

## Quiz, Lesson 6: Introduction to Linear Mixed Models

Your Score:  
100%

Congratulations! Your score of 100% indicates that you've mastered the topics in this lesson. If you'd like, you can review the feedback for each question.

When you're ready to start the next lesson, exit this lesson and begin the next one.



1. Suppose a company wants to determine which of two marketing promotions (A or B) is most effective. The company selects a random sample of customers to receive one of the marketing promotions, and measures the total amount of money each customer spent on promoted products. In the study data set, what type of effect is **Customer**?
  - a. fixed
  - b. random
  - c. mixed
  - d. none of the above

Your answer: **b**

Correct answer: **b**

**Customer** is a random effect. The customers in the study represent a sample of the larger population of customers. The inference from the data analysis applies to all of the company's customers and not only to the customers included in the study.



2. The general linear mixed model extends the general linear model in which of the following ways?
  - a. The general linear mixed model allows for random effects.
  - b. The general linear mixed model allows for both correlated error terms and error terms with heterogeneous variance.
  - c. The general linear mixed model allows for the response variable to have a nonnormal distribution.
  - d. both a and b

Your answer: **d**

Correct answer: **d**

The general linear mixed model extends the general linear model by including random effects in the model and allowing for both correlated error terms and error terms with heterogeneous variance.



3. In PROC GLIMMIX, which statement is used to specify the fixed effects?
  - a. FIXED statement
  - b. MODEL statement
  - c. RANDOM statement
  - d. RANDOM statement with the RESIDUAL keyword

Your answer: **b**

**Correct answer: b**

In PROC GLIMMIX, the MODEL statement specifies the fixed effects. All random effects are specified in the RANDOM statement. There is no FIXED statement in PROC GLIMMIX.

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4. Which of the following is one of the assumptions for general linear mixed models?

- a. Random effects and random errors need not be normally distributed.
- b. Random effects and fixed effects are independent of each other.
- c. The response variable has a nonnormal distribution.
- d. Random effects and random errors are normally distributed with mean zero and covariance matrices G and R respectively.

**Your answer: d**

**Correct answer: d**

Random effects and random errors are normally distributed with mean zero and covariance matrices G and R respectively. Because normal data can be modeled entirely in terms of the means and variances (covariances), the two sets of parameters in a linear mixed model specify the complete probability distribution of the data. The parameters of the variance-covariance model, which are referred to as covariance parameters, consist of both the random-effects parameters (which are contained in the G matrix) and the random-errors parameters (which are contained in the R matrix).

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5. Which estimation technique is used by PROC GLIMMIX to estimate fixed-effect parameters and standard errors for linear mixed models?

- a. restricted maximum likelihood
- b. generalized least squares estimation
- c. ordinary least squares
- d. maximum likelihood

**Your answer: b**

**Correct answer: b**

For linear mixed models, PROC GLIMMIX uses the generalized least squares estimation method to estimate fixed-effect parameters and standard errors. This method takes into account the variance-covariance matrices for the random effects and residuals and is therefore more appropriate for linear mixed models than the ordinary least squares method.

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6. Suppose you are working with automotive data that have the two factors **State** and **Make** (make of the car). Each make of car can be found within each state. Which type of classification pattern does this data represent?

- a. nested classification
- b. crossed classification
- c. hierarchical classification
- d. There is not enough information to identify the classification pattern.

**Your answer: b**

**Correct answer: b**

If two factors are crossed, then observations are collected for each combination of each level of the two factors—that is, each level of each factor can occur with each level of the other factor. In this example, observations are collected for cars in each level of **Make** and **State**. It is clear that

each level of one factor can occur with each level of the other factor.

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