**Group 6 ADTA 5130 Project Report**

**LAY-OFFS ANALYSIS**

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**Introduction**

A recession is a time of sustained economic deterioration that can endure for several months or even years. Many people lose their jobs during a recession, and businesses have trouble turning a profit. Many people are going through difficult times right now, which might have a big impact on the economy and society as a whole.

A recession is brought on by a number of things, such as a drop in consumer and corporate confidence, excessive debt levels, inflation, supply chain interruptions, and financial crises. These elements may result in less spending and investment, which would hinder economic expansion.

The COVID-19 pandemic was the root cause of the most recent worldwide recession, which occurred in 2020. A significant drop in economic activity was caused by the epidemic, which also caused several firm closures, travel restrictions, and lower consumer purchasing.

Many people lose their jobs during a recession, which can cause them to struggle financially and have trouble paying their payments. Additionally, it might be difficult for enterprises to survive because they might have decreased revenue and have trouble acquiring funding.

Governments and central banks are able to take a number of actions to lessen the consequences of a recession, including establishing fiscal and monetary policies to boost demand, offering financial support to failing companies, and investing in infrastructure projects to generate jobs. These actions can support economic stability and serve to clear the way for a recovery.

It is crucial to remember that a recession is a normal phase of the economic cycle. Economic cycles include both growth and decline, and recessions can force required alterations and changes that, over time, can assist to create a more robust and sustainable economy.

In conclusion, a recession is a time of economic downturn that can significantly affect both individuals and society as a whole. Governments and central banks can take action to lessen the consequences of a recession and clear the way for a recovery, despite the fact that it can be a difficult period.

**Project Plan:**

As we received the data from public domain, we first perform data cleaning to remove empty values, data mismatches and make it ready for doing analysis on it. Data analysis to be done on cleaned up data by using various analytical and statistical tools by using R programming language. We can figure out which country and their city have affected most. We can study which industry got affected badly. We can explore companies which have higher layoff rates. We can get insights about layoffs happened over the years. These parameters can help to estimate country going into recession.

We can visualize laying off companies based on the country and their locations. We can find country with higher layoff rate, location where the layoffs are high. With this, we can predict whether country is going into recession. We are also going to visualize layoffs data based on industries like Infrastructure, Retail, Information Technology, etc. We can find out which companies in the sector have very high layoffs of their employees. We can also view which company fired employees in proportion to total employees. Which helps in predicting industries that hit by recession. We can get insights about the data based on time duration. We can understand layoffs happened during each quarter the past 3 years. We can estimate company’s performance.

**Data Plan:**

The dataset contains data about companies laying off their employees across the globe. Our data consists of various variables at source like locations, countries, industries, number of employees laid off, how much percentage employees laid off, funds raised by laying off employees, laid off date, stage, source and date on which the data added into dataset. The data is available from March 2020 to February 2023. Layoffs data consists of approximately 2300 rows. The dataset is made from multiple sources like Bloomberg, San Francisco Business Times, TechCrunch, The New York Times. This data can provide many different insights to understand effect of recession in the world.

**Problem statement:**

1. **Economic downturn:**

When there is a decline in economic activity overall, production declines, the Gross Domestic Product (GDP) declines, and poverty increases, there is an economic downturn that is a severe concern. As a result, businesses produce less goods and services, which lowers production and the GDP. Increased poverty is a result of the fall in economic activity as well as job losses and business closures. Consumer demand may decline as a result, further slowing down economic activity. Although policymakers may take action to alleviate the economic crisis, it may take some time before these measures have a noticeable impact. In general, the effects of a recession's economic downturn on people, businesses, and the economy are profound.

1. **Financial market instability:**

Volatility brought on by recessions, which can lower investor confidence and reduce liquidity, can exacerbate the economic situation. This lack of confidence may encourage investors to panic sell and pull their money out of the market, which will lower the value of stocks, bonds, and other financial instruments. Instability in the financial markets can also make it difficult for people and businesses to get credit, which can lead to layoffs and business closures. This starts a cycle that results in an extended recession and additional declines in economic activity. As a result, volatility in the financial markets is a significant issue during a recession, and policymakers may need to take action to calm the market and boost investor confidence.

**3.** **Laid off count:**

In order to cut costs and remain afloat during a recession, businesses may fire staff. Depending on the depth of the economic slump and the particulars of the company, the number of layoffs may vary. To survive a recession, businesses may occasionally be obliged to let go of a sizeable section of their personnel. For example, during the global financial crisis of 2008, countless businesses fired millions of employees. Similar to this, as businesses tried to survive, the COVID-19 epidemic resulted in a rapid rise in layoffs. Employees who are laid off may experience serious repercussions, and assistance may be offered to help them move to other career prospects.

**4.** **Percentage:**

Depending on the depth of the economic slump and the unique conditions of the organization, the percentage of employees laid off during a recession can change. In some circumstances, businesses may be required to let go of a sizeable section of its personnel in order to cut expenses and remain afloat. The size of the business and the sector in which it competes can also affect the proportion of employees let go out of the overall workforce. For instance, some industries, like hospitality and tourism, saw higher layoff rates than others during the recession brought on by the COVID-19 epidemic. However, it is challenging to give a precise proportion because it varies widely based on a number of circumstances.

**Methodologies Used:**

**Confidence Interval:**  a confidence interval is a range of sam that is likely to contain the population parameter of interest with a specified level of confidence. The confidence interval provides a measure of the accuracy of an estimate based on a sample of data.

To construct a confidence interval, one first needs to estimate the population parameter of interest based on a sample of data. For example, one might estimate the mean height of all adults in a population based on a sample of heights. Once the point estimate has been calculated, the next step is to determine the level of confidence that is desired. Common levels of confidence are 90%, 95%, or 99%.

**ANOVA ANALYSIS**: To compare the means of two or more sets of data, statisticians utilize the ANOVA (Analysis of Variance) approach. Finding out if there is a significant difference between the means of two or more populations is done using a hypothesis testing approach.

The analysis of variance (ANOVA) compares the variation between the means of the study groups to the variation within each group. This makes it possible for researchers to ascertain if any observed differences between the groups are statistically significant or are simply the result of chance.

The null hypothesis, which presupposes that there is no significant difference between the means of the groups being compared, is initially developed to conduct an ANOVA study. The ratio of the variation within the groups to the variance between the groups is used to generate the ANOVA test statistic. The null hypothesis is rejected if the test statistic's p-value is less than the preset significance level, showing that there is a significant difference between the means of the groups being compared.

**Linear Regression:** A statistical technique called linear regression is used to examine the relationship between one dependent variable and one or more independent variables. To represent the relationship between the variables, it entails fitting a linear equation to the data.

The equation for simple linear regression is Y = 0 + 1X +, where Y is the dependent variable, X is the independent variable, 0 is the intercept, 1 is the slope coefficient, and is the error term. Simple linear regression only uses one independent variable and one dependent variable.

In linear regression, finding the values of the coefficients (0 and 1) that minimize the discrepancy between the anticipated and actual values of the dependent variable is the main objective. To achieve this, the sum of squared errors, also known as the sum of squared disparities between the predicted values and the actual values, is minimized (SSE).

Several independent variables are taken into account in multiple linear regression, which has the equation Y = 0 + 1X1 + 2X2,... + nXn + where Xi are the independent variables and 0 1, 2,..., n are the coefficients. Estimating the values of the coefficients that reduce the SSE in this situation is the objective.

In many disciplines, including economics, finance, engineering, and the social sciences, linear regression is frequently used to examine the correlations between variables, generate predictions based on those associations, and pinpoint important variables that have an impact on the dependent variable.

**Hypothesis for the Problem Statements**

1. Whether the means of independent data samples taken from the data of different years is same or not.
2. Linear Regression between Laid\_off\_count and Funds Raised.
3. Linear Regression between Laid off count and Funds raised, Percentage.
4. Linear Regression between laid off count and Funds raised.

**Data Dictionary**

We have 12 variables in our dataset for our analysis.

These are the following attributes.

|  |  |
| --- | --- |
| **Variable** | **Meaning** |
| Laid\_Off\_Count | Number of employees laid off by the company |
| Percentage | Percentage of employees laid off out of total employees |
| Date | Date on which the layoffs happened in the company |
| Company | Name of the company |
| Industry | Name of the industry that company belongs to |
| Location | Location or city where the company’s head quarter located |
| Country | Name of the country |
| Funds Raised | Amount raised with layoffs |
| Stage | Status of the company |
| Source | Source of the layoff’s information |
| Date Added | Date added into the dataset |
| List\_of\_Employees\_Laid\_Off | Names of the employees (we do not use in the project) |

Control your budget, spending, and saving to prepare for what is coming next. Do your best at your current job to prevent being laid off. Also, remember to showcase your work/performance. However, practice coding interviews to prepare for a job search in case the uncontrollable happens. Review what you want (job with high salary, job that you like, or take some gap year for mental break, etc) Pick the jobs/industries/companies that are recession-proof. One way, in my opinion, is to see

**Data Understanding**

* Our data consists of companies and their layoffs from the start of COVID pandemic.
* The dataset contains data about companies laying off their employees across the globe.
* Our data consists of various variables at source like locations, countries, industries, number of employees laid off, how much percentage employees laid off, funds raised by laying off employees, laid off date, stage, source and date on which the data added into dataset.
* The data is available from March 2020 to February 2023. Layoffs data consists of approximately 2300 rows. The dataset is made from multiple sources like Bloomberg, San Francisco Business Times, TechCrunch, The New York Times. This data can provide many different insights to understand effect of recession in the world.

**Exploratory Data Analysis**

**Population Statistics**

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Mean (u) | **234.755498** |
| Standard Deviation (s) | **757.579259** |
| Minimum Value | **3** |
| 1st Quartile | **35** |
| 2nd Quartile | **76** |
| 3rd Quartile | **161** |
| Maximum Value | **12000** |
| IQR | **126** |

Sample Statistics

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Mean (x) | **98.5263158** |
| Standard Deviation | **72.1937875** |
| Minimum Value | **18** |
| Maximum Value | **99.825** |

1. In the population statistics, we got mean as 234.755 and standard deviation as 757.57.
2. In the sample statistics, we got mean as 98.52, standard deviation 72.19, maximum 18, and maximum value is 99.825.

**Problem** **Analysis**

**Box Plot Analysis:**

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Description automatically generated with medium confidence

Box plot is a method for graphically demonstrating the locality, spread and skewness groups of numerical data through their quartiles. In addition to the box on a box plot, there can be lines called whiskers extending from the box indicating variability outside the upper and lower quartiles, thus, the plot is also termed as the box-and-whisker plot and the box-and-whisker diagram.

Box plot is very useful plotting in identifying outliers in data. Outliers are the data points which are spread largely wide on the plane. These data points influence the results by making deviations in the outcomes. In order have proper results in the analysis, removing outliers plays significant role. Outlier detection using box plot is very basic and easy technique in statistics. Box plot can be drawn using quartiles, minimum, maximum, and median values. Quartiles used in the box plot are 25th (1st), 50th (2nd) and 75th (3rd) percentiles of the data. An inter-quartile range (IQR) is calculated by finding the difference between 3rd and 1st quartiles. The value obtained is called inter quartile range. The value which is (3rd quartile + (1.5\*IQR)) is called max which is at top edge of whisker and the value (1st quartile - (1.5\*IQR)) is called min that will be at bottom edge of the whisker. Any value which is outside the range of min and max values is called outliers. An example for outliers, In our data set, company named Google have laid off count 12000 but the mean of the data is 197.2, so these kind of data points are very far from the mean hence we call them outliers.

In our data, we have chosen laid\_off\_count as a target variable. In order to have good analytical results we are removing outliers. We have calculated each box plot parameters and removed outliers from our data. Below table shows various parameters which we calculated for plotting box plot for laid off count. Data should within the range from -134 to 330. Any data either above or below this range are considered as outliers. We have shown box plot in the above image based on below box plot parameters.

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| **MIN** | -134 |
| **1st Quartile** | 40 |
| **2nd Quartile** | 80 |
| **3rd Quartile** | 156 |
| **MAX** | 330 |
| **IQR** | **116** |

After removing outliers from the data, our population size has been reduced to 722 observations. These observations are considered for further analysis using various statistical methods like ANOVA and Linear Regression and provide justification to the hypothesis we have considered at the beginning of the report.

**Confidence Interval:**

A confidence interval is a range of values, bounded above and below the statistic’s mean, that likely would contain an unknown population parameter. A confidence interval provides a measure of the uncertainty or variability in the estimate of the population parameter based on the sample data.

In real time, we do not know variance of the data. hence we considered variance as unknown for calculating confidence interval. To construct a confidence interval, a sample of data is taken from a population, and a statistic (such as the sample mean or sample proportion) is calculated from the sample data. The confidence interval is then calculated by taking the point estimate of the parameter (the sample statistic) and adding and subtracting a margin of error based on the standard error of the statistic and a specified level of confidence.

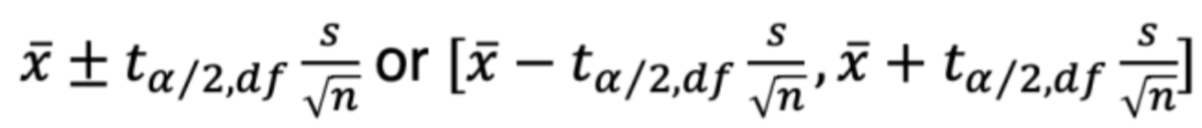
Our data is normally distributed. Hence we can find confidence interval of the data.

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To calculate confidence interval, we assumed significance level of 0.1 and population parameter as unknown.

We have used below formula for calculating the confidence interval.



We found that confidence interval is ranging from **94.968** to **157.98** with margin of error 31.5.

**Anova Analysis:**

ANOVA (analysis of variance) is a statistical technique used to determine if a difference exist between the means of three or more populations means under independent sampling. It compares the variance within each group to the variance between the groups and determines whether the differences observed in the sample means are likely due to chance or to a true difference in the population means.

The idea behind ANOVA is to partition the total variance of a set of data into two components: the variance between groups and the variance within groups. If the variance between groups is much larger than the variance within groups, then it is likely that the means of the groups are different from each other. In constrast, if the variance within groups is much larger than the variance between groups, then there is a likelihood that the means of the groups are similar to each other.

To perform an ANOVA, you need to first calculate the mean and variance of each group. Then you calculate the sum of squares between groups (SSB) and the sum of squares within groups (SSE). The SSB is the sum of the squared differences between the group means and the overall mean, multiplied by the number of observations in each group. The SSE is the sum of the squared differences between each observation and its group mean, summed across all groups. ANOVA arises from the error of alpha level inflation, which increases Type 1 error probability (false positive) and is caused by multiple comparisons.

Finally, The test is based on F distribution. You can use the F-statistic to determine whether the variance between groups is significantly greater than the variance within groups. The F-statistic is calculated by dividing the SSB by the degrees of freedom between groups and dividing the SSW by the degrees of freedom within groups. If the F-statistic is large enough, you can reject the null hypothesis that the means of all groups are equal and conclude that there is a significant difference between at least two of the group means.

In general it is used for testing population means under the following assumptions

1. The populations are normally distributed.
2. The population standard deviations are unknown but assumed equal
3. The populations are selected independently.

We have considered all these assumptions will performing analysis.

Ho : u1 = u2 = u3

HA: Not all population means are equal

We need to understand that HA does not need that all means must differ from one another. We can reject H0 in favor of HA even if only two means differ. While doing ANOVA analysis we examine all means to be equal at a time.

In ANOVA, a treatment denotes to the experimental conditions or groups that are being compared. For example, if you were conducting a study on the effect of different types of fertilizer on plant growth, the treatments would be the different types of fertilizer. Each treatment would have a group of plants assigned to it, and the growth of those plants would be measured and compared.

In ANOVA, the goal is to determine whether there is a statistically significant difference between the means of the different treatments. This is done by analyzing the variance between the treatment groups, and comparing it to the variance within each group.

To conduct an ANOVA analysis, the first step is to identify the treatments and create groups for each treatment. The next step is to randomly assign participants or samples to each group, and then apply the different treatments to the appropriate groups. After that, the data is collected and analyzed using ANOVA techniques to determine whether there is a significant difference between the means of the treatment groups.

Overall, treatments are an important aspect of ANOVA because they allow researchers to compare the effects of different conditions or interventions in a controlled way. By carefully selecting and applying treatments, researchers can gain insight into how different factors affect the outcome of a study, and use this information to make more informed decisions in their research.

Another important component in ANOVA is MSTR. MSTR stands for mean square treatment and represents the variance between groups, or the variation in the means of the different treatments or conditions being tested. MSTR is calculated by dividing the SSB by the degrees of freedom(df) between groups.

MSTR is an important component of the F-test in ANOVA, as it is used to calculate the F-statistic that determines whether there is a significant difference between the means of the treatment groups. The F-statistic is calculated by dividing the MSTR by the mean square error (MSE), which represents the variance within groups.

For our data, we are performing one-way ANOVA by considered samples taken from laid\_off\_count for different years from 2021 to 2023. Each sample is of size 20. We are considering significant value as 0.05.

ANOVA has several advantages over other statistical techniques such as t-tests, including the ability to test multiple groups simultaneously and to detect more subtle differences between groups. ANOVA also provides a more powerful analysis of variance by partitioning the variation into different sources, which can help researchers to better understand the factors that contribute to the observed differences.

Overall, ANOVA is a powerful statistical technique that can help researchers to draw significant conclusions about the effects of different treatments being tested. By analyzing the variance between and within groups.

Below is the data sample we considered for ANOVA analysis.

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We first found out sample means of the data.

|  |  |  |
| --- | --- | --- |
| **\_2023 (x1)** | **\_2022 (x2)** | **\_2021 (x3)** |
| 108.75 | 87 | 86.35 |

The grand mean of the samples is 94.033

Below image shows single factor ANOVA test.

A screenshot of a spreadsheet

Description automatically generated with medium confidence

From the above analysis we did for 3 sample sets of 20 sizes each. we found that Sum of squared treatment is 6501.63 and Sum of squares within the group is 230240.3. we also measured Mean Squared Treatment which is at 3250.81 and Mean Squared Error at 4039.3.

Now, F statistic can be calculated by dividing MSTR by MSE and the value is 0.804 with p-value of 0.452 and we got 3.158 as F-critical value in our test.

We can observe that F statistic < F-crit that means we can reject null hypothesis. Which means the sample means are not equal. Also, p-value of 0.45 > 0.05 that means the difference between the means is insignificant.

**Linear Regression**

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We used different plots to describe the values in the graphs one is line flot plot and Residual plot and Normal probability plot.

The dependent variable in a linear regression is the one you're trying to predict or explain, whereas the independent variables are the predictors or things you think have an impact on the dependent variable. Finding the best-fitting line that minimizes the discrepancies between the observed data points and the line's anticipated values is the aim of linear regression.

One independent variable in a simple linear regression model results in the following equation:

y = β₀ + β₁x + ε

where:

The dependent variable is y.

The independent variable is x.

The y-intercept, or the value of y when x is 0, is equal to 0.

The slope or coefficient, which measures the change in y for a unit change in x, is 1,

The error term (which represents the y-variation that cannot be explained) is

**Linear Regression (Line fit Plot)**

To fit a line to the scatter plot data, use a linear regression technique. By minimizing the discrepancies between the observed data points and the line's anticipated values, the best-fit line will be estimated. The common form of the regression line equation is y = 0 + 1x, where 0 is the y-intercept and 1 is the slope.

We used the Funds raised as an independent variable in this regression study because its value is unaffected by any outside forces, and the Laid of count as a dependent variable.

We obtained the following regression line equation from the analysis and

R Square = 0.67427981

Adjusted R Square= 0.66570823

We draw the conclusion that the laid of count has swiftly increased and is expressing positively.

**Linear Regression (Residual Plot)**

A regression model's goodness of fit is evaluated using a residual plot, a graphical representation. It shows the residuals, which are the discrepancies between the values of the dependent variable that were observed and those that the regression model projected to be present.

We used the Funds raised as an independent variable in this regression study because its value is unaffected by any outside forces, and the Laid of count as a dependent variable.

We obtained the following regression line equation from the analysis and

R Square = 0.67427981 and

Adjusted R Square= 0.66570823

Additionally, we used 40 observations in this experiment. And the percentage laid of count in

Residual is 79.23111716 and Residual is -72.231117

We used the 40 observations in the regression process each observation is divided with separate.

probabilities output.

We conclude that laid of count increases, its funds is likely to fall.

**Linear Regression (Normal Probability plot)**

A normal plot, sometimes referred to as a quantile-quantile plot (Q-Q plot), is a graphical tool used to determine if a dataset conforms to a particular probability distribution, usually the normal distribution. The plot's points should nearly lie along a straight line to indicate that the data matches the assumed distribution when the quantiles of the dataset are compared to the quantiles of the theoretical distribution.

You may visually contrast the distribution of your dataset with the theoretical distribution using the normal plot. Divergences from the assumed distribution may be indicated by deviations from a straight line. The data may have heavier or lighter tails than the normal distribution, for instance, if the points dramatically depart from the straight line at the ends of the plot.

We used the Funds raised as an independent variable in this regression study because its value is unaffected by any outside forces, and the Laid of count as a dependent variable.

We obtained the following regression line equation from the analysis and

R Square = 0.67427981 and

Adjusted R Square= 0.66570823

**Visualizations:**

The visualization of the total number of laid-off workers by country is shown in the pie chart below.

The pie chart below breaks down the number of employees who lost their jobs throughout the recession process by nation and the number of people affected. *A picture containing text, screenshot, diagram, design

Description automatically generated*

Looking at this pie chart, we can observe that Australia saw the highest rate of layoffs in comparison to the other nations.

Belgium and Austria are in second and third place, respectively.

Overall, the GDP loss is held in Australia on the basis of financial resources.

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**Conclusion:**

We have first measured the confidence interval on the data by considering variance as unknown. Our results show that 90% of population parameter is likely to reside in the range of between 94.96 and 157.98 and the margin of error of 31.5.

In our analysis we use anova and regression analysis techniques. ANOVA given the results of F statistic value is 0.80 and F-crit is 3.15. That means F statistic is lesser than F-crit, we can reject the null hypothesis which we considered in the beginning. P-value is greater than significant value of 0.05 hence we can say that the difference in the means are insignificant.

In the regression analysis, we have considered laid\_off\_count as dependent variable and Funds raised as a independent variable and the sample size is 40 observations. After doing the analysis in excel spreadsheet we got adjusted R2 value as 66.57% and R2 value as 67.4%.

**Limitations:**

In difficult economic times, organizations frequently must make painful decisions like layoffs. Here are some suggestions to aid in the process if you're thinking about or involved in layoffs.

Clearly expressed: Inform the impacted employees honestly and openly about the reasons for the layoffs, the selection procedures, and the support services available to them. Give details on severance payments, outplacement services, and other sources you may have access to for becoming retrained or finding new work.

Establish fair and consistent selection standards before choosing which personnel to let go of. To ensure fairness and prevent appearances of favoritism or discrimination, these criteria should be founded on valid business needs and applied consistently. Support services: Make resources and assistance available to assist impacted employees in finding new employment. This could be resume writing seminars, career counseling, job search support, or networking events. By providing these services, you can assist people in rebuilding their careers and boosting their confidence through trying times.

Key talent retention: Think about the long-term effects of the layoff decisions. Determine whether employees have the essential knowledge, expertise, or institutional skills needed for the organization's future success. Maintaining essential personnel can make the transfer go more smoothly and have less of an impact on continuing operations.

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