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ASSIGNMENT 6

6.2 EM algorithm for noisy-OR

1. **(d)**

iteration	mistakes	log-likelihood
0	195	-1.04456
1	60	-0.50494
2	43	-0.41076
4	42	-0.36513
8	44	-0.34766
16	40	-0.33468
32	37	-0.32259
64	37	-0.31483
128	36	-0.31116
256	36	-0.31016

2. **(e)**

   Source Code is attached as hw6_2.m.

6.3 Auxiliary function

1. **(c)**

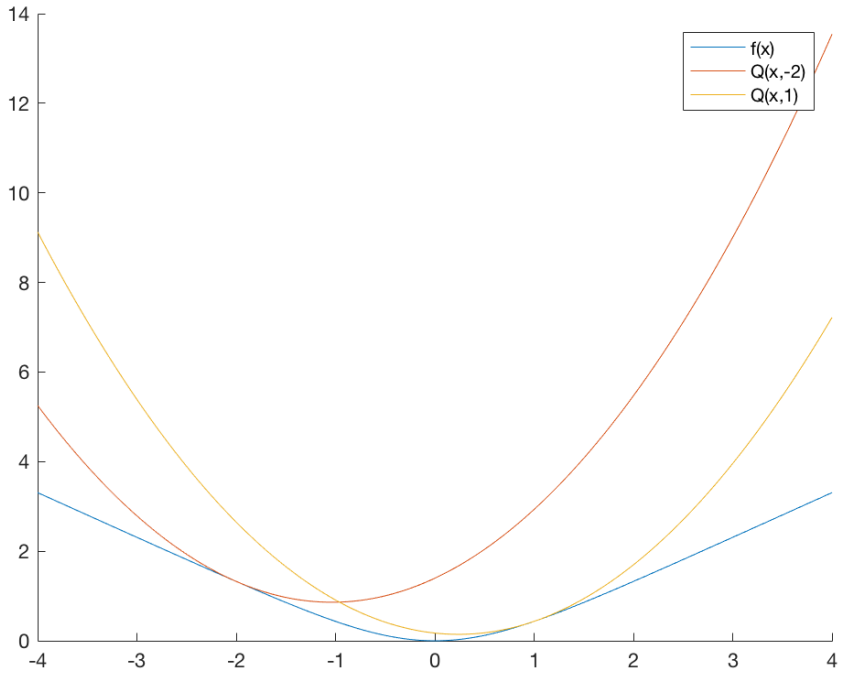

Figure 1: $f(x),\ Q(x,-2),\ Q(x,1)$

2. **(f)**

The left one is $x_0 = -2$ and the right one is $x_0 = 1$. We can see that both two converge numerically.

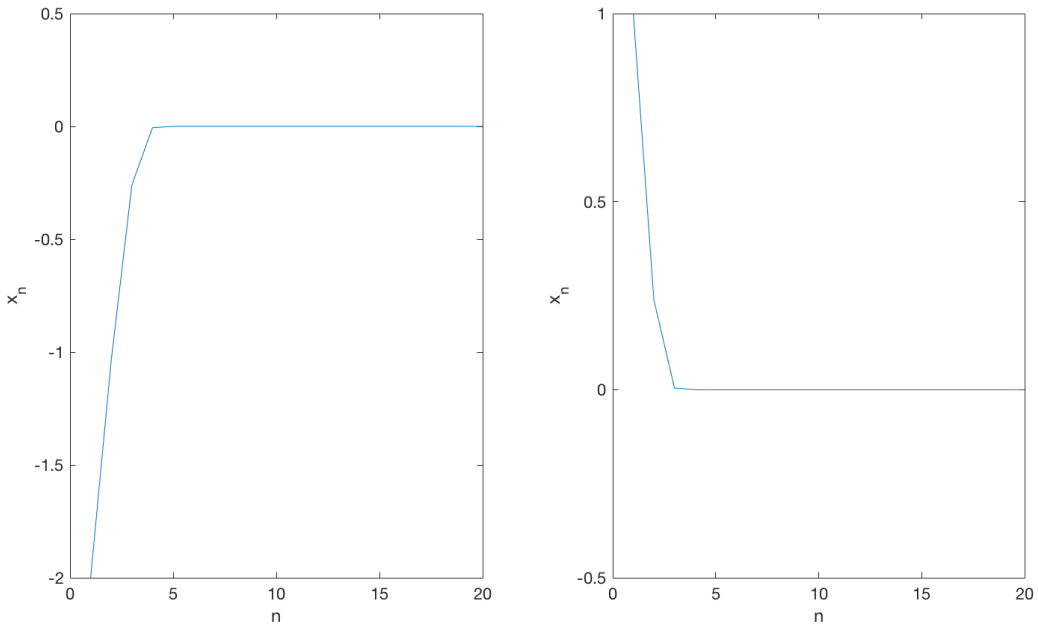

Figure 2: x_n versus n

3. **(h)**

It is no longer simple to find the exact minimum.

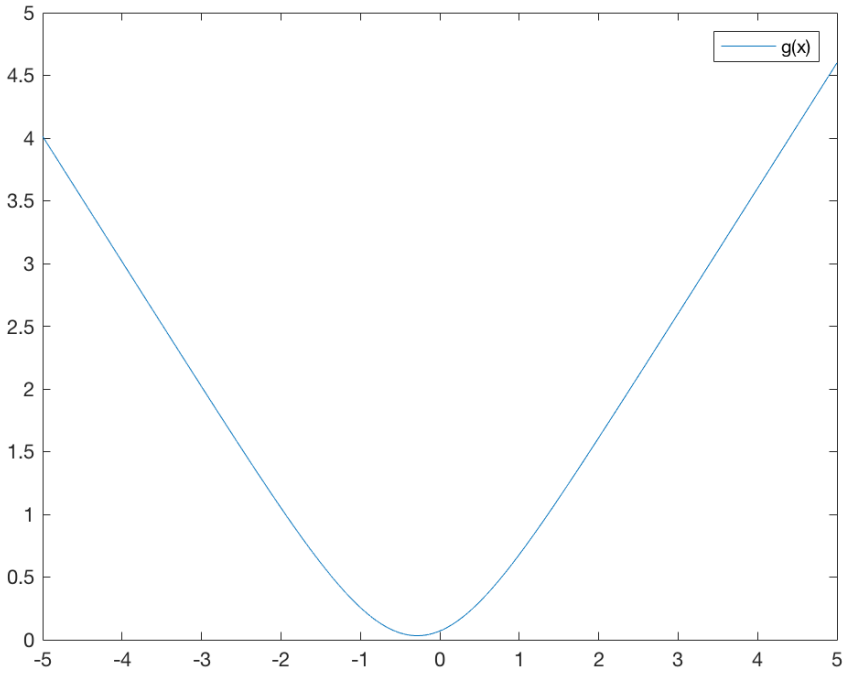

Figure 3: $g(x)$

4. **(k)**

The minimum lies at $x = -0.2830$, where $g(x) = 0.0327$. The source code is attached.

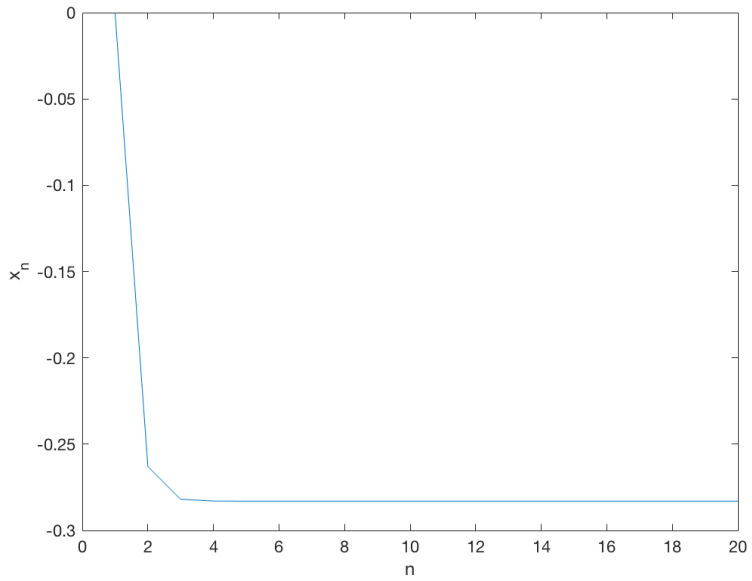

Figure 4: x_n versus n

1 Source Code for 6.2

Listing 1: hw6_2.m

```
xt = load('spectX.txt');
yt = load('spectY.txt');

% config of EM
[T, n] = size(xt);
iter = 257;
pi = ones(1,n)/n;
Ti = sum(xt);
res = zeros(iter, 2);

for i = 1 : iter
    % update pi
    prob(1:T,1) = 1-prod((1-pi)'.^(xt(1:T,:)'));
    Pzx = xt .* yt .* pi ./ prob;
    pi = sum(Pzx)./Ti;
    % mistake
    M = sum(abs(round(prob)-yt));
    % log-likelihood
    L = sum(log(yt.*prob + (1-yt).*(1-prob)))/T;
    res(i,:) = [M, L];
end
```

2 Source Code for 6.3

Listing 2: hw6_3.m

```
%% 6.3.c
f = @(x)log(cosh(x));
fD1 = @(x)(exp(x)-exp(-x))./(exp(x)+exp(-x));
fD2 = @(x)4./(exp(x)+exp(-x)).^2;
Q = @(x,y)(f(y)+fD1(y).*(x-y)+0.5*(x-y).^2);
x = -4:0.0001:4;
figure;
hold on;
plot(x, f(x));
plot(x, Q(x, -2));
plot(x, Q(x, 1));
legend('f(x)', 'Q(x,-2)', 'Q(x,1)');


%% 6.3.f
x = zeros(20,1);

% x_0 = -2
x(1) = -2;
for i = 2 : 20
    x(i) = x(i-1) - fD1(x(i-1));
end
figure;
subplot(1,2,1);
plot(x);
xlabel('n');
ylabel('x_n');

% x_0 = 1
x(1) = 1;
for i = 2 : 20
    x(i) = x(i-1) - fD1(x(i-1));
end
subplot(1,2,2);
plot(x);
axis([0 20 -0.5 1]);
xlabel('n');
ylabel('x_n');


%% 6.3.g
% x = 1;
```

```
x = 3;
for i = 1 : 3
    x = x - fD1(x)/fD2(x);
    fprintf('%f\n',x);
end

%% 6.3.h
g = @(x) 0.1 * sum(log(cosh(x+[1;1/2;1/3;1/4;1/5;1/6;1/7;1/8;1/9;1/10])));
x = -5 : 0.0001 : 5;
index = find(g(x) == min(g(x)));
x_min = x(index);
g_min = g(x_min);
figure;
plot(x,g(x));
legend('g(x)')

%% 6.3.k
gD1 = @(x) 0.1 * sum(tanh(x+[1;1/2;1/3;1/4;1/5;1/6;1/7;1/8;1/9;1/10]));
x = zeros(20,1);
for i = 2 : 20
    x(i) = x(i-1) - gD1(x(i-1));
end
figure;
plot(x);
xlabel('n');
ylabel('x_n');
legend('g''(x)')
```

Submitted by Xiaowen Mao on Nov 8.