Assignment 1:Factors of a neural network

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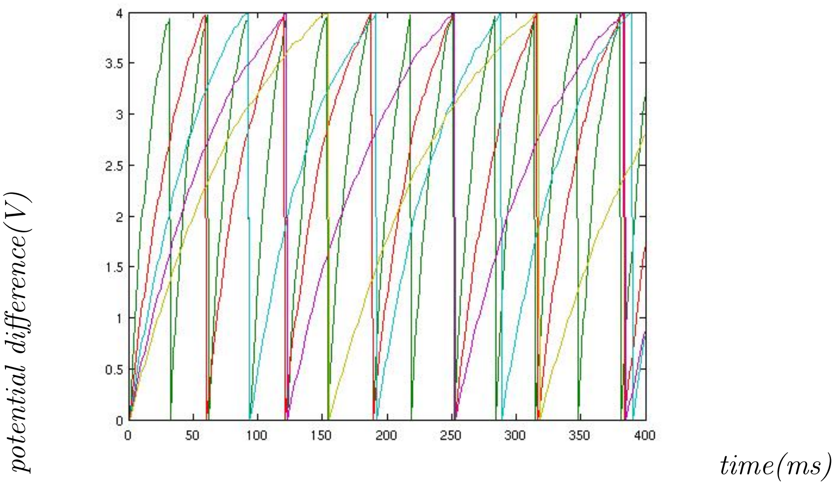
1 Report

1. Tau
   To test the influence of tau on the spiking of the simulated neuron, we let the function run with different values from 0 to 100 in steps of 20. as you can see the time consistently increase by about 33 ms. You can also see that in the graph below. There is no value tau = 0 because then the number of spikes per time unit is infinitely high due to the fact that in the formula the current is devided by tau.

Tau	average interspike times	colors
0	NaN	
20	32.9	green
40	66.3	orange
60	98.5	light blue
80	132.7	pink
100	165	yellow

Figure 1: Plot for different values of Tau



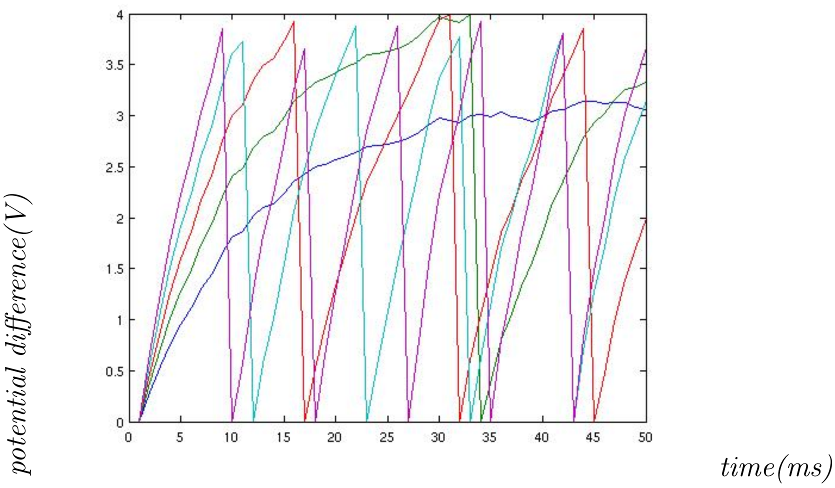
2. Rin

   Rin is the resistance, by looking at equation 2 that is provided at the assignment paper we can see that a higher resistance would lead to a faster change in potential in relation to time.

   In order to investigate the influence of Rin we ran the simulation with a different values of rin ranging from 0 to 7. When increasing Rin we observed that the time it takes to reach the treshhold decreases as have predicted. Furthermore, we observe that a resistance value below theta (the threshold value) results in the threshold not being reached and the stimulatory circuit not being closed.

Rin	average interspike times	colors
3	NAN	blue
4	38	green
5	16.33	orange
6	11	light blue
7	8.4	pink

Figure 2: Plot for different values of Rin

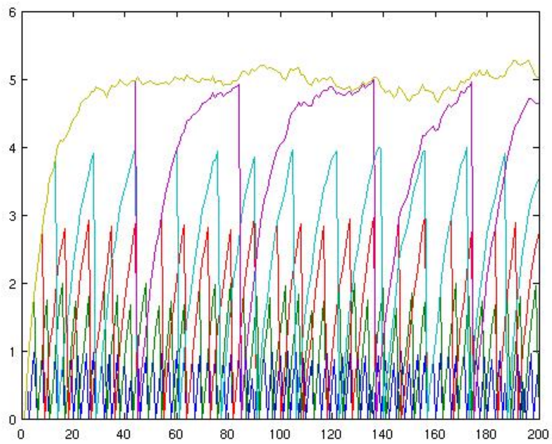


3. Theta

   Theta is the threshold level for the spikes. If it changes so does the maximum voltage the membrane can have. You can see very clearly in the graph that the spikes are at different levels for the different values of theta. Because the voltage is higher that needs to be reach in order to create the sudden drop in voltage and therefore the spike it also takes a longer time for the membrane to get to that point. This is why the spike times keep increasing with increasing theta. The last value for the table is not existend because the neuron will never spike with a theta of 5 and 6 since the resistance Rin with a value of 5 is lower then that and therefore the threshold can't be reached.

Theta	average interspike times	colors
1	2.8841	blue
2	5.4054	green
3	9.3333	orange
4	16.5000	light blue
5	57.3333	pink
6	NaN	yellow

Figure 3: Plot for different values of theta



potential difference(V)

time(ms)

2 Code

4. Code for the first experiment with the change of tau

neuronTau.m

```
nstep = 400;                    % Number of timesteps to integrate over
Inoise = 0.1;
I0 = 1+Inoise*randn(1,nstep);  % Input current in nA
dt = 1;                         % time step in ms
tau = 10;                       % membrane time constant in ms
theta = 4;                      % threshold in mV

v = zeros(1,nstep);      % Allocate space for Voltage in mV
Rin = 5;                 % Input resistance in MOhm
tspike = [];             % place to store spike times
spikeAverages = [];      % spike time averegaes for different tau values
t = (1:nstep)*dt;
for tau = 0:20:100
    count =0;
    sum = 0;
    lastT=0;
    for n = 2:nstep
        v(n) = v(n-1) + dt * (-v(n-1)/tau + Rin * I0(n)/tau);
        if (v(n) > theta)
            v(n) =0;
            tspike = [tspike;tau,t(n)-lastT];
            sum = sum + (t(n) -lastT);
            count = count + 1;
            lastT = t(n);
        end
    end
    spikeAverages = [spikeAverages; tau, sum/count];
    plot(t,v)
    hold all
end
disp(spikeAverages)
```

5. Code for the second experiment with the change of Rin

neuronRin.m

```
nstep = 50;                     % Number of timesteps to integrate over
Inoise = 0.1;
I0 = 1+Inoise*randn(1,nstep);  % Input current in nA
dt = 1;                         % time step in ms
tau = 10;                       % membrane time constant in ms
```

```
theta = 4;                         % threshold in mV

v = zeros(1,nstep);      % Allocate space for Voltage in mV
Rin = 5;                 % Input resistance in MOhm
tspike = [];             % place to store spike times
spikeAverages = [];      % spike time averegaes for different Rin values
t = (1:nstep)*dt;
for Rin = 3:7
    count = 0;
    sum=0;
    lastT = 0;
    for n = 2:nstep
        v(n) = v(n-1) + dt * (-v(n-1)/tau + Rin * I0(n)/tau);
        if (v(n) > theta)
            v(n) =0;
            tspike = [tspike;Rin,t(n)-lastT];
            sum = sum + (t(n) -lastT);
            count = count + 1;
            lastT = t(n);
        end
    end
    spikeAverages = [spikeAverages; Rin, sum/count];
    plot(t,v)
    hold all
end
disp(spikeAverages)
```

6. Code for the third experiment with the change of theta

neuronTheta.m

```
nstep = 200;                       % Number of timesteps to integrate over
Inoise = 0.1;
I0 = 1+Inoise*randn(1,nstep);      % Input current in nA
dt = 1;                            % time step in ms
tau = 10;                          % membrane time constant in ms
theta = 4;                         % threshold in mV

v = zeros(1,nstep);      % Allocate space for Voltage in mV
Rin = 5;                 % Input resistance in MOhm
tspike = [];             % place to store spike time intervals
spikeAverages = [];      % spike time averegaes for different theta values
t = (1:nstep)*dt;
for theta = 1:6
    count =0;
    sum = 0;
```

```
    lastT=0;
    for n = 2:nstep
       v(n) = v(n-1) + dt * (-v(n-1)/tau + Rin * I0(n)/tau);
       if (v(n) > theta)
          v(n) =0;
          tspike = [tspike;theta,t(n)-lastT];
          sum = sum + (t(n) -lastT);
          count = count + 1;
          lastT=t(n);
       end
    end
    spikeAverages = [spikeAverages; theta, sum/count];
    plot(t,v)
    hold all
end
disp(spikeAverages);
```