Q3 Adjusting the weights to elicit a spike response

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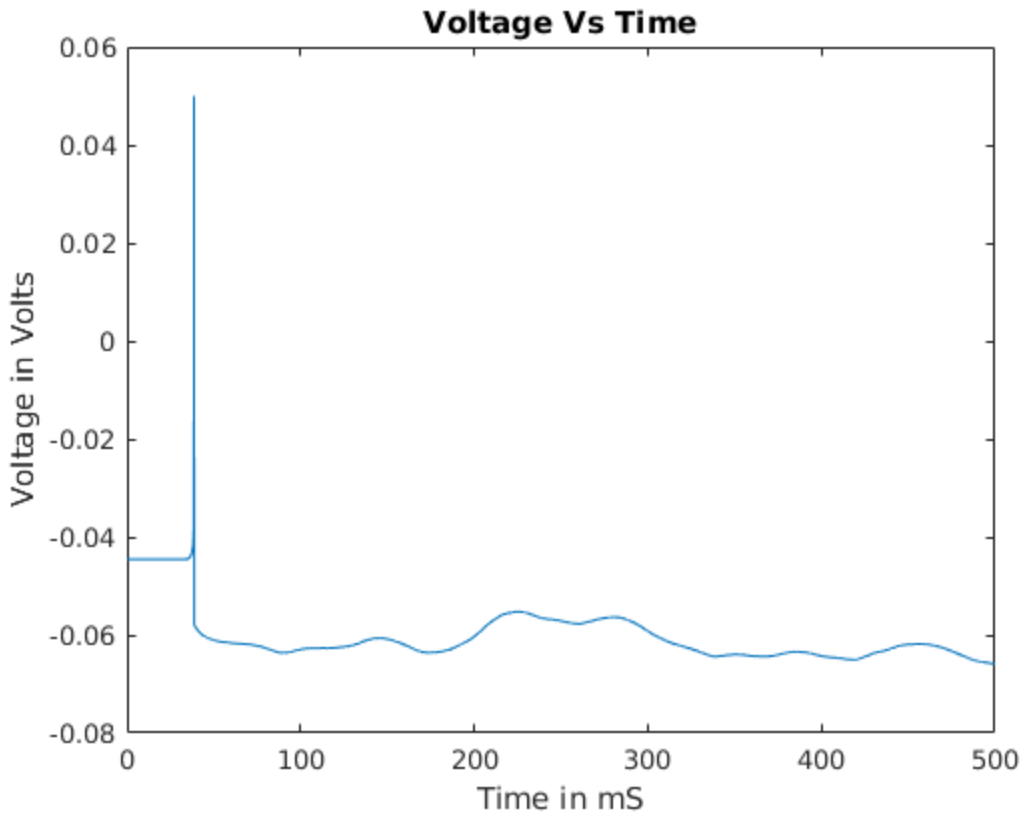
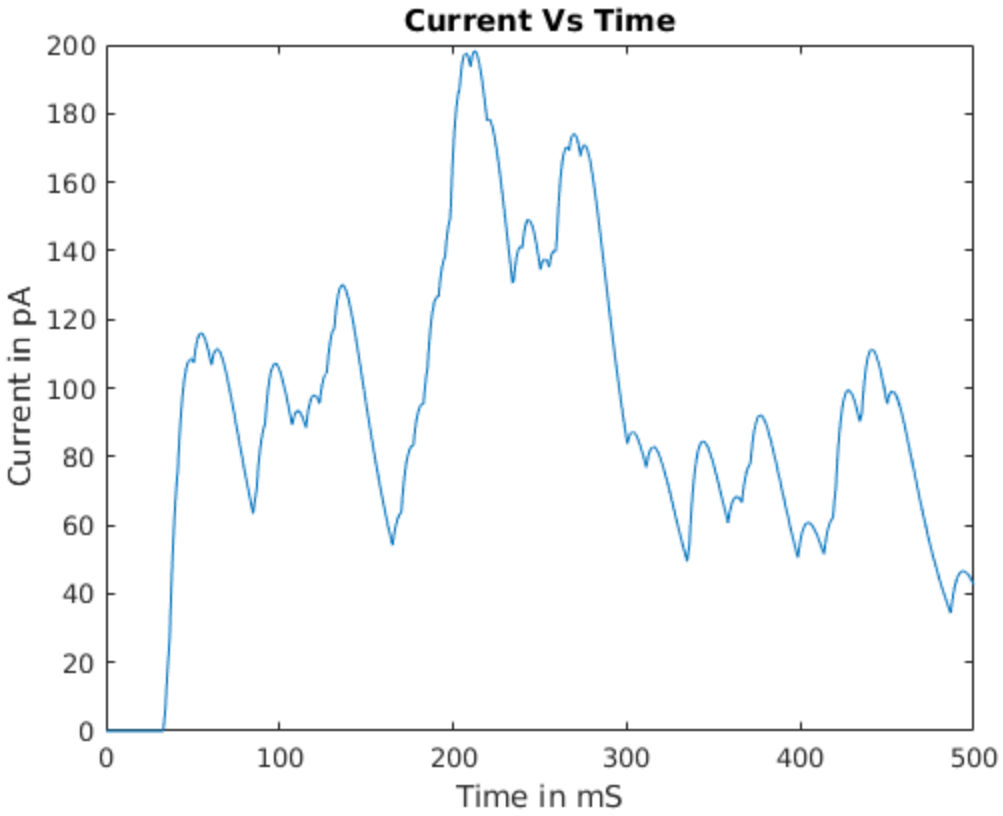
Q3 part A stimulus generation

```
ms=1E-3;
T=500*ms;
delta_t=0.1*ms;
steps=T/delta_t;
Ns=100;
lambda=1;


myPoissonSpikeTrain = rand(Ns, steps) < lambda*delta_t;


Io=1E-12;
Wo=50;
sigma_w=5;
tau=25*ms;
taus=tau/4;
t=0:delta_t:T;
Iapp_global=zeros(size(t));
synapse_strengths=Wo+sigma_w*randn(1,Ns);

Iapp_synapse=zeros(Ns,size(t,2));

for k=1:1:Ns

    tm=find(myPoissonSpikeTrain(k,:)==1)*0.1*ms;


        for j=1:size(t,2)
            temp=0;
           for i=1:size(tm,2)

               if t(j)>tm(i)
                   temp=temp+exp((tm(i)-t(j))/tau)-exp((tm(i)-t(j))/
taus);
               end
```

```
            end
            Iapp_synapse(k,j)=temp;

        end
    Iapp_global=Iapp_global+synapse_strengths(k)*Iapp_synapse(k,:);
end

Iapp_global=Io*Iapp_global;

[V,U] = AEF(delta_t,T,Iapp_global,1);


figure();
plot(t*1E3,V);
xlabel('Time in mS');ylabel('Voltage in Volts');
title('Voltage Vs Time');

figure();
plot(t*1E3,Iapp_global*1E12);
xlabel('Time in mS');ylabel('Current in pA');
title('Current Vs Time');
Vold=V;
Iold=Iapp_global;
synapse_strengthsold=synapse_strengths;
```

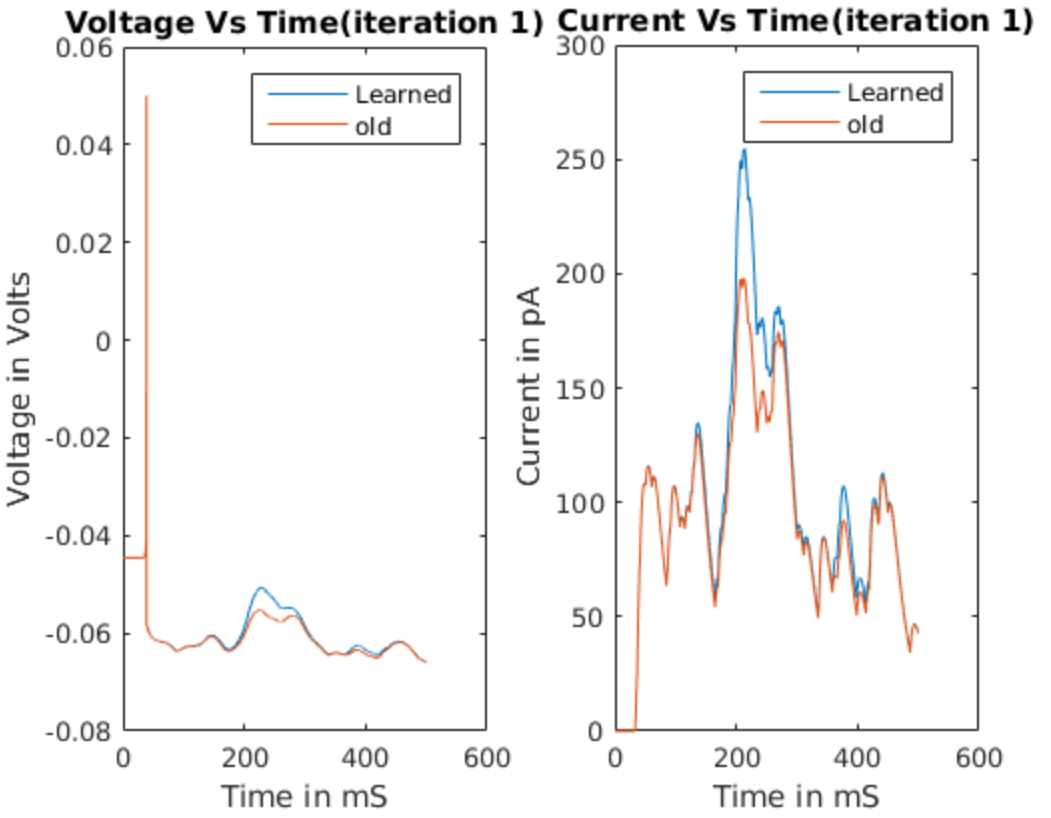




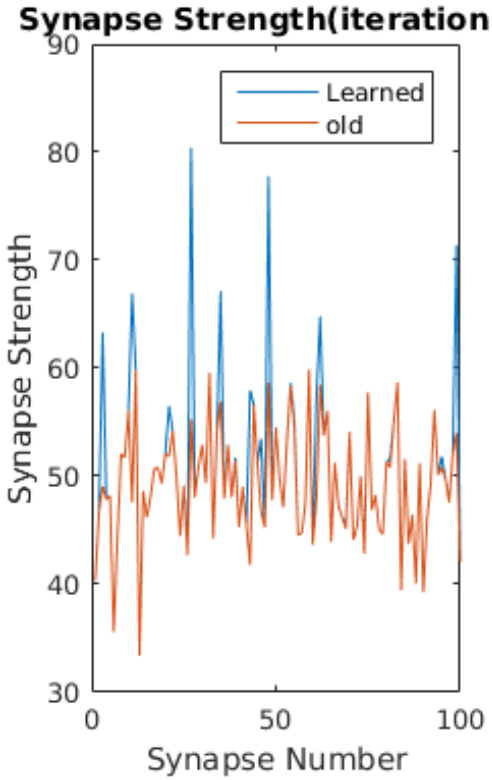
Q3 part B Learning part

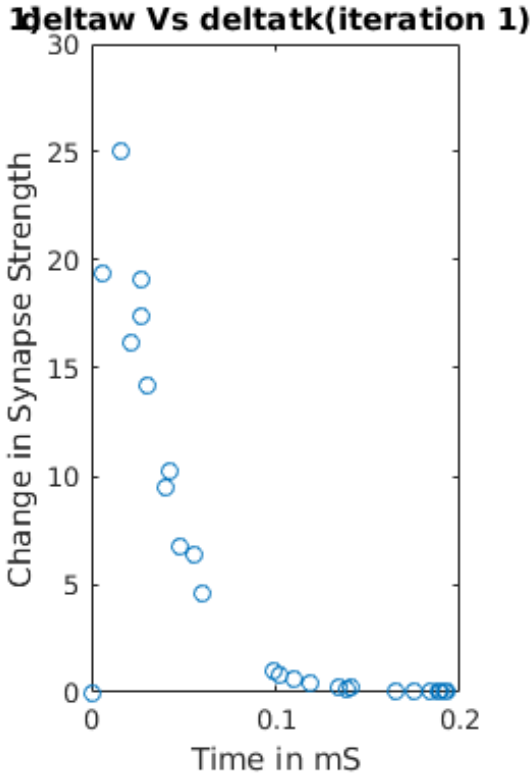
```
tmax=find(V==max(V(500:end)))*0.1*ms;
gamma=1;
for iteration=1:100

    delta_w=zeros(1,Ns);
    delta_tk=zeros(1,Ns);
    for k=1:Ns

        tm=find(myPoissonSpikeTrain(k,:)==1)*0.1*ms;
        indices=find(tm<tmax);
        if size(indices,2)~=0
            delta_tk(k)=tmax-tm(indices(end));
            delta_w(k)=synapse_strengths(k)*gamma*(exp(-delta_tk(k)/
tau)-exp(-delta_tk(k)/taus));

        end

    end

    synapse_strengths=synapse_strengths+delta_w;
    Iapp=diag(synapse_strengths)*Iapp_synapse;
    Iapp=Io*sum(Iapp);
    [V,U] = AEF(delta_t,T,Iapp,1);
```

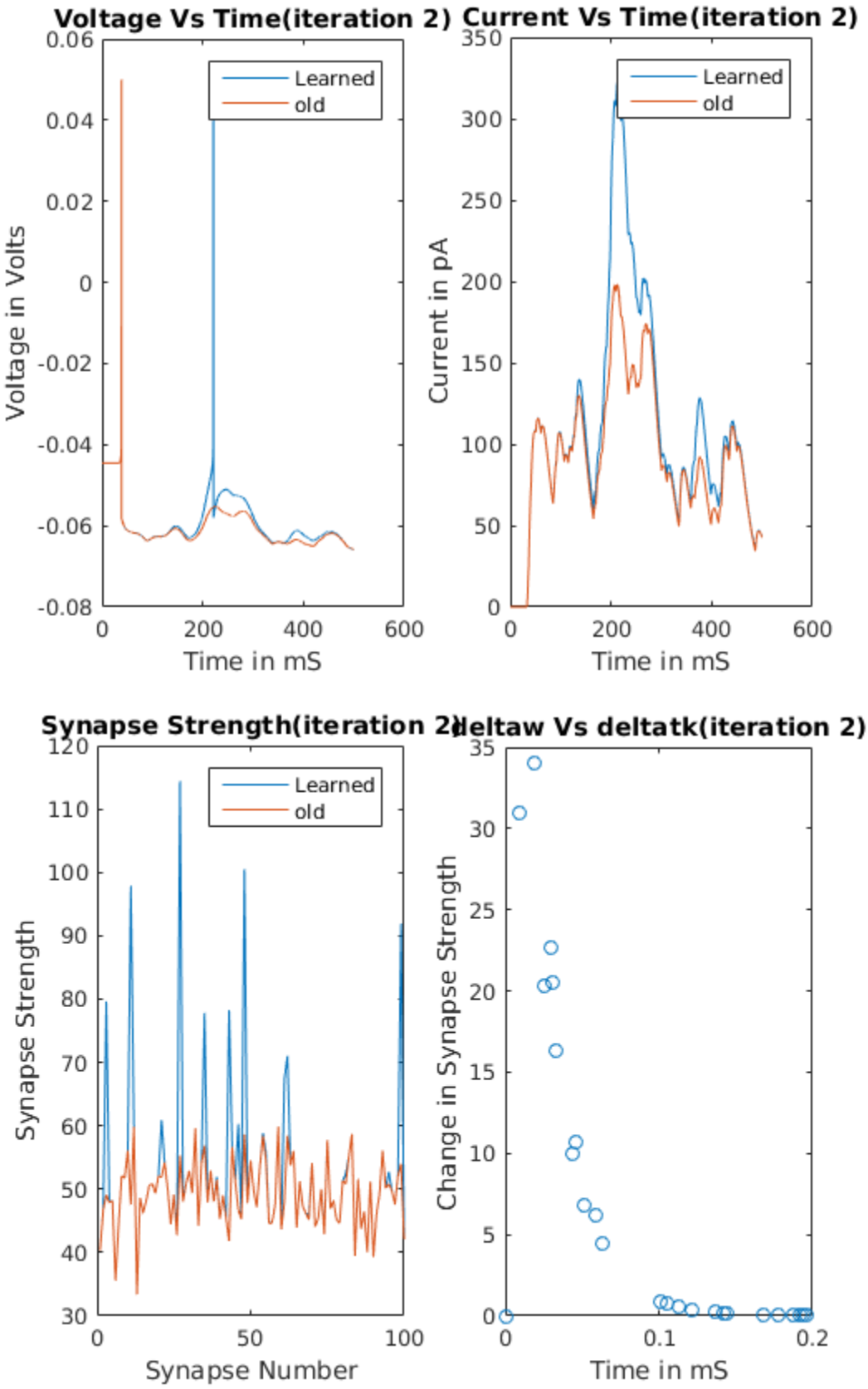
```
    tmax=find(V==max(V(500:end)))*0.1*ms;


    figure()
    subplot(1,2,1)
    plot(t*1E3,V,t*1E3,Vold);
    xlabel('Time in mS');ylabel('Voltage in Volts');
    title(sprintf('Voltage Vs Time(iteration %d)',iteration));
    legend('Learned','old');

     subplot(1,2,2)
    plot(t*1E3,Iapp*1E12,t*1E3,Iapp_global*1E12);
    xlabel('Time in mS');ylabel('Current in pA');
    title(sprintf('Current Vs Time(iteration %d)',iteration));
    legend('Learned','old');

    figure();
    subplot(1,2,1)
    plot(synapse_strengths)
    hold on;
    plot(synapse_strengthsold);
    hold off;
    xlabel('Synapse Number');ylabel('Synapse Strength');
    title(sprintf('Synapse Strength(iteration %d)',iteration));
    legend('Learned','old');

     subplot(1,2,2)
    plot(delta_tk,delta_w,'o');
    xlabel('Time in mS');ylabel('Change in Synapse Strength');
    title(sprintf('deltaw Vs deltatk(iteration %d)',iteration));

    spike=find(V==0.05);
    if size(spike,2)==2
        break
    end
end

fprintf('Number of iteration needed =%d',iteration);

Number of iteration needed =2
```


Voltage Vs Time(iteration 1)
Learned
old
Voltage in Volts
Time in mS
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
0
200
400
600

Current Vs Time(iteration 1)
Learned
old
Current in pA
Time in mS
300
250
200
150
100
50
0
0
200
400
600


Synapse Strength(iteration 1)
Learned
old
Synapse Strength
Synapse Number
90
80
70
60
50
40
30
0
50
100


deltaw Vs deltatk(iteration 1)
Change in Synapse Strength
Time in mS
30
25
20
15
10
5
0
0
0.1
0.2


Voltage Vs Time(iteration 2)
Learned
old
Voltage in Volts
Time in mS
Current Vs Time(iteration 2)
Learned
old
Current in pA
Time in mS
Synapse Strength(iteration 2)
Learned
old
Synapse Strength
Synapse Number
deltaw Vs deltatk(iteration 2)
Change in Synapse Strength
Time in mS

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