**Quantitative Methods**

**List of Exercises N. 5**

**Selected Exercises from McClave (2014) – Chapter 7**

**7.2 Formulating Hypothesis And Setting Up the Rejection Region**

1. (15). ***FDA certification of new drugs***. According to Chemical Marketing Reporter, pharmaceutical companies spend USD 15 billion per year on research and development of new drugs. The pharmaceutical company must subject each new drug to lengthy and involved testing before receiving the necessary permission from the Food and Drug Administration (FDA) to market the drug. The FDA’s policy is that the pharmaceutical company must provide substantial evidence that a new drug is safe prior to receiving FDA approval, so that the FDA can confidently certify the safety of the drug to potential consumers.

1. If the new drug testing were to be placed in a test of hypothesis framework, would the null hypothesis be that the drug is safe or unsafe? The alternative hypothesis?
2. Given the choice of null and alternative hypothesis in part a, describe Type I and Type II errors in terms of this application. Define α and β I terms of this application.
3. If the FDA wants to be very confident that the drug is safe before permitting it to be marketed, is it more important that α or β be small? Explain.

2. (16). ***Authorizing computer users***. At high-technologies industries, computer security is achieved by using a password – a collection of symbols (usually letters and numbers) that must be supplied by the user before the computer permits access to the account. The problem is that persistent hackers can create programs that enter millions of combinations of symbols into a target system until the correct password is found. The newest systems solve this problem by requiring authorized users to identify themselves by unique body characteristics. For example, a system developed by Palmguard Inc. tests the hypothesis

H0: The proposed user is authorized

Ha: The proposed user is unauthorized

by checking characteristics of the proposed user’s palm against those stored in the authorized users’ data bank.

1. Define a Type I error and Type II error for this test. Which is the more serious error? Why?
2. Palmguard reports that the Type II error rate for its system is less than 1%, whereas the Type II error rate is 0.00025%. Interpret these error rates.
3. Another successful security system, the EyeDentifier, “spots authorized computer users by reading the one-of-a-kind patterns formed by the network of minute blood vessels across the retina at the back of the eye.” The EyeDentifyer reports Type I and II error rates of 0,01% (1 in 10.000) and 0,005% (5 in 100.000), respectively. Interpret these rates.

**7.4 Test of Hypothesis about a Population Mean: Normal z – Statistic**

4. (41). ***Point spreads of NFL games.*** During the National Football League (NFL) season, Las Vegas odds makers establish a point spread on each game for betting purposes. For example, the New England Patriots were established as 3,5 – point favorites over eventual champion New York Giants in the 2012 Super Bowl. The final scores of NFL games were compared against the final point spreads established by the odds makers in Chance (Fall 1998). The difference between the game outcome and point spread (called a point-spread error) was calculated for 240 NFL games. The mean and standard deviation of the point-spread errors are = -1,6, s = 13,3. Use this information to test the hypothesis that the true mean point-spread error for all NFL games differs from 0. Conduct the test at α = 0,01 and interpret the result.

5. (42, NFDA). ***Revenue for a full-service funeral.*** According to the National Funeral Directors Assosciation (NFDA), the nation’s 22.000 funeral homes collected an average of 6.500 USD per full service funeral in 2009 ([www.nfda.org](http://www.nfda.org)). A random sample of 36 funeral homes reported revenue data for the current year. Among other measures, each reported its average fee for a full-service funeral. These data (in thousands of dollars) are shown in the following table.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 7,4 | 9,4 | 5,3 | 8,4 | 7,5 | 6,5 | 6,2 | 8,3 | 6,7 |
| 11,6 | 6,3 | 5,9 | 6,7 | 5,8 | 5,2 | 6,4 | 6,0 | 7,4 |
| 7,2 | 6,6 | 6,3 | 5,3 | 6,6 | 5,6 | 8,4 | 7,2 | 7,4 |
| 5,8 | 6,3 | 6,1 | 7,0 | 7,2 | 6,1 | 5,4 | 7,4 | 6,6 |

1. What are the appropriate null and alternative hypothesis to test wheter the average full-service fee of US funeral homes this year exceeds 6.500 USD?
2. Conduct the test at α = 0,05. Do the sample data provide sufficient evidence to conclude that the average fee this year is higher than in 2009?
3. In conducting the test, was it necessary to assume that the population of average full-service fees was normally distributed? Justify your answer.

**7.5 Test of Hypothesis about a Population Mean: Student’s t – Statistic**

6. (61). ***Crack intensity of paved highways.*** The Mississippi Department of Transportation collected data on the number of cracks (called crack intensity) in an undivided two-lane highway using van-mounted, state-of-the-art video technology (Journal of Infrastructure Systems, Mar. 1995). The mean number of cracks found in a sample of eight 50-meters sections of the highway was = 0,210, with a variance of s2 = 0,011. Suppose the American Associaton of State Highway and Transportation Officials (AASHTO) recommends a maximum mean crack intensity of 0.100 for safety purposes. Is there evidence to say that the true mean crack intensity of the Mississipi highway exceeds the AASHTO recommended maximum? Use α = 0.01 in the test.

7. (62, NUKES). Active nuclear power plants. The US Energy Information Administration’s compiled a list of active nuclear power plants operating in each of a sample of 20 states. The data are reproduced in the table below:

|  |  |  |  |
| --- | --- | --- | --- |
| State | N. of Power Plants | State | N. of Power Plants |
| Alabama | 5 | New Hampshire | 1 |
| Arizona | 2 | New York | 6 |
| California | 4 | North Carolina | 5 |
| Florida | 5 | Ohio | 3 |
| Georgia | 4 | Pennsylvania | 9 |
| Illinois | 11 | South Carolina | 7 |
| Kansas | 1 | Tennessee | 3 |
| Louisiana | 2 | Texas | 4 |
| Massachusetts | 1 | Vermont | 1 |
| Mississippi | 1 | Wisconsin | 3 |

1. Is there sufficient evidence to claim that the mean number of active nuclear power plants operating in all states exceeds 3? Test using α = 0.10.
2. Are the conditions required for a valid small-sample test reasonably satisfied? Explain.
3. Eliminate the lowest 2 values and the highest 2 values from the data set, then conduct the test of part a on the smaller data set. What impact does this have on the test results?
4. Why is it dangerous to eliminate data points in order to satisfy an assumption for a test of hypothesis?

**7.6 Large-sample test of hypothesis about a population proportion**

8. (67, SNACK). In this study, 50 consumers taste-tested a new snack food. Their responses (were 0 = do not like; 1 = like; 2 = indifferent) are produced below.

a) Test *H0*: *p = .5* against *Ha*: *p* >.5, where *p* is the proportion of customers who do not like the snack food.

b) Find the observed significance level of your test.

|  |
| --- |
| 1 0 0 1 2 0 1 1 0 0 0 1 |
| 0 2 0 2 2 0 0 1 1 0 0 0 |
| 0 1 0 2 0 0 0 1 0 0 1 0 |
| 0 1 0 1 0 2 0 0 1 1 0 0 |
| 0 1 |

**7.7 Test of hypothesis about a population variance**

9. (92, HPLC). Analytical chemistry (Dec. 15, 2009) did a study of a new method used by GlaxoSmithKline Medicines Research Center to determine the amount of drug in a tablet. Drug concentrations (measured as a percentage) for 50 randomly selected tablets are repeated in the accompanying table. The standard method of assessing drug content yields a concentration variance of 9. Can the scientists at GlaxoSmithKline conclude that the new method of determining drug concentration is less variable then the standard method? Test using α = .01.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 91.28 | 92.83 | 89.35 | 91.90 | 82.85 | 94.83 | 89.83 | 89.00 | 84.62 |
| 86.96 | 88.32 | 91.17 | 83.86 | 89.74 | 92.24 | 92.59 | 84.21 | 89.36 |
| 90.96 | 92.85 | 89.39 | 89.82 | 89.91 | 92.16 | 88.67 | 89.35 | 86.51 |
| 89.04 | 91.82 | 93.02 | 88.32 | 88.76 | 89.26 | 90.36 | 87.16 | 91.74 |
| 86.12 | 92.10 | 83.33 | 87.61 | 88.20 | 92.78 | 86.35 | 93.84 | 91.20 |
| 93.44 | 86.77 | 83.77 | 93.19 | 81.79 |  |  |  |  |