fair_coin

May 23, 2025

1 Experimenting & Plotting Relative Frequencies of Heads & Tails with respect to Number of Tosses for a Fair Coin with help of pseudo-random choosing.

[151]:
```
# installing required modules

%pip install matplotlib
```

```
Requirement already satisfied: matplotlib in
d:\projects\dwaidatta-10\.venv\lib\site-packages (3.10.3)
Requirement already satisfied: contourpy>=1.0.1 in
d:\projects\dwaidatta-10\.venv\lib\site-packages (from matplotlib) (1.3.2)
Requirement already satisfied: cycler>=0.10 in
d:\projects\dwaidatta-10\.venv\lib\site-packages (from matplotlib) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in
d:\projects\dwaidatta-10\.venv\lib\site-packages (from matplotlib) (4.57.0)
Requirement already satisfied: kiwisolver>=1.3.1 in
d:\projects\dwaidatta-10\.venv\lib\site-packages (from matplotlib) (1.4.8)
Requirement already satisfied: numpy>=1.23 in
d:\projects\dwaidatta-10\.venv\lib\site-packages (from matplotlib) (2.2.5)
Requirement already satisfied: packaging>=20.0 in
d:\projects\dwaidatta-10\.venv\lib\site-packages (from matplotlib) (25.0)
Requirement already satisfied: pillow>=8 in
d:\projects\dwaidatta-10\.venv\lib\site-packages (from matplotlib) (11.2.1)
Requirement already satisfied: pyparsing>=2.3.1 in
d:\projects\dwaidatta-10\.venv\lib\site-packages (from matplotlib) (3.2.3)
Requirement already satisfied: python-dateutil>=2.7 in
d:\projects\dwaidatta-10\.venv\lib\site-packages (from matplotlib) (2.9.0.post0)
Requirement already satisfied: six>=1.5 in
d:\projects\dwaidatta-10\.venv\lib\site-packages (from python-
dateutil>=2.7->matplotlib) (1.17.0)
Note: you may need to restart the kernel to use updated packages.
```

[152]:
```
#importing required modules

import matplotlib.pyplot as plt
import random
```

[153]:
```
def take_input():
    # function to take input the number of tosses

    n = int(input("Enter number of tosses: "))
    return n
```

[154]:
```
def calculate():

    no_of_tosses = take_input()
    print("Number of tosses:", no_of_tosses)

    toss_result = None # will store H or T
    tosses = [] # stores the results as list
    possible_outcomes = ['H', 'T'] # possible outcomes

    count_H = 0 # counter for H
    count_T = 0 # counter for T

    rel_freq_H = 0.0 # relative frequency for H
    rel_freq_T = 0.0 # relative frequency for H

    rel_freq_list_H = [] # relative frequency list for H
    rel_freq_list_T = [] # relative frequency list for T

    for toss_number in range(1, (no_of_tosses + 1)): # range: [1, total number␣
↪of tosses entered]

        toss_result = random.choice(possible_outcomes) # randomly selects from␣
↪H or T
        tosses.append(toss_result) # stores the result into list

        # obvious logic implementation below (^_^)

        if (toss_result == 'H'):
            count_H += 1

        else:
            count_T += 1

        rel_freq_H = round(float(count_H/toss_number), 3)
        rel_freq_T = round(float(count_T/toss_number), 3)

        rel_freq_list_H.append(rel_freq_H)
        rel_freq_list_T.append(rel_freq_T)

    # printing to see the values
```

```
    print("Tosses list:")
    print(tosses)

    print("Relative frequency list of Heads H:")
    print(rel_freq_list_H)

    print("Relative frequency list of Tails T:")
    print(rel_freq_list_T)

    return(no_of_tosses, rel_freq_list_H, rel_freq_list_T)
```

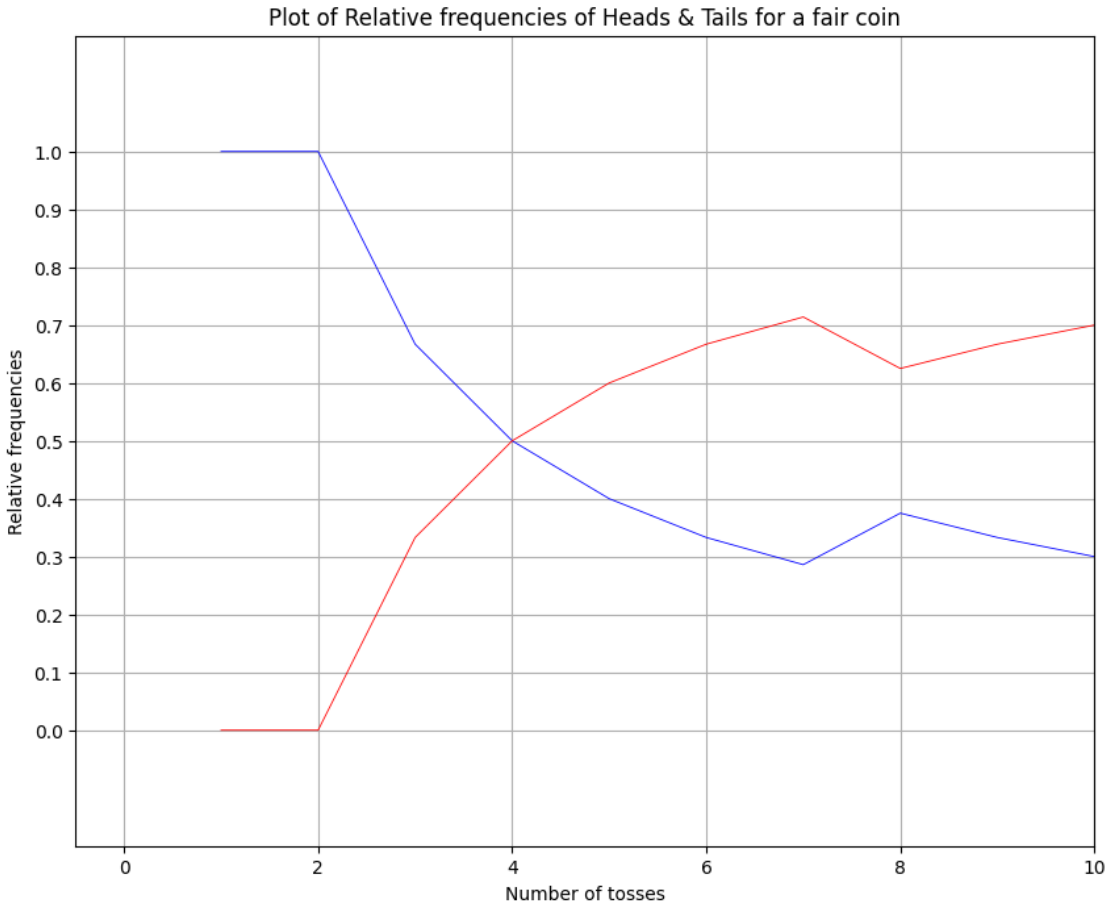
[ ]:
```
def plotting():

    no_of_tosses, rel_freq_list_H, rel_freq_list_T = calculate() # receive the␣
 ↪values from the function

    x_values = list(range(1, no_of_tosses+1)) # X axis range: [1, total number␣
 ↪of tosses entered]

    # plotting customization

    plt.figure(figsize=(10, 8))

    plt.plot(x_values, rel_freq_list_H, linestyle = '-', color = 'blue',␣
 ↪linewidth=0.6)
    plt.plot(x_values, rel_freq_list_T, linestyle = '-', color = 'red',␣
 ↪linewidth=0.6)

    plt.yticks([0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0])

    plt.xlim(-0.5, no_of_tosses)
    plt.ylim(-0.2, 1.2)

    plt.xlabel("Number of tosses")
    plt.ylabel("Relative frequencies")

    plt.title("Plot of Relative frequencies of Heads & Tails for a fair coin")
    plt.grid(True)

    plt.show()
```

1.0.1 Plotting with three different values for `total number of tosses`.

[156]:
```
plotting()
```

```
Number of tosses: 10
Tosses list:
```

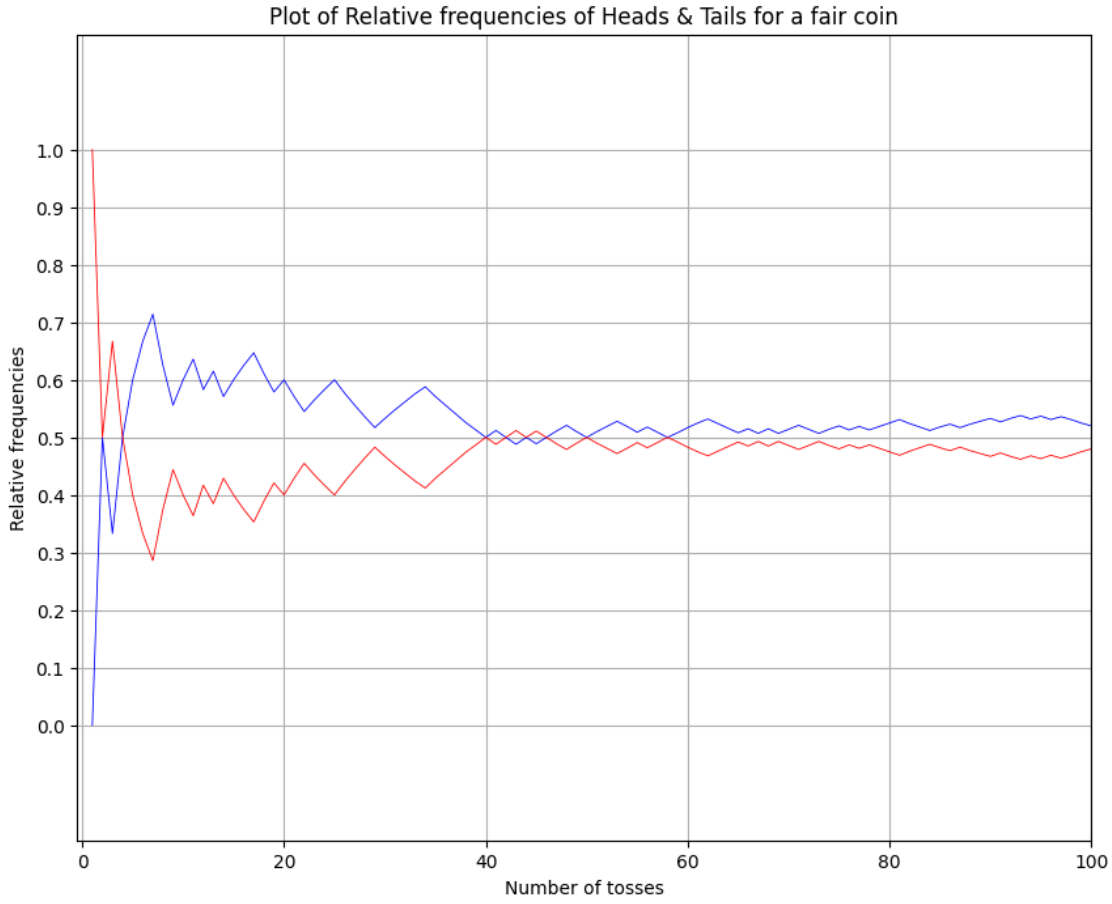
```
['H', 'H', 'T', 'T', 'T', 'T', 'T', 'H', 'T', 'T']
Relative frequency list of Heads H:
[1.0, 1.0, 0.667, 0.5, 0.4, 0.333, 0.286, 0.375, 0.333, 0.3]
Relative frequency list of Tails T:
[0.0, 0.0, 0.333, 0.5, 0.6, 0.667, 0.714, 0.625, 0.667, 0.7]
```



[157]:
```
plotting()
```

```
Number of tosses: 100
Tosses list:
['T', 'H', 'T', 'H', 'H', 'H', 'H', 'T', 'T', 'H', 'H', 'T', 'H', 'T', 'H', 'H',
'H', 'T', 'T', 'H', 'T', 'T', 'H', 'H', 'H', 'T', 'T', 'T', 'T', 'H', 'H', 'H',
'H', 'H', 'T', 'T', 'T', 'T', 'T', 'T', 'H', 'T', 'T', 'H', 'T', 'H', 'H', 'H',
'T', 'T', 'H', 'H', 'H', 'T', 'T', 'H', 'T', 'T', 'H', 'H', 'H', 'H', 'T', 'T',
'T', 'H', 'T', 'H', 'T', 'H', 'H', 'T', 'T', 'H', 'H', 'T', 'H', 'T', 'H', 'H',
'H', 'T', 'T', 'T', 'H', 'H', 'T', 'H', 'H', 'H', 'T', 'H', 'H', 'T', 'H', 'T',
'H', 'T', 'T', 'T']
Relative frequency list of Heads H:
[0.0, 0.5, 0.333, 0.5, 0.6, 0.667, 0.714, 0.625, 0.556, 0.6, 0.636, 0.583,
```

```
0.615, 0.571, 0.6, 0.625, 0.647, 0.611, 0.579, 0.6, 0.571, 0.545, 0.565, 0.583,
0.6, 0.577, 0.556, 0.536, 0.517, 0.533, 0.548, 0.562, 0.576, 0.588, 0.571,
0.556, 0.541, 0.526, 0.513, 0.5, 0.512, 0.5, 0.488, 0.5, 0.489, 0.5, 0.511,
0.521, 0.51, 0.5, 0.51, 0.519, 0.528, 0.519, 0.509, 0.518, 0.509, 0.5, 0.508,
0.517, 0.525, 0.532, 0.524, 0.516, 0.508, 0.515, 0.507, 0.515, 0.507, 0.514,
0.521, 0.514, 0.507, 0.514, 0.52, 0.513, 0.519, 0.513, 0.519, 0.525, 0.531,
0.524, 0.518, 0.512, 0.518, 0.523, 0.517, 0.523, 0.528, 0.533, 0.527, 0.533,
0.538, 0.532, 0.537, 0.531, 0.536, 0.531, 0.525, 0.52]
Relative frequency list of Tails T:
[1.0, 0.5, 0.667, 0.5, 0.4, 0.333, 0.286, 0.375, 0.444, 0.4, 0.364, 0.417,
0.385, 0.429, 0.4, 0.375, 0.353, 0.389, 0.421, 0.4, 0.429, 0.455, 0.435, 0.417,
0.4, 0.423, 0.444, 0.464, 0.483, 0.467, 0.452, 0.438, 0.424, 0.412, 0.429,
0.444, 0.459, 0.474, 0.487, 0.5, 0.488, 0.5, 0.512, 0.5, 0.511, 0.5, 0.489,
0.479, 0.49, 0.5, 0.49, 0.481, 0.472, 0.481, 0.491, 0.482, 0.491, 0.5, 0.492,
0.483, 0.475, 0.468, 0.476, 0.484, 0.492, 0.485, 0.493, 0.485, 0.493, 0.486,
0.479, 0.486, 0.493, 0.486, 0.48, 0.487, 0.481, 0.487, 0.481, 0.475, 0.469,
0.476, 0.482, 0.488, 0.482, 0.477, 0.483, 0.477, 0.472, 0.467, 0.473, 0.467,
0.462, 0.468, 0.463, 0.469, 0.464, 0.469, 0.475, 0.48]
```



[158]:
```
plotting()
```

```
Number of tosses: 1000
Tosses list:
['H', 'T', 'T', 'T', 'H', 'T', 'T', 'T', 'H', 'T', 'T', 'H', 'T', 'H', 'T', 'H',
'T', 'T', 'T', 'T', 'T', 'T', 'H', 'T', 'T', 'H', 'H', 'T', 'T', 'T', 'H', 'H',
'H', 'T', 'T', 'H', 'H', 'T', 'H', 'T', 'H', 'H', 'T', 'H', 'T', 'H', 'H', 'T',
'H', 'H', 'T', 'T', 'T', 'T', 'T', 'H', 'T', 'T', 'H', 'T', 'H', 'H', 'H', 'H',
'H', 'T', 'H', 'T', 'T', 'T', 'H', 'H', 'H', 'H', 'H', 'H', 'H', 'T', 'T', 'T',
'T', 'H', 'T', 'T', 'T', 'T', 'T', 'T', 'H', 'H', 'T', 'H', 'H', 'H', 'H', 'H',
'T', 'T', 'T', 'H', 'T', 'T', 'T', 'H', 'H', 'T', 'T', 'T', 'H', 'T', 'H', 'H',
'T', 'H', 'T', 'T', 'H', 'T', 'T', 'H', 'T', 'T', 'T', 'H', 'T', 'H', 'H', 'H',
'H', 'T', 'H', 'T', 'T', 'T', 'T', 'T', 'H', 'T', 'T', 'H', 'T', 'T', 'H', 'T',
'H', 'T', 'T', 'H', 'H', 'T', 'H', 'H', 'T', 'H', 'T', 'H', 'T', 'T', 'T', 'H',
'T', 'T', 'T', 'T', 'T', 'T', 'T', 'T', 'T', 'H', 'H', 'T', 'T', 'T', 'H', 'T',
'H', 'H', 'H', 'T', 'T', 'T', 'H', 'H', 'H', 'T', 'H', 'H', 'H', 'H', 'T', 'H',
'T', 'H', 'H', 'T', 'H', 'H', 'T', 'H', 'T', 'T', 'H', 'H', 'H', 'T', 'H', 'H',
'T', 'T', 'H', 'H', 'T', 'T', 'H', 'H', 'T', 'T', 'H', 'H', 'H', 'T', 'H', 'H',
'T', 'H', 'T', 'H', 'H', 'T', 'T', 'T', 'T', 'H', 'H', 'T', 'H', 'H', 'H', 'H',
'T', 'H', 'H', 'H', 'T', 'H', 'T', 'H', 'H', 'T', 'T', 'T', 'T', 'T', 'T', 'H',
'H', 'T', 'T', 'H', 'H', 'T', 'T', 'H', 'H', 'H', 'H', 'H', 'H', 'H', 'H', 'T',
'H', 'T', 'H', 'T', 'T', 'H', 'T', 'H', 'H', 'T', 'H', 'H', 'T', 'T', 'H', 'T',
'H', 'H', 'H', 'H', 'H', 'H', 'T', 'T', 'H', 'T', 'H', 'T', 'H', 'H', 'T', 'T',
'H', 'H', 'H', 'T', 'T', 'T', 'H', 'T', 'T', 'T', 'H', 'T', 'H', 'T', 'T', 'H',
'T', 'H', 'H', 'H', 'T', 'T', 'H', 'H', 'H', 'T', 'H', 'T', 'H', 'H', 'H', 'T',
'H', 'H', 'T', 'T', 'T', 'H', 'H', 'H', 'T', 'T', 'T', 'H', 'T', 'H', 'T', 'T',
'T', 'T', 'T', 'H', 'H', 'H', 'H', 'T', 'T', 'H', 'T', 'T', 'H', 'H', 'H', 'H',
'H', 'H', 'H', 'T', 'T', 'H', 'H', 'T', 'T', 'T', 'H', 'T', 'H', 'H', 'T', 'T',
'T', 'H', 'H', 'H', 'H', 'T', 'T', 'H', 'T', 'T', 'T', 'T', 'H', 'H', 'H', 'H',
'T', 'H', 'T', 'T', 'H', 'H', 'T', 'T', 'H', 'T', 'T', 'T', 'H', 'T', 'T', 'T',
'H', 'T', 'T', 'H', 'T', 'H', 'T', 'T', 'H', 'T', 'H', 'T', 'T', 'H', 'H', 'H',
'T', 'T', 'T', 'T', 'T', 'H', 'T', 'H', 'T', 'T', 'H', 'H', 'H', 'H', 'T', 'H',
'T', 'T', 'H', 'T', 'T', 'T', 'T', 'H', 'H', 'H', 'T', 'T', 'H', 'T', 'H', 'T',
'H', 'H', 'H', 'T', 'H', 'T', 'T', 'T', 'H', 'T', 'H', 'T', 'H', 'T', 'T', 'T',
'T', 'T', 'H', 'H', 'H', 'T', 'H', 'H', 'H', 'H', 'T', 'T', 'T', 'T', 'T', 'T',
'T', 'H', 'H', 'T', 'T', 'H', 'T', 'T', 'T', 'H', 'T', 'H', 'H', 'H', 'T', 'T',
'T', 'H', 'H', 'H', 'H', 'T', 'T', 'H', 'T', 'H', 'H', 'T', 'T', 'H', 'T', 'H',
'T', 'H', 'T', 'H', 'H', 'T', 'H', 'H', 'T', 'T', 'T', 'T', 'H', 'T', 'T', 'T',
'T', 'H', 'T', 'H', 'H', 'H', 'T', 'H', 'H', 'T', 'H', 'T', 'T', 'H', 'H', 'T',
'H', 'T', 'T', 'T', 'T', 'H', 'H', 'H', 'T', 'H', 'H', 'H', 'T', 'T', 'H', 'H',
'T', 'H', 'H', 'T', 'H', 'H', 'H', 'T', 'T', 'H', 'T', 'T', 'T', 'H', 'H', 'T',
'T', 'T', 'T', 'H', 'T', 'H', 'T', 'T', 'T', 'T', 'T', 'T', 'H', 'T', 'T', 'H',
'H', 'T', 'T', 'H', 'T', 'H', 'H', 'T', 'T', 'T', 'H', 'H', 'H', 'H', 'T', 'H',
'H', 'H', 'H', 'H', 'H', 'T', 'T', 'H', 'H', 'T', 'H', 'H', 'H', 'H', 'H', 'H',
'T', 'H', 'T', 'H', 'H', 'H', 'H', 'T', 'T', 'H', 'T', 'T', 'H', 'T', 'H', 'H',
'H', 'T', 'T', 'T', 'T', 'H', 'H', 'H', 'H', 'T', 'H', 'H', 'T', 'T', 'T', 'T',
'T', 'T', 'T', 'T', 'H', 'H', 'T', 'H', 'T', 'T', 'T', 'T', 'T', 'T', 'T', 'H',
'H', 'H', 'T', 'H', 'T', 'H', 'T', 'H', 'H', 'H', 'H', 'T', 'H', 'T', 'T', 'T',
```

```
'H', 'H', 'H', 'H', 'H', 'H', 'H', 'T', 'T', 'H', 'H', 'T', 'H', 'T', 'H', 'H',
'H', 'T', 'H', 'T', 'T', 'T', 'H', 'T', 'H', 'T', 'H', 'T', 'H', 'H', 'H', 'H',
'H', 'T', 'T', 'T', 'H', 'T', 'H', 'H', 'H', 'H', 'H', 'T', 'H', 'H', 'H', 'H',
'H', 'T', 'H', 'T', 'H', 'T', 'H', 'T', 'H', 'T', 'T', 'T', 'T', 'H', 'T', 'T',
'H', 'H', 'H', 'T', 'H', 'T', 'T', 'H', 'H', 'T', 'H', 'T', 'T', 'H', 'H', 'H',
'H', 'T', 'T', 'H', 'H', 'T', 'H', 'T', 'T', 'T', 'T', 'H', 'T', 'T', 'T', 'H',
'H', 'T', 'T', 'H', 'T', 'H', 'T', 'H', 'T', 'H', 'T', 'H', 'H', 'H', 'H', 'T',
'T', 'T', 'T', 'H', 'T', 'H', 'T', 'T', 'T', 'T', 'T', 'H', 'H', 'H', 'T', 'H',
'T', 'T', 'H', 'T', 'T', 'T', 'T', 'T', 'H', 'H', 'H', 'T', 'H', 'H', 'H', 'T',
'T', 'T', 'H', 'T', 'H', 'H', 'H', 'H', 'H', 'T', 'T', 'T', 'H', 'H', 'H', 'H',
'H', 'T', 'H', 'H', 'T', 'H', 'H', 'H', 'T', 'T', 'H', 'T', 'H', 'T', 'H', 'T',
'H', 'H', 'T', 'T', 'T', 'H', 'T', 'H', 'T', 'T', 'T', 'T', 'T', 'H', 'T', 'H',
'H', 'T', 'T', 'T', 'T', 'H', 'T', 'T', 'H', 'T', 'T', 'H', 'H', 'H', 'T', 'T',
'H', 'T', 'T', 'H', 'H', 'H', 'T', 'T', 'H', 'T', 'H', 'H', 'T', 'H', 'T', 'T',
'H', 'T', 'T', 'T', 'H', 'T', 'T', 'H', 'T', 'T', 'H', 'T', 'H', 'T', 'T', 'T',
'T', 'T', 'T', 'H', 'H', 'T', 'T', 'T', 'H', 'H', 'T', 'T', 'T', 'T', 'T', 'T',
'T', 'H', 'T', 'H', 'H', 'H', 'H', 'H', 'T', 'H', 'T', 'T', 'H', 'H', 'T', 'T',
'T', 'T', 'T', 'H', 'H', 'T', 'H', 'H', 'T', 'T', 'T', 'H', 'T', 'H', 'T', 'H',
'T', 'H', 'T', 'T', 'H', 'T', 'H', 'T']
Relative frequency list of Heads H:
[1.0, 0.5, 0.333, 0.25, 0.4, 0.333, 0.286, 0.25, 0.333, 0.3, 0.273, 0.333,
0.308, 0.357, 0.333, 0.375, 0.353, 0.333, 0.316, 0.3, 0.286, 0.273, 0.304,
0.292, 0.28, 0.308, 0.333, 0.321, 0.31, 0.3, 0.323, 0.344, 0.364, 0.353, 0.343,
0.361, 0.378, 0.368, 0.385, 0.375, 0.39, 0.405, 0.395, 0.409, 0.4, 0.413, 0.426,
0.417, 0.429, 0.44, 0.431, 0.423, 0.415, 0.407, 0.4, 0.411, 0.404, 0.397, 0.407,
0.4, 0.41, 0.419, 0.429, 0.438, 0.446, 0.439, 0.448, 0.441, 0.435, 0.429, 0.437,
0.444, 0.452, 0.459, 0.467, 0.474, 0.481, 0.474, 0.468, 0.463, 0.457, 0.463,
0.458, 0.452, 0.447, 0.442, 0.437, 0.432, 0.438, 0.444, 0.44, 0.446, 0.452,
0.457, 0.463, 0.469, 0.464, 0.459, 0.455, 0.46, 0.455, 0.451, 0.447, 0.452,
0.457, 0.453, 0.449, 0.444, 0.45, 0.445, 0.45, 0.455, 0.451, 0.456, 0.452,
0.448, 0.453, 0.449, 0.445, 0.45, 0.446, 0.443, 0.439, 0.444, 0.44, 0.444,
0.449, 0.453, 0.457, 0.454, 0.458, 0.455, 0.451, 0.448, 0.444, 0.441, 0.445,
0.442, 0.439, 0.443, 0.44, 0.437, 0.441, 0.438, 0.441, 0.438, 0.435, 0.439,
0.443, 0.44, 0.444, 0.447, 0.444, 0.448, 0.445, 0.449, 0.446, 0.443, 0.44,
0.444, 0.441, 0.438, 0.436, 0.433, 0.43, 0.428, 0.425, 0.423, 0.42, 0.424,
0.427, 0.424, 0.422, 0.42, 0.423, 0.42, 0.424, 0.427, 0.43, 0.428, 0.425, 0.423,
0.426, 0.429, 0.432, 0.43, 0.433, 0.436, 0.439, 0.442, 0.44, 0.443, 0.44, 0.443,
0.446, 0.444, 0.447, 0.449, 0.447, 0.45, 0.448, 0.446, 0.448, 0.451, 0.454,
0.451, 0.454, 0.457, 0.455, 0.452, 0.455, 0.458, 0.455, 0.453, 0.456, 0.458,
0.456, 0.454, 0.457, 0.459, 0.462, 0.459, 0.462, 0.464, 0.462, 0.465, 0.463,
0.465, 0.467, 0.465, 0.463, 0.461, 0.459, 0.462, 0.464, 0.462, 0.464, 0.466,
0.469, 0.471, 0.469, 0.471, 0.473, 0.475, 0.473, 0.476, 0.474, 0.476, 0.478,
0.476, 0.474, 0.472, 0.47, 0.469, 0.467, 0.469, 0.471, 0.469, 0.467, 0.469,
0.471, 0.469, 0.468, 0.47, 0.472, 0.474, 0.476, 0.478, 0.48, 0.481, 0.483,
0.482, 0.484, 0.482, 0.484, 0.482, 0.48, 0.482, 0.48, 0.482, 0.484, 0.482,
0.484, 0.486, 0.484, 0.483, 0.484, 0.483, 0.484, 0.486, 0.488, 0.49, 0.491,
0.493, 0.492, 0.49, 0.492, 0.49, 0.492, 0.49, 0.492, 0.493, 0.492, 0.49, 0.492,
0.493, 0.495, 0.494, 0.492, 0.49, 0.492, 0.49, 0.489, 0.487, 0.489, 0.487,
```

0.489, 0.487, 0.486, 0.487, 0.486, 0.488, 0.489, 0.491, 0.489, 0.488, 0.489,
0.491, 0.492, 0.491, 0.492, 0.491, 0.492, 0.494, 0.496, 0.494, 0.496, 0.497,
0.496, 0.494, 0.493, 0.494, 0.496, 0.497, 0.496, 0.494, 0.493, 0.494, 0.493,
0.494, 0.493, 0.491, 0.49, 0.489, 0.487, 0.489, 0.49, 0.492, 0.493, 0.492, 0.49,
0.492, 0.49, 0.489, 0.49, 0.492, 0.493, 0.495, 0.496, 0.497, 0.499, 0.497,
0.496, 0.497, 0.499, 0.497, 0.496, 0.495, 0.496, 0.495, 0.496, 0.497, 0.496,
0.495, 0.494, 0.495, 0.496, 0.497, 0.499, 0.497, 0.496, 0.497, 0.496, 0.495,
0.494, 0.492, 0.494, 0.495, 0.496, 0.497, 0.496, 0.498, 0.496, 0.495, 0.496,
0.498, 0.496, 0.495, 0.496, 0.495, 0.494, 0.493, 0.494, 0.493, 0.492, 0.49,
0.492, 0.49, 0.489, 0.49, 0.489, 0.491, 0.489, 0.488, 0.489, 0.488, 0.489,
0.488, 0.487, 0.488, 0.49, 0.491, 0.49, 0.488, 0.487, 0.486, 0.485, 0.486,
0.485, 0.486, 0.485, 0.484, 0.485, 0.486, 0.488, 0.489, 0.488, 0.489, 0.488,
0.487, 0.488, 0.487, 0.486, 0.485, 0.484, 0.485, 0.486, 0.487, 0.486, 0.485,
0.486, 0.485, 0.486, 0.485, 0.486, 0.487, 0.488, 0.487, 0.488, 0.487, 0.486,
0.485, 0.486, 0.485, 0.486, 0.485, 0.486, 0.485, 0.484, 0.483, 0.482, 0.481,
0.482, 0.483, 0.485, 0.484, 0.485, 0.486, 0.487, 0.488, 0.487, 0.486, 0.485,
0.484, 0.483, 0.482, 0.481, 0.482, 0.483, 0.482, 0.481, 0.482, 0.481, 0.48,
0.479, 0.48, 0.479, 0.48, 0.481, 0.482, 0.481, 0.48, 0.48, 0.481, 0.482, 0.483,
0.484, 0.483, 0.482, 0.483, 0.482, 0.483, 0.484, 0.483, 0.482, 0.483, 0.482,
0.483, 0.482, 0.483, 0.482, 0.483, 0.484, 0.483, 0.484, 0.485, 0.484, 0.483,
0.482, 0.481, 0.482, 0.482, 0.481, 0.48, 0.479, 0.48, 0.479, 0.48, 0.481, 0.482,
0.481, 0.482, 0.483, 0.482, 0.483, 0.482, 0.481, 0.482, 0.483, 0.482, 0.483,
0.482, 0.481, 0.48, 0.48, 0.481, 0.481, 0.482, 0.482, 0.482, 0.483, 0.484,
0.483, 0.483, 0.483, 0.484, 0.484, 0.484, 0.485, 0.484, 0.485, 0.486, 0.487,
0.486, 0.485, 0.486, 0.486, 0.485, 0.484, 0.485, 0.486, 0.485, 0.484, 0.483,
0.482, 0.483, 0.482, 0.483, 0.482, 0.482, 0.481, 0.48, 0.479, 0.478, 0.479,
0.479, 0.478, 0.479, 0.479, 0.479, 0.478, 0.479, 0.478, 0.479, 0.48, 0.479,
0.478, 0.477, 0.478, 0.479, 0.48, 0.481, 0.48, 0.481, 0.482, 0.482, 0.483,
0.484, 0.485, 0.484, 0.483, 0.484, 0.485, 0.484, 0.485, 0.486, 0.487, 0.487,
0.488, 0.489, 0.488, 0.489, 0.488, 0.489, 0.49, 0.491, 0.491, 0.491, 0.49,
0.491, 0.49, 0.489, 0.49, 0.489, 0.49, 0.491, 0.492, 0.491, 0.49, 0.489, 0.489,
0.489, 0.49, 0.491, 0.492, 0.492, 0.492, 0.493, 0.493, 0.493, 0.492, 0.491,
0.49, 0.49, 0.489, 0.488, 0.489, 0.49, 0.489, 0.49, 0.489, 0.488, 0.488, 0.487,
0.486, 0.485, 0.485, 0.485, 0.486, 0.487, 0.486, 0.487, 0.486, 0.487, 0.486,
0.487, 0.488, 0.489, 0.489, 0.489, 0.489, 0.489, 0.488, 0.487, 0.488, 0.489,
0.489, 0.49, 0.491, 0.492, 0.492, 0.492, 0.491, 0.492, 0.492, 0.492, 0.492,
0.492, 0.492, 0.493, 0.494, 0.493, 0.494, 0.493, 0.492, 0.492, 0.492, 0.492,
0.492, 0.492, 0.492, 0.492, 0.492, 0.493, 0.494, 0.495, 0.495, 0.495, 0.494,
0.493, 0.494, 0.493, 0.494, 0.495, 0.495, 0.496, 0.497, 0.496, 0.497, 0.497,
0.498, 0.499, 0.499, 0.499, 0.499, 0.499, 0.499, 0.499, 0.499, 0.499, 0.499,
0.499, 0.498, 0.497, 0.497, 0.497, 0.497, 0.496, 0.497, 0.497, 0.498, 0.497,
0.498, 0.497, 0.497, 0.497, 0.498, 0.497, 0.498, 0.497, 0.497, 0.497, 0.498,
0.499, 0.499, 0.499, 0.498, 0.499, 0.499, 0.499, 0.499, 0.499, 0.498, 0.497,
0.497, 0.497, 0.497, 0.496, 0.496, 0.496, 0.497, 0.496, 0.496, 0.496, 0.496,
0.496, 0.496, 0.496, 0.496, 0.496, 0.496, 0.496, 0.497, 0.498, 0.498, 0.498,
0.497, 0.496, 0.496, 0.496, 0.496, 0.496, 0.496, 0.495, 0.495, 0.494, 0.493,
0.494, 0.495, 0.495, 0.495, 0.495, 0.495, 0.494, 0.495, 0.494, 0.493, 0.493,
0.492, 0.492, 0.492, 0.493, 0.493, 0.493, 0.493, 0.494, 0.495, 0.494, 0.494,

0.493, 0.494, 0.493, 0.494, 0.494, 0.495, 0.495, 0.496, 0.495, 0.495, 0.494,
0.495, 0.495, 0.496, 0.497, 0.497, 0.497, 0.497, 0.498, 0.497, 0.498, 0.498,
0.499, 0.498, 0.498, 0.498, 0.498, 0.498, 0.498, 0.498, 0.498, 0.498, 0.499,
0.498, 0.498, 0.497, 0.498, 0.497, 0.498, 0.497, 0.497, 0.496, 0.496, 0.495,
0.496, 0.495, 0.496, 0.496, 0.496, 0.495, 0.494, 0.494, 0.494, 0.494, 0.493,
0.494, 0.493, 0.493, 0.493, 0.494, 0.495, 0.494, 0.493, 0.494, 0.493, 0.493,
0.493, 0.494, 0.495, 0.494, 0.493, 0.494, 0.493, 0.494, 0.495, 0.494, 0.495,
0.494, 0.494, 0.494, 0.494, 0.493, 0.492, 0.493, 0.493, 0.492, 0.493, 0.492,
0.491, 0.492, 0.491, 0.492, 0.492, 0.491, 0.49, 0.49, 0.489, 0.489, 0.489, 0.49,
0.489, 0.489, 0.488, 0.489, 0.49, 0.489, 0.488, 0.488, 0.487, 0.487, 0.486,
0.486, 0.486, 0.486, 0.487, 0.487, 0.488, 0.488, 0.489, 0.488, 0.489, 0.488,
0.488, 0.488, 0.489, 0.488, 0.488, 0.487, 0.487, 0.486, 0.487, 0.487, 0.487,
0.487, 0.488, 0.487, 0.487, 0.486, 0.487, 0.486, 0.487, 0.486, 0.487, 0.486,
0.487, 0.486, 0.486, 0.486, 0.486, 0.486, 0.486]
Relative frequency list of Tails T:
[0.0, 0.5, 0.667, 0.75, 0.6, 0.667, 0.714, 0.75, 0.667, 0.7, 0.727, 0.667,
0.692, 0.643, 0.667, 0.625, 0.647, 0.667, 0.684, 0.7, 0.714, 0.727, 0.696,
0.708, 0.72, 0.692, 0.667, 0.679, 0.69, 0.7, 0.677, 0.656, 0.636, 0.647, 0.657,
0.639, 0.622, 0.632, 0.615, 0.625, 0.61, 0.595, 0.605, 0.591, 0.6, 0.587, 0.574,
0.583, 0.571, 0.56, 0.569, 0.577, 0.585, 0.593, 0.6, 0.589, 0.596, 0.603, 0.593,
0.6, 0.59, 0.581, 0.571, 0.562, 0.554, 0.561, 0.552, 0.559, 0.565, 0.571, 0.563,
0.556, 0.548, 0.541, 0.533, 0.526, 0.519, 0.526, 0.532, 0.537, 0.543, 0.537,
0.542, 0.548, 0.553, 0.558, 0.563, 0.568, 0.562, 0.556, 0.56, 0.554, 0.548,
0.543, 0.537, 0.531, 0.536, 0.541, 0.545, 0.54, 0.545, 0.549, 0.553, 0.548,
0.543, 0.547, 0.551, 0.556, 0.55, 0.555, 0.55, 0.545, 0.549, 0.544, 0.548,
0.552, 0.547, 0.551, 0.555, 0.55, 0.554, 0.557, 0.561, 0.556, 0.56, 0.556,
0.551, 0.547, 0.543, 0.546, 0.542, 0.545, 0.549, 0.552, 0.556, 0.559, 0.555,
0.558, 0.561, 0.557, 0.56, 0.563, 0.559, 0.562, 0.559, 0.562, 0.565, 0.561,
0.557, 0.56, 0.556, 0.553, 0.556, 0.552, 0.555, 0.551, 0.554, 0.557, 0.56,
0.556, 0.559, 0.562, 0.564, 0.567, 0.57, 0.572, 0.575, 0.577, 0.58, 0.576,
0.573, 0.576, 0.578, 0.58, 0.577, 0.58, 0.576, 0.573, 0.57, 0.572, 0.575, 0.577,
0.574, 0.571, 0.568, 0.57, 0.567, 0.564, 0.561, 0.558, 0.56, 0.557, 0.56, 0.557,
0.554, 0.556, 0.553, 0.551, 0.553, 0.55, 0.552, 0.554, 0.552, 0.549, 0.546,
0.549, 0.546, 0.543, 0.545, 0.548, 0.545, 0.542, 0.545, 0.547, 0.544, 0.542,
0.544, 0.546, 0.543, 0.541, 0.538, 0.541, 0.538, 0.536, 0.538, 0.535, 0.537,
0.535, 0.533, 0.535, 0.537, 0.539, 0.541, 0.538, 0.536, 0.538, 0.536, 0.534,
0.531, 0.529, 0.531, 0.529, 0.527, 0.525, 0.527, 0.524, 0.526, 0.524, 0.522,
0.524, 0.526, 0.528, 0.53, 0.531, 0.533, 0.531, 0.529, 0.531, 0.533, 0.531,
0.529, 0.531, 0.532, 0.53, 0.528, 0.526, 0.524, 0.522, 0.52, 0.519, 0.517,
0.518, 0.516, 0.518, 0.516, 0.518, 0.52, 0.518, 0.52, 0.518, 0.516, 0.518,
0.516, 0.514, 0.516, 0.517, 0.516, 0.517, 0.516, 0.514, 0.512, 0.51, 0.509,
0.507, 0.508, 0.51, 0.508, 0.51, 0.508, 0.51, 0.508, 0.507, 0.508, 0.51, 0.508,
0.507, 0.505, 0.506, 0.508, 0.51, 0.508, 0.51, 0.511, 0.513, 0.511, 0.513,
0.511, 0.513, 0.514, 0.512, 0.514, 0.512, 0.511, 0.509, 0.511, 0.512, 0.511,
0.509, 0.508, 0.509, 0.508, 0.509, 0.508, 0.506, 0.504, 0.506, 0.504, 0.503,
0.504, 0.506, 0.507, 0.506, 0.504, 0.503, 0.504, 0.506, 0.507, 0.506, 0.507,
0.506, 0.507, 0.509, 0.51, 0.511, 0.513, 0.511, 0.51, 0.508, 0.507, 0.508, 0.51,
0.508, 0.51, 0.511, 0.51, 0.508, 0.507, 0.505, 0.504, 0.503, 0.501, 0.503,

0.504, 0.503, 0.501, 0.503, 0.504, 0.505, 0.504, 0.505, 0.504, 0.503, 0.504,
0.505, 0.506, 0.505, 0.504, 0.503, 0.501, 0.503, 0.504, 0.503, 0.504, 0.505,
0.506, 0.508, 0.506, 0.505, 0.504, 0.502, 0.504, 0.502, 0.504, 0.505, 0.504,
0.502, 0.504, 0.505, 0.504, 0.505, 0.506, 0.507, 0.506, 0.507, 0.508, 0.51,
0.508, 0.51, 0.511, 0.51, 0.511, 0.509, 0.511, 0.512, 0.511, 0.512, 0.511,
0.512, 0.513, 0.512, 0.51, 0.509, 0.51, 0.512, 0.513, 0.514, 0.515, 0.514,
0.515, 0.514, 0.515, 0.516, 0.515, 0.514, 0.512, 0.511, 0.512, 0.511, 0.512,
0.513, 0.512, 0.513, 0.514, 0.515, 0.516, 0.515, 0.514, 0.513, 0.514, 0.515,
0.514, 0.515, 0.514, 0.515, 0.514, 0.513, 0.512, 0.513, 0.512, 0.513, 0.514,
0.515, 0.514, 0.515, 0.514, 0.515, 0.514, 0.515, 0.516, 0.517, 0.518, 0.519,
0.518, 0.517, 0.515, 0.516, 0.515, 0.514, 0.513, 0.512, 0.513, 0.514, 0.515,
0.516, 0.517, 0.518, 0.519, 0.518, 0.517, 0.518, 0.519, 0.518, 0.519, 0.52,
0.521, 0.52, 0.521, 0.52, 0.519, 0.518, 0.519, 0.52, 0.52, 0.519, 0.518, 0.517,
0.516, 0.517, 0.518, 0.517, 0.518, 0.517, 0.516, 0.517, 0.518, 0.517, 0.518,
0.517, 0.518, 0.517, 0.518, 0.517, 0.516, 0.517, 0.516, 0.515, 0.516, 0.517,
0.518, 0.519, 0.518, 0.518, 0.519, 0.52, 0.521, 0.52, 0.521, 0.52, 0.519, 0.518,
0.519, 0.518, 0.517, 0.518, 0.517, 0.518, 0.519, 0.518, 0.517, 0.518, 0.517,
0.518, 0.519, 0.52, 0.52, 0.519, 0.519, 0.518, 0.518, 0.518, 0.517, 0.516,
0.517, 0.517, 0.517, 0.516, 0.516, 0.516, 0.515, 0.516, 0.515, 0.514, 0.513,
0.514, 0.515, 0.514, 0.514, 0.515, 0.516, 0.515, 0.514, 0.515, 0.516, 0.517,
0.518, 0.517, 0.518, 0.517, 0.518, 0.518, 0.519, 0.52, 0.521, 0.522, 0.521,
0.521, 0.522, 0.521, 0.521, 0.521, 0.522, 0.521, 0.522, 0.521, 0.52, 0.521,
0.522, 0.523, 0.522, 0.521, 0.52, 0.519, 0.52, 0.519, 0.518, 0.518, 0.517,
0.516, 0.515, 0.516, 0.517, 0.516, 0.515, 0.516, 0.515, 0.514, 0.513, 0.513,
0.512, 0.511, 0.512, 0.511, 0.512, 0.511, 0.51, 0.509, 0.509, 0.509, 0.51,
0.509, 0.51, 0.511, 0.51, 0.511, 0.51, 0.509, 0.508, 0.509, 0.51, 0.511, 0.511,
0.511, 0.51, 0.509, 0.508, 0.508, 0.508, 0.507, 0.507, 0.507, 0.508, 0.509,
0.51, 0.51, 0.511, 0.512, 0.511, 0.51, 0.511, 0.51, 0.511, 0.512, 0.512, 0.513,
0.514, 0.515, 0.515, 0.515, 0.514, 0.513, 0.514, 0.513, 0.514, 0.513, 0.514,
0.513, 0.512, 0.511, 0.511, 0.511, 0.511, 0.511, 0.512, 0.513, 0.512, 0.511,
0.511, 0.51, 0.509, 0.508, 0.508, 0.508, 0.509, 0.508, 0.508, 0.508, 0.508,
0.508, 0.508, 0.507, 0.506, 0.507, 0.506, 0.507, 0.508, 0.508, 0.508, 0.508,
0.508, 0.508, 0.508, 0.508, 0.508, 0.507, 0.506, 0.505, 0.505, 0.505, 0.506,
0.507, 0.506, 0.507, 0.506, 0.505, 0.505, 0.504, 0.503, 0.504, 0.503, 0.503,
0.502, 0.501, 0.501, 0.501, 0.501, 0.501, 0.501, 0.501, 0.501, 0.501, 0.501,
0.501, 0.502, 0.503, 0.503, 0.503, 0.503, 0.504, 0.503, 0.503, 0.502, 0.503,
0.502, 0.503, 0.503, 0.503, 0.502, 0.503, 0.502, 0.503, 0.503, 0.503, 0.502,
0.501, 0.501, 0.501, 0.502, 0.501, 0.501, 0.501, 0.501, 0.501, 0.502, 0.503,
0.503, 0.503, 0.503, 0.504, 0.504, 0.504, 0.503, 0.504, 0.504, 0.504, 0.504,
0.504, 0.504, 0.504, 0.504, 0.504, 0.504, 0.504, 0.503, 0.502, 0.502, 0.502,
0.503, 0.504, 0.504, 0.504, 0.504, 0.504, 0.504, 0.505, 0.505, 0.506, 0.507,
0.506, 0.505, 0.505, 0.505, 0.505, 0.505, 0.506, 0.505, 0.506, 0.507, 0.507,
0.508, 0.508, 0.508, 0.507, 0.507, 0.507, 0.507, 0.506, 0.505, 0.506, 0.506,
0.507, 0.506, 0.507, 0.506, 0.506, 0.505, 0.505, 0.504, 0.505, 0.505, 0.506,
0.505, 0.505, 0.504, 0.503, 0.503, 0.503, 0.503, 0.502, 0.503, 0.502, 0.502,
0.501, 0.502, 0.502, 0.502, 0.502, 0.502, 0.502, 0.502, 0.502, 0.502, 0.501,
0.502, 0.502, 0.503, 0.502, 0.503, 0.502, 0.503, 0.503, 0.504, 0.504, 0.505,
0.504, 0.505, 0.504, 0.504, 0.504, 0.505, 0.506, 0.506, 0.506, 0.506, 0.507,

```
0.506, 0.507, 0.507, 0.507, 0.506, 0.505, 0.506, 0.507, 0.506, 0.507, 0.507,
0.507, 0.506, 0.505, 0.506, 0.507, 0.506, 0.507, 0.506, 0.505, 0.506, 0.505,
0.506, 0.506, 0.506, 0.506, 0.507, 0.508, 0.507, 0.507, 0.508, 0.507, 0.508,
0.509, 0.508, 0.509, 0.508, 0.508, 0.509, 0.51, 0.51, 0.511, 0.511, 0.511, 0.51,
0.511, 0.511, 0.512, 0.511, 0.51, 0.511, 0.512, 0.512, 0.513, 0.513, 0.514,
0.514, 0.514, 0.514, 0.513, 0.513, 0.512, 0.512, 0.511, 0.512, 0.511, 0.512,
0.512, 0.512, 0.511, 0.512, 0.512, 0.513, 0.513, 0.514, 0.513, 0.513, 0.513,
0.513, 0.512, 0.513, 0.513, 0.514, 0.513, 0.514, 0.513, 0.514, 0.513, 0.514,
0.513, 0.514, 0.514, 0.514, 0.514, 0.514, 0.514]
```