



CalCOFI

The purpose of this research paper is to provide a comprehensive, step-by-step guide for conducting a **Repeated Measures ANOVA** using the Isalos Analytics Platform. Repeated Measures ANOVA extends one-way ANOVA by analyzing **multiple measurements** taken from the same subjects (or casts) across different conditions or time points, allowing analysts to assess how within-subject factors (e.g., depth) and between-subject factors (e.g., cast) influence a set of interrelated continuous outcomes. This methodology is particularly valuable in oceanographic research, where environmental parameters such as temperature and salinity are measured at various depths and should be analyzed together to account for within-cast correlations.

Repeated Measures ANOVA combines the principles of multivariate ANOVA (MANOVA) and univariate repeated measures. By including within-subject factors (e.g., Depth), the procedure accounts for the correlation between repeated measurements, thereby increasing statistical power and providing more accurate estimates of differences across conditions while controlling for individual variability.

Isalos version used: 2.1.5

The dataset used in this analysis is the **CalCOFI (California Cooperative Oceanic Fisheries Investigations) reduced Dataset**, available on Kaggle.

Source: [CalCOFI](#)

This dataset simulates real-world oceanographic records and includes cast-level information such as bottle count, cast count, depth measurements, temperature, and salinity. It is designed to support environmental monitoring and ecological research.

For the purposes of this Repeated Measures ANOVA analysis, variables are classified as follows:

- **Dependent Variables (Responses):**

- *T_degC* — Temperature in degrees Celsius or
- *Salnty* — Salinity in practical salinity units

These are continuous outcome measures to be analyzed simultaneously across depths.

- **Within-Subject Factor:**

- *Depthm* — Depth in meters (e.g., 0, 10, 20, 30, 50, 75 m)

This categorical variable represents the repeated-measures condition across which each cast is measured.

- **Between-Subject Factor:**

- *Cst_Cnt* — Cast count (e.g., 1 through 6)

This categorical variable represents independent groups whose multivariate effect on the oceanographic outcomes is of primary interest.

Step 1: Import Data from file

Firstly, launch the Isalos Analytics Platform (version 2.1.2). Then, in the left spreadsheet panel, create a new tab by clicking **File** and choose **Open** to load the CalCOFI dataset (or simply copy-paste the data from your spreadsheet).

Btl_Cnt	Cst_Cnt	Depthm	T_degC	Salnty
1	1	0	10.5	33.44
2	1	10	10.46	33.437
3	1	20	10.45	33.421
4	1	30	10.45	33.431
5	1	50	10.24	33.424
6	1	75	9.86	33.494
7	1	100	9.67	33.58
8	2	0	10.1	32.95
9	2	10	9.89	32.94
10	2	20	9.75	32.939
11	2	30	9.52	33.013
12	2	50	9.04	33.272
13	2	75	8.83	33.488
14	2	100	8.26	33.631
15	3	0	10.2	32.63
16	3	10	10.05	32.66

Step 2: Access the RM-ANOVA function

Navigate to the analysis module through the main menu by choosing the following path:

Statistics → Analysis of (Co)Variance → RM ANOVA

Then, you will see the RM ANOVA configuration window:

Repeated Measures ANOVA

Confidence Level (%) Double (0,100), Default: -

Sum of Squares for Tests Adjusted (Type III) ▼

Subject Column ▼

Within Column ▼

Dependent Variable ▼

Execute Cancel

Step 3: Configure RM ANOVA parameters

The Repeated Measures ANOVA model can be specified with varying levels of complexity. The model is expressed as:

$$[T_degC, Salnty] = \mu + \alpha_i(Cst_Cnt) + \beta_j(Depthm) + (\alpha\beta)_{ij} + \epsilon_{ijk}$$

This is a multivariate repeated measures model where the two dependent variables are regressed onto the within-subject factor (Depth) and the between-subject factor (Cast). The model includes main effects and the interaction between Cast and Depth.

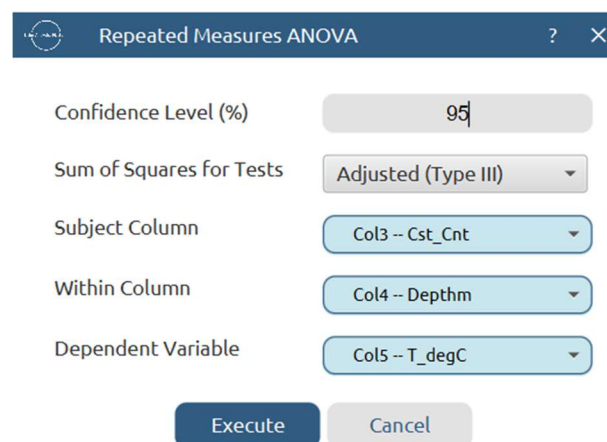
Important: The inclusion of interaction terms (e.g., $Cst_Cnt \times Depthm$) should be guided by theoretical considerations and exploratory data analysis. Repeated Measures ANOVA assumes sphericity—if this assumption is violated, corrections (e.g., Greenhouse-Geisser) may be necessary. For this basic demonstration, we focus on the **full factorial model**.

Steps in Isalos Analytics Platform:

In the RM ANOVA configuration window, set the following parameters:

- * **Confidence Level (%)**: 95
- * **Subject Column**: Col3 -- Cst_Cnt
- * **Within Column**: Col4 -- Depthm
- * **Dependent Variable**: Col5 -- T_degC

The formula preview will display the multivariate model as shown below:



The screenshot shows a dialog box titled "Repeated Measures ANOVA" with a question mark icon and a close button. It contains five configuration fields: "Confidence Level (%)" with a text input field containing "95"; "Sum of Squares for Tests" with a dropdown menu showing "Adjusted (Type III)"; "Subject Column" with a dropdown menu showing "Col3 -- Cst_Cnt"; "Within Column" with a dropdown menu showing "Col4 -- Depthm"; and "Dependent Variable" with a dropdown menu showing "Col5 -- T_degC". At the bottom, there are two buttons: "Execute" and "Cancel".

After configuring all parameters:

- * Review all selections to ensure accuracy.
- * Click the **Execute** button to run the analysis.
- * Wait for the computation to complete (processing time depends on dataset size and the number of dependent variables).

Step 4: Results

The analysis results will be displayed in the right spreadsheet panel. The output typically includes the following components:

WITHIN-SUBJECTS EFFECTS							
Source	Depthm	DF	Adj SS	Adj MS	F-Value	P-Value	Significant
Depthm	Linear	1	6.5331175	6.5331175	21.3491685	0.0012534	Yes
Error(Depthm)	Linear	9	2.7541146	0.3060127			
Depthm	Quadratic	1	1.1805001	1.1805001	12.8985658	0.0058255	Yes
Error(Depthm)	Quadratic	9	0.8236963	0.0915218			
Depthm	Cubic	1	0.0601667	0.0601667	1.1751302	0.3065340	No
Error(Depthm)	Cubic	9	0.4608000	0.0512000			
Depthm	Quartic	1	0.0056894	0.0056894	0.2649781	0.6191230	No
Error(Depthm)	Quartic	9	0.1932392	0.0214710			
Depthm	Order 5	1	0.0001458	0.0001458	0.0345801	0.8566020	No
Error(Depthm)	Order 5	9	0.0379554	0.0042173			
Depthm	Order 6	1	0.0043091	0.0043091	2.7022689	0.1346180	No
Error(Depthm)	Order 6	9	0.0143516	0.0015946			
BETWEEN-SUBJECTS EFFECTS							
Source	DF	Adj SS	Adj MS	F-Value	P-Value	Significant	
Intercept	1	8260.1165714	8260.1165714	892.4651812	0E-7	Yes	
Error	9	83.2985429	9.2553937				

Step 5 : Residual Analysis & Assumption's checks

Choose

Statistics → Analysis of (Co)Variance → RM ANOVA

and choose

Residual Analysis & Assumption's Checks.

You get the following window:

Residual Analysis & Assumption's Checks

Normality of Residuals

Statistical Tests

☐ Shapiro-Wilk Test

☐ Anderson-Darling Test

☐ Kolmogorov-Smirnov Test

Plots

☐ Normal Q-Q Plots

☐ Histogram of Residuals

☐ Density Plot of Residuals

Homogeneity of Variance (Homoscedasticity)

Statistical Tests

☐ Mauchly's Test

Plots

☐ Residuals vs Fitted Values

☐ Residuals vs Dependent Variable

☐ Boxplots by Group

☐ Violin Plot by Group

Residual Diagnostics

Plots

☐ Residuals vs Observation Order

Model Adequacy

Plots

☐ Residuals vs Fitted values

☐ Residuals vs Each Factors

Save

Cancel

and then choose the tests you want. For example, choose the following:

Residual Analysis & Assumption's Checks

Normality of Residuals

Statistical Tests

☒ Shapiro-Wilk Test

☒ Anderson-Darling Test

☒ Kolmogorov-Smirnov Test

Plots

☒ Normal Q-Q Plots

☒ Histogram of Residuals

☒ Density Plot of Residuals

Homogeneity of Variance (Homoscedasticity)

Statistical Tests

☐ Mauchly's Test

Plots

☒ Residuals vs Fitted Values

☒ Residuals vs Dependent Variable

☒ Boxplots by Group

☒ Violin Plot by Group

Residual Diagnostics

Plots

☒ Residuals vs Observation Order

Model Adequacy

Plots

☒ Residuals vs Fitted values

☒ Residuals vs Each Factors

Save

Cancel

and click save. You should have the following window open:


Repeated Measures ANOVA
?

Confidence Level (%)

Sum of Squares for Tests

Subject Column

Within Column

Dependent Variable

Residual Analysis & Assumption's Checks

After that, click execute and you get the results

