HW5 Report

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November 28, 2018

Here, I include the code and the output but the m.files and the diary can be found in the directory. **(Questions 1-3)** My code for calculating log-likelihood under given assumption with GQ method is under the comment Question 1; calculating log-likelihood using MC is under the comment Question 2; and maximum likelihood estimates using both techniques are under the comment Question 3 in the main file[1]:

```
%Ece Teoman

%% Question 1 (GQ)

clear all
clc

load('hw5.mat', 'data');

N=100;
T=20;
```

[1] I include the subroutines at the end of this document.

```
X=data.X;
Y=data.Y;
Z=data.Z;



beta0=0.1;
s_beta=1;

fun=@(beta)integrand(beta, X, Y);

%Nodes are created:

k=20;

[nodes, weights] = qnwnorm(k, beta0, s_beta);

beta=nodes*ones(1, N);
fval=zeros(k, N);
val=zeros(k, N);

for i=1:k
      fval(i, :)=fun(beta(i,:));
      val(i, :)=fval(i, :).*weights(i, 1);
end

int=sum(val);
l=prod(int');
```

```
logint=log(int');
ll=sum(logint);

%% Question 2 (MC)

n_nodes=100;

beta_mc=(beta0.*ones(1, n_nodes)+s_beta.*randn(1, n_nodes))'*ones(1, N);

fval_mc=zeros(n_nodes, N);

for i=1:n_nodes
    fval_mc(i, :)=fun(beta_mc(i,:));
end

int_mc=mean(fval_mc);
logint_mc=prod(int_mc');

logint_mc=log(int_mc');
logll_mc=sum(logint_mc);

%% Question 3

par_0=[beta0, s_beta];
A=[0, -1];
b=0;

% GQ:
```

```
l_gq=@(par)ll_gq(par, X, Y);
[par_gq, ll_gq] = fmincon(l_gq,par_0,A,b);



% MC:

l_mc=@(par)ll_mc(par, X, Y);
[par_mc, ll_mc] = fmincon(l_mc,par_0,A,b);

%% Question 5

disp('GQ:')

disp('Initial value:')
disp(par_0)

disp('MLE:')
disp(par_gq)

disp('Maximum LogLikelihood:')
disp(ll_gq)

%%

disp('MC')

disp('Initial value:')
```

```
disp(par_0)


disp('MLE:')
disp(par_mc)


disp('Maximum LogLikelihood:')
disp(ll_mc)
```

(Q4) I don't have a working code for question 4 as I was never able to get any numbers in this more general case.

(Q5) The output I received as result of maximum likelihood estimates are as follows:

GQ:

```
Initial value:
0.1000      1.0000


MLE:
0.3970      0.2161


Maximum LogLikelihood:
1.2281e+03
```

MC

```
Initial value:
0.1000      1.0000


MLE:
0.1111      1.0459


Maximum LogLikelihood:
```

```
1.2439e+03
```

0.1 Functions

```
function [integrand]=integrand(beta, X, Y)



[T, N] = size(X);
oo=ones(T, 1);
Beta=oo*beta;

%We calculate the individual random effects.
epsilon=Beta.*X;

%To feed into logistic distribution:
ooo=ones(T, N);

succ=(ooo+exp(-epsilon)).^(-1);
fail=ooo-(ooo+exp(-epsilon)).^(-1);



ll=prod((succ.^Y).*(fail.^(ooo-Y)));
%Invididual likelihoods:
[integrand]=ll;
end

function ll_gq=ll_gq(par, X, Y)
```

```
k=20;
[~, N] = size(X);

[nodes, weights] = qnwnorm(k, par(1), par(2));

beta=nodes*ones(1, N);

fval=zeros(k, N);
val=zeros(k, N);
for i=1:k
      fval(i, :)=integrand(beta(i,:), X, Y);
      val(i, :)=fval(i, :).*weights(i, 1);
end
int_gq=sum(val);
logint_gq=log(int_gq');
ll_gq=-sum(logint_gq);
end

function ll_mc=ll_mc(par, X, Y)

m=100;
[~, N] = size(X);

beta_mc=(par(1).*ones(1, m)+par(2).*randn(1, m))'*ones(1, N);

fval_mc=zeros(m, N);
for i=1:m
    fval_mc(i, :)=integrand(beta_mc(i,:), X, Y);
end
```

```
int_mc=mean(fval_mc);
logint_mc=log(int_mc');
ll_mc=-sum(logint_mc);
end
```