STATISTICS WORKSHEET-1

Q1 to Q9 have only one correct answer. Choose the correct option to answer your question.

1. Bernoulli random variables take (only) the values 1 and 0.
a) True
b) False

Answer - B (False)

2. Which of the following theorem states that the distribution of averages of iid variables, properly normalized, becomes that of a standard normal as the sample size increases?
a) Central Limit Theorem
b) Central Mean Theorem
c) Centroid Limit Theorem
d) All of the mentioned

Answer - A (Central Limit Theorem)

3. Which of the following is incorrect with respect to use of Poisson distribution?
a) Modeling event/time data
b) Modeling bounded count data
c) Modeling contingency tables
d) All of the mentioned

Answer - B (Modeling bounded count data)

4. Point out the correct statement.
a) The exponent of a normally distributed random variables follows what is called the log- normal distribution
b) Sums of normally distributed random variables are again normally distributed even if the variables are dependent
c) The square of a standard normal random variable follows what is called chi-squared distribution
d) All of the mentioned

Answer - D (All of the mentioned)

5. _____ random variables are used to model rates.

a) Empirical
b) Binomial
c) Poisson -
d) All of the mentioned

Answer - C (Poisson)

6. Usually replacing the standard error by its estimated value does change the CLT.
a) True
b) False

Answer - B (False)

7. Which of the following testing is concerned with making decisions using data?
a) Probability
b) Hypothesis
c) Causal
d) None of the mentioned

Answer - B (Hypothesis)

8. Normalized data are centered at_____and have units equal to standard deviations of the original data.
a) 0
b) 5
c) 1
d) 10

Answer - A (0)

9. Which of the following statement is incorrect with respect to outliers?
a) Outliers can have varying degrees of influence
b) Outliers can be the result of spurious or real processes
c) Outliers cannot conform to the regression relationship
d) None of the mentioned

Answer - C (Outliers cannot conform to the regression relationship)

Q10and Q15 are subjective answer type questions, Answer them in your own words briefly.

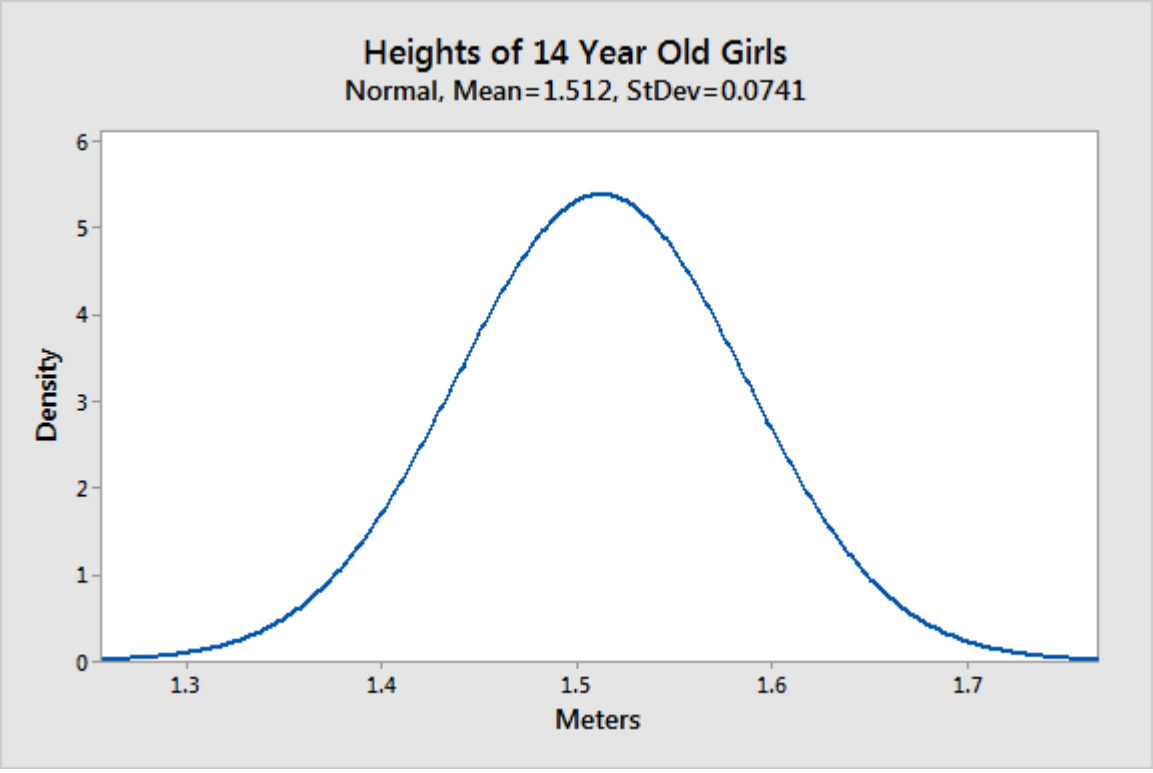
10. What do you understand by the term Normal Distribution?

Answer - The normal distribution is a continuous probability distribution that is symmetrical around its mean, most of the observations cluster around the central peak, and the probabilities for values further away from the mean taper off equally in both directions. Extreme values in both tails of the distribution are similarly unlikely.

As with any probability distribution, the normal distribution describes how the values of a variable are distributed. It is the most important probability distribution in statistics because it fits many natural phenomena. For example, heights, blood pressure, measurement error, and IQ scores follow the normal distribution. It is also known as the Gaussian distribution and the bell curve.

Example -

Height data are normally distributed. The distribution in this example fits real data that I collected from 14-year-old girls during a study.



Parameters of the Normal Distribution -

As with any probability distribution, the parameters for the normal distribution define its shape and probabilities entirely. The normal distribution has two parameters, the mean and standard deviation. The Gaussian distribution does not have just one form. Instead, the shape changes based on the parameter values, as shown in the graphs below.

11. How do you handle missing data? What imputation techniques do you recommend?

Answer - Missing data can skew anything for data scientists, from economic analysis to clinical trials. After all, any analysis is only as good as the data. A data scientist doesn't want to produce biased estimates that lead to invalid results. The concept of missing data is implied in the name: it's data that is not captured for a variable for the observation in question. Missing data reduces the statistical power of the analysis, which can distort the validity of the results.

1. **Imputation -**

When dealing with missing data, data scientists can use two primary methods to solve the error: imputation or the removal of data.

The imputation method develops reasonable guesses for missing data. It's most useful when the percentage of missing data is low. If the portion of missing data is too high, the results lack natural variation that could result in an effective model.

The other option is to remove data. When dealing with data that is missing at random, related data can be deleted to reduce bias. Removing data may not be the best option if there are not enough observations to result in a reliable analysis. In some situations, observation of specific events or factors may be required.

Before deciding which approach to employ, data scientists must understand why the data is missing.

Missing at Random (MAR)

Missing at Random means the data is missing relative to the observed data. It is not related to the specific missing values. The data is not missing across all observations but only within sub-samples of the data. It is not known if the data

should be there; instead, it is missing given the observed data. The missing data can be predicted based on the complete observed data.

Missing Completely at Random (MCAR)

In the MCAR situation, the data is missing across all observations regardless of the expected value or other variables. Data scientists can compare two sets of data, one with missing observations and one without. Using a t-test, if there is no difference between the two data sets, the data is characterized as MCAR.

Data may be missing due to test design, failure in the observations or failure in recording observations. This type of data is seen as MCAR because the reasons for its absence are external and not related to the value of the observation.

It is typically safe to remove MCAR data because the results will be unbiased. The test may not be as powerful, but the results will be reliable.

Missing Not at Random (MNAR)

The MNAR category applies when the missing data has a structure to it. In other words, there appear to be reasons the data is missing. In a survey, perhaps a specific group of people – say women ages 45 to 55 – did not answer a question. Like MAR, the data cannot be determined by the observed data, because the missing information is unknown. Data scientists must model the missing data to develop an unbiased estimate. Simply removing observations with missing data could result in a model with bias.

2. **Deletion -**

There are two primary methods for deleting data when dealing with missing data: listwise and dropping variables.

Listwise

In this method, all data for an observation that has one or more missing values are deleted. The analysis is run only on observations that have a complete set of data. If the data set is small, it may be the most efficient method to eliminate those cases from the analysis. However, in most cases, the data are not missing completely at random (MCAR). Deleting the instances with missing observations can result in biased parameters and estimates and reduce the statistical power of the analysis.

Pairwise

Pairwise deletion assumes data are missing completely at random (MCAR), but all the cases with data, even those with missing data, are used in the analysis.

Pairwise deletion allows data scientists to use more of the data. However, the resulting statistics may vary because they are based on different data sets. The results may be impossible to duplicate with a complete set of data.

Dropping Variables

If data is missing for more than 60% of the observations, it may be wise to discard it if the variable is insignificant.

Imputation Techniques -

When data is missing, it may make sense to delete data, as mentioned above. However, that may not be the most effective option. For example, if too much information is discarded, it may not be possible to complete a reliable analysis. Or there may be insufficient data to generate a reliable prediction for observations that have missing data.

Instead of deletion, data scientists have multiple solutions to impute the value of missing data. Depending why the data are missing, imputation methods can deliver reasonably reliable results. These are examples of single imputation methods for replacing missing data.

Mean, Median and Mode

This is one of the most common methods of imputing values when dealing with missing data. In cases where there are a small number of missing observations, data scientists can calculate the mean or median of the existing observations. However, when there are many missing variables, mean or median results can result in a loss of variation in the data. This method does not use time-series characteristics or depend on the relationship between the variables.

Time-Series Specific Methods

Another option is to use time-series specific methods when appropriate to impute data. There are four types of time-series data:

- No trend or seasonality.
- Trend, but no seasonality.
- Seasonality, but no trend.
- Both trend and seasonality.

The time series methods of imputation assume the adjacent observations will be like the missing data. These methods work well when that assumption is valid.

However, these methods won't always produce reasonable results, particularly in the case of strong seasonality.

Last Observation Carried Forward (LOCF) & Next Observation Carried Backward (NOCB)

These options are used to analyze longitudinal repeated measures data, in which follow-up observations may be missing. In this method, every missing value is replaced with the last observed value. Longitudinal data track the same instance at different points along a timeline. This method is easy to understand and implement. However, this method may introduce bias when data has a visible trend. It assumes the value is unchanged by the missing data.

Linear Interpolation

Linear interpolation is often used to approximate a value of some function by using two known values of that function at other points. This formula can also be understood as a weighted average. The weights are inversely related to the distance from the end points to the unknown point. The closer point has more influence than the farther point.

When dealing with missing data, you should use this method in a time series that exhibits a trend line, but it's not appropriate for seasonal data.

Seasonal Adjustment with Linear Interpolation

When dealing with data that exhibits both trend and seasonality characteristics, use seasonal adjustment with linear interpolation. First you would perform the seasonal adjustment by computing a centered moving average or taking the average of multiple averages – say, two one-year averages – that are offset by one period relative to another. You can then complete data smoothing with linear interpolation as discussed above.

12. What is A/B testing?

Answer - A/B testing is one of the most popular controlled experiments used to optimize web marketing strategies. It allows decision makers to choose the best design for a website by looking at the analytics results obtained with two possible alternatives A and B.

An AB test is an example of statistical hypothesis testing, a process whereby a hypothesis is made about the relationship between two data sets and those data sets are then compared against each other to determine if there is a statistically significant relationship or not.

To put this in more practical terms, a prediction is made that Page Variation #B will perform better than Page Variation #A. Then, data sets from both pages are observed and compared to determine if Page Variation #B is a statistically significant improvement over Page Variation #A.

A/B testing (also known as split testing or bucket testing) is a method of comparing two versions of a web page or app against each other to determine which one performs better. A/B testing is essentially an experiment where two or more variants of a page are shown to users at random, and statistical analysis is used to determine which variation performs better for a given conversion goal.

13 Is mean imputation of missing data acceptable practice?

Answer - The process of replacing null values in a data collection with the data's mean is known as mean imputation.

Mean imputation is typically considered terrible practice since it ignores feature correlation. Consider the following scenario: we have a table with age and fitness scores, and an eight-year-old has a missing fitness score. If we average the fitness scores of people between the ages of 15 and 80, the eighty-year-old will appear to have a significantly greater fitness level than he actually does.

Second, mean imputation decreases the variance of our data while increasing bias. As a result of the reduced variance, the model is less accurate and the confidence interval is narrower.

here are three problems with using mean-imputed variables in statistical analyses:

- Mean imputation reduces the variance of the imputed variables.
- Mean imputation shrinks standard errors, which invalidates most hypothesis tests and the calculation of confidence interval.

- Mean imputation does not preserve relationships between variables such as correlations.

14. What is linear regression in statistics?

Answer - Regression is a statistical method used in finance, investing, and other disciplines that attempts to determine the strength and character of the relationship between one dependent variable (usually denoted by Y) and a series of other variables (known as independent variables).

Regression helps investment and financial managers to value assets and understand the relationships between variables, such as commodity prices and the stocks of businesses dealing in those commodities.

Regression Explained

The two basic types of regression are simple linear regression and multiple linear regression, although there are non-linear regression methods for more complicated data and analysis. Simple linear regression uses one independent variable to explain or predict the outcome of the dependent variable Y, while multiple linear regression uses two or more independent variables to predict the outcome.

Regression can help finance and investment professionals as well as professionals in other businesses. Regression can also help predict sales for a company based on weather, previous sales, GDP growth, or other types of conditions. The capital asset pricing model (CAPM) is an often-used regression model in finance for pricing assets and discovering costs of capital.

The general form of each type of regression is:

- **Simple linear regression:** $Y = a + bX + u$
- **Multiple linear regression:** $Y = a + b_1X_1 + b_2X_2 + b_3X_3 + ... + b_tX_t + u$

Where:

- Y = the variable that you are trying to predict (dependent variable).
- X = the variable that you are using to predict Y (independent variable).
- a = the intercept.
- b = the slope.
- u = the regression residual.

15. What are the various branches of statistics?

Answer - The two main branches of statistics are descriptive statistics and inferential statistics. Both of these are employed in scientific analysis of data and both are equally important for the student of statistics.

Descriptive Statistics

Descriptive statistics deals with the presentation and collection of data. This is usually the first part of a statistical analysis. It is usually not as simple as it sounds, and the statistician needs to be aware of designing experiments, choosing the right focus group and avoid biases that are so easy to creep into the experiment.

Different areas of study require different kinds of analysis using descriptive statistics. For example, a physicist studying turbulence in the laboratory needs the average quantities that vary over small intervals of time. The nature of this problem requires that physical quantities be averaged from a host of data collected through the experiment.

Inferential Statistics

Inferential statistics, as the name suggests, involves drawing the right conclusions from the statistical analysis that has been performed using descriptive statistics. In the end, it is the inferences that make studies important and this aspect is dealt with in inferential statistics.

Most predictions of the future and generalizations about a population by studying a smaller sample come under the purview of inferential statistics. Most social sciences experiments deal with studying a small sample population that helps determine how the population in general behaves. By designing the right experiment, the researcher is able to draw conclusions relevant to his study.

While drawing conclusions, one needs to be very careful so as not to draw the wrong or biased conclusions. Even though this appears like a science, there are ways in which one can manipulate studies and results through various means. For example, data dredging is increasingly becoming a problem as computers hold loads of information and it is easy, either intentionally or unintentionally, to use the wrong inferential methods.