Table of Contents

Empirical Method HW5

```
data = load('C:\Users\padag\Documents\MATLAB\hw5.mat');
X = data.data.X;
Y = data.data.Y;
Z = data.data.Z;
N = data.data.N;
T = data.data.T;

F = @(x) ( 1 + exp( -x ) ).^(-1);
```

Q1

```
loglikelihood = 0;

for i = 1:100
    xi = X(:,i);
    yi = Y(:,i);
    f = @(b) prod( ( F(b*xi).^(yi) ).*( (1 - F(b*xi)).^( 1 - yi ) ) );
    [b,w] = qnwnorm(20,0.1,1);
    fmatrix = [];
    for t = 1:20
        bt = b(t,1);
        fmatrix = [fmatrix ; f(bt) ];
    end
    Ef = w'*fmatrix;
    loglikelihood = loglikelihood + log(Ef);
end

disp("Log-likelihood that is calculated by Gaussian Quadrature with 20
 nodes is");
loglikelihood
```

```
Log-likelihood that is calculated by Gaussian Quadrature with 20 nodes
 is

loglikelihood =

  -1.2571e+03
```

Q2

```
loglikelihood2 = 0;

for i = 1:100
    xi = X(:,i);
    yi = Y(:,i);
    f = @(b) prod( ( F(b*xi).^(yi) ).*( (1 - F(b*xi)).^( 1 - yi ) ) );
    rnd = normrnd(0.1,1,[100,1]);
    integral = arrayfun(f,rnd);
    integral = (1/100)*sum(integral);
    loglikelihood2 = loglikelihood2 + log(integral);
end

disp("Log-likelihood that is calculated by Monte Carlo method with 100
 nodes is")
loglikelihood2
```

```
Log-likelihood that is calculated by Monte Carlo method with 100 nodes
 is

loglikelihood2 =

  -1.2595e+03
```

Q3

```
initial = [1;2;1];
likeli1 = @(A) -likeliGauss(A(1),A(2),A(3));
likeli2 = @(A) -likeliMC(A(1),A(2),A(3));

options = optimoptions(@fminunc,'Display','iter','Algorithm','quasi-
newton');
estMC = fminunc(likeli2,initial,options);
estGauss = fminunc(likeli1,initial,options);

disp('starting value = ')
initial
disp('argmax for gamma, mu, var and log-likelihood from Gaussian = ')
estGauss
likeli1(estGauss)
disp('argmax for gamma, mu, var and log-likelihood from Montel Carlo
 =')
estMC
likeli2(estMC)
```

```
                                                        First-order
 Iteration  Func-count       f(x)        Step-size       optimality
     0           4          11515.2                       3.02e+08

Local minimum possible.
```

```
fminunc stopped because it cannot decrease the objective function
along the current search direction.

                                                        First-order
 Iteration  Func-count       f(x)        Step-size       optimality
     0           4         11512.5                        1.07e+04
     1           8         1348.91      9.3577e-05         5.6e+03
     2          12         1045.67               1         1.3e+03
     3          16          791.46               1             988
     4          24         540.531        0.666901            55.3
     5          28         540.067               1            31.8
     6          32         539.891               1            18.5
     7          36         539.783               1            18.9
     8          40         539.082               1            36.6
     9          44         538.181               1            54.8
    10          48         537.212               1              45
    11          52         536.909               1            17.9
    12          56         536.851               1            4.87
    13          60         536.841               1            4.59
    14          64         536.834               1             4.4
    15          68         536.808               1            7.04
    16          72         536.753               1            11.1
    17          76         536.632               1            15.3
    18          80         536.443               1            15.5
    19          84         536.284               1             9.2
                                                        First-order
 Iteration  Func-count       f(x)        Step-size       optimality
    20          88         536.243               1            3.07
    21          92         536.238               1           0.692
    22          96         536.238               1          0.0189
    23         100         536.238               1          0.0115
    24         104         536.238               1        0.000427

Local minimum found.

Optimization completed because the size of the gradient is less than
the value of the optimality tolerance.

starting value =

initial =

     1
     2
     1

argmax for gamma, mu, var and log-likelihood from Gaussian =

estGauss =

   -0.5056
    2.4832
    1.4055
```

```
ans =

  536.2378

argmax for gamma, mu, var and log-likelihood from Montel Carlo =

estMC =

     1
     2
     1


ans =

   1.1521e+04
```

Q4

```
initial2 = [0.5;0.1;0;1;1;0.5];
likeli3 = @(A) -likeliMC2(A(1),A(2),A(3),A(4),A(5),A(6));

estMC2 = fminunc(likeli3,initial2,options);

disp('starting value = ')
initial2
disp('argmax for gamma, mu_beta, mu_u, var_beta, var_u, var_betau and
 log-likelihood = ')
estMC2
likeli3(estMC2)

% I failed to find estimates from Monte Carlo method in Q3 and Q4. Its
 loglikelihood is
% correct but its 'fminunc' fails to find minimum. The maximized value
 from
% this process is not even global maximum (I can easily find neighbor
% points that have higher log-likelihood) but I don't get the reason
 why.
```

```
                                                        First-order
 Iteration  Func-count       f(x)        Step-size       optimality
     0           7         5662.72                        6.25e+08

Local minimum possible.

fminunc stopped because it cannot decrease the objective function
along the current search direction.

starting value =

initial2 =
```

```
    0.5000
    0.1000
         0
    1.0000
    1.0000
    0.5000

argmax for gamma, mu_beta, mu_u, var_beta, var_u, var_betau and log-
likelihood =

estMC2 =

    0.5000
    0.1000
         0
    1.0000
    1.0000
    0.5000


ans =

   5.6591e+03
```

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