Report on analysis of Daily Passenger Number of an airline over three years (2021-2023) using Fourier Series and Power Spectrum

By Tiasa Malitya (Student ID – 24005709)

Dataset Structure and Variables

The dataset I have used is "airline0" which contains daily performance data of an airline throughout the years from 2021 to the end of 2023. It has four main variables which are structured as columns with one entry per day for a total of 1095 rows. In the following table I have discussed all the four columns and what It does contain.

Day	Identity of each row starting from 0 corresponding to January 1, 2021 (0 to 1094 index)
Date	Date of each corresponding Day in YYYY-MM-DD format
Number	Total number of passengers in thousands carried that Day
Price	Average ticket price in Euros of that Date

Exploring the figures

I have created two figures of plots to analyse the dataset which are

Figure 1:

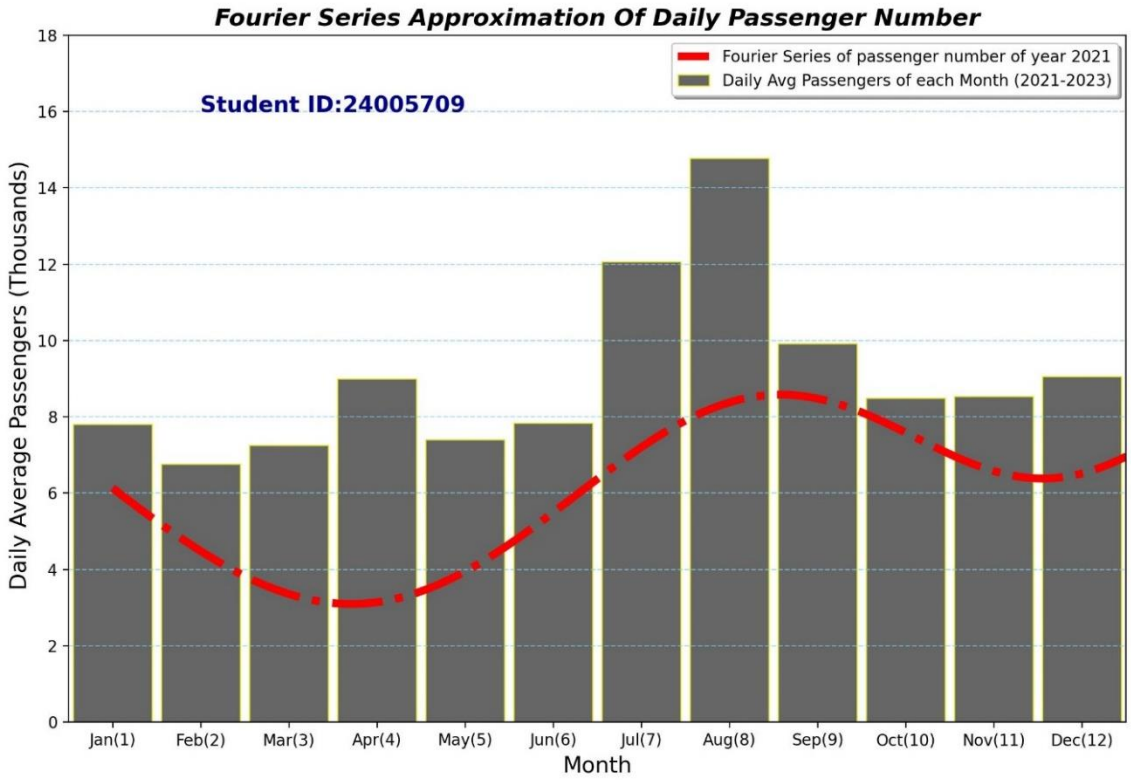

Figure 1 shows Bar chart of daily average passenger (Thousands) of each month carried by the airline during the year 2021,2022 and 2023. In addition, I have plotted a Fourier series approximating the variation of the daily number of passengers in 2021 on the same figure overlaying the Bar chart. The Fourier series is limited up to the first eight terms which represents the cyclical pattern. Furthermore, the x axis reflects the months of a year (1 to 12) and y axis is ranging from 0 to 18 labelled as Daily Average Passengers in thousands. Here

$Daily\ average\ passengers_i = \frac{\sum NM_i}{\sum DM_i}$, i : months from January to December

Where, NM = number of passengers of each day corresponding a month (i) from 2021 to 2023

DM = days corresponding a month (i) from 2021 to 2023

Figure 2:

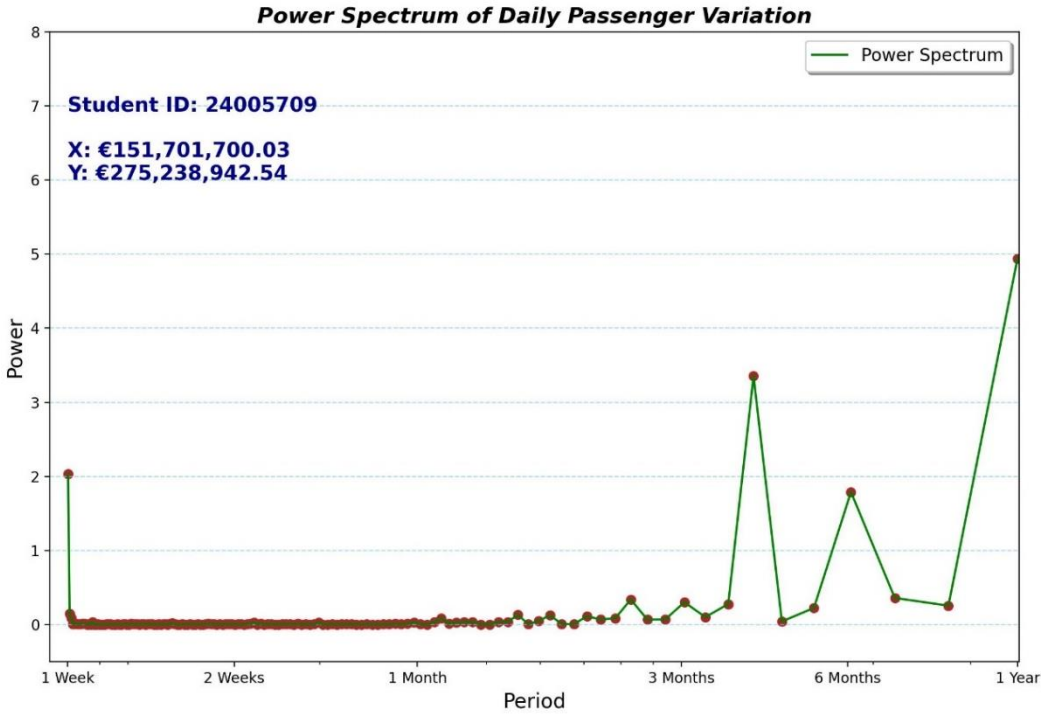

Figure 2 represents the Power spectrum which I have derived by using the Fourier series. The spectrum tells the contribution of different periods in the variation of the number of daily passengers of 2021. Here x and y axis depict the power value (0 to 8) and period (1 week to 1 year) respectively. We can see the pecks are the highest at 1 week with power 2 and 1 year with power 5. I have also printed the calculated X and Y values in the figure 2 which are total revenue of 2021 and 2022.

Formulas

- Calculate the total revenue of the airline in 2021(X value)

$$X = \sum_{i=0}^{364}(N_i * 1000 * P_i)$$

- Calculate the total revenue of the airline in 2022(Y value)

$$Y = \sum_{i=365}^{729}(N_i * 1000 * P_i)$$

Where $N: Number\ of\ Passenger$, $P: Average\ Price, i: Days$

Conclusion

In the conclusion, we can tell how Fourier fit and power spectrum helps to understand the periodic trend in airline operations. Start from **Figure 1** which represents the bar chart with overlaid Fourier series of daily number of passengers of year 2021, we can observe that the highest peak in daily average passenger number is in the month of June to August. This is the period particularly summer months when Holiday and Vacation travel are the most common in Europe. As the year progresses into autumn and winter, the passenger numbers begin to decrease. So, the Fourier series identifies the pattern of periods like when the airline company needs to increase capacity and optimize the ticket pricing in high-demand months. Secondly, **Figure 2** of Power Spectrum which highlights the significant periodicities in the daily passenger's number with highest peak at 7-day period and 365-day period which clearly tells a huge number of people travels the most in the weekends and in the winter vacations in 2021. Although daily average passengers of three years behave slight differently with peak value in the month of summer. So, we can assume in 2022 and 2023 people travel the most in the month July, August. Lastly, the total revenue for 2021 (Value X) and 2022 (Value Y) shows a big increase in the airline's earnings, from **151,701,700 Euros in 2021** to **275,238,942 Euros in 2022** which interprets the year 2021 was heavily impacted by the COVID-19 pandemic, which led to reduced passenger numbers and revenues across the airline industry. This report shows how important it is for the airline to plan well and adjust ticket prices, crew members to make the most of busy travel times.