q_02

December 28, 2020

[2]:
```
import numpy as np
from matplotlib import pyplot as plt
import seaborn as sns
import random as rnd
plt.style.use('seaborn-dark-palette')
plt.rcParams.update({'font.size':12})
#np.random.seed(3435333422)
rnd.seed(945526237263)
```

[3]:
```
import numpy as np
def pdf_const_bin(x, bins):
    '''
    generate Probability distribution function corresponding
    to given samples of random variables x
    against bins
    '''
    x = np.asarray(x)
    v_min = np.amin(x)
    v_max = np.amax(x)
    h = (v_max-v_min)/bins
    tot_length = len(x)
    #print(v_min , v_max)
    hist = []
    x_axis = []
    for i in range(bins):
        temp_min = v_min+i*h
        temp_max = v_min+(i+1)*h
        #print(temp_min, temp_max)
        temp = [x_val for x_val in x if ((x_val>temp_min) and(x_val<=temp_max))]
        #print(temp)
        count = (len(temp)/tot_length)/h
        hist.append(count)
        x_axis.append((temp_min+temp_max)/2)
    return(hist , x_axis)


def histogram(x,bins):
```

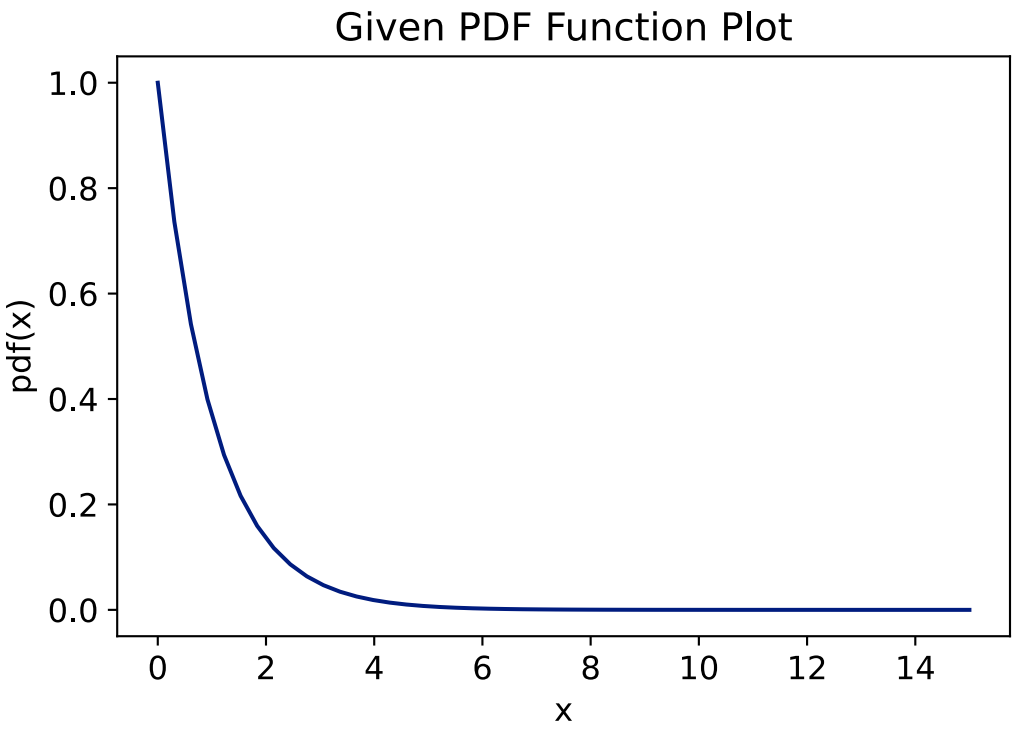
```
    def histogram_const_bin(x, bins):
        x = np.asarray(x)
        v_min = np.amin(x)
        v_max = np.amax(x)
        h = (v_max-v_min)/bins
            #print(v_min , v_max)
        hist = []
        x_axis = []
        for i in range(bins):
            temp_min = v_min+i*h
            temp_max = v_min+(i+1)*h
                #print(temp_min, temp_max)
            temp = [x_val for x_val in x if ((x_val>temp_min) and␣
↪(x_val<=temp_max))]
                #print(temp)
            count = len(temp)
            hist.append(count)
            x_axis.append((temp_min+temp_max)/2)
        return(hist , x_axis)

    def histogram_given_bin(x, bins):
        x = np.asarray(x)
        v_min = np.amin(x)
        v_max = np.amax(x)
        h = (v_max-v_min)/bins
            #print(v_min , v_max)
        hist = []
        x_axis = []
        for i in range(len(bins)):
            temp = [x_val for x_val in x if ((x_val>bins[i]) and␣
↪(x_val<=bins[i+1]))]
                #print(temp)
            count = len(temp)
            hist.append(count)
                #x_axis.append((temp_min+temp_max)/2)
        return(hist, bins)


    if(type(bins)==int):
        hist , bins = histogram_const_bin(x,bins)
    else:
        hist , bins = histogram_given_bin(x,bins)
    return(hist, bins)
```

[4]:
```
def gen_rand_n(x_min ,x_max , n):
    #import random as rnd
```

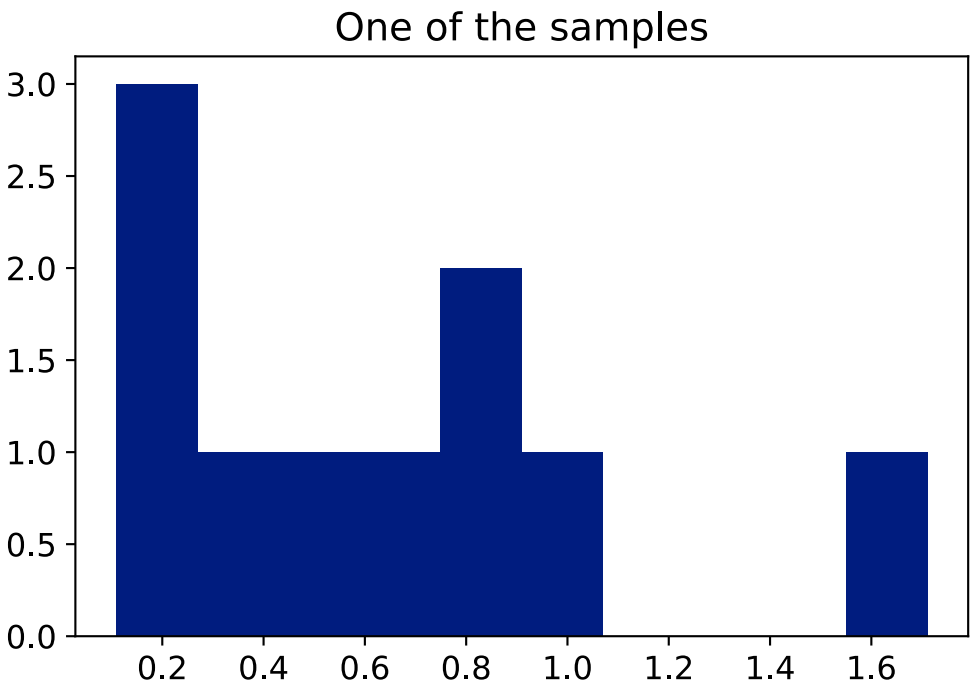
```
    x = []
    n = int(n)
    for i in range(n):
        mu = rnd.uniform(0,1)
        xi = x_min + mu*(x_max-x_min)
        x.append(xi)
    if (len(x)==1):
        return x[0]
    else:
        return x

def gen_samples(f,x_min , x_max , y_max , N):
    #import numpy as np
    x_acc = []
    i = 0
    while(i<N):
        x = gen_rand_n(x_min,x_max,1)
        y = gen_rand_n(0,y_max , 1)
        if(y<=f(x)):
            x_acc.append(x)
            i+=1
    return x_acc
```

[5]:
```
def pdf(lmd):
    def f(x):
        val = lmd*np.exp(-lmd*x)
        return val
    return f
```

[6]:
```
x= np.linspace(0,15)
plt.plot(x, pdf(1)(x))
plt.title('Given PDF Function Plot')
plt.xlabel('x')
plt.ylabel('pdf(x)')
plt.show()
```



[7]:
```
lmd = 1
y_max = lmd
samples = gen_samples(pdf(lmd) , 0,15 ,y_max ,10)
plt.hist(samples)
plt.title('One of the samples')
plt.show()
```

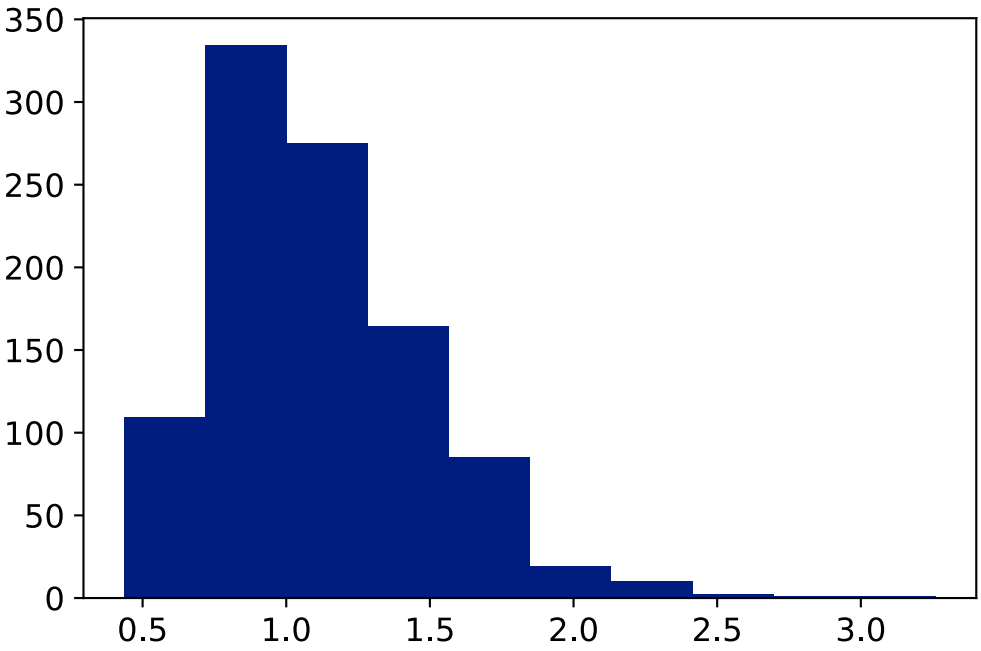


0.0.1 Generating 1000 samples for n=10

[8]:
```
N = 1000
lmd = 1
samples = []
n = 10
for i in range(N):
    s = gen_samples(pdf(lmd) , 0,15 ,y_max , n)
    samples.append(s)
```

[9]:
```
lmd_estim = []
for s in samples:
    lm =len(s)/sum(s)
    lmd_estim.append(lm)
```

[10]:
```
plt.hist(lmd_estim)
plt.show()
```



[11]:
```
mean_lambda = sum(lmd_estim)/len(lmd_estim)
var_lmd = np.var(lmd_estim)
print("Mean of lambda:" , mean_lambda)
print("Variance of lambda:" , var_lmd)
```

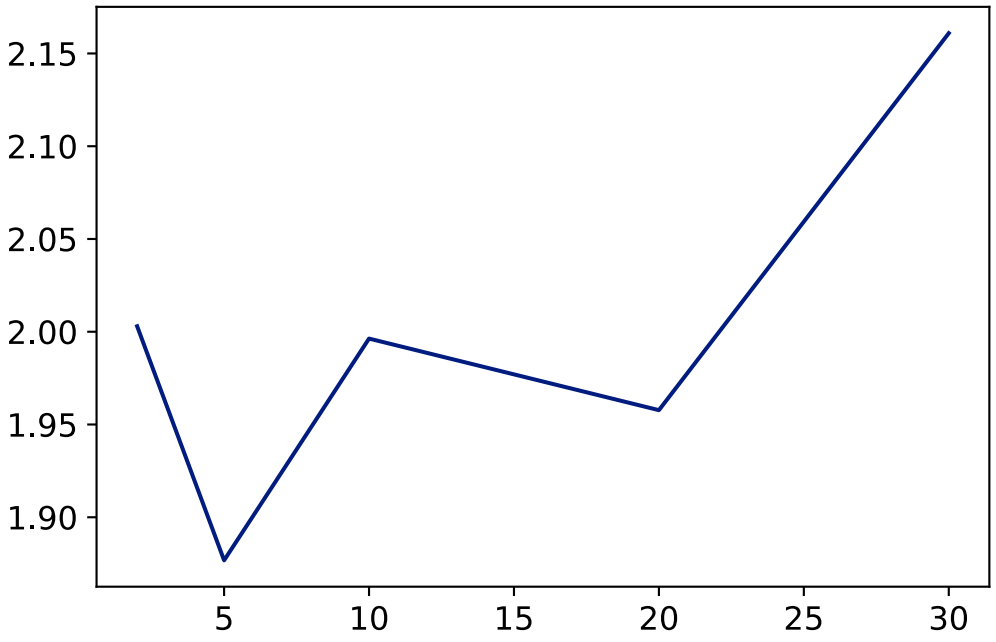
```
Mean of lambda: 1.1125262252856571
Variance of lambda: 0.1347435341403754
```

[13]:
```
means = []
n_val = [2,5,10,20,30]
for n in n_val:
    N = 1000
    lmd = 1
    samples = []
    #means = []
    n = 2
    for i in range(N):
        s = gen_samples(pdf(lmd) , 0,15 ,y_max , n)
        samples.append(s)
    lmd_estim = []
    for s in samples:
        lm =len(s)/sum(s)
        lmd_estim.append(lm)
    mean_lambda = sum(lmd_estim)/len(lmd_estim)
    var_lmd = np.var(lmd_estim)
```

```
    means.append(mean_lambda)
    print("Mean of lambda:" , mean_lambda)
    print("Variance of lambda:" , var_lmd)
```

```
Mean of lambda: 2.0029584314198554
Variance of lambda: 7.844554512521748
Mean of lambda: 1.8767833379468284
Variance of lambda: 11.788953860423218
Mean of lambda: 1.9963125299729982
Variance of lambda: 9.55505271219699
Mean of lambda: 1.9577376559949602
Variance of lambda: 6.809674692854301
Mean of lambda: 2.1609204495921417
Variance of lambda: 18.976327379854474
```

[15]:
```
plt.plot(n_val , means)
plt.show()
```



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