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Advanced ANOVA Configuration Guide

-> Example Excel template: the sample spreadsheet is included in the repository docs as `docs/StatisticalAnalyzer_Excel_Template.xlsx`. If you don't see it yet, run `./scripts/move_template.sh` (or `scripts\\move_template.bat` on Windows) from the repo root to move the file into `docs`.

Overview

This guide explains how to properly configure different types of ANOVA tests in BioMedStatX. Choosing the correct ANOVA type and variable assignments is crucial for obtaining valid statistical results.

ANOVA Types Available

1. Mixed ANOVA (Between + Within)
 2. Repeated Measures ANOVA (Within only)
 3. Two-Way ANOVA (Between only)
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Mixed ANOVA (Between + Within)

Use when: You have both repeated measurements over time/conditions AND different groups

Configuration:

- Select test: Mixed ANOVA (Between + Within)
- Dependent variable: Value (your outcome measure)
- Subject/ID variable: SubjectID (unique identifier for each participant)
- Within factors: Timepoint, Condition, Session (repeated measurements)
- Between factors: Group, Treatment, Gender (independent groups)

Example Scenarios:

- **Drug Study:** Measuring blood pressure (Value) before/after treatment (Timepoint) in placebo vs drug groups (Treatment)
- **Learning Study:** Testing performance (Value) across multiple sessions (Session) for different teaching methods (Method)
- **Clinical Trial:** Measuring symptoms (Value) at baseline/follow-up (Time) for different therapies (Therapy)

Data Structure Example:

SubjectID	Group	Timepoint	Value
S001	Drug	Pre	120
S001		Post	110
S002	Drug	Pre	130
S002		Post	115
S003	Placebo	Pre	125
S003	Placebo	Post	123

Repeated Measures ANOVA (Within only)

Use when: You have repeated measurements but ALL participants are in the same group

Configuration:

- Select test: Repeated Measures ANOVA (Within only)
- Dependent variable: Value (your outcome measure)
- Subject/ID variable: SubjectID (unique identifier)
- Within factors: Timepoint, Condition, Trial (repeated factor)
- Between factors: [LEAVE EMPTY!]

Example Scenarios:

- **Learning Curve:** Testing the same group's performance over multiple weeks
- **Dose Response:** Testing different drug doses on the same participants
- **Cognitive Testing:** Measuring reaction time under different cognitive loads

Data Structure Example:

SubjectID	Timepoint	Value
S001	Week1	85
S001	Week2	92
S001	Week3	98
S002	Week1	78
S002	Week2	85
S002	Week3	91

Two-Way ANOVA (Between only)

Use when: You have two independent factors but NO repeated measurements

Configuration:

- Select test: Two-Way ANOVA (Between only)
- Dependent variable: Value (your outcome measure)
- Subject/ID variable: [Can be empty or SubjectID]
- Within factors: [LEAVE EMPTY!]
- Between factors: Factor1, Factor2 (two independent factors)

Example Scenarios:

- **Treatment × Gender:** Testing treatment effect across different genders (one measurement per person)
- **Diet × Exercise:** Testing weight loss for different diet/exercise combinations
- **Education × Socioeconomic:** Testing academic performance across education levels and socioeconomic status

Data Structure Example:

SubjectID	Treatment	Gender	Value
S001	DrugA	Male	145
S002	DrugA	Female	132

S003	DrugB	Male	158
S004	DrugB	Female	141
S005	Placebo	Male	135
S006	Placebo	Female	128

Decision Tree: Which ANOVA to Choose?

Do you have repeated measurements?

- YES: Do you also have different groups?
 - YES: Mixed ANOVA (Between + Within)
 - NO: Repeated Measures ANOVA (Within only)
 - NO: Do you have two independent factors?
 - YES: Two-Way ANOVA (Between only)
 - NO: One-Way ANOVA (not covered in advanced tests)
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Common Configuration Errors

Don't Do This:

1. **Mixed ANOVA without Subject/ID:**
 - Will treat repeated measurements as independent
 - Violates assumptions and gives wrong results
 2. **Repeated Measures with Between factors:**
 - Use Mixed ANOVA instead
 - RM ANOVA is for within-subjects only
 3. **Two-Way ANOVA with repeated data:**
 - Will ignore the repeated nature of data
 - Use Mixed or RM ANOVA instead
 4. **Wrong factor assignment:**
 - Do not put grouping variables in “Within factors”
 - Do not put time/condition variables in “Between factors”
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Variable Assignment Checklist

Dependent Variable:

- Your outcome measure (continuous data)
- Examples: score, time, concentration, rating

Subject/ID Variable:

- Unique identifier for each participant
- Required for any repeated measures design
- Examples: SubjectID, ParticipantNumber, PatientID

Within Factors (Repeated):

- Variables measured multiple times on same subjects
- Examples: Time, Session, Condition, Trial, Dose
- Values: Pre/Post, Week1/Week2/Week3, Low/Medium/High

Between Factors (Independent):

- Variables that differ between subjects
 - Examples: Group, Treatment, Gender, Age_Category
 - Values: Control/Treatment, Male/Female, Young/Old
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Assumptions and Requirements

All ANOVA Types:

- **Normality:** Residuals should be normally distributed
- **Independence:** Observations should be independent (except for repeated measures)
- **Homogeneity:** Equal variances across groups

Additional for Repeated Measures:

- **Sphericity:** Equal variances of differences between all pairs of repeated measures
- Tested with Mauchly's test
- Corrected with Greenhouse-Geisser or Huynh-Feldt when violated

Additional for Mixed ANOVA:

- **Between-factor homogeneity:** Equal variances across between-subjects groups
 - **Within-factor sphericity:** For the repeated measures component
 - **Compound symmetry:** More stringent assumption than sphericity
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Example Outputs to Expect

Main Effects:

- **Significant main effect of Time:** Change occurs over time/conditions
- **Significant main effect of Group:** Groups differ overall
- **Non-significant main effect:** No overall difference for that factor

Interactions:

- **Significant interaction:** The effect of one factor depends on the level of another
- **Non-significant interaction:** Factors act independently

Post-hoc Tests:

- **Between-subjects:** Tukey HSD, Dunnett tests
 - **Within-subjects:** Paired t-tests with correction
 - **Mixed comparisons:** Combination of both approaches
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Best Practices

1. Plan your analysis before data collection
2. Check your data structure matches your ANOVA type
3. Verify all assumptions before interpreting results
4. Use appropriate post-hoc tests for significant effects
5. Report effect sizes along with p-values

6. Consider corrections for multiple comparisons

This guide is part of the BioMedStatX documentation. For technical issues or feature requests, please visit our GitHub repository.