BUSINESS UNDERSTANDING

The goal of this project is to analyze the AviationData.csv dataset to provide valuable insights that will guide in identifying which aviation engines are best, the most affected years and months by aviation accidents and the most affected countries.

PROBLEM STATEMENT

This analysis aims to explore the AviationData dataset to assess an aircraft operations project viability analysis. In particular, the analysis will assess the incidence of airplane accidents, assess the risk involved in the accidents, countries worst hit out of such accidents and compare survival rates in the aftermath of such accidents.

OBJECTIVES

1. Figure out the relationship between engine type and the frequency of accidents.
2. Identify the most affected year by airplane accidents.
3. Identify the months in which the most accidents occur.
4. Investigate survival rates after the accidents.
5. Generate visualizations that give insights and findings from the analysis.

RESEARCH QUESTIONS

1. How does the engine type correlate with accident frequency?
2. How do accident rates vary by year and month? Are there any identifiable patterns over time?
3. Which countries are the most affected by aviation accidents?

DATA UNDERSTANDING:

Getting to know and understand what the dataset contains.

In [270…
```
#Importing the necessary libraries
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
```

In [271…
```
#reading the csv dataset.
#setting the encoding to latin1 for compatibility
#Using low_memory=false to prevent warnings about inconsistent data types
Aviation_df = pd.read_csv('AviationData.csv', encoding='latin1', low_memory= False)
```

In [272…
```
#This gets the first 10 columns of the dataset
Aviation_df.head(10)
```

Out[272…

	Event.Id	Investigation.Type	Accident.Number	Event.Date	Location	Country	Latitude	Longitude	Airport.Code	Airport.Name	...	Purpose.of.flight	Air.carrier	Total.Fatal.Injuries
0	20001218X45444	Accident	SEA87LA080	1948-10-24	MOOSE CREEK, ID	United States	NaN	NaN	NaN	NaN	...	Personal	NaN	2.0
1	20001218X45447	Accident	LAX94LA336	1962-07-19	BRIDGEPORT, CA	United States	NaN	NaN	NaN	NaN	...	Personal	NaN	4.0
2	20061025X01555	Accident	NYC07LA005	1974-08-30	Saltville, VA	United States	36.922223	-81.878056	NaN	NaN	...	Personal	NaN	3.0
3	20001218X45448	Accident	LAX96LA321	1977-06-19	EUREKA, CA	United States	NaN	NaN	NaN	NaN	...	Personal	NaN	2.0
4	20041105X01764	Accident	CHI79FA064	1979-08-02	Canton, OH	United States	NaN	NaN	NaN	NaN	...	Personal	NaN	1.0
5	20170710X52551	Accident	NYC79AA106	1979-09-17	BOSTON, MA	United States	42.445277	-70.758333	NaN	NaN	...	NaN	Air Canada	NaN
6	20001218X45446	Accident	CHI81LA106	1981-08-01	COTTON, MN	United States	NaN	NaN	NaN	NaN	...	Personal	NaN	4.0
7	20020909X01562	Accident	SEA82DA022	1982-01-01	PULLMAN, WA	United States	NaN	NaN	NaN	BLACKBURN AG STRIP	...	Personal	NaN	0.0
8	20020909X01561	Accident	NYC82DA015	1982-01-01	EAST HANOVER, NJ	United States	NaN	NaN	N58	HANOVER	...	Business	NaN	0.0
9	20020909X01560	Accident	MIA82DA029	1982-01-01	JACKSONVILLE, FL	United States	NaN	NaN	JAX	JACKSONVILLE INTL	...	Personal	NaN	0.0

10 rows × 31 columns

In [273…
```
#Getting summary information about our dataset.
Aviation_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 88889 entries, 0 to 88888
Data columns (total 31 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   Event.Id                88889 non-null  object
 1   Investigation.Type      88889 non-null  object
 2   Accident.Number         88889 non-null  object
 3   Event.Date              88889 non-null  object
 4   Location                88837 non-null  object
 5   Country                 88663 non-null  object
 6   Latitude                34382 non-null  object
 7   Longitude               34373 non-null  object
 8   Airport.Code            50249 non-null  object
 9   Airport.Name            52790 non-null  object
 10  Injury.Severity         87889 non-null  object
 11  Aircraft.damage         85695 non-null  object
 12  Aircraft.Category       32287 non-null  object
 13  Registration.Number     87572 non-null  object
 14  Make                    88826 non-null  object
 15  Model                   88797 non-null  object
 16  Amateur.Built           88787 non-null  object
 17  Number.of.Engines       82805 non-null  float64
 18  Engine.Type             81812 non-null  object
 19  FAR.Description         32023 non-null  object
 20  Schedule                12582 non-null  object
 21  Purpose.of.flight       82697 non-null  object
 22  Air.carrier             16648 non-null  object
 23  Total.Fatal.Injuries    77488 non-null  float64
 24  Total.Serious.Injuries  76379 non-null  float64
 25  Total.Minor.Injuries    76956 non-null  float64
 26  Total.Uninjured         82977 non-null  float64
 27  Weather.Condition       84397 non-null  object
 28  Broad.phase.of.flight   61724 non-null  object
 29  Report.Status           82508 non-null  object
 30  Publication.Date        75118 non-null  object
dtypes: float64(5), object(26)
memory usage: 21.0+ MB
```

In [274…
```
#Show basic summary statistics for each column with numbers
Aviation_df.describe()
```

Out[274…

	Number.of.Engines	Total.Fatal.Injuries	Total.Serious.Injuries	Total.Minor.Injuries	Total.Uninjured
count	82805.000000	77488.000000	76379.000000	76956.000000	82977.000000
mean	1.146585	0.647855	0.279881	0.357061	5.325440
std	0.446510	5.485960	1.544084	2.235625	27.913634
min	0.000000	0.000000	0.000000	0.000000	0.000000
25%	1.000000	0.000000	0.000000	0.000000	0.000000
50%	1.000000	0.000000	0.000000	0.000000	1.000000
75%	1.000000	0.000000	0.000000	0.000000	2.000000
max	8.000000	349.000000	161.000000	380.000000	699.000000

In [275…
```
#returns a tuple showing the dimensions of the D
Aviation_df.shape
```

Out[275…
```
(88889, 31)
```

DATA ANALYSIS

In [276…
```
#Checking for total missing data in every column
columns_total_null = Aviation_df.isna().sum()
columns_total_null
```

Out[276…
```
Event.Id                      0
Investigation.Type            0
Accident.Number               0
Event.Date                    0
Location                     52
Country                     226
Latitude                  54507
Longitude                 54516
Airport.Code              38640
Airport.Name              36099
Injury.Severity            1000
Aircraft.damage            3194
Aircraft.Category         56602
Registration.Number        1317
Make                         63
Model                        92
Amateur.Built               102
Number.of.Engines          6084
Engine.Type                7077
FAR.Description           56866
Schedule                  76307
Purpose.of.flight          6192
Air.carrier               72241
Total.Fatal.Injuries      11401
Total.Serious.Injuries    12510
Total.Minor.Injuries      11933
Total.Uninjured            5912
Weather.Condition          4492
Broad.phase.of.flight     27165
Report.Status              6381
Publication.Date          13771
dtype: int64
```

In [277…
```
#Checking for any duplicates
Aviation_df.duplicated().value_counts()
```

Out[277…
```
False    88889
dtype: int64
```

In [278…
```
# Fill missing values (NaN) in specific columns of the DataFrame
#Setting NaNs to 0

Aviation_df = Aviation_df.fillna({'Total.Fatal.Injuries': 0, 'Total.Serious.Injuries':0, 'Total.Minor.Injuries':0, 'Total.Uninjured':0, 'Number.of.Engines':0
```

In [279…
```
#Replacing missing values in the Aircraft damage/Phase of flight column
Aviation_df = Aviation_df.fillna({'Aircraft.damage': 'Unknown', 'Broad.phase.of.flight': 'Unknown'})
```

In [280…
```
#Additional replacement of missing values
Aviation_df = Aviation_df.fillna({'Country': 'Undefined', 'Location': 'Unknown', 'Injury.Severity': 'Unknown', 'Model': 0, 'Make': 'Unknown', 'Purpose.of.fli
```

In [281…
```
#show columns in the dataset
Aviation_df.columns
```

Out[281…
```
Index(['Event.Id', 'Investigation.Type', 'Accident.Number', 'Event.Date',
       'Location', 'Country', 'Latitude', 'Longitude', 'Airport.Code',
       'Airport.Name', 'Injury.Severity', 'Aircraft.damage',
       'Aircraft.Category', 'Registration.Number', 'Make', 'Model',
       'Amateur.Built', 'Number.of.Engines', 'Engine.Type', 'FAR.Description',
       'Schedule', 'Purpose.of.flight', 'Air.carrier', 'Total.Fatal.Injuries',
       'Total.Serious.Injuries', 'Total.Minor.Injuries', 'Total.Uninjured',
       'Weather.Condition', 'Broad.phase.of.flight', 'Report.Status',
       'Publication.Date'],
      dtype='object')
```

In [282…
```
# Drop columns that contain many NaN values
Aviation_df= Aviation_df.drop(columns=['Latitude', 'Longitude', 'Airport.Code', 'Airport.Name', 'Aircraft.Category', 'FAR.Description',
                 'Schedule', 'Air.carrier'])
df.head()
```

Out[282…

	Event-Id	Investigation-Type	Accident-Number	Event-Date	Location	Country	Injury-Severity	Aircraft-damage	Registration-Number	Make	...	Engine-Type	Purpose-of-flight	Total-Fatal-Injuries	Total-Serious-Injuries	Total-Minor-Injuries	Total-Uninjured	Weather-Conditior
0	20001218X45444	Accident	SEA87LA080	1948-10-24	MOOSE CREEK, ID	United States	Fatal(2)	Destroyed	NC6404	Stinson	...	Reciprocating	Personal	2.0	0.0	0.0	0.0	UNK
1	20001218X45447	Accident	LAX94LA336	1962-07-19	BRIDGEPORT, CA	United States	Fatal(4)	Destroyed	N5069P	Piper	...	Reciprocating	Personal	4.0	0.0	0.0	0.0	UNK
2	20061025X01555	Accident	NYC07LA005	1974-08-30	Saltville, VA	United States	Fatal(3)	Destroyed	N5142R	Cessna	...	Reciprocating	Personal	3.0	NaN	NaN	NaN	IMC
3	20001218X45448	Accident	LAX96LA321	1977-06-19	EUREKA, CA	United States	Fatal(2)	Destroyed	N1168J	Rockwell	...	Reciprocating	Personal	2.0	0.0	0.0	0.0	IMC
4	20041105X01764	Accident	CHI79FA064	1979-08-02	Canton, OH	United States	Fatal(1)	Destroyed	N15NY	Cessna	...	NaN	Personal	1.0	2.0	NaN	0.0	VMC

5 rows × 23 columns

In [283…
```
Aviation_df.isna().sum()
```

Out[283…
```
Event.Id                     0
Investigation.Type           0
Accident.Number              0
Event.Date                   0
Location                     0
Country                      0
Injury.Severity              0
Aircraft.damage              0
Registration.Number       1317
Make                         0
Model                        0
Amateur.Built                0
Number.of.Engines            0
Engine.Type                  0
Purpose.of.flight            0
Total.Fatal.Injuries         0
Total.Serious.Injuries       0
Total.Minor.Injuries         0
Total.Uninjured              0
Weather.Condition            0
Broad.phase.of.flight        0
Report.Status             6381
Publication.Date         13771
dtype: int64
```

In [284…
```
Aviation_df.columns
```

Out[284…
```
Index(['Event.Id', 'Investigation.Type', 'Accident.Number', 'Event.Date',
       'Location', 'Country', 'Injury.Severity', 'Aircraft.damage',
       'Registration.Number', 'Make', 'Model', 'Amateur.Built',
       'Number.of.Engines', 'Engine.Type', 'Purpose.of.flight',
       'Total.Fatal.Injuries', 'Total.Serious.Injuries',
       'Total.Minor.Injuries', 'Total.Uninjured', 'Weather.Condition',
       'Broad.phase.of.flight', 'Report.Status', 'Publication.Date'],
      dtype='object')
```

In [285…
```
# Substitute dots in column names with hyphen
Aviation_df.columns = Aviation_df.columns.str.replace('.', '-')
```

In [286…
```
# Converting 'Event-Date' and 'Publication-Date' to datetime format
Aviation_df['Event-Date'] = pd.to_datetime(Aviation_df['Event-Date'], errors='coerce')
Aviation_df['Publication-Date'] = pd.to_datetime(Aviation_df['Publication-Date'], errors='coerce', dayfirst=True)
```

In [287…
```
#Converting datatype for number of engines to intager.
Aviation_df['Number-of-Engines']=Aviation_df['Number-of-Engines'].astype(int)
```

In [288…
```
Aviation_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 88889 entries, 0 to 88888
Data columns (total 23 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   Event-Id                88889 non-null  object
 1   Investigation-Type      88889 non-null  object
 2   Accident-Number         88889 non-null  object
 3   Event-Date              88889 non-null  datetime64[ns]
 4   Location                88889 non-null  object
 5   Country                 88889 non-null  object
 6   Injury-Severity         88889 non-null  object
 7   Aircraft-damage         88889 non-null  object
 8   Registration-Number     87572 non-null  object
 9   Make                    88889 non-null  object
 10  Model                   88889 non-null  object
 11  Amateur-Built           88889 non-null  object
 12  Number-of-Engines       88889 non-null  int32
 13  Engine-Type             88889 non-null  object
 14  Purpose-of-flight       88889 non-null  object
 15  Total-Fatal-Injuries    88889 non-null  float64
 16  Total-Serious-Injuries  88889 non-null  float64
 17  Total-Minor-Injuries    88889 non-null  float64
 18  Total-Uninjured         88889 non-null  float64
 19  Weather-Condition       88889 non-null  object
 20  Broad-phase-of-flight   88889 non-null  object
 21  Report-Status           82508 non-null  object
 22  Publication-Date        75118 non-null  datetime64[ns]
dtypes: datetime64[ns](2), float64(4), int32(1), object(16)
memory usage: 15.3+ MB
```

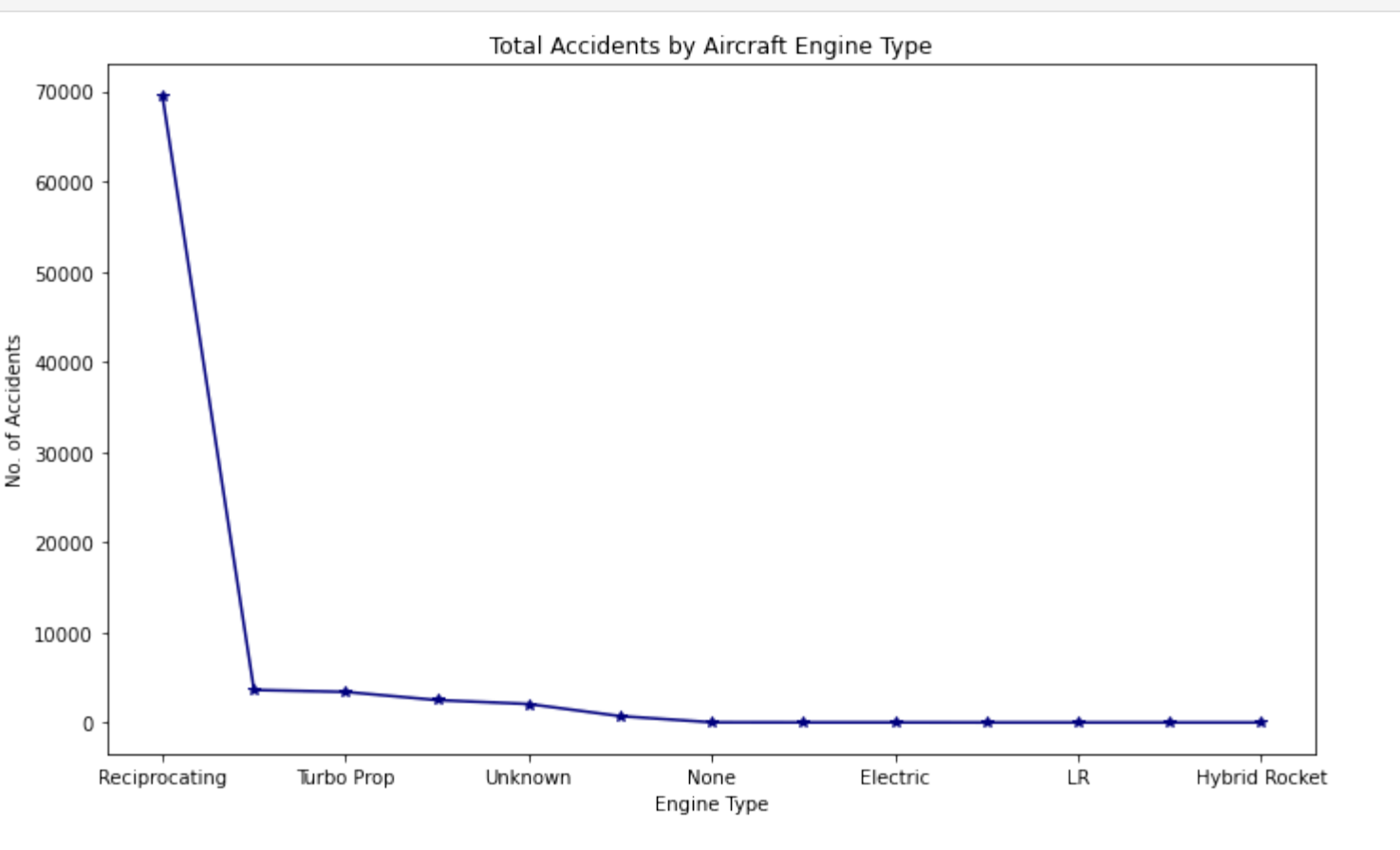
Visualizations

In [289…
```
#Creating a summary table counting occurrences of each Engine-Type
Summary_data = Aviation_df.pivot_table(aggfunc='size', index='Engine-Type', fill_value=0)
print(Summary_data)
```

```
Engine-Type
Electric              10
Geared Turbofan       12
Hybrid Rocket          1
LR                     2
NONE                   2
None                  19
Reciprocating      69530
Turbo Fan           2481
Turbo Jet            703
Turbo Prop          3391
Turbo Shaft         3609
UNK                    1
Unknown             9128
dtype: int64
```

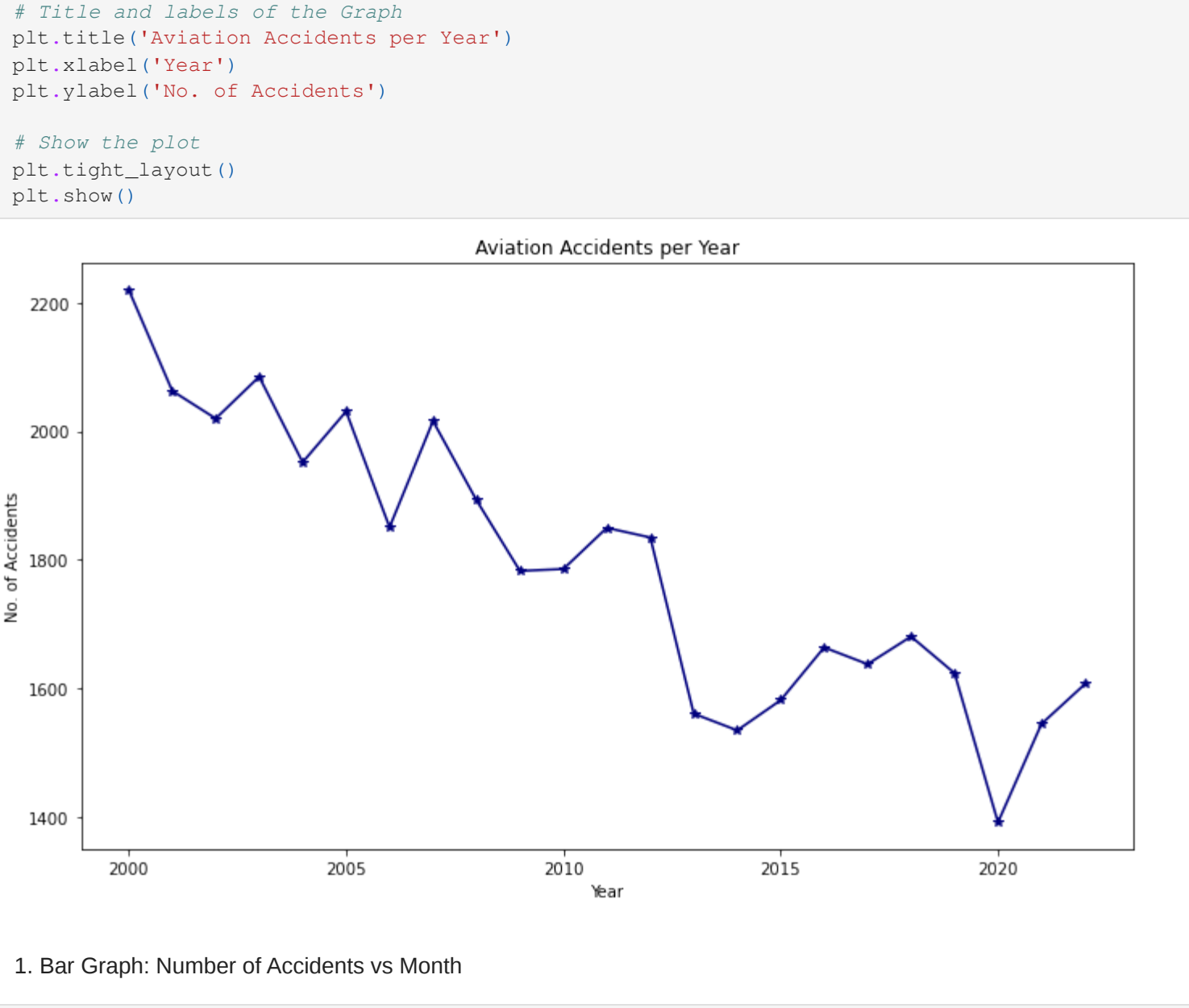
1. Line graph:Engine vs Accidents

In [290…
```
# Number of accidents for each Engine Type
engine_accident_count = df['Engine-Type'].value_counts()

# Plot the line graph
plt.figure(figsize=(10, 6))
engine_accident_count.plot(kind='line', marker='*', color='navy')

# Adding labels and title
plt.title('Total Accidents by Aircraft Engine Type')
plt.xlabel('Engine Type')
plt.ylabel('No. of Accidents')


# Show the plot
plt.tight_layout()
plt.show()
```



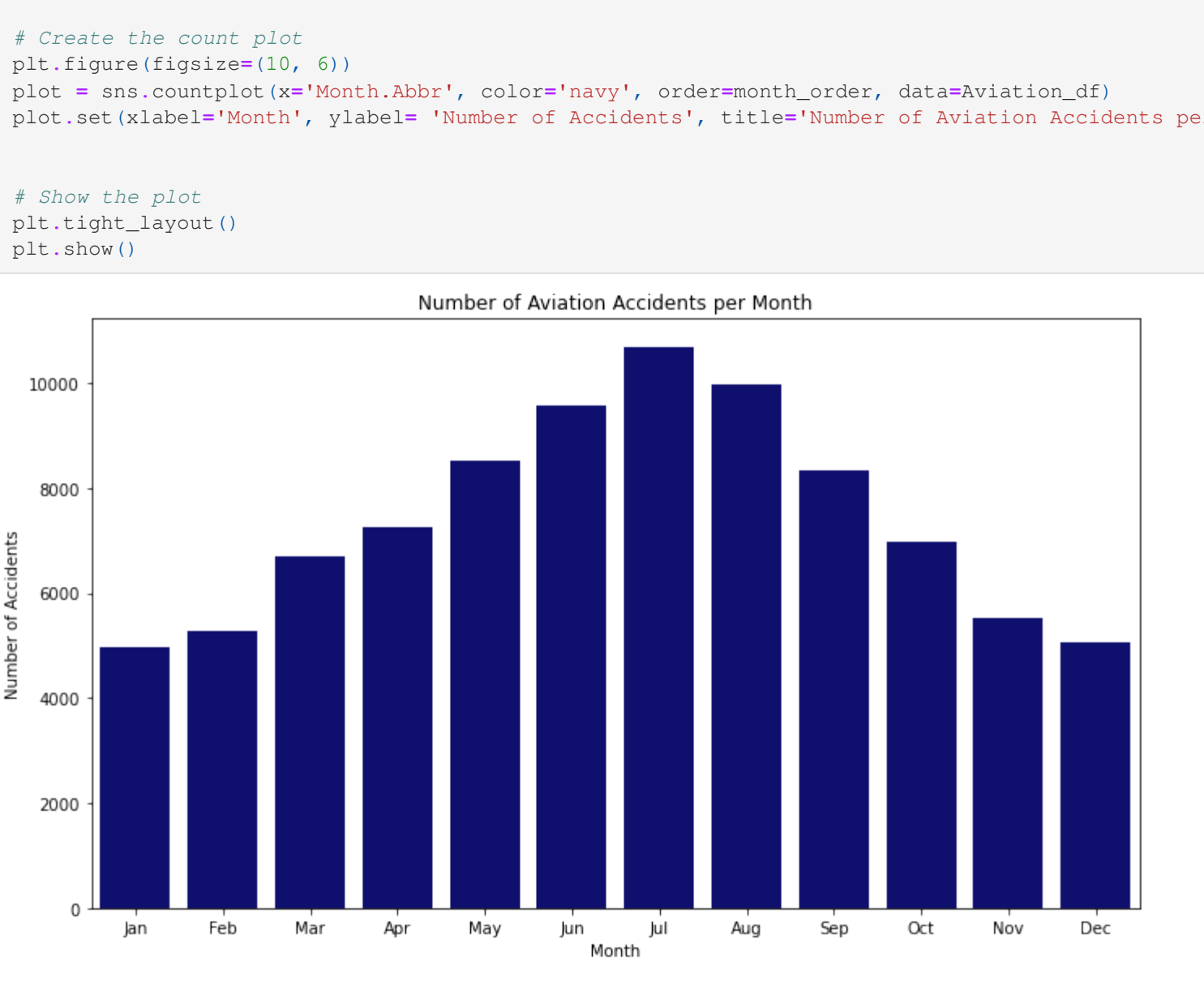
1. Line Graph: Total accidents vs Year

In [291…
```
Aviation_df['Event-Date'] = pd.to_datetime(Aviation_df['Event-Date'], errors='coerce')

# Extract the year from the 'Event-Date' column
Aviation_df['Year'] = Aviation_df['Event-Date'].dt.year

# Filter the data to only include incidents from 2000 to 2022
Aviation_df_filtered = Aviation_df[(Aviation_df['Year'] >= 2000) & (Aviation_df['Year'] <= 2022)]

# Group the data by year and count the number of incidents per year
Grouped_by_Year = Aviation_df_filtered.groupby('Year').size()

# Plot the incidents per year as a line chart
Grouped_by_Year.plot(kind='line', color='navy', marker='*', figsize=(10, 6))

# Title and labels of the Graph
plt.title('Aviation Accidents per Year')
plt.xlabel('Year')
plt.ylabel('No. of Accidents')

# Show the plot
plt.tight_layout()
plt.show()
```



1. Bar Graph: Number of Accidents vs Month

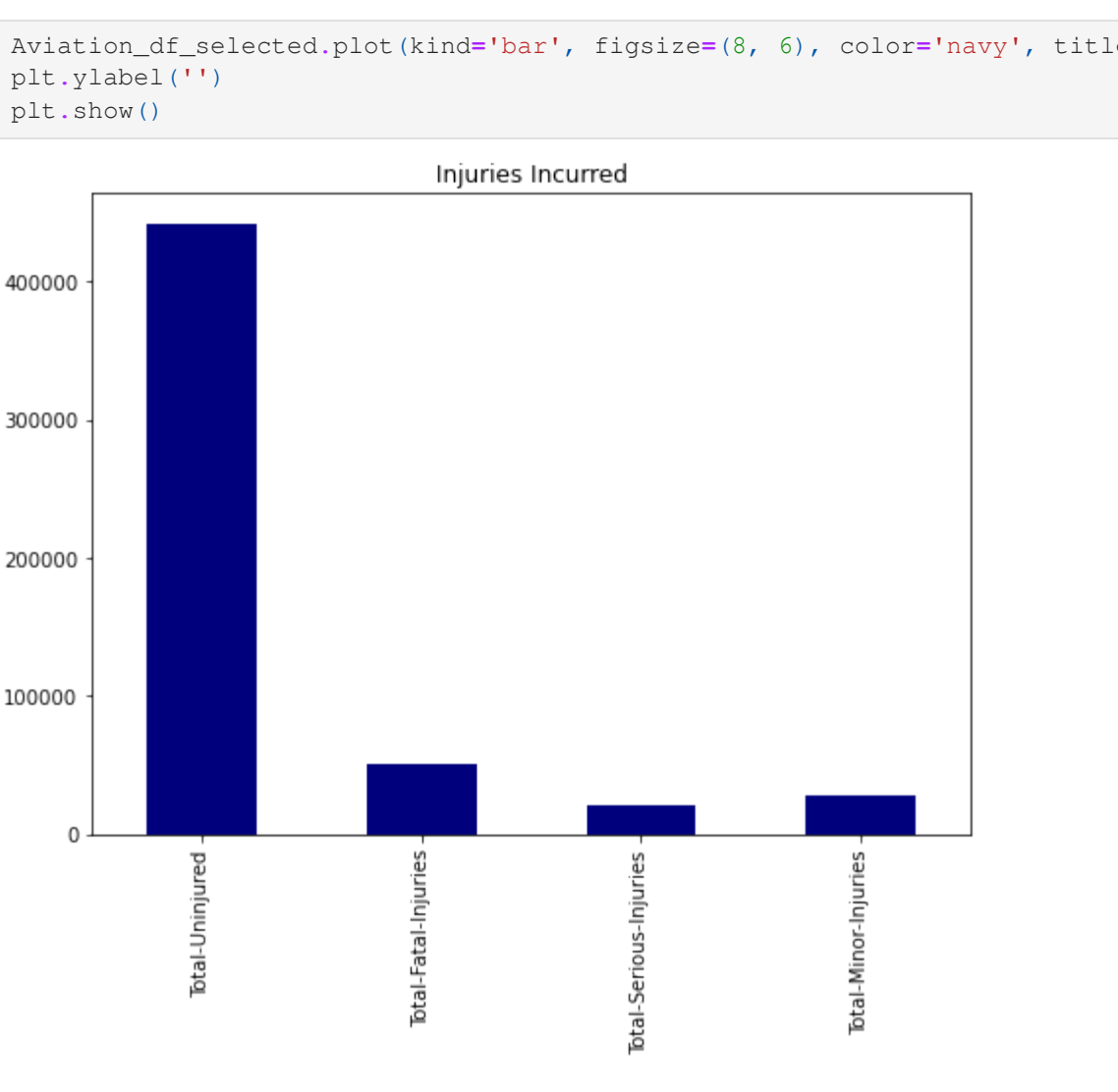
In [292…
```
# Create a new column for month abbreviations
#dt.strftime('%b') to show abbreviated month
Aviation_df['Month.Abbr'] = Aviation_df['Event-Date'].dt.strftime('%b')


# Create the count plot
plt.figure(figsize=(10, 6))
plot = sns.countplot(x='Month.Abbr', color='navy', order=month_order, data=Aviation_df)
plot.set(xlabel='Month', ylabel= 'Number of Accidents', title='Number of Aviation Accidents per Month')


# Show the plot
plt.tight_layout()
plt.show()
```



1. Bar Graph for survival rates

In [293…
```
Aviation_df_selected = Aviation_df[['Total-Uninjured', 'Total-Fatal-Injuries', 'Total-Serious-Injuries', 'Total-Minor-Injuries']].sum()
```

In [294…
```
Aviation_df_selected.plot(kind='bar', figsize=(8, 6), color='navy', title="Injuries Incurred")
plt.ylabel('')
plt.show()
```



1. Bar Graph: Number of Accidents vs country

In [295…
```
#Top ten countries
top_countries = df['Country'].value_counts().head(10)

# Plotting the data
plt.figure(figsize=(10, 6))
plt.bar(top_10_states.index, top_10_states.values, color='navy')
plt.title('Top 10 Countries by Number of Accidents')
plt.xlabel('Country')
plt.ylabel('No. of Accidents')

#to avoid country names from overlapping
plt.xticks(rotation=45)
#display the plot
plt.tight_layout()
plt.show()
```