Probability and Statistics – Fall 2020
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P18-0030
Section B

~ Question 1

$$\binom{n}{k} p^k (1-p)^{n-k}$$

Question 1 using ~~Binomial~~ Binomial Random Vaiable

TTTTTTTTTT $\binom{10}{0} (0.72)^0 (0.28)^{10} = 0.000002961$

HTTHTTTTTT $\binom{10}{2} (0.72)^2 (0.28)^8 = 0.000881336$

TTHHTHTTHT $\binom{10}{4} (0.72)^4 (0.28)^6 = 0.0271955$

THTHTHTHHH $\binom{10}{6} (0.72)^6 (0.28)^4 = 0.17982$

HHHTHHHTHH $\binom{10}{8} (0.72)^8 (0.28)^2 = 0.2547936$

HHHHHHHHHH $\binom{10}{10} (0.72)^{10} (0.28)^0 = 0.0374391$

↓ any order of H's so Combination is used in ~~Binomial~~ R.V. Formula Binomial

↓ Sum = 0.50014

Probability of H coming even number of times

~ **Question 2**

Assignment 04

```
import pandas as pd
import numpy as np
from scipy import stats
import statistics
import seaborn as sns
import matplotlib
import matplotlib.pyplot as plt
%matplotlib inline
```

```
sns.set(color_codes=True)
sns.set_style("white")
```

```
np.random.uniform(low=0.0, high=1.0)
```

```
0.7991585642167236
```

```
def flip(num = 1):
    flips = []

    for i in range(num):
        num = np.random.uniform(low=0.0, high=1.0)
        if num > 0.5:
            flips.append('H')
        else:
            flips.append('T')

    return flips

flips = flip(10)
values, counts = np.unique(flips, return_counts=True)

print(flips)
print(values)
print(counts)
```

```
['T', 'H', 'H', 'T', 'H', 'H', 'T', 'H', 'T', 'T']
['H' 'T']
[5 5]
```

Reproducible Randomness

```
np.random.seed(0)

def flip(num = 1):
    flips = []

    for i in range(num):
        num = np.random.uniform(low=0.0, high=1.0)
        if num > 0.5:
            flips.append('H')
        else:
            flips.append('T')

    return flips

flips = flip(10)
values, counts = np.unique(flips, return_counts=True)

print(flips)
print(values)
print(counts)
```

```
['H', 'H', 'H', 'H', 'T', 'H', 'T', 'H', 'H', 'T']
['H' 'T']
[7 3]
```

Probability of Flips

```
# flips = ['H']
```

```
from collections import Counter, defaultdict

def get_freq(flips):
    keys = Counter(flips).keys()
    values = Counter(flips).values()

#     return dict(zip(keys,values))


#     defaultdict: to avoid KeyError if we get H/T 0, default dict returns default value

    return defaultdict(int, dict(zip(keys,values)))



freq = get_freq(flips)
print(freq)
```

```
defaultdict(<class 'int'>, {'H': 7, 'T': 3})
```

```
#checking the working of defaultdict

p_h = freq['T'] / len(flips)
p_h
```

```
0.8
```

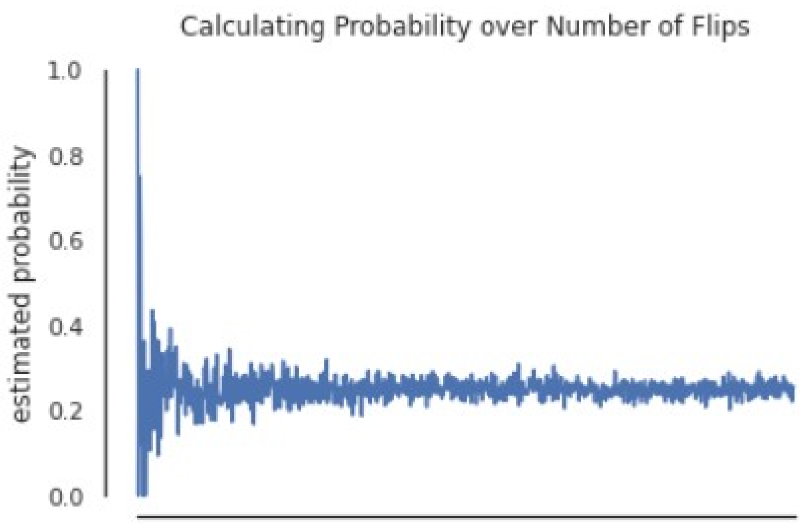
Experiment: 1 - N Flips

```
max_flips = 1000

probs = []

# number of heads / number of flips

for num_flips in range(1, max_flips):

    flips = flip(num_flips)
    freq = get_freq(flips)
    p_h = freq['H'] / len(flips)

    probs.append(p_h)


# print(probs)
```

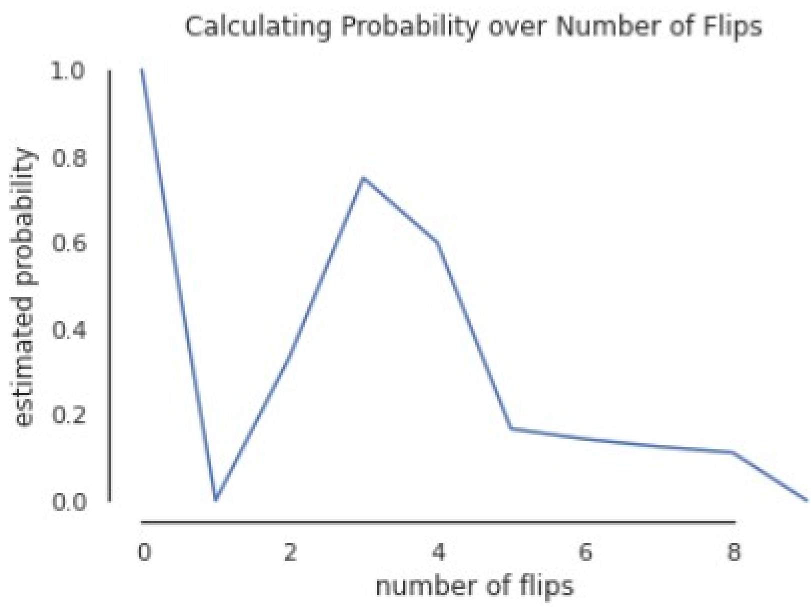
```
print(freq)
```

```
defaultdict(<class 'int'>, {'H': 497, 'T': 502})
```

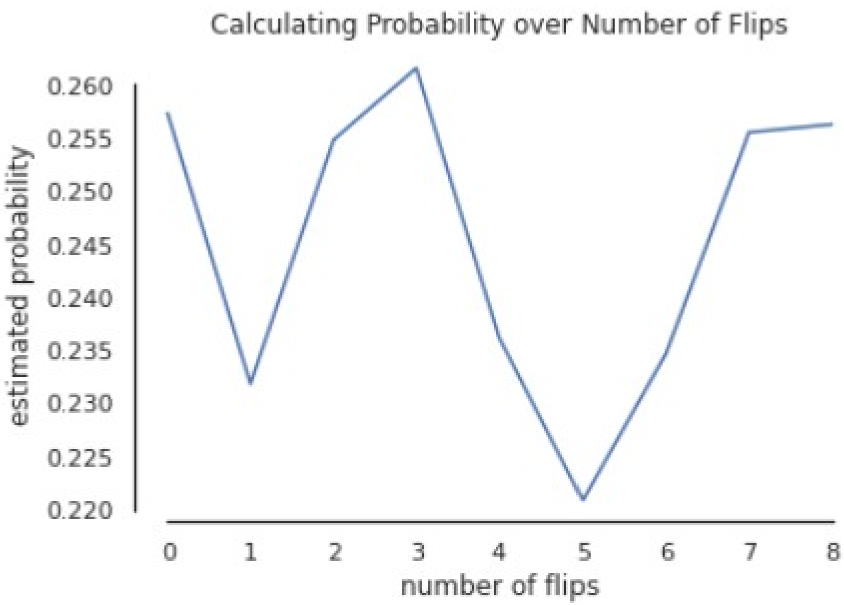
```
plt.plot(probs)
plt.xlabel('number of flips')
plt.ylabel('estimated probability')
plt.title('Calculating Probability over Number of Flips')
sns.despine(offset=0, trim=True);
plt.show()
```



```python
#initial 10 flips

plt.plot(probs[:10])
plt.xlabel('number of flips')
plt.ylabel('estimated probability')
plt.title('Calculating Probability over Number of Flips')
sns.despine(offset=0, trim=True);
plt.show()
```



```
#last 10 flips

plt.plot(probs[max_flips-10:])
plt.xlabel('number of flips')
plt.ylabel('estimated probability')
plt.title('Calculating Probability over Number of Flips')
sns.despine(offset=0, trim=True);
plt.show()
```



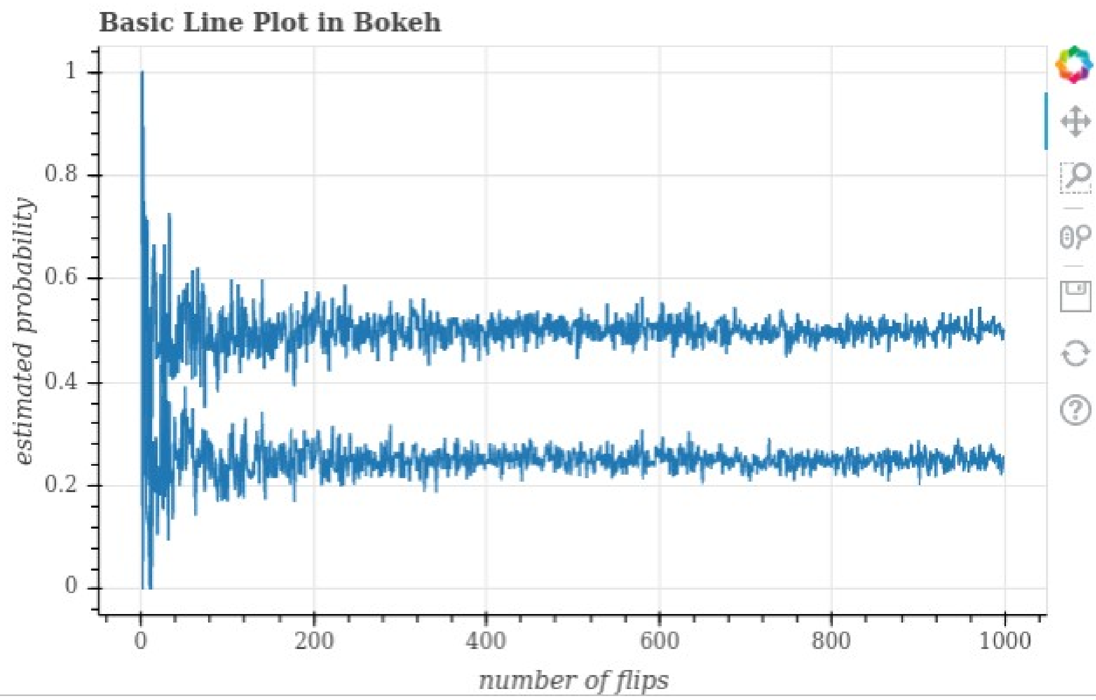
Interactive Plots

```
from bokeh.io import show, output_notebook
from bokeh.plotting import figure

output_notebook()
```

BokehJS 2.1.1 successfully loaded.

```
p = figure(title = 'Basic Line Plot in Bokeh',
          x_axis_label = 'number of flips',
          y_axis_label = 'estimated probability',
          plot_width = 580, plot_height = 380)
```

```
x = range(1, max_flips)
p.line(x=x, y=probs)

# upper graph is for 0.5
#lower graph is for 0.75
show(p)
```



~ Question 3:

Question 3

$S = \{HH, HT, TH\}$

$= \dfrac{\text{one is T}}{\text{one is H for sure}}$

$= \dfrac{2}{3} = 0.667$

$S = \{HH, TH\}$

$= \dfrac{\text{first one is T}}{\text{second flip is H for sure}}$

$= \dfrac{1}{2} = 0.5$

Yes, the answer changes when the statement changes.