 26

T_2 : 0 + 0 + 2 + 1 = 3

T_3 : 4 + 9+ 1 + 5 = 19

$G = T_1 + T_2 + T_3 = 48$

STAGE 1

- State the hypothesis

$$H_o : \mu_1 = \mu_2 = \mu_3$$

STEP 2

$$F = \frac{78.34}{4.06} = 19.30$$

$$MSb = \frac{SSb}{dfb}$$

$$SSb = \left[\sum \frac{T^2}{n}\right] - \frac{G^2}{N}$$

$$= \left[\frac{T_1^2}{n_1} + \frac{T_2^2}{n_2} + \frac{T_3^2}{n_3}\right] - \frac{G^2}{N}$$

$$= \left[\frac{26^2}{} + \frac{3^2}{} + \frac{19^2}{}\right] - \frac{(48)^2}{}$$

$$MSw = \frac{SSw}{dfw}$$

$$dfw = N - k$$
$$= 12 - 3$$
$$= 9$$

$$SSw = \sum X_1^2 - \frac{(\sum X_1)^2}{n_1} + \sum X_2^2 - \frac{(\sum X_2)^2}{n_2} + \sum X_3^2 - \frac{(\sum X_3)^2}{n_3}$$

$$= 174 - \frac{(26)^2}{4} + 5 - \frac{(3)^2}{4} + 123 - \frac{(19)^2}{4}$$

$$= 1.03 + 2.75 + 32.75$$

$$= 36.53$$

STEP 3

dfb = k – 1
= 3 – 1
= **2**

dfw = N – k
= 12 – 3
= **9**

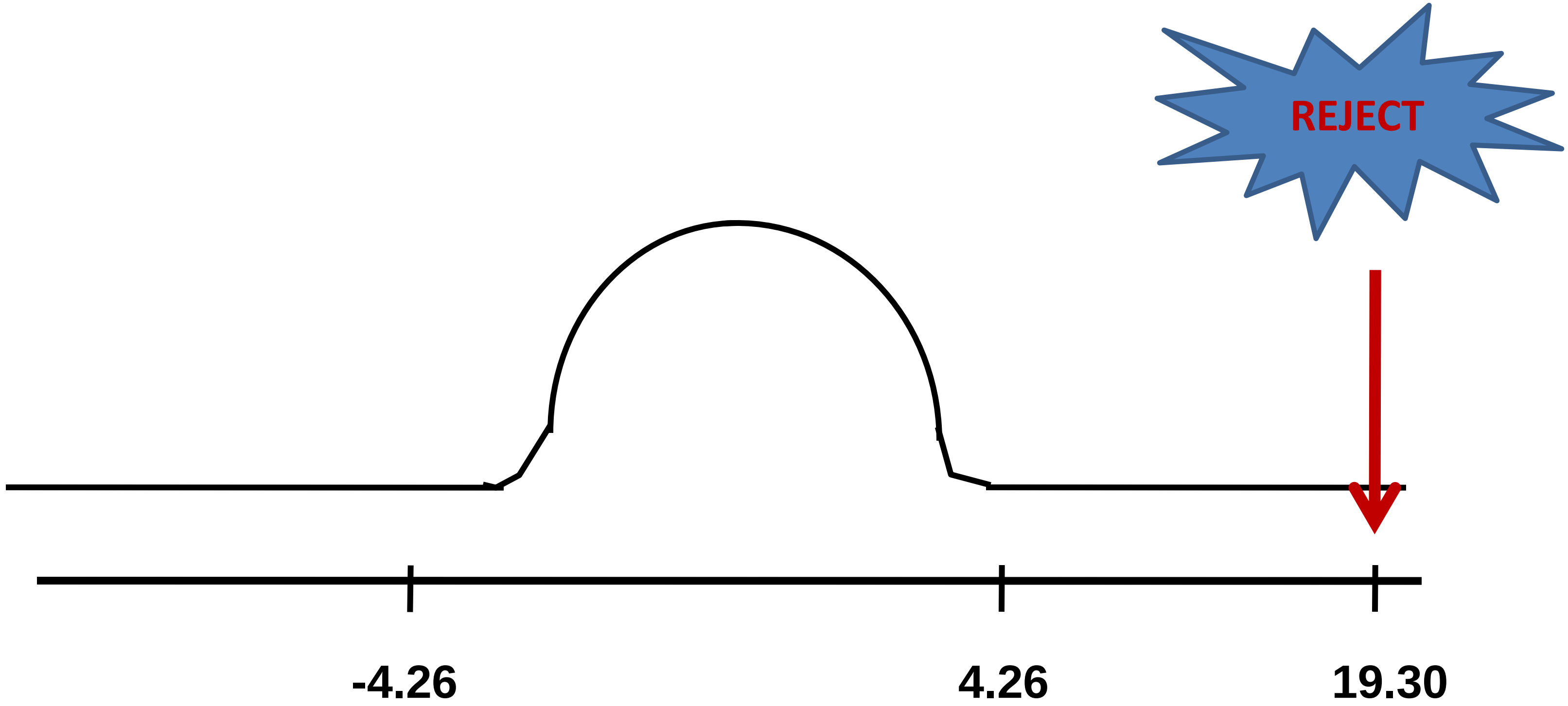
4.26

CRITICAL VALUES OF THE F DISTRIBUTION (1/6)

[illegible]ained F is significant at a given level if it is equal to or greater than the value shown in the table. The α=0.05 points on [illegible]tion are shown in the light row, and the α=0.01 points are shown in the dark row. [illegible] shown are the right tail of the distribution obtained by dividing the larger variance estimate by the smaller variance [illegible]e. [illegible]d the complementary left or lower tail for a given df and α level, reverse the degrees of freedom and find the [illegible]cal of [illegible]value in the F table. For example, the value cutting off the top 5 percent of the area for df of 7 and 12 is 2.85. To find the cutoff o[illegible] bottom 5 percent of the area, find the tabled value at the α=.05 level for 12 and 7 df (which equals 3.57). The reciprocal is 1/3.57[illegible].28. Thus 5% of the area falls at or below an F=0.28.

	Degrees of freedom for numerator											
	1	2	3	4	5	6	7	8	9	10	11	12
1	161 **4052**	[illegible] **[illegible]**	216 **5403**	225 **5625**	230 **5764**	234 **5859**	237 **5928**	239 **5981**	241 **6022**	242 **6056**	243 **6082**	244 **6106**
2	18.51 **98.49**	[illegible] **[illegible]**	19.16 **99.17**	19.25 **99.25**	19.30 **99.30**	19.33 **99.33**	19.36 **99.34**	19.37 **99.36**	19.38 **99.38**	19.39 **99.40**	19.40 **99.41**	19.41 **99.42**
3	10.13 **34.12**	[illegible] **[illegible]**	9.28 **29.46**	9.12 **28.71**	9.01 **28.24**	8.94 **27.91**	8.88 **27.67**	8.84 **27.49**	8.81 **27.34**	8.78 **27.23**	8.76 **27.13**	8.74 **27.05**
4	7.71 **21.20**	[illegible] **[illegible]**	6.59 **16.69**	6.39 **15.98**	6.26 **15.52**	6.16 **15.21**	6.09 **14.98**	6.04 **14.80**	6.00 **14.66**	5.96 **14.54**	5.93 **14.45**	5.91 **14.37**
5	6.61 **16.26**	[illegible] **[illegible]**	5.41 **12.06**	5.19 **11.39**	5.05 **10.97**	4.95 **10.67**	4.88 **10.45**	4.82 **10.27**	4.78 **10.15**	4.74 **10.05**	4.70 **9.96**	4.68 **9.89**
6	5.99 **13.74**	[illegible] **[illegible]**	4.76 **9.78**	4.53 **[illegible]**	4.39 **8.75**	4.28 **8.47**	4.21 **8.26**	4.15 **8.10**	4.10 **7.98**	4.06 **7.87**	4.03 **7.79**	4.00 **7.72**
7	5.59 **12.25**	[illegible] **[illegible]**	[illegible] **[illegible]**	[illegible] **[illegible]**	[illegible] **[illegible]**	3.87 **7.19**	3.79 **7.00**	3.73 **6.84**	3.68 **6.71**	3.63 **6.62**	3.60 **6.54**	3.57 **6.47**
8	5.32 **[illegible]**	[illegible] **[illegible]**	[illegible] **[illegible]**	[illegible] **[illegible]**	[illegible] **[illegible]**	3.58 **6.37**	3.50 **6.19**	3.44 **6.03**	3.39 **5.91**	3.34 **5.82**	3.31 **5.74**	3.28 **5.67**
9	[illegible] **[illegible]**	4.26 **8.02**	[illegible] **[illegible]**	[illegible] **[illegible]**	[illegible] **[illegible]**	3.37 **5.80**	3.29 **5.62**	3.23 **5.47**	3.18 **5.35**	3.13 **5.26**	3.10 **5.18**	3.07 **5.11**
10	4.96 **10.04**	4.10 **7.56**	[illegible] **6.55**	[illegible] **[illegible]**	[illegible] **5.64**	3.22 **5.39**	3.14 **5.21**	3.07 **5.06**	3.02 **4.95**	2.97 **4.85**	2.94 **4.78**	2.91 **4.71**
11	4.84 **9.65**	3.98 **7.20**	3.59 **6.22**	3.36 **5.67**	3.20 **5.32**	3.09 **5.07**	3.01 **4.88**	2.95 **4.74**	2.90 **4.63**	2.86 **4.54**	2.82 **4.46**	2.79 **4.40**
12	4.75 **9.33**	3.88 **6.93**	3.49 **5.95**	3.26 **5.41**	3.11 **5.06**	3.00 **4.82**	2.92 **4.65**	2.85 **4.50**	2.80 **4.39**	2.76 **4.30**	2.72 **4.22**	2.69 **4.16**
13	4.67 **9.07**	3.80 **6.70**	3.41 **5.74**	3.18 **5.20**	3.02 **4.86**	2.92 **4.62**	2.84 **4.44**	2.77 **4.30**	2.72 **4.19**	2.67 **4.10**	2.63 **4.02**	2.60 **3.96**
14	4.60 **8.86**	3.74 **6.51**	3.34 **5.56**	3.11 **5.03**	2.96 **4.69**	2.85 **4.46**	2.77 **4.28**	2.70 **4.14**	2.65 **4.03**	2.60 **3.94**	2.56 **3.86**	2.53 **3.80**
15	4.54 **8.68**	3.68 **6.36**	3.29 **5.42**	3.06 **4.89**	2.90 **4.56**	2.79 **4.32**	2.70 **4.14**	2.64 **4.00**	2.59 **3.89**	2.55 **3.80**	2.51 **3.73**	2.48 **3.67**
16	4.49 **8.53**	3.63 **6.23**	3.24 **5.29**	3.01 **4.77**	2.85 **4.44**	2.74 **4.20**	2.66 **4.03**	2.59 **3.89**	2.54 **3.78**	2.49 **3.69**	2.45 **3.61**	2.42 **3.55**
17	4.45 **8.40**	3.59 **6.11**	3.20 **5.18**	2.96 **4.67**	2.81 **4.34**	2.70 **4.10**	2.62 **3.93**	2.55 **3.79**	2.50 **3.68**	2.45 **3.59**	2.41 **3.52**	2.38 **3.45**
18	4.41 **8.28**	3.55 **6.01**	3.16 **5.09**	2.93 **4.58**	2.77 **4.25**	2.66 **4.01**	2.58 **3.85**	2.51 **3.71**	2.46 **3.60**	2.41 **3.51**	2.37 **3.44**	2.34 **3.37**

STEP 4



PERFORMING ANOVA (USING SPSS)

CALCULATING ANOVA (HYPOTHESIS TESTING) USING SPSS SOFTWARE

1. State hypothesis

   $H_o : \mu1 = \mu2 = \mu3$

2. Open the SPSS software

3. Insert variable
   a. >variable view
   b. >create data
   c. >Group ....—values = 1>walk in shopping
      = 2>online shopping
      = 3>sales day shopping
   d. >Sales

4. Insert the number
   a. >data view >Group ...- just put 1,2 and 3

>Sales ... – put in sales number

5. To find the answer
    a. >analyze
    b. >compare means
    c. >one way ANOVA
        i. >dependent list >sales
        ii. >factor >group
    d. >OK
    e. ...wait for the processing time....
    f. >result appeared

6. Interpreting the result
    a. Look at result’s table
    b. >sig
    c. If “sig” is bigger than 0.05 = accept the H_0
    d. If “sig” is smaller than 0.05 = reject the H_0