

What is the complete guide for interpreting ANOVA results in SAS?

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The complete guide for interpreting ANOVA results in SAS is a comprehensive resource that outlines the steps and considerations for effectively interpreting the output of an analysis of variance (ANOVA) in the SAS statistical software. This guide covers topics such as understanding the basic concepts of ANOVA, interpreting key statistics and graphs from the output, evaluating the significance of the results, and making appropriate conclusions based on the data. It also includes tips and best practices for effectively communicating the ANOVA results to others. By following this guide, SAS users can gain a better understanding of their ANOVA results and make informed decisions based on the findings.

Complete Guide: Interpret ANOVA Results in SAS

A one-way ANOVA is used to determine whether or not there is a statistically significant difference between the means of three or more independent groups.

The following example shows how to interpret the results of a one-way ANOVA in SAS.

Example: Interpret ANOVA Results in SAS

Suppose a researcher recruits 30 students to participate in a study. The students are to use one of three studying methods to prepare for an exam.

The exam results for each student are shown below:

Method A	Method B	Method C
78	81	84
81	83	88
82	83	88
82	85	89
85	86	90
88	88	93
88	90	95
90	91	98

We can use the following code to create this dataset in SAS:

```
/*create dataset*/  
data my_data;  
input Method $ Score;  
datalines;  
A 78  
A 81  
A 82  
A 82  
A 85  
A 88  
A 88  
A 90  
B 81
```

B 83

B 83

B 85

B 86

B 88

B 90

B 91

C 84

C 88

C 88

C 89

C 90

C 93

C 95

C 98

;

run;

Next, we'll use proc ANOVA to perform the one-way ANOVA:

```
/*perform one-way ANOVA*/  
proc ANOVAdata=my_data;  
class Method;
```

```

model Score = Method;
means Method / tukey cldiff;
run;

```

Note: We used the means statement along with the tukey and cldiff options to specify that a Tukey post-hoc test should be performed (with confidence intervals) if the overall p-value of the one-way ANOVA is statistically significant.

First, we'll look at the ANOVA table in the output:

The ANOVA Procedure
Dependent Variable: Score

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	175.5833333	87.7916667	5.26	0.0140
Error	21	350.2500000	16.6785714		
Corrected Total	23	525.8333333			

R-Square	Coeff Var	Root MSE	Score Mean
0.333914	4.698685	4.083941	86.91667

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Method	2	175.5833333	87.7916667	5.26	0.0140

Here is how to interpret every value in the output:

DF Model: The degrees of freedom for the variable

method. This is calculated as $\#groups - 1$. In this case, there were 3 different studying methods, so this value is: $3 - 1 = 2$.

DF Error: The degrees of freedom for the residuals. This is calculated as $\#total\ observations - \# groups$. In this case, there were 24 observations and 3 groups, so this value is: $24 - 3 = 21$.

Corrected Total: The sum of DF Model and DF Error. This value is $2 + 21 = 23$.

Sum of Squares Error: The sum of squares associated with the residuals or "errors." This value is 350.25.

Sum of Squares Corrected Total: The sum of SS Model and SS Error. This value is 525.833.

Mean Square Model: The mean sum of squares associated with *method*. This is calculated as $SS\ Model / DF\ Model$, which is $175.583 / 2 = 87.79$.

Mean Square Error: The mean sum of squares associated with the residuals. This is calculated as $SS\ Error / DF\ Error$, which is $350.25 / 21 = 16.68$.

F Value: The overall F-statistic of the ANOVA model. This is calculated as Mean Square Model / Mean Square Error, which is $87.79 / 16.68 = 5.26$.

Pr >F: The p-value associated with the F-statistic with numerator df = 2 and denominator df = 21. In this case, the p-value is 0.0140.

The most important value in the entire output is the p-value because this tells us whether there is a significant difference in the mean values between the three groups.

Recall that a one-way ANOVA uses the following null and alternative hypotheses:

H0 (null hypothesis): All group means are equal.
HA (alternative hypothesis): At least one group mean is different from the rest.

Since the p-value in our ANOVA table (0.0140) is less than .05, we reject the null hypothesis.

This means we have sufficient evidence to say that the mean exam score is not equal between the three studying methods.

To determine exactly which group means are different, we must refer to the final table in the output that shows the results of the Tukey post-hoc tests:

The ANOVA Procedure

Tukey's Studentized Range (HSD) Test for Score

Note: This test controls the Type I experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	21
Error Mean Square	16.67857
Critical Value of Studentized Range	3.56462
Minimum Significant Difference	5.1469

Comparisons significant at the 0.05 level are indicated by ***.

Method Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
C - B	4.750	-0.397	9.897	
C - A	6.375	1.228	11.522	***
B - C	-4.750	-9.897	0.397	
B - A	1.625	-3.522	6.772	
A - C	-6.375	-11.522	-1.228	***
A - B	-1.625	-6.772	3.522	

To tell which group means are different, we must look at which pairwise comparisons have stars (***) next to them.

From the table we can see there is a statistically significant difference in mean exam scores between

group A and group C.

Specifically, the mean difference in exam scores between group C and group A is 6.375.

The 95% confidence interval for the mean difference is .

There are no statistically significant differences between any other group means.

The following tutorials provide additional information about ANOVA models:

[A Guide to Using Post Hoc Tests with ANOVA](#)