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1. Introduction

In this project, there is a requirement of exploring and categorizing the hourly data set of weather, such that required information could be extracted and the decision-making process could be facilitated. Data analysis needs to be performed using the concept of R-programming taught in our module along with new and additional concepts.

Here in this project, we first have to import the provided data set of weather using the required commands to change it to our preferred format. Furthermore, concepts of data exploration, visualization of data, and manipulation will be implemented in the project. Graphs are to be generated for the provided data set using the concepts of R-programming where different data analyses will be performed. The data set, that we are provided for this project is the hourly weather report of two different airports (JFK and LGA) based in the United States and we need to perform data analysis and generate graphs for the same, in order to facilitate the airport operation and decision making (Wickham & Grolemund, 2016).

2. Assumptions

Before starting working on this project, we need to make some assumptions regarding the data set and the project to be developed, in order to increase the credibility of the system. This will further help to perform this task with a realistic approach. First of all, we need to assume some variables for the project, which we will use during the project development phase i.e., programming, Second, we need to assume that the data set provided to us is the actual weather data set without any manipulation and third, the data were collected from proper working tools or devices so that the credibility of the data set could be assured (Lander, 2013).

Furthermore, the data analysis which we will be performing in the project should be properly generated using the appropriate and relevant concepts of R-programming. Different graphs, charts, and plots are to be generated during the data analysis process, which is assumed to be used by the airport departments to enhance the decision-making process.

3. Data Analysis

3.1. Analysis 1

```
#Analysis 1
#Temperature differences between JFK and LGA Airport throughout the year.

library(ggplot2)

ggplot(data=data, mapping=aes(x=month, y=temp, colour=origin)) +
  aes(x = month, y = temp, colour = origin) +
  geom_jitter(size = 1.5) +
  scale_x_continuous(breaks=c(1:12, 1))+
  scale_color_brewer(palette = "Dark2", direction = 1) +
  labs(x = "Month", y = "Temperature", title = "Temperature Differences",
       color = "Airport") +
  theme_classic() +
  theme(plot.title = element_text(size = 15L, face = "bold",
                                  hjust = 0.5)) +
  facet_wrap(vars(origin))
```

Figure 1: Source code for analyzing the difference in temperature between airports

Here for the first analysis, I have written source code for analyzing the difference in temperature between 2 airports. Library of ggplot2 is used, where the mapping of the graph to be generated is defined in origin color, with the month on X-axis and the temperature on Y-axis. Furthermore, different parameters are set for size, break, palette, direction, and face of the graph.

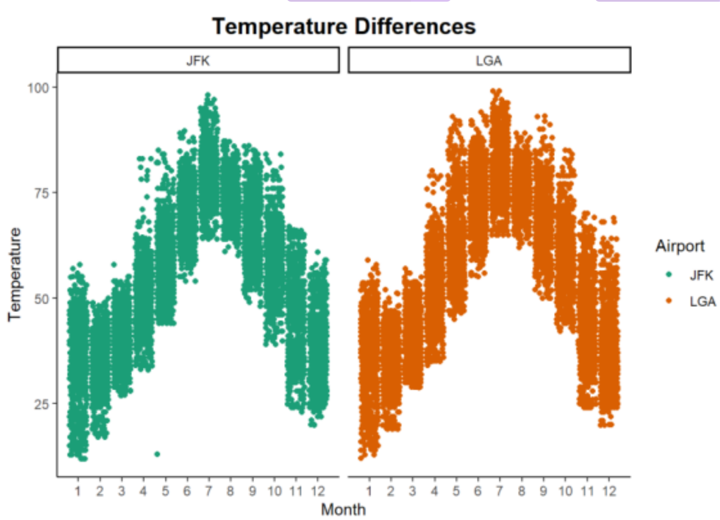

Figure 2: Outcome of analysis 1 represented graphically

The generated graph shows that the temperature at both the airport, reach up to 75 degrees at the end of the month of May. The temperature at both the airport remains lowest in the month of January and reaches the highest in the month of August. The temperature of months throughout the years is demonstrated by the generated graph. Hence by analyzing this graph, we got to know that, the temperature pattern is almost similar in both airports.

3.2. Analysis 2

```r
#Analysis 2
#Pressure patterns throughout the year

ggplot(data=data, mapping=aes(x=month, y=pressure, colour=origin)) +
  aes(x = month, y = pressure, colour = origin) +
  geom_jitter(size = 0.5) +
  scale_x_continuous(breaks=c(1:12, 1))+
  scale_color_brewer(palette = "Dark2", direction = 1) +
  labs(x = "Month", y = "Pressure", title = "Pressure Patterns Throughout The Year",
       color = "Airport") +
  theme_classic() +
  theme(plot.title = element_text(size = 15L, face = "bold",
                                  hjust = 0.5))
```

Figure 3: Source code for analyzing pressure pattern

In the second analysis, I have written source code for analyzing the pattern of pressure at two different airports throughout the years. For this, I have set different parameters regarding the size, breaks, palette, color, title text, and the face of the title text of the graph. Here the scale_x_continuous breaks are defined from c(1:12, 1).

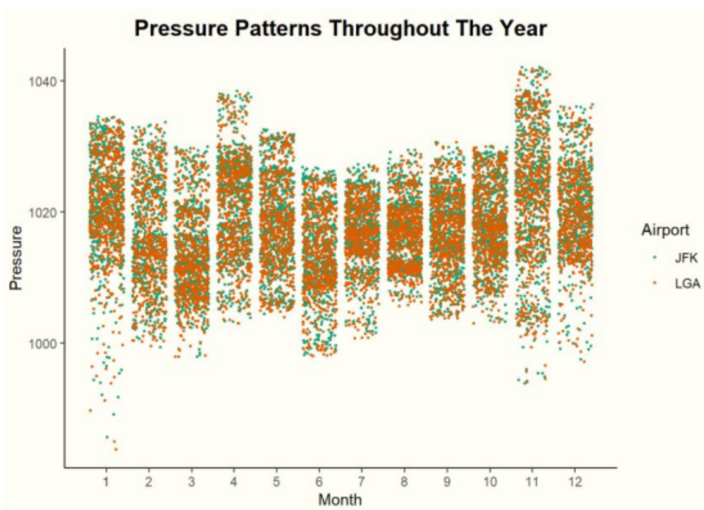

Figure 4: Outcome of analysis 2 represented graphically

A graph is generated showing the variation of pressure patterns at both of the airports throughout the year. At the beginning of the month of January, the pressure remains lowest which eventually starts increasing throughout the month. From February to October, the pressure pattern doesn't fluctuate much but once November starts, the pressure falls below at the beginning of the month but ends up being the highest pressure measure of the year at the end of the same month. Furthermore, the pressure pattern of December is similar to the month of March and June. Here in this graphical representation, the measure of pressure is placed on the Y-axis and the month on X-axis.

3.3. Analysis 3

```
#Analysis 3
#Wind Speed

ggplot(data=data, mapping=aes(x=wind_speed, fill=origin)) +
  aes(x = wind_speed, fill = origin) +
  geom_histogram(bins = 30L) +
  scale_fill_brewer(palette = "Dark2",
                    direction = 1) +
  labs(x = "Wind Speed", y = "Count", title = "Histogram of Wind Speed", fill = "Airport") +
  theme_classic() +
  theme(plot.title = element_text(size = 15L, face = "bold", hjust = 0.5)) +
  facet_wrap(vars(origin))
```

Figure 5: Source code for analyzing the wind speed

Article Error

In the third analysis, I have written the given source code for analyzing the wind speed at the airports. Here ggplot is used, and the original color is used to fill the graph. Furthermore, bins are defined for 30L, the palette for Dark2, and direction for 1. Wind speed and count are placed on the X and Y axis respectively.

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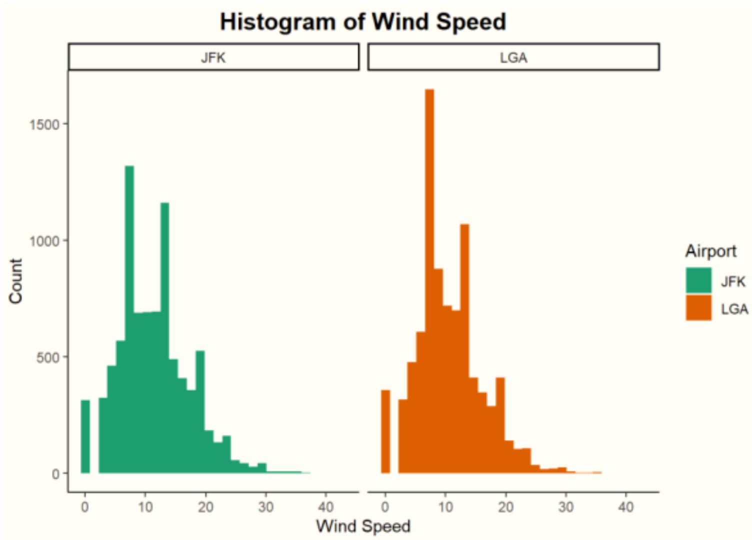

Figure 6: Outcome of analysis 3 represented graphically

The required histogram was generated through the source code, representing the variation of wind speed at LGA and JKF airports. Wind speed is a very important factor for airports in order to prescribe the pilot for landing and take off. The air traffic controller track this data, as well as the pilots in order to decisions accordingly.

3.4. Analysis 4

```
#Analysis 4
#Temperature affecting dew point


ggplot(data=data, mapping=aes(x=temp, y=dewp, colour=origin)) +
  aes(x = temp, y = dewp, colour = origin) +
  geom_point(shape = "circle",
             size = 1.5) +
  scale_color_brewer(palette = "Dark2", direction = 1) +
  labs(x = "Temperature", y = "Dewpoint",
       title = "Temperature Affecting Dewpoint", color = "Airport") +
  theme_classic() +
  theme(plot.title = element_text(size = 15L,
                                  face = "bold", hjust = 0.5))
```

Figure 7: Source code for analyzing the dew point affecting temperature

In the fourth analysis, I have written source code for analyzing the dew point affecting the temperature. Through this analysis, the dew point at the airport will be determined. In the source code, I have used ggplot, the geometric shape of the graph is set to circle, color to the origin, palette to Dark2, and direction to 1. Furthermore, temperature and dew point is set to the X and Y axis respectively.

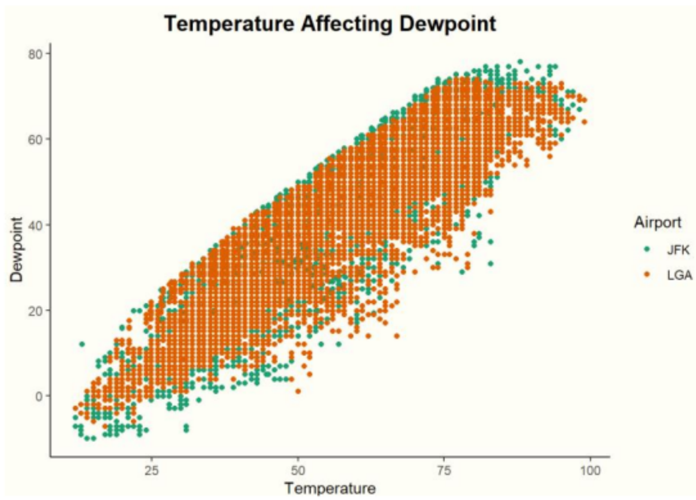

Figure 8: Outcome of analysis 4 represented graphically

Here from the generated graph from our source code, we can analyze the relation between the temperature and dewpoint is directly proportional, where the increase in temperature leads to the raise in dew point and the decrease in temperature leads to the downfall of dew point.

3.5. Analysis 5

```
#Monthly wind gust patterns

ggplot(data=data, mapping=aes(x=day, y=wind_gust, colour=origin)) +
  aes(x = day, y = wind_gust, colour = origin) +
  geom_point(shape = "star",
             size = 1.5) +
  scale_color_brewer(palette = "Dark2", direction = 1) +
  labs(x = "Day", y = "Wind Gust",
       title = "Wind Gust Patterns for Every Month", color = "Airport") +
  theme_classic() +
  theme(plot.title = element_text(size = 15L,
                                  face = "bold", hjust = 0.5)) +
  facet_wrap(vars(month))
```

Figure 9: Source code for analyzing the monthly pattern of wind gust

For the fourth analysis, I have written code for analyzing the monthly pattern of a wind gust. Here ggplot is used, where mapping in the graph is set as day and wind gust on the X and Y axis respectively. Also, the color of the graph is set to the origin, shape to star, size to 1.5, palette to Dark2, and direction to 1.

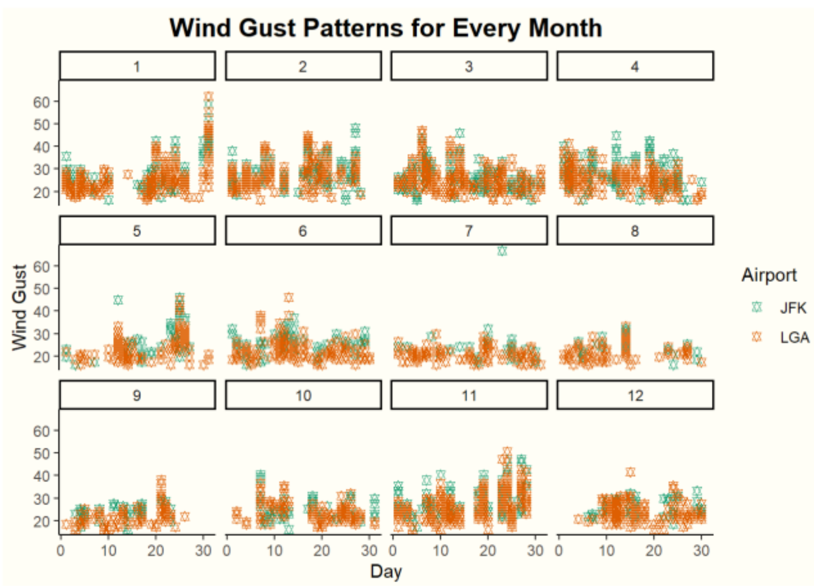

Figure 10: Outcome of analysis 5 represented graphically

From the graph generated, we found out that the wind gust at both of the airports are higher in the first four months and the month of November. For the rest of the months, the wind gust remains below 50. Here we can also analyze that the wind gust at JFK is comparatively higher than that of LGA. The wind gust report is very critical to the airport operation because the decision for landing and takeoffs are made accordingly.

3.6. Analysis 6

```
#Analysis 6
#Dew point throughout the year for each day

ggplot(data=data, mapping=aes(x=month, y=day, colour=origin, size=dewp)) +
  aes(x = month, y = day, colour = origin, size = dewp) +
  geom_point(shape = "circle") +
  scale_x_continuous(breaks=c(1:12, 1))+
  scale_color_brewer(palette = "Dark2", direction = 1) +
  labs(x = "Month", y = "Days in the Month",
       title = "Dewpoint Throughout The Year For Each Day", color = "Airport", size = "Dewpoint") +
  theme_classic() +
  theme(plot.title = element_text(size = 15L, face = "bold", hjust = 0.5)) +
  facet_wrap(vars(origin))
```

Figure 11: Source code for analyzing dew point

In the sixth analysis, I have written source code for analyzing the dew point of every day throughout the year. Here ggplot is used and in the graph mapping and month and day are placed on the X and Y axis respectively. The size of the graph is set to dewp, shape to circle breaks to c(12:1), palette to Dark2, and direction to 1. Furthermore, the element text size is set to 15L, face to bold, and hjust to 0.5.

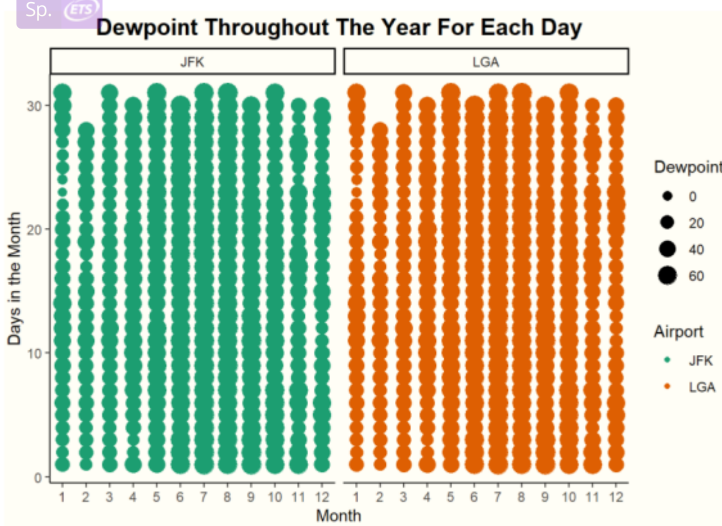

Figure 12: Outcome of analysis 6 represented graphically

In the graph generated above, a bubble plot is used to demonstrate the everyday dew point at different airports. The dew point of the airport varies on the size of the bubble plot as determined on the right side of the graph.

3.7. Analysis 7

```
#Analysis 7
#Relationship Between Wind Direction and Wind Speed

ggplot(data=data, mapping=aes(x = wind_dir, y = wind_speed, fill = origin, colour = origin)) +
  aes(x = wind_dir, y = wind_speed, fill = origin, colour = origin) +
  geom_line(size = 0.5) +
  scale_fill_brewer(palette = "Dark2", direction = 1) +
  scale_color_brewer(palette = "Dark2",
                     direction = 1) +
  labs(x = "Wind Direction", y = "Wind Speed", title = "Relationship Between Wind Direction and Wind Speed'
       color = "Airport") +
  theme_classic() +
  theme(plot.title = element_text(size = 15L, face = "bold",
                                  hjust = 0.5))
```

Figure 13: Source code for analyzing wind speed and direction relationship

In the seventh analysis, I have written source code for analyzing the wind direction and wind speed relationship. Here ggplot is used, and mapping is set with wind direction and wind speed on the X and Y axis respectively with a fill set to origin and color to origin as well. Furthermore, the geom line size is set to 0.5, palette to Dark2, and direction to 1.

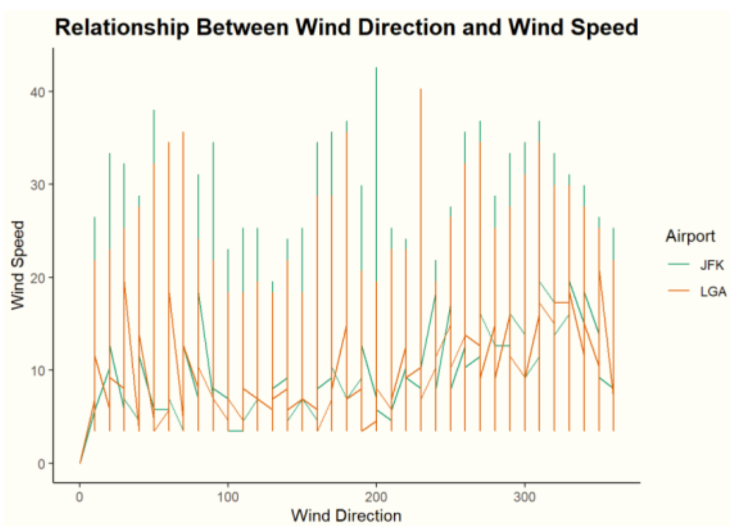

Figure 14: Outcome of analysis 7 represented graphically

Here we found that the wind speed and direction are related as one factor also affects the other factor. For JFK airport, when the wind speed is highest at 42 mph, the wind direction is found to be 200 degrees. Furthermore, for the LGA airport, when the wind speed is highest at 40 mph, the wind speed is found to be 230 degrees.

3.8. Analysis 8

```
#Analysis 8
#Analysis on how temperature affects pressure


ggplot(data=data, mapping =aes(x = temp, y = pressure, fill = origin) ) +
  aes(x = temp, y = pressure, fill = origin) +
  geom_tile(size = 0.5) +
  scale_fill_brewer(palette = "Dark2", direction = 1) +
  labs(x = "Temperature", y = "Pressure",
       title = "Temperature Affecting Pressure",
       fill = "Airport") +
  theme_classic() +
  theme(plot.title = element_text(size = 15L, face = "bold",
                                  hjust = 0.5))
```

Figure 15: Source code for analyzing temperature affecting pressure

Here in the eighth analysis, I have written source code for analyzing the effect of temperature on pressure at the airport. We have used ggplot and mapping is set with the temperature and pressure on the X and Y axis respectively. The graph fill is set to the origin, the geom title to 0.5, the palette to Dark2, and the direction to 1.

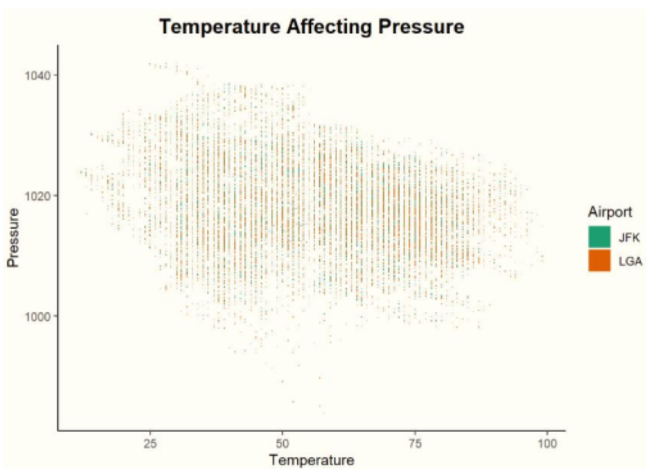

Figure 16: Outcome of analysis 8 represented graphically

From the generated graph, we can analyze that temperature is directly related to pressure. As the temperature raises in the JFK airport so the pressure increases and a decrease in temperature lead to a decrease in pressure. This case goes identical for LGA airport as well.

3.9. Analysis 9

```
#Analysis 9
#Mean of Wind Speed at each day (Data exploration and manipulation)

library(ggplot2)
aggregate(wind_speed~day, data, mean)

data%>%ggplot(aes(x = day, y = wind_speed))+
  scale_x_continuous(breaks=c(1:12, 1))+
  geom_point(color="purple") + geom_smooth(method="lm", color="green")
labs(x = "year", y = "Wind Speed",
     title = "Wind Speed of Each day", color = "Airport")
```

Figure 17: Source code for analyzing mean of wind speed

In analysis 9, I have written source code for analyzing the wind speed at the airport. Here we have used the concept of data manipulation and exploration. Library of ggplot2 is used for this analysis, where breaks are set to c(1:12, 1), geom_point color to purple and geom_smooth color to green.

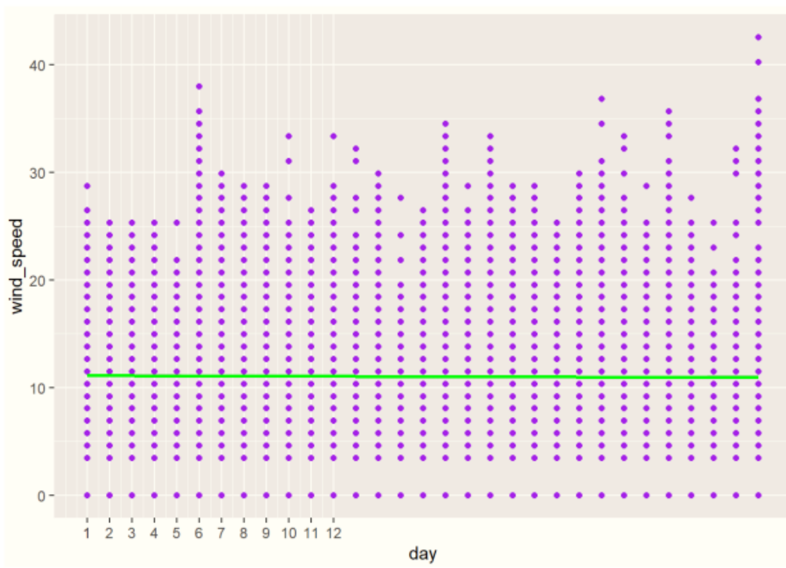

Figure 18: Outcome of analysis 9 represented graphically

Here we have analyzed that the line shown in the graph is in declining order, verifying that the wind speed is decreasing as per the day, which will eventually end up decreasing per month and throughout the year.

3.10. Analysis 10

```
#Analysis_10
#Relationship between humidity and visibility (Data Manipulation; use of dplyr)

data%>%ggplot(aes(x=humid, y=visib))+
  facet_wrap(~year)+
  labs(title="Relationship Between Humidity and Visibility For Each Month", x="Humidity", y="Visibility")+
  geom_point(color="purple")+ geom_smooth(color="yellow")
cor(x=data$humid, y=data$visib, use="complete.obs")
```

Figure 19: Source code for analyzing visibility and humidity relationship

In this analysis, I have written source code for analyzing the visibility and humidity relationship. Here in the mapping of the graph, humidity and visibility are set to the X and Y axis respectively. Furthermore, the geom_point color is set to purple and the geom_smooth color to yellow.

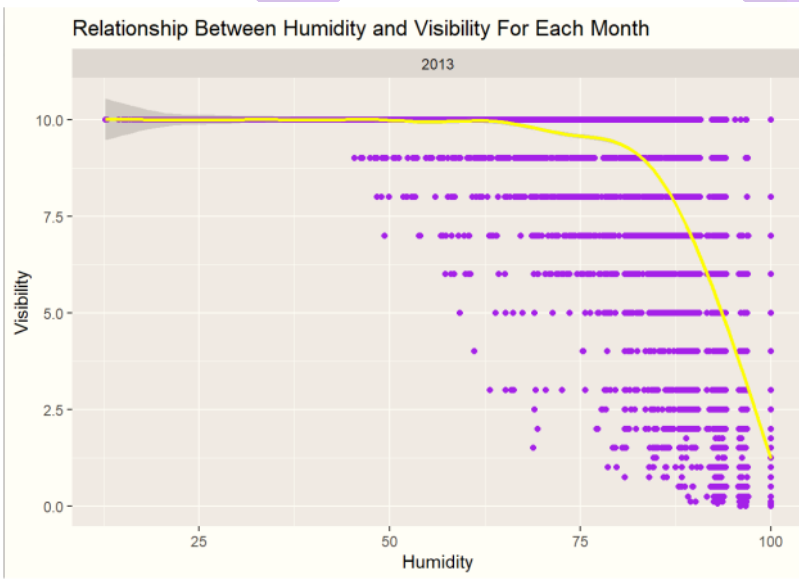

Figure 20: Outcome of analysis 10 represented graphically

The graph illustrates the relationship between humidity and visibility in the year 2013. It shows that both factors are interrelated and affect the other factor. Here the graph shows that the humidity and visibility are inversely proportional and the high humidity leads to low visibility in the airport.

3.11. Analysis 11

```
#Analysis-11
# In this analysis Histogram is made for Humidity
ggplot(data = data, mapping = aes(x = humid,  fill = origin)) +
  geom_histogram() +
  labs(title = "Histogram of Humidity", x = "Humidity", y = "Count") +
  theme(panel.background = element_rect(fill = "#545454"),
        panel.grid = element_blank()) +
  facet_wrap(~origin)
```

Figure 21: Source code for analyzing humidity histogram

In this analysis, a ggplot is used to analyze the humidity histogram. For the mapping of the histogram, humidity and count are set to the X and Y axis respectively. Furthermore, the panel grid is set to element_black and the facet_wrap to origin.

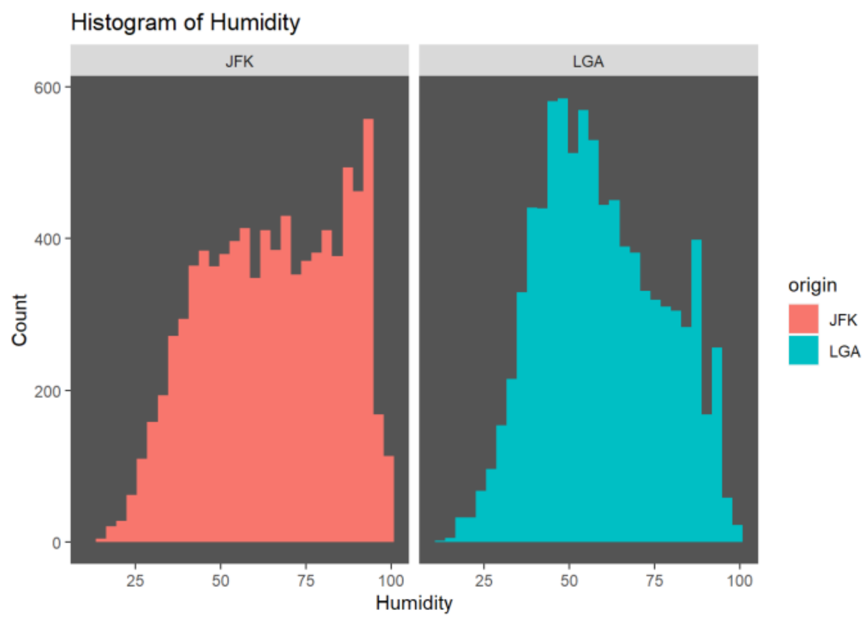

Figure 22:Outcome of analysis 11 represented graphically

Here is the histogram for the humidity count of LGA and JFK airports. The humidity at the LGA airport seems to be higher than that of the humidity count of JFK airport. The highest humidity count for LGA is 580 and for JKF it’s 550. The humidity count is very critical to airport operation since it determines the visibility in the airport.

3.12.   Analysis 12

```
#Analysis 12
#Humidity


ggplot(data=data, mapping=aes(x=humid, fill=origin)) +
  aes(x = humid, fill = origin) +
  geom_histogram(bins = 50L) +
  scale_fill_brewer(palette = "Set1",
                    direction = 1) +
  labs(x = "Humidity", y = "Count", title = "Histogram of Humidity", fill = "Airport") +
  theme_classic() +
  theme(plot.title = element_text(size = 10L, face = "bold", hjust = 0.5))
```

Figure 23: Source code for analyzing humidity

Here in this analysis, I have written source code for analyzing the humidity count of the airport on a single plot to find out the identical or overlapping humidity count of LGA and JFK airports. I have used ggplot with the mapping of fill set to the origin, geom_histogram bins to 50L, palette to set1, and direction to 1.

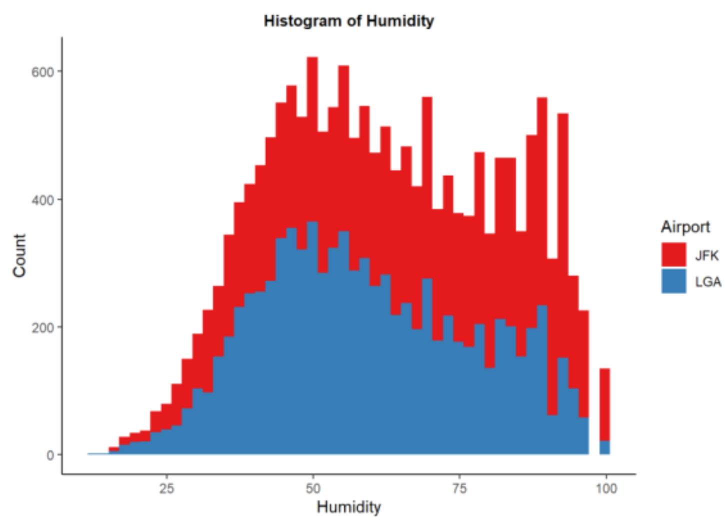

Figure 24:Outcome of analysis 12 represented graphically

The generated graph from the source code illustrates that the humidity count at both airports differs. Also, the humidity count at LGA airport is comparatively lower than that of the humidity count of JFK airport.

3.13. Analysis 13

```r
#Analysis 13

#Precipitation Levels at JFK and LGA Airport throughout the year.


ggplot(data=data, mapping=aes(x=month, y-precip, colour=origin)) +
  aes(x = month, y = precip, colour = origin) +
  geom_line(size = 0.5) +
  scale_x_continuous(breaks=c(1:12, 1))+
  scale_color_brewer(palette = "Dark2", direction = 1) +
  labs(x = "Month", y = "Precipitation", title = "Precipitation Throughout The Year",
       color = "Airport") +
  theme_classic() +
  theme(plot.title = element_text(size = 15L, face = "bold",
                                  hjust = 0.5))
```

Figure 25: Source code for analyzing precipitation

In this analysis, I have written source code for analyzing the level of precipitation at airports. For this we have used ggplot, mapping with month and precipitation on the X and Y axis respectively. The color is set to the origin, breaks to c(1:12, 1), palette to Dark2, and direction to 1.

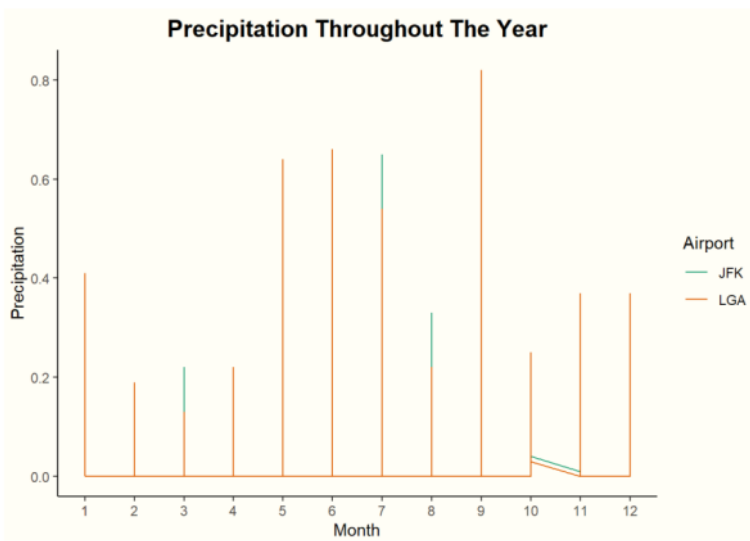

Figure 26:Outcome of analysis 13 represented graphically

Here is the graph generated for our source code, which represents the precipitation level as per the months of the year. In the month of September, the precipitation level is highest at 0.8, and in the month of February, the precipitation level is lowest at 0.2.

3.14. Analysis 14

```r
#Analysis 14
#Visibility Throughout the Year


ggplot(data=data, mapping = aes(x = "", y = visib, fill = origin) ) +
  aes(x = "", y = visib, fill = origin) +
  geom_violin(adjust = 20L, scale = "area") +
  scale_fill_brewer(palette = "Dark2", direction = 1) +
  labs(x = "Count", y = "Visibility", title = "Visibility Throughout the Year",
       fill = "Airport") +
  theme_minimal() +
  theme(plot.title = element_text(size = 5L, face = "bold",hjust = 0.5)) +
  facet_wrap(vars(month))
```

Figure 27: Source code for analyzing visibility

In this analysis, I have written source code for analyzing the visibility of the airport throughout the year. I have used ggplot and mapping is set as count and visibility on the X and Y axis respectively. Furthermore, the fill is set to the origin, adjust to 20L, scaled to the area, palette to Dark2, and direction to 1.

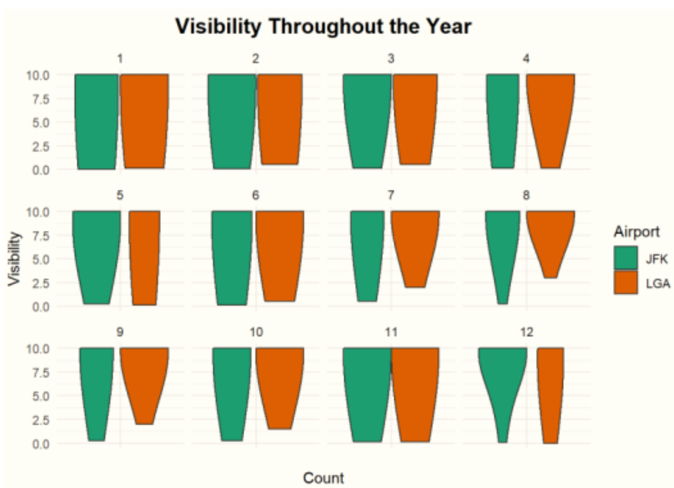

Figure 28: Outcome of analysis 14 represented graphically

Here is the graph generated from the source code, representing the visibility count of the airport throughout the year. The visibility at both of the airports is identical for the first 3 months of a year and the fluctuation starts from the 4th month. For both of the airports, the visibility is lowest during the month of December.

4. Additional features

Once done with the regular data analysis, further data analysis is performed using new concepts and generating unique data visualization.

4.1. Additional feature 1

```
#Additional feature 1

#Determine Visibility Issue

Visibility4.19JFK = data %>% #taking data stored in Weather
  filter(origin=="JFK")%>% #only get values for JFK
  filter(month=="4")%>% #only get values for the month April
  filter(day=="19")%>% #only get values for the 19th of April
  select(hour,temp,dewp,precip,wind_speed,humid,visib)
View(Visibility4.19JFK)

TempMinusDewp = c((Visibility4.19JFK$temp)-(Visibility4.19JFK$dewp))
VisibFactors4.19JFK = cbind(Visibility4.19JFK,TempMinusDewp)
View(VisibFactors4.19JFK)
```

```
TempMinusDewp = c((Visibility4.19JFK$temp)-(Visibility4.19JFK$dewp))
VisibFactors4.19JFK = cbind(Visibility4.19JFK,TempMinusDewp)
View(VisibFactors4.19JFK)

ggplot(VisibFactors4.19JFK,aes(x=hour, y=visib, col=temp))+
  geom_line()+
  geom_point()+
  scale_x_continuous(breaks=seq(0,23,1))+
  ggtitle("Hour vs Visibility 19th April JFK")+
  xlab("Hours")+
  ylab("Visibility")+
  geom_vline(xintercept=10, linetype="longdash", color="yellow")+

  geom_vline(xintercept=12, linetype="longdash", color="orange")+
  geom_vline(xintercept =14, linetype ="longdash", color="red")+
  geom_vline(xintercept =21, linetype ="longdash", color="purple")+
  geom_vline(xintercept =23, linetype ="longdash", color="blue")
#-----------------------------------------------------------#
```

Figure 29: Source code for analyzing visibility per hour

Article Error

In this analysis, I have written source code for analyzing the visibility per hour at the airports. Here we have set different paraments to obtain the required graph. I have used ggplot where mapping was set with an hour and visibility on the X and Y axis of the graph respectively. Furthermore, the line type is set to a long dash with different colors as shown in the source code.

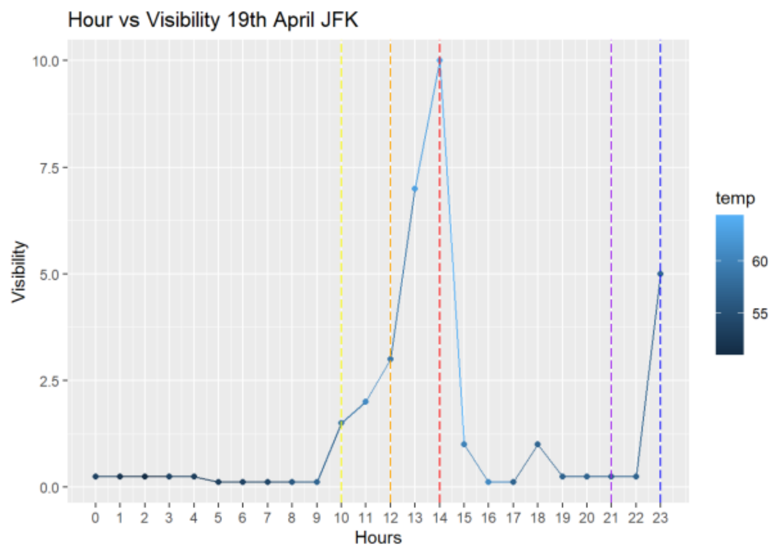

Figure 30: Outcome of additional feature 1 represented graphically

Here is the generated graph for the first additional analysis which shows the fluctuation in visibility in a day of a month. In the first 9 hours of the day, the visibility is steady and remains at 0.0. The visibility starts rising from 9 AM and reached a peak at 2 PM. After 2 PM the visibility drops suddenly to 1.1 and slightly fluctuates between 2 PM to 10 PM and the visibility ends up at 5.0 at 11 PM.

4.2. Additional feature 2

```
#Additional feature 2
#Analysis of Pressure in LGA (Data Manipulation and Data Exploration)

data%>%filter(origin=="LGA")%>%ggplot(aes(x=pressure))+
  geom_histogram(bins=30)+
  facet_wrap(~month)+
  labs(title="Histogram of Pressure in LGA Throughout the Year", x="Pressure", y="Frequency")
data.frame(y=data[["data"]], x=pressure[["data"]][[1]][["x"]])
data%>%summarise(Origin="LGA", MaxPressure=max(pressure, na.rm = TRUE), MinPressure=min(pressure, na.rm = T
                 MeanPressure=mean(pressure,na.rm = TRUE))
```

Figure 31: Source code for analyzing LGA Pressure

In this analysis, I have written source code for analyzing the pressure in LGA using data exploration and manipulation concepts. Here for mapping, the X and Y axis are set to pressure and frequency respectively. Furthermore, parameters for geom_histogram bins are set to 30, and pressure, na.rm is set to true.

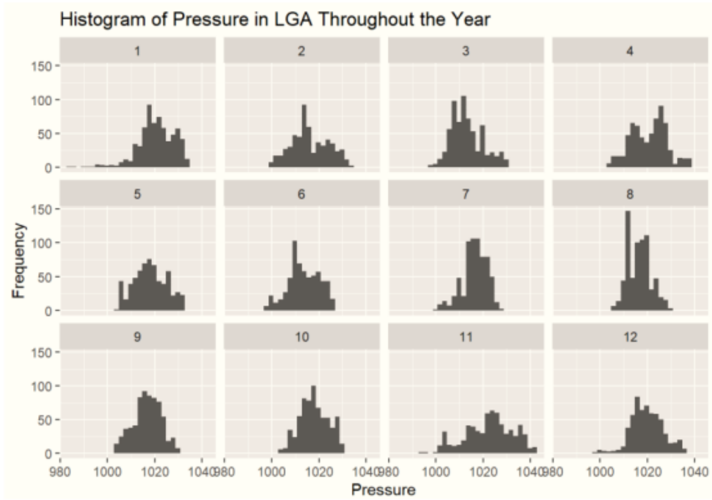

Figure 32:Outcome of additional feature 2 represented graphically

This is the histogram generated from the second additional analysis. Here the relation between pressure and frequency is analyzed throughout the year. From this histogram, we got to know that increase in pressure at the airport leads to an increase in frequency and vice-versa.

5. Explanation for additional features

Here in this project, I have performed further two data analyses using the unique concept of R-programming and generated unique visualization. The first additional feature shows the visibility of the airport during working hours of the airport. Visibility is very critical data for air traffic controllers to give direction to pilots and for the pilot itself to make decisions for landing. This analysis will help them, by providing hourly data regarding the visibility of the airport.

In my second additional analysis, I analyzed the pressure histogram for the LGA airport, which will help the airport departments to track the frequency along with the fluctuation in the airport pressure. This analysis will further help in decision-making.

6. Conclusion

I investigated and organized the hourly weather data set in this project so that the decision-making process could be sped up and the necessary data could be extracted. The R-programming concept that we covered in our module is combined with new and additional concepts to perform data analysis.

In order to convert the provided weather data set to the format, we prefer in this project, I first import it using the necessary commands. Additionally, the project included the implementation of data exploration, visualization, and manipulation concepts. Using the principles of R programming, graphs were produced for the provided data set where various data analyses were carried out. I performed data analysis and generated graphs for the hourly weather forecasts of two different airports (JFK and LGA) in the United States that were provided to us for this project to aid in international terminal and judgment. Therefore, fulfilling every project requirement, this project was successfully developed and demonstrated.

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