Final Project Submission

Please fill out:

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- Scheduled project review date/time:
- Instructor name: Mark Barbour
- Blog post URL:

In [1]:
```python
#load the necessary libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sns
```

In [2]:
```python
#load the data to work with
aircraft_df = pd.read_csv('data/Aviation_Data.csv')
aircraft_df.head()
```

```
<ipython-input-2-20fd87075e1e>:2: DtypeWarning: Columns (6,7,28) have mixed types. Spe
cify dtype option on import or set low_memory=False.
  aircraft_df = pd.read_csv('data/Aviation_Data.csv')
```

Out[2]:

	Event.Id	Investigation.Type	Accident.Number	Event.Date	Location	Country	Latitude
0	20001218X45444	Accident	SEA87LA080	1948-10-24	MOOSE CREEK, ID	United States	NaN
1	20001218X45447	Accident	LAX94LA336	1962-07-19	BRIDGEPORT, CA	United States	NaN
2	20061025X01555	Accident	NYC07LA005	1974-08-30	Saltville, VA	United States	36.922223
3	20001218X45448	Accident	LAX96LA321	1977-06-19	EUREKA, CA	United States	NaN
4	20041105X01764	Accident	CHI79FA064	1979-08-02	Canton, OH	United States	NaN

5 rows × 31 columns

In [3]:
```python
#inspect the size of the dataframe
aircraft_df.shape
```

Out[3]:
```
(90348, 31)
```

In [4]:
```python
#find the names of all of the columns
aircraft_df.columns
```

Out[4]:
```
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 [5]:
```python
#replace '.' with '_' across the column titles of the dataframe
aircraft_df.columns = aircraft_df.columns.str.replace('.', '_')
print(aircraft_df)
```

```
             Event_Id Investigation_Type Accident_Number  Event_Date  \
0      20001218X45444           Accident      SEA87LA080  1948-10-24
1      20001218X45447           Accident      LAX94LA336  1962-07-19
2      20061025X01555           Accident      NYC07LA005  1974-08-30
3      20001218X45448           Accident      LAX96LA321  1977-06-19
4      20041105X01764           Accident      CHI79FA064  1979-08-02
...               ...                ...             ...         ...
90343  20221227106491           Accident      ERA23LA093  2022-12-26
90344  20221227106494           Accident      ERA23LA095  2022-12-26
90345  20221227106497           Accident      WPR23LA075  2022-12-26
90346  20221227106498           Accident      WPR23LA076  2022-12-26
90347  20221230106513           Accident      ERA23LA097  2022-12-29

              Location        Country   Latitude  Longitude Airport_Code  \
0      MOOSE CREEK, ID  United States        NaN        NaN          NaN
1       BRIDGEPORT, CA  United States        NaN        NaN          NaN
2        Saltville, VA  United States  36.922223 -81.878056          NaN
3           EUREKA, CA  United States        NaN        NaN          NaN
4           Canton, OH  United States        NaN        NaN          NaN
...                ...            ...        ...        ...          ...
90343    Annapolis, MD  United States        NaN        NaN          NaN
90344      Hampton, NH  United States        NaN        NaN          NaN
90345       Payson, AZ  United States    341525N   1112021W          PAN
90346       Morgan, UT  United States        NaN        NaN          NaN
90347       Athens, GA  United States        NaN        NaN          NaN

      Airport_Name  ... Purpose_of_flight         Air_carrier  \
0              NaN  ...          Personal                 NaN
1              NaN  ...          Personal                 NaN
2              NaN  ...          Personal                 NaN
3              NaN  ...          Personal                 NaN
4              NaN  ...          Personal                 NaN
...            ...  ...               ...                 ...
90343          NaN  ...          Personal                 NaN
90344          NaN  ...               NaN                 NaN
90345       PAYSON  ...          Personal                 NaN
90346          NaN  ...          Personal  MC CESSNA 210N LLC
90347          NaN  ...          Personal                 NaN

      Total_Fatal_Injuries Total_Serious_Injuries Total_Minor_Injuries  \
0                      2.0                    0.0                  0.0
1                      4.0                    0.0                  0.0
2                      3.0                    NaN                  NaN
3                      2.0                    0.0                  0.0
4                      1.0                    2.0                  NaN
...                    ...                    ...                  ...
90343                  0.0                    1.0                  0.0
90344                  0.0                    0.0                  0.0
90345                  0.0                    0.0                  0.0
90346                  0.0                    0.0                  0.0
90347                  0.0                    1.0                  0.0

      Total_Uninjured Weather_Condition  Broad_phase_of_flight  \
0                 0.0               UNK                 Cruise
1                 0.0               UNK                Unknown
2                 NaN               IMC                 Cruise
3                 0.0               IMC                 Cruise
4                 0.0               VMC               Approach
...               ...               ...                    ...
90343             0.0               NaN                    NaN
90344             0.0               NaN                    NaN
90345             1.0               VMC                    NaN
90346             0.0               NaN                    NaN
90347             1.0               NaN                    NaN

        Report_Status Publication_Date
0      Probable Cause              NaN
1      Probable Cause       19-09-1996
2      Probable Cause       26-02-2007
3      Probable Cause       12-09-2000
4      Probable Cause       16-04-1980
...               ...              ...
90343             NaN       29-12-2022
90344             NaN              NaN
90345             NaN       27-12-2022
90346             NaN              NaN
90347             NaN       30-12-2022

[90348 rows x 31 columns]
```

In [6]:
```python
#determine the different types of Latitude data values
latitude_unique_values = aircraft_df.Latitude.unique()
latitude_types = [type(val) for val in latitude_unique_values]
unique_latitude_types = []
for val in latitude_types:
    if val not in unique_latitude_types:
        unique_latitude_types.append(val)
print(unique_latitude_types)
```

```
[<class 'float'>, <class 'str'>]
```

In [7]:
```python
#convert all values in the Latitude column to strings
aircraft_df.Latitude = aircraft_df.Latitude.astype(str)
#convert all values in the Longitude column to strings
aircraft_df.Longitude = aircraft_df.Longitude.astype(str)
```

In [8]:
```python
#check the name of column 28
aircraft_df.columns[28]
```

Out[8]:
```
'Broad_phase_of_flight'
```

In [9]:
```python
#look at the unique values and their occurrences for Broad_phase_of_flight
aircraft_df.Broad_phase_of_flight.value_counts(dropna=False)
```

Out[9]:
```
Broad_phase_of_flight
NaN            28624
Landing        15428
Takeoff        12493
Cruise         10269
Maneuvering     8144
Approach        6546
Climb           2034
Taxi            1958
Descent         1887
Go-around       1353
Standing         945
Unknown          548
Other            119
Name: count, dtype: int64
```

In [10]:
```python
#look at example rows where Broad_phase_of_flight is NaN
phase_nan_rows = aircraft_df[aircraft_df.Broad_phase_of_flight.isna()]
phase_nan_rows.iloc[0:2]
```

Out[10]:

	Event_Id	Investigation_Type	Accident_Number	Event_Date	Location	Country	Latitu
3030	20020917X04924	Accident	MIA83LA011	1982-10-11	SARASOTA, FL	United States	na
3550	20020917X04800	Accident	LAX83FA061	1982-12-25	SANTA YSABEL, CA	United States	na

2 rows × 31 columns

In [11]:
```python
#replace NaN in Broad_phase_of_flight with Unknown
aircraft_df.Broad_phase_of_flight = aircraft_df.Broad_phase_of_flight.fillna("Unknown"
aircraft_df.Broad_phase_of_flight.value_counts(dropna=False)
```

Out[11]:
```
Broad_phase_of_flight
Unknown        29172
Landing        15428
Takeoff        12493
Cruise         10269
Maneuvering     8144
Approach        6546
Climb           2034
Taxi            1958
Descent         1887
Go-around       1353
Standing         945
Other            119
Name: count, dtype: int64
```

In [12]:
```python
#look at the different values of the Investigation_Type column
print(aircraft_df.Investigation_Type.unique())
```

```
['Accident' 'Incident' '25-09-2020' '14-06-2021' '03-11-2020' '24-02-2021'
 '02-02-2021' '05-05-2021' '03-12-2020' '07-12-2020' '06-05-2021'
 '19-11-2020' '04-08-2021' '13-09-2021' '10-06-2021' '14-12-2021'
 '08-06-2021' '24-06-2021' '24-08-2021' '31-03-2021' '27-05-2021'
 '20-05-2021' '18-11-2020' '25-05-2021' '01-06-2021' '15-07-2021'
 '15-10-2021' '26-09-2020' '03-06-2021' '29-09-2021' '28-01-2021'
 '20-10-2021' '11-12-2020' '11-02-2021' '13-12-2021' '06-01-2021'
 '31-08-2021' '04-03-2021' '05-04-2021' '26-01-2021' '29-01-2021'
 '26-08-2021' '08-11-2021' '20-08-2021' '05-01-2021' '22-09-2021'
 '20-09-2021' '16-07-2021' '19-10-2021' '16-11-2021' '17-12-2021'
 '14-06-2022' '22-06-2022' '13-10-2022' '03-11-2022' '13-07-2022'
 '05-07-2022' '01-09-2022' '12-08-2022' '08-09-2022' '22-09-2022'
 '01-11-2022' '01-07-2022' '20-07-2022' '06-10-2022' '23-09-2022'
 '02-12-2022' '05-08-2022' '08-12-2022' '15-12-2022' '20-12-2022']
```

In [13]:
```python
#look at the number of occurrences of each Investigation_Type value
print(aircraft_df.Investigation_Type.value_counts())
```

```
Investigation_Type
Accident      85015
Incident       3874
25-09-2020      702
26-09-2020       60
02-02-2021       39
              ...
13-09-2021        1
04-08-2021        1
05-08-2022        1
03-11-2020        1
06-01-2021        1
Name: count, Length: 71, dtype: int64
```

In [14]:
```python
#take a closer look at the entries exluding accident and incident as an investigation
investigation_excluded_values = ['Accident', 'Incident']
investigation_filtered_data = aircraft_df[~aircraft_df.Investigation_Type.isin(investi
print(investigation_filtered_data)
```

```
      Event_Id Investigation_Type Accident_Number Event_Date Location Country  \
64030      NaN         25-09-2020             NaN        NaN      NaN     NaN
64050      NaN         25-09-2020             NaN        NaN      NaN     NaN
64052      NaN         25-09-2020             NaN        NaN      NaN     NaN
64388      NaN         25-09-2020             NaN        NaN      NaN     NaN
64541      NaN         25-09-2020             NaN        NaN      NaN     NaN
...        ...                ...             ...        ...      ...     ...
90004      NaN         15-12-2022             NaN        NaN      NaN     NaN
90010      NaN         15-12-2022             NaN        NaN      NaN     NaN
90031      NaN         15-12-2022             NaN        NaN      NaN     NaN
90090      NaN         20-12-2022             NaN        NaN      NaN     NaN
90097      NaN         20-12-2022             NaN        NaN      NaN     NaN

      Latitude Longitude Airport_Code Airport_Name  ... Purpose_of_flight  \
64030      nan       nan          NaN          NaN  ...               NaN
64050      nan       nan          NaN          NaN  ...               NaN
64052      nan       nan          NaN          NaN  ...               NaN
64388      nan       nan          NaN          NaN  ...               NaN
64541      nan       nan          NaN          NaN  ...               NaN
...        ...       ...          ...          ...  ...               ...
90004      nan       nan          NaN          NaN  ...               NaN
90010      nan       nan          NaN          NaN  ...               NaN
90031      nan       nan          NaN          NaN  ...               NaN
90090      nan       nan          NaN          NaN  ...               NaN
90097      nan       nan          NaN          NaN  ...               NaN

      Air_carrier Total_Fatal_Injuries Total_Serious_Injuries  \
64030         NaN                  NaN                    NaN
64050         NaN                  NaN                    NaN
64052         NaN                  NaN                    NaN
64388         NaN                  NaN                    NaN
64541         NaN                  NaN                    NaN
...           ...                  ...                    ...
90004         NaN                  NaN                    NaN
90010         NaN                  NaN                    NaN
90031         NaN                  NaN                    NaN
90090         NaN                  NaN                    NaN
90097         NaN                  NaN                    NaN

      Total_Minor_Injuries Total_Uninjured Weather_Condition  \
64030                  NaN             NaN               NaN
64050                  NaN             NaN               NaN
64052                  NaN             NaN               NaN
64388                  NaN             NaN               NaN
64541                  NaN             NaN               NaN
...                    ...             ...               ...
90004                  NaN             NaN               NaN
90010                  NaN             NaN               NaN
90031                  NaN             NaN               NaN
90090                  NaN             NaN               NaN
90097                  NaN             NaN               NaN

      Broad_phase_of_flight Report_Status Publication_Date
64030               Unknown           NaN              NaN
64050               Unknown           NaN              NaN
64052               Unknown           NaN              NaN
64388               Unknown           NaN              NaN
64541               Unknown           NaN              NaN
...                     ...           ...              ...
90004               Unknown           NaN              NaN
90010               Unknown           NaN              NaN
90031               Unknown           NaN              NaN
90090               Unknown           NaN              NaN
90097               Unknown           NaN              NaN

[1459 rows x 31 columns]
```

In [15]:
```python
#look at a few more examples from above
print(aircraft_df[aircraft_df.Investigation_Type.isin(['13-09-2021', '04-08-2021', '0
```

```
      Event_Id Investigation_Type Accident_Number Event_Date Location Country  \
74420      NaN         03-11-2020             NaN        NaN      NaN     NaN
79013      NaN         04-08-2021             NaN        NaN      NaN     NaN
79821      NaN         13-09-2021             NaN        NaN      NaN     NaN
84151      NaN         06-01-2021             NaN        NaN      NaN     NaN
89492      NaN         05-08-2022             NaN        NaN      NaN     NaN

      Latitude Longitude Airport_Code Airport_Name  ... Purpose_of_flight  \
74420      nan       nan          NaN          NaN  ...               NaN
79013      nan       nan          NaN          NaN  ...               NaN
79821      nan       nan          NaN          NaN  ...               NaN
84151      nan       nan          NaN          NaN  ...               NaN
89492      nan       nan          NaN          NaN  ...               NaN

      Air_carrier Total_Fatal_Injuries Total_Serious_Injuries  \
74420         NaN                  NaN                    NaN
79013         NaN                  NaN                    NaN
79821         NaN                  NaN                    NaN
84151         NaN                  NaN                    NaN
89492         NaN                  NaN                    NaN

      Total_Minor_Injuries Total_Uninjured Weather_Condition  \
74420                  NaN             NaN               NaN
79013                  NaN             NaN               NaN
79821                  NaN             NaN               NaN
84151                  NaN             NaN               NaN
89492                  NaN             NaN               NaN

      Broad_phase_of_flight Report_Status Publication_Date
74420               Unknown           NaN              NaN
79013               Unknown           NaN              NaN
79821               Unknown           NaN              NaN
84151               Unknown           NaN              NaN
89492               Unknown           NaN              NaN

[5 rows x 31 columns]
```

In [16]:
```python
#drop all rows that do not contain incident or accident as an investigation type
aircraft_df = aircraft_df[aircraft_df.Investigation_Type.isin(investigation_excluded_v
aircraft_df
```

Out[16]:

	Event_Id	Investigation_Type	Accident_Number	Event_Date	Location	Country	L
0	20001218X45444	Accident	SEA87LA080	1948-10-24	MOOSE CREEK, ID	United States	
1	20001218X45447	Accident	LAX94LA336	1962-07-19	BRIDGEPORT, CA	United States	
2	20061025X01555	Accident	NYC07LA005	1974-08-30	Saltville, VA	United States	36.9
3	20001218X45448	Accident	LAX96LA321	1977-06-19	EUREKA, CA	United States	
4	20041105X01764	Accident	CHI79FA064	1979-08-02	Canton, OH	United States	
...	...	...	...	...	...	...	...
90343	20221227106491	Accident	ERA23LA093	2022-12-26	Annapolis, MD	United States	
90344	20221227106494	Accident	ERA23LA095	2022-12-26	Hampton, NH	United States	
90345	20221227106497	Accident	WPR23LA075	2022-12-26	Payson, AZ	United States	34
90346	20221227106498	Accident	WPR23LA076	2022-12-26	Morgan, UT	United States	
90347	20221230106513	Accident	ERA23LA097	2022-12-29	Athens, GA	United States	

88889 rows × 31 columns

In [17]:
```python
#double-check the only investigation values are Accident and Incident
aircraft_df.Investigation_Type.unique()
```

Out[17]:
```
array(['Accident', 'Incident'], dtype=object)
```

In [18]:
```python
#look at some examples of rows where the Investigation_Type is 'Incident'
print(aircraft_df[aircraft_df.Investigation_Type.isin(['Incident'])])
```

```
             Event_Id Investigation_Type Accident_Number  Event_Date  \
23     20020917X02333           Incident      LAX82IA034  1982-01-03
40     20020917X01764           Incident      ATL82IA029  1982-01-05
79     20020917X01897           Incident      CHI82IA026  1982-01-12
80     20020917X01765           Incident      ATL82IA034  1982-01-12
119    20020917X01766           Incident      ATL82IA038  1982-01-19
...               ...                ...             ...         ...
90268  20221125106356           Incident      DCA23WA074  2022-11-21
90278  20221125106362           Incident      DCA23WA076  2022-11-24
90280  20221125106357           Incident      DCA23WA075  2022-11-25
90285  20221222106484           Incident      DCA23WA099  2022-11-26
90310  20221222106485           Incident      DCA23WA100  2022-12-05

              Location        Country Latitude Longitude Airport_Code  \
23       VAN NUYS, CA  United States      nan       nan          VNY
40     PENSACOLA, FL  United States      nan       nan          NaN
79        CHICAGO, IL  United States      nan       nan          ORD
80     CLARKSBURG, WV  United States      nan       nan          CKB
119    WASHINGTON, DC  United States      nan       nan          IAD
...               ...            ...      ...       ...          ...
90268        Maturin,      Venezuela      nan       nan          NaN
90278       Maiquetia,     Venezuela      nan       nan          NaN
90280        Breslau,         Canada      nan       nan          NaN
90285        Bangkok,       Thailand      nan       nan          NaN
90310        Bangkok,       Thailand      nan       nan          NaN

                Airport_Name  ... Purpose_of_flight  \
23                  VAN NUYS  ...          Personal
40                       NaN  ...          Business
79     CHICAGO O'HARE INTER'L  ...           Unknown
80                   BENEDUM  ...           Unknown
119                      NaN  ...             Ferry
...                      ...  ...               ...
90268                    NaN  ...               NaN
90278                    NaN  ...               NaN
90280                    NaN  ...               NaN
90285                    NaN  ...               NaN
90310                    NaN  ...               NaN

                    Air_carrier Total_Fatal_Injuries Total_Serious_Injuries  \
23                          NaN                  0.0                    0.0
40                          NaN                  0.0                    0.0
79         Trans World Airlines                  0.0                    0.0
80        Aeromech Incorporated                  0.0                    0.0
119                         NaN                  0.0                    0.0
...                         ...                  ...                    ...
90268                       NaN                  0.0                    0.0
90278     Turpial Airlines, C.A.                 0.0                    0.0
90280         Flair Airlines Ltd                 0.0                    0.0
90285                       NaN                  0.0                    0.0
90310  Thai Lion Mentari co.,ltd                 0.0                    0.0

      Total_Minor_Injuries Total_Uninjured Weather_Condition  \
23                     0.0             1.0               VMC
40                     0.0             1.0               VMC
79                     0.0           149.0               UNK
80                     0.0             2.0               VMC
119                    0.0             1.0               IMC
...                    ...             ...               ...
90268                  0.0            71.0               NaN
90278                  0.0            73.0               NaN
90280                  0.0           140.0               NaN
90285                  0.0           186.0               NaN
90310                  0.0           102.0               NaN

      Broad_phase_of_flight   Report_Status Publication_Date
23                 Approach  Probable Cause       03-01-1983
40                   Cruise  Probable Cause       05-01-1983
79                   Cruise  Probable Cause       12-01-1983
80                     Taxi  Probable Cause       12-01-1983
119                 Descent  Probable Cause       19-01-1983
...                     ...             ...              ...
90268               Unknown             NaN       25-11-2022
90278               Unknown             NaN       25-11-2022
90280               Unknown             NaN       25-11-2022
90285               Unknown             NaN       22-12-2022
90310               Unknown             NaN       22-12-2022

[3874 rows x 31 columns]
```

In [19]:
```python
#create a dataframe of only incident flights and review their data
incident_aircraft_df = aircraft_df[aircraft_df.Investigation_Type.isin(['Incident'])]
incident_aircraft_df.head()
```

Out[19]:

	Event_Id	Investigation_Type	Accident_Number	Event_Date	Location	Country	Latitude
0	20020917X02333	Incident	LAX82IA034	1982-01-03	VAN NUYS, CA	United States	na
1	20020917X01764	Incident	ATL82IA029	1982-01-05	PENSACOLA, FL	United States	na
2	20020917X01897	Incident	CHI82IA026	1982-01-12	CHICAGO, IL	United States	na
3	20020917X01765	Incident	ATL82IA034	1982-01-12	CLARKSBURG, WV	United States	na
4	20020917X01766	Incident	ATL82IA038	1982-01-19	WASHINGTON, DC	United States	na

5 rows × 31 columns

In [20]:
```python
#check for injuries in incident dataframe
print(incident_aircraft_df.Total_Fatal_Injuries.unique())
print(incident_aircraft_df.Total_Serious_Injuries.unique())
print(incident_aircraft_df.Total_Minor_Injuries.unique())
```

```
[ 0. nan  1.  2.  3.]
[ 0. nan  1. 11.  6. 88.  2. 33.  5.  3.  7.  4. 13.  8. 27.  9.]
[  0.  nan   1.  17.  33.  14.   2.   6.  13.   4.   3.  42.   7.  16.
  10.  11.  18.  24.  25.  12.   5.  22.   9.   8.  28. 380.]
```

In [21]:
```python
#check the different report statuses in incident dataframe
print(incident_aircraft_df.Report_Status.head())
print(incident_aircraft_df.Report_Status.tail())
```

```
0    Probable Cause
1    Probable Cause
2    Probable Cause
3    Probable Cause
4    Probable Cause
Name: Report_Status, dtype: object
3869    NaN
3870    NaN
3871    NaN
3872    NaN
3873    NaN
Name: Report_Status, dtype: object
```

In [22]:
```python
#determine how many entries have a blank report status field in aircraft_df
print(aircraft_df.Report_Status.isnull().sum())
```

```
6384
```

In [23]:
```python
#find the different entries for the carrier
print(aircraft_df.Air_carrier.value_counts(dropna=False))
```

```
Air_carrier
NaN                                72241
Pilot                                258
American Airlines                     90
United Airlines                       89
Delta Air Lines                       53
                                   ...
American Classic Outfitters, Inc.      1
Great Lakes Aviation, Ltd.             1
Harold Parker                          1
Ernie Dale Willis                      1
MC CESSNA 210N LLC                     1
Name: count, Length: 13591, dtype: int64
```

In [24]:
```python
#find the different entries for the aircraft make
print(aircraft_df.Make.value_counts(dropna=False))
```

```
Make
Cessna             22227
Piper              12029
CESSNA              4922
Beech               4330
PIPER               2841
                   ...
Leonard Walters        1
Maule Air Inc.         1
Motley Vans            1
Perlick                1
ROYSE RALPH L          1
Name: count, Length: 8238, dtype: int64
```

In [25]:
```python
#Check the data types that are not a string for the different values in the Make colu
make_unique_values = aircraft_df.Make.unique()
make_data_types = {value: type(value).__name__ for value in make_unique_values}
for make, data_type in make_data_types.items():
    if data_type != 'str':
        print(f"Make: {make}, Data Type: {data_type}")
```

```
Make: nan, Data Type: float
```

In [26]:
```python
#Get the sum of rows where the Make column is null
print(aircraft_df.Make.isnull().sum())
```

```
63
```

In [27]:
```python
#Create a new data frame using only the rows where the Make column is null and observ
make_null_df = aircraft_df[aircraft_df.Make.isnull()]
print(make_null_df)
print(make_null_df.Model)
print(make_null_df.Aircraft_Category)
```

```
             Event_Id Investigation_Type Accident_Number  Event_Date  \
1767   20020917X02887           Accident      ATL82FLQ07  1982-07-01
1971   20020917X02861           Accident      ATL82FIG10  1982-07-16
2458   20020917X03618           Accident      LAX82DA316  1982-08-21
2507   20020917X03865           Accident      MKC82DA156  1982-08-24
2733   20020917X04964           Accident      MKC82FA171  1982-09-11
...               ...                ...             ...         ...
73385  20130307X10950           Incident      DCA13WA062  2013-03-06
73735  20130531X43222           Incident      DCA13WA097  2013-05-22
73761  20130808X52306           Incident      CEN13WA470  2013-05-26
75113  20140327X61657           Accident      ERA14LA174  2014-03-26
78394  20160314X33602           Incident      ENG16WA009  2016-03-10

                 Location        Country Latitude Longitude Airport_Code  \
1767        MCWHORTER, KY  United States      nan       nan          NaN
1971        FREDERICK, MD  United States      nan       nan          NaN
2458          VENTURA, CA  United States      nan       nan          NaN
2507           SIDNEY, NE  United States      nan       nan          SNY
2733       PLATTSBURG, MO  United States      nan       nan          NaN
...                   ...            ...      ...       ...          ...
73385         Chicago, IL  United States  415322N  0873710W          NaN
73735  Panama City, Panama         Panama      nan       nan          NaN
73761     Geneva, Eswatini       Eswatini      nan       nan          NaN
75113        Patillas, PR  United States  175831N  0066115W          X64
78394     Zurich, Eswatini       Eswatini      nan       nan          NaN

          Airport_Name  ... Purpose_of_flight     Air_carrier  \
1767               NaN  ...          Personal             NaN
1971   FREDERICK MUNI.  ...           Unknown             NaN
2458               NaN  ...          Personal             NaN
2507       SIDNEY MUNI  ...          Personal             NaN
2733               NaN  ...          Personal             NaN
...                ...  ...               ...             ...
73385              NaN  ...               NaN             NaN
73735              NaN  ...               NaN             NaN
73761              NaN  ...               NaN             NaN
75113 Patillas Airport  ...          Personal  Emerito Guzman
78394              NaN  ...               NaN             NaN

      Total_Fatal_Injuries Total_Serious_Injuries Total_Minor_Injuries  \
1767                   0.0                    1.0                  1.0
1971                   1.0                    0.0                  0.0
2458                   0.0                    0.0                  0.0
2507                   0.0                    0.0                  0.0
2733                   0.0                    2.0                  0.0
...                    ...                    ...                  ...
73385                  0.0                    0.0                  0.0
73735                  0.0                    0.0                  0.0
73761                  0.0                    0.0                  0.0
75113                  1.0                    0.0                  0.0
78394                  0.0                    0.0                  0.0

      Total_Uninjured Weather_Condition  Broad_phase_of_flight  \
1767              0.0               VMC                 Cruise
1971              0.0               VMC               Approach
2458              1.0               VMC            Maneuvering
2507              1.0               VMC                Landing
2733              0.0               VMC                Takeoff
...               ...               ...                    ...
73385             0.0               NaN                Unknown
73735            90.0               NaN                Unknown
73761             0.0               VMC                Unknown
75113             0.0               VMC                Unknown
78394            90.0               NaN                Unknown

                                          Report_Status Publication_Date
1767                                     Probable Cause       01-07-1983
1971                                     Probable Cause       16-07-1983
2458                                     Probable Cause       21-08-1983
2507                                     Probable Cause       24-08-1983
2733                                     Probable Cause       11-09-1983
...                                                 ...              ...
73385                                               NaN       25-09-2020
73735                                               NaN       03-11-2020
73761                                               NaN       03-11-2020
75113  The pilot  s failure to maintain airplane contr...       25-09-2020
78394                                               NaN       25-09-2020

[63 rows x 31 columns]
1767                KR-2
1971           WINDWAGON
2458      MIDGET MUSTANG
2507             SKYBOLT
2733       STARDUSTER TOO
              ...
73385             Airbus
73735                NaN
73761                NaN
75113                NaN
78394                NaN
Name: Model, Length: 63, dtype: object
1767     Airplane
1971     Airplane
2458     Airplane
2507     Airplane
2733     Airplane
           ...
73385         NaN
73735         NaN
73761         NaN
75113    Airplane
78394         NaN
Name: Aircraft_Category, Length: 63, dtype: object
```

In [28]:
```python
#Given the lack of details and the miniscule amount of entries with a null entry for 
aircraft_df.dropna(subset=['Make'], inplace=True)
print(aircraft_df.Make.isnull().sum())
```

```
0
```

In [29]:
```python
#now convert all entries in the Make Column to strings and
#adjust the capitalizations of the make column to eliminate different values of the s
aircraft_df['Make'] = aircraft_df['Make'].astype(str).str.upper()
print(aircraft_df.Make.value_counts(dropna=False))
```

```
Make
CESSNA           27149
PIPER            14870
BEECH             5372
BOEING            2745
BELL              2722
                 ...
COHEN                1
KITCHENS             1
LUTES                1
IZATT                1
ROYSE RALPH L        1
Name: count, Length: 7587, dtype: int64
```

In [30]:
```python
#do the same thing for the air carrier
aircraft_df['Air_carrier'] = aircraft_df['Air_carrier'].astype(str).str.upper().replac
print(aircraft_df.Air_carrier.value_counts(dropna=False))
```

```
Air_carrier
NA                          72202
PILOT                         258
UNITED AIRLINES                89
AMERICAN AIRLINES              89
DELTA AIR LINES                53
                            ...
WORGULL ROBERT C                1
BRANHAM ADVENTURES INC.         1
PRIDMORE-BROWN JULIAN N         1
AURORA AVIATION, LLC            1
MC CESSNA 210N LLC              1
Name: count, Length: 13193, dtype: int64
```

In [31]:
```python
#do the same thing for the air model
aircraft_df['Model'] = aircraft_df['Model'].astype(str).str.upper()
print(aircraft_df.Model.value_counts(dropna=False))
```

```
Model
152                    2367
172                    1756
172N                   1164
PA-28-140               932
150                     829
                       ...
CHALLENGER 2              1
BUSHBY MUSTANG M-II       1
HARVARD MK II             1
UC45J                     1
M-8 EAGLE                 1
Name: count, Length: 11641, dtype: int64
```

In [32]:
```python
#examine the dataframe again
print(aircraft_df.head())
print(aircraft_df.tail())
```

```
         Event_Id Investigation_Type Accident_Number  Event_Date  \
0  20001218X45444           Accident      SEA87LA080  1948-10-24
1  20001218X45447           Accident      LAX94LA336  1962-07-19
2  20061025X01555           Accident      NYC07LA005  1974-08-30
3  20001218X45448           Accident      LAX96LA321  1977-06-19
4  20041105X01764           Accident      CHI79FA064  1979-08-02

          Location        Country   Latitude   Longitude Airport_Code  \
0  MOOSE CREEK, ID  United States        nan         nan          NaN
1   BRIDGEPORT, CA  United States        nan         nan          NaN
2    Saltville, VA  United States  36.922223  -81.878056          NaN
3       EUREKA, CA  United States        nan         nan          NaN
4       Canton, OH  United States        nan         nan          NaN

  Airport_Name  ... Purpose_of_flight Air_carrier Total_Fatal_Injuries  \
0          NaN  ...          Personal          NA                  2.0
1          NaN  ...          Personal          NA                  4.0
2          NaN  ...          Personal          NA                  3.0
3          NaN  ...          Personal          NA                  2.0
4          NaN  ...          Personal          NA                  1.0

  Total_Serious_Injuries Total_Minor_Injuries Total_Uninjured  \
0                    0.0                  0.0             0.0
1                    0.0                  0.0             0.0
2                    NaN                  NaN             NaN
3                    0.0                  0.0             0.0
4                    2.0                  NaN             0.0

  Weather_Condition  Broad_phase_of_flight   Report_Status Publication_Date
0               UNK                 Cruise  Probable Cause              NaN
1               UNK                Unknown  Probable Cause       19-09-1996
2               IMC                 Cruise  Probable Cause       26-02-2007
3               IMC                 Cruise  Probable Cause       12-09-2000
4               VMC               Approach  Probable Cause       16-04-1980

[5 rows x 31 columns]
             Event_Id Investigation_Type Accident_Number  Event_Date  \
90343  20221227106491           Accident      ERA23LA093  2022-12-26
90344  20221227106494           Accident      ERA23LA095  2022-12-26
90345  20221227106497           Accident      WPR23LA075  2022-12-26
90346  20221227106498           Accident      WPR23LA076  2022-12-26
90347  20221230106513           Accident      ERA23LA097  2022-12-29

            Location        Country Latitude Longitude Airport_Code  \
90343  Annapolis, MD  United States      nan       nan          NaN
90344    Hampton, NH  United States      nan       nan          NaN
90345     Payson, AZ  United States  341525N  1112021W          PAN
90346     Morgan, UT  United States      nan       nan          NaN
90347     Athens, GA  United States      nan       nan          NaN

      Airport_Name  ... Purpose_of_flight         Air_carrier  \
90343          NaN  ...          Personal                  NA
90344          NaN  ...               NaN                  NA
90345       PAYSON  ...          Personal                  NA
90346          NaN  ...          Personal  MC CESSNA 210N LLC
90347          NaN  ...          Personal                  NA

      Total_Fatal_Injuries Total_Serious_Injuries Total_Minor_Injuries  \
90343                  0.0                    1.0                  0.0
90344                  0.0                    0.0                  0.0
90345                  0.0                    0.0                  0.0
90346                  0.0                    0.0                  0.0
90347                  0.0                    1.0                  0.0

      Total_Uninjured Weather_Condition  Broad_phase_of_flight Report_Status  \
90343             0.0               NaN                Unknown           NaN
90344             0.0               NaN                Unknown           NaN
90345             1.0               VMC                Unknown           NaN
90346             0.0               NaN                Unknown           NaN
90347             1.0               NaN                Unknown           NaN

      Publication_Date
90343       29-12-2022
90344              NaN
90345       27-12-2022
90346              NaN
90347       30-12-2022

[5 rows x 31 columns]
```

In [33]:
```python
#check the unique values of the airport_name
print(aircraft_df.Airport_Name.value_counts(dropna=False))
```

```
Airport_Name
NaN                                36137
Private                              240
PRIVATE                              224
Private Airstrip                     153
NONE                                 146
                                   ...
OTTAWA MUNICIPAL                       1
DWIGHT AIRPORT                         1
PHOENIX DEER VALLEY MUNI               1
SEASIDE PARK                           1
WICHITA DWIGHT D EISENHOWER NT         1
Name: count, Length: 24863, dtype: int64
```

In [34]:
```python
#capitalize all airport_name entries
aircraft_df.Airport_Name = aircraft_df.Airport_Name.str.upper()
print(aircraft_df.Airport_Name.value_counts(dropna=False))
```

```
Airport_Name
NaN                                36137
PRIVATE                              471
PRIVATE AIRSTRIP                     266
PRIVATE STRIP                        161
NONE                                 146
                                   ...
KELLEY'S ISLAND LAND FLD               1
EUREKA MUNICIPAL                       1
NEAR VICTORY                           1
LAKES REGIONAL AIRPORT                 1
WICHITA DWIGHT D EISENHOWER NT         1
Name: count, Length: 21560, dtype: int64
```

In [35]:
```python
#combine NaN with NONE in the airport_name column
aircraft_df.Airport_Name = aircraft_df.Airport_Name.replace('NONE', np.nan)
print(aircraft_df.Airport_Name.value_counts(dropna=False))
```

```
Airport_Name
NaN                                36283
PRIVATE                              471
PRIVATE AIRSTRIP                     266
PRIVATE STRIP                        161
MERRILL FIELD                        109
                                   ...
KELLEY'S ISLAND LAND FLD               1
EUREKA MUNICIPAL                       1
NEAR VICTORY                           1
LAKES REGIONAL AIRPORT                 1
WICHITA DWIGHT D EISENHOWER NT         1
Name: count, Length: 21559, dtype: int64
```

In [36]:
```python
#convert NaN to a string and create one value in the Airport_Name column for entries 
aircraft_df.Airport_Name = aircraft_df.Airport_Name.fillna('NA')
aircraft_df.loc[aircraft_df.Airport_Name.str.contains('PRIVATE', case=False), 'Airport
print(aircraft_df.Airport_Name.value_counts(dropna=False))
```

```
Airport_Name
NA                                 36284
PRIVATE                             1211
MERRILL FIELD                        109
CENTENNIAL                           102
VAN NUYS                              97
                                   ...
WEST TINIAN                            1
ANTIQUERS                              1
BURNHAM FIELD                          1
NAS GUANTANAMO BAY                     1
WICHITA DWIGHT D EISENHOWER NT         1
Name: count, Length: 21337, dtype: int64
```

In [37]:
```python
#create one value for unknown, none, na, and nan in the aircraft carrier column
unknown_values = ['none', 'unknown', 'nan']
aircraft_df.Air_carrier = aircraft_df.Air_carrier.replace(['NONE', 'UNKNOWN', 'NAN'],
print(aircraft_df.Air_carrier.str.lower().isin(unknown_values))
```

```
0        False
1        False
2        False
3        False
4        False
         ...
90343    False
90344    False
90345    False
90346    False
90347    False
Name: Air_carrier, Length: 88826, dtype: bool
```

In [38]:
```
#do the same thing for the Make column
aircraft_df.Make = aircraft_df.Make.replace(['NONE', 'UNKNOWN', 'NAN'], 'NA')
```

In [39]:
```
#do the same thing for the Model column
aircraft_df.Model = aircraft_df.Model.replace(['NONE', 'UNKNOWN', 'NAN'], 'NA')
```

In [40]:
```
#create a list of the top 10 aircraft makes and calculate their sum of appearances
top_10_make_counts = aircraft_df.Make.value_counts().head(10).reset_index().values.to
print(top_10_make_counts)
print(sum(count for value, count in top_10_make_counts))
```

```
[['CESSNA', 27149], ['PIPER', 14870], ['BEECH', 5372], ['BOEING', 2745], ['BELL', 272
2], ['MOONEY', 1334], ['ROBINSON', 1230], ['GRUMMAN', 1172], ['BELLANCA', 1045], ['HUG
HES', 932]]
58571
```

In [41]:
```
#do the same thing for the Model column, including the corresponding Make value
model_counts = aircraft_df['Model'].value_counts().head(10).reset_index()
model_counts.columns = ['Model', 'Count']

make_counts = aircraft_df.groupby('Model')['Make'].first().reset_index()

result_df = pd.merge(model_counts, make_counts, on='Model')
top_10_model_counts_merged = result_df[['Make', 'Model', 'Count']].values.tolist()
print(top_10_model_counts_merged)
print(result_df['Count'].sum())
```

```
[['CESSNA', '152', 2367], ['CESSNA', '172', 1756], ['CESSNA', '172N', 1164], ['PIPER',
'PA-28-140', 932], ['CESSNA', '150', 829], ['CESSNA', '172M', 798], ['CESSNA', '172P',
689], ['CESSNA', '182', 659], ['CESSNA', '180', 622], ['CESSNA', '150M', 585]]
10401
```

In [42]:
```
#check which columns still have empty values
columns_with_nan = aircraft_df.columns[aircraft_df.isna().any()]
columns_with_nan
```

Out[42]:
```
Index(['Location', 'Country', 'Airport_Code', 'Injury_Severity',
       'Aircraft_damage', 'Aircraft_Category', 'Registration_Number',
       'Amateur_Built', 'Number_of_Engines', 'Engine_Type', 'FAR_Description',
       'Schedule', 'Purpose_of_flight', 'Total_Fatal_Injuries',
       'Total_Serious_Injuries', 'Total_Minor_Injuries', 'Total_Uninjured',
       'Weather_Condition', 'Report_Status', 'Publication_Date'],
      dtype='object')
```

In [43]:
```
#check Location value counts
aircraft_df.Location.value_counts(dropna=False)
```

Out[43]:
```
Location
ANCHORAGE, AK         434
MIAMI, FL             200
ALBUQUERQUE, NM       196
HOUSTON, TX           193
CHICAGO, IL           184
                     ...
ST. JOSEPH, LA          1
MILFORD CENTER, OH      1
ELK GARDEN, VA          1
PIURA, Peru             1
Brasnorte,              1
Name: count, Length: 27735, dtype: int64
```

In [44]:
```
#check Country value counts
aircraft_df.Country.value_counts(dropna=False)
```

Out[44]:
```
Country
United States                       82227
Brazil                                371
Mexico                                358
Canada                                357
United Kingdom                        344
                                    ...
Palau                                   1
Libya                                   1
Saint Vincent and the Grenadines        1
Malampa                                 1
Turks and Caicos Islands                1
Name: count, Length: 220, dtype: int64
```

In [45]:
```
#check Airport_Code value counts
aircraft_df.Airport_Code.value_counts(dropna=False)
```

Out[45]:
```
Airport_Code
NaN     38708
NONE     1487
PVT       485
APA       160
ORD       149
        ...
TN95        1
IGI         1
3M8         1
4CO3        1
EIKH        1
Name: count, Length: 10372, dtype: int64
```

In [46]:
```
#fill empty Airport_Code entries with "NONE"
aircraft_df.Airport_Code = aircraft_df.Airport_Code.fillna("NONE")
aircraft_df.Airport_Code.value_counts(dropna=False)
```

Out[46]:
```
Airport_Code
NONE    40195
PVT       485
APA       160
ORD       149
MRI       137
        ...
TN95        1
IGI         1
3M8         1
4CO3        1
EIKH        1
Name: count, Length: 10371, dtype: int64
```

In [47]:
```
#check Injury_Severity value counts
aircraft_df.Injury_Severity.value_counts(dropna=False)
```

Out[47]:
```
Injury_Severity
Non-Fatal     67332
Fatal(1)       6163
Fatal          5253
Fatal(2)       3709
Incident       2216
              ...
Fatal(80)         1
Fatal(217)        1
Fatal(169)        1
Fatal(88)         1
Fatal(189)        1
Name: count, Length: 110, dtype: int64
```

In [48]:
```
#check Weather_Condition value counts
aircraft_df.Weather_Condition.value_counts(dropna=False)
```

Out[48]:
```
Weather_Condition
VMC    77282
IMC     5973
NaN     4454
UNK      855
Unk      262
Name: count, dtype: int64
```

In [49]:
```
#capitalize Unk in Weather_Condition column
aircraft_df.loc[aircraft_df.Weather_Condition == 'Unk', 'Weather_Condition'] = 'UNK'
#fill empty values with UNK
aircraft_df.Weather_Condition.fillna("UNK", inplace=True)
aircraft_df.Weather_Condition.value_counts(dropna=False)
```

Out[49]:
```
Weather_Condition
VMC    77282
IMC     5973
UNK     5571
Name: count, dtype: int64
```

In [50]:
```
#check the value counts of Amateur_Built
aircraft_df.Amateur_Built.value_counts(dropna=False)
```

Out[50]:
```
Amateur_Built
No     80266
Yes     8460
NaN      100
Name: count, dtype: int64
```

In [51]:
```
#check the value count of Number_of_Engines
aircraft_df.Number_of_Engines.value_counts(dropna=False)
```

Out[51]:
```
Number_of_Engines
1.0    69569
2.0    11078
NaN     6035
0.0     1226
3.0      483
4.0      431
8.0        3
6.0        1
Name: count, dtype: int64
```

In [52]:
```
#check the value count of Engine_Type
aircraft_df.Engine_Type.value_counts(dropna=False)
```

Out[52]:
```
Engine_Type
Reciprocating      69519
NaN                 7045
Turbo Shaft         3609
Turbo Prop          3391
Turbo Fan           2481
Unknown             2050
Turbo Jet            703
Geared Turbofan       12
Electric              10
LR                     2
NONE                   2
Hybrid Rocket          1
UNK                    1
Name: count, dtype: int64
```

In [53]:
```
#replace UNK and NaN with Unknown in Engine_Type column
aircraft_df.loc[aircraft_df.Engine_Type == 'UNK', 'Engine_Type'] = 'Unknown'
aircraft_df.Engine_Type = aircraft_df.Engine_Type.fillna("Unknown")
aircraft_df.Engine_Type.value_counts(dropna=False)
```

Out[53]:
```
Engine_Type
Reciprocating      69519
Unknown             9096
Turbo Shaft         3609
Turbo Prop          3391
Turbo Fan           2481
Turbo Jet            703
Geared Turbofan       12
Electric              10
LR                     2
NONE                   2
Hybrid Rocket          1
Name: count, dtype: int64
```

In [54]:
```
#rename Aircraft_damage to Aircraft_Damage and check the value counts of Aircraft_Dam
aircraft_df = aircraft_df.rename(columns={'Aircraft_damage': 'Aircraft_Damage'})
aircraft_df.Aircraft_Damage.value_counts(dropna=False)
```

Out[54]:
```
Aircraft_Damage
Substantial    64124
Destroyed      18612
NaN             3176
Minor           2795
Unknown          119
Name: count, dtype: int64
```

In [55]:
```
#fill empty values in Aircraft_Damage with Unknown
aircraft_df.Aircraft_Damage = aircraft_df.Aircraft_Damage.fillna('Unknown')
aircraft_df.Aircraft_Damage.value_counts(dropna=False)
```

Out[55]:
```
Aircraft_Damage
Substantial    64124
Destroyed      18612
Unknown         3295
Minor           2795
Name: count, dtype: int64
```

In [56]:
```
#check the value counts for Aircraft_Category
aircraft_df.Aircraft_Category.value_counts(dropna=False)
```

Out[56]:
```
Aircraft_Category
NaN                  56551
Airplane             27608
Helicopter            3437
Glider                 508
Balloon                231
Gyrocraft              173
Weight-Shift           161
Powered Parachute       91
Ultralight              30
Unknown                 14
WSFT                     9
Powered-Lift             5
Blimp                    4
UNK                      2
Rocket                   1
ULTR                     1
Name: count, dtype: int64
```

In [57]:
```
#replace UNK and NaN with Unknown in Aircraft_Category
aircraft_df.loc[aircraft_df.Aircraft_Category == 'UNK', 'Aircraft_Category'] = 'Unknow
aircraft_df.Aircraft_Category = aircraft_df.Aircraft_Category.fillna('Unknown')
aircraft_df.Aircraft_Category.value_counts(dropna=False)
```

Out[57]:
```
Aircraft_Category
Unknown              56567
Airplane             27608
Helicopter            3437
Glider                 508
Balloon                231
Gyrocraft              173
Weight-Shift           161
Powered Parachute       91
Ultralight              30
WSFT                     9
Powered-Lift             5
Blimp                    4
Rocket                   1
ULTR                     1
Name: count, dtype: int64
```

In [58]:
```
#drop all rows except ones in which the Aircraft_Category is either Unknown, Airplane
#Helicopter
aircraft_categories = ['Unknown', 'Airplane', 'Helicopter']
aircraft_df = aircraft_df[aircraft_df.Aircraft_Category.isin(aircraft_categories)].re
aircraft_df.Aircraft_Category.value_counts(dropna=False)
```

Out[58]:
```
Aircraft_Category
Unknown       56567
Airplane      27608
Helicopter     3437
Name: count, dtype: int64
```

In [59]:
```
#check value counts of Schedule
aircraft_df.Schedule.value_counts(dropna=False)
```

Out[59]:
```
Schedule
NaN     75091
NSCH     4443
UNK      4099
SCHD     3979
Name: count, dtype: int64
```

In [60]:
```
#fill NaN in Schedule column with UNK
aircraft_df.Schedule = aircraft_df.Schedule.fillna("UNK")
aircraft_df.Schedule.value_counts(dropna=False)
```

Out[60]:
```
Schedule
UNK     79190
NSCH     4443
SCHD     3979
Name: count, dtype: int64
```

In [61]:
```
#check value counts of FAR_Description
aircraft_df.FAR_Description.value_counts(dropna=False)
```

Out[61]:
```
FAR_Description
NaN                                 56848
091                                 17288
Part 91: General Aviation            6221
NUSN                                 1573
137                                  1010
NUSC                                  989
135                                   746
121                                   674
Part 137: Agricultural                437
UNK                                   364
Part 135: Air Taxi & Commuter         298
PUBU                                  251
129                                   244
Part 121: Air Carrier                 165
133                                   107
Part 129: Foreign                      98
Non-U.S., Non-Commercial               96
Non-U.S., Commercial                   91
Part 133: Rotorcraft Ext. Load         32
Unknown                                22
Public Use                             18
091K                                   14
ARMF                                    7
125                                     5
Part 125: 20+ Pax,6000+ lbs             5
107                                     4
Public Aircraft                         2
Armed Forces                            1
Part 91F: Special Flt Ops.              1
Part 91 Subpart K: Fractional           1
Name: count, dtype: int64
```

In [62]:
```
#fill empty values in FAR_Description with Unknown
aircraft_df.FAR_Description = aircraft_df.FAR_Description.fillna("Unknown")
aircraft_df.FAR_Description.value_counts(dropna=False)
```

Out[62]:
```
FAR_Description
Unknown                             56870
091                                 17288
Part 91: General Aviation            6221
NUSN                                 1573
137                                  1010
NUSC                                  989
135                                   746
121                                   674
Part 137: Agricultural                437
UNK                                   364
Part 135: Air Taxi & Commuter         298
PUBU                                  251
129                                   244
Part 121: Air Carrier                 165
133                                   107
Part 129: Foreign                      98
Non-U.S., Non-Commercial               96
Non-U.S., Commercial                   91
Part 133: Rotorcraft Ext. Load         32
Public Use                             18
091K                                   14
ARMF                                    7
125                                     5
Part 125: 20+ Pax,6000+ lbs             5
107                                     4
Public Aircraft                         2
Armed Forces                            1
Part 91F: Special Flt Ops.              1
Part 91 Subpart K: Fractional           1
Name: count, dtype: int64
```

In [63]:
```
#check the value counts in Purpose_of_flight
aircraft_df.Purpose_of_flight.value_counts(dropna=False)
```

Out[63]:
```
Purpose_of_flight
Personal                     48555
Instructional                10473
Unknown                       6777
NaN                           6133
Aerial Application            4712
Business                      3986
Positioning                   1644
Other Work Use                1207
Ferry                          812
Aerial Observation             768
Public Aircraft                719
Executive/corporate            553
Flight Test                    389
Skydiving                      181
External Load                  122
Public Aircraft - Federal      105
Banner Tow                     101
Air Race show                   78
Public Aircraft - Local         73
Public Aircraft - State         64
Air Race/show                   56
Glider Tow                      42
Firefighting                    40
Air Drop                        11
ASHO                             6
PUBS                             4
PUBL                             1
Name: count, dtype: int64
```

In [64]:
```
#fill empty fields on Purpose_of_flight with Unknown
aircraft_df.Purpose_of_flight = aircraft_df.Purpose_of_flight.fillna("Unknown")
aircraft_df.Purpose_of_flight.value_counts(dropna=False)
```

Out[64]:
```
Purpose_of_flight
Personal                     48555
Unknown                      12910
Instructional                10473
Aerial Application            4712
Business                      3986
Positioning                   1644
Other Work Use                1207
Ferry                          812
Aerial Observation             768
Public Aircraft                719
Executive/corporate            553
Flight Test                    389
Skydiving                      181
External Load                  122
Public Aircraft - Federal      105
Banner Tow                     101
Air Race show                   78
Public Aircraft - Local         73
Public Aircraft - State         64
Air Race/show                   56
Glider Tow                      42
Firefighting                    40
Air Drop                        11
ASHO                             6
PUBS                             4
PUBL                             1
Name: count, dtype: int64
```

In [65]:
```
#make all entries containing Public Aircraft in Purpose_of_flight column one spelling
aircraft_df.loc[aircraft_df.Purpose_of_flight.str.contains('Public Aircraft', na=False
aircraft_df.Purpose_of_flight.value_counts()
```

Out[65]:
```
Purpose_of_flight
Personal               48555
Unknown                12910
Instructional          10473
Aerial Application      4712
Business                3986
Positioning             1644
Other Work Use          1207
Public Aircraft          961
Ferry                    812
Aerial Observation       768
Executive/corporate      553
Flight Test              389
Skydiving                181
External Load            122
Banner Tow               101
Air Race show             78
Air Race/show             56
Glider Tow                42
Firefighting              40
Air Drop                  11
ASHO                       6
PUBS                       4
PUBL                       1
Name: count, dtype: int64
```

In [66]:
```
#drop all rows except ones in which the Purpose_of_flight is either Personal, Instruc
#Unknown, Aerial Application, Business, Positioning, Other Work Use, Ferry, Aerial Ob
purpose_categories = ['Personal', 'Unknown', 'Instructional', 'Aerial Application', '
aircraft_df = aircraft_df[aircraft_df.Purpose_of_flight.isin(purpose_categories)].rese
aircraft_df.Purpose_of_flight.value_counts(dropna=False)
```

Out[66]:
```
Purpose_of_flight
Personal               48555
Unknown                12910
Instructional          10473
Aerial Application      4712
Business                3986
Positioning             1644
Other Work Use          1207
Public Aircraft          961
Ferry                    812
Aerial Observation       768
Executive/corporate      553
Flight Test              389
Name: count, dtype: int64
```

In [67]:
```
#look at the most common Make values
aircraft_df.Make.value_counts()
```

Out[67]:
```
Make
CESSNA               26978
PIPER                14790
BEECH                 5351
BOEING                2735
BELL                  2678
                     ...
HAZELRIGE                1
MASKO                    1
FRANK H MARCHETTI        1
SHANKLIN                 1
ROYSE RALPH L            1
Name: count, Length: 7196, dtype: int64
```

In [68]:
```
#calculate the fatalities for CESSNA accidents
cessna_fatal_injuries = aircraft_df.loc[aircraft_df.Make == 'CESSNA', 'Total_Fatal_In
cessna_fatal_injuries
```

Out[68]: 9518.0

In [69]:
```
#check the sum of Total_Fatal_Injuries of the entire dataframe
aircraft_df.Total_Fatal_Injuries.sum()
```

Out[69]: 49418.0

In [70]:
```
#make a series of the top 5 makes and their occurences
top_5_make_counts = aircraft_df.Make.value_counts().head(5)
top_5_make_counts
```

Out[70]:
```
Make
CESSNA    26978
PIPER     14790
BEECH      5351
BOEING     2735
BELL       2678
Name: count, dtype: int64
```

In [71]:
```
#create a table of the top 5 for Makea, Accidents, and Total_Fatal_Injuries
make_fatalities = aircraft_df.groupby('Make')['Total_Fatal_Injuries'].sum()
merged_make_fatal_df = pd.DataFrame({'Make': top_5_make_counts.index, 'Counts': top_5_
merged_make_fatal_df = merged_make_fatal_df.merge(make_fatalities, on='Make')
merged_make_fatal_df = merged_make_fatal_df.rename(columns={'Total_Fatal_Injuries_x':
merged_make_fatal_df
```

Out[71]:

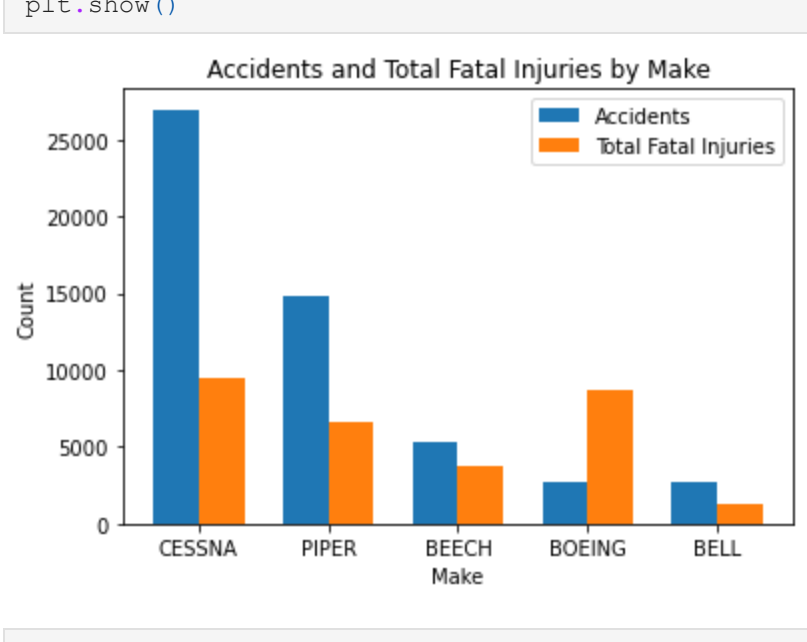
	Make	Accidents	Total_Fatal_Injuries
0	CESSNA	26978	9518.0
1	PIPER	14790	6673.0
2	BEECH	5351	3708.0
3	BOEING	2735	8738.0
4	BELL	2678	1301.0

In [72]:
```
#create a series of the top 5 total fatal injuries by make
total_fatal_injuries = aircraft_df.groupby('Make')['Total_Fatal_Injuries'].sum().sort_
total_fatal_injuries_df = pd.DataFrame({'Make': total_fatal_injuries.index, 'Total_Fa
total_fatal_injuries_df = total_fatal_injuries_df.head(5)
total_fatal_injuries_df
```

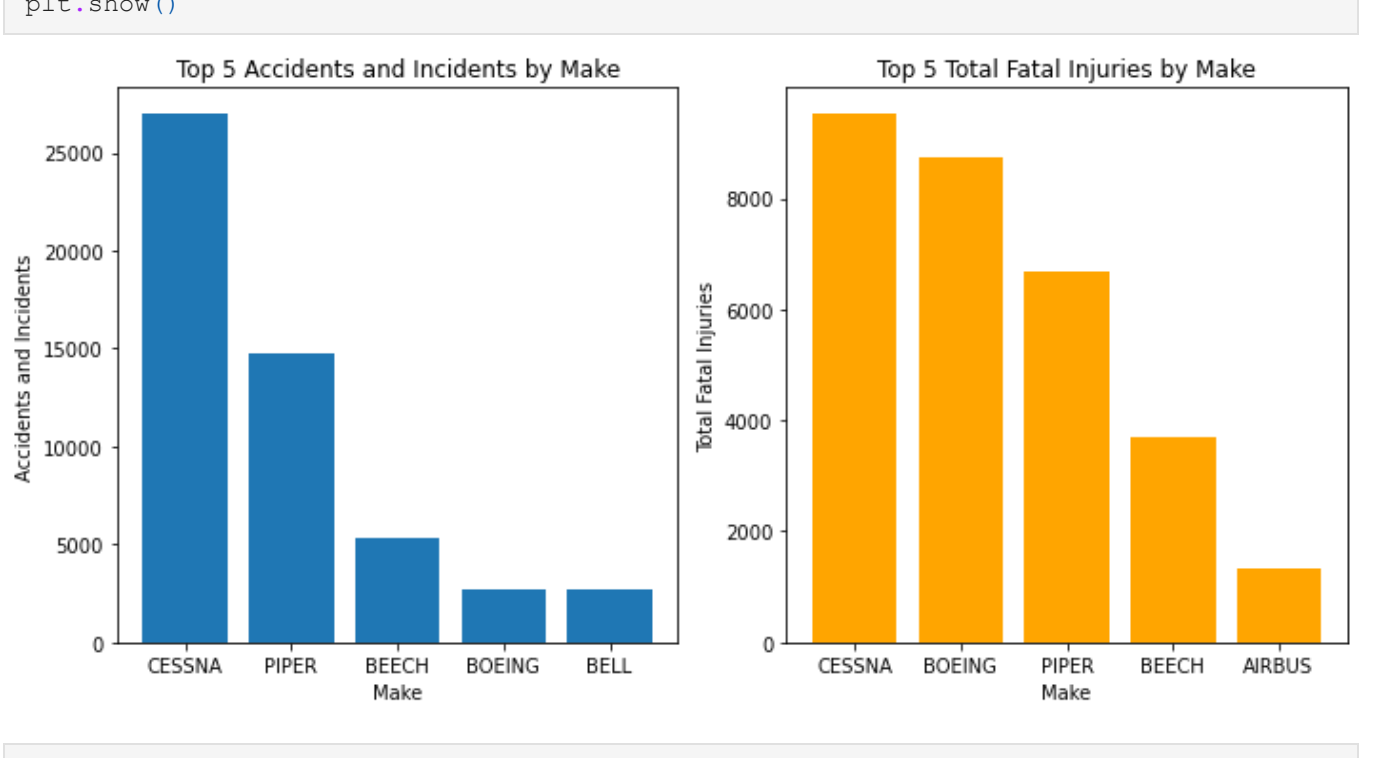
Out[72]:

	Make	Total_Fatal_Injuries
0	CESSNA	9518.0
1	BOEING	8738.0
2	PIPER	6673.0
3	BEECH	3708.0
4	AIRBUS	1325.0

In [73]:
```
#plot a double bar chart to represent the top 5 makes to appear and their total fatal

#set bar width
bar_width = 0.35

#set the index
index = np.arange(len(merged_make_fatal_df['Make']))

#plot the bar chart
plt.bar(index, merged_make_fatal_df['Accidents'], bar_width, label='Accidents')
plt.bar(index + bar_width, merged_make_fatal_df['Total_Fatal_Injuries'], bar_width, la

#label the axis and title
plt.xlabel('Make')
plt.ylabel('Count')
plt.title('Accidents and Total Fatal Injuries by Make')

#adjust the x ticks
plt.xticks(index + bar_width/2, merged_make_fatal_df['Make'])

#create a legend and show the graph
plt.legend()
plt.show()
```



In [74]:
```
# Create a figure with two subplots
fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(10, 5))

# Plot the first bar graph for 'Accidents/Incidents'
ax1.bar(merged_make_fatal_df['Make'], merged_make_fatal_df['Accidents'])
ax1.set_xlabel('Make')
ax1.set_ylabel('Accidents and Incidents')
ax1.set_title('Top 5 Accidents and Incidents by Make')

# Plot the second bar graph for 'Total_Fatal_Injuries'
ax2.bar(total_fatal_injuries_df['Make'], total_fatal_injuries_df['Total_Fatal_Injurie
ax2.set_xlabel('Make')
ax2.set_ylabel('Total Fatal Injuries')
ax2.set_title('Top 5 Total Fatal Injuries by Make')

# Adjust the spacing between subplots
plt.tight_layout()

# Display the plots
plt.show()
```



In [75]:
```
#change the Event_Date column to datetimelike values
aircraft_df['Event_Date'] = pd.to_datetime(aircraft_df['Event_Date'])
#create a Year column from the Event_Date values
aircraft_df['Year'] = aircraft_df['Event_Date'].dt.year
aircraft_df['Year']
```

Out[75]:
```
0        1948
1        1962
2        1974
3        1977
4        1979
         ...
86965    2022
86966    2022
86967    2022
86968    2022
86969    2022
Name: Year, Length: 86970, dtype: int32
```

In [76]:
```
#group the data into a frame containing Year, Weather_Condition, Aircraft_Damage, Tot
injured_grouped_df = aircraft_df.groupby(['Year', 'Weather_Condition', 'Aircraft_Damag

#convert the year to an integer type
injured_grouped_df.Year = injured_grouped_df.Year.astype(int)

#filter out entries prior to 1980
injured_grouped_df = injured_grouped_df[injured_grouped_df.Year >= 1980]

#create another column Total_Injuries that combines the three Injuries columns
injured_grouped_df['Total_Injuries'] = injured_grouped_df[['Total_Fatal_Injuries', 'T

#reset the index
injured_grouped_df = injured_grouped_df.reset_index(drop=True)
injured_grouped_df
```

Out[76]:

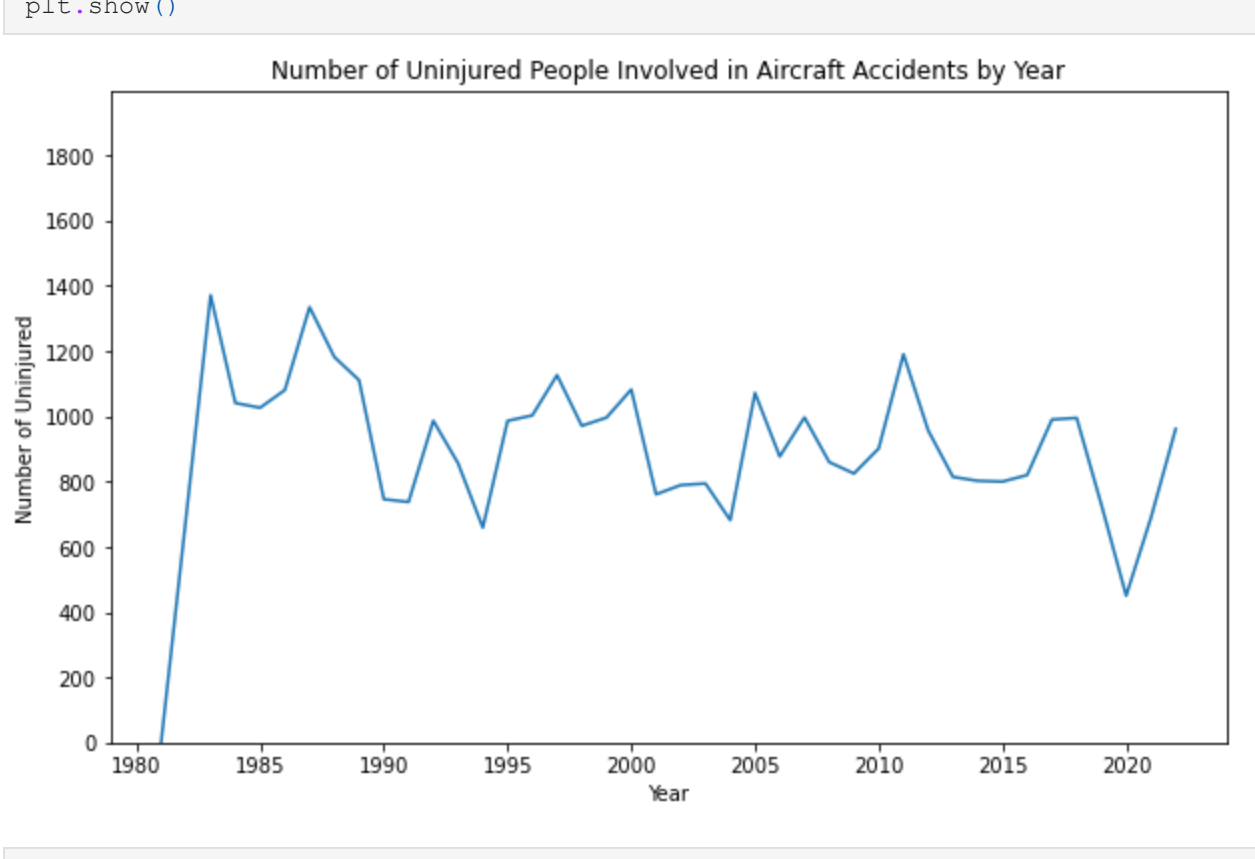
	Year	Weather_Condition	Aircraft_Damage	Total_Fatal_Injuries	Total_Serious_Injuries	Total_Minor
0	1981	IMC	Destroyed	4.0	0.0	
1	1982	IMC	Destroyed	427.0	65.0	
2	1982	IMC	Minor	0.0	1.0	
3	1982	IMC	Substantial	18.0	14.0	
4	1982	IMC	Unknown	2.0	0.0	
...	...	...	...	...	...	
472	2022	UNK	Unknown	53.0	39.0	
473	2022	VMC	Destroyed	106.0	5.0	
474	2022	VMC	Minor	2.0	1.0	
475	2022	VMC	Substantial	123.0	227.0	
476	2022	VMC	Unknown	9.0	9.0	

477 rows × 8 columns

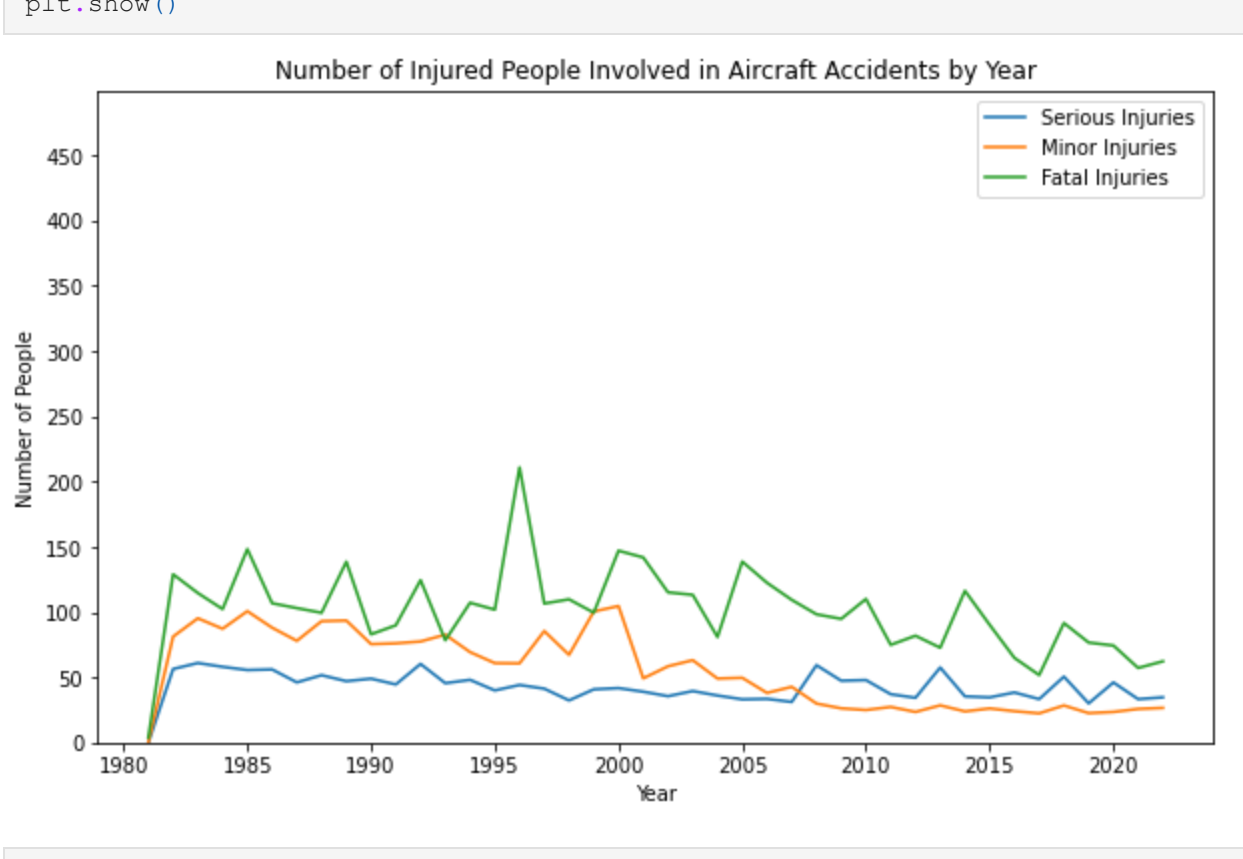
In [77]:
```
# Filter the DataFrame to exclude Unknown from Aircraft_Damage
injured_grouped_filtered_df = injured_grouped_df[injured_grouped_df['Aircraft_Damage']
injured_grouped_filtered_df.Aircraft_Damage.value_counts(dropna=False)
```

Out[77]:
```
Aircraft_Damage
Destroyed      124
Substantial    123
Minor          114
Name: count, dtype: int64
```

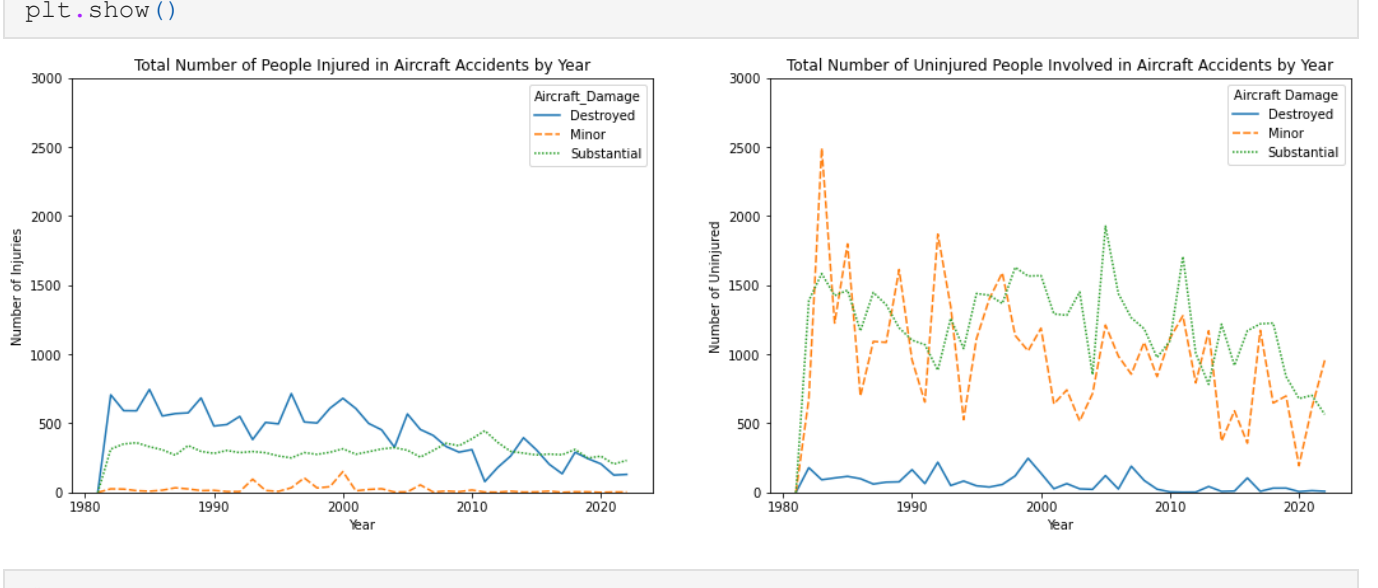
In [78]:
```
#create a plot
plt.figure(figsize=(10, 6))

#plot a line graph of Total Uninjured People by Year in Accidents
sns.lineplot(data=injured_grouped_df, x='Year', y='Total_Uninjured', ci=None)

#customize the labels and title
plt.xlabel('Year')
plt.ylabel('Number of Uninjured')
plt.title('Number of Uninjured People Involved in Aircraft Accidents by Year')

#customize the ticks and limit of the Y axis
plt.xticks(range(1980, 2023, 5))
plt.yticks(range(0, 2000, 200))
plt.ylim(0, 2000)

#show the graph
plt.show()
```



In [79]:
```
#create a plot
plt.figure(figsize=(10, 6))

#create a line graph for the three types of Injuries
sns.lineplot(data=injured_grouped_df, x='Year', y='Total_Serious_Injuries', label='Se
sns.lineplot(data=injured_grouped_df, x='Year', y='Total_Minor_Injuries', label='Mino
sns.lineplot(data=injured_grouped_df, x='Year', y='Total_Fatal_Injuries', label='Fata

#customize the labels and title
plt.xlabel('Year')
plt.ylabel('Number of People')
plt.title('Number of Injured People Involved in Aircraft Accidents by Year')

#customize the ticks and Y limit
plt.xticks(range(1980, 2023, 5))
plt.yticks(range(0, 500, 50))
plt.ylim(0, 500)

#show the legend and graph
plt.legend()
plt.show()
```



In [80]:
```
#create a plot for two separate graphs
fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(18, 6))

# Create a pivot table to reshape the data
injured_pivot_df = injured_grouped_filtered_df.pivot_table(index='Year', columns='Airc
uninjured_pivot_df = injured_grouped_filtered_df.pivot_table(index='Year', columns='A

# Create a Total Injuries line plot using Seaborn
sns.lineplot(data=injured_pivot_df, ax=ax1)

# Set the labels and title
ax1.set_xlabel('Year')
ax1.set_ylabel('Number of Injuries')
ax1.set_title('Total Number of People Injured in Aircraft Accidents by Year')

#set the y lim
ax1.set_ylim(0, 3000)

# Create a Total Uninjured line plot using Seaborn
sns.lineplot(data=uninjured_pivot_df, ax=ax2)

# Set the labels and title
ax2.set_xlabel('Year')
ax2.set_ylabel('Number of Uninjured')
ax2.set_title('Total Number of Uninjured People Involved in Aircraft Accidents by Yea

#set the y lim
ax2.set_ylim(0, 3000)

# Display the legend and show the plot
plt.legend(title='Aircraft Damage')
plt.show()
```

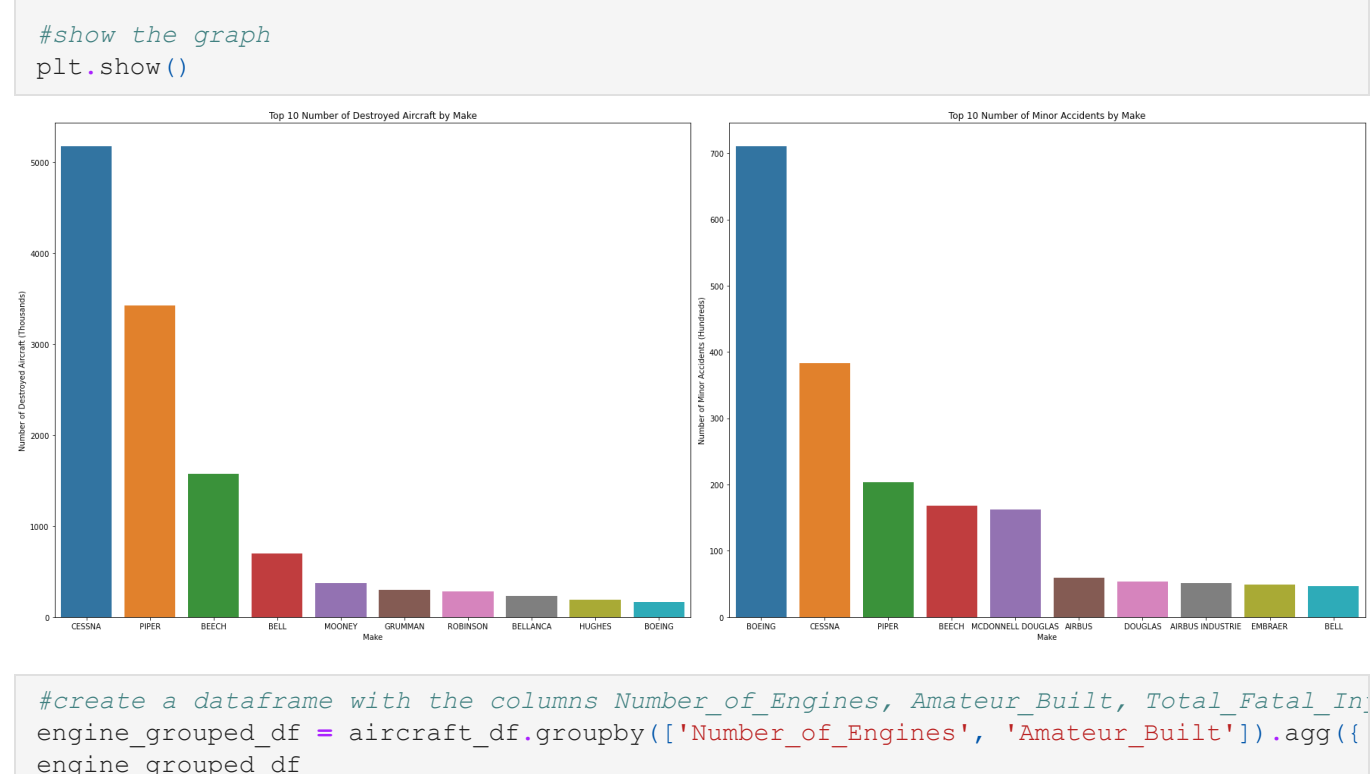


In [81]:
```
#create a dataframe based on the Make and Aircraft_Damage columns
make_damage_grouped_df = aircraft_df.groupby(['Make', 'Aircraft_Damage']).size().sort_

# Filter the DataFrame to only show Destroyed from Aircraft_Damage
make_damage_destroyed_df = make_damage_grouped_df[make_damage_grouped_df['Aircraft_Da

#create a top 10
top10_make_damage_destroyed_df = make_damage_destroyed_df.head(10).reset_index(drop=T

#Filter the DataFrame to only show Minor from Aircraft_Damage
make_damage_minor_df = make_damage_grouped_df[make_damage_grouped_df['Aircraft_Damage

#create a top 10
top10_make_damage_minor_df = make_damage_minor_df.head(10).reset_index(drop=True)
print(top10_make_damage_destroyed_df)
print(top10_make_damage_minor_df)
```

```
       Make Aircraft_Damage  Count
0    CESSNA       Destroyed   5172
1     PIPER       Destroyed   3423
2     BEECH       Destroyed   1576
3      BELL       Destroyed    696
4    MOONEY       Destroyed    373
5   GRUMMAN       Destroyed    298
6  ROBINSON       Destroyed    282
7  BELLANCA       Destroyed    231
8    HUGHES       Destroyed    187
9    BOEING       Destroyed    166
                Make Aircraft_Damage  Count
0             BOEING           Minor    710
1             CESSNA           Minor    383
2              PIPER           Minor    204
3              BEECH           Minor    168
4  MCDONNELL DOUGLAS           Minor    162
5             AIRBUS           Minor     59
6            DOUGLAS           Minor     54
7   AIRBUS INDUSTRIE           Minor     51
8            EMBRAER           Minor     49
9               BELL           Minor     47
```

In [82]:
```
#create a plot for two separate graphs
fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(25, 10))

#create a Destroyed Make bar plot using Seaborn
sns.barplot(data=top10_make_damage_destroyed_df, x='Make', y='Count', ax=ax1)

#set the labels and title
ax1.set_xlabel('Make')
ax1.set_ylabel('Number of Destroyed Aircraft (Thousands)')
ax1.set_title('Top 10 Number of Destroyed Aircraft by Make')
```

```
#create a Minor Make bar plot using Seaborn
sns.barplot(data=top10_make_damage_minor_df, x='Make', y='Count', ax=ax2)

#set the labels and title
ax2.set_xlabel('Make')
ax2.set_ylabel('Number of Minor Accidents (Hundreds)')
ax2.set_title('Top 10 Number of Minor Accidents by Make')

#adjust the spacing
plt.tight_layout()

#show the graph
plt.show()
```



In [83]:

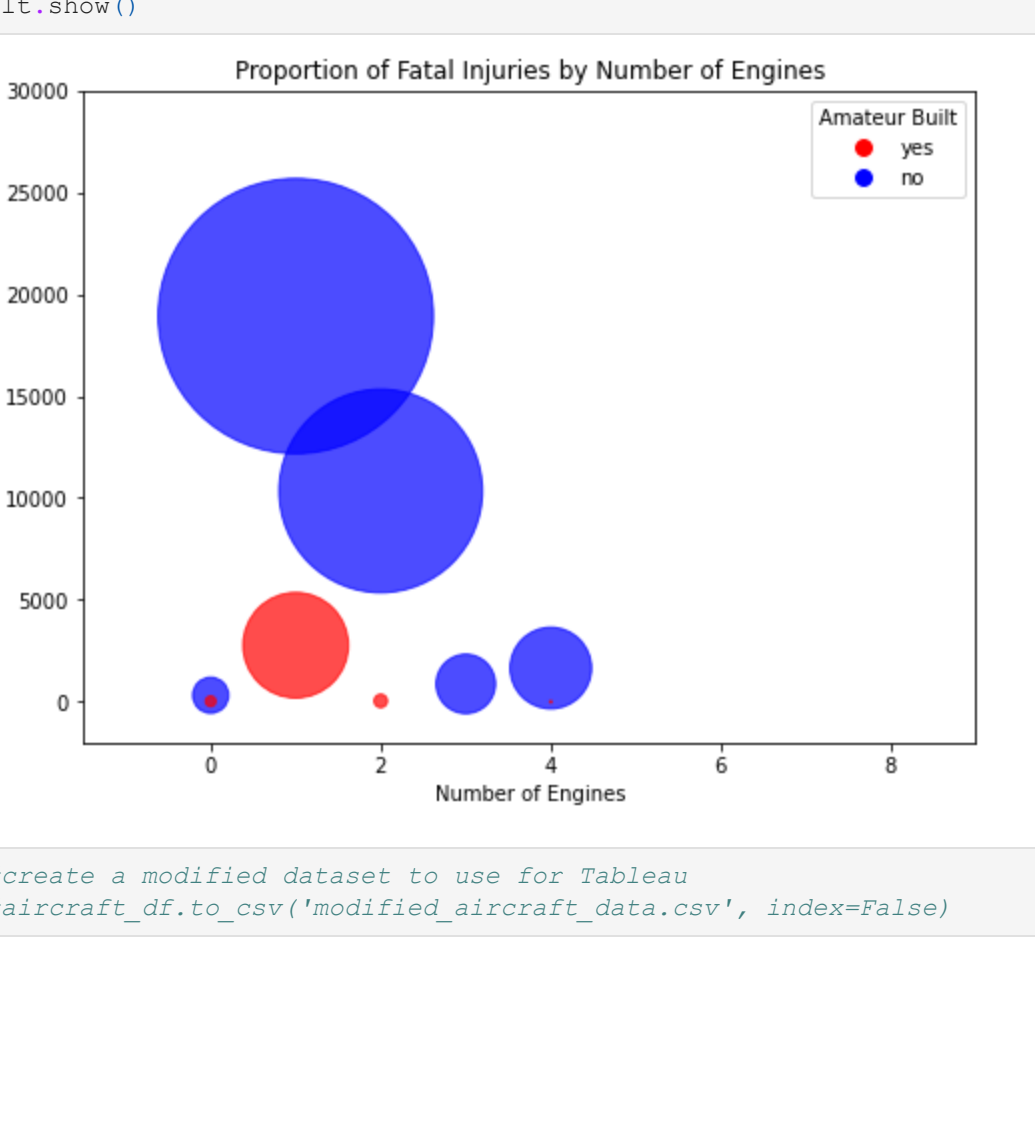
```
#create a dataframe with the columns Number_of_Engines, Amateur_Built, Total_Fatal_In
engine_grouped_df = aircraft_df.groupby(['Number_of_Engines', 'Amateur_Built']).agg({
engine_grouped_df
```

Out[83]:

	Number_of_Engines	Amateur_Built	Total_Fatal_Injuries	Total_Uninjured
0	0.0	No	321.0	2372.0
1	0.0	Yes	27.0	11.0
2	1.0	No	18922.0	67739.0
3	1.0	Yes	2775.0	4653.0
4	2.0	No	10344.0	194599.0
5	2.0	Yes	44.0	489.0
6	3.0	No	878.0	51245.0
7	3.0	Yes	0.0	137.0
8	4.0	No	1656.0	40876.0
9	4.0	Yes	1.0	17.0
10	6.0	No	0.0	0.0
11	8.0	No	0.0	0.0

In [84]:

```
#create a plot
plt.figure(figsize=(8, 6))

#create a scatter plot of fatal injuries by number of engines with matplotlib and col
plt.scatter(engine_grouped_df['Number_of_Engines'], engine_grouped_df['Total_Fatal_In

#customize the labels and title
plt.xlabel('Number of Engines')
plt.ylabel('Number of Fatal Injuries')
plt.title('Proportion of Fatal Injuries by Number of Engines')

#customize the xlim and ylim
plt.xlim(-1.5, engine_grouped_df['Number_of_Engines'].max() + 1)
plt.ylim(-2000, 30000)

#customize the legend
legend_elements = [plt.Line2D([0], [0], marker='o', color='w', label='yes', markerface

#show the legend and plot
plt.legend(handles=legend_elements, title='Amateur Built')
plt.show()
```



In [85]:

```
#create a modified dataset to use for Tableau
#aircraft_df.to_csv('modified_aircraft_data.csv', index=False)
```