module-1

August 30, 2021

1 Module 1

1.1 Setup

[1]:

```
import numpy as np
%matplotlib inline
import matplotlib.pyplot as plt
from scipy.stats import rv_discrete
import os
```

1.2 Win / Loss

[2]:

```
win_prob = 20/100
loss_prob = 80/100
win_prob + loss_prob == 1
```

[2]:

```
True
```

1.3 Exam Scores

[3]:

```
scores = {"50-60": 20, "61-80": 30, "81-100": 50}
```

[4]:

```
tot = sum(scores.values())
probs = np.divide(list(scores.values()),tot)
print(probs)
```

```
[0.2 0.3 0.5]
```

[5]:

```
sum(probs) == 1
```

[5]:

```
True
```

1.4 Coin Toss

[6]:

```
np.random.choice(["heads", "tails"])
```

[6]:

```
'heads'
```

1.5 Roll Dice

[7]:

```
np.random.randint(1,6)
```

[7]:

```
1
```

[8]:

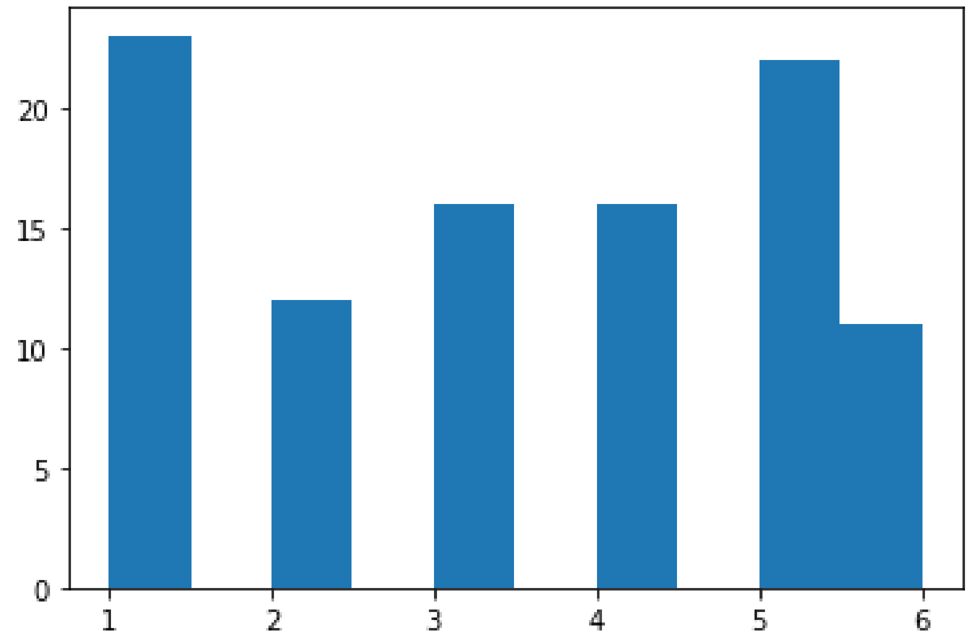
```
def roll_dice(n):
    return np.random.randint(1, 7, n)
```

[9]:

```
rolls = [roll_dice(n) for n in [100, 10000, 1000000]]
```

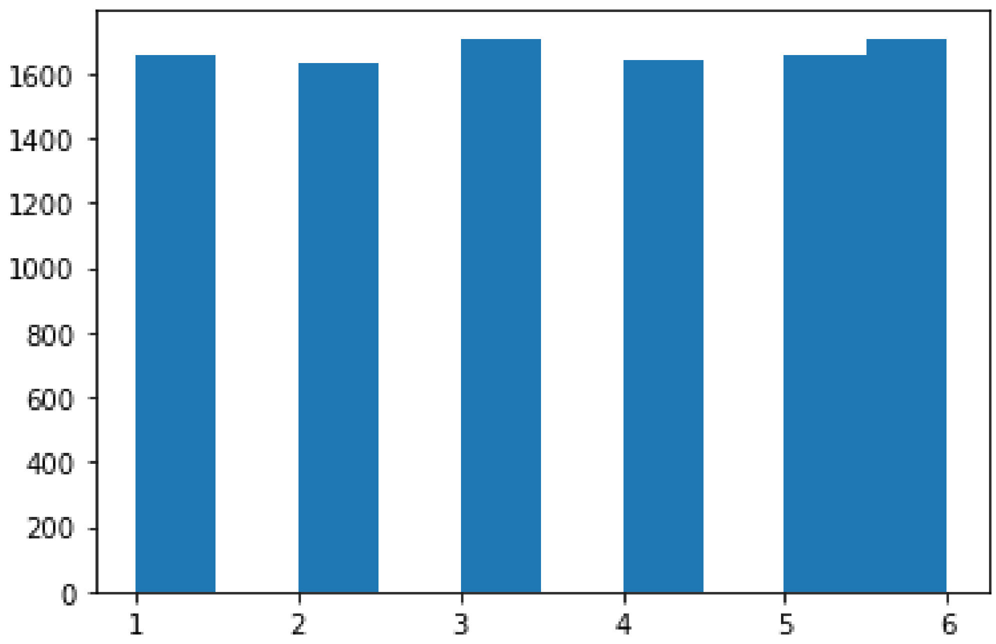
[10]:

```
plt.hist(rolls[0]);
```



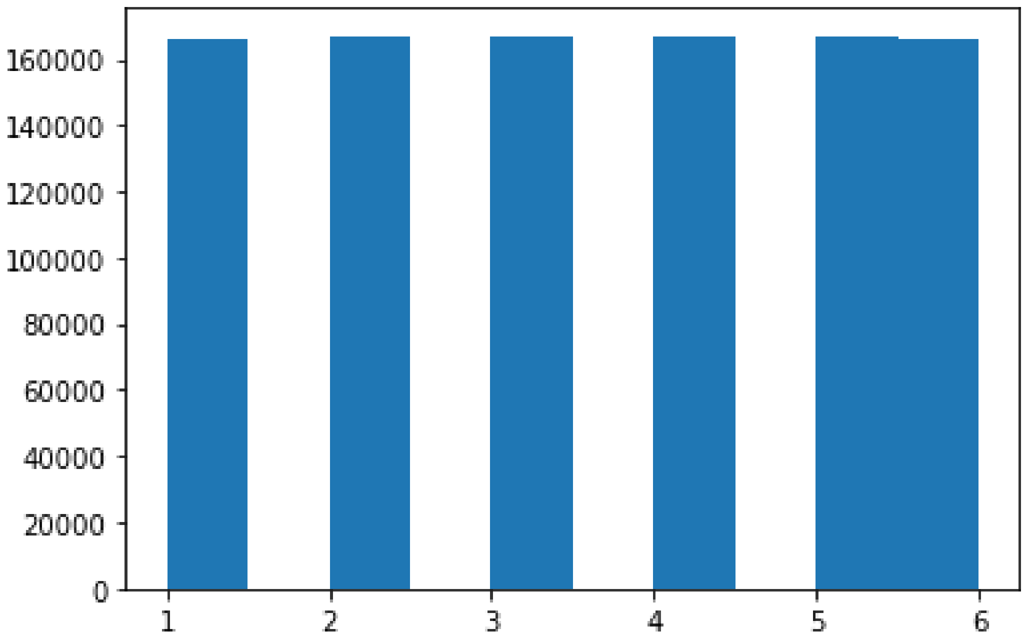
[11]:

```
plt.hist(rolls[1]);
```



[12]:

```
plt.hist(rolls[2]);
```



[13]:

```
p = 1/6
di_probs = {i:p for i in range(1,7)}
```

[14]:

```
sum(di_probs.values())
```

[14]:

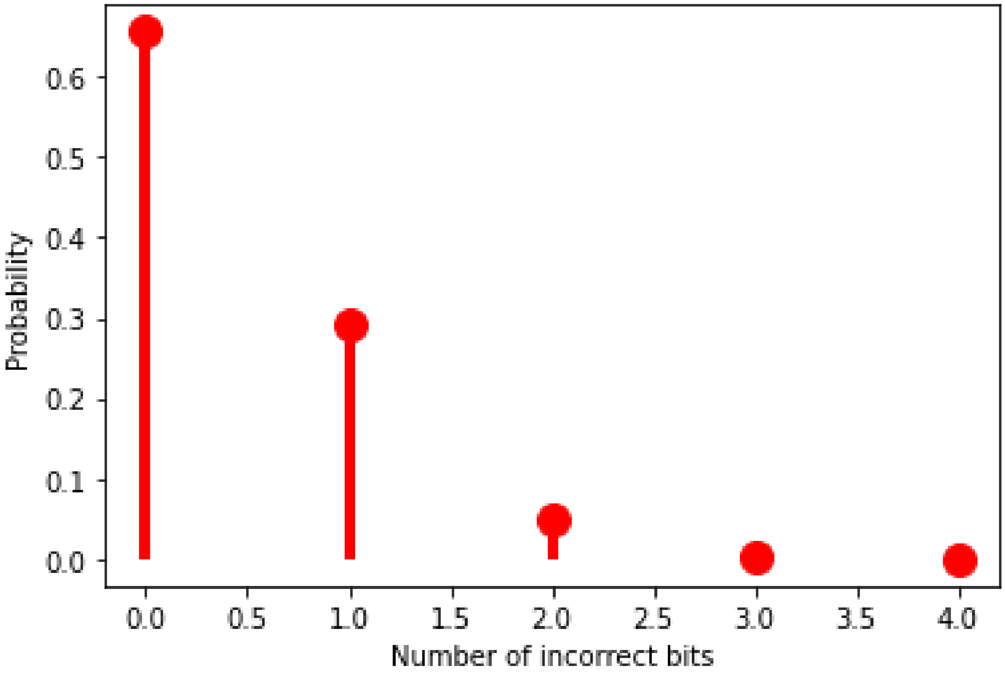
```
0.9999999999999999
```

1.6 Digital Channel (Ex 3.5)

[15]:

```
# modified from https://docs.scipy.org/doc/scipy/reference/generated/scipy.
 ↪stats.rv_discrete.html
xk = np.arange(5)
pk = [0.6561, 0.2916, 0.0486, 0.0036, 0.0001]
custm = rv_discrete(name='custm', values=(xk, pk))

fig, ax = plt.subplots(1, 1)
ax.plot(xk, custm.pmf(xk), 'ro', ms=12, mec='r')
ax.vlines(xk, 0, custm.pmf(xk), colors='r', lw=4)
plt.xlabel("Number of incorrect bits")
plt.ylabel("Probability")
plt.show()
```



1.6.1 Cumulative Sum

[16]:

```
print(np.cumsum(pk))
```

```
[0.6561 0.9477 0.9963 0.9999 1.    ]
```

1.6.2 Expectation Value

[17]:
```
mu = np.dot(xk, pk)
print(mu)
```

```
0.4
```

1.6.3 Variance

[18]:
```
var = sum([p*(x-mu)**2 for x, p in zip(xk, pk)])
print(var)
```

```
0.3600000000000001
```

Note that np.var() calculates the population variance with equal weights (assuming default arguments for np.var()). Notice that the result is incorrect.

[19]:
```
np.var(pk)
```

[19]:
```
0.06357454
```

Helper Function for Mean and Variance

[20]:
```
def dist_mean_var(xk, pk):
    mu = np.dot(xk, pk)
    var = sum([p*(x-mu)**2 for x, p in zip(xk, pk)])
    return mu, var
```

1.6.4 Standard Deviation

[21]:
```
np.sqrt(var)
```

[21]:
```
0.6000000000000001
```

[22]:
```
mu, var = dist_mean_var(xk, pk)
print(mu, var)
```

```
0.4 0.3600000000000001
```

1.7 NiCd Battery (3.3.6)

[23]:
```
battery = {0: 0.17, 2: 0.35, 3: 0.33, 4: 0.15}
charges = list(battery.keys())
vals = list(battery.values())
cdf = np.cumsum(vals)
print(cdf)
```

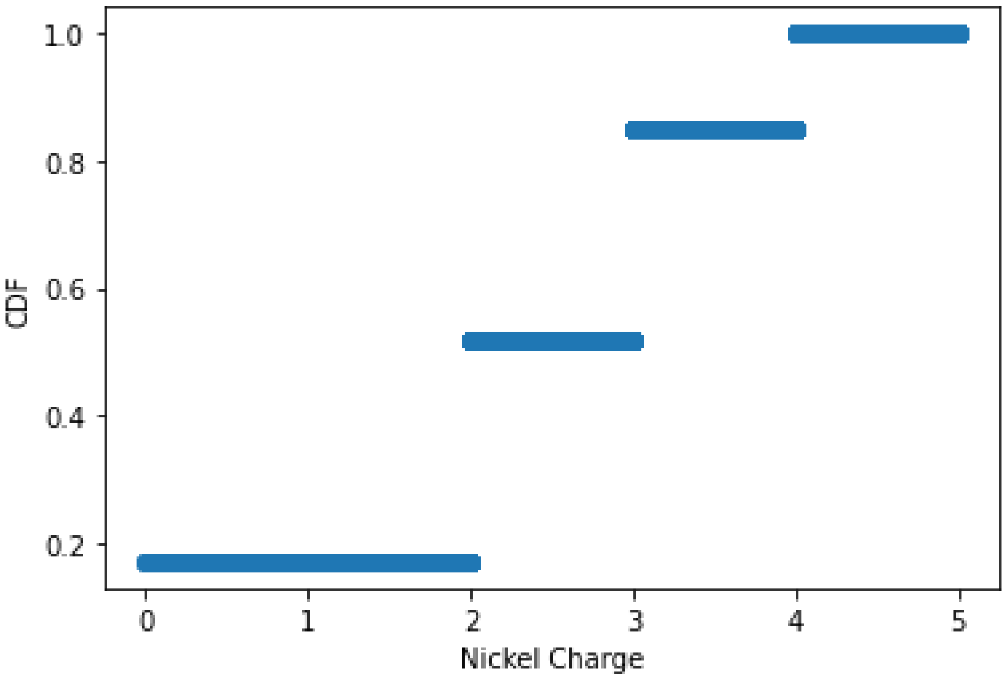
```
[0.17 0.52 0.85 1.  ]
```

[24]:
```
n = 10000
x = np.linspace(0, 5, num=n)
```

```
c1 = (x >= 0) & (x < 2)
c2 = (x >= 2) & (x < 3)
c3 = (x >= 3) & (x < 4)
c4 = x >= 4
conds = [c1, c2, c3, c4]
pw = np.piecewise(x, conds, cdf)
```

[25]:
```
plt.scatter(x,pw)
plt.xlabel("Nickel Charge")
plt.ylabel("CDF")
```

[25]:
```
Text(0, 0.5, 'CDF')
```



[26]:
```
mu, var = dist_mean_var(charges, vals)
sigma = np.sqrt(var)
print(mu, sigma)
```

```
2.29 1.235273249123448
```

2 Code Graveyard

[27]:
```
n = 10000
x = np.linspace(0, 100, num=n)
c1 = (x >= 50) & (x <= 60)
```

```
c2 = (x >= 61) & (x <= 80)
c3 = (x >= 81) & (x <= 100)
conds = [c1, c2, c3]
vals = np.array([20/(60-50), 30/(80-61), 50/(100-81)])/n
```

[28]:

```
pw = np.piecewise(x, conds, vals)
print(pw)
```

```
[0.         0.         0.         … 0.00026316 0.00026316 0.00026316]
```

[29]:

```
sum(pw)
```

[29]:

```
0.9999999999999853
```

[30]:

```
[sum(c*pw) for c in conds]
```

[30]:

```
[0.20000000000000367, 0.2999999999999941, 0.5000000000000163]
```

[31]:

```
conds = [0, 1, 2, 3, 4]
vals = [0.6561, 0.2916, 0.0486, 0.0036, 0.0001]
digi_chan = {cond: val for cond, val in zip(conds,vals)}
print(digi_chan)
```

```
{0: 0.6561, 1: 0.2916, 2: 0.0486, 3: 0.0036, 4: 0.0001}
```

3 Print to PDF

[32]:

```
os.system("jupyter nbconvert --to pdf module-1.ipynb")
```

[32]:

```
0
```