***(2 points) Question 1***

Let us say you have to decide between two distributions, and that a random variable has. Given below are the probability distributions showing the probabilities that the distributions assign to the values of :

|  |  |  |
| --- | --- | --- |
|  |  |  |
| 0 | 0.1 | 0.2 |
| 1 | 0.1 | 0.1 |
| 2 | 0.1 | 0.1 |
| 3 | 0.1 | 0.2 |
| 4 | 0.2 | 0.2 |
| 5 | 0.1 | 0.1 |
| 6 | 0.3 | 0.1 |

There is a single observation on available and you want to test

is correct

is correct

Consider one possible decision procedure to fail to reject if or and answer the following two parts:

1. *(1 point)* Find the probability of a Type I error.
2. *(1 point)* Find the probability of a Type II error.

***(8 points) Question 2***

The current no-smoking regulations in office buildings require workers who smoke to take breaks and leave the building in order to satisfy their habits. A study indicates that such workers average 32 minutes per day taking smoking breaks. The standard deviation is 8 minutes. To help reduce the average break, rooms with powerful exhausts were installed in the buildings. To see whether these rooms serve their designed purpose, a random sample of 110 smokers was taken. The total amount of time away from their desks was measured for 1 day. Test to determine whether there has been a decrease in the mean time away from their desks. Compute the -value and interpret it relative to the costs of Type I and Type II errors.

A financial analyst has determined that a 2-minute reduction in the average break would increase productivity. As a result, the company would hate to lose this opportunity. In such a case, calculate the probability of erroneously concluding that the renovation would not be successful. If this probability is high, describe how it can be reduced.

***(5 points) Question 3***

This is a case on test marketing. A manufacturer of hardware products needs some help in deciding the price to charge for a new product. The marketing analyst through the use of pricing analytics determined that the new product should sell for $10, but the pricing model made some assumptions that the marketing manager was uncomfortable with. The manager is unsure if the sales volume will differ significantly if it is priced at $9 or $11. To conduct a pricing experiment, she distributes the new product to a sample of 60 stores. These 60 stores are all located in similar neighborhoods. The manager randomly selects 20 stores in which to sell the item at $9, 20 stores to sell it at $10, and the remaining 20 stores to sell it at $11. Sales at the end of the trial period were recorded. Although I do not have the dataset containing the individual sales figures, enough information is available for you to run an appropriate statistical test using principles. The mean sales at stores which sell the item at $9 is 153.60, at $10 is 151.50, and at $11 is 133.25. The standard deviations of sales are 25.57, 30.39, and 25.03 at stores which sell the item at $9, $10, and $11, respectively. Based on the given information, run an appropriate statistical test and describe what should the manager conclude.

***(20 points) Question 4***

If you walk down the aisle of breakfast cereals at a grocery store, you will find that the cereal market is flooded with a bewildering number of breakfast cereals. Each company produces several different kinds of cereal in the belief that there are distinct market segments. For example, there is a market segment comprised primarily of children, another segment for diet-conscious adults, and yet another for health-conscious adults. Each cereal the companies produce has at least one market segment as its target. However, we consumers make our own decisions, which may or may not match the target predicted by the cereal maker.

One such cereal maker in the northeastern part of the United States is attempting to distinguish between consumers. It administered a survey to adults between 25 and 65. Each was asked a few questions, including age, income, and years of education, as well as the brand of cereal each consumed most frequently. The cereal choices are:

1. Sugar Rush, a children’s cereal
2. Special K, a cereal aimed at dieters
3. Fiber One, a cereal that is advertised as healthy
4. Cheerios, a cereal that is targeted to a combination of dieters and health conscious consumers

The results of the survey were recorded. The data are available under the CSV file *Question 4*. The first column contains the cereal choice, second column records the age of respondent, third column records the annual household income, and the fourth column records the years of education.

Run an appropriate statistical test to address the following objectives:

1. *(5 points)* Are there differences between the ages of the consumers of the four cereals?
2. *(5 points)* Are there differences between the incomes of the consumers of the four cereals?
3. *(5 points)* Are there differences between the educational levels of the consumers of the four cereals?
4. *(5 points)* Prepare a summary for the cereal maker describing the differences between the four groups of cereal consumers.

***(5 points) Question 5***

The first thing that comes to mind when we want to lose weight is to eat less. Of course, we all know that exercise also plays a key role, but many find it hard to fit exercise in their daily routine. Hence, going on a diet (controlling what we eat) seems to be low-hanging. How well do diets work? In a study, 20 people who were more than 20 pounds overweight, were recruited to compare four diets. The people were matched by age. The oldest four became group 1, the next oldest four became group 2, and so on There were five groups in all. The number of pounds that each person lost by following one of the four diets were recorded. Although I do not have access to the data but have enough information for you to run the appropriate statistical test. The mean weight lost by following diet 1, diet 2, diet 3, and diet 4 was 6.2 pounds, 8.0 pounds, 10.8 pounds, and 8.2 pounds, respectively. The mean weight lost by groups 1, 2, 3, 4, and 5 was 5.25 pounds, 7.25 pounds, 7.25 pounds, 10.25 pounds, and 11.5 pounds, respectively. Use this information and run an appropriate statistical test from principles to infer at 1% significance level whether there are differences among the four diets. What experimental design was used? From your analysis, state if the experimental design was sound.

***(5 points) Question 6***

A recruiter for a computer company would like to determine whether there are differences in sales ability between business, arts, and science graduates. She takes a random sample of 20 business graduates who have been working for the company for the past 2 years. Each is then matched with an arts graduate and a science graduate with similar educational and working experience. The commission earned by each (in $1,000s) in the last year was recorded. The dataset is available on the CSV file *Question6*. Use 5% significance level.

1. Is there sufficient evidence to allow the recruiter to conclude that there are differences in sales ability between the holders of the three types of degrees?
2. Conduct a test to assess if any other experimental design would have been a better choice.
3. What are the required conditions for the test in Part a? Are the required conditions satisfied?

***(5 points) Question 7***

Statistical techniques are used to determine auto insurance premiums. The premiums are proportional to the risks and costs of accidents. AutoState, a leading insurance agency in the United States, hired an analyst to conduct a study that looked at miles driven in the previous year, ages of the drivers, and their gender. The age categories are 16-19, 20-34, 35-54, 55-64, and 65+. The dataset is provided on the CSV file *Question7*. Conduct an appropriate statistical test at 5% significance level to determine if we have enough evidence to conclude that males and female drivers differ in the number of miles they drive. Can we infer that there are differences between the age categories in the number of miles they drive? What other analysis can you perform to generate additional insights for statistical inference?

***(5 points) Question 8***

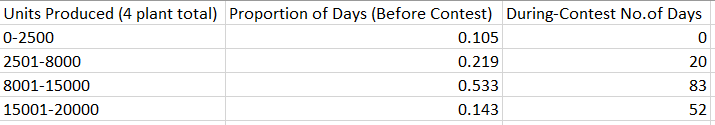
On Saturday morning, Barbara Kenworth received a call at her home from the production supervisor at Kenworth Electronics Plant 1. The supervisor indicated that she and the supervisors from Plants 2, 3, and 4 had agreed that something must be done to improve company morale and thereby increase the production output of their plants. Barbara Kenworth, president of Kenworth Electronics, agreed to set up a Monday morning meeting with the supervisors to see if they could arrive at a plan for accomplishing these objectives.

By Monday, each supervisor had compiled a list of several ideas, including a four-day work week and interplant competitions of various kinds. A second meeting was set for Wednesday to discuss the issue further.

Following the Wednesday afternoon meeting, Barbara Kenworth and her plant supervisors agreed to implement a weekly contest called the BEST Game of the Week. The plant producing the most each week would be considered the BEST Game of the Week winner and would receive 10 points. The second-place plant would receive 7 points, and the third- and fourth-place plants would receive 3 points and 1 point, respectively. The contest would last 26 weeks. At the end of that period, a $200,000 bonus would be divided among the employees in the four plants proportional to the total points accumulated by each plant.

The announcement of the contest created a lot of excitement and enthusiasm at the four plants. No one complained about the rules because the four plants were designed and staffed to produce equally.

At the close of the contest, Barbara Kenworth called the supervisors into a meeting, at which time she asked for data to determine whether the contest had significantly improved productivity. She indicated that she had to know this before she could authorize a second contest. The supervisors, expecting this request, had put together the data available. The data, shown below, contains the proportion of days each category of units was produced before the contest and the number of days each category of units was produced during the contest.

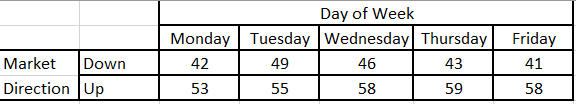


Barbara examined the data and said, “There must be some way to statistically test the worthiness of this contest. I have to see the results before I will authorize the second contest.”

Your job as an analyst is to help Barbara assess the statistical significance of the results of the contest by running an appropriate statistical test.

***(5 points) Question 9***

A multinational investment banking firm on the Wall Street is trying to devise a new investment strategy for its clients. Investment banking firms keep a close watch on how the market performed each day of the week so that it can monitor the soundness of the strategies. They hire “quants” to design and formulate such strategies. Quants usually have PhD in Math or Physics and they use financial engineering to develop techniques that go into formulating such strategies. Say, you are hired as an analyst to work on this project along with the quant. Your task on this project is to assess whether trading on some days of the week is better or worse than any other. The following table summarizes whether the stock market went up or down during each trading day of last year. Run the appropriate statistical test to address the objective. Verify the required conditions necessary for calling your statistical method a valid one. Do the data impose any limitations on the conclusions drawn from the study?



***(5 points) Question 10***

The Survey of Consumer Finances (SCF) is conducted every 3 years to provide detailed information on the finances of U.S. households. The study is sponsored by the Federal Reserve Board in cooperation with the Department of the Treasury. Since 1992, data have been collected by the National Opinion Research Center (NORC) at the University of Chicago. The full dataset is very large, and the number of variables is extremely large as well. For this exercise, I have created a subset of the dataset. This subset contains data for the middle-class households (40% - 60% of the net worth).

We believe that people who completed a college degree fare better financially than those who started college and never finished. One way to judge financial success is by measuring assets. Is there enough evidence to conclude that heads of households with college degrees have more assets than those who have some college? Run an appropriate statistical technique to infer.

The dataset in the CSV file *Question10* contains data for the education level (EDCL) and the total value of assets (ASSET) for middle class households.

The variable definitions are:

ASSET: Total value of assets held by household

EDCL Education category of head of household: 1. No high school diploma, 2. High school diploma, 3. Some college, 4. College degree

***(5 points) Question 11***

A hospital conducted a study of the waiting time in its emergency room. The hospital has a main campus, along with three satellite locations. Management had a business objective of reducing waiting time for emergency room cases that did not require immediate attention. To study this, a random sample of 15 emergency room cases at each location were selected on a particular day, and the waiting time (recorded from check-in to when the patient was called into the clinic area) was measured. The results are stored in the CSV file *Question11*. Conduct an appropriate statistical test to determine if there is any evidence of a difference in the waiting times.

***(5 points) Question 12***

A well-known soft-drink manufacturer has used the same secret recipe for its product since its introduction over 100 years ago. In response to a decreasing market share, however, the president of the company is contemplating changing the recipe. He has developed two alternative recipes. In a preliminary study, he asked 20 people to taste the original recipe and the two new recipes. He asked each to evaluate the taste of the product on a 5-point scale, where 1 = Awful, 2=Poor,3=Fair,4=Good, and 5=Wonderful. The dataset is available on the CSV file *Question12*. The president decides that unless significant differences exist between evaluations of the products, he will not make any changes. At 5% significance level, use an appropriate statistical test to conclude if there are any differences in the ratings of the three recipes.

***(5 points) Question 13***

Kira Breyan works as a financial advisor at a large investment firm. She meets with an inexperienced investor who has some questions regarding two approaches to mutual fund investing: growth investing versus value investing. The investor has heard that growth funds invest in companies whose stock prices are expected to grow at a faster rate, relative to the overall stock market, and value funds invest in companies whose stock prices are below their true worth. The investor has also heard that the main component of investment return is through capital appreciation in growth funds and through dividend income in value funds. The investor shows Kira the annual return data for Vanguard’s Growth Index mutual fund (Growth) and Vanguard’s Value Index mutual fund (Value). The CSV file *Question13* shows the annual return data for these two mutual funds for the years 2007–2016. Using the appropriate statistical test, determine if the performance of the returns of these two funds were similar over the 2007-2016 timeframe.

***(5 points) Question 14***

Refer to the dataset from the General Social Survey provided on the CSV file *Question14*. If one works longer hours (HRS1) does the chances of losing one’s job (JOBLOSE: 1 = Very likely, 2 = Fairly likely, 3 = Not too likely, 4 = Not likely) become less likely? Conduct an appropriate statistical test to answer the question.

***(5 points) Question 15***

Does the brand name of an ice cream affect consumers’ perceptions of it? The marketing manager of a major dairy pondered this question. She decided to ask 60 randomly selected people to taste the same flavor of ice cream in two different dishes. The dishes contained exactly the same ice cream but were labeled differently. One was given a name that suggested that its maker was European and sophisticated; the other was given a name that implied that the product was domestic and inexpensive. The tasters were asked to rate each ice cream on a 5-point scale, where 1 = Poor, 2 = Fair, 3 = Good, 4 = Very good, and 5 = Excellent. Do the results allow the manager to conclude at the 10% significance level that the European brand is preferred? Dataset is on the CSV file *Question15*.

***(5 points) Question 16***

The *New York Times* has been publishing its weekly list of best-selling books in the United States for more than 80 years. For certain book subcategories, the best-selling lists are published monthly. On the *New York Times* best-selling book website, there is a “buy” button below (or next to) each listed book. The button directs the viewer to online bookstore options. Two such options are: Amazon and Barnes and Noble. The CSV dataset *Question16* contains online prices of the best-selling business books for the month of September a couple of years ago. Older titles are paperback versus paperback comparisons, while newer titles are hardback versus hardback comparisons. Is there a systematic difference in book prices between the two online booksellers? Use an appropriate statistical test at the 5% significance level to infer.

***(5 points) Question 17***

Suppose that a random sample of 100 observations was drawn from a population. After calculating the mean and standard deviation, each observation was standardized and the number of observations in each of the following intervals was counted. Using the chi-squared test for normality, can we infer at the 5% significance level that the data were not drawn from a normal population? *Note: We have covered using chi-squared test to assess if the observed counts match the Poisson distribution. This exercise is to assess if the data comes from (fits) the normal distribution. This is another way to assess normality.*

|  |  |
| --- | --- |
| **Interval** | **Frequency** |
|  | 10 |
|  | 18 |
|  | 48 |
|  | 16 |
|  | 8 |