# HW4_Q4

February 28, 2022

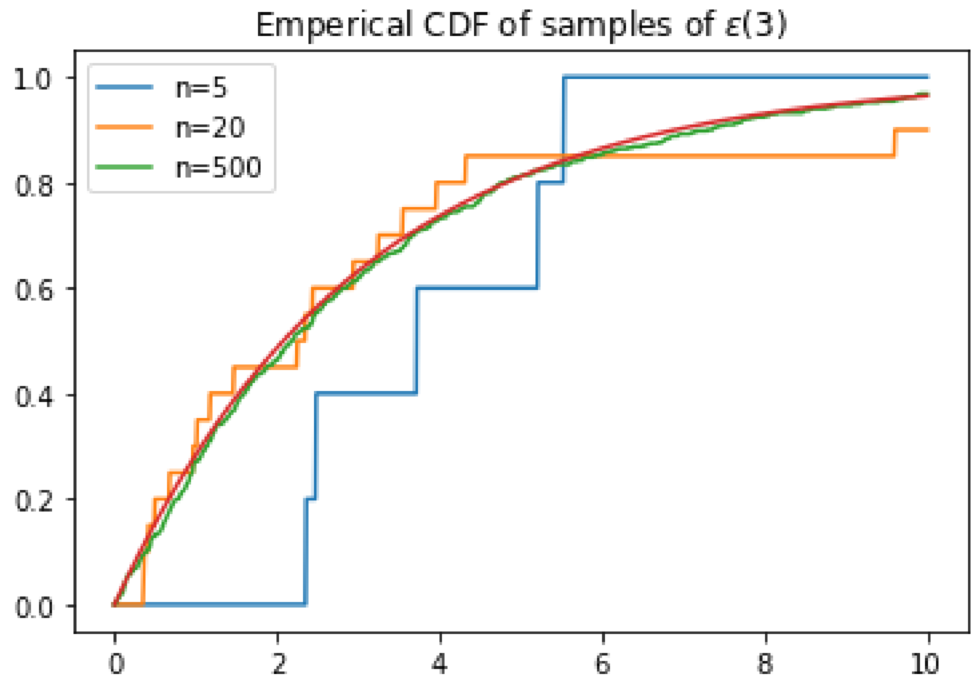
[1]:
```
import numpy as np
from scipy import stats
import matplotlib.pyplot as plt
import pandas as pd
from statsmodels.distributions.empirical_distribution import ECDF
```

## 0.1 4(b)

[2]:
```
# Set up the data array
expo5 = [np.random.exponential(3) for i in range(5)]
expo20 = [np.random.exponential(3) for i in range(20)]
expo500 = [np.random.exponential(3) for i in range(500)]
```

[3]:
```
# Use ECDF method to generate the emperical cdf
ecdf5 = ECDF(expo5)
ecdf20 = ECDF(expo20)
ecdf500 = ECDF(expo500)
```

[4]:
```
x_space = np.linspace(0, 10, 1000)
plt.plot(x_space, ecdf5(x_space), label="n=5")
plt.plot(x_space, ecdf20(x_space), label="n=20")
plt.plot(x_space, ecdf500(x_space), label="n=500")
plt.title("Emperical CDF of samples of " + r"$\epsilon(3)$")
plt.plot(x_space, stats.expon.cdf(x_space, scale=3))
plt.legend()
plt.show()
```




### 0.1.1 Obeservations

- The empirical CDF are more or less step functions
- The empirical CDFs simulates the actual CDF
- The bigger times of experiments, $n$, is, the better the simulation is. In the meantime, the empirical CDF is more smooth as $n$ grows bigger.

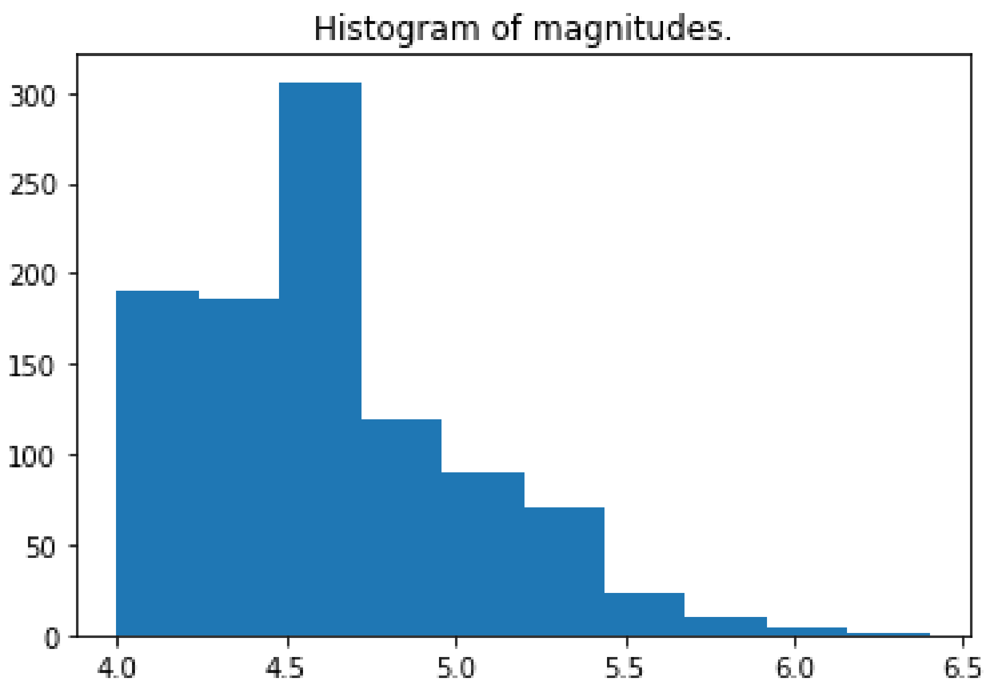
## 0.2 4(c)

[5]:
```
# use pandas to extract the data
df = pd.read_csv(
    "fijiquakes.dat",
    sep="\s+",
    skiprows=1,
    usecols= [1, 2, 3, 4, 5],
    names= ["lat", "long", "depth", "mag", "stations"]
)

# We are 'using the maginitudes
mag = df["mag"].to_numpy()

mean = mag.mean()
variance = mag.var(ddof=1)
print("Sample mean: {:.4f}".format(mean))
```

```
print("Sample variance: {:.4f}".format(variance))
```

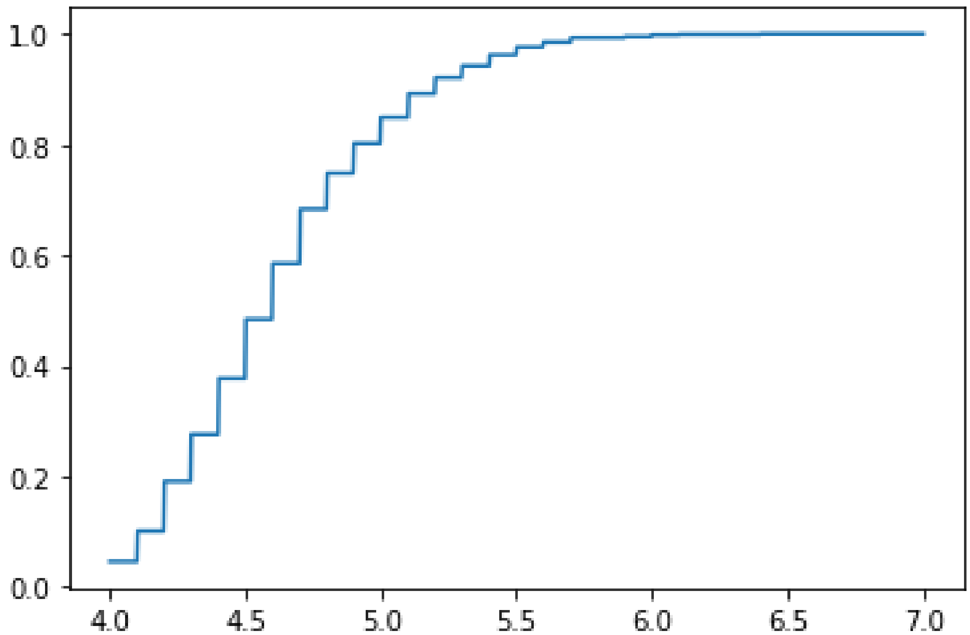
```
Sample mean: 4.6204
Sample variance: 0.1622
```

[6]:
```
# Visualization
plt.hist(mag)
plt.title("Histogram of magnitudes.")
plt.show()
```



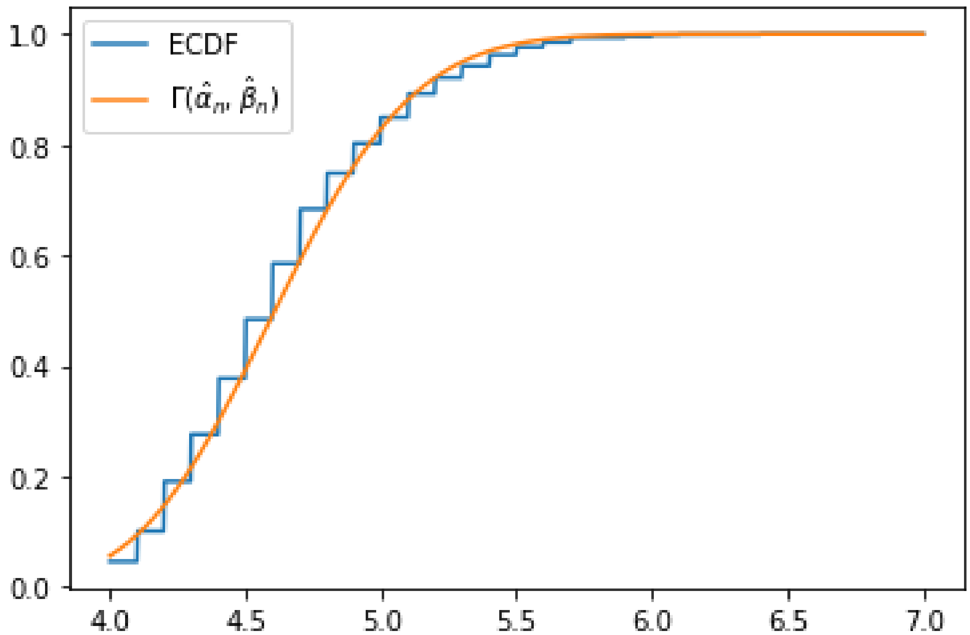

[7]:
```
x_space = np.linspace(4, 7, 1000)
ecdf = ECDF(mag)
plt.plot(x_space, ecdf(x_space))
```

[7]:
```
[<matplotlib.lines.Line2D at 0x7f887d81f040>]
```




[8]:
```
alpha_hat_n = mean**2 / variance
beta_hat_n = mean / variance
plt.plot(x_space, ecdf(x_space), label="ECDF")
plt.plot(x_space, stats.gamma.cdf(x_space, a=alpha_hat_n, scale=1/beta_hat_n),\
    label=r"$\Gamma(\hat{\alpha}_n, \hat{\beta}_n)$")

plt.legend()
```

[8]: <matplotlib.legend.Legend at 0x7f887d7d15b0>




### 0.2.1 Observations

- The empirical CDF is more or less a step function
- It, however, simulates the actual CDF very well.