Homework 2

STA 307

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```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from ISLP import load_data
from sklearn.datasets import load_iris
from sklearn.preprocessing import StandardScaler
from sklearn.decomposition import PCA

AUTO = load_data("Auto")
```

Question 1

```
selected_coloumns = ['mpg','cylinders', 'displacement',  'weight', 'acceleration', ]
X = AUTO[selected_coloumns]
y = AUTO['origin'] # Origin of car (1. American, 2. European, 3. Japanese)
print(X.head)

print("American cars: {0}".format((y == 1).sum())) # American
print("European cars: {0}".format((y == 2).sum())) # European
print("Japanese cars: {0}".format((y == 3).sum())) # Japanese
```

```
<bound method NDFrame.head of       mpg  cylinders  displacement  weight  acceleration
0    18.0          8         307.0    3504          12.0
1    15.0          8         350.0    3693          11.5
2    18.0          8         318.0    3436          11.0
3    16.0          8         304.0    3433          12.0
4    17.0          8         302.0    3449          10.5
..    ...        ...           ...     ...           ...
387  27.0          4         140.0    2790          15.6
388  44.0          4          97.0    2130          24.6
389  32.0          4         135.0    2295          11.6
390  28.0          4         120.0    2625          18.6
391  31.0          4         119.0    2720          19.4

[392 rows x 5 columns]>
American cars: 245
European cars: 68
```

```
Japanese cars: 79
```

Question 2

```python
print("Standard deviation")
print(X.std())
print("\n")
print("Mean")
print(X.mean())
```

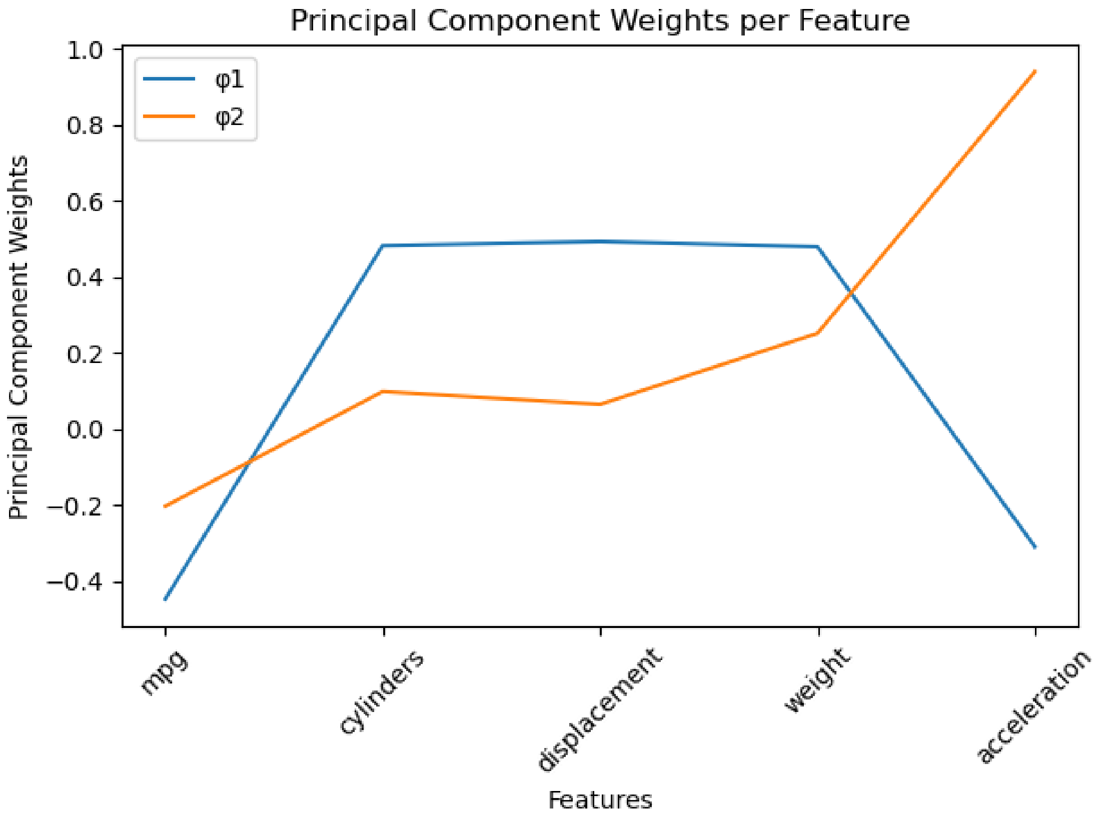
```
Standard deviation
mpg                7.805007
cylinders          1.705783
displacement     104.644004
weight           849.402560
acceleration       2.758864
dtype: float64


Mean
mpg                23.445918
cylinders           5.471939
displacement      194.411990
weight           2977.584184
acceleration       15.541327
dtype: float64
```

Qustion 3

a

```python

# scaler = StandardScaler()
# scaler.fit(X)
# X_standardized = scaler.transform(X)

# print("Means: ",np.mean(X_standardized,axis=0))
# print("Standard deviations: ",np.std(X_standardized,axis=0))

print("Original data size:",X.shape)
# Implement PCA with 2 principal components
pca = PCA(n_components=2)

# Fit the PCA model to the data and transform the data
X_reduced = pca.fit_transform(X)
print("Reduced data size:", X_reduced.shape)

#principal components
components = pca.components_
x = np.arange(components.shape[1]) # 6

# Plot the first and second principal components
```

```
plt.plot(x, components[0], label='1')
plt.plot(x, components[1], label='2')

# Define feature names as tick labels
names = ['mpg', 'cylinders', 'displacement', 'weight', 'acceleration']
plt.xticks(ticks=x, labels=selected_coloumns, rotation=45)

# Labeling the axes and the legend
plt.xlabel('Features')
plt.ylabel('Principal Component Weights')
plt.title('Principal Component Weights per Feature')
plt.legend()

# Show plot
plt.tight_layout()
plt.savefig("plot.png", bbox_inches='tight')
plt.show()
```



b

It seems pca is caputring the data with larger scales this can lead to misleading conclusions and the importance of features

Question 4

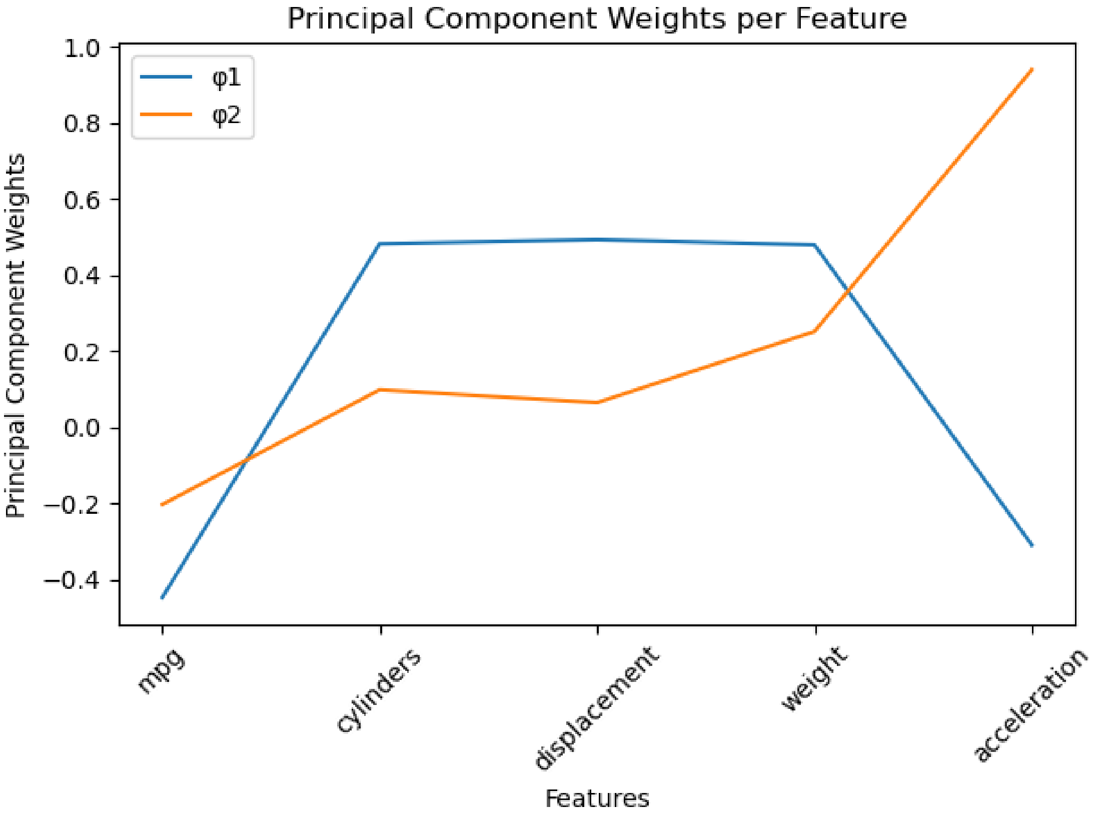
```
# Manually standardize the data to have mean 0 and standard deviation 1
means = np.mean(X, axis=0)
stds = np.std(X, axis=0)
Z = (X - means) / stds

# Verify that all features in Z have a mean of approximately zero and a standard deviation of one
means_Z = np.mean(Z, axis=0)
stds_Z = np.std(Z, axis=0)

print(means_Z, stds_Z)
```

```
mpg             1.450087e-16
cylinders      -1.087565e-16
displacement   -7.250436e-17
weight         -1.812609e-17
acceleration    4.350262e-16
dtype: float64 mpg             1.0
cylinders       1.0
displacement    1.0
weight          1.0
acceleration    1.0
dtype: float64
```

Question 5

##+begin$_{\text{src}}$ python :session graphics :results output :exports both :eval yes

```
pca = PCA(n_components=2)
Z_reduced = pca.fit_transform(Z)
print("Reduced data size:", Z_reduced.shape)
components = pca.components_
plt.plot(x, components[0], label='1')
plt.plot(x, components[1], label='2')

plt.xticks(ticks=x, labels=selected_coloumns, rotation=45)

plt.xlabel('Features')
plt.ylabel('Principal Component Weights')
plt.title('Principal Component Weights per Feature')
plt.legend()

# Show plot
plt.tight_layout()
plt.savefig("plot.png", bbox_inches='tight')
plt.show()
```


Principal Component Weights per Feature
φ1
φ2
Principal Component Weights
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
mpg
cylinders
displacement
weight
acceleration
Features