STATISTICS FOR ENGINEERS
ASSIGNMENT 12
ANSWERS

This homework assignment deals with problems from all previous chapters. Please make sure you read the questions thoroughly and think about them before you begin your answer. Some of these questions use a real data set; you will need to use a data analysis program. At this point, Excel is still usable. The solutions I will post, however, will use `R`. Download the data from the web site. The filename is `crime.csv`. When you download the dataset, remember to right click and save it as a `csv` file.

The data come from a 50-state (plus the District) survey of crime rates wealth and education. There are several variables in the data, but the variables of interest are `vcrime90` and `vcrime00` (the violent crime rate in 1990 and in 2000), `pcrime90` and `pcrime00` (the property crime rate in 1990 and 2000), `unemp90` and `unemp00` (unemployment rates in 1990 and 2000), `cultdom` (the dominant political culture in the state), and `census4` (the census region of the United States for that state).

This assignment needs to be typed in a nice format, with a brief discussion for each problem. Each answer should be a paragraph in length (a few sentences) and should specify your null hypothesis, your test(s), the tests statistic(s), the degrees of freedom, and the p-value(s). When you hand in this assignment, attach your work to the back of the typed pages. That way, if your numbers are different from mine, I may be able to determine what you did wrong.

Good luck!

Problem 12.1

Did the violent crime rate in the South change significantly between 1990 and 2000? To determine this, find the means and variances of the violent crime rate in the South for 1990 and 2000. Determine which test should be used. Perform the test. Report your results.

Solution: In 1990, the violent crime rate in the South was 767 (with a variance of 267,913), while in 2000 it was 602 per 100,000 people (with a variance of 98,414). Thus, the violent crime rate did decline in the South during that decade. However, is this difference statistically significant? To determine this, we will use a paired t-test of the means, since we have repeated measures on the same individuals (states, here). According to the test, the violent crime rate in 2000 was significantly different at the $\alpha = 0.05$ level from the violent crime rate in 1990 in the South ($t = 2.8605$, $\nu = 16$, $p = 0.01133$). ◇

Problem 12.2

Was there a significant relationship between the unemployment rate in 1990 and the violent crime rate in 1990? To determine this, find the means and variances of the two variables. Find the covariance and the correlation between the two variables. Determine if this correlation is significantly different from zero.

Solution: Many hypothesize a relationship between unemployment rates and violent crime rates. In 1990, the unemployment rate was 5.47 (with a variance of 1.26) and the violent crime rate was 572 (with a variance of 151,636). The covariance between these two variables is 8.36. Dividing the covariance by the product of the standard deviations give us a correlation of $\rho = 0.0189$. This is not statistically different from zero ($t = 0.1322$, $\nu = 49$, $p = 0.8954$). As such, we can conclude that the data supports the hypothesis that there is no relationship between unemployment and violent crime. ◇

Problem 12.3

Which of the three political cultures corresponded to states with the highest property crime rates in 2000? Was this culture significantly larger than either of the other two? To determine this, find the means and variances for each of the three types of political cultures, and perform means tests between each pair of cultures (3 tests altogether). Make the appropriate p-value alteration using Bonferroni's method (as discussed in the book).

Solution: There are three political cultures in the United States: Individualistic, Moralistic, and Traditionalistic. Dividing the 50 states into three groups based on their dominant political culture allows us to ask if there is a relationship among the three and the property crime rate in 2000. The Individualistic states had a mean property crime rate of 3563 (with a variance of 842,669). The Moralistic states had a mean property crime rate of 3308 (with a variance of 582,860). The Traditionalistic states had a mean property crime rate of 3946 (with a variance of 757,893).

Using a series of three t-tests, assuming equal variances as none of the variances were statistically different, $F = 0.6917$, $\nu_n = 16$, $\nu_d = 16$, $p = 0.4692$, we find that Traditionalistic states did have a statistically higher property crime rate than Moralistic states ($t = -2.2418$, $\nu = 31$, $p = 0.03227$). However Traditionalistic states did not have a statistically higher property crime rate than individualistic states ($t = 1.2302$, $\nu = 31$, $p = 0.2279$), nor did Moralistic states have higher property crime rates than Individualistic states ($t = -0.8783$, $\nu = 32$, $p = 0.3863$). ◇

Problem 12.4

Oklahoma's property crime rate in 2000 was 4060.8 per 100,000 people. The national average was 3602.84. Was Oklahoma's property crime rate significantly higher than the national average in 2000? What about in 1990?

Solution: In 2000, Oklahoma's property crime rate was 4060.8, whereas the national average was 3602.84. Using a one-sample t-test, we can see that Oklahoma *did* have a statistically higher property crime rate than the average state ($t = -3.7713$, $\nu = 50$, $p = 0.0004306$).

In 1990, Oklahoma's property crime rate was 5051.2, whereas the national average was 4734.82. Again using a one-sample t-test, we can see that Oklahoma did *not* have a statistically higher property crime rate than the average state ($t = -1.8934$, $\nu = 50$, $p = 0.0641$). ◇