In [1]:

```
import matplotlib.pyplot as plt
import numpy as np
import seaborn as sns
from collections import Counter, defaultdict
from bokeh.io import show, output_notebook
from bokeh.plotting import figure

output_notebook()
sns.set(color_codes=True)
sns.set_style('white')
```

(https://bokeh.org) Loading BokehJS ...

In [2]:

```
np.random.seed(42)  # For sake of reproducible randomness
```

In [3]:

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

    for i in range(num):
        num = np.random.uniform(low=0.0, high=1.0)
        if num >= 0.28:  # float number is For tails
            flips.append('H')
        else:
            flips.append('T')
    return flips


def get_freqs(flips):
    keys = Counter(flips).keys()
    vals = Counter(flips).values()

    return defaultdict(int, dict(zip(keys, vals)))  # defaultdict coz what it will give error for nomarl dic
tionay if either 'H' or 'T' is not present
```

In [4]:

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

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

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

In [5]:

```
freqs = get_freqs(flips)
print(freqs)
```

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

In [6]:

```
prob_h = freqs['H'] / len(flips)
print(prob_h)
```

```
0.7
```

In [7]:

```
# Running experiment
maximum_flips = 2000

probs_h = []
for num_flips in range(1, maximum_flips):
    flips = flip(num_flips)
    freqs = get_freqs(flips)
#     if freqs['H'] % 2 == 0:
#         prob_h = freqs['H']/len(flips)   # Didn't Work?
    prob_h = freqs['H'] / len(flips)

    probs_h.append(prob_h)
```

In [8]:

```
print(len(probs_h))
```

```
1999
```

In [9]:

```
p = figure(title="Simple Line Plot in Bokeh",
           x_axis_label='Number of Flips in Experiment',
           y_axis_label='Estimated Probability of Head',
           plot_width=580, plot_height=380)
```

In [10]:

```
# Add a line renderer with legend and line thickness
x = range(1, maximum_flips)
p.line(x=x, y=probs_h)

# Show the results
show(p)
```

In [11]:

```
poss = [('H',0.72), ('T',0.28)]
outcomes = []
for one in poss:
    res = ''
    for two in poss:
        for three in poss:
            for four in poss:
                for five in poss:
                    for six in poss:
                        for seven in poss:
                            for eight in poss:
                                for nine in poss:
                                    for ten in poss:
                                        res = one[0] + two[0] + three[0] + four[0] + five[0] + six[0] + seve
n[0] + eight[0] + nine[0] + ten[0]
                                        prob = one[1] * two[1] * three[1] * four[1] * five[1] * six[1] * sev
en[1] * eight[1] * nine[1] * ten[1]
                                        outcomes.append((res,prob))
```

In [17]:

```
print(outcomes[:10])
```

```
[('HHHHHHHHHH', 0.03743906242624486), ('HHHHHHHHHT', 0.014559635387984113), ('HHHHHHHHTH', 0.01
4559635387984115), ('HHHHHHHHTT', 0.00566208042866049), ('HHHHHHHTHH', 0.014559635387984115), (
'HHHHHHHTHT', 0.00566208042866049), ('HHHHHHHTTH', 0.005662080428660489), ('HHHHHHHTTT', 0.0022
019201667013016), ('HHHHHHTHHH', 0.014559635387984115), ('HHHHHHTHHT', 0.00566208042866049)]
```

In [13]:

```
print(len(outcomes))
```

```
1024
```

In [14]:

```
def is_even_heads(result_prob):
    result = result_prob[0]
    c = 0

    for head_or_tail in result_prob[0]:
        if head_or_tail == 'H':
            c = c + 1

    return c % 2 == 0
```

In [15]:

```
evens = list(filter(is_even_heads, outcomes))
print(len(evens))
```

```
512
```

In [16]:

```
print("The probability of head to come even times when coin is tossed 10 times is :", sum( [res[1] for res i
n evens] ))
```

```
The probability of head to come even times when coin is tossed 10 times is : 0.5001359868047001
```

You flip a fair coin two times. You know that one of them was heads. What is the probability that the other one was tails ?

Let A = One of them is heads

Let B = One of them is tails

Ω = {HH, HT, TH, TT}

atleast one of them is heads so : New universe = {HH, HT, TH}

P(A) = 3/4 = 0.75

P(B) = 3/4 = 0.75

As A and B are independent P(A$\bigcap$B) = 2/4 = 1/2 = 0.5

P(B | A) = P(A$\bigcap$B) / P(A) = 0.5 / 0.75 **= 0.667**

0.667 Or 2/3 As 3 are the number of outcomes in our new universe and 2/3 satisfy event B given A

Does your answer change if we change the statement to: You flip a fair coin two times. You know that the second flip was heads. What is the probability that the first one was tails?

Let A = Second flip is heads

Let B = First one is tails

Ω = {HH, HT, TH, TT}

Second flip is heads so : New universe = {HH, TH}

P(A) = 2/4 = 1/2 = 0.5

P(B) = 2/4 = 1/2 = 0.5

As A and B are independent P(A$\bigcap$B) = 1/4 = 0.25

P(B | A) = P(A$\bigcap$B) / P(A) = 0.25 / 0.5 **= 0.5**

0.5 Or 1/2 As 2 are the number of outcomes in our new universe and 1/2 satisfy event B given A