module-1

September 3, 2021

1 Module 1

1.1 Setup

[2]:
```
import numpy as np
import matplotlib.pyplot as plt
from scipy.stats import rv_discrete
import os
```

```
---------------------------------------------------------------------------
ImportError                               Traceback (most recent call last)
~\AppData\Local\Temp/ipykernel_20016/803452693.py in <module>
      1 import numpy as np
----> 2 import matplotlib.pyplot as plt
      3 from scipy.stats import rv_discrete
      4 import os

~\anaconda3\envs\mete-3070\lib\site-packages\matplotlib\__init__.py in <module>
    105 # cbook must import matplotlib only within function
    106 # definitions, so it is safe to import from it here.
--> 107 from . import _api, cbook, docstring, rcsetup
    108 from matplotlib.cbook import MatplotlibDeprecationWarning,␣
 ↪sanitize_sequence
    109 from matplotlib.cbook import mplDeprecation  # deprecated

~\anaconda3\envs\mete-3070\lib\site-packages\matplotlib\rcsetup.py in <module>
     24 from matplotlib import _api, animation, cbook
     25 from matplotlib.cbook import ls_mapper
---> 26 from matplotlib.colors import Colormap, is_color_like
     27 from matplotlib.fontconfig_pattern import parse_fontconfig_pattern
     28 from matplotlib._enums import JoinStyle, CapStyle

~\anaconda3\envs\mete-3070\lib\site-packages\matplotlib\colors.py in <module>
     80 import matplotlib as mpl
     81 import numpy as np
---> 82 from matplotlib import _api, cbook, scale
     83 from ._color_data import BASE_COLORS, TABLEAU_COLORS, CSS4_COLORS,␣
 ↪XKCD_COLORS
```

```
     84

~\anaconda3\envs\mete-3070\lib\site-packages\matplotlib\scale.py in <module>
     16 import matplotlib as mpl
     17 from matplotlib import _api, docstring
---> 18 from matplotlib.ticker import (
     19     NullFormatter, ScalarFormatter, LogFormatterSciNotation,␣
 ↪LogitFormatter,
     20     NullLocator, LogLocator, AutoLocator, AutoMinorLocator,

~\anaconda3\envs\mete-3070\lib\site-packages\matplotlib\ticker.py in <module>
    177 import matplotlib as mpl
    178 from matplotlib import _api, cbook
--> 179 from matplotlib import transforms as mtransforms
    180
    181 _log = logging.getLogger(__name__)

~\anaconda3\envs\mete-3070\lib\site-packages\matplotlib\transforms.py in <modul>
     41
     42 import numpy as np
---> 43 from numpy.linalg import inv
     44
     45 from matplotlib import _api

ImportError: cannot import name 'inv' from 'numpy.linalg' (unknown location)
```

1.2 Win / Loss

[ ]:
```
win_prob = 20/100
loss_prob = 80/100
win_prob + loss_prob == 1
```

1.3 Exam Scores

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

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

[ ]:
```
sum(probs) == 1
```

1.4 Coin Toss

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

1.5 Roll Dice

[ ]:
```
np.random.randint(1,6)
```

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

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

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

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

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

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

[ ]:
```
sum(di_probs.values())
```

1.6 Digital Channel (Ex 3.5)

[ ]:
```
# 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

[ ]:
```
print(np.cumsum(pk))
```

1.6.2 Expectation Value

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

1.6.3 Variance

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

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

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

Helper Function for Mean and Variance

```
[ ]: 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

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

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

1.7 NiCd Battery (3.3.6)

```
[ ]: 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)
```

```
[ ]: 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)
```

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

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

2 Code Graveyard

[ ]:
```
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
```

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

[ ]:
```
sum(pw)
```

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

[ ]:
```
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)
```

[ ]:
```
xk = list(range(0,9))
pk = [0.07826, 0.2775, 0.1656, 0.0694, 0.04136, 0.0694, 0.07481, 0.08538, 0.
↪1388]
dist_mean_var(xk, pk)
```

3 Print to PDF

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