SOLUTION FOR LAB 9 VS265 - BOLTZMAN MACHINES

MAYUR MUDIGONDA

1. Boltzman Machine Code

```
N=9;
Tr=randn(N,N);
Tr=(Tr+Tr')/2;
Tr=Tr- diag(diag(Tr));
br=randn(N,1);
X=sample(Tr,br,10000,10);

num_trials=1000;
batch_size=1000;
eta=0.1;

T=zeros(N,N); % weight matrix
b=zeros(N,1); % bias
S=2*(rand(N,1)<0.5)-1;

figure(1)
subplot(211)
hT=imagesc(T,[-3 3]); axis image
subplot(212)
bar(b)
drawnow

for t=1:num_trials

    % data statistics (clamped)
    D=get_batch(X,batch_size);
    % ...
    cov_D = D*D';

    % prior statistics (unclamped)
    S=sample(T,b,batch_size,S(:,1));
    cov_S = S*S';
```

```
    % update params
    delta_t = eta*((cov_D-cov_S)/batch_size);
    T=T+delta_t;
    T=T-diag(diag(T));

    %update delta_b
    delta_b = eta*(mean(D-S,2));
    b=b+delta_b;

    % display
    set(hT,'CData',T)
    bar(b)
    drawnow

end
```

2. The case of the ground truth

In the case where we have ground truth, we see from the learned covariances that the model's covariance[2] is pretty similar to the data's covariance [1]. Having solved this simple test, we move on to the more complicated case of trying to make a model for scribbled lines.

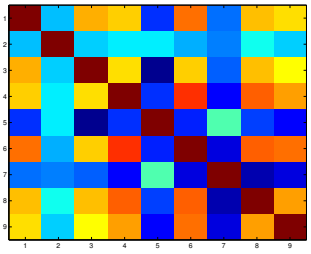

Figure 1. Covariance of the data

3. The case of scribbled lines

Note that the covariances of the data[5] and the model[6] look fairly similar. Yet, the rank ordered probability of the patches[3,4] tell us a very different story. This problem can be partially addressed using hidden units, better sampling methods and higher order correlations. A convolutional type model can also address the pitfalls of a simple Boltzman machine better.

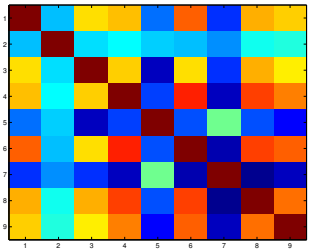

FIGURE 2. Covariance of the model

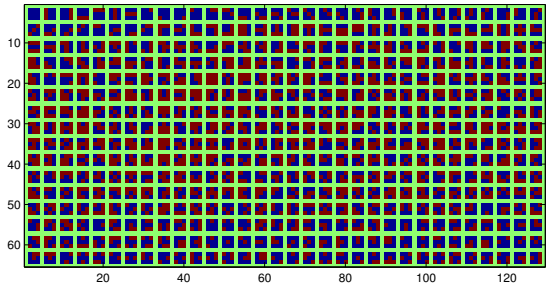

FIGURE 3. Patches from the data for scribbled lines. Rank ordered.

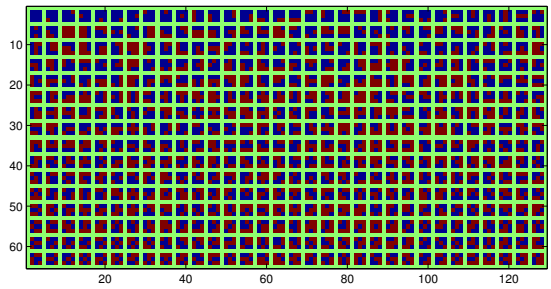

FIGURE 4. Patches from the model for scribbled lines.. Rank ordered.

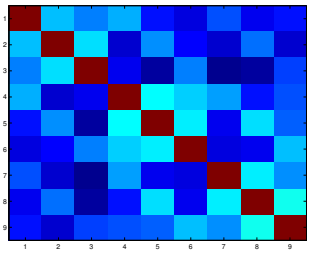

FIGURE 5. Covariance of the data for the scribbled lines

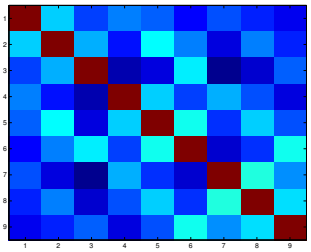

FIGURE 6. Covariance of the model for the scribbled lines