AMATH 522: Problem Set 2

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1 Theory

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2 Simulating Dwell times

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```
%% Dwell times

clear all; close all;
rng('shuffle')
numsteps = 1000000 ; %number of timesteps simulated

A = [0.98, 0.1,0 ;
0.02, 0.7,0.05;
0 , 0.2, 0.95;] ;

%list of states on this realization. xlist(k)=1 means in state 1 at
%timestep k, etc
states=zeros(1,numsteps);

%initial state
states(1)=1;

for k=1:numsteps-1

%uniformly distributed random number - will use for transitions from
%timestep k to current timestep k+1
rd=rand ;

if rd < A(1,states(k))  %for transition FROM states(k) to state 1
states(k+1)=1;
elseif rd <A(2,states(k)) +A(1,states(k))  %for transition FROM states(k) to
  state 1=2
states(k+1)=2;
else
states(k+1)=3;
end

end;

%----
figure
set(gca,'FontSize',18)
plot(1:numsteps,states,'.','MarkerSize',20)
xlabel('timestep','FontSize',16)
ylabel('state','FontSize',16)

rstates= 2*ones(1,numsteps);
Ind= find(states==1 | states ==2);
rstates(1,Ind)=1;
figure;
```

```
rstates(states)=1;
plot(rstates);
strt = states(1);
time=1;
dwellist1=[];
dwellist2=[];

for k=2:length(rstates)
if rstates(k)== strt

else
dwell = k- time;
if strt ==1

dwellist1 = [dwellist1 dwell];
else
dwellist2 = [dwellist2 dwell];
end;
strt =rstates(k);
time=k;
end;

end;
figure;
[counts,centers] = hist(dwellist2,70);
set(gca,'FontSize',18)
bar(centers,counts);
xlabel('bins','FontSize',16)
ylabel('Histogram of dwell times','FontSize',16)
figure
f = fit(centers',counts','exp1');
set(gca,'FontSize',18);
plot(f,centers,counts);

xlabel('bins','FontSize',16)
ylabel('Exponential fit','FontSize',16)


```

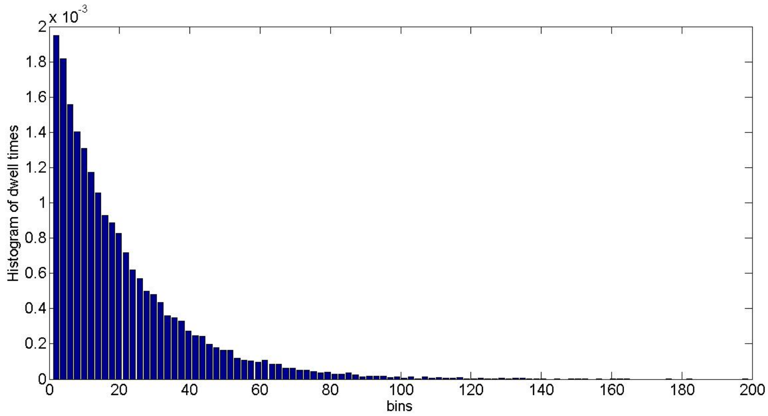

Figure 1: The histogram of dwell times

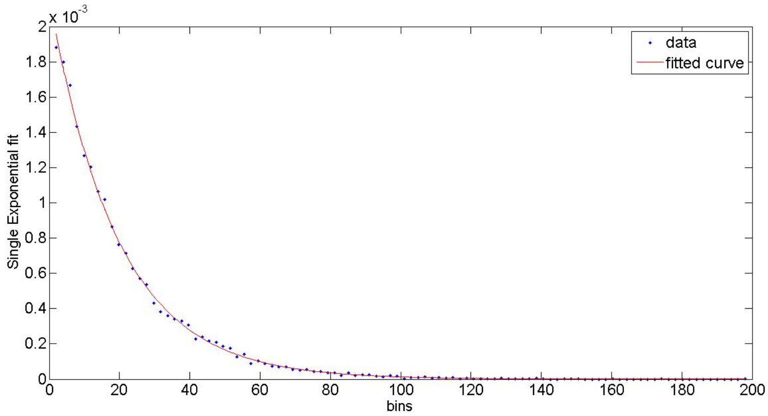

Figure 2: The single exponential fit to the histogram

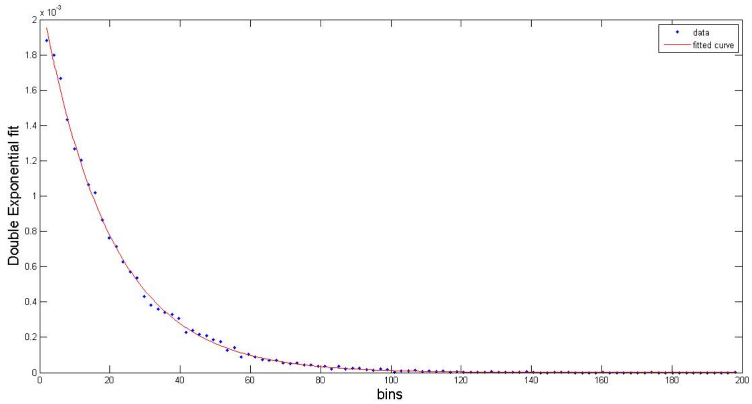

Figure 3: The double exponential fit to the histogram

Obviously, the single exponential function is not a good fit because there are two eigenvalues for the system staying in the closed state.

3 Neural Spiking

```
%% Neural Spiking

clear all;
parpool; % Parallel computing because this takes a while

A = [0.98, 0.1,0 ;
0.02, 0.7,0.05;
0 , 0.2, 0.95;] ;

[T,L] =eigs(A);
prb =T(:,1);
probin =[prb(1)+prb(2);prb(3);];
probin =probin./sum(probin);

B = [0.9 0.1 0; 0.1 0.6 0.1; 0 0.3 0.9;];

[T,L] =eigs(B);
prb =T(:,1);
```

```
    probout =[prb(1)+prb(2);prb(3);];
    probout =probout./sum(probout);

    Popenout= 0.4;
    Popenin=0.6;
    Nin = 100;
    Nout =50;
    parfor T=0:1:Nin-1
      sum=0;
      for w = 0:1:Nout
        sum=sum+ binopdf(w, Nout,Popenin)*(1-binocdf(T+w, Nin,Popenout));
        if T+w>Nin
          break;
        end
      end
      p(T+1) =sum;
    end
    Nin = 10;
    Nout =5;
    parfor T=0:1:Nin-1
      sum=0;
      for w = 0:1:Nout
        sum=sum+ binopdf(w, Nout,Popenin)*(1-binocdf(T+w, Nin,Popenout));
        if T+w>Nin
          break;
        end
      end
      p2(T+1) =sum;
    end

    Nin = 1000;
    Nout =500;
    parfor T=0:1:Nin-1
      sum=0;
      for w = 0:1:Nout
        sum=sum+ binopdf(w, Nout,Popenin)*(1-binocdf(T+w, Nin,Popenout));
        if T+w>Nin
          break;
        end
      end
      p3(T+1) =sum;
    end
```

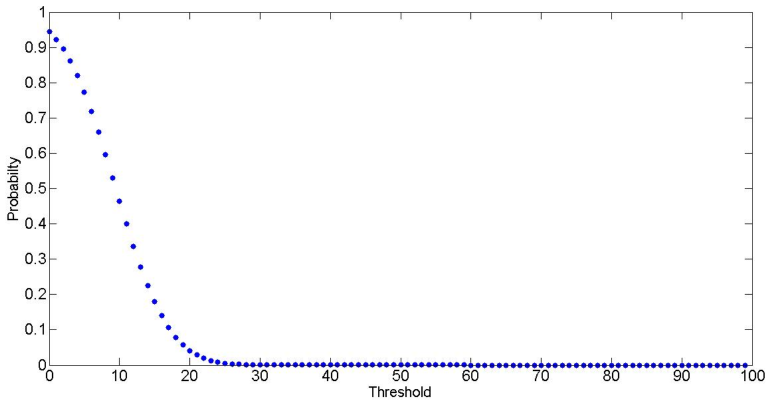

Figure 4: Distribution with $N_{inward} = 100$ and $N_{outward} = 50$

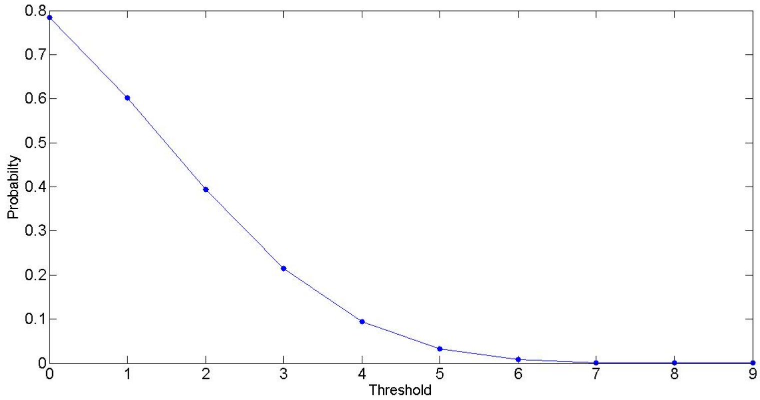

Figure 5: Distribution with $N_{inward} = 10$ and $N_{outward} = 5$

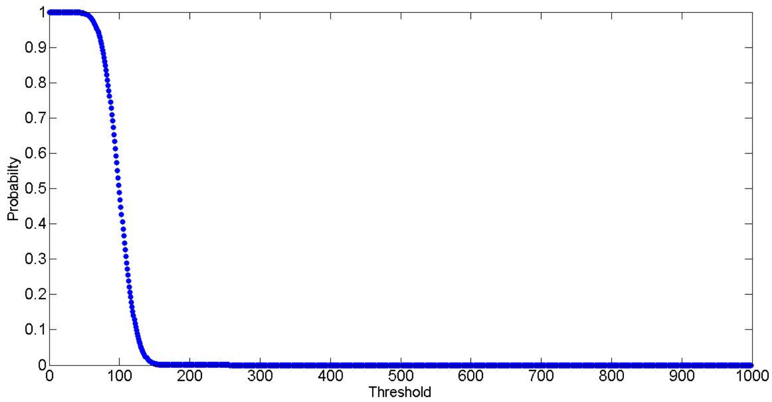

Figure 6: Distribution with $N_{inward} = 1000$ and $N_{outward} = 500$

As we increase the number of channels, the distribution begins to look more and more like a guassian distribution, a good representation of the coin flipping.