Type I and Type II Error Rates

Earlier in this lesson, you reviewed the three assumptions of ANOVA. The assumption of independent observations means that no observations provide any information about any other observations that you collect. For example, measurements are not repeated on the same subject. The assumption that the data for each group is approximately normal can be verified by examining plots of the data. In theory, the data for each group should be checked separately for normality. In practice, residuals are usually checked for normality. Residuals are the differences between the observed and predicted values for each observation. The assumption of constant variances can be checked by looking at descriptive statistics and plots of the data. A test for constant variances for one-way ANOVA can also be conducted. If these assumptions are not valid, then the probability of drawing incorrect conclusions from the analysis might be increased.

The effects of violating the assumptions underlying the ANOVA on Type I and Type II error rates have been of great concern to researchers and statisticians. Let's look at these effects and also review the concept of Type I and Type II error rates. Broadly speaking, the goal of testing statistical hypotheses is to determine whether a claim or conjecture about some feature of the population, a parameter, is strongly supported by the information obtained from the sample data.

Recall that we're interested in determining whether or not a significant difference in the mean value of the response variable exists across the groups. The null hypothesis, H_0, for ANOVA states that the average value of the response variable is the same for the groups being tested. The alternative hypothesis, H_1, states that the average is not the same for the groups being tested. Therefore, based on the results of the hypothesis test, you can reject the null hypothesis in favor of the alternative hypothesis and conclude that there is a significant difference in the group means. As an alternative, you can fail to reject the null hypothesis and state that there is not enough evidence to conclude a significant difference in the group means.

In hypothesis testing, we can identify two types of potential errors, labeled Type I error and Type II error. The Type I error rate, often denoted as α, is the probability of wrongly rejecting the null hypothesis when H_0 is true. The Type I error rate is also called the significance level of a test. A customary level for alpha for a hypothesis test is 0.05.

The Type II error rate, often denoted as β, is the probability of failing to reject the null hypothesis when H_0 is false. The power of a statistical test is equal to 1-β. This is the probability that you correctly reject the null hypothesis, or the probability of detecting a true effect. You prefer that your tests have a low Type I error rate and a high power. However, α and β cannot be determined independently of each other. They also depend on the sample size and the standard errors of the test of interest.

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