Understanding Repeated Measures ANOVA using Google Sheets: A Step-by-Step Guide

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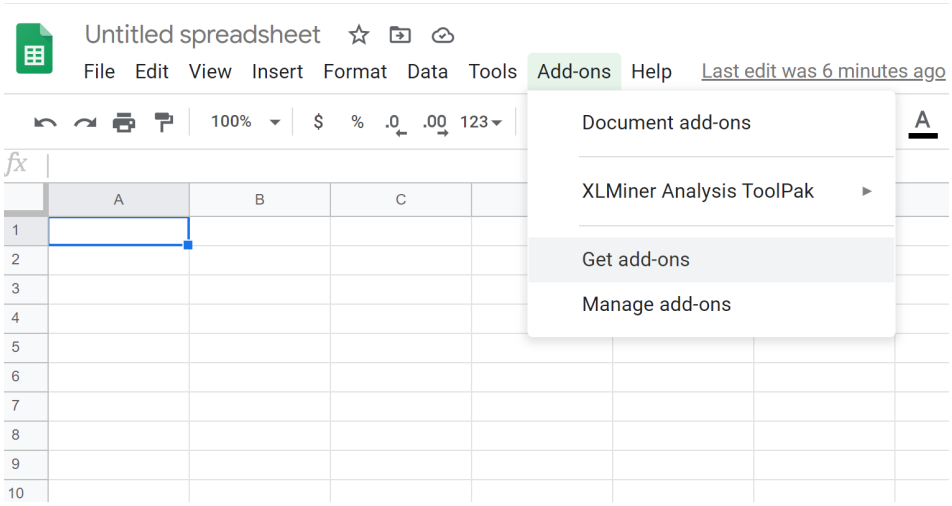
The repeated measures ANOVA (often abbreviated as RM ANOVA) is a powerful statistical test designed to assess whether there is a statistically significant difference between the means of three or more groups when the same subjects are measured across all conditions. This methodology is crucial in longitudinal studies or experiments where individual variability must be controlled, as subjects serve as their own control.

While specialized statistical software is typically used for complex analysis, this tutorial provides a comprehensive, step-by-step guide on how to successfully execute and interpret a repeated measures ANOVA using the accessible platform of Google Sheets.

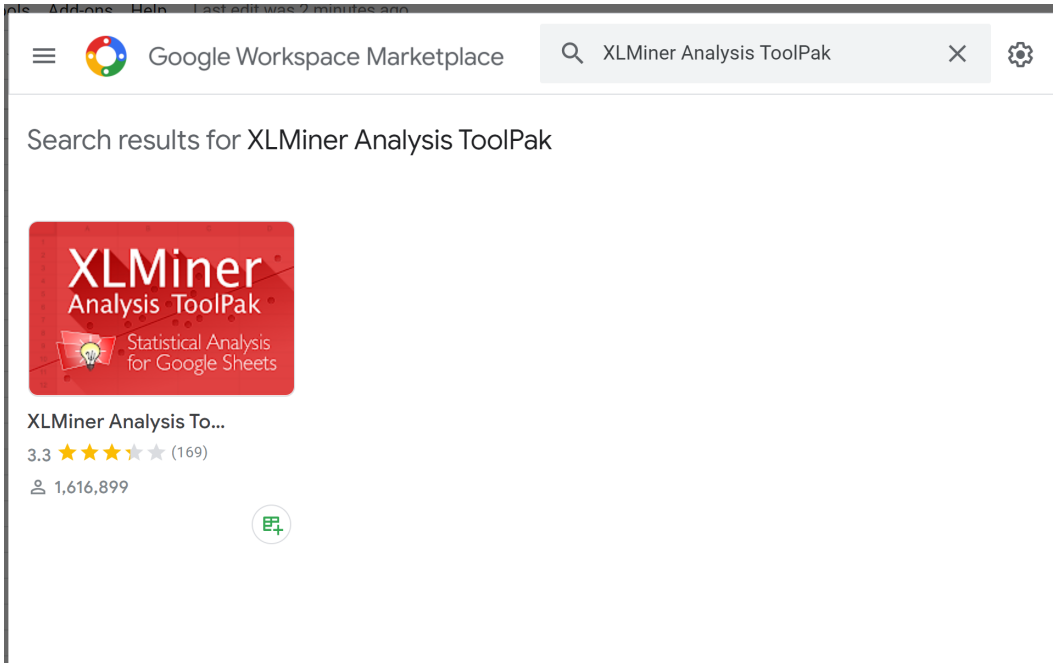
Step 1: Installing the XLMiner Analysis ToolPak Add-on

To enable the necessary advanced statistical functions within Google Sheets, such as the one-way ANOVA required for this analysis, we must first install the free extension known as the **XLMiner Analysis ToolPak**. This extension provides the computational power required to handle complex statistical calculations in the spreadsheet environment.

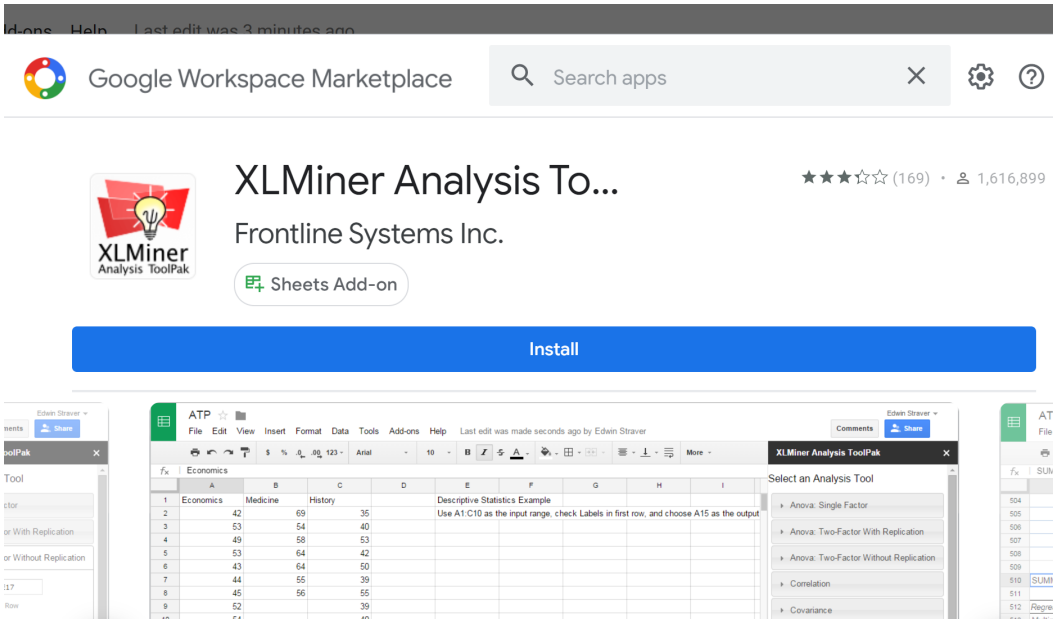
To begin the installation process, navigate to the main menu bar in Google Sheets and click on **Add-ons > Get add-ons**:



In the resulting search bar, input the name **XLMiner Analysis ToolPak** and select the corresponding icon that appears:



Finally, confirm the installation by clicking the **Install** button. Once installed, the XLMiner Analysis ToolPak will be permanently accessible under the 'Add-ons' menu, preparing your workspace for statistical analysis.



Step 2: Preparing and Entering the Data Set

The next critical step involves structuring and inputting the raw data that will be analyzed. Proper data formatting is absolutely essential for the ToolPak to execute the calculation correctly,

particularly ensuring that each subject's measurements are kept together in a single row.

For this example, imagine researchers are investigating whether four distinct pharmaceutical drugs lead to varying patient reaction times. To test this hypothesis, they measure the reaction time of five different patients under the influence of each of the four drugs. Because the same five patients participate in all four conditions, this is a classic within-subjects design, making the repeated measures ANOVA the statistically appropriate choice.

The recorded reaction times are structured below, with each column representing a drug condition and each row representing a unique patient (subject):

	A	B	C	D	E
1	**Patient**	**Drug 1**	**Drug 2**	**Drug 3**	**Drug 4**
2	Patient 1	30	28	16	34
3	Patient 2	14	18	10	22
4	Patient 3	24	20	18	30
5	Patient 4	38	34	20	44
6	Patient 5	26	28	14	30
7					
8					
9					
10					
11					
12					
13					
14					
15					

Step 3: Executing the Repeated Measures ANOVA Calculation

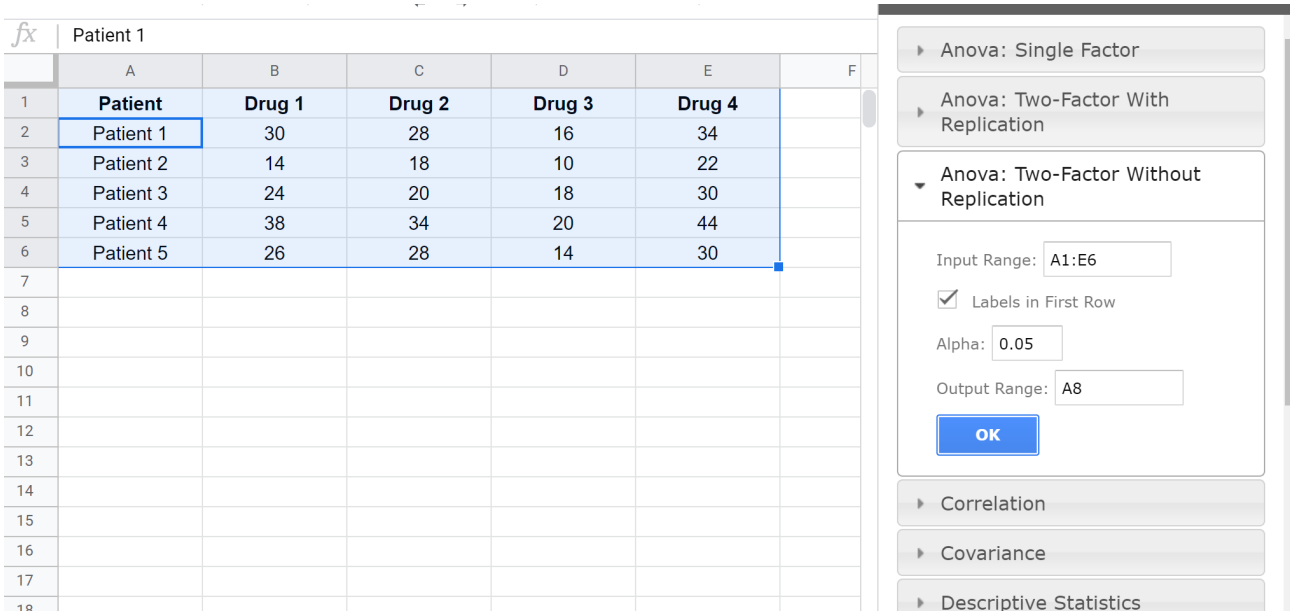
With the data entered correctly and the XLMiner add-on installed, we can now proceed to run the analysis. Access the ToolPak by clicking **Add-ons > XLMiner Analysis ToolPak > Start**. This action will open the analysis sidebar on the right side of your screen.

For a repeated measures design in this particular tool, you must select **ANOVA: Two-Factor With Replication**. Although this sounds like a two-way factorial ANOVA, this specific option is used to correctly partition the variance (separating the subject effect from the error term) for within-subjects designs.

Configure the parameters within the ToolPak interface as follows:

Input Range: Select the entire range of your data, ensuring you include the column headers (e.g., A1:D6).
Rows per sample: Since we have 5 subjects (rows) being measured repeatedly, you must enter the value 5 here.
Alpha: Set the significance level (typically 0.05).
Output Range: Specify the cell where you want the comprehensive results table to begin (e.g., A8).

After verifying all settings are accurate, click **OK** to generate the statistical output tables.



	A	B	C	D	E
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5	Patient 4	38	34	20	44
6	Patient 5	26	28	14	30

Step 4: Interpreting the ANOVA Results Table

Once you click **OK**, the results of the repeated measures ANOVA will instantly populate the spreadsheet starting at the output cell you specified (A8). The output provides several statistical summaries, but only a few key metrics are necessary for drawing conclusions regarding the drug effectiveness.

8	Anova: Two-Factor Without Replication						
9							
10	*SUMMARY*	*Count*	*Sum*	*Average*	*Variance*		
11	Patient 1	4	108	27	60		
12	Patient 2	4	64	16	26.66666667		
13	Patient 3	4	92	23	28		
14	Patient 4	4	136	34	104		
15	Patient 5	4	98	24.5	51.66666667		
16							
17	Drug 1	5	132	26.4	76.8		
18	Drug 2	5	128	25.6	42.8		
19	Drug 3	5	78	15.6	14.8		
20	Drug 4	5	160	32	64		
21							
22							
23	ANOVA						
24	*ource of Variatio*	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
25	Rows	680.8	4	170.2	18.10638298	0.000050689778	3.259166727
26	Columns	698.2	3	232.7333333	24.75886525	0.000019925013	3.490294821
27	Error	112.8	12	9.4			
28							
29	Total	1491.8	19				
30							

In this context, we are primarily interested in the variation explained by the different drugs, which is found under the **Columns** output section. The **Rows** section relates to the variance between the subjects themselves, which is typically factored out in a repeated measures design.

Reviewing the results for the Columns section, we identify the crucial statistics required for hypothesis testing:

The calculated F test-statistic is **24.75887**.
The corresponding p-value is **0.0000199**.

The F-statistic quantifies the ratio of variance explained by the treatment (the drugs) to the variance unexplained (error). The associated p-value represents the probability of observing the differences in means if the null hypothesis were true.

Step 5: Drawing a Final Conclusion

The final step in the analysis is to use the computed p-value to test the null hypothesis (H0), which posits that there is absolutely no difference in the mean reaction times across the four drug conditions.

The decision rule is straightforward: if the calculated p-value is less than the predetermined

significance level (Alpha, set at 0.05), we must **reject the null hypothesis**. If the p-value exceeds 0.05, we fail to reject H0.

In this specific example, the computed p-value (0.0000199) is significantly smaller than the alpha level of 0.05. Therefore, we firmly reject the null hypothesis and conclude that there is a statistically significant difference in mean response times among the four different drugs administered to the patients.

Additional Resources for Further Study

To deepen your understanding of this topic and explore alternative computational methods, consider the following instructional guides:

How to Perform a Repeated Measures ANOVA in Excel
Detailed Guide: How to Perform a Repeated Measures ANOVA By Hand
Online Tool: One-Way Repeated Measures ANOVA Calculator