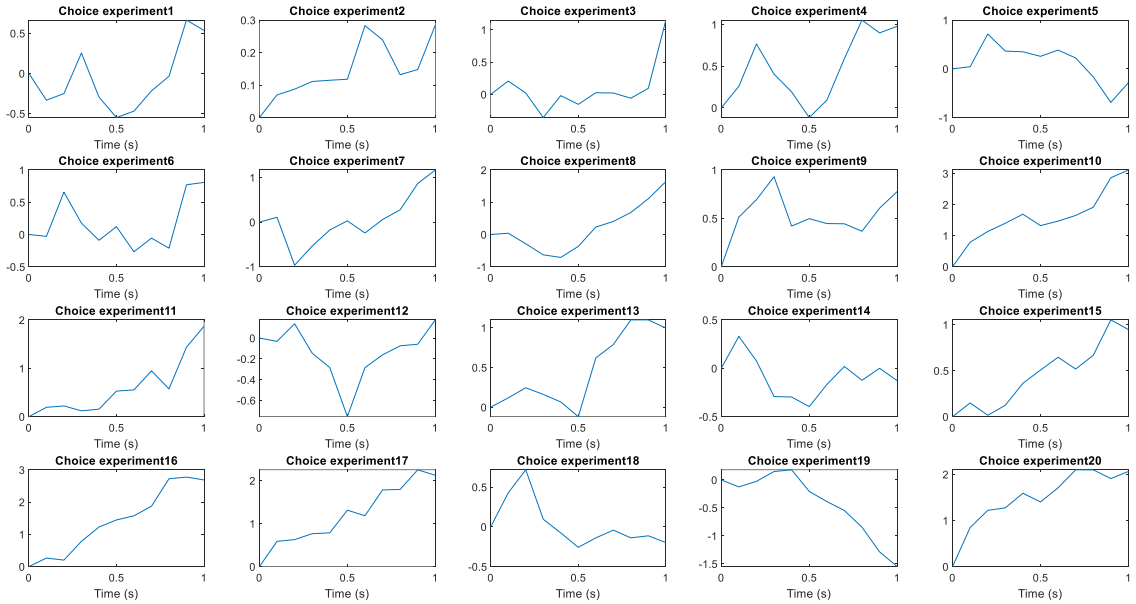
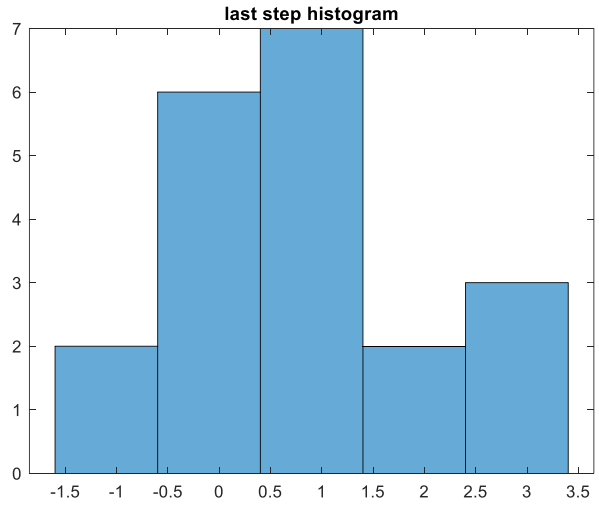
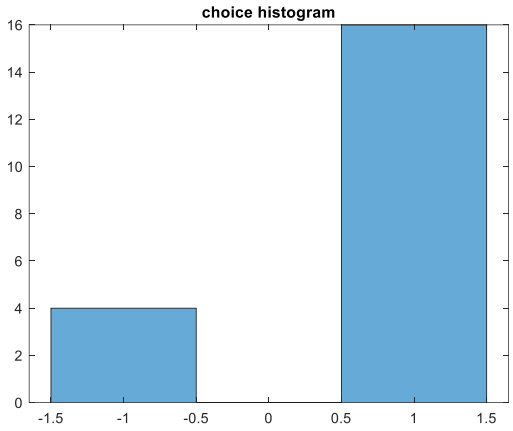
**Part 1:**

1. For this part we declare a function called **simple_model** which takes time vector, time step, constant bias, scaler scaling and two terms as p for plotting and start as the initial amount and returns two outputs, one choice and the other one named x which demonstrates the choice position during time.
2. In this part we first show 20 experiments with the fixed values as identified in structure:

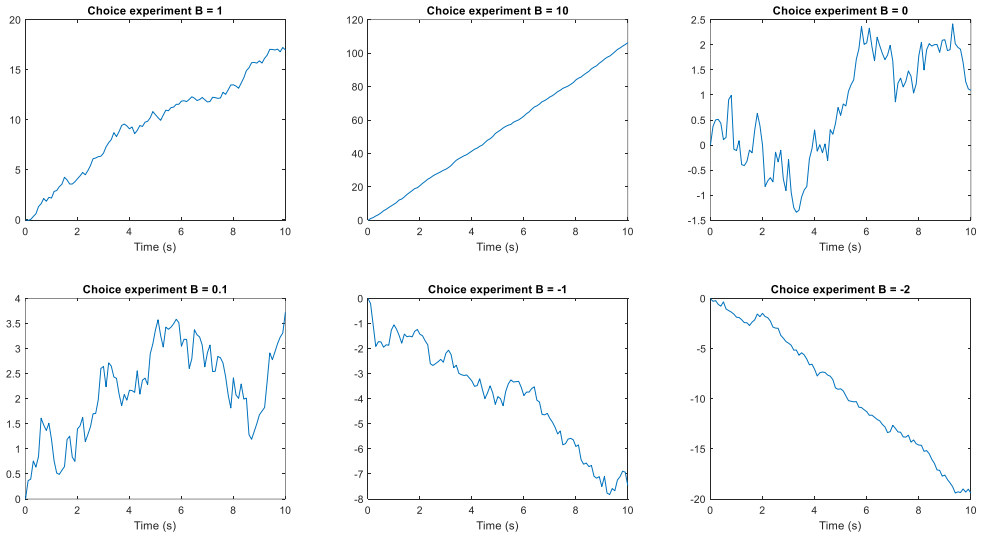



Then we analysis the data and find the histogram of the result:



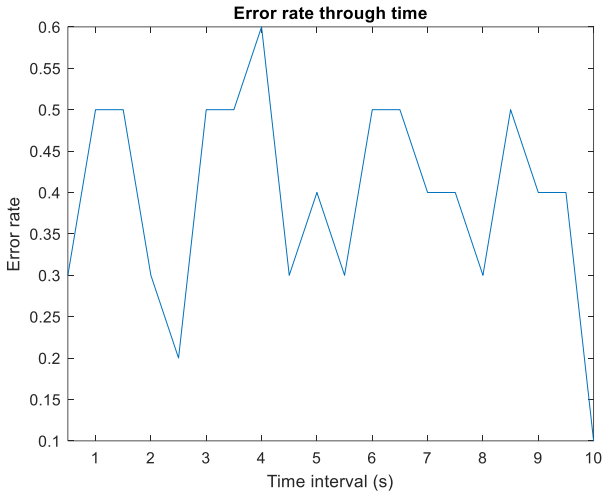



The last figure is for running the experiment with different values of B (constant bias):

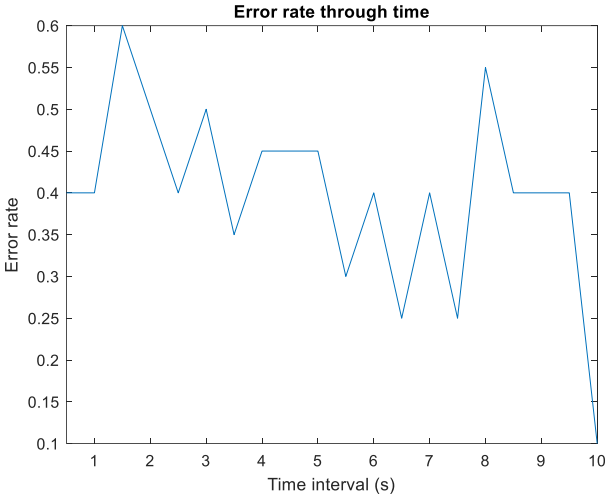



3. In this part we are investigating the effect of time interval on error rate:

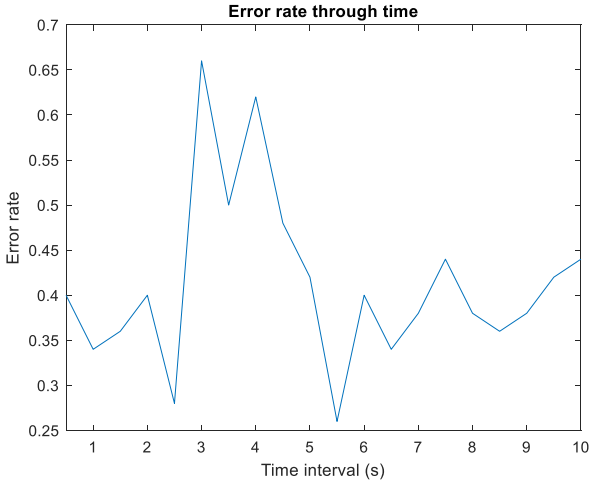
For 10 trials:



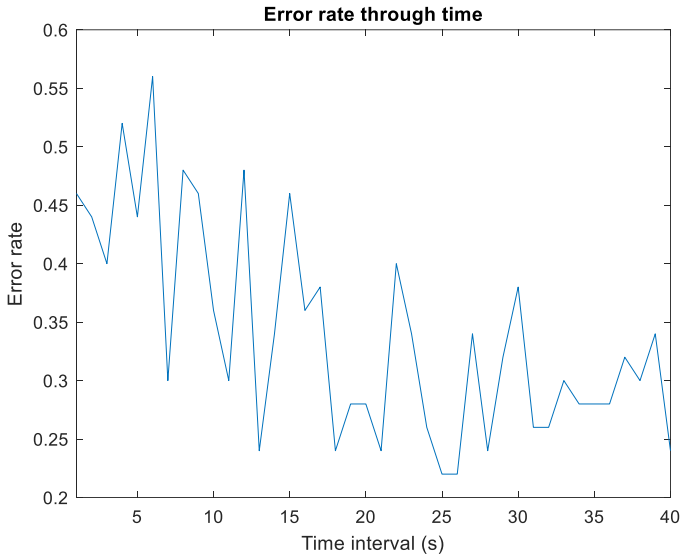

For 20 trials:




For 50 trials:



For 50 trials (time range 1:20 s):

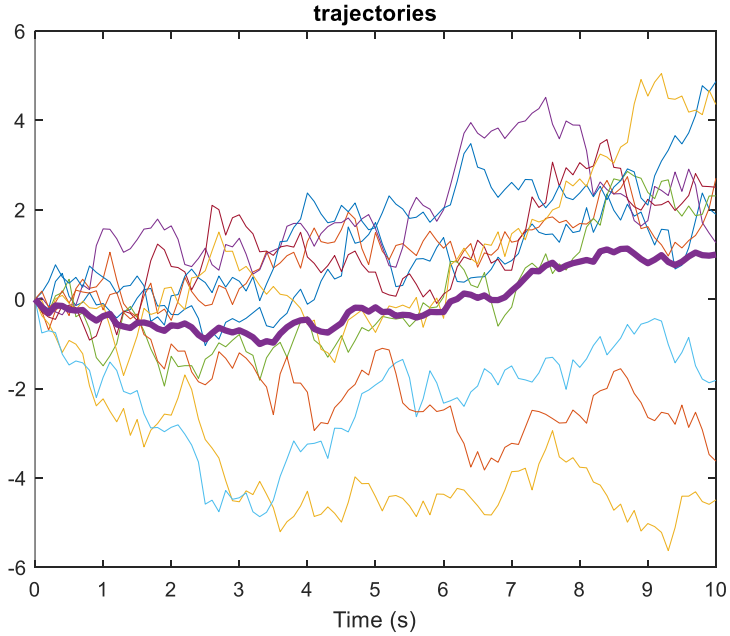


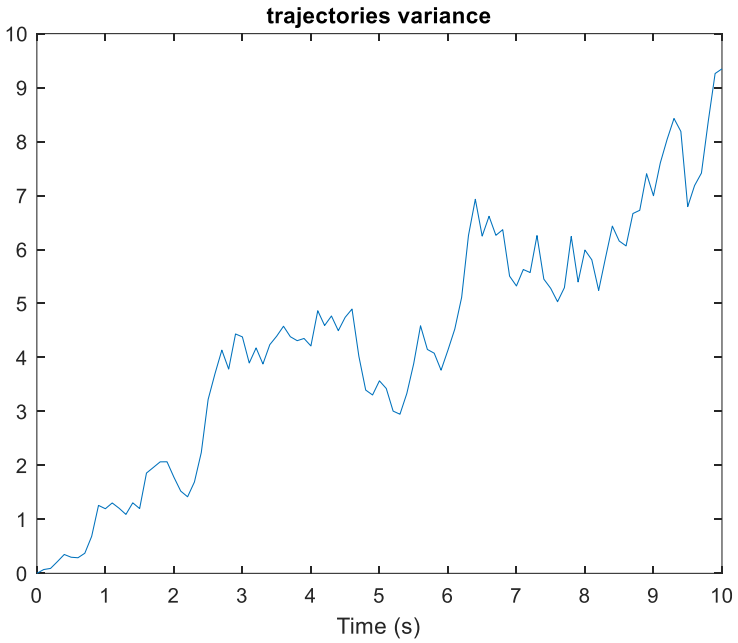

4. At first we try to find the distribution of decision variable theoretically:
   First let's investigate the below formula:

$$dX = Bdt + \sigma dW$$

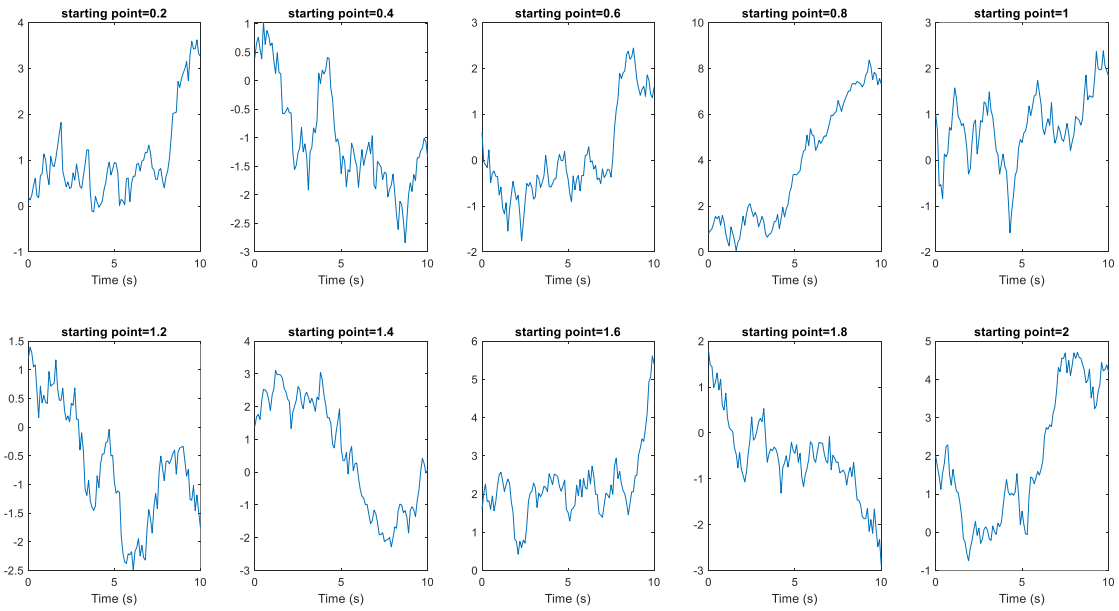
   As we consider the random variable $dW$ calculating from the normal distribution $N(0\,, dt)$, thus, the distribution of $dX$ will be: $N(Bdt\,,\ \sigma^2 dt)$.
   If we want to calculate the distribution of variable X which is the integrate of $dX$ we can easily find the answer considering the fact that sum of independent random variables will still remain the same distribution with different parameters:

$$X \sim N\left(\frac{t}{dt}Bdt\,, \frac{t}{dt}\,\sigma^2 dt\right) = N(Bt\,,\ \sigma^2 t)$$

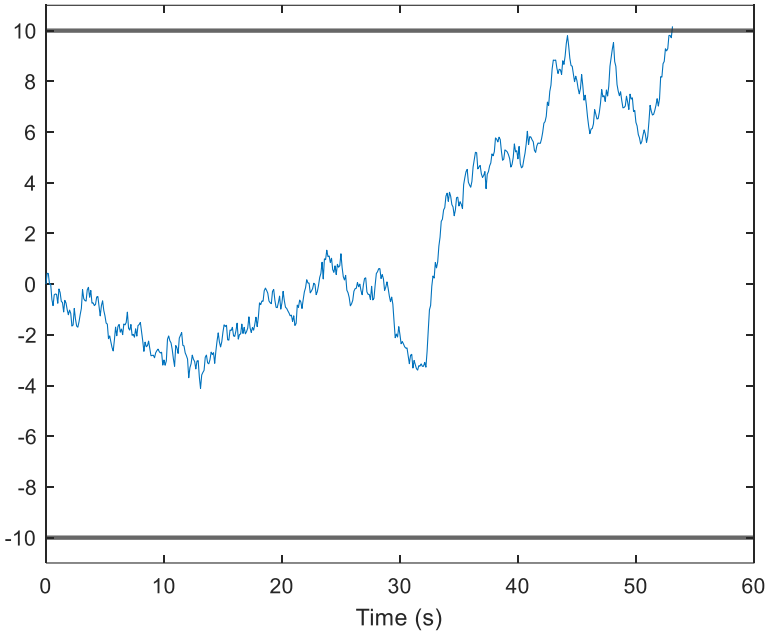




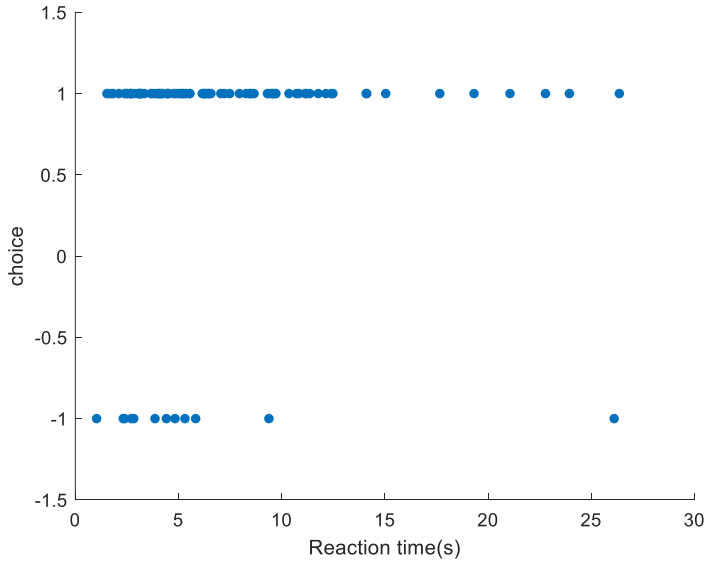

5. In this part we declare a new function called **simple_model2** which add the additional parameter start point to the previous function.



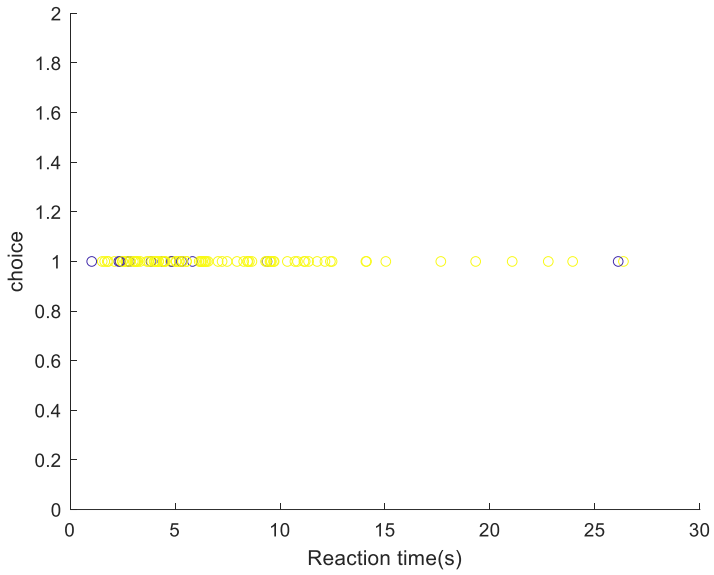

6. In this section we try to indicate one of the examples of simulating the mentioned function:



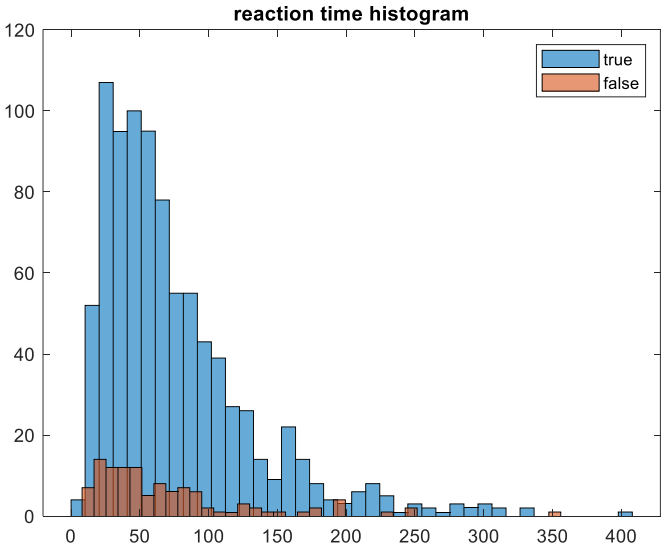

7. In this section we try to determine the correlation between response time and error rate:



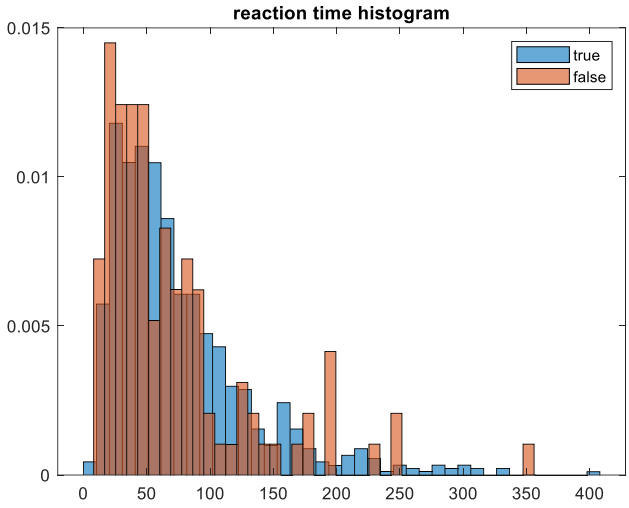
The blue circles are the false decision:



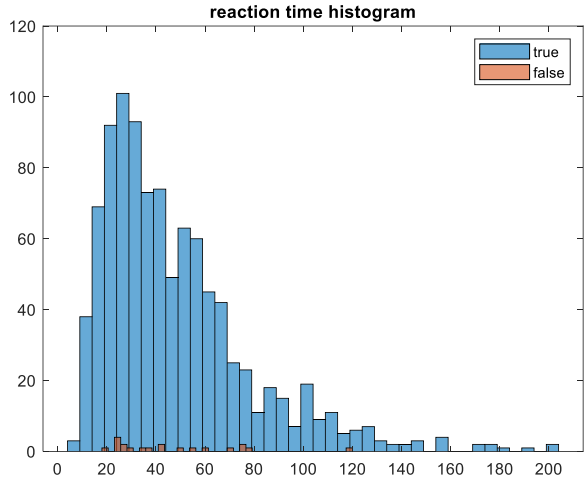

Now let's try to plot the distribution of reaction time for both right and wrong decisions:
Just the histogram:

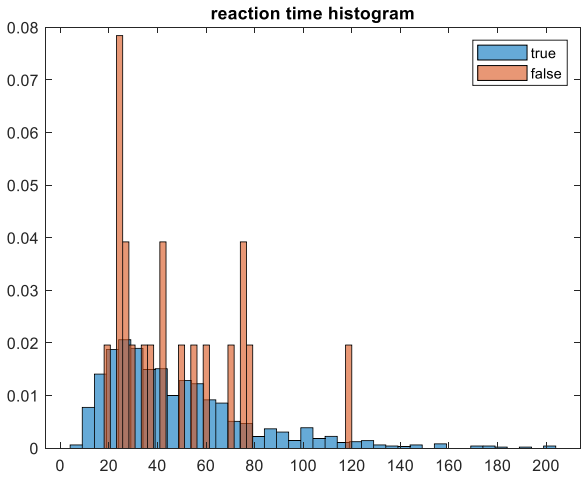


The pdf histogram:

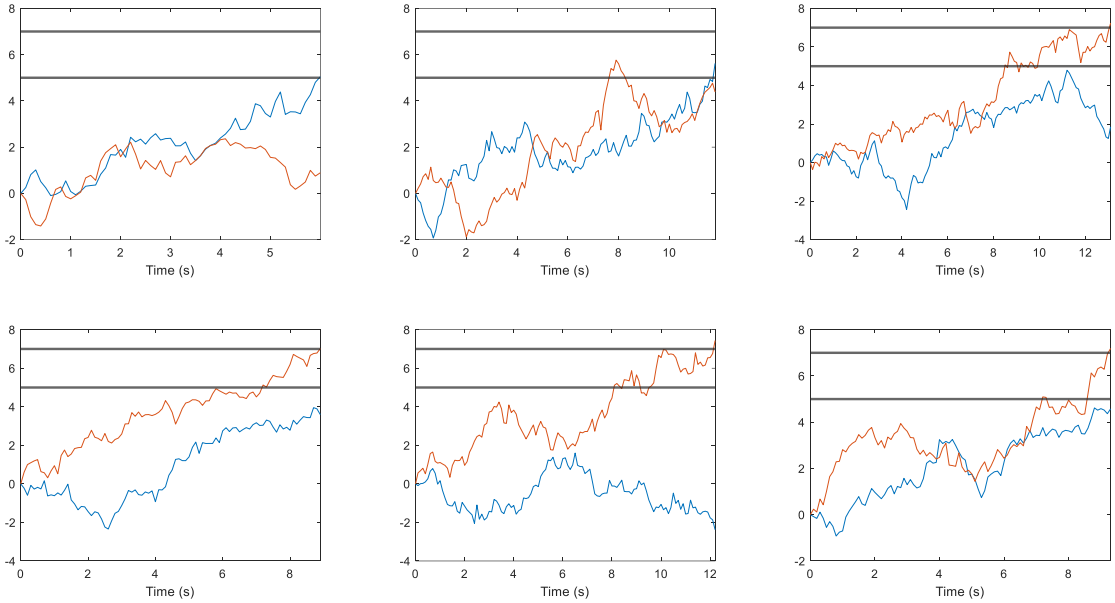



If we increase the bias value:



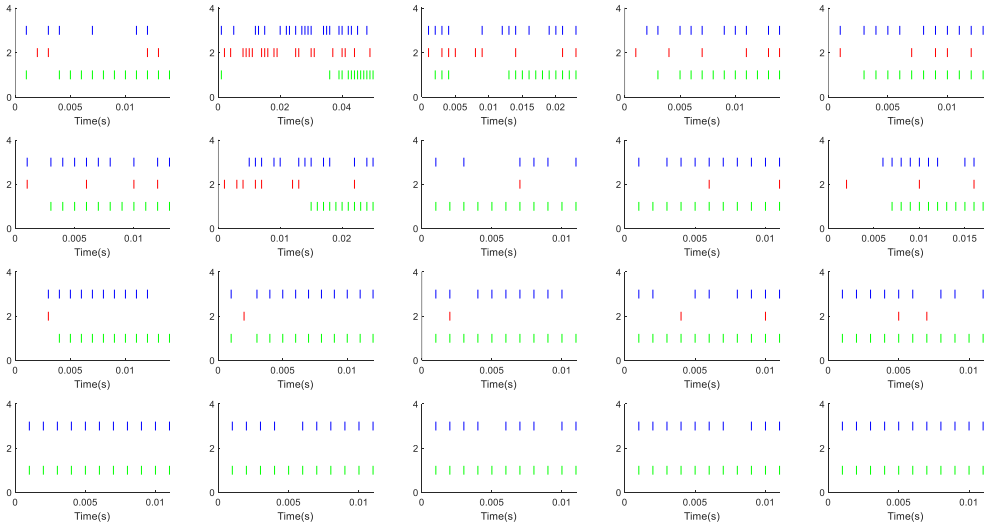



8. In this section we try to write a complete function for this regard.
9. We complete the previous function and then examine in a few times:




**Part 2:**

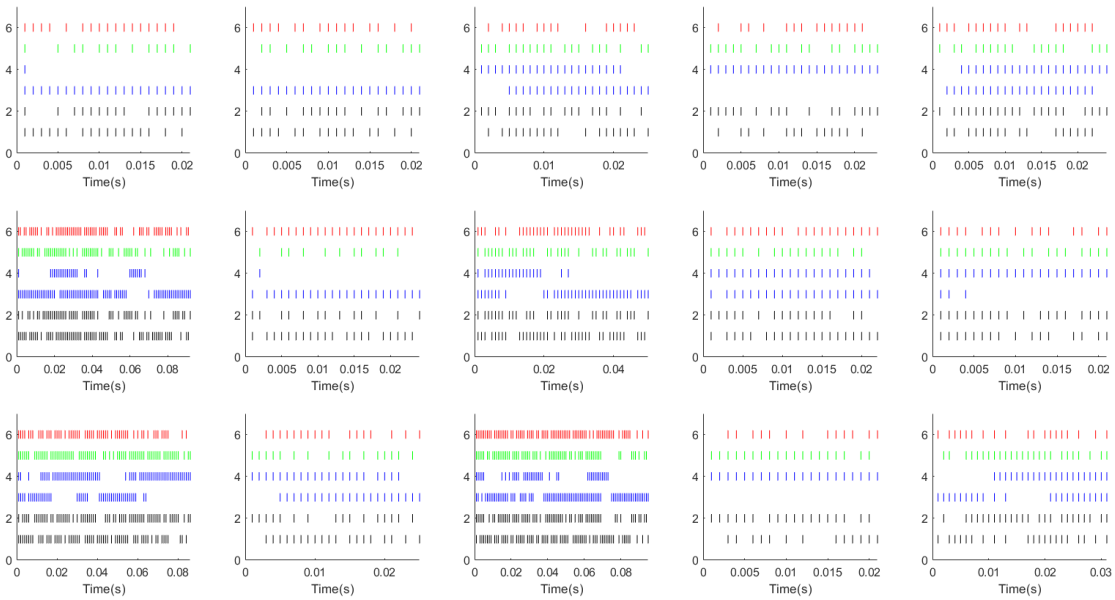
1. In this part we just try to show how this function can work for different probability of spike for each neuron:




In this figure the blue ones are the excitatory neuron, the red lines for the inhibitory neuron and the green ones are representing the LIP neuron.

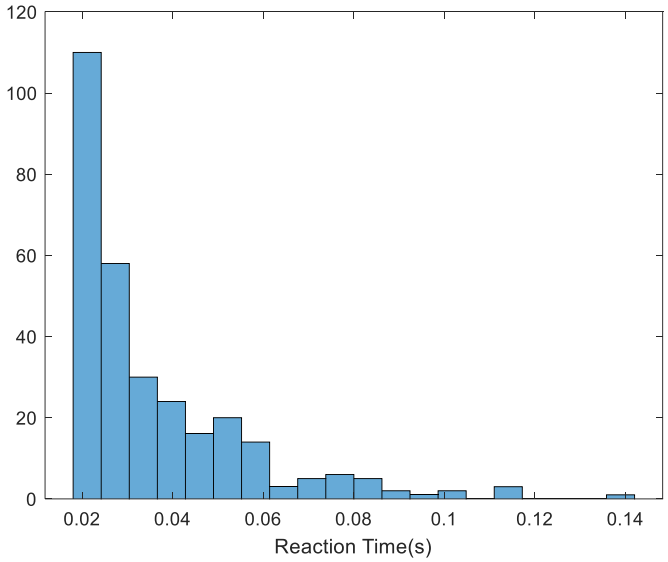
2. In this part we tried to simulate the question for 4 neurons and show the result:

50% chance of spike for each neuron:




In the above figure the blue ones are the output while the black ones are the stimuli for each direction and at last the red and green ones are the spiking neurons.

the histogram of RTs for 50% chance:




While the rate of true answer is 0.5067 as we expected.

*Advanced Topics in Neuroscience* *problem set # 7 (Evidence Accumulation)*
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*Student ID: 98104722*