In [1]:
```
#import libraries
import pandas as pd
import numpy as np
```

In [2]:
```
#load csv file data with headers

location = "./cars.csv"
df_src = pd.read_csv(location)
```

Data Preparation and Wrangling with Pandas and Numpy

In [3]:
```
df_src.head()
```

Out[3]:

	Car	MPG	Cylinders	Displacement	Horsepower	Weight	Acceleration	Model	Origin
0	Chevrolet Chevelle Malibu	18.0	8	307.0	130	3504	12.0	70	US
1	Buick Skylark 320	15.0	8	350.0	165	3693	11.5	70	US
2	Plymouth Satellite	18.0	8	318.0	150	3436	11.0	70	US
3	AMC Rebel SST	16.0	8	304.0	150	3433	12.0	70	US
4	Ford Torino	17.0	8	302.0	140	3449	10.5	70	US

In [4]:
```
df_src.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1218 entries, 0 to 1217
Data columns (total 9 columns):
 #   Column        Non-Null Count  Dtype  
---  ------        --------------  -----  
 0   Car           1218 non-null   object 
 1   MPG           1218 non-null   float64
 2   Cylinders     1218 non-null   int64  
 3   Displacement  1218 non-null   float64
 4   Horsepower    1218 non-null   int64  
 5   Weight        1218 non-null   int64  
 6   Acceleration  1218 non-null   float64
 7   Model         1218 non-null   int64  
 8   Origin        1218 non-null   object 
dtypes: float64(3), int64(4), object(2)
memory usage: 85.8+ KB
```

In [5]:
```
#create a dataframe the related factors for the model
#drop Model
df_src = df_src.drop(['Model'], axis=1)
df_src.head()
```

Out[5]:

	Car	MPG	Cylinders	Displacement	Horsepower	Weight	Acceleration	Origin
0	Chevrolet Chevelle Malibu	18.0	8	307.0	130	3504	12.0	US
1	Buick Skylark 320	15.0	8	350.0	165	3693	11.5	US
2	Plymouth Satellite	18.0	8	318.0	150	3436	11.0	US
3	AMC Rebel SST	16.0	8	304.0	150	3433	12.0	US
4	Ford Torino	17.0	8	302.0	140	3449	10.5	US

In [6]:
```
df_src.describe()
```

Out[6]:

	MPG	Cylinders	Displacement	Horsepower	Weight	Acceleration
count	1218.000000	1218.000000	1218.000000	1218.000000	1218.000000	1218.000000
mean	23.051232	5.475369	194.779557	103.529557	2979.413793	15.519704
std	8.394871	1.710752	104.836209	40.487350	846.308065	2.801054
min	0.000000	3.000000	68.000000	0.000000	1613.000000	8.000000
25%	17.000000	4.000000	105.000000	75.000000	2226.000000	13.700000
50%	22.350000	4.000000	151.000000	93.500000	2822.500000	15.500000
75%	29.000000	8.000000	302.000000	129.000000	3620.000000	17.200000
max	46.600000	8.000000	455.000000	230.000000	5140.000000	24.800000

In [7]:
```
#Checking Shape
print(df_src.shape)
```

```
(1218, 8)
```

In [8]:
```
#Check DataFrame type
type(df_src)
```

Out[8]:
```
pandas.core.frame.DataFrame
```

Clean and Arrange Data

In [9]:
```
df_src.columns
```

Out[9]:
```
Index(['Car', 'MPG', 'Cylinders', 'Displacement', 'Horsepower', 'Weight',
       'Acceleration', 'Origin'],
      dtype='object')
```

In [10]:
```
df_src.count()
```

Out[10]:
```
Car             1218
MPG             1218
Cylinders       1218
Displacement    1218
```

```
Horsepower      1218
Weight          1218
Acceleration    1218
Origin          1218
dtype: int64
```

In [11]:
```
zero_df = df_src[(df_src.Horsepower <= 0) | (df_src.MPG <= 0) | (df_src.Cylinders <= 0)
zero_df.count()
```

Out[11]:
```
Car             42
MPG             42
Cylinders       42
Displacement    42
Horsepower      42
Weight          42
Acceleration    42
Origin          42
dtype: int64
```

In [12]:
```
df_no_zero = df_src.drop(zero_df.index)
df_no_zero.count()
```

Out[12]:
```
Car             1176
MPG             1176
Cylinders       1176
Displacement    1176
Horsepower      1176
Weight          1176
Acceleration    1176
Origin          1176
dtype: int64
```

In [13]:
```
#Standard Deviation Method

meanmpg = df_no_zero['MPG'].mean()
stdmpg = df_no_zero['MPG'].std()
toprange = meanmpg + stdmpg * 1.96
botrange = meanmpg - stdmpg * 1.96

df = df_no_zero.copy() #to not mess up the original df
df = df.drop(df[df['MPG'] > toprange].index)
df = df.drop(df[df['MPG'] < botrange].index)

df.head()
```

Out[13]:

	Car	MPG	Cylinders	Displacement	Horsepower	Weight	Acceleration	Origin
0	Chevrolet Chevelle Malibu	18.0	8	307.0	130	3504	12.0	US
1	Buick Skylark 320	15.0	8	350.0	165	3693	11.5	US
2	Plymouth Satellite	18.0	8	318.0	150	3436	11.0	US
3	AMC Rebel SST	16.0	8	304.0	150	3433	12.0	US
4	Ford Torino	17.0	8	302.0	140	3449	10.5	US

In [14]:
```
df.count()
```

Out[14]:
```
Car             1143
MPG             1143
Cylinders       1143
Displacement    1143
Horsepower      1143
Weight          1143
Acceleration    1143
Origin          1143
dtype: int64
```

In [15]:
```
df['Origin'].value_counts()
```

Out[15]:
```
US        732
Japan     222
Europe    189
Name: Origin, dtype: int64
```

In [16]:
```
df.describe()
```

Out[16]:

	MPG	Cylinders	Displacement	Horsepower	Weight	Acceleration
count	1143.000000	1143.000000	1143.000000	1143.000000	1143.000000	1143.00000
mean	22.900262	5.514436	197.460630	105.750656	3004.629921	15.44147
std	7.195940	1.710049	104.476433	38.218882	845.151145	2.67089
min	9.000000	3.000000	68.000000	46.000000	1613.000000	8.00000
25%	17.000000	4.000000	107.000000	78.000000	2255.000000	13.60000
50%	22.000000	4.000000	151.000000	95.000000	2855.000000	15.50000
75%	28.000000	8.000000	302.000000	130.000000	3632.000000	17.00000
max	38.100000	8.000000	455.000000	230.000000	5140.000000	24.80000

Addressing NA/Null Values

In [17]:
```
# Check null
df.isnull()
```

Out[17]:

	Car	MPG	Cylinders	Displacement	Horsepower	Weight	Acceleration	Origin
0	False	False	False	False	False	False	False	False
1	False	False	False	False	False	False	False	False
2	False	False	False	False	False	False	False	False
3	False	False	False	False	False	False	False	False
4	False	False	False	False	False	False	False	False
...	...	...	...	...	...	...	...	...
1212	False	False	False	False	False	False	False	False

	Car	MPG	Cylinders	Displacement	Horsepower	Weight	Acceleration	Origin
1213	False	False	False	False	False	False	False	False
1215	False	False	False	False	False	False	False	False
1216	False	False	False	False	False	False	False	False
1217	False	False	False	False	False	False	False	False

1143 rows × 8 columns

In [18]:
```
# Null sum
df.isnull().sum()
```

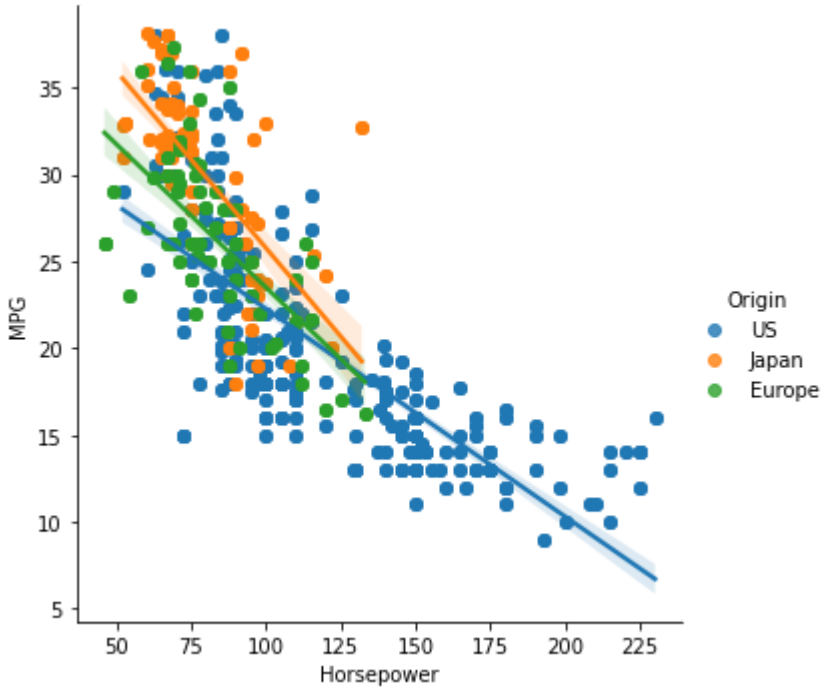
Out[18]:
```
Car             0
MPG             0
Cylinders       0
Displacement    0
Horsepower      0
Weight          0
Acceleration    0
Origin          0
dtype: int64
```

EDA and Data Visualization - scatterplot

In [19]:
```
import pandas as pd
from matplotlib import pyplot as plt
import seaborn as sns

%matplotlib inline
```

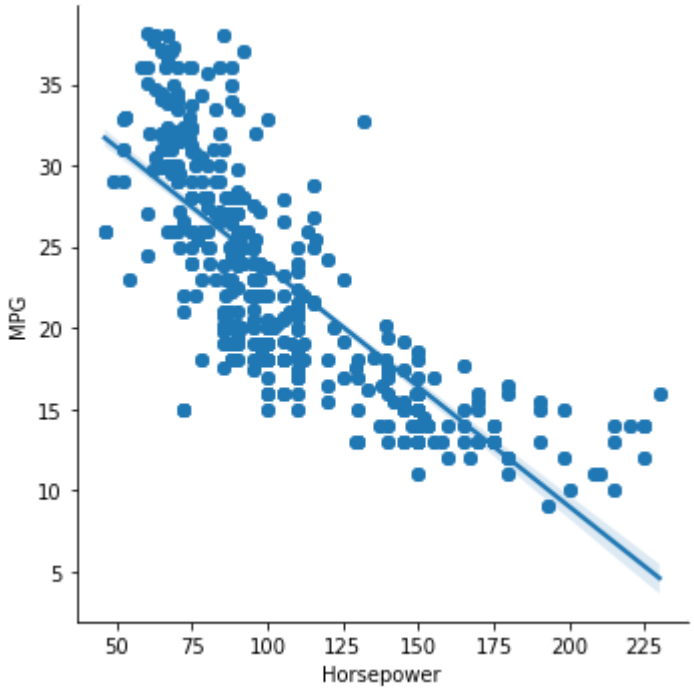
In [20]:
```
#make a scatterplot
sns.lmplot(x='Horsepower', y='MPG', data=df,
           #fit_reg=False, #remove regression lines    #Test - remove the lines -workin
           fit_reg=True, #keep regression lines
           hue='Origin')   #color by origin country
```

Out[20]:
```
<seaborn.axisgrid.FacetGrid at 0x202d5286a30>
```



In [21]:
```
#make a scatterplot
sns.lmplot(x='Horsepower', y='MPG', data=df,
           #fit_reg=False, #remove regression line  #Test - remove the line -working
           fit_reg=True) #keep regression line
           #hue='Origin')   #color by origin country
```

Out[21]: <seaborn.axisgrid.FacetGrid at 0x202d8771d30>



In [22]:
```
import statsmodels.formula.api as smf
```

In [23]:
```
#Get the result of summary for the MPG - Horsepower
result = smf.ols('MPG ~ Horsepower', data=df).fit()
```

In [24]:
```
result.summary()
```

Out[24]:

OLS Regression Results

Dep. Variable:	MPG	**R-squared:**	0.612
Model:	OLS	**Adj. R-squared:**	0.611
Method:	Least Squares	**F-statistic:**	1796.
Date:	Sat, 09 Apr 2022	**Prob (F-statistic):**	1.68e-236
Time:	17:04:27	**Log-Likelihood:**	-3336.7
No. Observations:	1143	**AIC:**	6677.
Df Residuals:	1141	**BIC:**	6688.
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	38.4704	0.391	98.480	0.000	37.704	39.237
Horsepower	-0.1472	0.003	-42.379	0.000	-0.154	-0.140

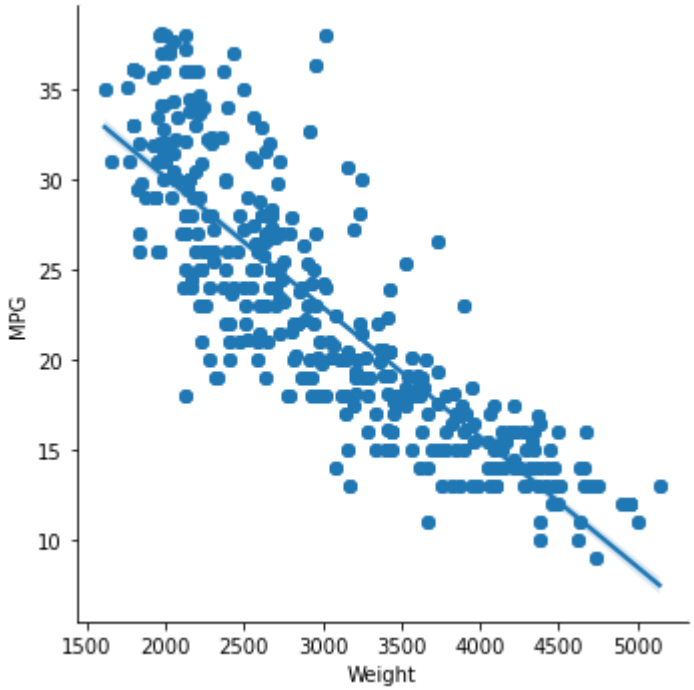
Omnibus:	18.293	**Durbin-Watson:**	0.928
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	18.975
Skew:	0.313	**Prob(JB):**	7.58e-05
Kurtosis:	2.912	**Cond. No.**	331.

Notes:

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

In [25]:
```
#make a scatterplot
sns.lmplot(x='Weight', y='MPG', data=df,
           #fit_reg=False, #remove regression line
           fit_reg=True) #remove regression line
           #hue='Origin')   #color by origin country
```

Out[25]:
```
<seaborn.axisgrid.FacetGrid at 0x202d901d5e0>
```



In [26]:
```
#Get the result of summary for the MPG-Weight
result = smf.ols('MPG ~ Weight', data=df).fit()
```

In [27]:
```
result.summary()
```

Out[27]:

OLS Regression Results

Dep. Variable:	MPG	**R-squared:**	0.716
Model:	OLS	**Adj. R-squared:**	0.715
Method:	Least Squares	**F-statistic:**	2872.
Date:	Sat, 09 Apr 2022	**Prob (F-statistic):**	6.92e-314
Time:	17:04:27	**Log-Likelihood:**	-3158.3
No. Observations:	1143	**AIC:**	6321.
Df Residuals:	1141	**BIC:**	6331.
Df Model:	1		
Covariance Type:	nonrobust		

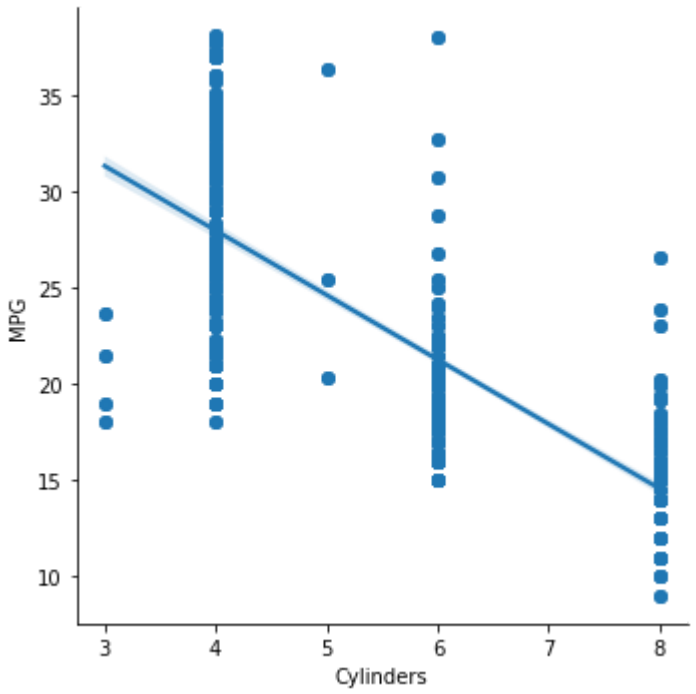
	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	44.5426	0.419	106.182	0.000	43.720	45.366
Weight	-0.0072	0.000	-53.592	0.000	-0.007	-0.007

Omnibus:	44.317	**Durbin-Watson:**	0.832
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	52.235
Skew:	0.434	**Prob(JB):**	4.54e-12
Kurtosis:	3.587	**Cond. No.**	1.15e+04

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The condition number is large, 1.15e+04. This might indicate that there are
strong multicollinearity or other numerical problems.

In [28]:
```
#make a scatterplot
sns.lmplot(x='Cylinders', y='MPG', data=df,
           #fit_reg=False, #remove regression line
           fit_reg=True) #remove regression line
           #hue='Origin')   #color by origin country
```

Out[28]:
```
<seaborn.axisgrid.FacetGrid at 0x202d90c62b0>
```



In [29]:
```
#MPG-Cylinders
result = smf.ols('MPG ~ Cylinders', data=df).fit()
```

In [30]:
```
result.summary()
```

Out[30]:

OLS Regression Results

Dep. Variable:	MPG	**R-squared:**	0.635
Model:	OLS	**Adj. R-squared:**	0.635
Method:	Least Squares	**F-statistic:**	1986.
Date:	Sat, 09 Apr 2022	**Prob (F-statistic):**	4.62e-252
Time:	17:04:27	**Log-Likelihood:**	-3300.9
No. Observations:	1143	**AIC:**	6606.

Df Residuals:	1141	**BIC:**	6616.
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	41.3936	0.434	95.282	0.000	40.541	42.246
Cylinders	-3.3536	0.075	-44.567	0.000	-3.501	-3.206

Omnibus:	42.433	**Durbin-Watson:**	1.033
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	49.523
Skew:	0.425	**Prob(JB):**	1.76e-11
Kurtosis:	3.563	**Cond. No.**	20.0

Notes:

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

In [31]:
```
#MPG-Cylinders+Displacement+Horsepower+Weight+Acceleration
result = smf.ols('MPG ~ Cylinders+Displacement+Horsepower+Weight+Acceleration', data=df
```

In [32]:
```
result.summary()
```

Out[32]:

OLS Regression Results

Dep. Variable:	MPG	**R-squared:**	0.734
Model:	OLS	**Adj. R-squared:**	0.733
Method:	Least Squares	**F-statistic:**	626.9
Date:	Sat, 09 Apr 2022	**Prob (F-statistic):**	9.88e-324
Time:	17:04:27	**Log-Likelihood:**	-3120.7
No. Observations:	1143	**AIC:**	6253.
Df Residuals:	1137	**BIC:**	6284.
Df Model:	5		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	48.6825	1.384	35.170	0.000	45.967	51.398
Cylinders	-0.6274	0.208	-3.014	0.003	-1.036	-0.219
Displacement	-0.0020	0.005	-0.445	0.657	-0.011	0.007
Horsepower	-0.0530	0.008	-6.249	0.000	-0.070	-0.036
Weight	-0.0041	0.000	-9.787	0.000	-0.005	-0.003

Acceleration	-0.2589	0.067	-3.889	0.000	-0.389	-0.128

Omnibus:	45.573	**Durbin-Watson:**	0.903
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	53.584
Skew:	0.443	**Prob(JB):**	2.31e-12
Kurtosis:	3.582	**Cond. No.**	3.95e+04

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The condition number is large, 3.95e+04. This might indicate that there are
strong multicollinearity or other numerical problems.

In [33]:
```
#MPG-Cylinders+Displacement+Horsepower+Weight+Acceleration
#set y-interception = 0
result = smf.ols('MPG ~ Cylinders+Displacement+Horsepower+Weight+Acceleration-1', data=
```

In [34]:
```
result.summary()
```

Out[34]:

OLS Regression Results

Dep. Variable:	MPG	**R-squared (uncentered):**	0.950
Model:	OLS	**Adj. R-squared (uncentered):**	0.950
Method:	Least Squares	**F-statistic:**	4333.
Date:	Sat, 09 Apr 2022	**Prob (F-statistic):**	0.00
Time:	17:04:27	**Log-Likelihood:**	-3541.4
No. Observations:	1143	**AIC:**	7093.
Df Residuals:	1138	**BIC:**	7118.
Df Model:	5		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Cylinders	2.1919	0.277	7.900	0.000	1.648	2.736
Displacement	-0.0629	0.006	-10.215	0.000	-0.075	-0.051
Horsepower	0.1395	0.009	14.898	0.000	0.121	0.158
Weight	-0.0059	0.001	-9.855	0.000	-0.007	-0.005
Acceleration	1.6805	0.054	31.206	0.000	1.575	1.786

Omnibus:	20.755	**Durbin-Watson:**	1.015
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	33.433

Skew:	0.139	**Prob(JB):**	5.50e-08
Kurtosis:	3.791	**Cond. No.**	5.49e+03

Notes:

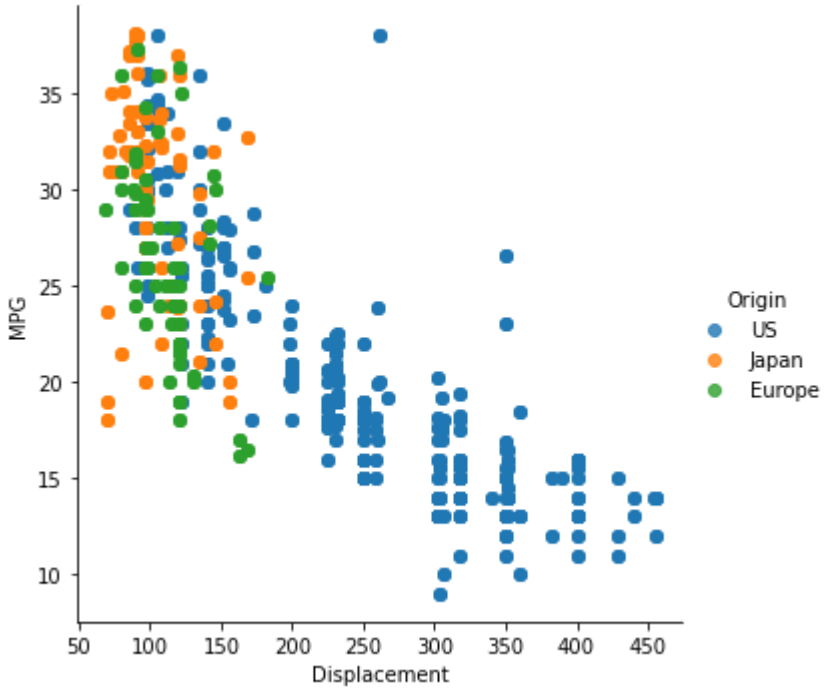
[1] R^2 is computed without centering (uncentered) since the model does not contain a constant.

[2] Standard Errors assume that the covariance matrix of the errors is correctly specified.

[3] The condition number is large, 5.49e+03. This might indicate that there are strong multicollinearity or other numerical problems.

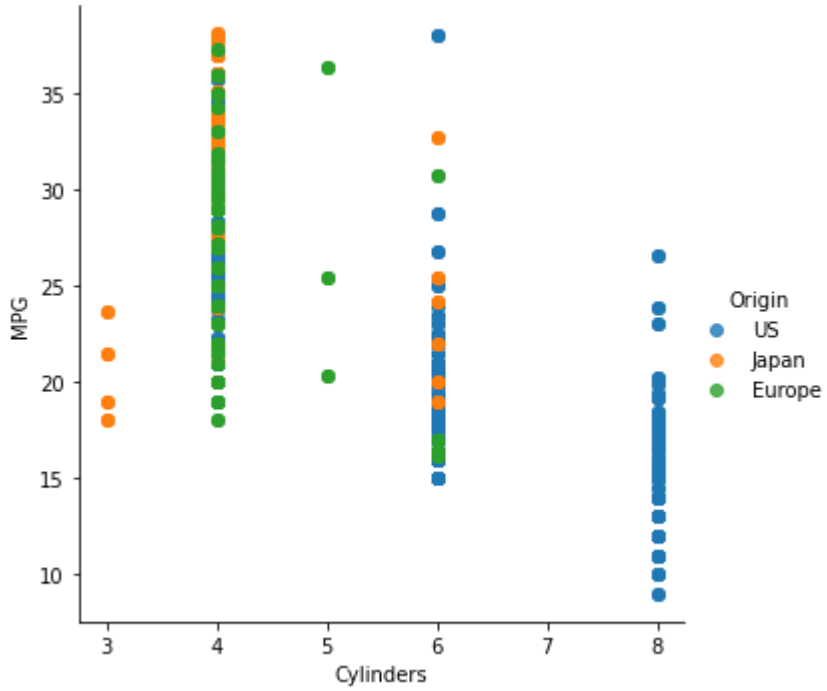
In [35]:
```
#make a scatterplot
sns.lmplot(x='Displacement', y='MPG', data=df,
           fit_reg=False, #remove regression line
           hue='Origin')   #color by origin country
```

Out[35]:
```
<seaborn.axisgrid.FacetGrid at 0x202d9140f40>
```



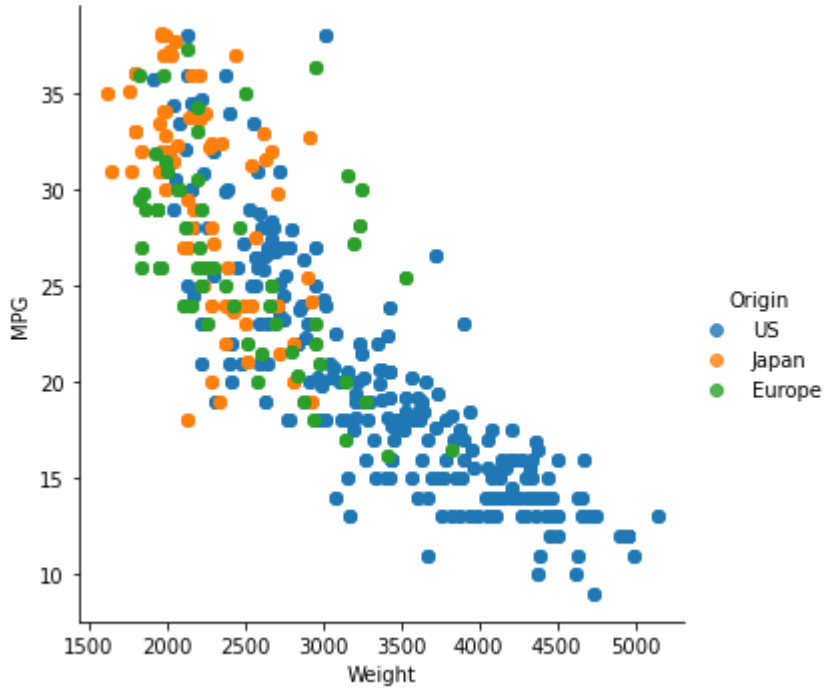
In [36]:
```
#make a scatterplot
sns.lmplot(x='Cylinders', y='MPG', data=df,
           fit_reg=False, #remove regression line
           hue='Origin')   #color by origin country
```

Out[36]:
```
<seaborn.axisgrid.FacetGrid at 0x202d9176d90>
```



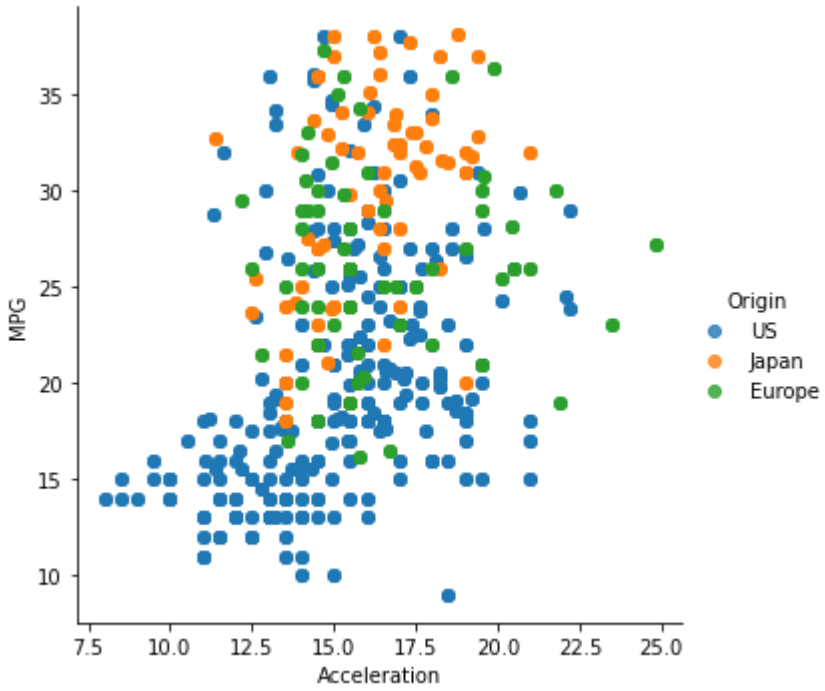
In [37]:
```
#make a scatterplot
sns.lmplot(x='Weight', y='MPG', data=df,
           fit_reg=False, #remove regression line
           hue='Origin')   #color by origin country
```

Out[37]: <seaborn.axisgrid.FacetGrid at 0x202d904dc70>



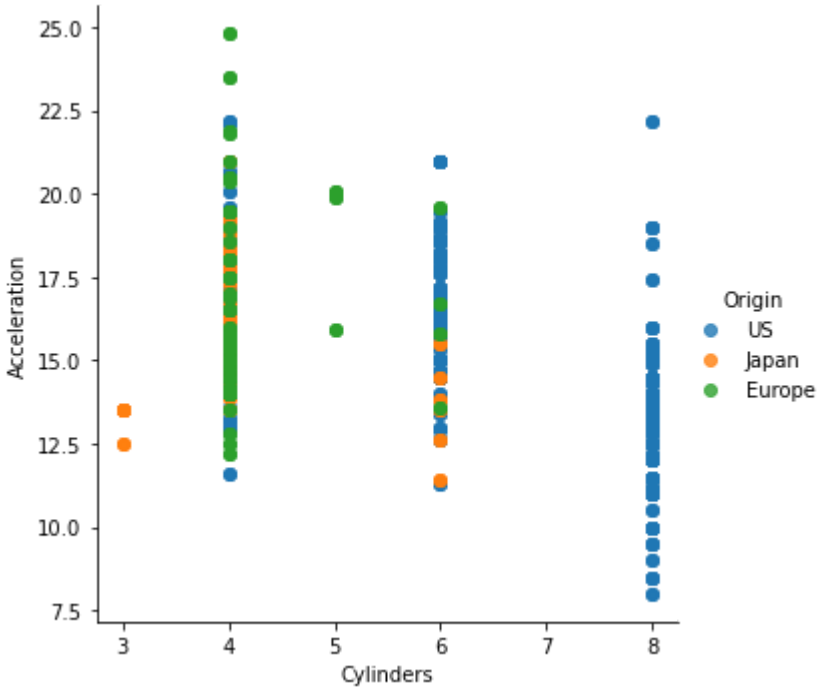
In [38]:
```
#make a scatterplot
sns.lmplot(x='Acceleration', y='MPG', data=df,
           fit_reg=False, #remove regression line
           hue='Origin')   #color by origin country
```

Out[38]: <seaborn.axisgrid.FacetGrid at 0x202dab02df0>



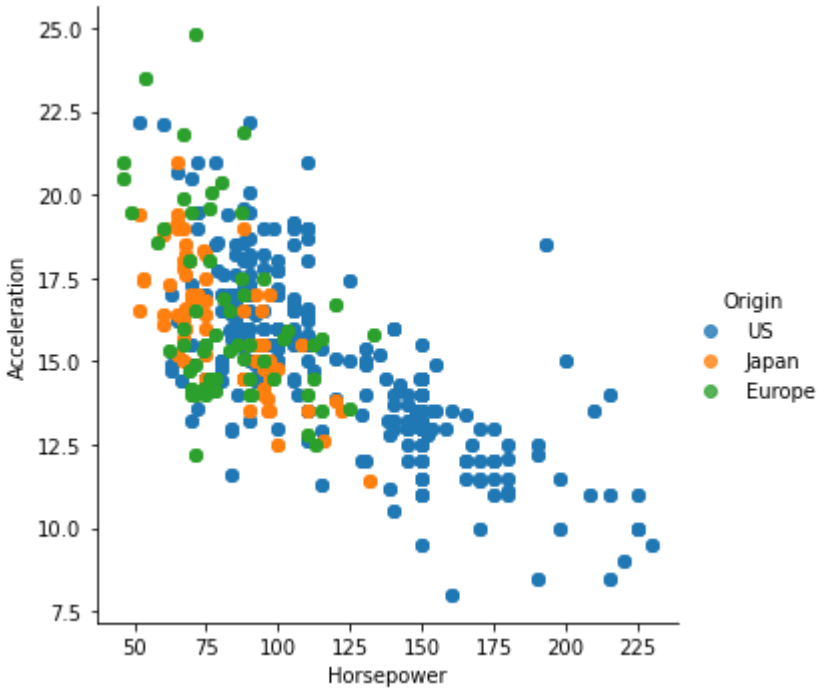
In [39]:
```
#remove regression line

#make a scatterplot
sns.lmplot(x='Cylinders', y='Acceleration', data=df,
           fit_reg=False,
           hue='Origin')   #color by origin country
```

Out[39]:
```
<seaborn.axisgrid.FacetGrid at 0x202dab93430>
```



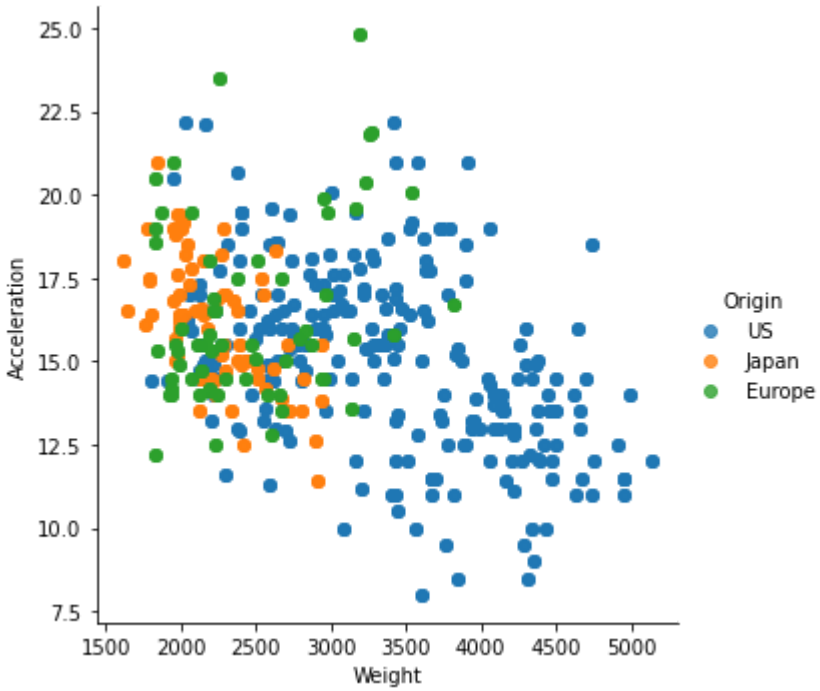
In [40]:
```
#make a scatterplot
sns.lmplot(x='Horsepower', y='Acceleration', data=df,
           fit_reg=False, #remove regression line
           hue='Origin')   #color by origin country
```

Out[40]:
```
<seaborn.axisgrid.FacetGrid at 0x202dac236d0>
```



In [41]:
```
#make a scatterplot
sns.lmplot(x='Weight', y='Acceleration', data=df,
           fit_reg=False, #remove regression line
           hue='Origin')   #color by origin country
```

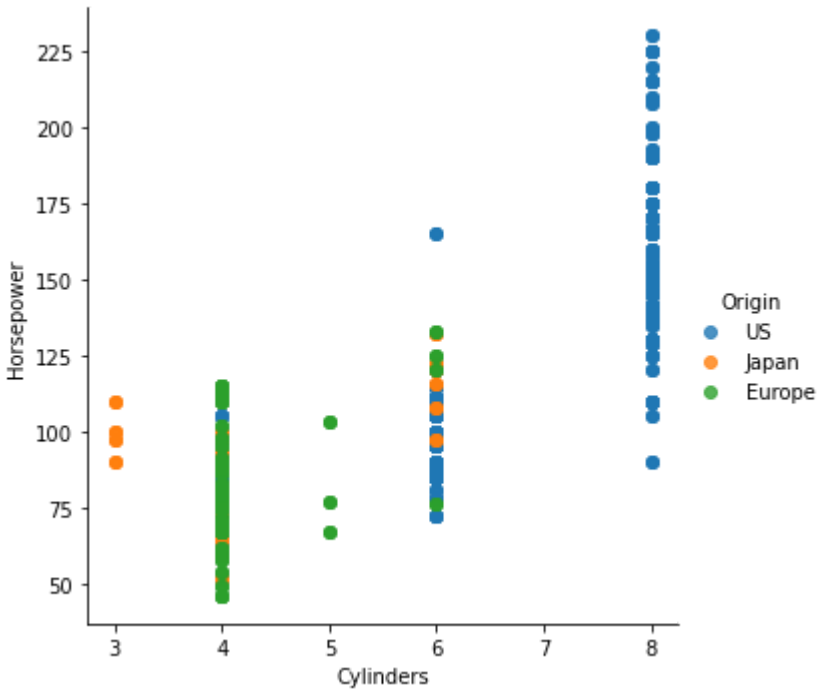
Out[41]:
```
<seaborn.axisgrid.FacetGrid at 0x202dac0b2b0>
```



In [42]:
```
#make a scatterplot
sns.lmplot(x='Cylinders', y='Horsepower', data=df,
```

```
            fit_reg=False, #remove regression line
            hue='Origin')   #color by origin country
```

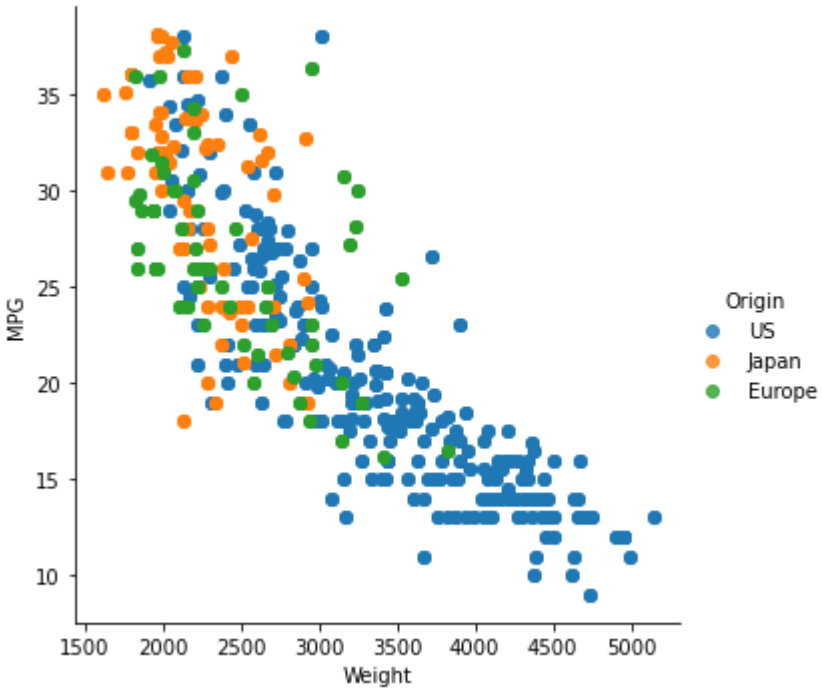
Out[42]: <seaborn.axisgrid.FacetGrid at 0x202dac8a730>



In [43]:

```
#add more details to scatterplot
sns.lmplot(x='Weight', y='MPG', data=df,
           fit_reg=False, #remove regression line
           hue='Origin')   #color by evolution stage
```

Out[43]: <seaborn.axisgrid.FacetGrid at 0x202dad17d30>

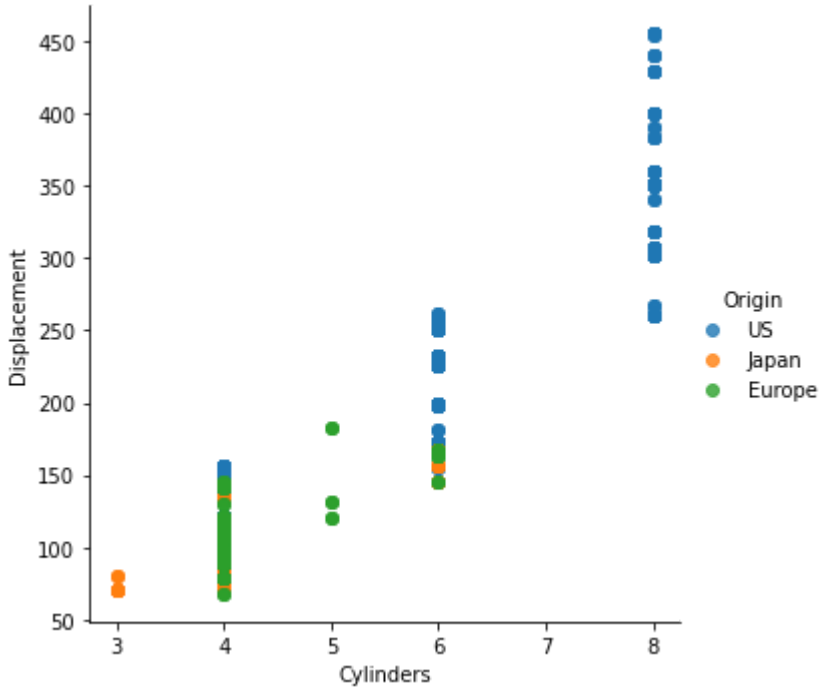


In [44]:

```
#add more details to scatterplot
```

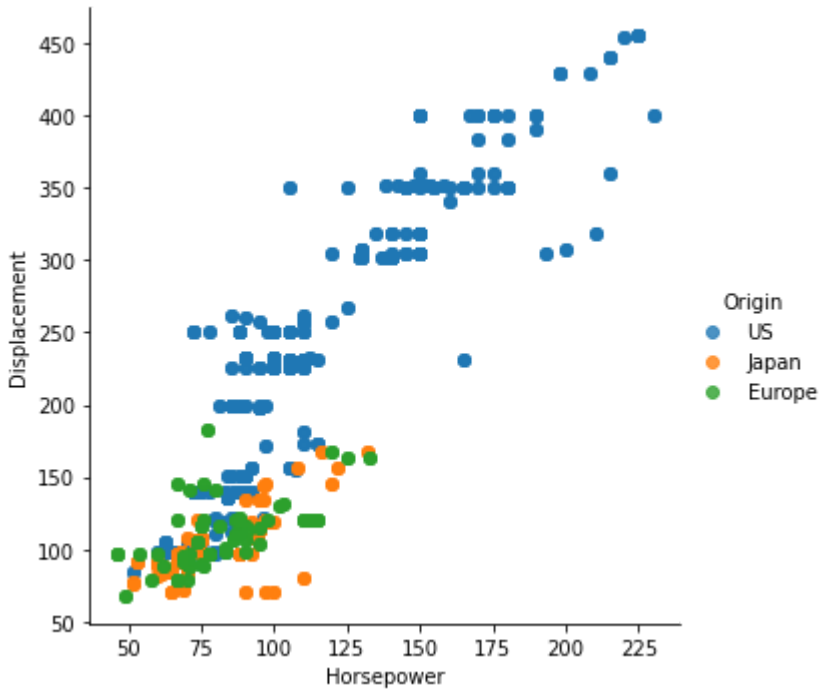
```
sns.lmplot(x='Cylinders', y='Displacement', data=df,
           fit_reg=False, #remove regression line
           hue='Origin')   #color by evolution stage
```

Out[44]: <seaborn.axisgrid.FacetGrid at 0x202dadb8520>



In [45]:
```
#add more details to scatterplot
sns.lmplot(x='Horsepower', y='Displacement', data=df,
           fit_reg=False, #remove regression line
           hue='Origin')   #color by evolution stage
```

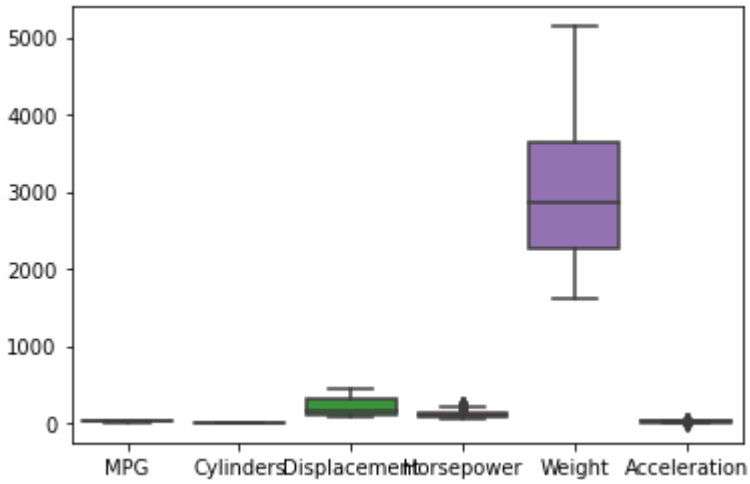
Out[45]: <seaborn.axisgrid.FacetGrid at 0x202dae838e0>



EDA and Data Visualization - boxplot

In [46]:
```
#boxplot showing stats for each characteristic
sns.boxplot(data=df)
```

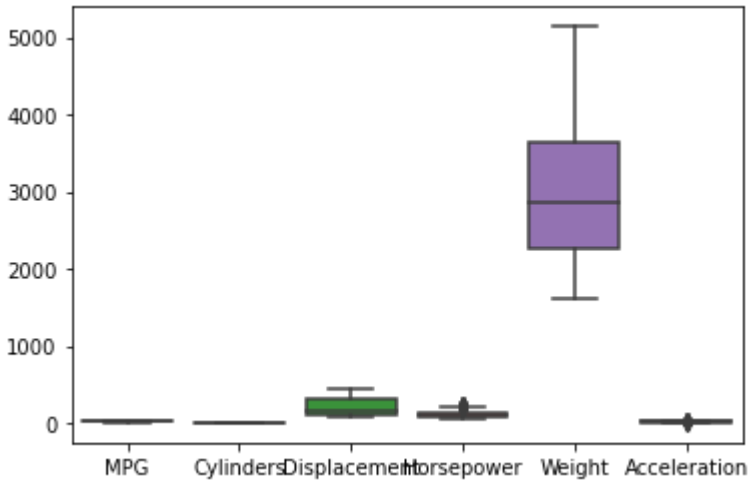
Out[46]: <AxesSubplot:>



In [47]:
```
#drop Model
#stats_df = df.drop(['Model'], axis=1)
#stats_df.head()

stats_df = df
```

In [48]:
```
#boxplot for stats
sns.boxplot(data=stats_df)
```

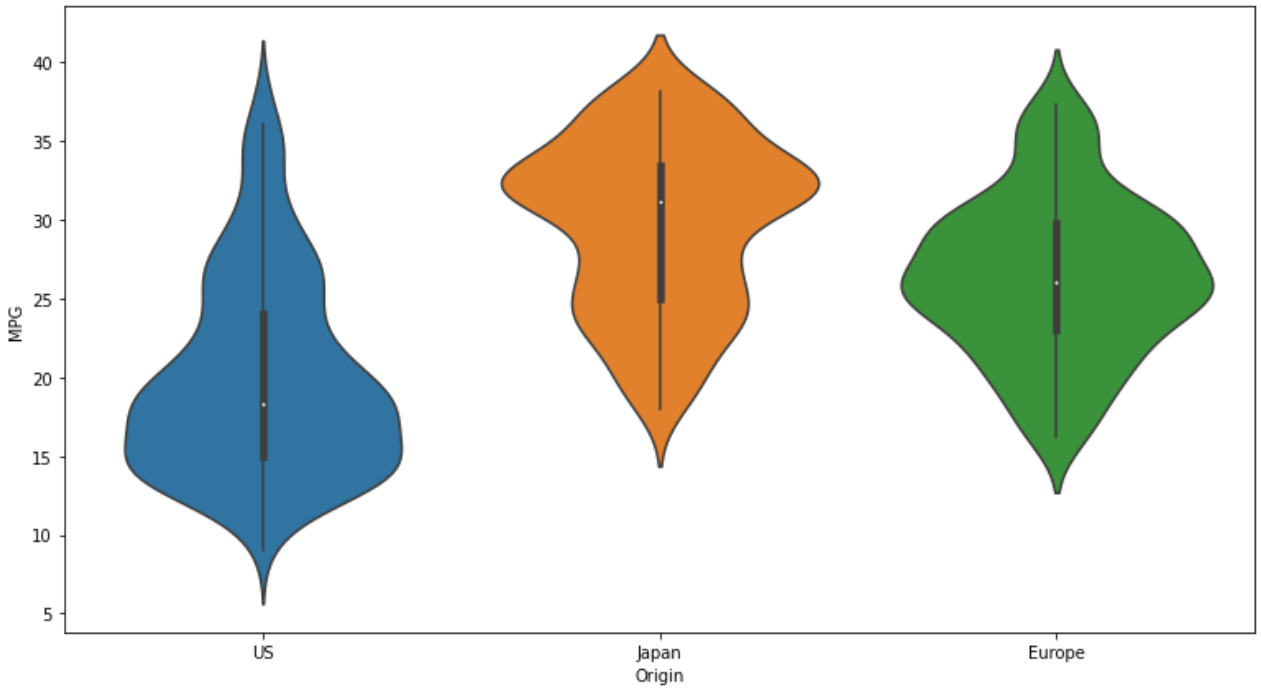
Out[48]: <AxesSubplot:>



EDA and Data Visualization - violinplot

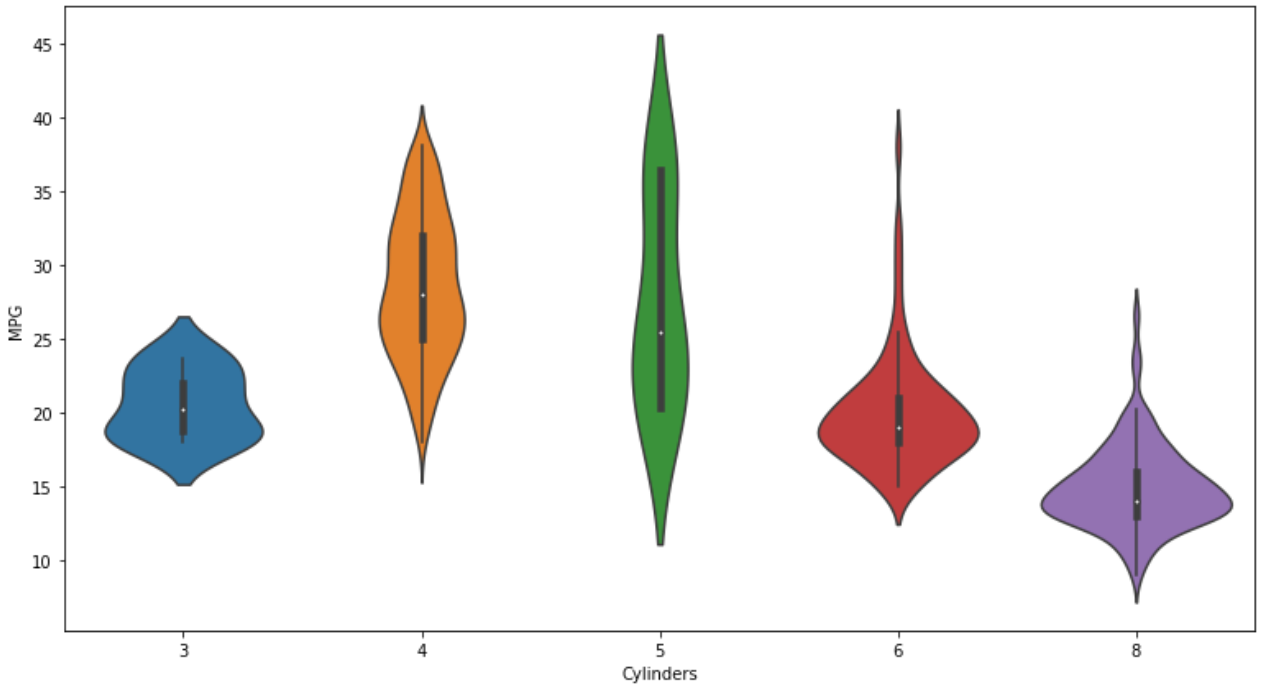
In [49]:
```
#change size of plot
plt.subplots(figsize=(13,7))

#violin plot shows the distribution of attack power for each type
sns.violinplot(x='Origin', y='MPG', data=df)
```

Out[49]: <AxesSubplot:xlabel='Origin', ylabel='MPG'>



In [50]:
```
#change size of plot
plt.subplots(figsize=(13,7))

#violin plot shows the distribution of attack power for each type
sns.violinplot(x='Cylinders', y='MPG', data=df)
```

Out[50]: <AxesSubplot:xlabel='Cylinders', ylabel='MPG'>



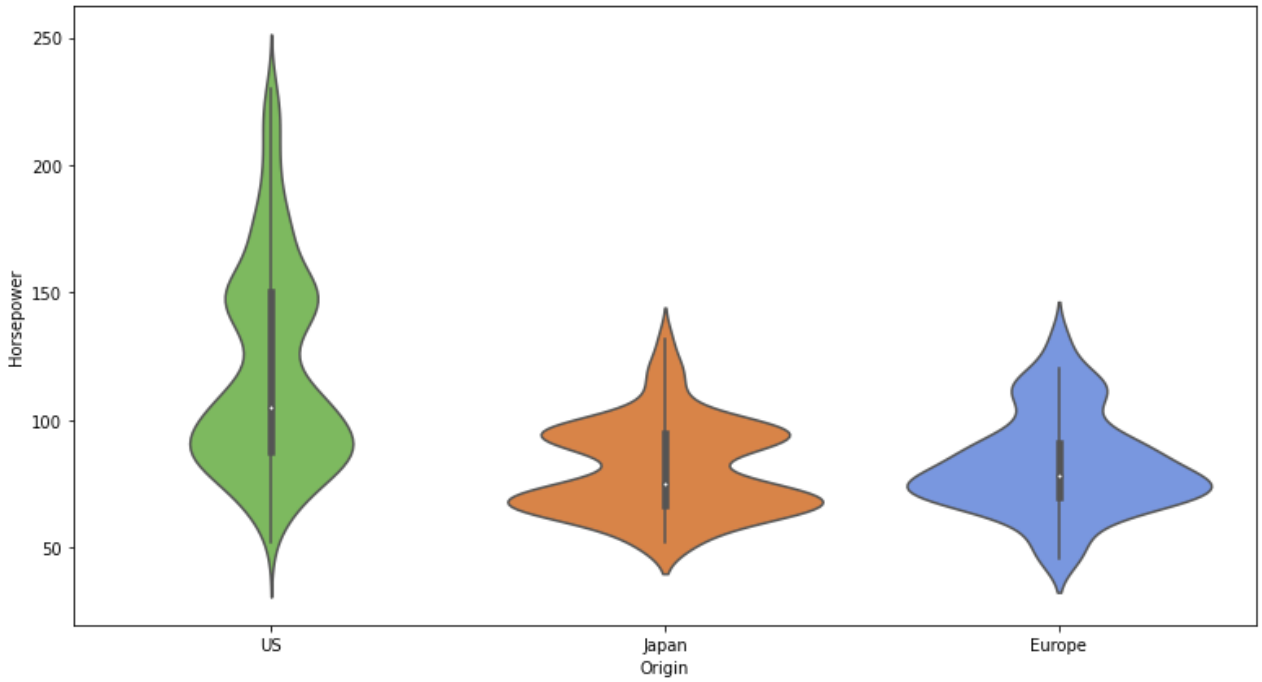
In [51]:
```
#create color palette
#color Hex numbers are from Bulbapedia (https://bulbapedia.bulbagarden.net/wiki/Categor
origin_colors = ['#78C850',  # US
                 '#F08030',  # Europe
```

```
                    '#6890F0'  # Japan
                   ]

#create color palette
#color Hex numbers are from Bulbapedia (https://bulbapedia.bulbagarden.net/wiki/Categor
cylinder_colors = ['#78C850',  # Grass
                   '#F08030',  # Fire
                   '#6890F0',  # Water
                   '#A8B820',  # Bug
                   '#A040A0'  # Poison
                   ]
```

In [52]:

```
#violin plot with Pokemon color palette
plt.subplots(figsize=(13,7))
sns.violinplot(x='Origin', y='Horsepower', data=df, palette=origin_colors)
```

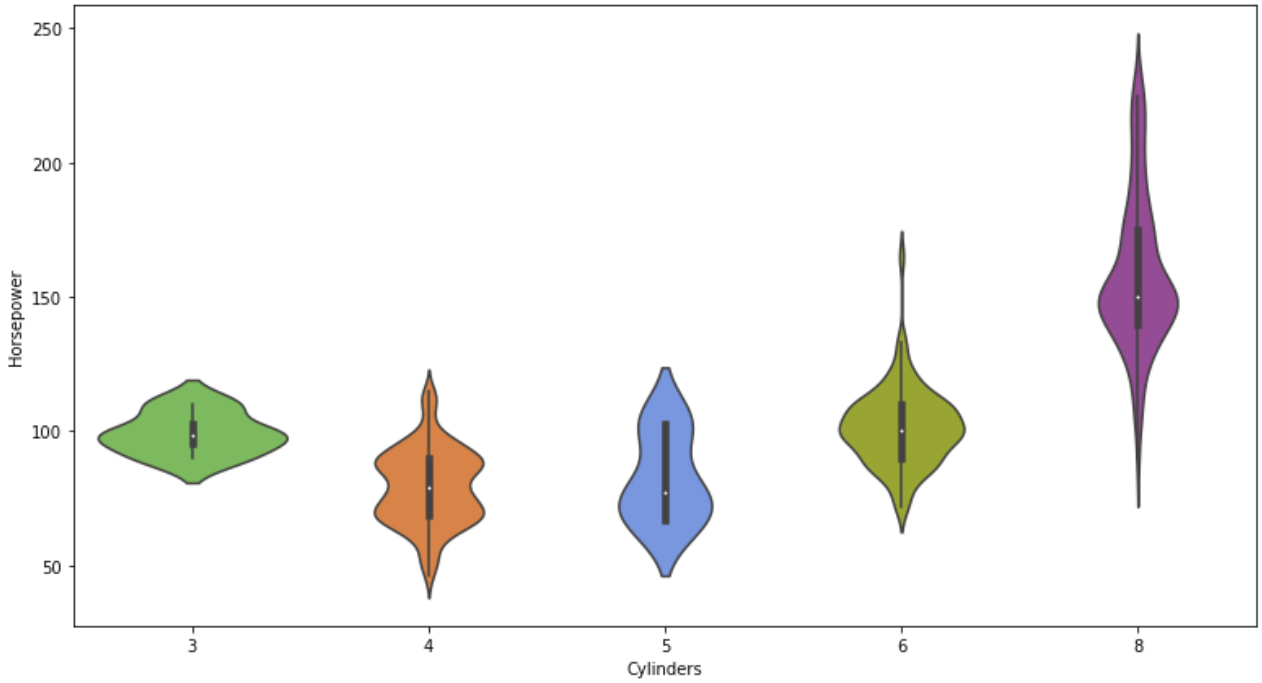
Out[52]: <AxesSubplot:xlabel='Origin', ylabel='Horsepower'>



In [53]:

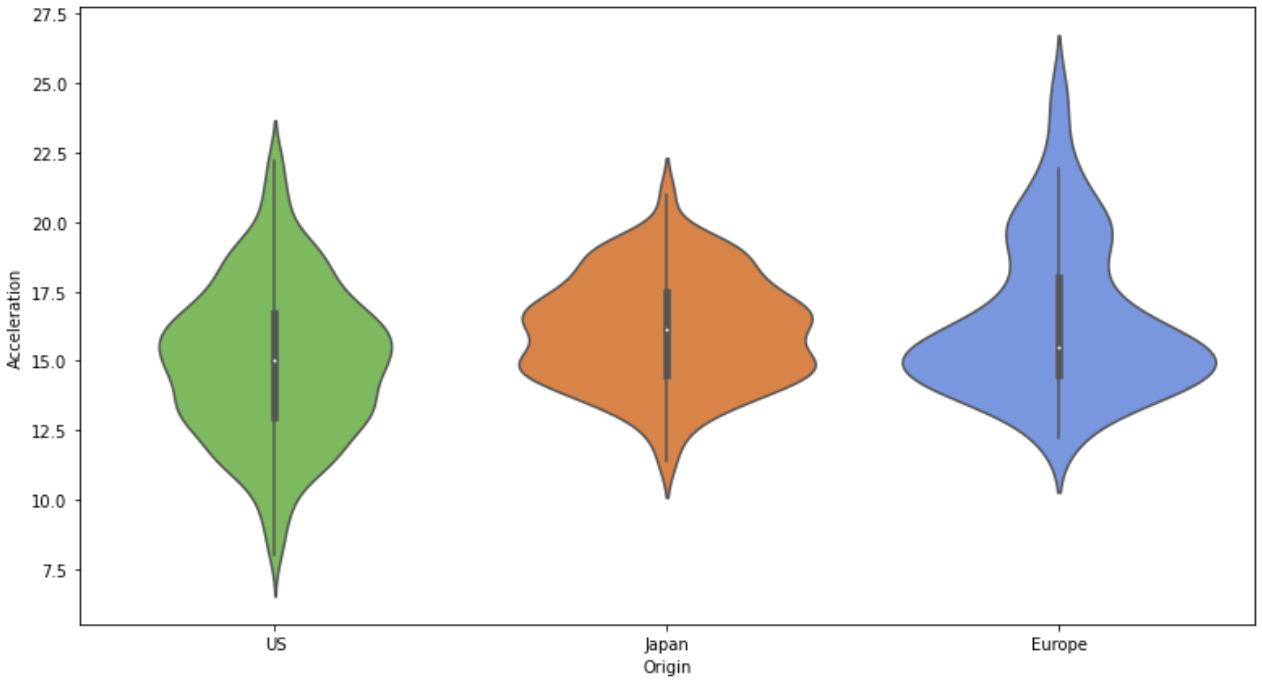
```
#violin plot with Pokemon color palette
plt.subplots(figsize=(13,7))
sns.violinplot(x='Cylinders', y='Horsepower', data=df, palette=cylinder_colors)
```

Out[53]: <AxesSubplot:xlabel='Cylinders', ylabel='Horsepower'>



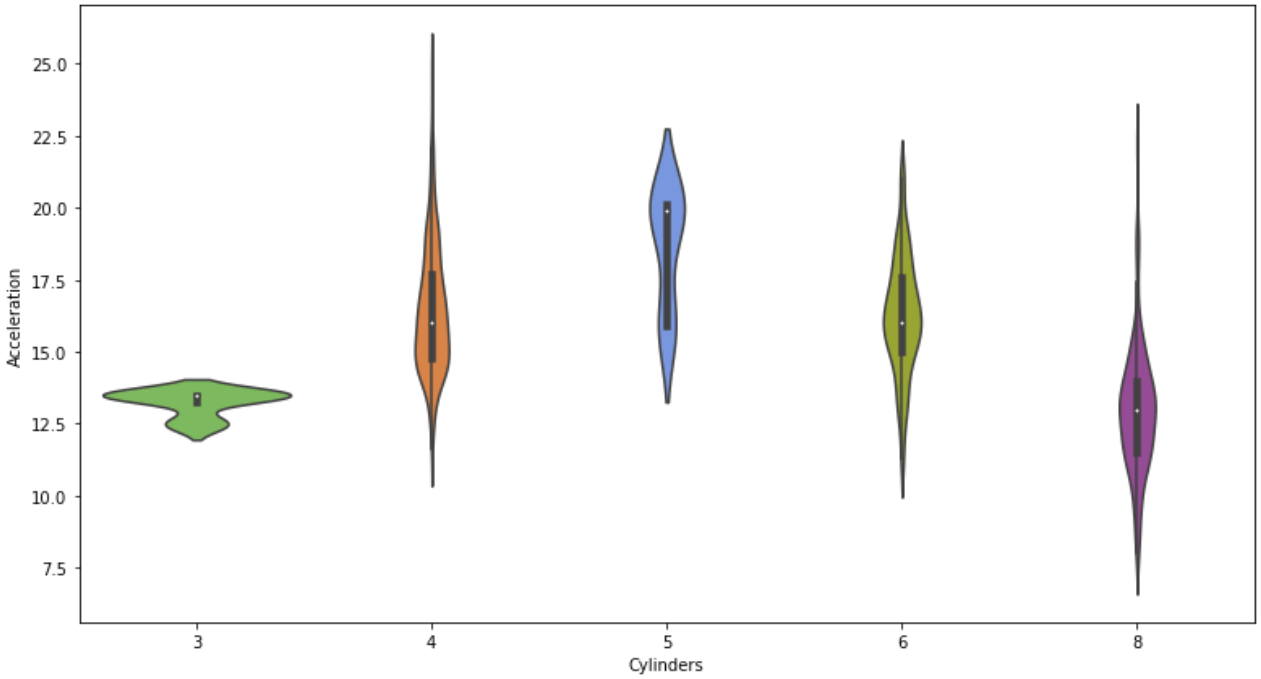
In [54]:
```
#violin plot with Pokemon color palette
plt.subplots(figsize=(13,7))
sns.violinplot(x='Origin', y='Acceleration', data=df, palette=origin_colors)
```

Out[54]:
```
<AxesSubplot:xlabel='Origin', ylabel='Acceleration'>
```



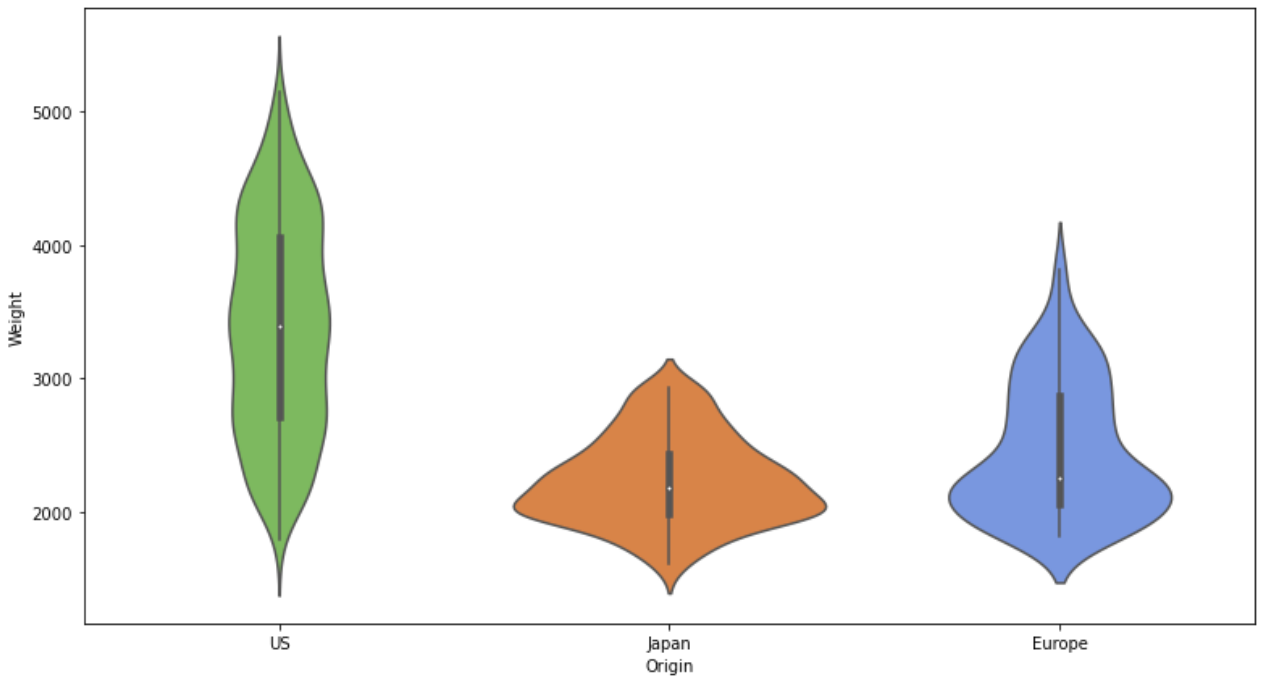
In [55]:
```
#violin plot with Pokemon color palette
plt.subplots(figsize=(13,7))
sns.violinplot(x='Cylinders', y='Acceleration', data=df, palette=cylinder_colors)
```

Out[55]:
```
<AxesSubplot:xlabel='Cylinders', ylabel='Acceleration'>
```



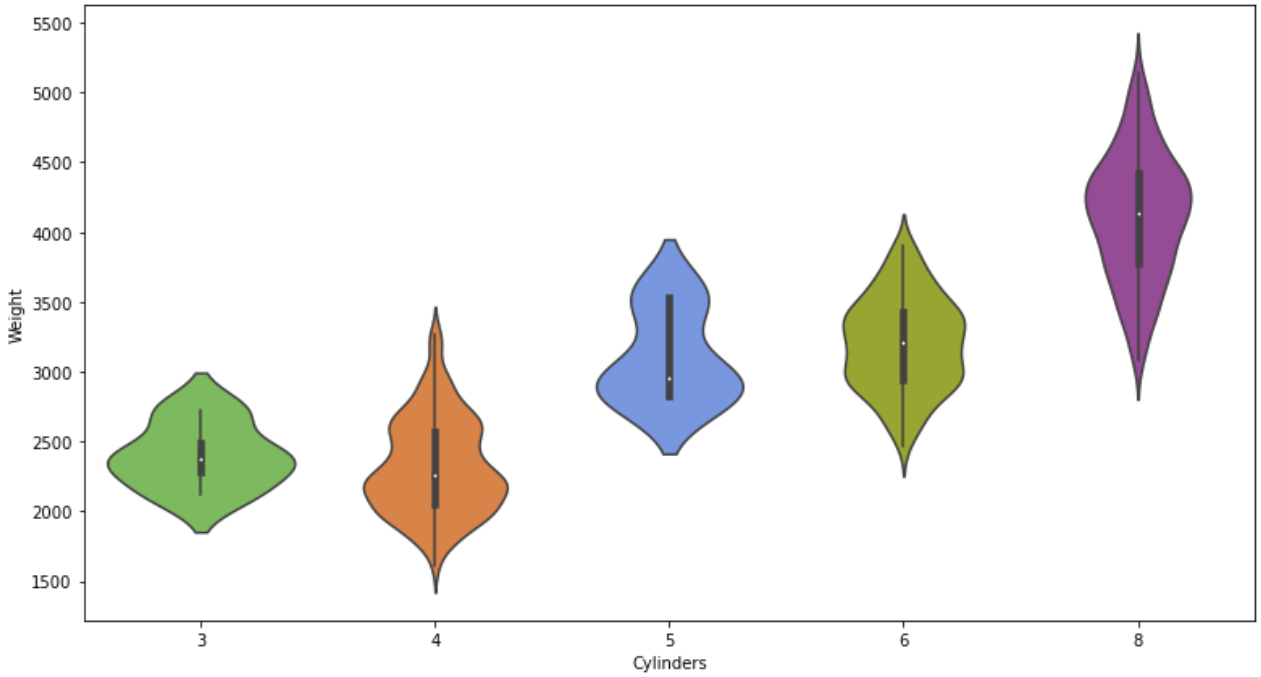
In [56]:
```
#violin plot with Pokemon color palette
plt.subplots(figsize=(13,7))
sns.violinplot(x='Origin', y='Weight', data=df, palette=origin_colors)
```

Out[56]:
```
<AxesSubplot:xlabel='Origin', ylabel='Weight'>
```



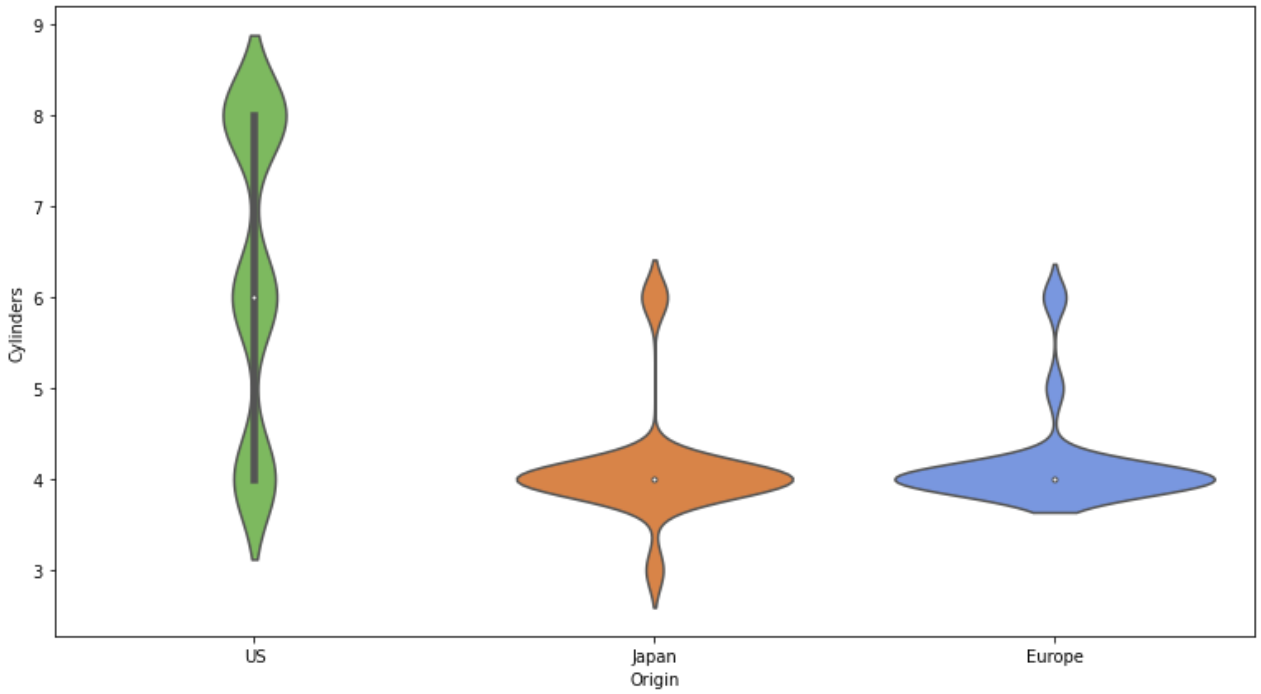
In [57]:
```
#violin plot with Pokemon color palette
plt.subplots(figsize=(13,7))
sns.violinplot(x='Cylinders', y='Weight', data=df, palette=cylinder_colors)
```

Out[57]:
```
<AxesSubplot:xlabel='Cylinders', ylabel='Weight'>
```



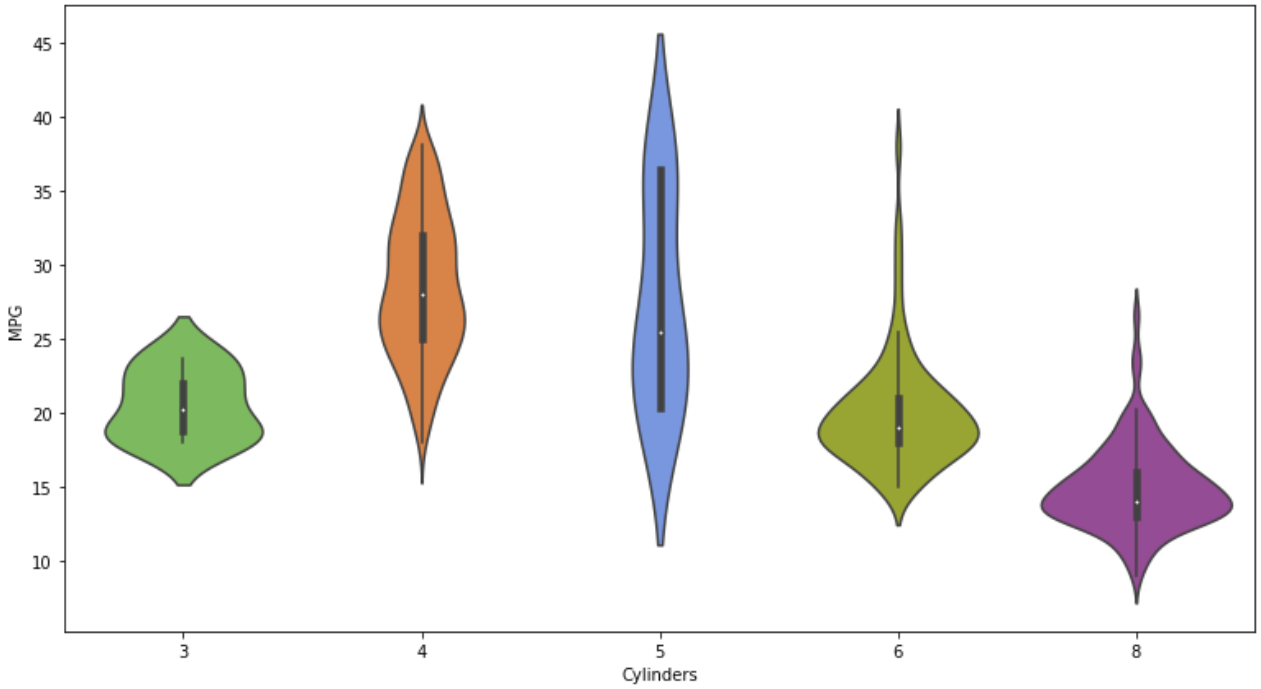
In [58]:
```
#violin plot with Pokemon color palette
plt.subplots(figsize=(13,7))
sns.violinplot(x='Origin', y='Cylinders', data=df, palette=origin_colors)
```

Out[58]:
```
<AxesSubplot:xlabel='Origin', ylabel='Cylinders'>
```



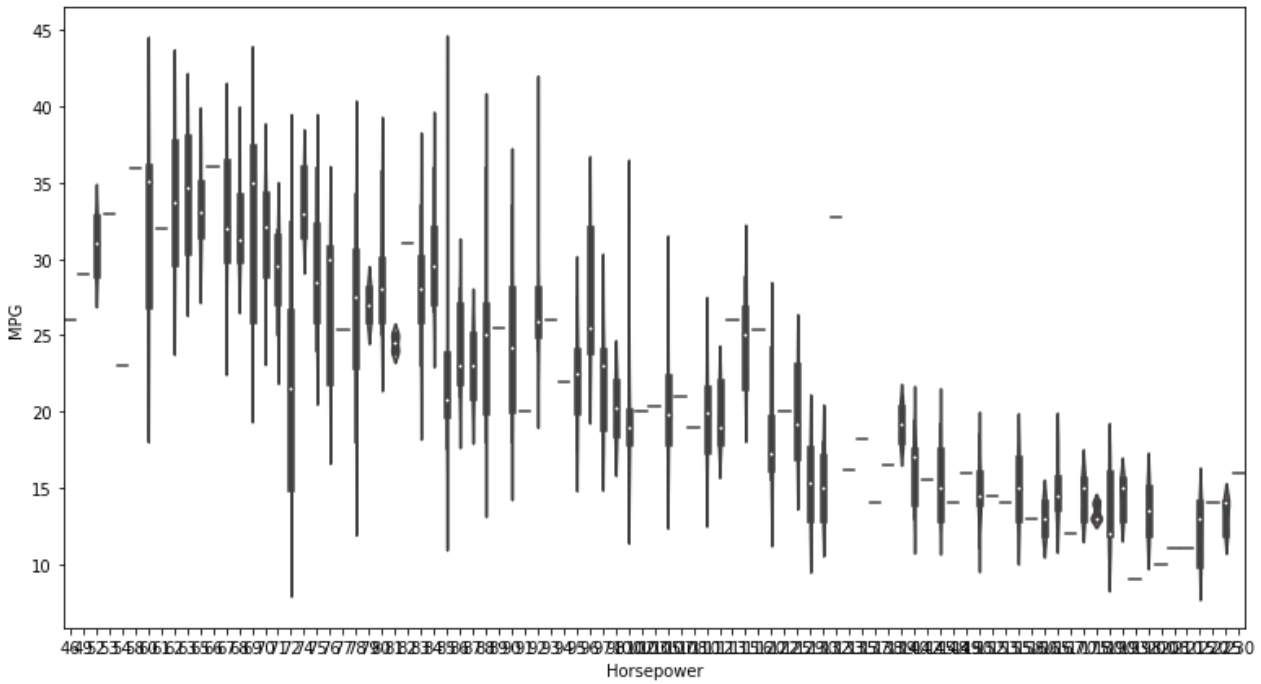
In [59]:
```
#violin plot with Pokemon color palette
plt.subplots(figsize=(13,7))
sns.violinplot(x='Cylinders', y='MPG', data=df, palette=cylinder_colors)
```

Out[59]:
```
<AxesSubplot:xlabel='Cylinders', ylabel='MPG'>
```



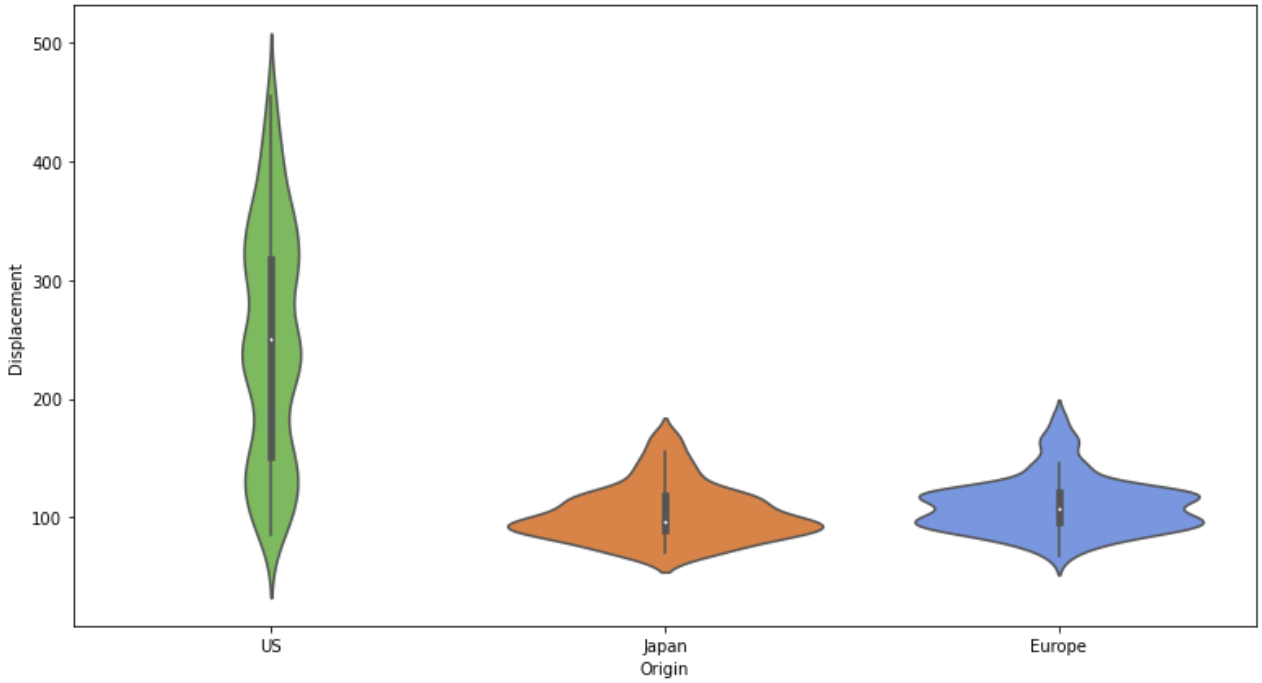
In [60]:
```
#violin plot with MPG-Horsepower
plt.subplots(figsize=(13,7))
sns.violinplot(x='Horsepower', y='MPG', data=df, palette=cylinder_colors)
```

Out[60]:
```
<AxesSubplot:xlabel='Horsepower', ylabel='MPG'>
```



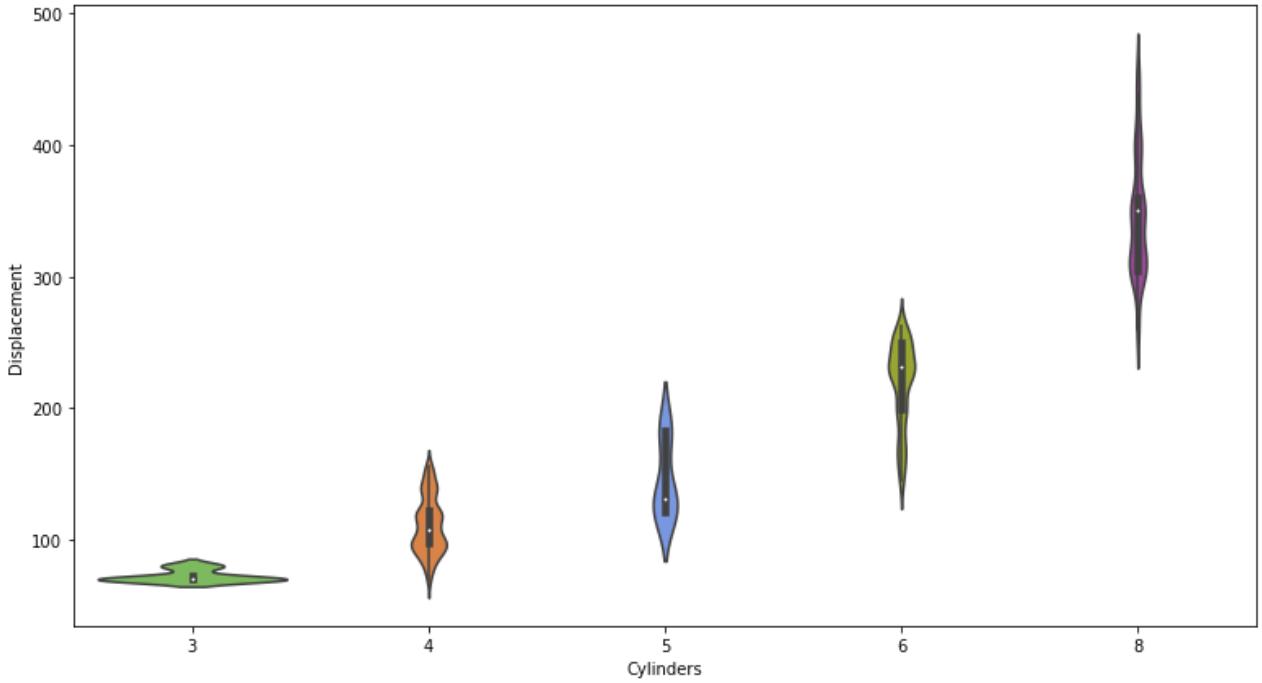
In [61]:
```
#violin plot with Pokemon color palette
plt.subplots(figsize=(13,7))
sns.violinplot(x='Origin', y='Displacement', data=df, palette=origin_colors)
```

Out[61]:
```
<AxesSubplot:xlabel='Origin', ylabel='Displacement'>
```



In [62]:
```
#violin plot with Pokemon color palette
plt.subplots(figsize=(13,7))
sns.violinplot(x='Cylinders', y='Displacement', data=df, palette=cylinder_colors)
```

Out[62]:
```
<AxesSubplot:xlabel='Cylinders', ylabel='Displacement'>
```



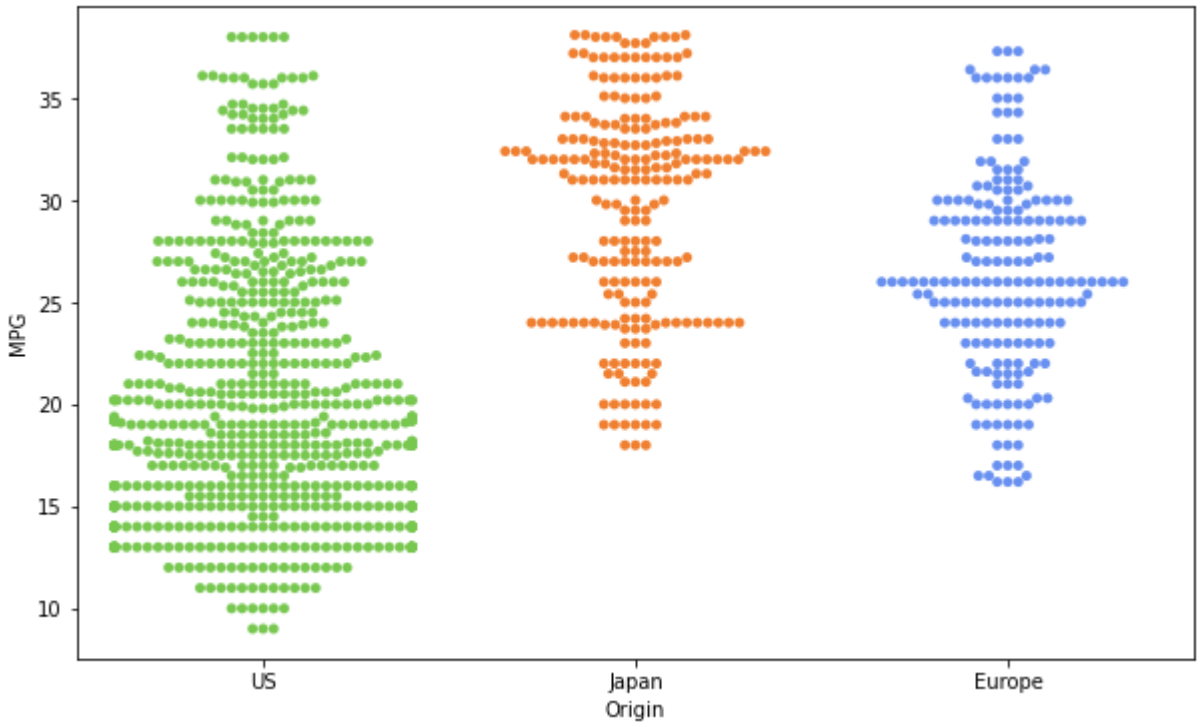
EDA and Data Visualization - swarmplot

In [63]:
```
#swarm plot
plt.subplots(figsize=(10,6))
sns.swarmplot(x='Origin', y='MPG', data=df, palette=origin_colors)
```

```
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 18.
0% of the points cannot be placed; you may want to decrease the size of the markers or u
```

```
se stripplot.
  warnings.warn(msg, UserWarning)
```

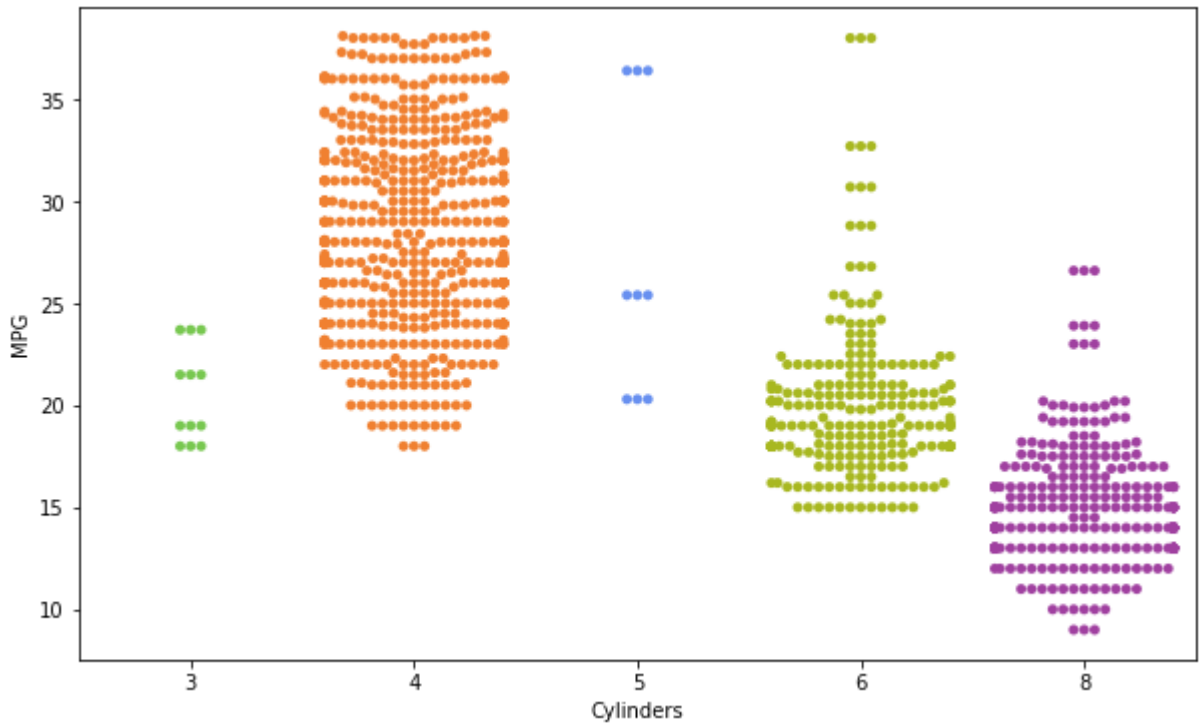
Out[63]:
```
<AxesSubplot:xlabel='Origin', ylabel='MPG'>
```



In [64]:
```
#swarm plot
plt.subplots(figsize=(10,6))
sns.swarmplot(x='Cylinders', y='MPG', data=df, palette=cylinder_colors)
```

```
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 30.
5% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 22.
9% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 35.
6% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
```

Out[64]:
```
<AxesSubplot:xlabel='Cylinders', ylabel='MPG'>
```

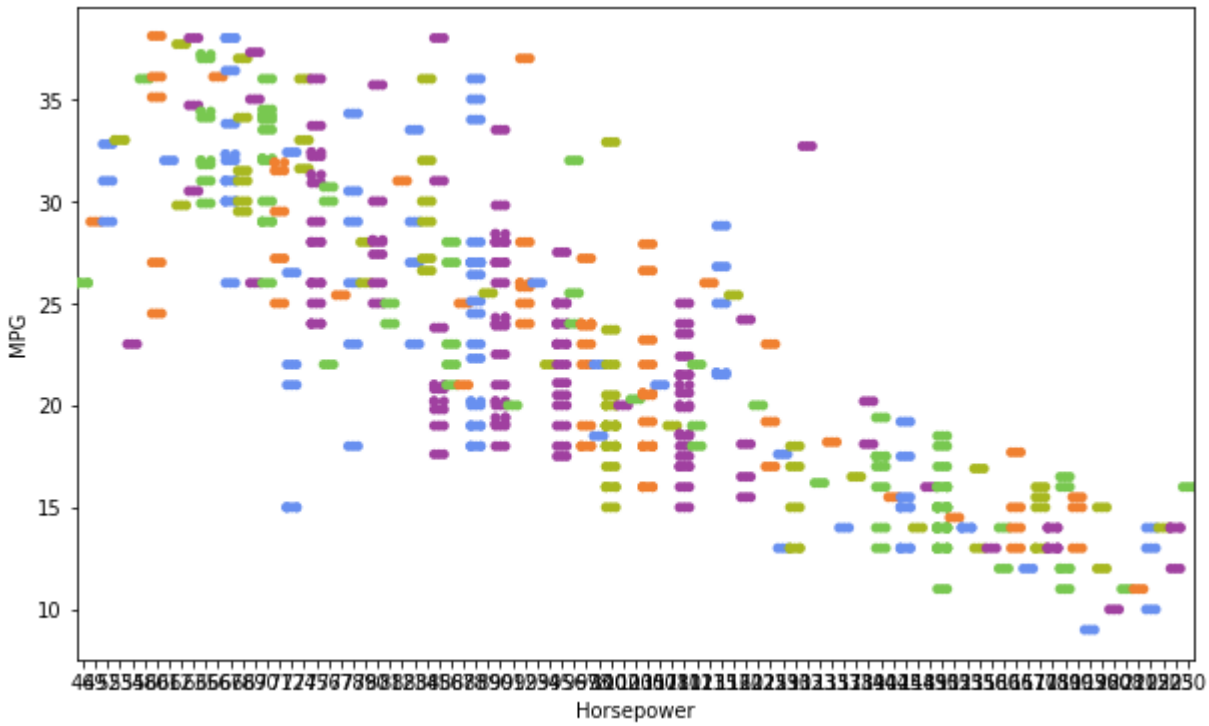


In [65]:
```
#swarm plot for MPG by Horsepower
plt.subplots(figsize=(10,6))
sns.swarmplot(x='Horsepower', y='MPG', data=df, palette=cylinder_colors)
```

```
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 83.
3% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 66.
7% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 79.
2% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 78.
8% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 75.
8% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 73.
3% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 72.
2% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 78.
6% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
```

```
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 71.
4% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 74.
1% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 77.
2% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 81.
7% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 73.
8% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 77.
8% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 80.
4% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 75.
9% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 76.
2% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 87.
9% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 86.
7% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
```

Out[65]: <AxesSubplot:xlabel='Horsepower', ylabel='MPG'>

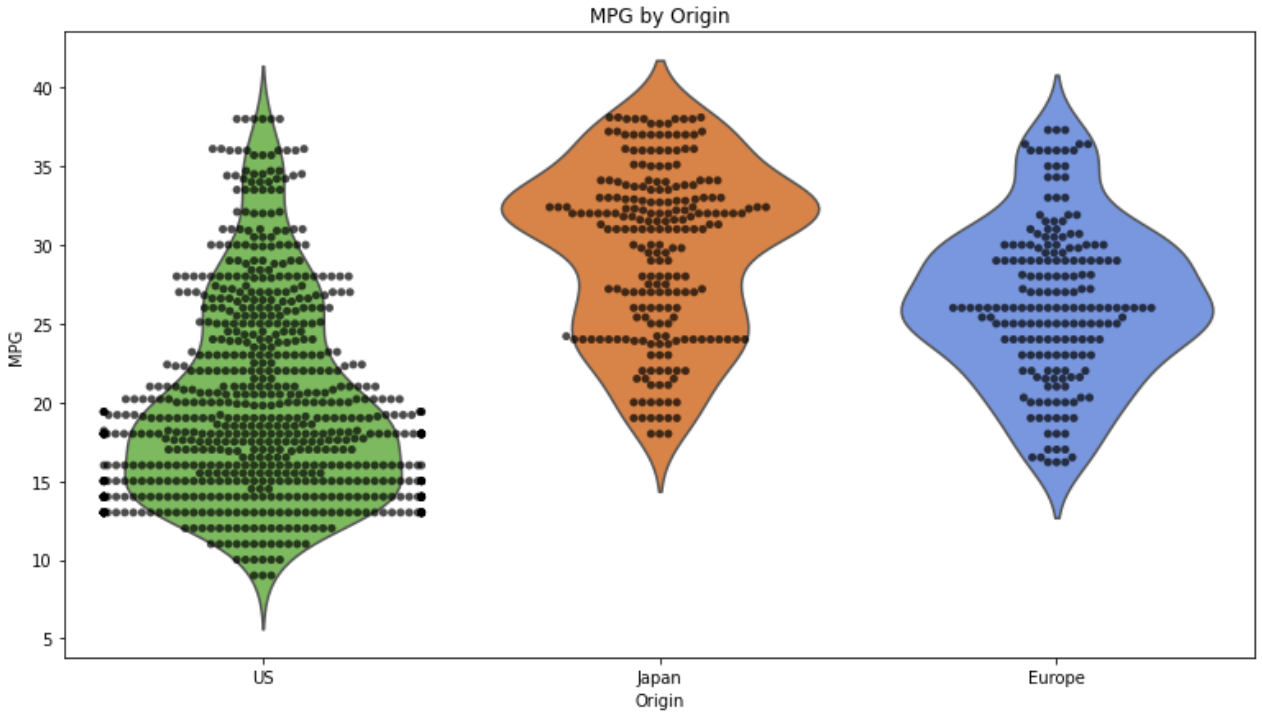


EDA and Data Visualization - swarmplot combine a violin plot with a swarm plot

In [66]:
```
#combine a violin plot with a swarm plot
plt.figure(figsize=(13,7))
sns.violinplot(x='Origin',
               y='MPG',
               data=df,
               inner=None, #removes bars inside violin plot
               palette=origin_colors)

sns.swarmplot(x='Origin',
              y='MPG',
              data=df,
              color='k', #make points black
              alpha=0.7) #slightly transparent

plt.title('MPG by Origin')
```

```
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 10.
8% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
```

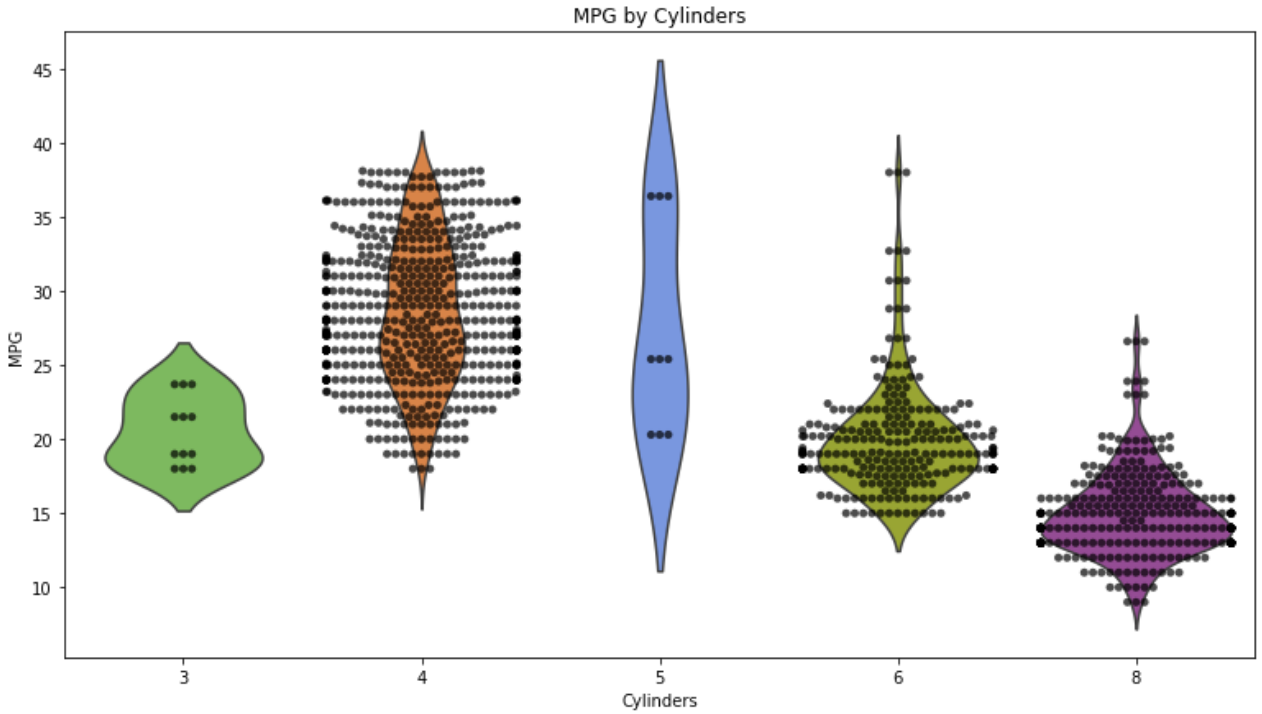
Out[66]:
```
Text(0.5, 1.0, 'MPG by Origin')
```



In [67]:
```
#combine a violin plot with a swarm plot
plt.figure(figsize=(13,7))
sns.violinplot(x='Cylinders',
               y='MPG',
               data=df,
               inner=None, #removes bars inside violin plot
               palette=cylinder_colors)

sns.swarmplot(x='Cylinders',
              y='MPG',
              data=df,
              color='k', #make points black
              alpha=0.7) #slightly transparent

plt.title('MPG by Cylinders')
```

```
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 19.
9% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 15.
7% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 27.
5% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
```

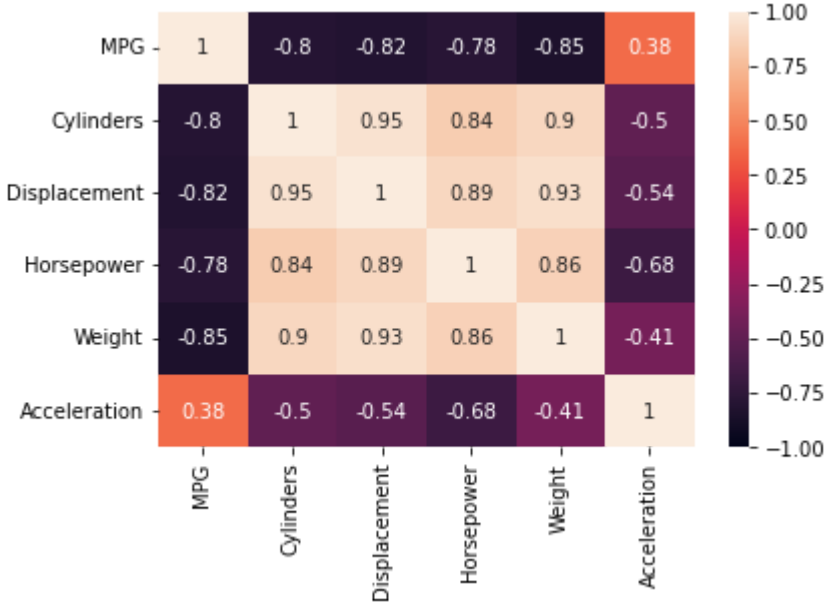
Out[67]:
```
Text(0.5, 1.0, 'MPG by Cylinders')
```



EDA and Data Visualization - heatmap

In [68]:
```
#show correlation of stats via heatmap
#corr = stats_df.corr()
corr = df.corr()
sns.heatmap(corr, vmin=-1, annot=True)
```

Out[68]:
```
<AxesSubplot:>
```



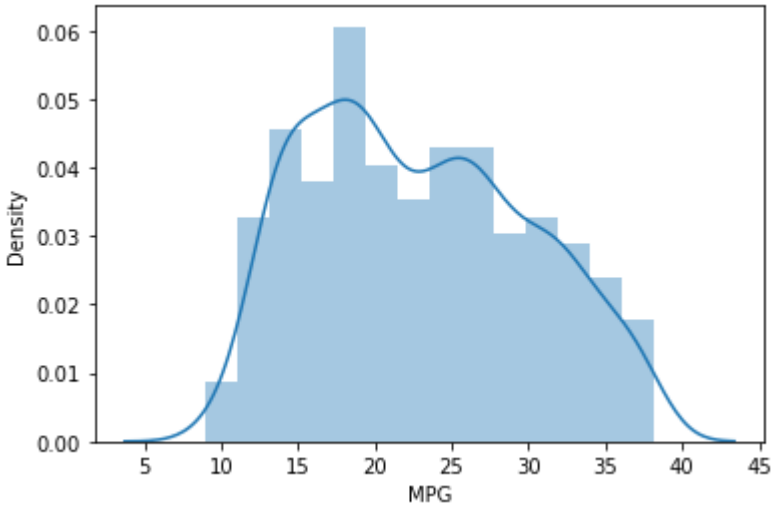
EDA and Data Visualization - distplot

In [69]:
```
#create a histogram of the distribution of MPG
sns.distplot(df['MPG'])
```

```
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\distributions.py:2619: FutureWarning:
```

```
`distplot` is a deprecated function and will be removed in a future version. Please adap
t your code to use either `displot` (a figure-level function with similar flexibility) o
r `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

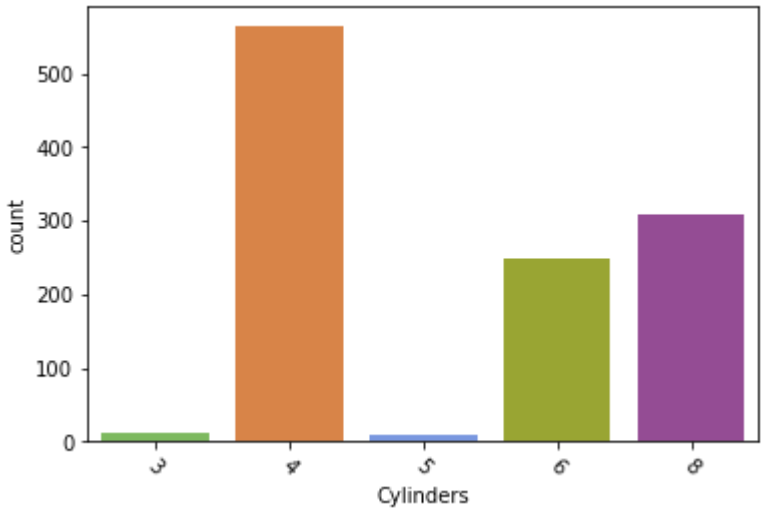
Out[69]:
```
<AxesSubplot:xlabel='MPG', ylabel='Density'>
```



EDA and Data Visualization - countplot

In [70]:
```
#create a bar plot of MPG frequency
sns.countplot(x='Cylinders',
              data=df,
              palette=cylinder_colors)

plt.xticks(rotation=-45)
```

Out[70]:
```
(array([0, 1, 2, 3, 4]),
 [Text(0, 0, '3'),
  Text(1, 0, '4'),
  Text(2, 0, '5'),
  Text(3, 0, '6'),
  Text(4, 0, '8')])
```



EDA and Data Visualization - factorplot

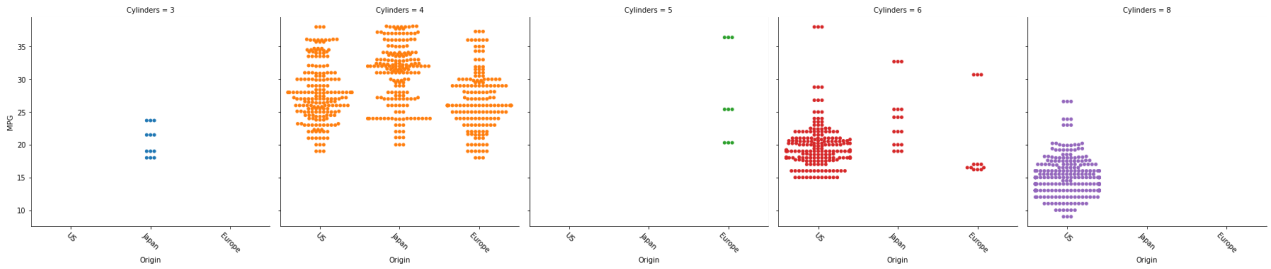
In [71]:
```
#scatterplot by origin (evolution level)
```

```
g = sns.factorplot(x='Origin', y='MPG',
                   data=df,
                   hue='Cylinders',
                   col='Cylinders',
                   kind='swarm')

#rotate x-axis labels on ALL charts
g.set_xticklabels(rotation=-45)
```

```
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:3717: UserWarning: The
`factorplot` function has been renamed to `catplot`. The original name will be removed i
n a future release. Please update your code. Note that the default `kind` in `factorplot
` (`'point'`) has changed `'strip'` in `catplot`.
  warnings.warn(msg)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 17.
8% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\categorical.py:1296: UserWarning: 35.
6% of the points cannot be placed; you may want to decrease the size of the markers or u
se stripplot.
  warnings.warn(msg, UserWarning)
```

Out[71]:

```
<seaborn.axisgrid.FacetGrid at 0x202df3a5340>
```



In [72]:

```
#creates a table of correlation values
#stats_df.corr()
df.corr()
```

Out[72]:

	MPG	Cylinders	Displacement	Horsepower	Weight	Acceleration
MPG	1.000000	-0.796957	-0.819711	-0.781986	-0.845981	0.382623
Cylinders	-0.796957	1.000000	0.949895	0.840144	0.895852	-0.500983
Displacement	-0.819711	0.949895	1.000000	0.894782	0.931252	-0.539336
Horsepower	-0.781986	0.840144	0.894782	1.000000	0.860802	-0.684429
Weight	-0.845981	0.895852	0.931252	0.860802	1.000000	-0.405727
Acceleration	0.382623	-0.500983	-0.539336	-0.684429	-0.405727	1.000000

In [73]:

```
#use this library to build a statistical test for linear regression
import statsmodels.formula.api as smf
```

In [74]:

```
#OLS is Ordinary Least Squares, the most common type of linear regression
#the fit function uses the predictive values to calculate the best linear regression li
result = smf.ols('MPG ~ Cylinders + Horsepower + Weight + Acceleration', data=df).fit()
```

In [75]:
```
#the summary will show the calculated values (slopes and y-intercept) for the linear re
#the closer to 1 the r-squared value is, the better the fit of the linear regression li
#the p-value shows how statistically significant a predictive feature could be the mode

result.summary()
```

Out[75]:

OLS Regression Results

Dep. Variable:	MPG	**R-squared:**	0.734
Model:	OLS	**Adj. R-squared:**	0.733
Method:	Least Squares	**F-statistic:**	784.1
Date:	Sat, 09 Apr 2022	**Prob (F-statistic):**	0.00
Time:	17:04:44	**Log-Likelihood:**	-3120.8
No. Observations:	1143	**AIC:**	6252.
Df Residuals:	1138	**BIC:**	6277.
Df Model:	4		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	48.9140	1.282	38.150	0.000	46.398	51.430
Cylinders	-0.6894	0.155	-4.458	0.000	-0.993	-0.386
Horsepower	-0.0540	0.008	-6.584	0.000	-0.070	-0.038
Weight	-0.0042	0.000	-11.095	0.000	-0.005	-0.003
Acceleration	-0.2555	0.066	-3.865	0.000	-0.385	-0.126

Omnibus:	44.301	**Durbin-Watson:**	0.903
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	51.830
Skew:	0.437	**Prob(JB):**	5.56e-12
Kurtosis:	3.570	**Cond. No.**	3.65e+04

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The condition number is large, 3.65e+04. This might indicate that there are
strong multicollinearity or other numerical problems.

In [76]:
```
result = smf.ols('MPG ~ Cylinders + Horsepower + Weight + Acceleration + Displacement -
result.summary()
```

Out[76]:

OLS Regression Results

Dep. Variable:	MPG	**R-squared (uncentered):**	0.950

Model:	OLS	**Adj. R-squared (uncentered):**	0.950
Method:	Least Squares	**F-statistic:**	4333.
Date:	Sat, 09 Apr 2022	**Prob (F-statistic):**	0.00
Time:	17:04:44	**Log-Likelihood:**	-3541.4
No. Observations:	1143	**AIC:**	7093.
Df Residuals:	1138	**BIC:**	7118.
Df Model:	5		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Cylinders	2.1919	0.277	7.900	0.000	1.648	2.736
Horsepower	0.1395	0.009	14.898	0.000	0.121	0.158
Weight	-0.0059	0.001	-9.855	0.000	-0.007	-0.005
Acceleration	1.6805	0.054	31.206	0.000	1.575	1.786
Displacement	-0.0629	0.006	-10.215	0.000	-0.075	-0.051

Omnibus:	20.755	**Durbin-Watson:**	1.015
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	33.433
Skew:	0.139	**Prob(JB):**	5.50e-08
Kurtosis:	3.791	**Cond. No.**	5.49e+03

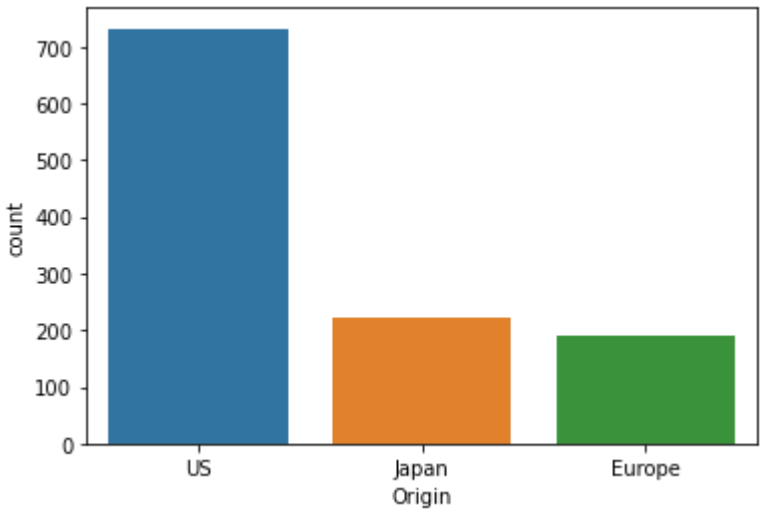
Notes:
[1] R^2 is computed without centering (uncentered) since the model does not contain a constant.
[2] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[3] The condition number is large, 5.49e+03. This might indicate that there are
strong multicollinearity or other numerical problems.

In [77]:
```
import pandas as pd
import numpy as np
import sklearn
import matplotlib.pyplot as plt
import seaborn as sns

%matplotlib inline

from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import train_test_split
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
from sklearn.metrics import accuracy_score
```

In [78]:

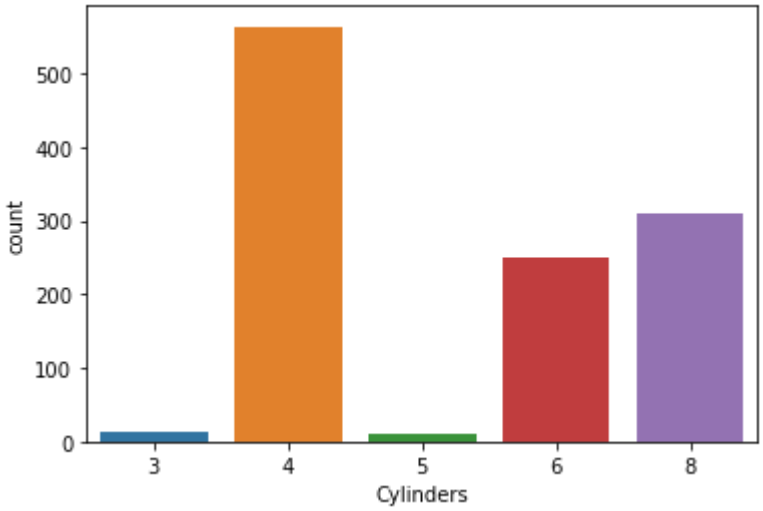
```
#bar chart of survival status count
sns.countplot(x='Origin', data=df)
```

Out[78]:
```
<AxesSubplot:xlabel='Origin', ylabel='count'>
```



In [79]:
```
#bar chart of survival status count
sns.countplot(x='Cylinders', data=df)
```

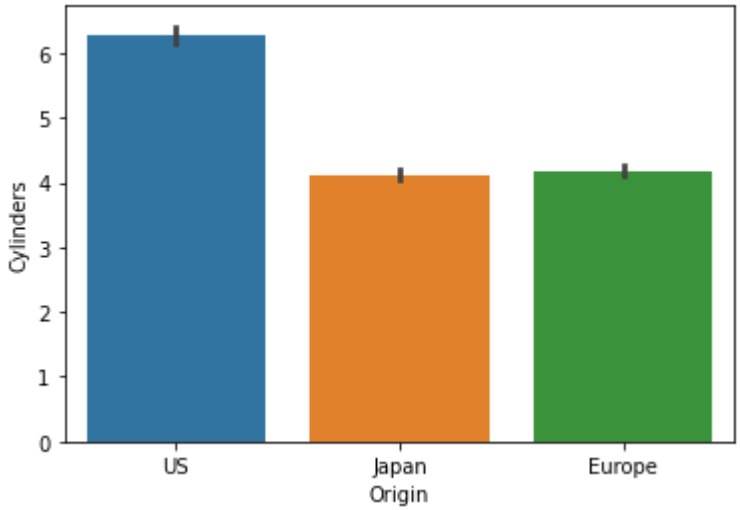
Out[79]:
```
<AxesSubplot:xlabel='Cylinders', ylabel='count'>
```



In [80]:
```
#survival status by sex
sns.barplot('Origin', 'Cylinders', data=df)
```

```
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pas
s the following variables as keyword args: x, y. From version 0.12, the only valid posit
ional argument will be `data`, and passing other arguments without an explicit keyword w
ill result in an error or misinterpretation.
  warnings.warn(
```

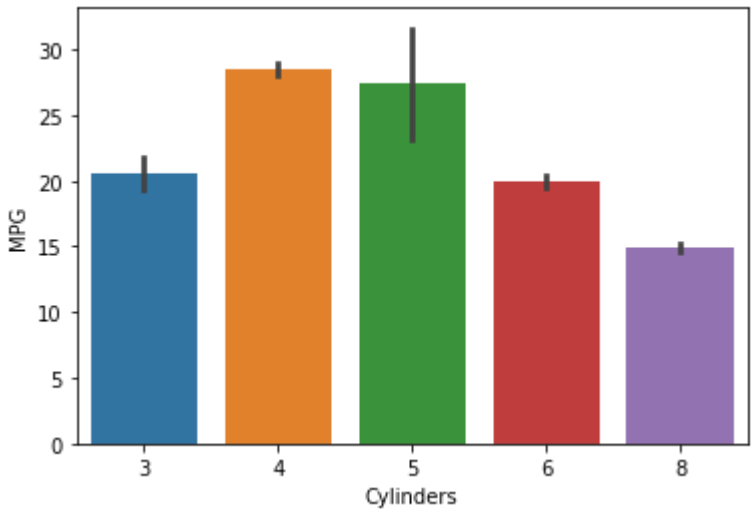
Out[80]:
```
<AxesSubplot:xlabel='Origin', ylabel='Cylinders'>
```



In [81]:
```
#survival status by sex
sns.barplot('Cylinders', 'MPG', data=df)
```

```
C:\Users\wrxio\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pas
s the following variables as keyword args: x, y. From version 0.12, the only valid posit
ional argument will be `data`, and passing other arguments without an explicit keyword w
ill result in an error or misinterpretation.
  warnings.warn(
```

Out[81]:
```
<AxesSubplot:xlabel='Cylinders', ylabel='MPG'>
```

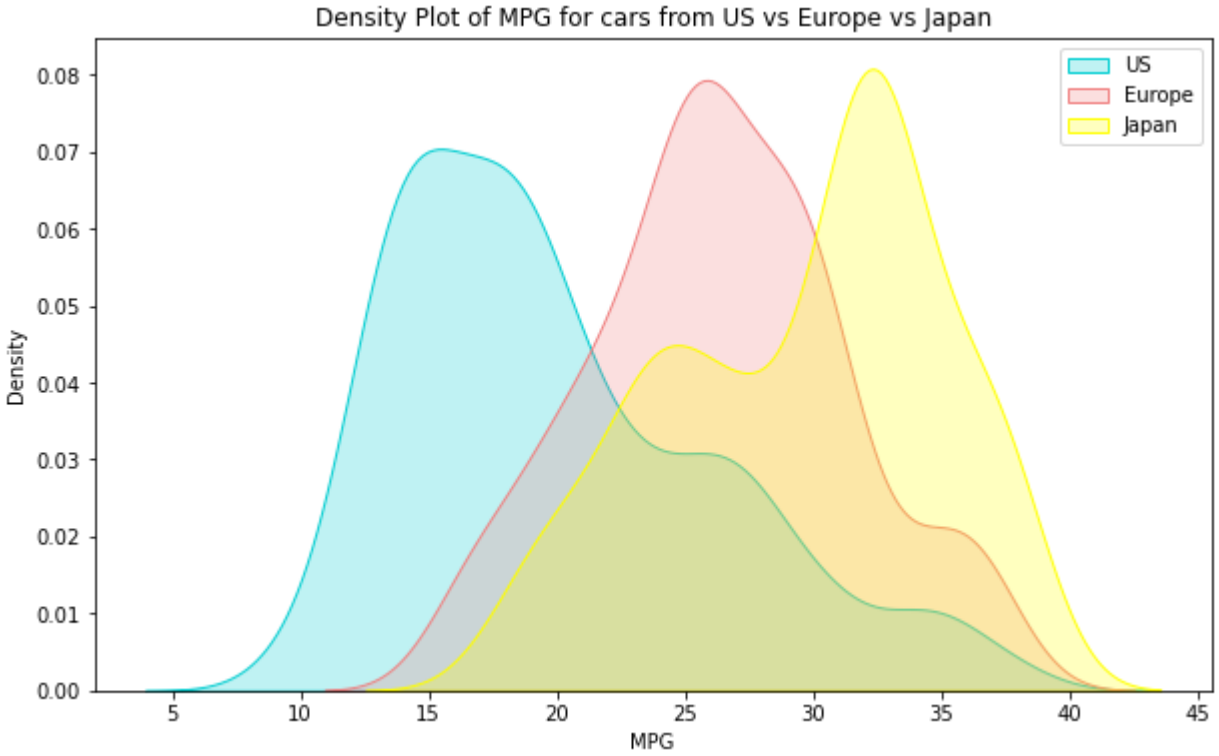


EDA and Data Visualization - kdeplot

In [82]:
```
#plot MPG by origin
plt.figure(figsize=(10,6))

ax = sns.kdeplot(df['MPG'][df['Origin'] == 'US'], #cars from US
                 color="darkturquoise",
                 shade=True)

sns.kdeplot(df['MPG'][df['Origin'] == 'Europe'], #cars from Europe
            color="lightcoral",
            shade=True)
```

```
sns.kdeplot(df['MPG'][df['Origin'] == 'Japan'], #cars from Japan
            color="yellow",
            shade=True)

plt.legend (['US', 'Europe', 'Japan'])
plt.title("Density Plot of MPG for cars from US vs Europe vs Japan")

ax.set(xlabel='MPG')
#plt.show()
```

Out[82]:
```
[Text(0.5, 0, 'MPG')]
```



In [83]:
```
#find columns that have missing values
df.isnull().sum()
```

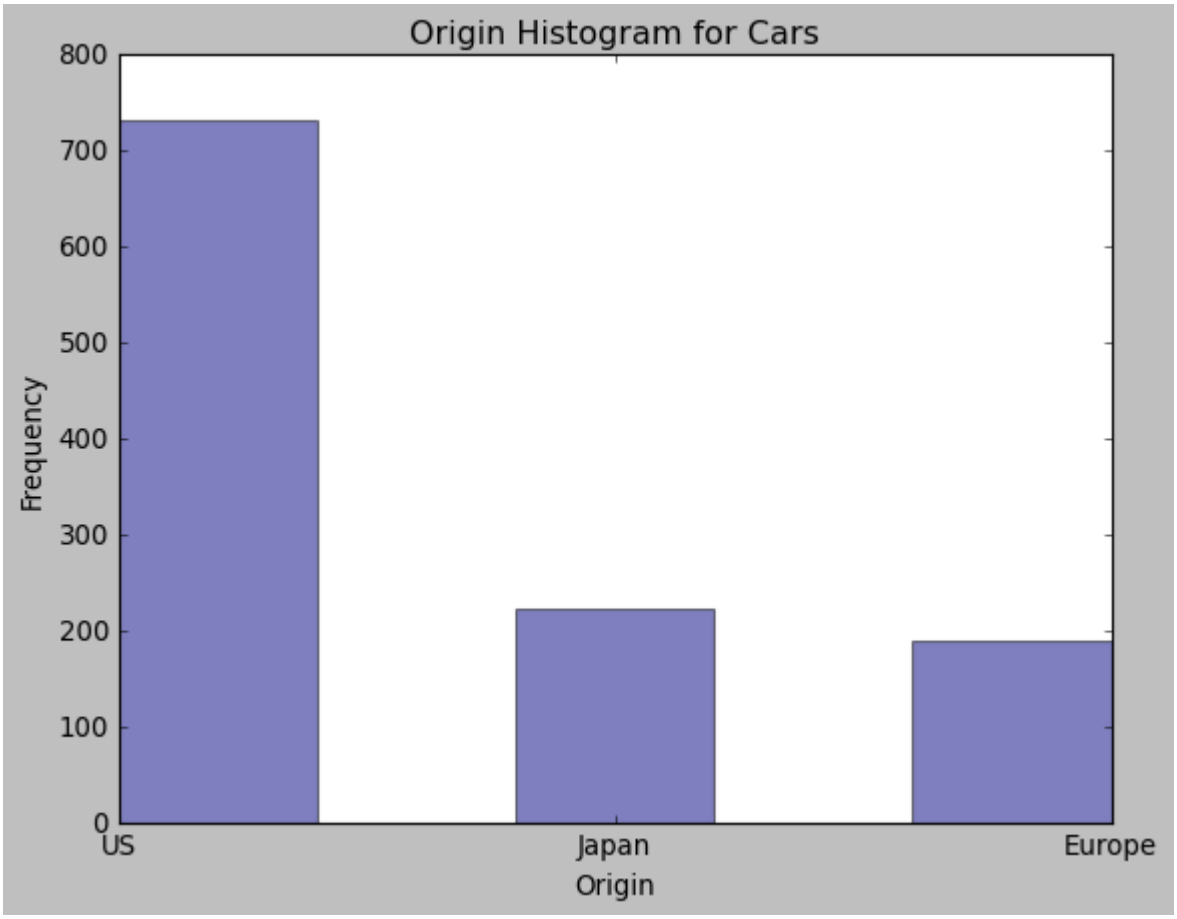
Out[83]:
```
Car             0
MPG             0
Cylinders       0
Displacement    0
Horsepower      0
Weight          0
Acceleration    0
Origin          0
dtype: int64
```

EDA and Data Visualization with Matplotlib and Seaborn

In [84]:
```
# Basic Plots with Matplotlib
import matplotlib as mpl
import matplotlib.pyplot as plt
plt.style.use('classic')
```

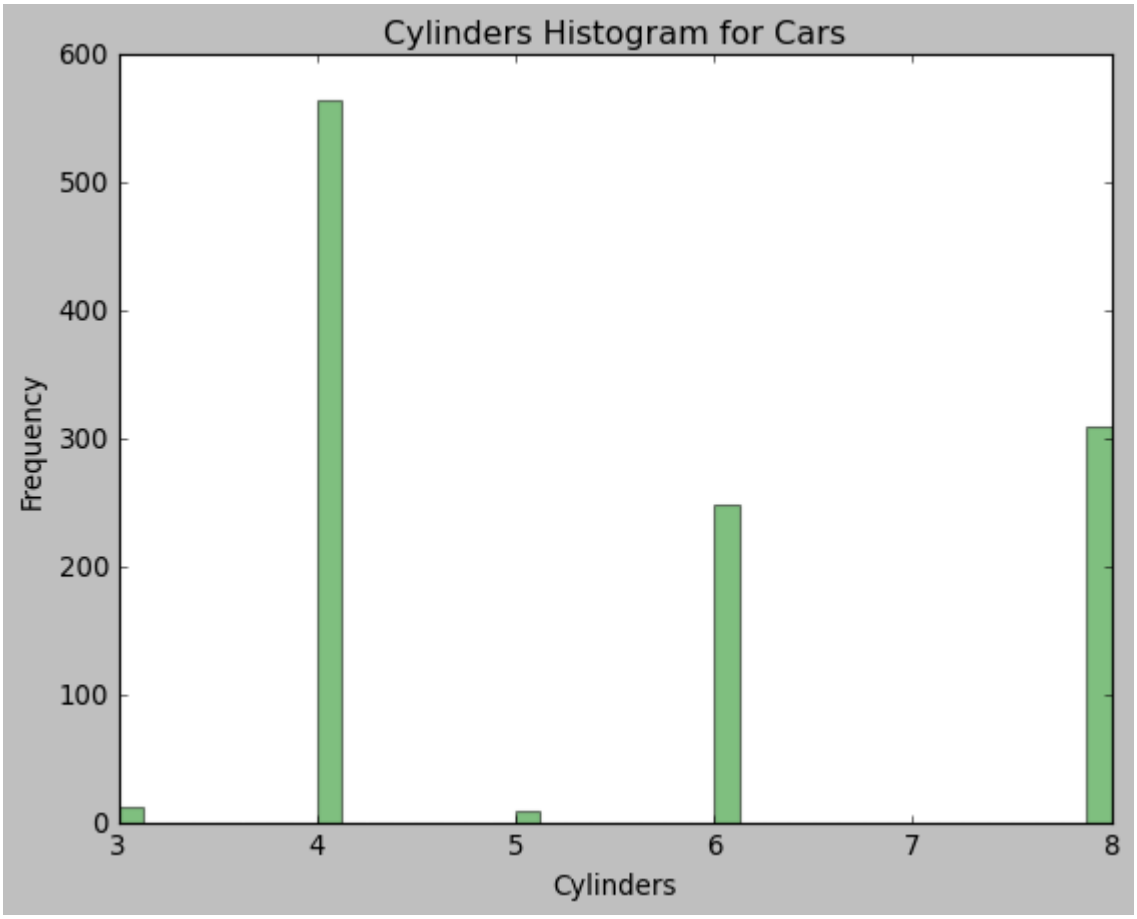
In [85]:
```
# Origin Histogram
```

```
plt.hist(df.Origin, bins=5, facecolor='navy', alpha=0.5)
plt.title('Origin Histogram for Cars')
plt.xlabel('Origin')
plt.ylabel('Frequency')
plt.show()
```

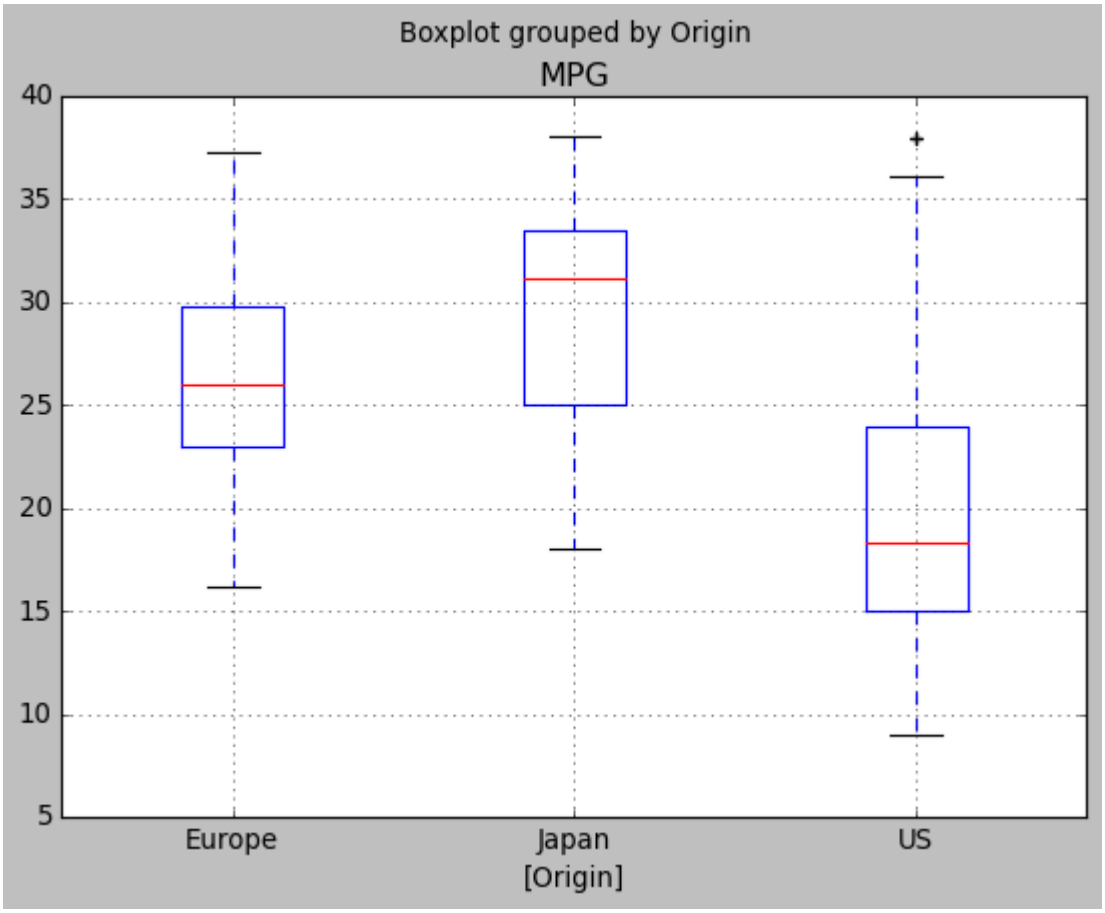


In [86]:

```
# Age Histogram
plt.hist(df.Cylinders, bins=40, facecolor='green', alpha=0.5)
plt.title('Cylinders Histogram for Cars')
plt.xlabel('Cylinders')
plt.ylabel('Frequency')
plt.show()
```

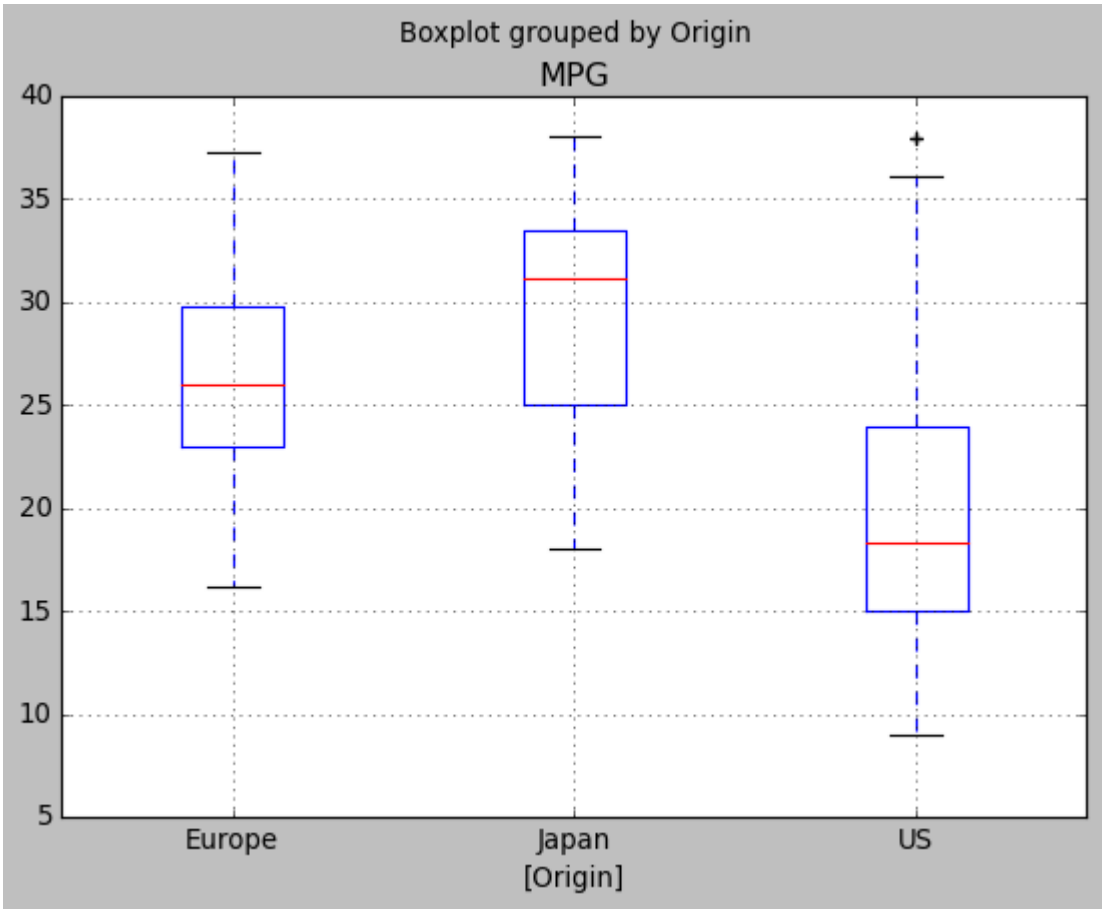


In [87]:
```
# Boxplot
boxplot = df.boxplot(column=['MPG' ], by = ['Origin'])
```



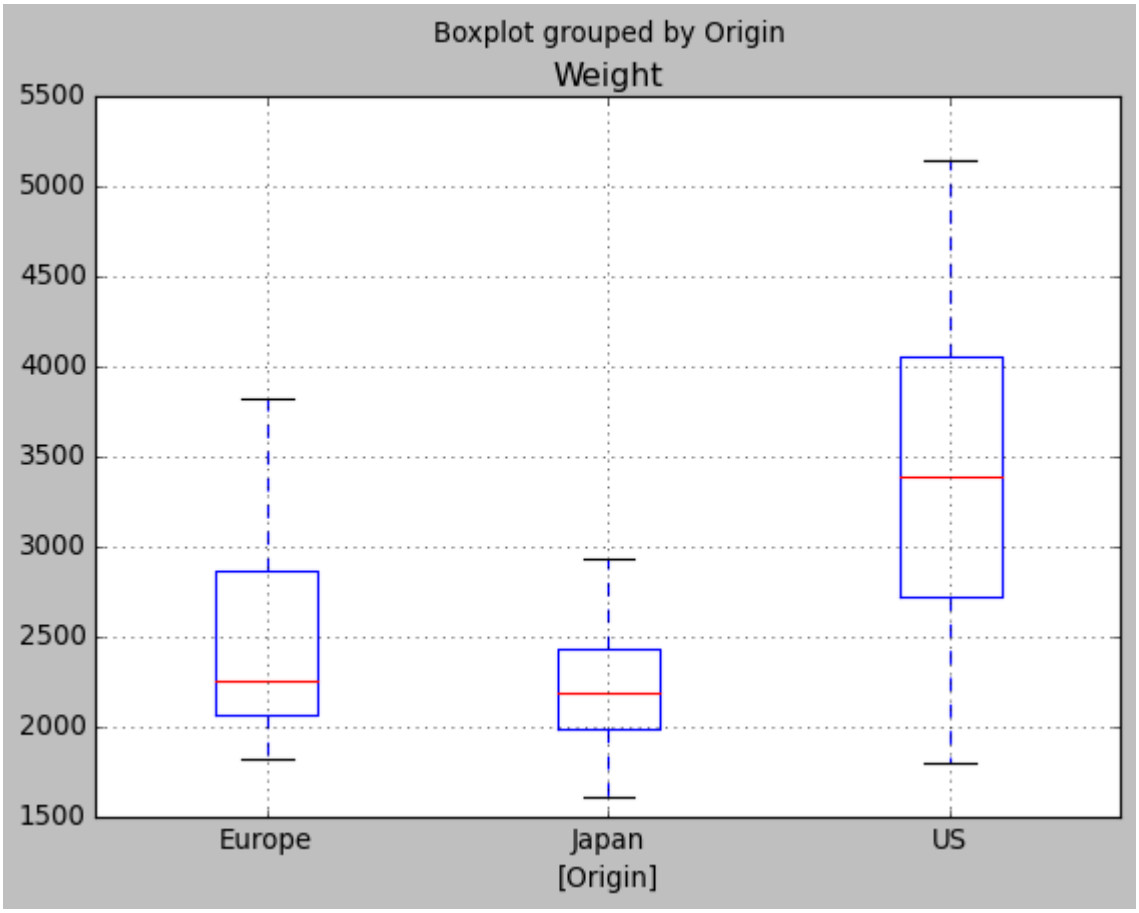
In [88]:

```
# Boxplot
boxplot = df.boxplot(column=['MPG' ], by = ['Origin'])
```



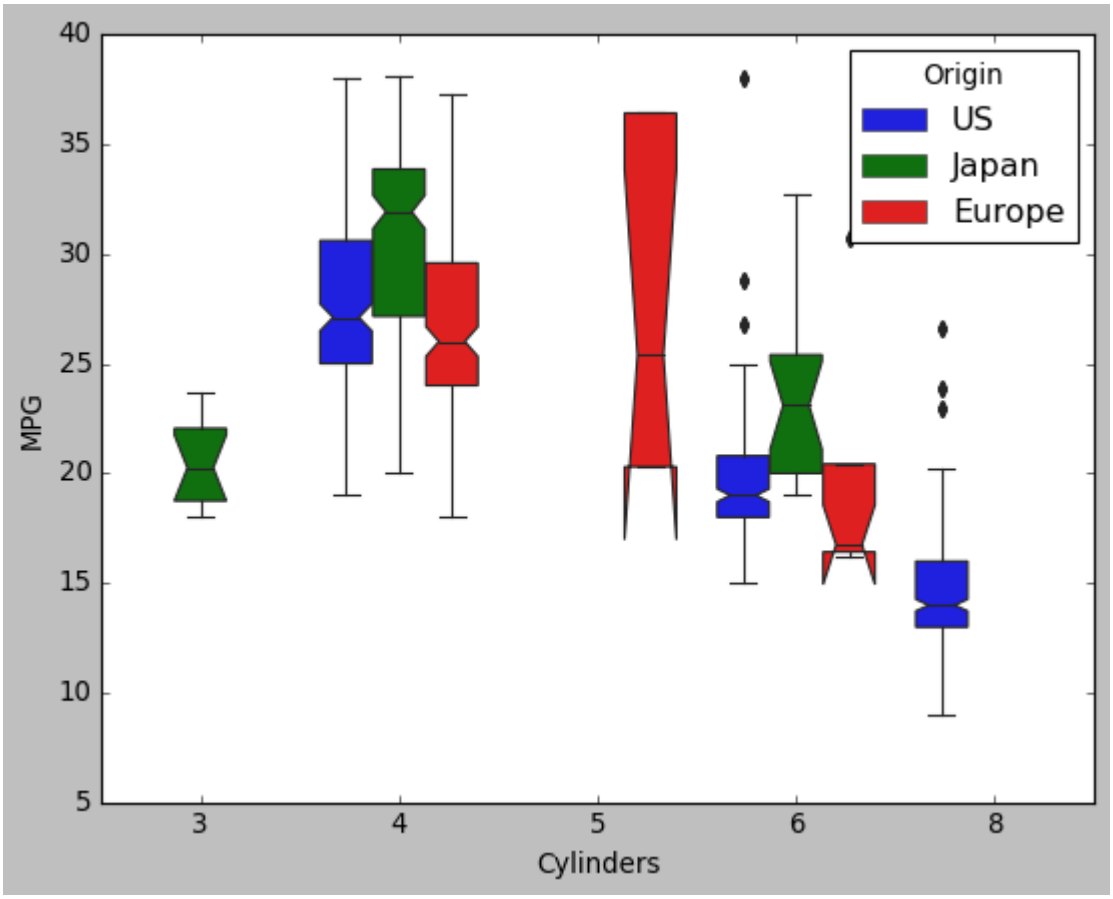
In [89]:

```
# Boxplot
boxplot = df.boxplot(column=['Weight' ], by = ['Origin'])
```



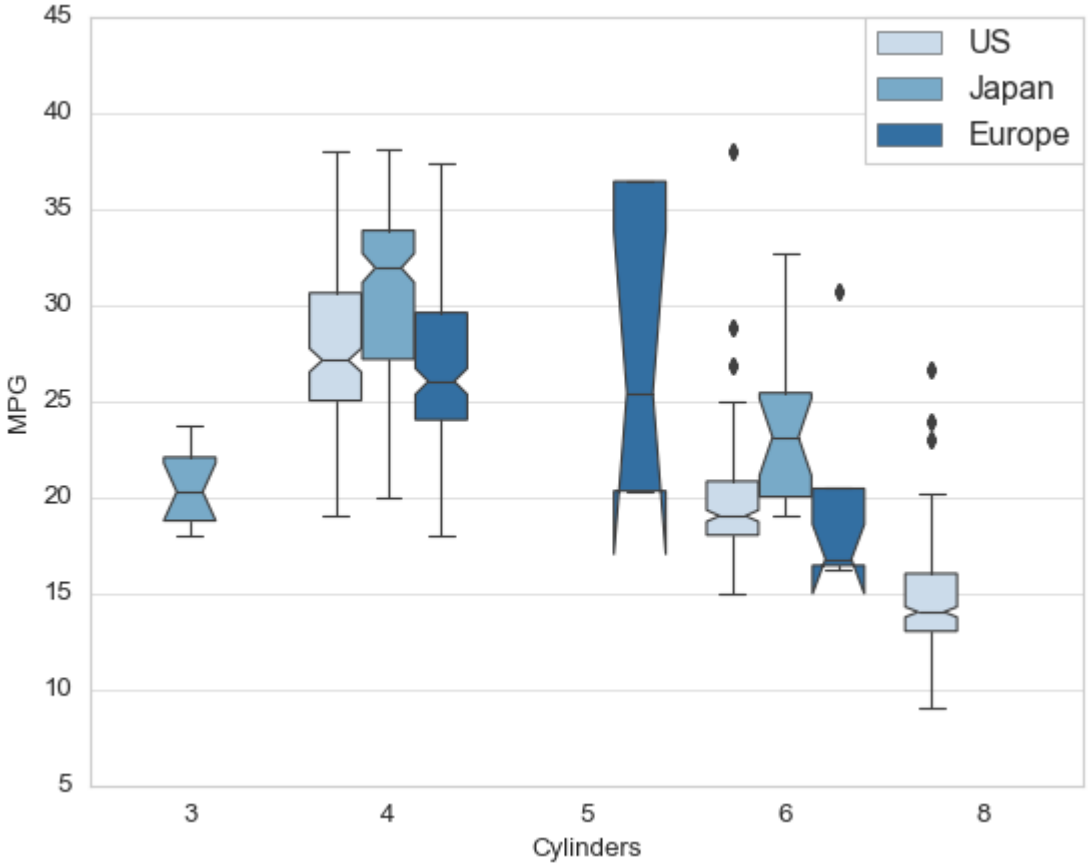
In [90]:
```
#Importing required modules
import seaborn as sns
import pandas as ppd


sns.boxplot(data = df , x = 'Cylinders' , y = 'MPG' , hue = 'Origin' , notch = True )
```

Out[90]:
```
<AxesSubplot:xlabel='Cylinders', ylabel='MPG'>
```



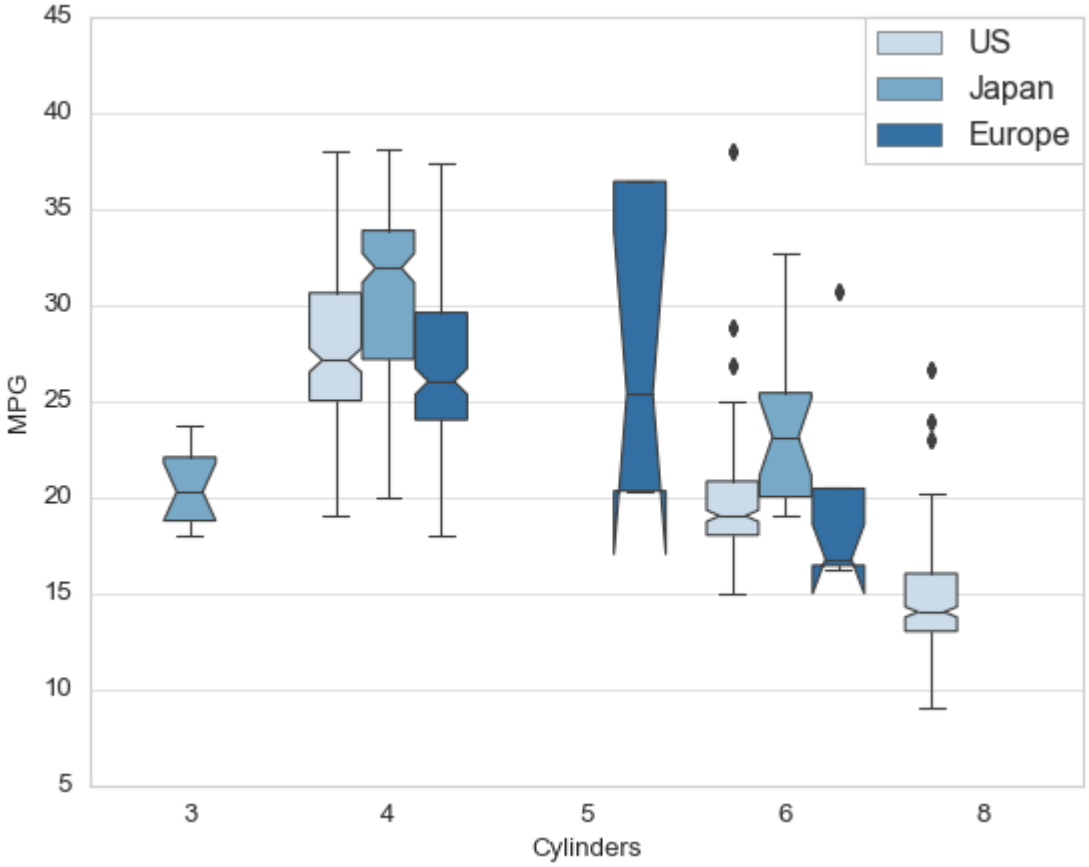
In [91]:

```
sns.set_style("whitegrid")
sns.boxplot(data = df , x = 'Cylinders' , y = 'MPG' , hue = 'Origin', notch = True, pal
# place the legend outside the figure/plot
plt.legend(bbox_to_anchor=(1,1),borderaxespad=0)
plt.ylim(5, 45)
plt.show()
```



In [92]:

```
sns.set_style("whitegrid")
sns.boxplot(data = df , x = 'Cylinders' , y = 'MPG' , hue = 'Origin', notch = True, pal
# place the legend outside the figure/plot
plt.legend(bbox_to_anchor=(1,1),borderaxespad=0)
plt.ylim(5, 45)
plt.show()
```



Simulated Nonparametric Inference of the Median, Mean and CI for Quantitative Variable - Bond Amount

In [93]:
```
# Median Bootstrapping - Sample 40
bootstrap = pd.DataFrame({'df': [df.sample(40, replace = True).MPG.median() for i in ra
```

In [94]:
```
bootstrap.head()
```

Out[94]:

	df
0	26.15
1	21.05
2	25.15
3	20.75
4	20.20

In [95]:
```
bootstrap.median()
```

Out[95]:
```
df    22.075
dtype: float64
```

In [96]:
```
df.MPG.median()
```

```
22.0
```

Out[96]:

In [97]:
```
# Median Bootstrapping 2 - Sample 1000
bootstrap2 = pd.DataFrame({'df': [df.sample(1000, replace = True).MPG.median() for i in
```

In [98]:
```
bootstrap2.median()
```

Out[98]:
```
df    22.0
dtype: float64
```

In [99]:
```
# Median Bootstrapping 3 - Sample 5000
bootstrap3 = pd.DataFrame({'df': [df.sample(5000, replace = True).MPG.median() for i in
```

In [100…
```
bootstrap3.median()
```

Out[100…
```
df    22.0
dtype: float64
```

In [101…
```
# Median Bootstrapping 3 - Sample 10%: 117
bootstrap_10pct = pd.DataFrame({'df': [df.sample(117, replace = True).MPG.median() for
```

In [102…
```
bootstrap_10pct.median()
```

Out[102…
```
df    22.0
dtype: float64
```

In [103…
```
# Dataset Mean
df.MPG.mean()
```

Out[103…
```
22.900262467191606
```

In [104…
```
# Mean Bootstrapping - Sample 100
bootstrap4 = pd.DataFrame({'df': [df.sample(100, replace = True).MPG.mean() for i in ra
bootstrap4.mean()
```

Out[104…
```
df    22.906551
dtype: float64
```

In [105…
```
# Mean Bootstrapping 2 - Sample 1000
bootstrap5 = pd.DataFrame({'df': [df.sample(1000, replace = True).MPG.mean() for i in r
bootstrap5.mean()
```

Out[105…
```
df    22.898582
dtype: float64
```

In [106…
```
# Mean Bootstrapping 3 - Sample 5000
bootstrap6 = pd.DataFrame({'df': [df.sample(5000, replace = True).MPG.mean() for i in r
bootstrap6.mean()
```

Out[106…
```
df    22.895975
```

```
dtype: float64
```

Confidence Intervals

In [107…
```
# 95% Confidence Interval - Median Bootstrapping - 100 Samples
conf_int1 = np.percentile(bootstrap, [2.5, 97.5]) # The middle 95% interval
conf_int1
```

Out[107…
```
array([19. , 25.7])
```

In [108…
```
# 95% Confidence Interval - Median Bootstrapping - 1000 Samples
conf_int2 = np.percentile(bootstrap2, [2.5, 97.5]) # The middle 95% interval
conf_int2
```

Out[108…
```
array([21.1, 23. ])
```

In [109…
```
# 95% Confidence Interval - Median Bootstrapping - 5000 Samples
conf_int3 = np.percentile(bootstrap3, [2.5, 97.5]) # The middle 95% interval
conf_int3
```

Out[109…
```
array([22. , 22.5])
```

In [110…
```
# 95% Confidence Interval - Median Original Dataset
conf_int_df = np.percentile(df.MPG.median(), [2.5, 97.5]) # The middle 95% interval
conf_int_df
```

Out[110…
```
array([22., 22.])
```

In [111…
```
# 95% Confidence Interval - Mean Bootstrapping - 100 Samples
conf_int4 = np.percentile(bootstrap4, [2.5, 97.5]) # The middle 95% interval
conf_int4
```

Out[111…
```
array([21.506975, 24.315025])
```

In [112…
```
# 95% Confidence Interval - Mean Bootstrapping - 1000 Samples
conf_int5 = np.percentile(bootstrap5, [2.5, 97.5]) # The middle 95% interval
conf_int5
```

Out[112…
```
array([22.44829, 23.3704 ])
```

In [113…
```
# 95% Confidence Interval - Mean Bootstrapping - 5000 Samples
conf_int6 = np.percentile(bootstrap6, [2.5, 97.5]) # The middle 95% interval
conf_int6
```

Out[113…
```
array([22.6993065, 23.0959205])
```

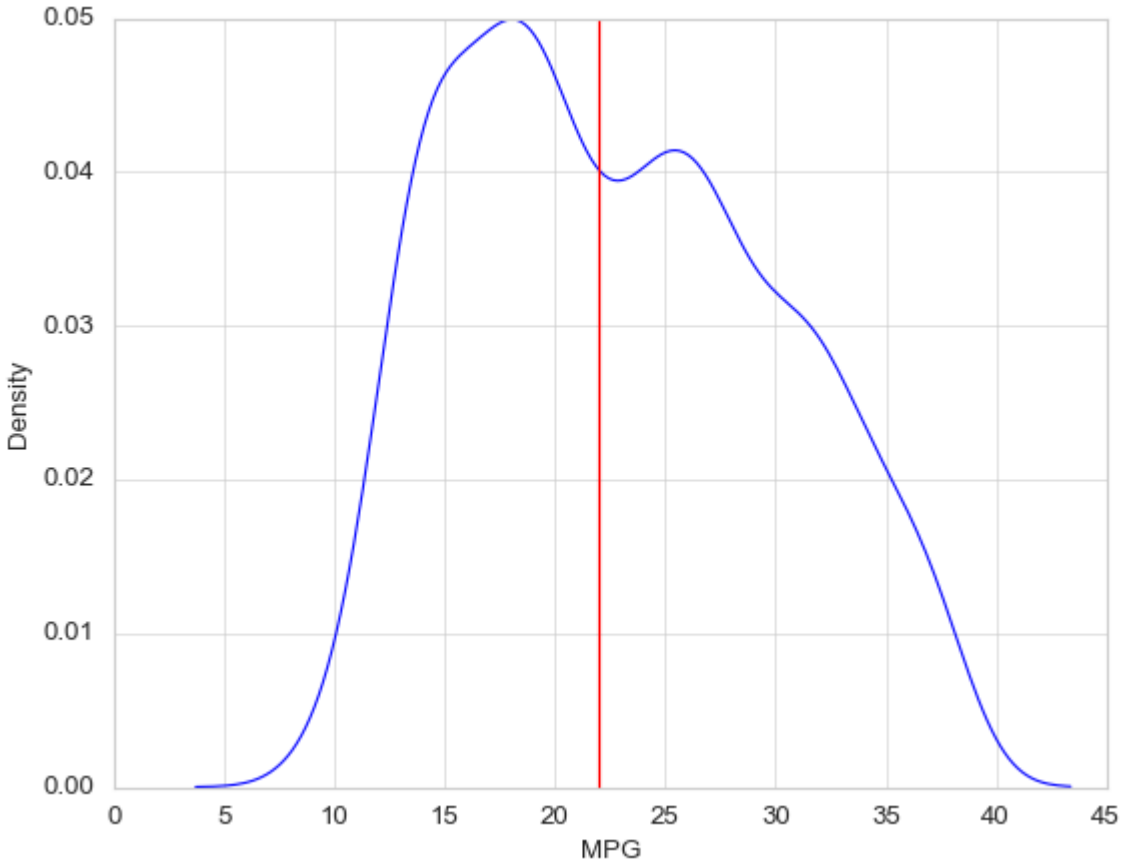
In [114…
```
# 95% Confidence Interval - Mean Bootstrapping - Original Dataset
conf_int_dfmean = np.percentile(df.MPG.mean(), [2.5, 97.5]) # The middle 95% interval
conf_int_dfmean
```

Out[114…
```
array([22.90026247, 22.90026247])
```

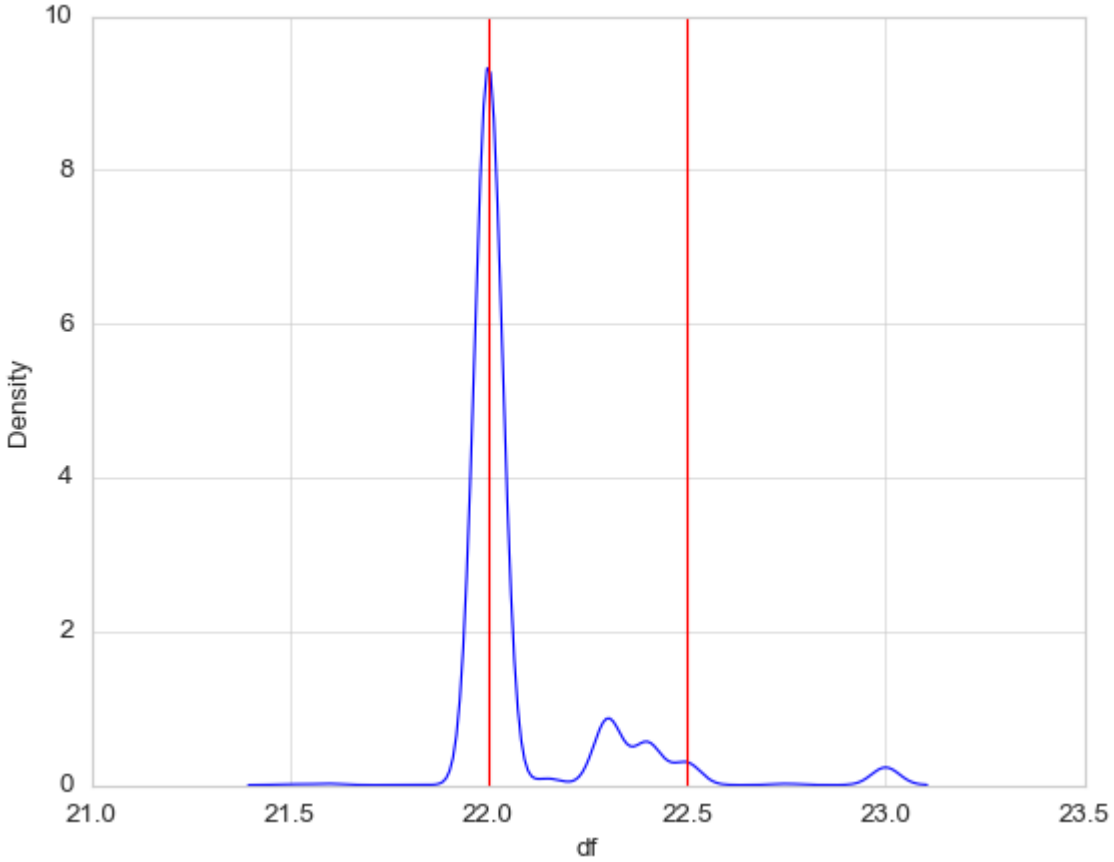
In [115…
```
df_bootstrap = pd.DataFrame(bootstrap, index=[0])
print(df_bootstrap)
```

```
      df
0  26.15
```

In [116…
```
# Confidence Interval Graph for Dataset - Median
import seaborn as sns
sns.kdeplot(df.MPG)
for endpoint in conf_int_df:
    plt.axvline(endpoint, color='red')
```



In [117…
```
# Confidence Interval Graph for Bootstrap Sample - Median
import seaborn as sns
sns.kdeplot(bootstrap3.df)
for endpoint in conf_int3:
    plt.axvline(endpoint, color='red')
```



In [118…

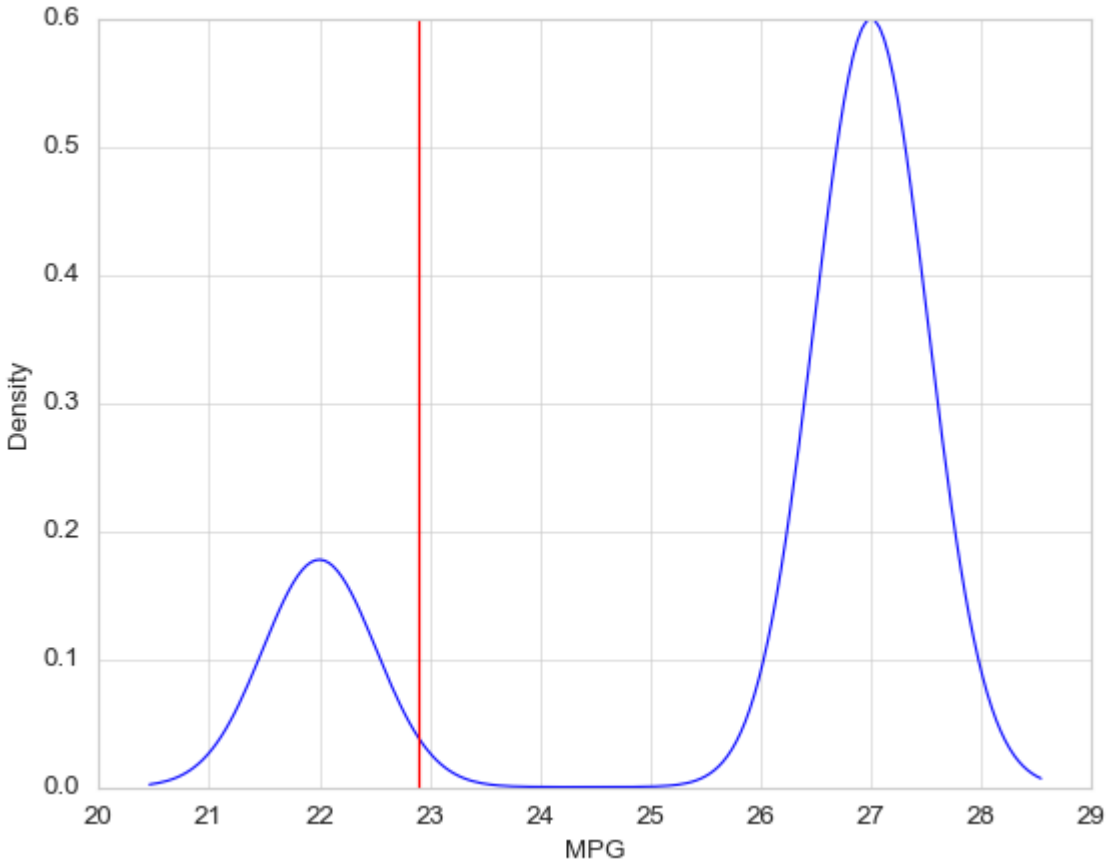
```
#Bootstrapping from all entries in dataset
median_boot_samples = []
for i in range(1000):
                df.MPG = np.random.choice(df.MPG, 1143)
                median_boot_samples.append(df.MPG.median())

np.median(median_boot_samples)
```

Out[118…

```
26.6
```

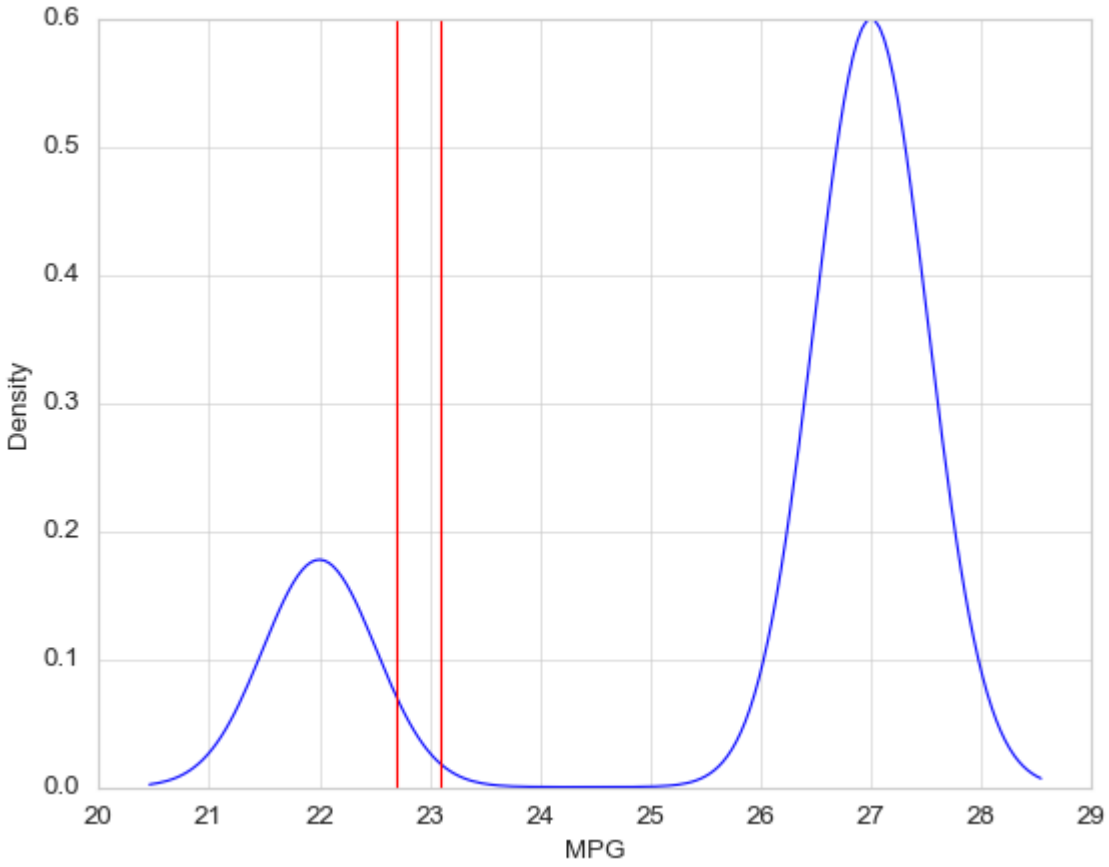
In [119…

```
# Confidence Interval Graph for Dataset Mean
import seaborn as sns
sns.kdeplot(df.MPG)
for endpoint in conf_int_dfmean:
    plt.axvline(endpoint, color='red')
```



In [120…

```
# Confidence Interval Graph for Bootstrap Mean - Sample 5000
import seaborn as sns
sns.kdeplot(df.MPG)
for endpoint in conf_int6:
    plt.axvline(endpoint, color='red')
```



In [121…

```
median_boot_samples = []
for i in range(1000):
                df.MPG = np.random.choice(df.MPG, 1143)
                median_boot_samples.append(df.MPG.median())

np.median(median_boot_samples)
```

Out[121…

```
27.0
```