

ELEC-3800

# Random Signals and Systems

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## Project 1

## Introduction

In this project, we were to run simulations in Matlab based on coin flip probability. There were five tasks given to us. We were to code in Matlab and find the probabilities of different problems given to us shown below.

### Exercise 1

In step 1 we were told to run a Matlab code that shows the probability of a coin flip landing on heads. The code is shown below in *Code 1*.

The relative frequency received from the console after running the code was: **0.52 or 52%**

```
trials = 100;  
flip = rand(trials,1);  
heads = (flip >= 0.5);  
percentheads = sum(heads)/trials
```

*Code 1*

### Exercise 2

In Exercise 2, we were asked to run the simulation up to 10 times and record all the outputs of the relevant frequency. The 10 recorded outputs are shown below in *Table 1*. We were also asked what the lowest relevant frequency was and why it is not always 0.5.

The lowest relevant frequency recorded was: **0.41**

The frequency is not always exactly 0.5 because 0.5 is an overall average of a large simulation. The simulation will be close to 0.5 though.

0.52
0.45
0.48
0.46
0.51
0.52
0.53
0.46
0.41
0.53

*Table 1*

### Exercise 3

In Exercise 3, we were asked to run the code again 10 times, but with  $trial = 1,000$  and  $trial = 100,000$ . The recordings are shown below in Tables 2 and 3 for  $trial = 1,000$  and  $trial = 100,000$  respectively. We were asked what was happening to the variation of the relevant frequency and why.

When increasing the trial runs, we saw more precision in the decimal places. This is because with more trial readings, you can have a more precise relative frequency.

0.5179
0.5240
0.5169
0.5000
0.4900
0.5150
0.4850
0.4910
0.5150
0.5040

*Table 2*

0.5003
0.5011
0.4987
0.4971
0.5021
0.5017
0.5020
0.5004
0.5005
0.4999

*Table 3*

## Exercise 4

For exercise 4, we were to write our own Matlab code based on the probability of flipping four coins and having 4 Heads in a row. We were to run 2 simulations, one with  $N = 10,000$ , and another with  $N = 100,000$ . The Matlab code I came up with is shown below in *Code 2*.

The relative frequency for the first simulation was: .0594 or 5.94%

The relative frequency for the second simulation was: 0.0625 or 6.25%

```
%%  
% Project 1 #4  
%Jacob Howard  
%Expected Probability of all 4 coins being heads is 6.25%  
  
%%  
%#4 Part 1  
% Setting n to 10,000  
n = 10000;  
allHeads = 0; % Setting number of times all heads appears to 0  
  
% loop N times to count every time all heads appear in 4 coin flips  
for i =1:n  
    coinFlip = randi([0,1],1,4); % randomly generates 4 coin flips (0 being  
    tails and 1 being heads)  
    if(sum(coinFlip) == 4) % if all heads, allHeads variable incremented by 1  
        allHeads = allHeads + 1;  
    end  
end  
  
% Set up a message that calculates and displays the percentage of all 4  
%coin tosses being heads  
fprintf('Percentage of all 4 Heads for: Part 1 / n = %d is  
%.2f\n',n, ((allHeads*100)/n));  
  
%%  
%#4 Part 2  
% Setting n to 100,000  
n = 100000;  
allHeads = 0; % set number of times all heads appears to 0  
  
% loop N times to count every time all heads appear in 4 coin flips  
for i =1:n  
    coinFlip = randi([0,1],1,4); % randomly generate 4 coin flips (0-tails, 1-  
    heads)  
    if(sum(coinFlip) == 4) % if all heads, increment all_heads by 1  
        allHeads = allHeads + 1;  
    end  
end  
  
% Set up a message that calculates and displays the percentage of all 4  
%coin tosses being heads  
fprintf('Percentafe of all 4 Heads for: Part 2 / n = %d is  
%.2f\n',n, ((allHeads*100)/n));  
%%
```

*Code 2*

## Exercise 5

In exercise 5, we were supposed to write a new code for an unfair coin with a 45% probability of it landing on heads. Once we wrote and verified that our code was correct, we needed to find the probability in which the unfair coin acted like a fair coin. The code is shown in *Code 3* below. We were asked to list that probability from our simulation. We were also asked if 100 flips seemed to be enough trials for this simulation.

Probability of the unfair coin having a relative frequency of 0.5 or higher: 0.1860 or 18.6%

I do not necessarily think the trials should be increased. I do not think a more precise number is needed on the percentage.

```
%%  
%Project 1 Part 5  
%Jacob Howard  
%%  
%probability of heads  
%expected probability of 0.45  
trials=100;  
p=0;  
for i=1:1000  
  
    flip=rand(1, trials);  
    heads=(flip>=0.55);  
    if (sum(heads)/100)>=0.5  
        p=p+1;  
    end  
end  
percentheads = sum(heads)/trials;  
p;  
fprintf("Relative frequency of unfair coin landing Heads =  
%f\n", percentheads);  
%%  
%Relative frequency of showing as a fair coin  
pFair=(p/1000);  
p=100*(p/1000);  
fprintf("Relative frequency of fair coin showing fair coin RF =  
%f\n", pFair);  
%%
```

*Code 3*