[(https://skills.network/?utm_medium=Exinfluencer&utm_source=Exinfluencer&utm_content=000026UJ&utm_term=1000SkillsNetwork-Channel-SkillsNetworkCoursesIBMDS0321ENSkillsNetwork26802033-2022-01-01)](https://skills.network/?utm_medium=Exinfluencer&utm_source=Exinfluencer&utm_content=000026UJ&utm_term=1000SkillsNetwork-Channel-SkillsNetworkCoursesIBMDS0321ENSkillsNetwork26802033-2022-01-01)

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Space X Falcon 9 First Stage Landing Prediction

Lab 2: Data wrangling

Estimated time needed: **60** minutes

In this lab, we will perform some Exploratory Data Analysis (EDA) to find some patterns in the data and determine what would be the label for training supervised models.

In the data set, there are several different cases where the booster did not land successfully. Sometimes a landing was attempted but failed due to an accident; for example, `True Ocean` means the mission outcome was successfully landed to a specific region of the ocean while `False Ocean` means the mission outcome was unsuccessfully landed to a specific region of the ocean. `True RTLS` means the mission outcome was successfully landed to a ground pad `False RTLS` means the mission outcome was unsuccessfully landed to a ground pad. `True ASDS` means the mission outcome was successfully landed on a drone ship `False ASDS` means the mission outcome was unsuccessfully landed on a drone ship.

In this lab we will mainly convert those outcomes into Training Labels with `1` means the booster successfully landed `0` means it was unsuccessful.

Falcon 9 first stage will land successfully

Several examples of an unsuccessful landing are shown here:

Objectives

- Perform Exploratory Data Analysis (EDA)
- Determine Training Labels

Import Libraries

In [1]:
```
import pandas as pd
import numpy as np
print("All libraries have been imported.")
```

```
All libraries have been imported.
```

Start Here

Data Analysis

In [2]:

```python
# Load the dataset from the first section (dataset_part_1.csv)
df = pd.read_csv("https://cf-courses-data.s3.us.cloud-object-storage.appdo
df.head(10)
```

Out[2]:

	FlightNumber	Date	BoosterVersion	PayloadMass	Orbit	LaunchSite	Outcome	Flights
0	1	2010-06-04	Falcon 9	6104.959412	LEO	CCAFS SLC 40	None None	1
1	2	2012-05-22	Falcon 9	525.000000	LEO	CCAFS SLC 40	None None	1
2	3	2013-03-01	Falcon 9	677.000000	ISS	CCAFS SLC 40	None None	1
3	4	2013-09-29	Falcon 9	500.000000	PO	VAFB SLC 4E	False Ocean	1
4	5	2013-12-03	Falcon 9	3170.000000	GTO	CCAFS SLC 40	None None	1
5	6	2014-01-06	Falcon 9	3325.000000	GTO	CCAFS SLC 40	None None	1
6	7	2014-04-18	Falcon 9	2296.000000	ISS	CCAFS SLC 40	True Ocean	1
7	8	2014-07-14	Falcon 9	1316.000000	LEO	CCAFS SLC 40	True Ocean	1
8	9	2014-08-05	Falcon 9	4535.000000	GTO	CCAFS SLC 40	None None	1
9	10	2014-09-07	Falcon 9	4428.000000	GTO	CCAFS SLC 40	None None	1

In [3]:
```
# Identify and calculate the percentage of the missing values in each attr
df.isnull().sum()/df.count()*100
```

Out[3]:
```
FlightNumber       0.000
Date               0.000
BoosterVersion     0.000
PayloadMass        0.000
Orbit              0.000
LaunchSite         0.000
Outcome            0.000
Flights            0.000
GridFins           0.000
Reused             0.000
Legs               0.000
LandingPad        40.625
Block              0.000
ReusedCount        0.000
Serial             0.000
Longitude          0.000
Latitude           0.000
dtype: float64
```

In [4]:
```
# Identify which columns are numerical and categorical
df.dtypes
```

Out[4]:
```
FlightNumber        int64
Date               object
BoosterVersion     object
PayloadMass       float64
Orbit              object
LaunchSite         object
Outcome            object
Flights             int64
GridFins             bool
Reused               bool
Legs                 bool
LandingPad         object
Block             float64
ReusedCount         int64
Serial             object
Longitude         float64
Latitude          float64
dtype: object
```

Task
1

TASK 1: Calculate the number of launches on each site

The data contains several Space X launch facilities: Cape Canaveral Space (https://en.wikipedia.org/wiki/List_of_Cape_Canaveral_and_Merritt_Island_launch_sites?utm_medium=Exinfluencer&utm_source=Exinfluencer&utm_content=000026UJ&utm_term=1000 SkillsNetwork-Channel-SkillsNetworkCoursesIBMDS0321ENSkillsNetwork26802033-2022-01-

01) Launch Complex 40 **VAFB SLC 4E** , Vandenberg Air Force Base Space Launch Complex 4E **(SLC-4E)**, Kennedy Space Center Launch Complex 39A **KSC LC 39A** .The location of each Launch Is placed in the column `LaunchSite`

Next, let's see the number of launches for each site.

Use the method `value_counts()` on the column `LaunchSite` to determine the number of launches on each site:

In [5]:
```
# Apply value_counts() on column LaunchSite to calculate the number of laun
df['LaunchSite'].value_counts()
```

Out[5]:
```
CCAFS SLC 40    55
KSC LC 39A      22
VAFB SLC 4E     13
Name: LaunchSite, dtype: int64
```

Common Orbit Types

- **LEO: Low Earth orbit** (LEO) is an Earth-centred orbit with an altitude of 2,000 km (1,200 mi) or less (approximately one-third of the radius of Earth),[1] or with at least 11.25 periods per day (an orbital period of 128 minutes or less) and an eccentricity less than 0.25.[2] Most of the manmade objects in outer space are in LEO [1] (https://en.wikipedia.org/wiki/Low_Earth_orbit?utm_medium=Exinfluencer&utm_source=Exinfluencer&utm_content=000026UJ&utm_term=1 SkillsNetwork-Channel-SkillsNetworkCoursesIBMDS0321ENSkillsNetwork26802033-2022-01-01).
- **VLEO: Very Low Earth Orbits** (VLEO) can be defined as the orbits with a mean altitude below 450 km. Operating in these orbits can provide a number of benefits to Earth observation spacecraft as the spacecraft operates closer to the observation[2] (https://www.researchgate.net/publication/271499606_Very_Low_Earth_Orbit_mission_conc utm_medium=Exinfluencer&utm_source=Exinfluencer&utm_content=000026UJ&utm_term=1 SkillsNetwork-Channel-SkillsNetworkCoursesIBMDS0321ENSkillsNetwork26802033-2022-01-01).
- **GTO A geosynchronous orbit** is a high Earth orbit that allows satellites to match Earth's rotation. Located at 22,236 miles (35,786 kilometers) above Earth's equator, this position is a valuable spot for monitoring weather, communications and surveillance. Because the satellite orbits at the same speed that the Earth is turning, the satellite seems to stay in place over a single longitude, though it may drift north to south," NASA wrote on its Earth Observatory website [3] (https://www.space.com/29222-geosynchronous-orbit.html?utm_medium=Exinfluencer&utm_source=Exinfluencer&utm_content=000026UJ&utm_term=1 SkillsNetwork-Channel-SkillsNetworkCoursesIBMDS0321ENSkillsNetwork26802033-2022-01-01).
- **SSO (or SO): It is a Sun-synchronous orbit** also called a heliosynchronous orbit is a nearly polar orbit around a planet, in which the satellite passes over any given point of the planet's surface at the same local mean solar time [4] (https://en.wikipedia.org/wiki/Sun-synchronous_orbit?

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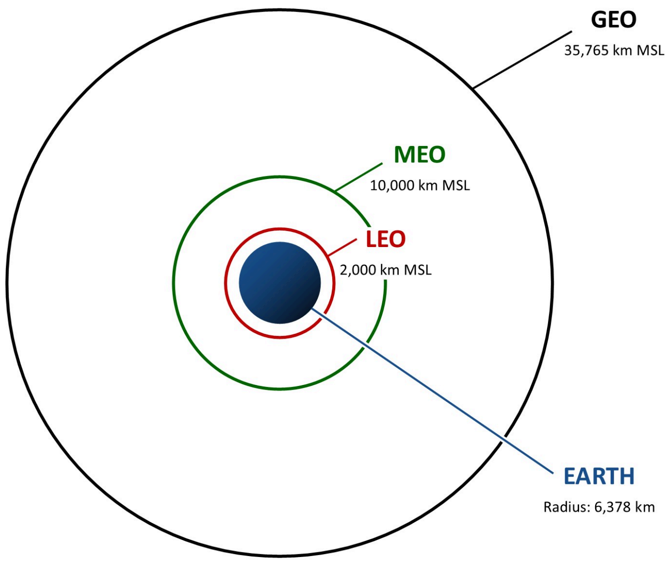
SkillsNetwork-Channel-SkillsNetworkCoursesIBMDS0321ENSkillsNetwork26802033-2022-01-01).

- **ES-L1 :** At the Lagrange points the gravitational forces of the two large bodies cancel out in such a way that a small object placed in orbit there is in equilibrium relative to the center of mass of the large bodies. L1 is one such point between the sun and the earth [5] (https://en.wikipedia.org/wiki/Lagrange_point?utm_medium=Exinfluencer&utm_source=Exinfluencer&utm_content=000026UJ&utm_term=1 SkillsNetwork-Channel-SkillsNetworkCoursesIBMDS0321ENSkillsNetwork26802033-2022-01-01#L1_point) .
- **HEO A highly elliptical orbit**, is an elliptic orbit with high eccentricity, usually referring to one around Earth [6] (https://en.wikipedia.org/wiki/Highly_elliptical_orbit?utm_medium=Exinfluencer&utm_source=Exinfluencer&utm_content=000026UJ&utm_term=1 SkillsNetwork-Channel-SkillsNetworkCoursesIBMDS0321ENSkillsNetwork26802033-2022-01-01).
- **ISS The International Space Station:** A modular space station (habitable artificial satellite) in low Earth orbit. It is a multinational collaborative project between five participating space agencies: NASA (United States), Roscosmos (Russia), JAXA (Japan), ESA (Europe), and CSA (Canada) [7] (https://en.wikipedia.org/wiki/International_Space_Station?utm_medium=Exinfluencer&utm_source=Exinfluencer&utm_content=000026UJ&utm_term=1 SkillsNetwork-Channel-SkillsNetworkCoursesIBMDS0321ENSkillsNetwork26802033-2022-01-01)
- **MEO Geocentric orbits** ranging in altitude from 2,000 km (1,200 mi) to just below geosynchronous orbit at 35,786 kilometers (22,236 mi). Also known as an intermediate circular orbit. These are "most commonly at 20,200 kilometers (12,600 mi), or 20,650 kilometers (12,830 mi), with an orbital period of 12 hours [8] (https://en.wikipedia.org/wiki/List_of_orbits?utm_medium=Exinfluencer&utm_source=Exinfluencer&utm_content=000026UJ&utm_term=1 SkillsNetwork-Channel-SkillsNetworkCoursesIBMDS0321ENSkillsNetwork26802033-2022-01-01)
- **HEO Geocentric orbits** above the altitude of geosynchronous orbit (35,786 km or 22,236 mi) [9] (https://en.wikipedia.org/wiki/List_of_orbits?utm_medium=Exinfluencer&utm_source=Exinfluencer&utm_content=000026UJ&utm_term=1 SkillsNetwork-Channel-SkillsNetworkCoursesIBMDS0321ENSkillsNetwork26802033-2022-01-01)
- **GEO It is a circular geosynchronous orbit** 35,786 kilometres (22,236 miles) above Earth's equator and following the direction of Earth's rotation [10] (https://en.wikipedia.org/wiki/Geostationary_orbit?utm_medium=Exinfluencer&utm_source=Exinfluencer&utm_content=000026UJ&utm_term=1 SkillsNetwork-Channel-SkillsNetworkCoursesIBMDS0321ENSkillsNetwork26802033-2022-01-01)
- **PO Polar Orbit:** It is one type of satellites in which a satellite passes above or nearly above both poles of the body being orbited (usually a planet such as the Earth [11] (https://en.wikipedia.org/wiki/Polar_orbit?utm_medium=Exinfluencer&utm_source=Exinfluencer&utm_content=000026UJ&utm_term=1 SkillsNetwork-Channel-SkillsNetworkCoursesIBMDS0321ENSkillsNetwork26802033-2022-01-01)



Task 2

TASK 2: Calculate the number and occurrence of each orbit

Use the method `.value_counts()` to determine the number and occurrence of each orbit in the column `Orbit`

In [6]:
```
# Determine the identity and quantity of the orbit types in the DataFrame.
df['Orbit'].value_counts()
```

Out[6]:
```
GTO      27
ISS      21
VLEO     14
PO        9
LEO       7
SSO       5
MEO       3
ES-L1     1
HEO       1
SO        1
GEO       1
Name: Orbit, dtype: int64
```

Task
3

TASK 3: Calculate the number and occurence of mission outcome

Use the method `.value_counts()` on the column `Outcome` to determine the number of `landing_outcomes` .Then assign it to a variable landing_outcomes.

In [7]:
```
# Set landing_outcomes = values on Outcome column
landing_outcomes = df['Outcome'].value_counts()
landing_outcomes
```

Out[7]:
```
True ASDS      41
None None      19
True RTLS      14
False ASDS      6
True Ocean      5
False Ocean     2
None ASDS       2
False RTLS      1
Name: Outcome, dtype: int64
```

`True Ocean` means the mission outcome was successfully landed to a specific region of the ocean while `False Ocean` means the mission outcome was unsuccessfully landed to a specific region of the ocean. `True RTLS` means the mission outcome was successfully landed to a ground pad `False RTLS` means the mission outcome was unsuccessfully landed to a ground pad. `True ASDS` means the mission outcome was successfully landed to a drone ship `False ASDS` means the mission outcome was unsuccessfully landed to a drone ship. `None ASDS` and `None None` these represent a failure to land.

In [8]:
```
# View the landing outcome types.
for count,i in enumerate(landing_outcomes.keys()):
    print(count,i)
```

```
0 True ASDS
1 None None
2 True RTLS
3 False ASDS
4 True Ocean
5 False Ocean
6 None ASDS
7 False RTLS
```

We create a set of outcomes where the first stage did not land successfully:

In [9]:
```python
# Create a set of the outcome types where the first stage landing was not s
bad_outcomes = set(landing_outcomes.keys()[[1,3,5,6,7]])
bad_outcomes
```

Out[9]: {'False ASDS', 'False Ocean', 'False RTLS', 'None ASDS', 'None None'}

Task
4

TASK 4: Create a landing outcome label from Outcome column

Using the `Outcome` , create a list where the element is zero if the corresponding row in `Outcome` is in the set `bad_outcome` ; otherwise, it's one. Then assign it to the variable `landing_class` :

In [10]:
```python
# Create list 'landing_class' with [landing_class = 0] if 'Outcome' is in s
landing_class = []
for i in df['Outcome']:
    if i in bad_outcomes:
        landing_class.append(0)
        print(0,'BAD',i)
    else:
        landing_class.append(1)
        print(1,'GOOD >>>>>>>>>>>',i)
landing_class
```

```
0 BAD None None
0 BAD None None
0 BAD None None
0 BAD False Ocean
0 BAD None None
0 BAD None None
1 GOOD >>>>>>>>>>> True Ocean
1 GOOD >>>>>>>>>>> True Ocean
0 BAD None None
0 BAD None None
0 BAD False Ocean
0 BAD False ASDS
1 GOOD >>>>>>>>>>> True Ocean
0 BAD False ASDS
0 BAD None None
0 BAD None ASDS
1 GOOD >>>>>>>>>>> True RTLS
0 BAD False ASDS
0 BAD False ASDS
```

In [11]:
```python
# Use the list 'landing_class' to create a new column in the DataFrame repr
# 0 = first stage did not land sucessfully
# 1 = first stage did land sucessfully
df['Class'] = landing_class
df[['Class']].head(8)
```

Out[11]:

	Class
0	0
1	0
2	0
3	0
4	0
5	0
6	1
7	1

In [12]:
```python
# View DataFrame
df.head(5)
```

Out[12]:

	FlightNumber	Date	BoosterVersion	PayloadMass	Orbit	LaunchSite	Outcome	Flights
0	1	2010-06-04	Falcon 9	6104.959412	LEO	CCAFS SLC 40	None None	1
1	2	2012-05-22	Falcon 9	525.000000	LEO	CCAFS SLC 40	None None	1
2	3	2013-03-01	Falcon 9	677.000000	ISS	CCAFS SLC 40	None None	1
3	4	2013-09-29	Falcon 9	500.000000	PO	VAFB SLC 4E	False Ocean	1
4	5	2013-12-03	Falcon 9	3170.000000	GTO	CCAFS SLC 40	None None	1

We can use the following line of code to determine the success rate:

In [13]:
```python
# Calculate the success rate of the Falcon 9 first stage landings.
df["Class"].mean()
```

Out[13]: 0.6666666666666666

Export DataFrame to .CSV

> **Note**
> dataset_part_2.csv

In [14]:

```python
# Export DataFrame as .csv
df.to_csv("dataset_part_2.csv", index=False)
```

End Here