Installing and importing packages

In [1]:
```
pip install requests beautifulsoup4 matplotlib pandas numpy sns
```

```
Requirement already satisfied: requests in c:\users\wikto\anaconda3\lib\site-packages (2.25.1)
Requirement already satisfied: beautifulsoup4 in c:\users\wikto\anaconda3\lib\site-packages (4.9.3)
Requirement already satisfied: matplotlib in c:\users\wikto\anaconda3\lib\site-packages (3.3.4)
Requirement already satisfied: pandas in c:\users\wikto\anaconda3\lib\site-packages (1.2.4)
Requirement already satisfied: numpy in c:\users\wikto\anaconda3\lib\site-packages (1.20.1)
Requirement already satisfied: sns in c:\users\wikto\anaconda3\lib\site-packages (0.1)
Requirement already satisfied: soupsieve>1.2 in c:\users\wikto\anaconda3\lib\site-packages (from beautifulsoup4) (2.2.1)
Requirement already satisfied: kiwisolver>=1.0.1 in c:\users\wikto\anaconda3\lib\site-packages (from matplotlib) (1.3.1)
Requirement already satisfied: pillow>=6.2.0 in c:\users\wikto\anaconda3\lib\site-packages (from matplotlib) (8.2.0)
Requirement already satisfied: python-dateutil>=2.1 in c:\users\wikto\anaconda3\lib\site-packages (from matplotlib) (2.8.1)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.3 in c:\users\wikto\anaconda3\lib\site-packages (from matp
lotlib) (2.4.7)
Requirement already satisfied: cycler>=0.10 in c:\users\wikto\anaconda3\lib\site-packages (from matplotlib) (0.10.0)
Requirement already satisfied: six in c:\users\wikto\anaconda3\lib\site-packages (from cycler>=0.10->matplotlib) (1.15.0)
Requirement already satisfied: pytz>=2017.3 in c:\users\wikto\anaconda3\lib\site-packages (from pandas) (2021.1)
Requirement already satisfied: chardet<5,>=3.0.2 in c:\users\wikto\anaconda3\lib\site-packages (from requests) (4.0.0)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in c:\users\wikto\anaconda3\lib\site-packages (from requests) (1.26.4)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\wikto\anaconda3\lib\site-packages (from requests) (2020.12.5)
Requirement already satisfied: idna<3,>=2.5 in c:\users\wikto\anaconda3\lib\site-packages (from requests) (2.10)
Note: you may need to restart the kernel to use updated packages.
```

In [2]:
```python
import requests
from bs4 import BeautifulSoup
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

Creating a scraping function

In [3]:
```python
#creating a function which looks for tables on the website and scrapes them
def scraping_function(table_url): #defining the function
    results_response = requests.get(table_url) #sending the get request to the specific url under which table is located
    results_soup = BeautifulSoup(results_response.text, 'html.parser') #creating an object in the BeautifulSoup library which con

    race_tables = [] #creating an empty dataframe

    for table in results_soup.find_all('table'): #looking for tables on the website
        table_name = table.find_previous('h2').text.strip() #stripping table text which is located under the subheading
        race_scraped = pd.read_html(str(table))[0] #saving the scraped table as a variable
        race_tables.append(race_scraped) #appending the scraped table to the empty dataframe created previously
    final_df = pd.concat(race_tables, ignore_index = True) #creating final dataframe with the scraped table

    return final_df
```

Scraping the necessary datasets

Scraping races data

In [4]:

```
races = scraping_function('https://www.formula1.com/en/results.html/2023/races.html')#applying the scraping function created abov
races
```

Out[4]:

	Unnamed: 0	Grand Prix	Date	Winner	Car	Laps	Time	Unnamed: 7
0	NaN	Bahrain	05 Mar 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	57	1:33:56.736	NaN
1	NaN	Saudi Arabia	19 Mar 2023	Sergio Perez PER	Red Bull Racing Honda RBPT	50	1:21:14.894	NaN
2	NaN	Australia	02 Apr 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	58	2:32:38.371	NaN
3	NaN	Azerbaijan	30 Apr 2023	Sergio Perez PER	Red Bull Racing Honda RBPT	51	1:32:42.436	NaN
4	NaN	Miami	07 May 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	57	1:27:38.241	NaN
5	NaN	Monaco	28 May 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	78	1:48:51.980	NaN
6	NaN	Spain	04 Jun 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	66	1:27:57.940	NaN
7	NaN	Canada	18 Jun 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	70	1:33:58.348	NaN
8	NaN	Austria	02 Jul 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	71	1:25:33.607	NaN
9	NaN	Great Britain	09 Jul 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	52	1:25:16.938	NaN
10	NaN	Hungary	23 Jul 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	70	1:38:08.634	NaN
11	NaN	Belgium	30 Jul 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	44	1:22:30.450	NaN
12	NaN	Netherlands	27 Aug 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	72	2:24:04.411	NaN
13	NaN	Italy	03 Sep 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	51	1:13:41.143	NaN
14	NaN	Singapore	17 Sep 2023	Carlos Sainz SAI	Ferrari	62	1:46:37.418	NaN
15	NaN	Japan	24 Sep 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	53	1:30:58.421	NaN
16	NaN	Qatar	08 Oct 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	57	1:27:39.168	NaN
17	NaN	United States	22 Oct 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	56	1:35:21.362	NaN
18	NaN	Mexico	29 Oct 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	71	2:02:30.814	NaN
19	NaN	Brazil	05 Nov 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	71	1:56:48.894	NaN
20	NaN	Las Vegas	18 Nov 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	50	1:29:08.289	NaN
21	NaN	Abu Dhabi	26 Nov 2023	Max Verstappen VER	Red Bull Racing Honda RBPT	58	1:27:02.624	NaN

Scraping race results for individual races

In [6]:

```
Bahrain = scraping_function('https://www.formula1.com/en/results.html/2023/races/1141/bahrain/race-result.html')
Saudi_arabia = scraping_function('https://www.formula1.com/en/results.html/2023/races/1142/saudi-arabia/race-result.html')
Australia = scraping_function('https://www.formula1.com/en/results.html/2023/races/1143/australia/race-result.html')
Azerbaijan = scraping_function('https://www.formula1.com/en/results.html/2023/races/1207/azerbaijan/race-result.html')
Miami = scraping_function('https://www.formula1.com/en/results.html/2023/races/1208/miami/race-result.html')
#note: the Emili_romagna race was cancelled hence there is no data to scrape hence it is not included here
Monaco = scraping_function('https://www.formula1.com/en/results.html/2023/races/1210/monaco/race-result.html')
Spain = scraping_function('https://www.formula1.com/en/results.html/2023/races/1211/spain/race-result.html')
Canada = scraping_function('https://www.formula1.com/en/results.html/2023/races/1212/canada/race-result.html')
Austria = scraping_function('https://www.formula1.com/en/results.html/2023/races/1213/austria/race-result.html')
Great_britain = scraping_function('https://www.formula1.com/en/results.html/2023/races/1214/great-britain/race-result.html')
Hungary = scraping_function('https://www.formula1.com/en/results.html/2023/races/1215/hungary/race-result.html')
Belgium = scraping_function('https://www.formula1.com/en/results.html/2023/races/1216/belgium/race-result.html')
Netherlands = scraping_function('https://www.formula1.com/en/results.html/2023/races/1217/netherlands/race-result.html')
Italy = scraping_function('https://www.formula1.com/en/results.html/2023/races/1218/italy/race-result.html')
Singapore = scraping_function('https://www.formula1.com/en/results.html/2023/races/1219/singapore/race-result.html')
Japan = scraping_function('https://www.formula1.com/en/results.html/2023/races/1220/japan/race-result.html')
Qatar = scraping_function('https://www.formula1.com/en/results.html/2023/races/1221/qatar/race-result.html')
US = scraping_function('https://www.formula1.com/en/results.html/2023/races/1222/united-states/race-result.html')
Mexico = scraping_function('https://www.formula1.com/en/results.html/2023/races/1223/mexico/race-result.html')
Brazil = scraping_function('https://www.formula1.com/en/results.html/2023/races/1224/brazil/race-result.html')
Las_vegas = scraping_function('https://www.formula1.com/en/results.html/2023/races/1225/las-vegas/race-result.html')
Abu_dhabi = scraping_function('https://www.formula1.com/en/results.html/2023/races/1226/abu-dhabi/race-result.html')
```

Scraping qualifiers data

In [7]:

```
Bahrain_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1141/bahrain/qualifying.html')
Saudi_arabia_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1142/saudi-arabia/qualifying.html')
Australia_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1143/australia/qualifying.html')
Azerbaijan_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1207/azerbaijan/qualifying.html')
Miami_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1208/miami/qualifying.html')
Monaco_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1210/monaco/qualifying.html')
Spain_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1211/spain/qualifying.html')
Canada_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1212/canada/qualifying.html')
Austria_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1213/austria/qualifying.html')
Great_britain_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1214/great-britain/qualifying.html')
Hungary_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1215/hungary/qualifying.html')
Belgium_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1216/belgium/qualifying.html')
Netherlands_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1217/netherlands/qualifying.html')
Italy_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1218/italy/qualifying.html')
Singapore_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1219/singapore/qualifying.html')
Japan_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1220/japan/qualifying.html')
Qatar_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1221/qatar/qualifying.html')
US_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1222/united-states/qualifying.html')
Mexico_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1223/mexico/qualifying.html')
Brazil_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1224/brazil/qualifying.html')
Las_vegas_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1225/las-vegas/qualifying.html')
Abu_dhabi_qual = scraping_function('https://www.formula1.com/en/results.html/2023/races/1226/abu-dhabi/qualifying.html')
```

In [8]:

```
#rename 'Pos' column for qualifying dataset to PosQ to distniguish between qualifying and race positions in the final dataset I a
qual_data = [Bahrain_qual, Saudi_arabia_qual, Australia_qual, Azerbaijan_qual, Miami_qual,
             Monaco_qual, Spain_qual, Canada_qual, Austria_qual, Great_britain_qual, Hungary_qual,
             Belgium_qual, Netherlands_qual, Italy_qual, Singapore_qual, Japan_qual, Qatar_qual,
             US_qual, Mexico_qual, Brazil_qual, Las_vegas_qual, Abu_dhabi_qual]

for df in qual_data:
    df.rename(columns={'Pos': 'PosQ'}, inplace=True) #rename Pos to PosQ to idenitfy qualifying positions
```

In [9]:

```
#Merging final results and qualifiers datasets for each race
Bahrain = pd.merge(Bahrain, Bahrain_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Saudi_arabia = pd.merge(Saudi_arabia, Saudi_arabia_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Australia = pd.merge(Australia, Australia_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Azerbaijan = pd.merge(Azerbaijan, Azerbaijan_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Miami = pd.merge(Miami, Miami_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Monaco = pd.merge(Monaco, Monaco_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Spain = pd.merge(Spain, Spain_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Canada = pd.merge(Canada, Canada_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Austria = pd.merge(Austria, Austria_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Great_britain = pd.merge(Great_britain, Great_britain_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Hungary_qual = pd.merge(Hungary, Hungary_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Belgium = pd.merge(Belgium, Belgium_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Netherlands = pd.merge(Netherlands, Netherlands_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Italy = pd.merge(Italy, Italy_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Singapore = pd.merge(Singapore, Singapore_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Japan = pd.merge(Japan, Japan_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Qatar_qual = pd.merge(Qatar, Qatar_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
US = pd.merge(US, US_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Mexico = pd.merge(Mexico, Mexico_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Brazil = pd.merge(Brazil, Brazil_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Las_vegas = pd.merge(Las_vegas, Las_vegas_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
Abu_dhabi = pd.merge(Abu_dhabi, Abu_dhabi_qual[['Driver', 'PosQ', 'Q1', 'Q2', 'Q3']], on = 'Driver',
                   how = 'inner')
```

Scraping pit stop data for each race

In [10]:

```
Bahrain_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1141/bahrain/pit-stop-summary.html')
Saudi_arabia_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1142/saudi-arabia/pit-stop-summary.html
Australia_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1143/australia/pit-stop-summary.html')
Azerbaijan_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1207/azerbaijan/pit-stop-summary.html')
Miami_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1208/miami/pit-stop-summary.html')
Monaco_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1210/monaco/pit-stop-summary.html')
Spain_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1211/spain/pit-stop-summary.html')
Canada_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1212/canada/pit-stop-summary.html')
Austria_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1213/austria/pit-stop-summary.html')
Great_britain_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1214/great-britain/pit-stop-summary.ht
Hungary_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1215/hungary/pit-stop-summary.html')
Belgium_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1216/belgium/pit-stop-summary.html')
Netherlands_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1217/netherlands/pit-stop-summary.html')
Italy_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1218/italy/pit-stop-summary.html')
Singapore_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1219/singapore/pit-stop-summary.html')
Japan_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1220/japan/pit-stop-summary.html')
Qatar_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1221/qatar/pit-stop-summary.html')
US_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1222/united-states/pit-stop-summary.html')
Mexico_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1223/mexico/pit-stop-summary.html')
Brazil_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1224/brazil/pit-stop-summary.html')
Las_vegas_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1225/las-vegas/pit-stop-summary.html')
Abu_dhabi_pit = scraping_function('https://www.formula1.com/en/results.html/2023/races/1226/abu-dhabi/pit-stop-summary.html')
```

Data Cleaning

Firstly I am adding identifier columns to all the dataframes so that I can join them up together

In [11]:

```
races['RaceID'] = races.reset_index().index #adding identifier column to the races dataset
races = races[['RaceID','Date', 'Grand Prix']] #reducing dataframe to  the columns needed for the analysis
races.loc[:,'Date'] = pd.to_datetime(races['Date'], format='%d %b %Y') #converting date column to date format
races
```

```
C:\Users\wikto\anaconda3\lib\site-packages\pandas\core\indexing.py:1676: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-ver
sus-a-copy (https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy)
  self._setitem_single_column(ilocs[0], value, pi)
```

Out[11]:

	RaceID	Date	Grand Prix
0	0	2023-03-05	Bahrain
1	1	2023-03-19	Saudi Arabia
2	2	2023-04-02	Australia
3	3	2023-04-30	Azerbaijan
4	4	2023-05-07	Miami
5	5	2023-05-28	Monaco
6	6	2023-06-04	Spain
7	7	2023-06-18	Canada
8	8	2023-07-02	Austria
9	9	2023-07-09	Great Britain
10	10	2023-07-23	Hungary
11	11	2023-07-30	Belgium
12	12	2023-08-27	Netherlands
13	13	2023-09-03	Italy
14	14	2023-09-17	Singapore
15	15	2023-09-24	Japan
16	16	2023-10-08	Qatar
17	17	2023-10-22	United States
18	18	2023-10-29	Mexico
19	19	2023-11-05	Brazil
20	20	2023-11-18	Las Vegas
21	21	2023-11-26	Abu Dhabi

In [12]:

```
#Adding identifier columns to individual races datasets
Bahrain['RaceID'] = '0'
Saudi_arabia['RaceID'] = '1'
Australia['RaceID'] = '2'
Azerbaijan['RaceID'] = '3'
Miami['RaceID'] = '4'
Monaco['RaceID'] = '5'
Spain['RaceID'] = '6'
Canada['RaceID'] = '7'
Austria['RaceID'] = '8'
Great_britain['RaceID'] = '9'
Hungary['RaceID'] = '10'
Belgium['RaceID'] = '11'
Netherlands['RaceID'] = '12'
Italy['RaceID'] = '13'
Singapore['RaceID'] = '14'
Japan['RaceID'] = '15'
Qatar['RaceID'] = '16'
US['RaceID'] = '17'
Mexico['RaceID'] = '18'
Brazil['RaceID'] = '19'
Las_vegas['RaceID'] = '20'
Abu_dhabi['RaceID'] = '21'
```

Merging race dataframes to create the final dataframe

In [13]:

```
races_dataframes = [Bahrain, Saudi_arabia, Australia, Azerbaijan, Miami, Monaco, Spain, Canada, Austria, Great_britain,
                    Hungary, Belgium, Netherlands, Italy, Singapore, Japan, Qatar, US, Mexico, Brazil, Las_vegas, Abu_dhabi]
races_dataframes = pd.concat(races_dataframes, ignore_index=True) #joining up the races vertically
races_dataframes['RaceID'] = races_dataframes['RaceID'].astype(int) #converting the RaceID column from 'object' type to integer t
F1_full = pd.merge(races_dataframes, races, on ='RaceID', how='left') #merging Races and Results dataframes
F1_full = F1_full[['RaceID', 'Date', 'Grand Prix', 'Driver', 'Car', 'Pos','PTS', 'Laps', 'PosQ', 'Q1', 'Q2', 'Q3']] #reducing dat
```

In [14]:

```
#checking that all races have been merged together
F1_full['Grand Prix'].unique()
```

Out[14]:

```
array(['Bahrain', 'Saudi Arabia', 'Australia', 'Azerbaijan', 'Miami',
       'Monaco', 'Spain', 'Canada', 'Austria', 'Great Britain', 'Hungary',
       'Belgium', 'Netherlands', 'Italy', 'Singapore', 'Japan', 'Qatar',
       'United States', 'Mexico', 'Brazil', 'Las Vegas', 'Abu Dhabi'],
      dtype=object)
```

In [15]:

```
#Checking for duplicate observations
print(F1_full[F1_full.duplicated()])
```

```
Empty DataFrame
Columns: [RaceID, Date, Grand Prix, Driver, Car, Pos, PTS, Laps, PosQ, Q1, Q2, Q3]
Index: []
```

In [16]:

```
#Checking for missing values
F1_full.isnull().sum()
```

Out[16]:

```
RaceID          0
Date            0
Grand Prix      0
Driver          0
Car             0
Pos             0
PTS             0
Laps            0
PosQ           40
Q1             40
Q2            140
Q3            239
dtype: int64
```

Note: when checking for missing values we are only informed about the missing values in the qualifiers dataset but we know that there are observations under the 'Pos' column with values 'NC' which corresponds to not classified, and 'DQ' corresponding to disqualified. I therefore want to replace these with NaN values so that I can perform calculations on the 'Pos' column. I am keeping these in the final dataframe as these are real observations where drivers simply did not finish the race or did not qualify for the next round of qualifiers but we can still derive important insights from other columns corresponding to these observations

In [17]:

```
#replacing NC, DQ, and DNF values in 'Pos' column with 'Nan'
F1_full.replace('NC', np.nan, inplace=True)
F1_full.replace('DQ', np.nan, inplace=True)
F1_full.replace('DNF', np.nan, inplace=True)
F1_full.isnull().sum() #now we can clearly see the missing values in 'Pos' column corresponding to unclassified drivers
```

Out[17]:

```
RaceID          0
Date            0
Grand Prix      0
Driver          0
Car             0
Pos            51
PTS             0
Laps            0
PosQ           47
Q1             44
Q2            143
Q3            243
dtype: int64
```

Working with datatypes

In [18]:

```
#checking column datatypes
print(F1_full.dtypes)
```

```
RaceID                 int32
Date          datetime64[ns]
Grand Prix            object
Driver                object
Car                   object
Pos                   object
PTS                    int64
Laps                   int64
PosQ                  object
Q1                    object
Q2                    object
Q3                    object
dtype: object
```

In [19]:

```
#converting Pos and PosQ columns to integer datatype to allow us to perform calculations on this column
F1_full['Pos'] = pd.to_numeric(F1_full['Pos'])
F1_full['PosQ'] = pd.to_numeric(F1_full['PosQ'])
print(F1_full.dtypes)
```

```
RaceID                 int32
Date          datetime64[ns]
Grand Prix            object
Driver                object
Car                   object
Pos                  float64
PTS                    int64
Laps                   int64
PosQ                 float64
Q1                    object
Q2                    object
Q3                    object
dtype: object
```

Cleaning the pit stop dataset

In [20]:

```
#Adding identifier column to each pit stop dataframe
Bahrain_pit['RaceID'] = '0'
Saudi_arabia_pit['RaceID'] = '1'
Australia_pit['RaceID'] = '2'
Azerbaijan_pit['RaceID'] = '3'
Miami_pit['RaceID'] = '4'
Monaco_pit['RaceID'] = '5'
Spain_pit['RaceID'] = '6'
Canada_pit['RaceID'] = '7'
Austria_pit['RaceID'] = '8'
Great_britain_pit['RaceID'] = '9'
Hungary_pit['RaceID'] = '10'
Belgium_pit['RaceID'] = '11'
Netherlands_pit['RaceID'] = '12'
Italy_pit['RaceID'] = '13'
Singapore_pit['RaceID'] = '14'
Japan_pit['RaceID'] = '15'
Qatar_pit['RaceID'] = '16'
US_pit['RaceID'] = '17'
Mexico_pit['RaceID'] = '18'
Brazil_pit['RaceID'] = '19'
Las_vegas_pit['RaceID'] = '20'
Abu_dhabi_pit['RaceID'] = '21'
```

```
In [21]: #Combining all pit stop dataframes into 1 big dataframe
         pitstops = [Bahrain_pit, Saudi_arabia_pit,Australia_pit, Azerbaijan_pit, Miami_pit, Monaco_pit, Spain_pit, Canada_pit,
                              Austria_pit, Great_britain_pit, Hungary_pit, Belgium_pit, Netherlands_pit, Italy_pit, Singapore_pit,
                             Japan_pit, Qatar_pit, US_pit, Mexico_pit, Brazil_pit, Las_vegas_pit, Abu_dhabi_pit]
         F1_pit = pd.concat(pitstops) #joining up all pit stop dataframes vertically
```

```
In [22]: #modelling the dataset to keep only the columns necessary for analysis
         F1_pit = F1_pit [['RaceID', 'Driver', 'Car', 'Stops', 'Time', 'Total']]
```

```
In [23]: #renaming columns to make them clearer for my analysis
         F1_pit.rename(columns={'Stops': 'Pitstop_quantity', 'Time': 'Pit_time', 'Total': 'Total_Pit_time'}, inplace=True)
```

```
In [24]: #checking datatypes
         print(F1_pit.dtypes)
```

```
RaceID              object
Driver              object
Car                 object
Pitstop_quantity     int64
Pit_time            object
Total_Pit_time      object
dtype: object
```

```
In [25]: #modifying datatypes - important error to note
         F1_pit['Pit_time'] = pd.to_numeric(F1_pit['Pit_time'])
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
pandas\_libs\lib.pyx in pandas._libs.lib.maybe_convert_numeric()

ValueError: Unable to parse string "15:25.181"

During handling of the above exception, another exception occurred:

ValueError                                Traceback (most recent call last)
<ipython-input-25-b99c81bf6f09> in <module>
      1 #modifying datatypes - important error to note
----> 2 F1_pit['Pit_time'] = pd.to_numeric(F1_pit['Pit_time'])

~\anaconda3\lib\site-packages\pandas\core\tools\numeric.py in to_numeric(arg, errors, downcast)
    152         coerce_numeric = errors not in ("ignore", "raise")
    153         try:
--> 154             values = lib.maybe_convert_numeric(
    155                 values, set(), coerce_numeric=coerce_numeric
    156             )

pandas\_libs\lib.pyx in pandas._libs.lib.maybe_convert_numeric()

ValueError: Unable to parse string "15:25.181" at position 84
```

Note: the code above returns an error which gives us important information about the values in teh 'Pit_time' column. There are values in this column which cannot be turned into time format. Upon further investigation I found that Australia is the only race where this applies. Therefore I investigate the Australia dataframe further in the next step.

```
In [26]: F1_pit[F1_pit['RaceID'] == '2'] #investigating pit stop data for Austrialia race which is assigned to RaceID of 2
```

Out[26]:

	RaceID	Driver	Car	Pitstop_quantity	Pit_time	Total_Pit_time
0	2	Esteban Ocon OCO	Alpine Renault	1	18.056	18.056
1	2	Zhou Guanyu ZHO	Alfa Romeo Ferrari	1	18.951	18.951
2	2	Logan Sargeant SAR	Williams Mercedes	1	18.382	18.382
3	2	Sergio Perez PER	Red Bull Racing Honda RBPT	1	17.657	17.657
4	2	Valtteri Bottas BOT	Alfa Romeo Ferrari	1	21.659	21.659
...	...	...	...	...	...	...
60	2	Zhou Guanyu ZHO	Alfa Romeo Ferrari	5	31:04.998	61:25.244
61	2	Valtteri Bottas BOT	Alfa Romeo Ferrari	6	31:07.182	61:02.236
62	2	Sergio Perez PER	Red Bull Racing Honda RBPT	5	30:53.568	61:43.013
63	2	Fernando Alonso ALO	Aston Martin Aramco Mercedes	3	30:45.073	60:46.319
64	2	Lance Stroll STR	Aston Martin Aramco Mercedes	3	30:45.925	60:48.200

65 rows × 6 columns

Upon further investigating the Austrialia pit stop dataframe I found that there are observations where pit time is not the recorded pit stop duration but rather the time at which the pit stop occured which is not data we need. Therefore I proceed to use regular expressions to identify the observations with this type of input and drop them from the pit stop dataframe.

```
In [27]: #Fixing the error above by using regular expressions to match the values in the 'Pit_time' column which have a different pattern
         import re
         time_pattern = r'^\d{2}:\d{2}\.\d{3}$' #first string pattern to match
         F1_pit = F1_pit[~F1_pit['Pit_time'].astype(str).str.match(time_pattern)] #dropping the observations with matched string pattern
         time_pattern2 = r'^\d{1}:\d{2}\.\d{3}$' #second string patter match
         F1_pit = F1_pit[~F1_pit['Pit_time'].astype(str).str.match(time_pattern2)] #dropping observations wtih second string pattern
```

```
In [28]: F1_pit['Pit_time'] = pd.to_numeric(F1_pit['Pit_time']) #running the code to change the datatype again now that the anomalies have
```

```
In [29]: #Repeating the procedure above for the total__pit_time column
         F1_pit = F1_pit[~F1_pit['Total_Pit_time'].astype(str).str.match(time_pattern)]
         F1_pit = F1_pit[~F1_pit['Total_Pit_time'].astype(str).str.match(time_pattern2)]
         F1_pit['Total_Pit_time'] = pd.to_numeric(F1_pit['Total_Pit_time']) #running the code to change the datatype again now that the an
```

```
In [30]: F1_pit['RaceID'] = pd.to_numeric(F1_pit['RaceID']) #changing the raceID to numeric type to match the F1_full dataset raceID colum
```

```
In [31]: F1_pit.dtypes #checking datatypes to ensure all necessary columns have been converted
```

```
Out[31]: RaceID                int64
         Driver               object
         Car                  object
         Pitstop_quantity      int64
         Pit_time            float64
         Total_Pit_time      float64
         dtype: object
```

Merging F1_full (race results) and F1_pit (pit stops) dataframes into one big dataframe to allow me to analyse pit stop against different race variables

```
In [32]: F1_pit_full = pd.merge(F1_full, F1_pit, on = ['RaceID', 'Driver'], how = 'inner') #merging F1_full and F1_pit dataframes
         F1_pit_full = F1_pit_full[['RaceID', 'Date', 'Grand Prix', 'Driver', 'Car_x', 'Pos', 'PTS', 'Laps',
                                    'PosQ', 'Pitstop_quantity', 'Pit_time', 'Total_Pit_time' ]] #modelling the dataframes to the columns we
         F1_pit_full.rename(columns={'Car_x': 'Car'}, inplace=True) #renaming columns which were duplicated in both dataframes
```

```
In [33]: F1_pit_full #viewing the final pit stop dataframe
```

Out[33]:

	RaceID	Date	Grand Prix	Driver	Car	Pos	PTS	Laps	PosQ	Pitstop_quantity	Pit_time	Total_Pit_time
0	0	2023-03-05	Bahrain	Max Verstappen VER	Red Bull Racing Honda RBPT	1.0	25	57	1.0	1	24.289	24.289
1	0	2023-03-05	Bahrain	Max Verstappen VER	Red Bull Racing Honda RBPT	1.0	25	57	1.0	2	24.910	49.199
2	0	2023-03-05	Bahrain	Sergio Perez PER	Red Bull Racing Honda RBPT	2.0	18	57	2.0	1	24.264	24.264
3	0	2023-03-05	Bahrain	Sergio Perez PER	Red Bull Racing Honda RBPT	2.0	18	57	2.0	2	25.091	49.355
4	0	2023-03-05	Bahrain	Fernando Alonso ALO	Aston Martin Aramco Mercedes	3.0	15	57	5.0	1	25.800	25.800
...	...	...	...	...	...	...	...	...	...	...	...	...
629	21	2023-11-26	Abu Dhabi	Carlos Sainz SAI	Ferrari	18.0	0	57	16.0	1	21.229	21.229
630	21	2023-11-26	Abu Dhabi	Carlos Sainz SAI	Ferrari	18.0	0	57	16.0	2	21.564	42.793
631	21	2023-11-26	Abu Dhabi	Valtteri Bottas BOT	Alfa Romeo Ferrari	19.0	0	57	18.0	1	22.665	22.665
632	21	2023-11-26	Abu Dhabi	Kevin Magnussen MAG	Haas Ferrari	20.0	0	57	17.0	1	22.764	22.764
633	21	2023-11-26	Abu Dhabi	Kevin Magnussen MAG	Haas Ferrari	20.0	0	57	17.0	2	22.163	44.927

634 rows × 12 columns

Saving the dataframes to CSV files

Now we have 2 dataframes: 1. Full race results, 2. Full pit stop data

```
In [34]: #saving a local copy of the dataframes in CSV format
         F1_full.to_csv('F1_full_scraped.csv', index = False)
         F1_pit_full.to_csv('F1_pit_scraped.csv', index=False)
```

Creating Insights

Team Performance

In [35]:

```
#creating team leaderboard
F1_full.groupby('Car')['PTS'].sum().sort_values(ascending = False)
team_points = pd.DataFrame(data=F1_full.groupby('Car')['PTS'].sum().sort_values(ascending = False))
team_points
```

Out[35]:

	PTS
Car	
Red Bull Racing Honda RBPT	790
Mercedes	374
Ferrari	363
Aston Martin Aramco Mercedes	266
McLaren Mercedes	266
Alpine Renault	110
Williams Mercedes	26
AlphaTauri Honda RBPT	22
Alfa Romeo Ferrari	16
Haas Ferrari	9

In [36]:

```
F1_full['Car'].unique() #viewing all unique teams
```

Out[36]:

```
array(['Red Bull Racing Honda RBPT', 'Aston Martin Aramco Mercedes',
       'Ferrari', 'Mercedes', 'Alfa Romeo Ferrari', 'Alpine Renault',
       'Williams Mercedes', 'AlphaTauri Honda RBPT', 'Haas Ferrari',
       'McLaren Mercedes'], dtype=object)
```

In [37]:

```
#setting team colours
team_colours = {'Red Bull Racing Honda RBPT': '#FFCC00','Ferrari': '#DC0000',  'Mercedes' : '#00D2BE',
                'Aston Martin Aramco Mercedes' : '#006F62' , 'McLaren Mercedes' : '#FF8000','Alpine Renault' : '#FD4BC7',
                'AlphaTauri Honda RBPT' : '#00293F', 'Williams Mercedes' : '#00A3E0',
               'Haas Ferrari' : '#F9F2F2', 'Alfa Romeo Ferrari': '#900000'}
F1_full['Colours'] = F1_full['Car'].map(team_colours)
```

In [38]:

```
F1_full #checking that colours column has been added
```

Out[38]:

	RaceID	Date	Grand Prix	Driver	Car	Pos	PTS	Laps	PosQ	Q1	Q2	Q3	Colours
0	0	2023-03-05	Bahrain	Max Verstappen VER	Red Bull Racing Honda RBPT	1.0	25	57	1.0	1:31.295	1:30.503	1:29.708	#FFCC00
1	0	2023-03-05	Bahrain	Sergio Perez PER	Red Bull Racing Honda RBPT	2.0	18	57	2.0	1:31.479	1:30.746	1:29.846	#FFCC00
2	0	2023-03-05	Bahrain	Fernando Alonso ALO	Aston Martin Aramco Mercedes	3.0	15	57	5.0	1:31.158	1:30.645	1:30.336	#006F62
3	0	2023-03-05	Bahrain	Carlos Sainz SAI	Ferrari	4.0	12	57	4.0	1:30.993	1:30.515	1:30.154	#DC0000
4	0	2023-03-05	Bahrain	Lewis Hamilton HAM	Mercedes	5.0	10	57	7.0	1:31.543	1:30.513	1:30.384	#00D2BE
...	...	...	...	...	...	...	...	...	...	...	...	...	...
434	21	2023-11-26	Abu Dhabi	Logan Sargeant SAR	Williams Mercedes	16.0	0	58	NaN	NaN	NaN	NaN	#00A3E0
435	21	2023-11-26	Abu Dhabi	Zhou Guanyu ZHO	Alfa Romeo Ferrari	17.0	0	58	19.0	1:25.159	NaN	NaN	#900000
436	21	2023-11-26	Abu Dhabi	Carlos Sainz SAI	Ferrari	18.0	0	57	16.0	1:24.738	NaN	NaN	#DC0000
437	21	2023-11-26	Abu Dhabi	Valtteri Bottas BOT	Alfa Romeo Ferrari	19.0	0	57	18.0	1:24.788	NaN	NaN	#900000
438	21	2023-11-26	Abu Dhabi	Kevin Magnussen MAG	Haas Ferrari	20.0	0	57	17.0	1:24.764	NaN	NaN	#F9F2F2

439 rows × 13 columns

In [39]:

```
F1_date_sort = F1_full.sort_values(by = 'Date') #sorting full F1 dataset by date
F1_full['Cumulative_PTS'] = F1_date_sort.groupby('Car')['PTS'].cumsum() #creating column to hold cumulative values per car team
```

In [40]:

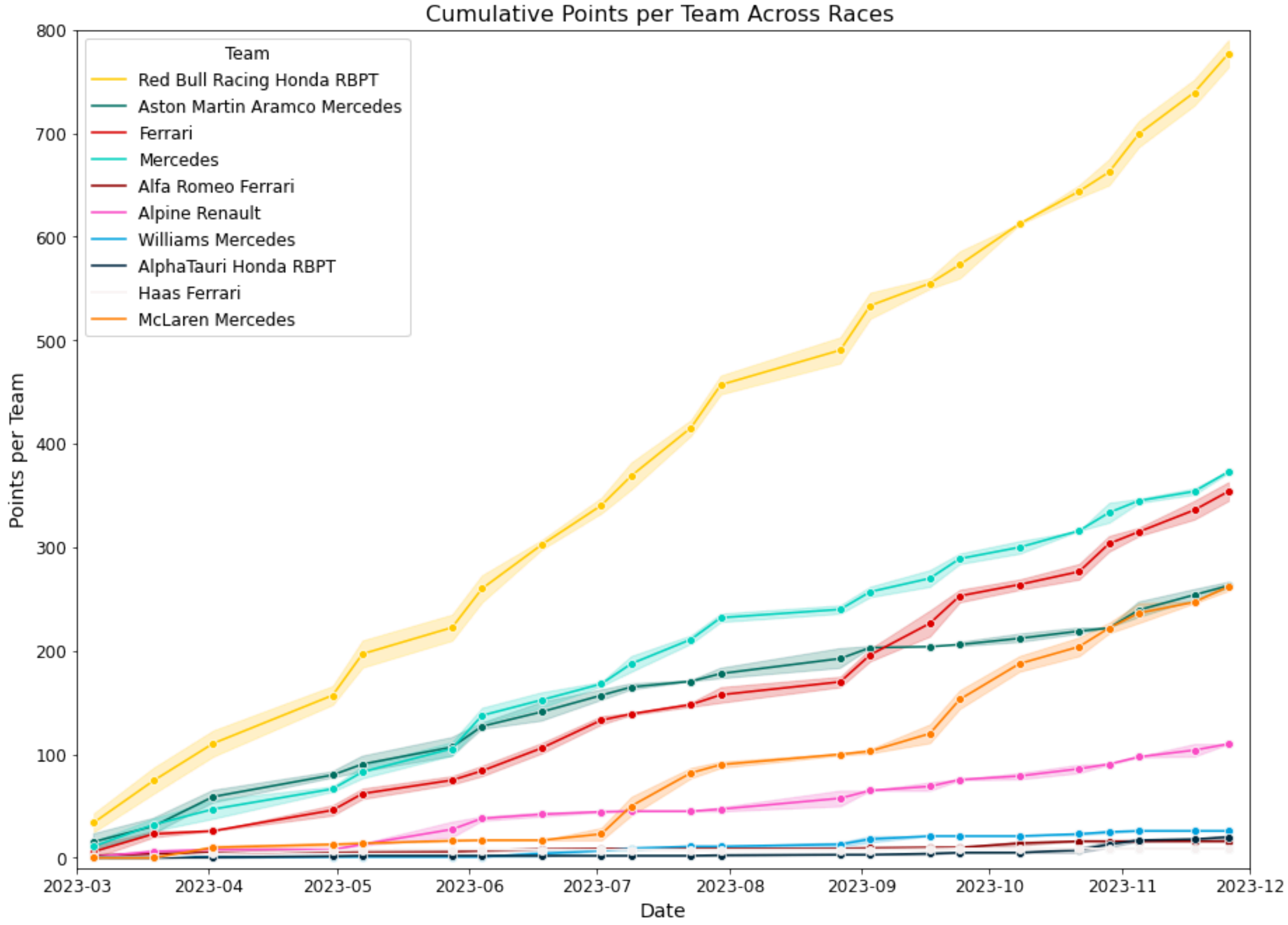
```
#sorting dataframe by points descending to help us see patterns more clearly
F1_sorted = F1_full.sort_values(by='PTS', ascending = False).reset_index()
```

In [41]:

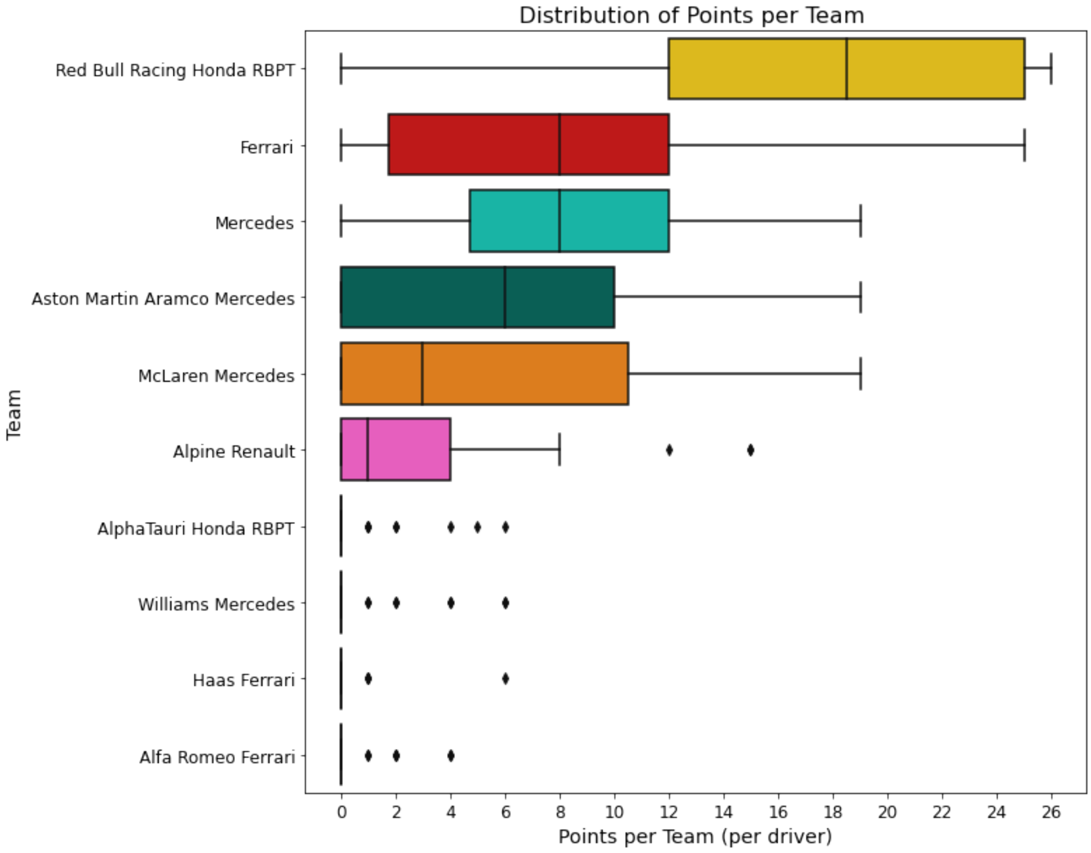
```
#creating a dictionary with each car assigned to its respective colour to apply to plots
team_colours_func = dict(zip(F1_sorted['Car'], F1_sorted['Colours']))
```

In [68]:

```
#creating a time series linechart of cumulative points to investigate team performance over the season
plt.figure(figsize = (15,11))
sns.lineplot(data = F1_full, x = 'Date', y = 'Cumulative_PTS', hue = 'Car', marker = 'o', palette = team_colours_func)
plt.xlabel('Date', fontsize = 14)
plt.ylabel('Points per Team', fontsize = 14)
plt.xticks(fontsize = 12)
plt.yticks(fontsize = 12)
plt.ylim(-10,800)
plt.xlim(pd.Timestamp('2023-03'), pd.Timestamp('2023-12'))
plt.title('Cumulative Points per Team Across Races ', fontsize = 16)
plt.legend(title = 'Team', prop = {'size': 12}, fontsize = '10', title_fontsize = '12')
plt.show()
```



In [67]:
```
#creating a boxplot to visualise the distribution of points scored per team
plt.figure(figsize = (10,10))
sns.boxplot(x = 'PTS', y = 'Car', data = F1_sorted, palette = team_colours_func)
plt.title('Distribution of Points per Team ', fontsize = 16)
plt.xlabel('Points per Team (per driver)', fontsize = 14)
plt.ylabel('Team', fontsize = 14)
plt.xticks(np.arange(0, 27, step=2),fontsize = 12)
plt.yticks(fontsize = 12)
plt.show()
```



Driver Performance

In [44]:
```
F1_full.groupby('Driver')['PTS'].sum().sort_values(ascending=False)
```

Out[44]:
```
Driver
Max Verstappen VER      530
Sergio Perez PER        260
Lewis Hamilton HAM      217
Fernando Alonso ALO     198
Charles Leclerc LEC     185
Lando Norris NOR        184
Carlos Sainz SAI        178
George Russell RUS      157
Oscar Piastri PIA        82
Lance Stroll STR         68
Esteban Ocon OCO         56
Pierre Gasly GAS         54
Alexander Albon ALB      25
Yuki Tsunoda TSU         14
Valtteri Bottas BOT      10
Zhou Guanyu ZHO           6
Nico Hulkenberg HUL       6
Daniel Ricciardo RIC      6
Kevin Magnussen MAG       3
Liam Lawson LAW           2
Logan Sargeant SAR        1
Nyck De Vries DEV         0
Name: PTS, dtype: int64
```

```
In [45]: F1_full.groupby('Driver')['PTS'].describe().round(2)
```

Out[45]:

Driver	count	mean	std	min	25%	50%	75%	max
Alexander Albon ALB	22.0	1.14	2.01	0.0	0.00	0.0	1.75	6.0
Carlos Sainz SAI	22.0	8.09	6.08	0.0	4.00	8.0	10.00	25.0
Charles Leclerc LEC	22.0	8.41	6.70	0.0	0.50	9.0	14.25	18.0
Daniel Ricciardo RIC	7.0	0.86	2.27	0.0	0.00	0.0	0.00	6.0
Esteban Ocon OCO	22.0	2.55	4.01	0.0	0.00	1.0	4.00	15.0
Fernando Alonso ALO	22.0	9.00	6.53	0.0	2.50	9.0	15.00	19.0
George Russell RUS	22.0	7.14	4.89	0.0	4.25	8.0	10.00	15.0
Kevin Magnussen MAG	22.0	0.14	0.35	0.0	0.00	0.0	0.00	1.0
Lance Stroll STR	21.0	3.24	4.11	0.0	0.00	1.0	6.00	12.0
Lando Norris NOR	22.0	8.36	7.47	0.0	0.50	7.0	17.25	19.0
Lewis Hamilton HAM	22.0	9.86	5.71	0.0	6.50	10.0	14.50	19.0
Liam Lawson LAW	5.0	0.40	0.89	0.0	0.00	0.0	0.00	2.0
Logan Sargeant SAR	22.0	0.05	0.21	0.0	0.00	0.0	0.00	1.0
Max Verstappen VER	22.0	24.09	3.78	10.0	25.00	25.0	26.00	26.0
Nico Hulkenberg HUL	22.0	0.27	1.28	0.0	0.00	0.0	0.00	6.0
Nyck De Vries DEV	10.0	0.00	0.00	0.0	0.00	0.0	0.00	0.0
Oscar Piastri PIA	22.0	3.73	5.47	0.0	0.00	0.5	5.50	18.0
Pierre Gasly GAS	22.0	2.45	3.90	0.0	0.00	0.5	3.50	15.0
Sergio Perez PER	22.0	11.82	7.40	0.0	8.25	12.0	17.25	25.0
Valtteri Bottas BOT	22.0	0.45	1.18	0.0	0.00	0.0	0.00	4.0
Yuki Tsunoda TSU	22.0	0.64	1.36	0.0	0.00	0.0	0.75	5.0
Zhou Guanyu ZHO	22.0	0.27	0.70	0.0	0.00	0.0	0.00	2.0

```
In [46]: #Creating a dictionary to apply correct colour to each driver
         driver_colours_func = dict(zip(F1_sorted['Driver'], F1_sorted['Colours']))
```

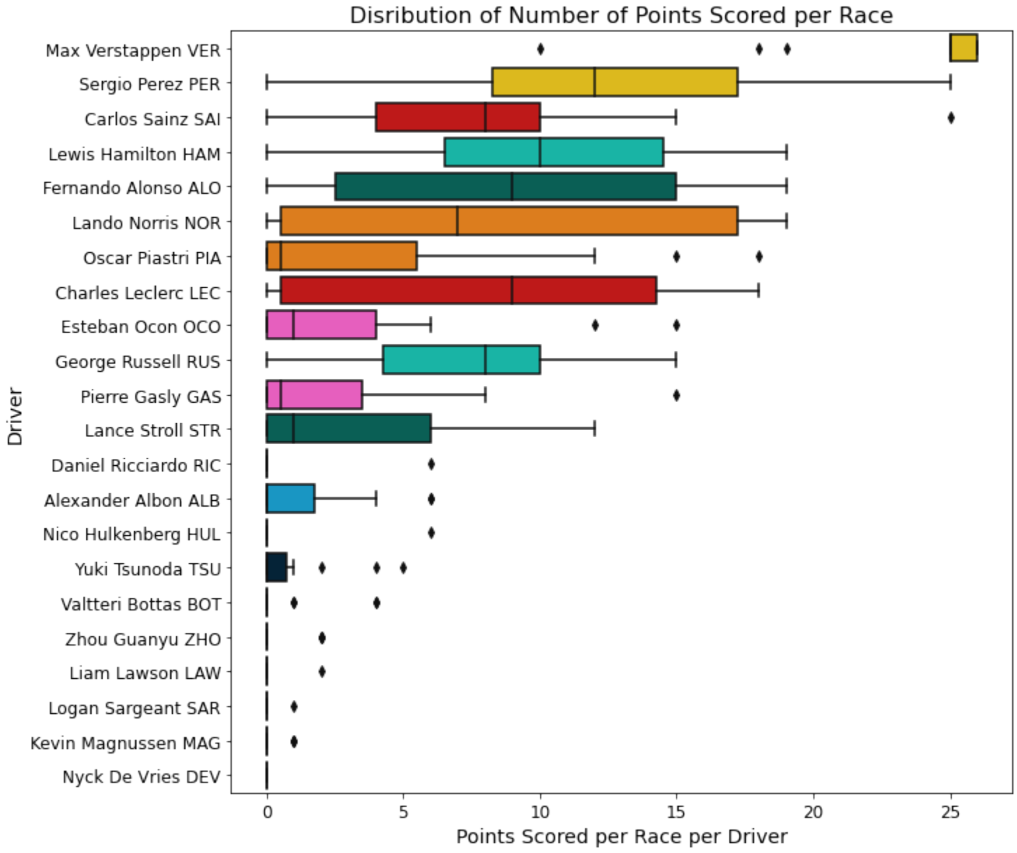
```
In [47]: F1_sorted #checking that the colours column has been applied
```

Out[47]:

	index	RaceID	Date	Grand Prix	Driver	Car	Pos	PTS	Laps	PosQ	Q1	Q2	Q3	Colours	Cumulative_PTS
0	419	21	2023-11-26	Abu Dhabi	Max Verstappen VER	Red Bull Racing Honda RBPT	1.0	26	58	1.0	1:24.160	1:23.740	1:23.445	#FFCC00	790
1	319	16	2023-10-08	Qatar	Max Verstappen VER	Red Bull Racing Honda RBPT	1.0	26	57	NaN	NaN	NaN	NaN	#FFCC00	612
2	160	8	2023-07-02	Austria	Max Verstappen VER	Red Bull Racing Honda RBPT	1.0	26	71	1.0	1:05.116	1:04.951	1:04.391	#FFCC00	333
3	299	15	2023-09-24	Japan	Max Verstappen VER	Red Bull Racing Honda RBPT	1.0	26	53	1.0	1:29.878	1:29.964	1:28.877	#FFCC00	586
4	200	10	2023-07-23	Hungary	Max Verstappen VER	Red Bull Racing Honda RBPT	1.0	26	70	NaN	NaN	NaN	NaN	#FFCC00	408
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
434	194	9	2023-07-09	Great Britain	Zhou Guanyu ZHO	Alfa Romeo Ferrari	15.0	0	52	17.0	1:30.123	NaN	NaN	#900000	9
435	193	9	2023-07-09	Great Britain	Lance Stroll STR	Aston Martin Aramco Mercedes	14.0	0	52	12.0	1:29.448	1:28.935	NaN	#006F62	162
436	192	9	2023-07-09	Great Britain	Nico Hulkenberg HUL	Haas Ferrari	13.0	0	52	11.0	1:29.603	1:28.896	NaN	#F9F2F2	8
437	191	9	2023-07-09	Great Britain	Valtteri Bottas BOT	Alfa Romeo Ferrari	12.0	0	52	NaN	1:29.798	NaN	NaN	#900000	9
438	438	21	2023-11-26	Abu Dhabi	Kevin Magnussen MAG	Haas Ferrari	20.0	0	57	17.0	1:24.764	NaN	NaN	#F9F2F2	9

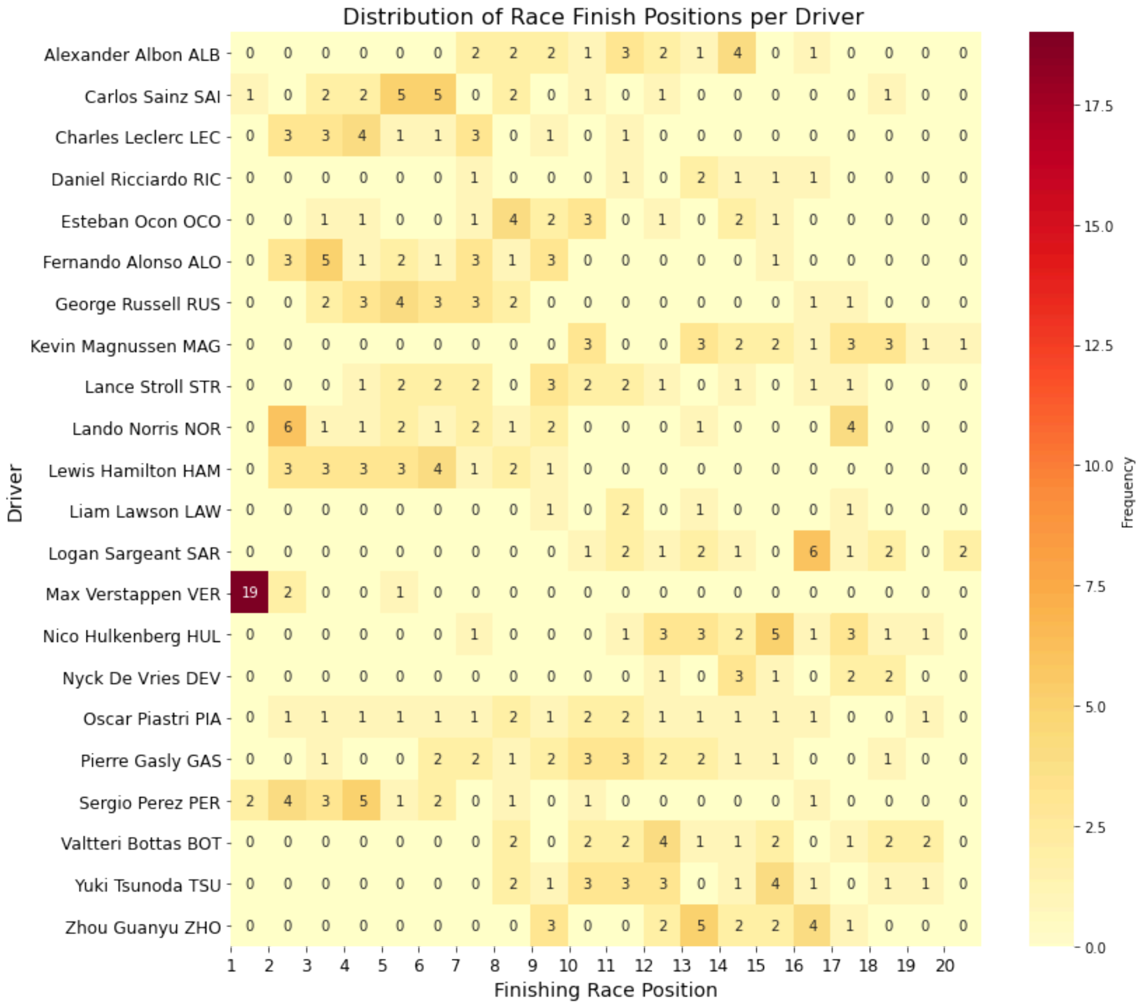
439 rows × 15 columns

```
In [71]: #creating a boxplot to visualise the distribution of points scored per driver
         plt.figure(figsize = (10,10))
         sns.boxplot(data = F1_sorted, x = 'PTS', y = 'Driver', palette = driver_colours_func)
         plt.xlabel('Points Scored per Race per Driver', fontsize = 14)
         plt.ylabel('Driver', fontsize = 14)
         plt.title('Disribution of Number of Points Scored per Race', fontsize = 16)
         plt.yticks(fontsize = 12)
         plt.xticks(fontsize = 12)
         plt.show()
```



In [65]:

```
#creating a heatmap of driver race finishing positions
plt.figure(figsize = (12,12))
driver_pivot = F1_sorted.pivot_table(index = 'Driver', columns = 'Pos', aggfunc = 'size', fill_value = 0)
sns.heatmap(driver_pivot, annot = True,  cmap = 'YlOrRd', fmt = 'd', cbar_kws ={ 'label': 'Frequency'})
plt.xlabel('Finishing Race Position', fontsize = 14)
plt.ylabel('Driver', fontsize = 14)
plt.yticks(fontsize = 12)
plt.xticks(fontsize = 12, rotation = 0)
plt.xticks(range(len(driver_pivot.columns)), map(int, driver_pivot.columns))
plt.title('Distribution of Race Finish Positions per Driver ', fontsize = 16)
plt.show()
```



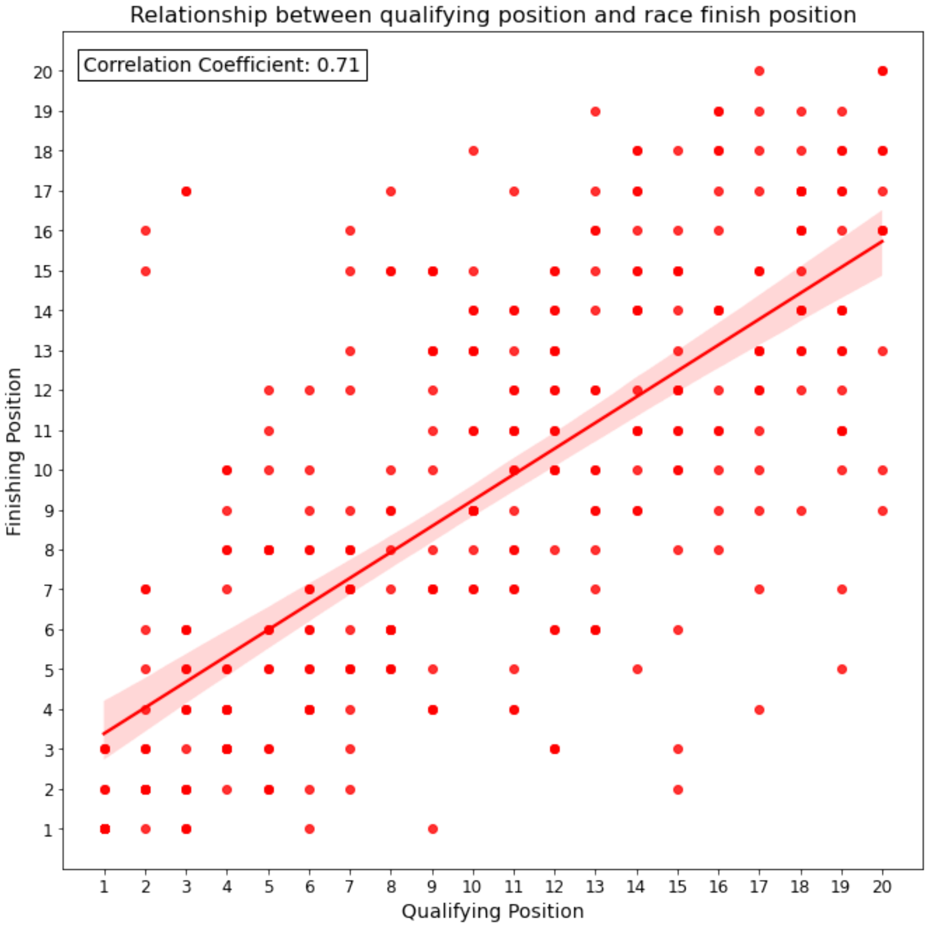
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Alexander Albon ALB	0	0	0	0	0	0	2	2	2	1	3	2	1	4	0	1	0	0	0	0
Carlos Sainz SAI	1	0	2	2	5	5	0	2	0	1	0	1	0	0	0	0	0	1	0	0
Charles Leclerc LEC	0	3	3	4	1	1	3	0	1	0	1	0	0	0	0	0	0	0	0	0
Daniel Ricciardo RIC	0	0	0	0	0	0	1	0	0	0	1	0	2	1	1	1	0	0	0	0
Esteban Ocon OCO	0	0	1	1	0	0	1	4	2	3	0	1	0	2	1	0	0	0	0	0
Fernando Alonso ALO	0	3	5	1	2	1	3	1	3	0	0	0	0	0	1	0	0	0	0	0
George Russell RUS	0	0	2	3	4	3	3	2	0	0	0	0	0	0	0	1	1	0	0	0
Kevin Magnussen MAG	0	0	0	0	0	0	0	0	0	3	0	0	3	2	2	1	3	3	1	1
Lance Stroll STR	0	0	0	1	2	2	2	0	3	2	2	1	0	1	0	1	1	0	0	0
Lando Norris NOR	0	6	1	1	2	1	2	1	2	0	0	0	1	0	0	0	4	0	0	0
Lewis Hamilton HAM	0	3	3	3	3	4	1	2	1	0	0	0	0	0	0	0	0	0	0	0
Liam Lawson LAW	0	0	0	0	0	0	0	0	1	0	2	0	1	0	0	0	1	0	0	0
Logan Sargeant SAR	0	0	0	0	0	0	0	0	0	1	2	1	2	1	0	6	1	2	0	2
Max Verstappen VER	19	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nico Hulkenberg HUL	0	0	0	0	0	0	1	0	0	0	1	3	3	2	5	1	3	1	1	0
Nyck De Vries DEV	0	0	0	0	0	0	0	0	0	0	0	1	0	3	1	0	2	2	0	0
Oscar Piastri PIA	0	1	1	1	1	1	1	2	1	2	2	1	1	1	1	1	0	0	1	0
Pierre Gasly GAS	0	0	1	0	0	2	2	1	2	3	3	2	2	1	1	0	0	1	0	0
Sergio Perez PER	2	4	3	5	1	2	0	1	0	1	0	0	0	0	0	1	0	0	0	0
Valtteri Bottas BOT	0	0	0	0	0	0	0	2	0	2	2	4	1	1	2	0	1	2	2	0
Yuki Tsunoda TSU	0	0	0	0	0	0	0	2	1	3	3	3	0	1	4	1	0	1	1	0
Zhou Guanyu ZHO	0	0	0	0	0	0	0	0	3	0	0	2	5	2	2	4	1	0	0	0

Qualifying Position vs Race Finish Position

In [50]:

```
#Creating a measure for the difference between final race finishing positions and qualifying position
F1_full['pos_diff'] = F1_full['PosQ'] - F1_full['Pos']
```

```
In [69]: #creating a scatterplot to visualise qualifying position vs finishing position
         plt.figure(figsize = (11,11))
         sns.regplot(data = F1_sorted, x = 'PosQ', y = 'Pos', color = 'red', marker = 'o')
         plt.xticks(np.arange(1, 21, 1), fontsize = 12)
         plt.yticks(np.arange(1, 21, 1), fontsize = 12)
         plt.xlim(0,21)
         plt.ylim(0,21)
         plt.xlabel('Qualifying Position', fontsize = 14)
         plt.ylabel('Finishing Position', fontsize = 14)
         plt.title('Relationship between qualifying position and race finish position', fontsize = 16)
         correlation_coef = F1_full['PosQ'].corr(F1_full['Pos']).round(2)
         plt.text(0.5, 20, f'Correlation Coefficient: {correlation_coef}', fontsize = 14, bbox = dict(facecolor = 'white'))
         plt.show()
```



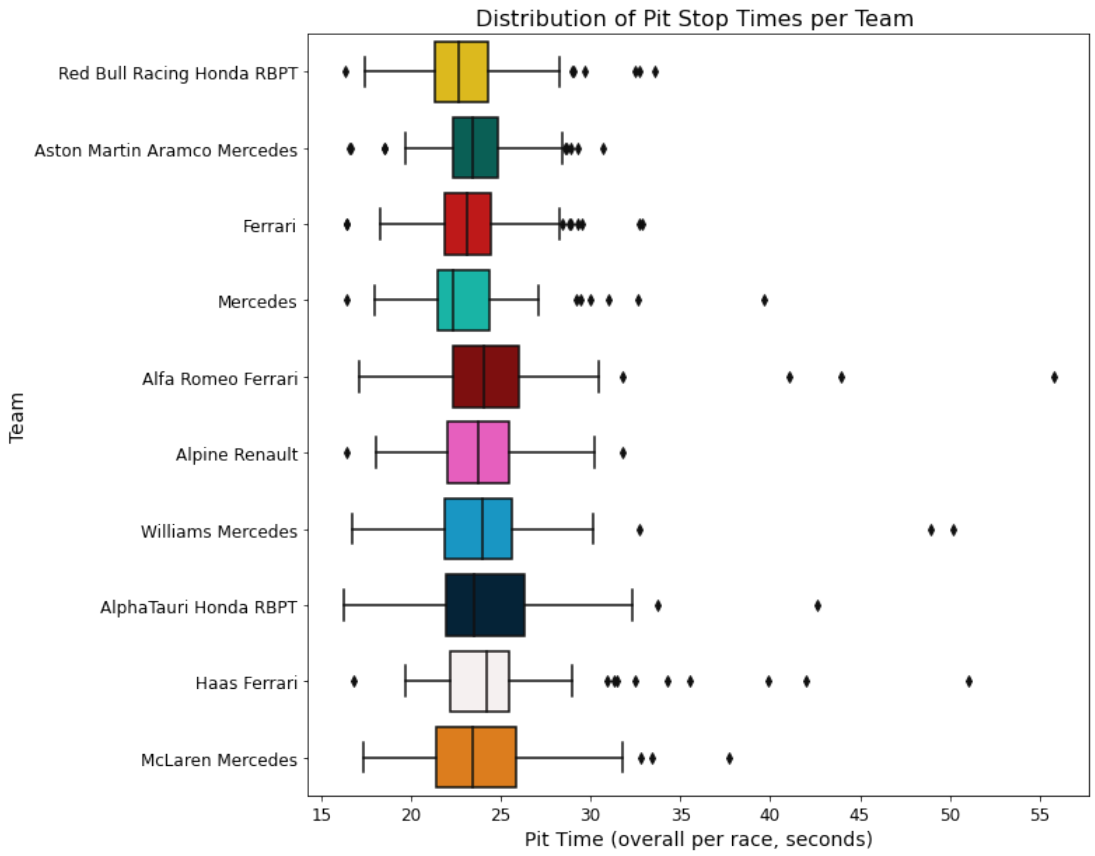
Pit Stops

```
In [52]: F1_pit.groupby('Car')['Pit_time'].describe().round(2)#pit stop summary statistics for each team
```

```
Out[52]:
                              count   mean   std    min    25%    50%    75%    max
                          Car
           Alfa Romeo Ferrari  68.0  25.29  5.81  17.13  22.32  24.04  26.00  55.80
        AlphaTauri Honda RBPT  63.0  24.45  4.20  16.25  21.97  23.49  26.34  42.64
               Alpine Renault  58.0  23.95  3.24  16.38  22.05  23.74  25.49  31.80
 Aston Martin Aramco Mercedes  65.0  23.63  2.84  16.60  22.37  23.44  24.82  30.67
                      Ferrari  63.0  23.62  3.27  16.38  21.85  23.15  24.42  32.89
                 Haas Ferrari  65.0  25.36  5.47  16.78  22.16  24.20  25.45  51.05
             McLaren Mercedes  60.0  24.17  4.10  17.32  21.41  23.42  25.85  37.74
                     Mercedes  63.0  23.29  3.63  16.42  21.52  22.31  24.38  39.69
     Red Bull Racing Honda RBPT  69.0  23.20  3.48  16.37  21.32  22.67  24.29  33.60
             Williams Mercedes  60.0  24.92  5.65  16.74  21.91  23.94  25.62  50.14
```

In [70]:

```
#creating a box plot to visualise the distribution of pit stop times per team
plt.figure(figsize = (10,10))
sns.boxplot(data = F1_pit_full, x = 'Pit_time', y = 'Car', color = 'red', palette = team_colours_func)
plt.xlabel('Pit Time (overall per race, seconds)', fontsize = 14)
plt.ylabel('Team',fontsize = 14)
plt.xticks(fontsize = 12)
plt.yticks(fontsize = 12)
plt.title('Distribution of Pit Stop Times per Team ', fontsize = 16)
plt.show()
```



Regression

In [54]:

```
#importing packages
from statsmodels.regression.linear_model import OLS
from statsmodels.tools import add_constant
```

In [55]:

```
#setting independent and dependent variables
F1_clean = F1_pit_full.dropna()#dropping columns with Nan values as these will prevent the regression from being carried out
X = F1_clean[['PosQ','Pit_time' ]] #assigning independent variables
Y = F1_clean['PTS'] #assigning dependent variable
```

In [56]:

```
X = add_constant(X) #adding a constant term to the regression
```

In [57]:

```
regression = OLS(Y, X)
regression_results = regression.fit()
print(regression_results.summary())
```

```
                            OLS Regression Results                            
==============================================================================
Dep. Variable:                    PTS   R-squared:                       0.481
Model:                            OLS   Adj. R-squared:                  0.479
Method:                 Least Squares   F-statistic:                     241.5
Date:                Thu, 25 Apr 2024   Prob (F-statistic):           5.51e-75
Time:                        09:00:58   Log-Likelihood:                -1634.0
No. Observations:                 525   AIC:                             3274.
Df Residuals:                     522   BIC:                             3287.
Df Model:                           2                                         
Covariance Type:            nonrobust                                         
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         17.2190      1.468     11.726      0.000      14.334      20.104
PosQ          -0.8956      0.042    -21.525      0.000      -0.977      -0.814
Pit_time      -0.0894      0.060     -1.480      0.139      -0.208       0.029
==============================================================================
Omnibus:                       23.331   Durbin-Watson:                   0.831
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               25.323
Skew:                           0.504   Prob(JB):                     3.17e-06
Kurtosis:                       3.375   Cond. No.                         163.
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

In [ ]: