Assignment 1

Raghav Juyal\ EP20BTECH11018

Imports

In [ ]:
```
import numpy as np
import matplotlib.pyplot as plt
import scipy.stats as st
import astropy as ap
import astroML.stats as aml
import pandas as pd
```

Question 1

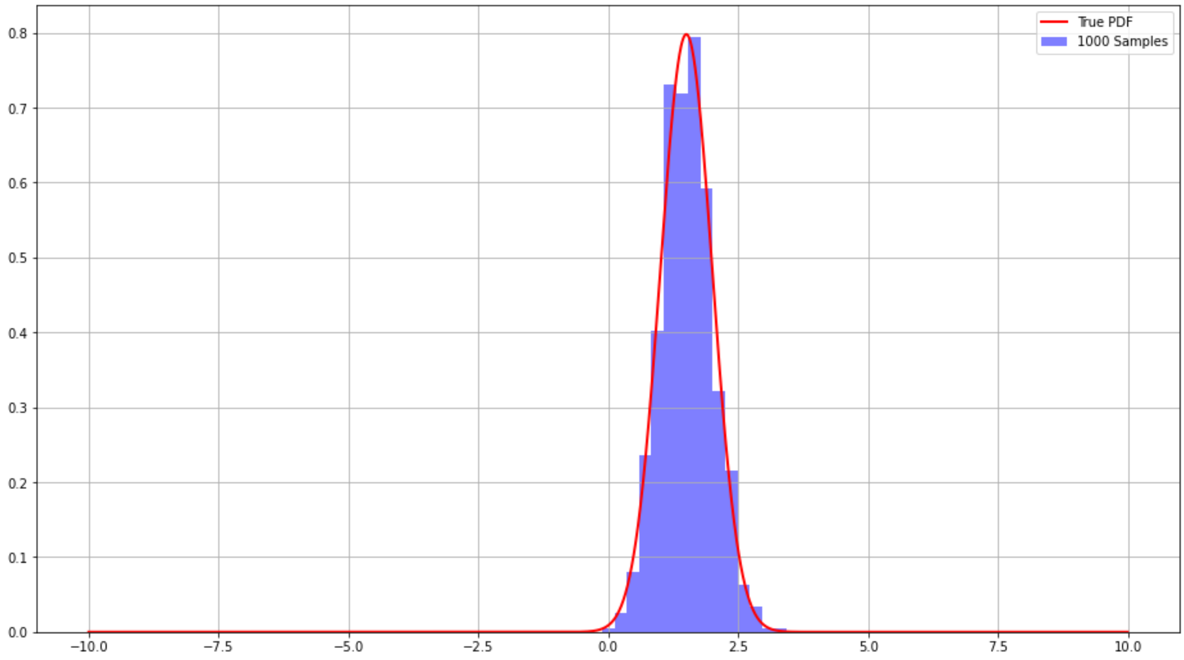
Create 1000 draws from a normal distribution of mean of 1.5 and standard deviation of 0.5.\ Plot the pdf. Calculate the sample mean, variance, skewness, kurtosis as well as standard deviation using MAD and σ_G of these samples.

In [ ]:
```
np.random.seed(42)
obj = st.norm(1.5, 0.5)
rv = obj.rvs(size=1000)

print(f"Sample Mean: {rv.mean():.3f}")
print(f"Sample Variance: {float(rv.var()*1000/999.0):.3f}")
print(f"Skewness: {st.skew(rv):.3f}")
print(f"Kurtosis: {st.kurtosis(rv):.3f}")
print(f"MAD: {st.median_abs_deviation(rv):.3f}")
print(f"Standard Deviation: {(1.482*st.median_abs_deviation(rv)):.3f}")
print(f"sigma_G: {aml.sigmaG(rv):.3f}")

plt.figure(figsize=(16, 9))
plt.plot(np.arange(-10, 10, 0.01), obj.pdf(np.arange(-10, 10, 0.01)), c='r', lw=2,
plt.grid()
plt.hist(rv, bins=15, density=True, alpha=0.5, color='b', label='1000 Samples')
plt.legend()
plt.show()
```

```
Sample Mean: 1.510
Sample Variance: 0.240
Skewness: 0.117
Kurtosis: 0.066
MAD: 0.323
Standard Deviation: 0.479
sigma_G: 0.480
```



Question 2

Plot a Cauchy distribution with μ=0 and γ=1.5 superposed on the top of a Gaussian distribution with μ=0 and σ=1.5. \ Use two different line styles to distinguish between the Gaussan and Cauchy distribution on the plot and also indicate these in the legends.

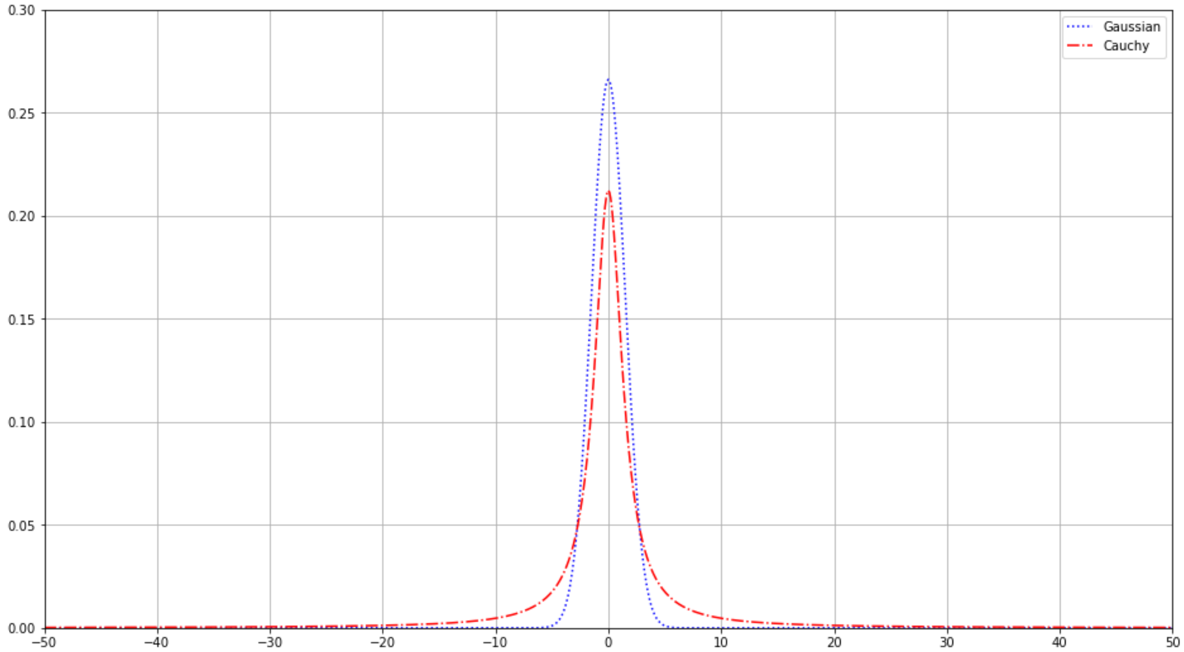
In [ ]:
```
pdf_cauchy = st.cauchy(0, 1.5).pdf(np.arange(-50, 50, 0.1))  # Cauchy PDF
pdf_gaussian = st.norm(0, 1.5).pdf(np.arange(-50, 50, 0.1))  # Gaussian PDF

plt.figure(figsize=(16, 9))

# Gaussian Plot
plt.plot(np.arange(-50, 50, 0.1), pdf_gaussian, label="Gaussian", color='b', ls =

# Cauchy Plot
plt.plot(np.arange(-50, 50, 0.1), pdf_cauchy, label="Cauchy", color='r', ls = '-.'

plt.grid(which='both')
plt.ylim(0, 0.3)
plt.xlim(-50, 50)
plt.xticks(np.arange(-50, 51, 10))
plt.legend()
plt.show()
```



Question 3

Plot Poisson distribution with mean of 5, superposed on top of a Gaussian distribution with mean of 5 and standard deviation of square root of 5.\ Use two different line styles for the two distributions and make sure the plot contains legends for both of them.

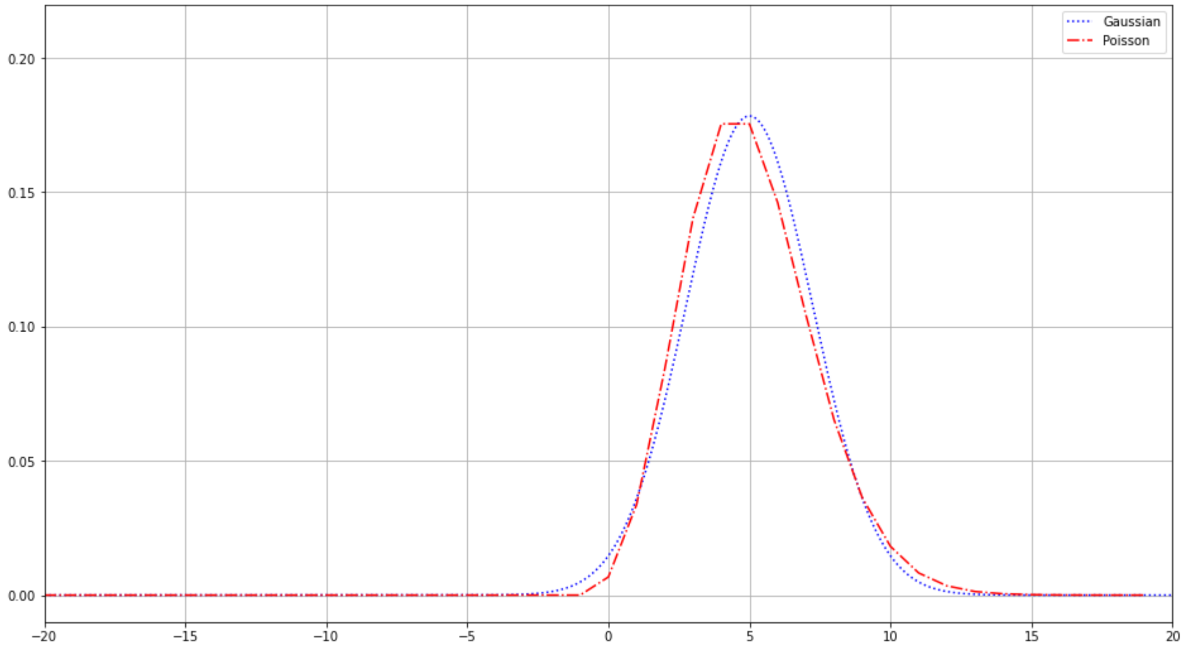
In [ ]:
```
pdf_poisson = st.poisson(5).pmf(np.arange(-20, 20, 1))     # Poisson PDF
pdf_gaussian = st.norm(5, np.sqrt(5)).pdf(np.arange(-20, 20, 0.01))   # Gaussian Pl

plt.figure(figsize=(16, 9))

# Gaussian Plot
plt.plot(np.arange(-20, 20, 0.01), pdf_gaussian, label="Gaussian", color='b', ls =

# Poisson Plot
plt.plot(np.arange(-20, 20, 1), pdf_poisson, label="Poisson", color='r', ls = '-.'

plt.grid(which='both')
plt.ylim(-0.01, 0.22)
plt.xlim(-20, 20)
plt.legend()
plt.show()
```



Question 4

The following were the measurements of mean lifetime of K meson (as of 1990) (in units of 10−10 s) :\ 0.8920±0.00044; 0.881±0.009; 0.8913±0.00032; 0.9837±0.00048; 0.8958± 0.00045.\ Calculate the weighted mean lifetime and uncertainty of the mean.

In [ ]:
```
lifetime = np.asfarray([0.892, 0.881, 0.8913, 0.9837, 0.8958])
error = np.asfarray([0.00044, 0.009, 0.00032, 0.00048, 0.00045])

weighted_mean = np.sum(np.divide(lifetime, np.square(error)))/np.sum(np.divide(1, 

uncertainity = 1/np.sqrt(np.sum(np.divide(1, np.square(error))))

print(f"Weighted Mean: {weighted_mean:.3f}")
print(f"Uncertainity of Weighted Mean: {uncertainity:.3f}")
```

```
Weighted Mean: 0.909
Uncertainity of Weighted Mean: 0.000
```

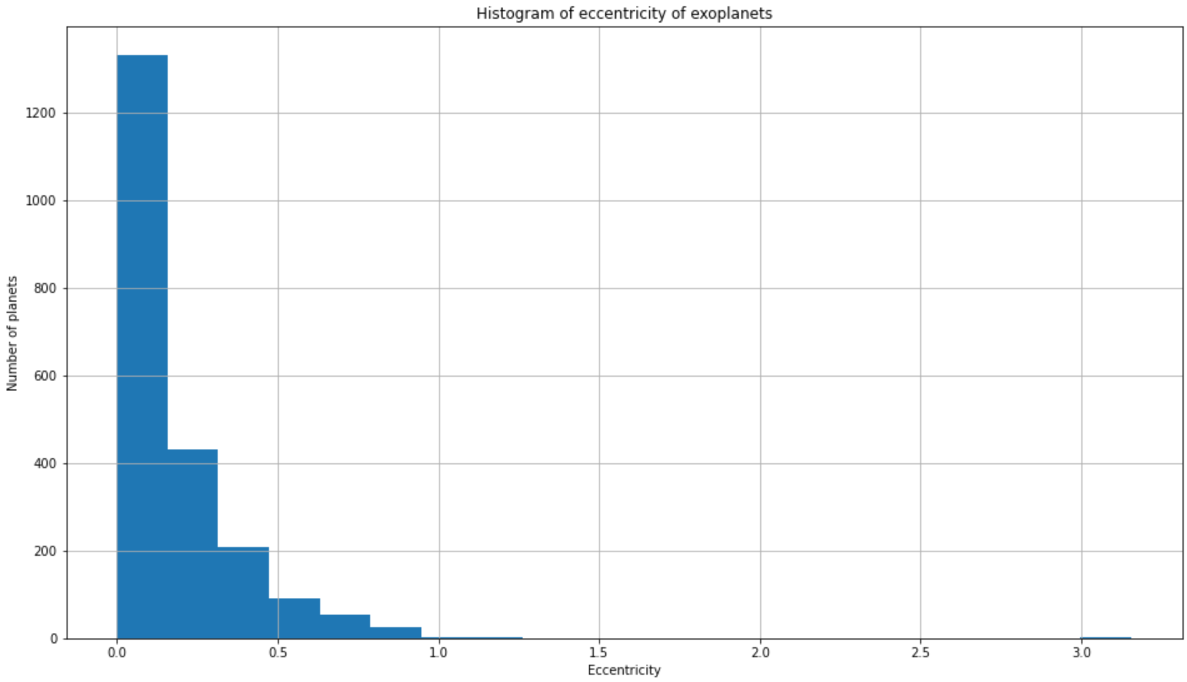
Question 5

Download the eccentricity distribution of exoplanets from the exoplanet catalog http://exoplanet.eu/catalog/.\ Look for the column titled e, which denotes the eccentricity. Draw the histogram of this distribution.\ Then redraw the same histogram after Gaussianizing the distribution using Box-transformation either using scipy.stats.boxcox\ or from first principles using the equations shown in class or in arXiv:1508.00931.\ Note that exoplanets without eccentricity data or withe e=0, can be ignored.

In [ ]:
```
# Reading data
df = pd.read_csv("exoplanet.eu_catalog.csv")
print(df['eccentricity'].count())
```

```
2145
```

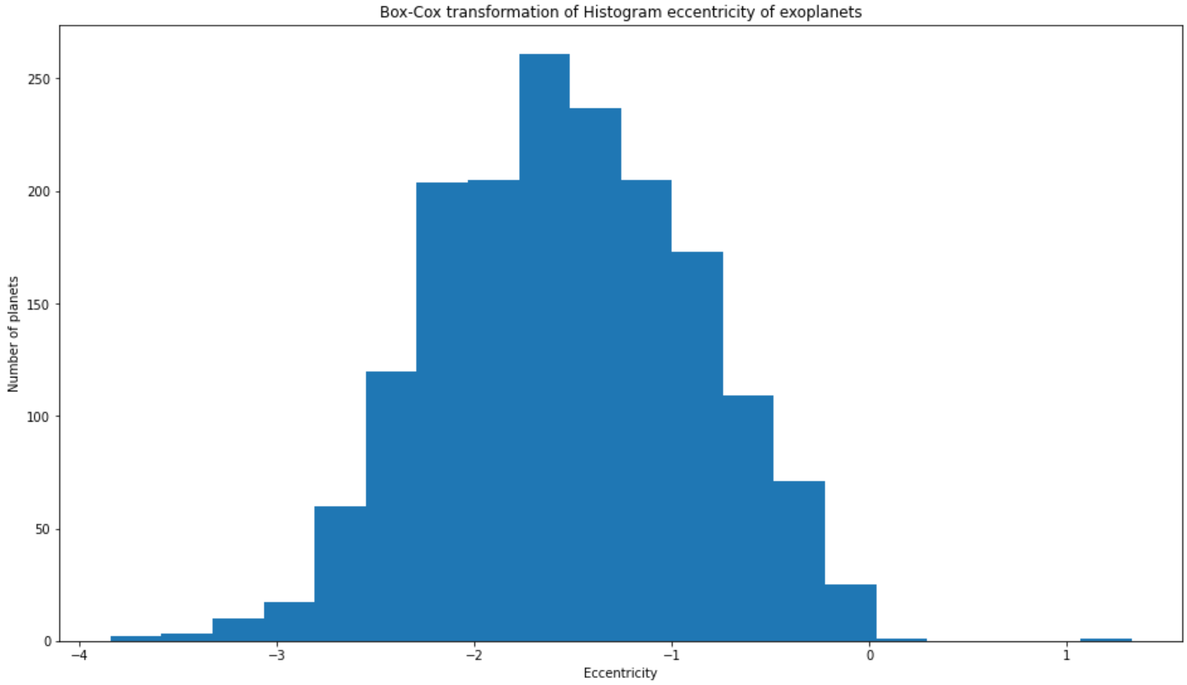
In [ ]:
```
# Plotting original data
plt.figure(figsize=(16, 9))
plt.hist(df['eccentricity'], bins=20)
plt.grid(which='both')
plt.xlabel("Eccentricity")
plt.ylabel("Number of planets")
plt.title("Histogram of eccentricity of exoplanets")
plt.show()
```



In [ ]:
```
# Removing data with e=0
for x in df.index:
  if not(df.loc[x, "eccentricity"] > 0):
    df.drop(x, inplace = True)
print(df['eccentricity'].count())
```

```
1704
```

In [ ]:
```
# Plotting Gaussianized data(Using Box-Cox transformation)
plt.figure(figsize=(16, 9))
plt.hist(st.boxcox(df['eccentricity'])[0], bins=20)
plt.xlabel("Eccentricity")
plt.ylabel("Number of planets")
plt.title("Box-Cox transformation of Histogram eccentricity of exoplanets")
plt.show()
```


Box-Cox transformation of Histogram eccentricity of exoplanets
Number of planets
Eccentricity
0
50
100
150
200
250
−4
−3
−2
−1
0
1