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Practice 4.2 (Level 1): Least Squares Means for an ANCOVA Model

Task

In this practice, you continue to work with the ANCOVA model that is based on the **mydata.school** data set, which shows the effect of **Words1** and **Gender** on **Reading3** scores. Here, you use least squares means to produce the estimate of the average dependent variable for each group at the mean value of the covariate. This enables you to determine which group means are different. Note: For additional details about the model, see practice 4.1.

Reminder: Make sure you've defined the **mydata** library.

1. Write a PROC GLM step and use the LSMEANS statement to determine whether there is a difference between the genders when **Words1** equals the average value, *40*, or *60*. Use the ADJUST=TUKEY option. Examine the means plots and diffograms.

```
proc glm data=mydata.school;
   class Gender;
   model Reading3=Gender|Words1;
   lsmeans Gender / pdiff adjust=tukey;
   lsmeans Gender / at Words1=40 pdiff adjust=tukey;
   lsmeans Gender / at Words1=60 pdiff adjust=tukey;
title 'L-S Means';
run;
quit;
```

   Examine the results.

   In the first Least Squares Means table (from the first LSMEANS statement), the least squares means are calculated with **Words1** at the mean score of 18.12. (The mean of **Words1** is not shown here, but you can use PROC MEANS to display the mean, as you would in initial exploratory analysis.) The Least Squares Means table shows that The *p*-value shown is 0.3515. Therefore, you do not reject the null hypothesis. At the average value of **Words1** (18.12), there is not sufficient evidence to conclude that there is a difference in the average **Reading3** scores for boys and girls. In the Reading3 Comparisons for Gender diffogram, notice that the line segment crosses the diagonal reference line. This indicates no significant difference between the two least squares means when **Words1** equals its average value of 18.12.

   In the second Least Squares Means table (from the second LSMEANS statement), least squares means are calculated with **Words1** at a value of 40. The *p*-value is 0.0136. Presuming a level of significance of 0.05, you reject the null hypothesis. When **Words1** = 40, there is sufficient evidence to conclude that there is a difference in the average **Reading3** scores for boys and girls. In the diffogram, notice that the line segment does not cross the diagonal reference line. This indicates that when **Words1** equals 40, **Reading3** scores for boys and girls do differ significantly.

   In the third Least Squares Means table (from the third LSMEANS statement), least squares means are calculated with **Words1** at a value of 60. The *p*-value shown is 0.0117. Presuming a level of significance of 0.05, you reject the null hypothesis. When **Words1** = 60, there is sufficient evidence to conclude that there is a difference in the average **Reading3** scores for boys and girls. The diffogram illustrates that when **Words1** equals 60, **Reading3** scores for boys and girls are significantly different.

   Note: The TUKEY adjustment might not be necessary because you were comparing only two groups in each LSMEANS statement. The adjusted tests are the same as the unadjusted tests for this situation.

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