clc;

clear;

close all;

y = ([607, 583, 521, 494, 369, 782, 570, 678, 467, 620, 425, 395, 346, 361, 310, 300, 382, 294, 315, 323, 421, 339, 398, 328, 335, 291, 329, 310, 294, 321, 286, 349, 279, 268, 293, 310, 259, 241, 243, 272, 247, 275, 220, 245, 268, 357, 273, 301, 322, 276, 401, 368, 149, 507, 411, 362, 358, 355, 362, 324, 332, 268, 259, 274, 248, 254, 242, 286, 276, 237, 259, 251, 239, 247, 260, 237, 206, 242, 361, 267, 245, 331, 357, 284, 263, 244, 317, 225, 254, 253, 251, 314, 239, 248, 250, 200, 256, 233, 427, 391, 331, 395, 337, 392, 352, 381, 330, 368, 381, 316, 335, 316, 302, 375, 361, 330, 351, 186, 221, 278, 244, 218, 126, 269, 238, 194, 384, 154, 555, 387, 317, 365, 357, 390, 320, 316, 297, 354, 266, 279, 327, 285, 258, 267, 226, 237, 264, 510, 490, 458, 425, 522, 927, 555, 550, 516, 548, 560, 545, 633, 496, 498, 223, 222, 309, 244, 207, 258, 255, 281, 258, 226, 257, 263, 266, 238, 249, 340, 247, 216, 241, 239, 226, 273, 235, 251, 290, 473, 416, 451, 475, 406, 349, 401, 334, 446, 401, 252, 266, 210, 228, 250, 265, 236, 289, 244, 327, 274, 223, 327, 307, 338, 345, 381, 369, 445, 296, 303, 326, 321, 309, 307, 319, 288, 299, 284, 278, 310, 282, 275, 372, 295, 306, 303, 285, 316, 294, 284, 324, 264, 278, 369, 254, 306, 237, 439, 287, 285, 261, 299, 311, 265, 292, 282, 271, 268, 270, 259, 269, 249, 261, 425, 291, 291, 441, 222, 347, 244, 232, 272, 264, 190, 219, 317, 232, 256, 185, 210, 213, 202, 226, 250, 238, 252, 233, 221, 220, 287, 267, 264, 273, 304, 294, 236, 200, 219, 276, 287, 365, 438, 420, 396, 359, 405, 397, 383, 360, 387, 429, 358, 459, 371, 368, 452, 358, 371]);

ind = [1, 1, 1, 1, 1, 2, 2, 2, 2, 2, 3, 3, 3, 3, 3, 3, 3, 3, 3, 4, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 6, 6, 6, 6, 6, 6, 6, 6, 6, 7, 7, 7, 7, 7, 8, 8, 8, 8, 8, 9, 9, 9, 9, 9, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 13, 13, 13, 13, 13, 13, 13, 13, 13, 13, 14, 14, 14, 14, 14, 14, 14, 14, 14, 14, 14, 14, 14, 15, 15, 15, 15, 15, 15, 16, 16, 16, 16, 16, 17, 17, 17, 17, 17, 18, 18, 18, 18, 18, 19, 19, 19, 19, 19, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 21, 21, 21, 21, 21, 21, 21, 21, 21, 21, 22, 22, 22, 22, 22, 22, 22, 22, 22, 22, 22, 22, 23, 23, 23, 23, 23, 23, 23, 23, 23, 23, 24, 24, 24, 24, 24, 24, 24, 24, 24, 24, 24, 24, 24, 24, 24, 24, 24, 24, 24, 24, 25, 25, 25, 25, 25, 25, 25, 25, 25, 25, 25, 25, 25, 26, 26, 26, 26, 26, 27, 27, 27, 27, 27, 28, 28, 28, 28, 28, 28, 28, 28, 28, 29, 29, 29, 29, 29, 29, 29, 29, 29, 29, 30, 30, 30, 30, 30, 30, 31, 31, 31, 31, 31, 32, 32, 32, 32, 32, 33, 34, 34, 34, 34, 34, 34, 34, 34, 34, 34, 34, 34, 34, 34, 34, 34, 34, 34];

child = [1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0];

attempt =([1, 2, 3, 4, 5, 1, 2, 3, 4, 5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 1, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 1, 2, 3, 4, 5, 6, 7, 8, 9, 1, 2, 3, 4, 5, 1, 2, 3, 4, 5, 1, 2, 3, 4, 5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 1, 2, 3, 4, 5, 6, 1, 2, 3, 4, 5, 1, 2, 3, 4, 5, 1, 2, 3, 4, 5, 1, 2, 3, 4, 5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 1, 2, 3, 4, 5, 1, 2, 3, 4, 5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 1, 2, 3, 4, 5, 6, 1, 2, 3, 4, 5, 1, 2, 3, 4, 5, 1, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18]);

logy = log(y);

std\_logy = std(logy);

mean\_logy = mean(logy);

zlogy=(logy-mean\_logy)/std\_logy;

zattempt=(attempt-mean(attempt))/std(attempt);

individuals = 34;

ind\_mean = zeros(1,individuals);

for i = 1:individuals

ind\_mean(i) = mean(zlogy(ind==i)); % mean reaction time for each individual

end

initial = rand(2\*ind(end)+7,1);

logpdf = @(x)logpost(x,zlogy,ind,child,attempt); % posterior calculation

N = 50000; % no of samples

w = 0.5; %jump

samples = slicesample(initial,N,'logpdf',logpdf,'width',w,'thin',100,'burnin',1000);

%% =========== Task3 =========

mu0 = samples(:,end-2)+samples(:,end-3)\*child; % mu0+phi0\*child

mu1 = samples(:,70)+samples(:,end-6)\*child; % mu1+phi1\*child

theta0 = mu0 + samples(:,end-1).\*samples(:,1:34); % mu0+tau0\*

theta1 = mu1 + samples(:,end-4).\*samples(:,35:68);

sigma2\_samp=std\_logy.\*samples(:,75);

mean\_attempt=mean(attempt);

std\_attempt=std(attempt);

theta02\_samp=std\_logy.\*theta0+mean\_logy;

theta12\_samp=std\_logy.\*theta1;

theta03\_samp=theta02\_samp-theta12\_samp\*(mean\_attempt./std\_attempt);%%theta0 unscaled

theta13\_samp=theta12\_samp./std\_attempt;%%%%theta1\_unscaled

mu\_y\_samp\_1=exp(theta03\_samp+1\*theta13\_samp+((sigma2\_samp).^2)./2);

mu\_y\_samp\_5=exp(theta03\_samp+5\*theta13\_samp+((sigma2\_samp).^2)./2);

% ---------------------first individual (Oliver) ---------------------

figure(1)

% x=1; first attempt

h = histogram(mu\_y\_samp\_1(:,1),'Normalization','pdf');

h.NumBins = 100;

hold on

mean1\_Oliver=mean(mu\_y\_samp\_1(:,1));

median1\_Oliver=median(mu\_y\_samp\_1(:,1));

% --------- Confidence interval (HDI) --------

credMass = 0.95;

HDI = HDIofMCMC(mu\_y\_samp\_1(:,1),credMass);

hdiLow = HDI(1);

hdiHigh = HDI(2);

% Additional stuff: To make Matlab figure look more like R figure

ax = axis;

yl = ax([3 4]);

ydiff = yl(2)-yl(1);

yl = [yl(1)-ydiff/20 yl(2)];

ylim(yl);

set(gca,'TickDir','out');

axis square;

% ----------Display the HDI on hist plot----

hold on

plot(HDI,[0 0],'k-','LineWidth',4);

str = [num2str(100\*credMass,2) '% HDI'];

text(mean(HDI),ydiff/20+ydiff/20,str,'HorizontalAlignment','center');

str = num2str(HDI(1),4);

text(HDI(1),ydiff/20,str,'HorizontalAlignment','center');

str = num2str(HDI(2),4);

text(HDI(2),ydiff/20,str,'HorizontalAlignment','center');

%-----------------------------------------

hold on

plot ([mean1\_Oliver,mean1\_Oliver],[0,1],'r','LineWidth',2)

str = ['mean=',num2str(mean1\_Oliver)];

text(mean1\_Oliver+10,0.052,str)

% hold on

% plot ([median1\_Oliver,median1\_Oliver],[0,1],'r','LineWidth',2)

% str = ['median=',num2str(median1\_Oliver)];

% text(median1\_Oliver+10,0.045,str)

% hold off

% x=5; first attempt

h = histogram(mu\_y\_samp\_5(:,1),'Normalization','pdf');

h.NumBins = 100;

legend('Attempt=1','Attempt=5')

title("First Individual (Oliver)")

mean5\_Oliver=mean(mu\_y\_samp\_5(:,1));

median5\_Oliver=median(mu\_y\_samp\_5(:,1));

% --------- Confidence interval (HDI) --------

credMass = 0.95;

HDI = HDIofMCMC(mu\_y\_samp\_5(:,1),credMass);

hdiLow = HDI(1);

hdiHigh = HDI(2);

% Additional stuff: To make Matlab figure look more like R figure

ax = axis;

yl = ax([3 4]);

ydiff = yl(2)-yl(1);

yl = [yl(1)-ydiff/20 yl(2)];

ylim(yl);

set(gca,'TickDir','out');

axis square;

% ----------Display the HDI on hist plot----

hold on

plot(HDI,[0 0],'k-','LineWidth',4);

str = [num2str(100\*credMass,2) '% HDI'];

text(mean(HDI),ydiff/20+ydiff/20,str,'HorizontalAlignment','center');

str = num2str(HDI(1),4);

text(HDI(1),ydiff/20,str,'HorizontalAlignment','center');

str = num2str(HDI(2),4);

text(HDI(2),ydiff/20,str,'HorizontalAlignment','center');

%-----------------------------------------

hold on

plot ([mean5\_Oliver,mean5\_Oliver],[0,1],'r','LineWidth',2)

str = ['mean=',num2str(mean5\_Oliver)];

text(mean5\_Oliver+10,0.052,str)

hold off

% ---------------------Third individual (Jesper) ---------------------

figure(2)

% x=1; first attempt

h = histogram(mu\_y\_samp\_1(:,3),'Normalization','pdf');

h.NumBins = 100;

hold on

mean1\_Jesper=mean(mu\_y\_samp\_1(:,3));

median1\_Jesper=median(mu\_y\_samp\_1(:,3));

% --------- Confidence interval (HDI) --------

credMass = 0.95;

HDI = HDIofMCMC(mu\_y\_samp\_1(:,3),credMass);

hdiLow = HDI(1);

hdiHigh = HDI(2);

% Additional stuff: To make Matlab figure look more like R figure

ax = axis;

yl = ax([3 4]);

ydiff = yl(2)-yl(1);

yl = [yl(1)-ydiff/20 yl(2)];

ylim(yl);

set(gca,'TickDir','out');

axis square;

% ----------Display the HDI on hist plot----

hold on

plot(HDI,[0 0],'k-','LineWidth',4);

str = [num2str(100\*credMass,2) '% HDI'];

text(mean(HDI),ydiff/20+ydiff/20,str,'HorizontalAlignment','center');

str = num2str(HDI(1),4);

text(HDI(1),ydiff/20,str,'HorizontalAlignment','center');

str = num2str(HDI(2),4);

text(HDI(2),ydiff/20,str,'HorizontalAlignment','center');

%-----------------------------------------

hold on

plot ([mean1\_Jesper,mean1\_Jesper],[0,1],'r','LineWidth',2)

str = ['mean=',num2str(mean1\_Jesper)];

text(mean1\_Jesper+10,0.052,str)

% x=5; first attempt

h = histogram(mu\_y\_samp\_5(:,3),'Normalization','pdf');

h.NumBins = 100;

legend('Attempt=1','Attempt=5')

title("Third individual (Jesper)")

mean5\_Jesper=mean(mu\_y\_samp\_5(:,3));

median5\_Jesper=median(mu\_y\_samp\_5(:,3));

% --------- Confidence interval (HDI) --------

credMass = 0.95;

HDI = HDIofMCMC(mu\_y\_samp\_5(:,3),credMass);

hdiLow = HDI(1);

hdiHigh = HDI(2);

% Additional stuff: To make Matlab figure look more like R figure

ax = axis;

yl = ax([3 4]);

ydiff = yl(2)-yl(1);

yl = [yl(1)-ydiff/20 yl(2)];

ylim(yl);

set(gca,'TickDir','out');

axis square;

% ----------Display the HDI on hist plot----

hold on

plot(HDI,[0 0],'k-','LineWidth',4);

str = [num2str(100\*credMass,2) '% HDI'];

text(mean(HDI),ydiff/20+ydiff/20,str,'HorizontalAlignment','center');

str = num2str(HDI(1),4);

text(HDI(1),ydiff/20,str,'HorizontalAlignment','center');

str = num2str(HDI(2),4);

text(HDI(2),ydiff/20,str,'HorizontalAlignment','center');

%-----------------------------------------

hold on

plot ([mean5\_Jesper,mean5\_Jesper],[0,1],'r','LineWidth',2)

str = ['mean=',num2str(mean5\_Jesper)];

text(mean5\_Jesper+10,0.052,str)

% ---------------------Fifth individual (dude) ---------------------

figure(3)

% x=1; first attempt

h = histogram(mu\_y\_samp\_1(:,5),'Normalization','pdf');

h.NumBins = 100;

hold on

mean1\_dude=mean(mu\_y\_samp\_1(:,5));

median1\_dude=median(mu\_y\_samp\_1(:,5));

% --------- Confidence interval (HDI) --------

credMass = 0.95;

HDI = HDIofMCMC(mu\_y\_samp\_1(:,5),credMass);

hdiLow = HDI(1);

hdiHigh = HDI(2);

% Additional stuff: To make Matlab figure look more like R figure

ax = axis;

yl = ax([3 4]);

ydiff = yl(2)-yl(1);

yl = [yl(1)-ydiff/20 yl(2)];

ylim(yl);

set(gca,'TickDir','out');

axis square;

% ----------Display the HDI on hist plot----

hold on

plot(HDI,[0 0],'k-','LineWidth',4);

str = [num2str(100\*credMass,2) '% HDI'];

text(mean(HDI),ydiff/20+ydiff/20,str,'HorizontalAlignment','center');

str = num2str(HDI(1),4);

text(HDI(1),ydiff/20,str,'HorizontalAlignment','center');

str = num2str(HDI(2),4);

text(HDI(2),ydiff/20,str,'HorizontalAlignment','center');

%-----------------------------------------

hold on

plot ([mean1\_dude,mean1\_dude],[0,1],'r','LineWidth',2)

str = ['mean=',num2str(mean1\_dude)];

text(mean1\_dude+10,0.052,str)

% x=5; first attempt

h = histogram(mu\_y\_samp\_5(:,5),'Normalization','pdf');

h.NumBins = 100;

legend('Attempt=1','Attempt=5')

title("Fifth individual (dude)")

mean5\_dude=mean(mu\_y\_samp\_5(:,5));

median5\_dude=median(mu\_y\_samp\_5(:,5));

% --------- Confidence interval (HDI) --------

credMass = 0.95;

HDI = HDIofMCMC(mu\_y\_samp\_5(:,5),credMass);

hdiLow = HDI(1);

hdiHigh = HDI(2);

% Additional stuff: To make Matlab figure look more like R figure

ax = axis;

yl = ax([3 4]);

ydiff = yl(2)-yl(1);

yl = [yl(1)-ydiff/20 yl(2)];

ylim(yl);

set(gca,'TickDir','out');

axis square;

% ----------Display the HDI on hist plot----

hold on

plot(HDI,[0 0],'k-','LineWidth',4);

str = [num2str(100\*credMass,2) '% HDI'];

text(mean(HDI),ydiff/20+ydiff/20,str,'HorizontalAlignment','center');

str = num2str(HDI(1),4);

text(HDI(1),ydiff/20,str,'HorizontalAlignment','center');

str = num2str(HDI(2),4);

text(HDI(2),ydiff/20,str,'HorizontalAlignment','center');

%-----------------------------------------

hold on

plot ([mean5\_dude,mean5\_dude],[0,1],'r','LineWidth',2)

str = ['mean=',num2str(mean5\_dude)];

text(mean5\_dude+10,0.052,str)

%-----------------------------------------

function logposterior = logpost(x,zlogy,ind,child,attempt)

sigma=x(end);

tau0=x(end-1);

mu0=x(end-2);

phi0=x(end-3);

tau1=x(end-4);

mu1=x(end-5);

phi1=x(end-6);

k=length(x(1:end-7))/2;

theta0=x(1:k);

theta1=x(k+1:end-7);

theta0=theta0(:);

theta1=theta1(:);

child=child(:);

attempt=attempt(:);

logprior\_theta=@(theta,mu,tau,phi,child) sum(-log(tau)-0.5\*((theta-(mu+phi.\*child))./tau).^2);

% prior sigma

logprior\_sigma=@(sigma) log(double(sigma>0));

% prior tau

logprior\_tau =@(tau) log(double(tau>0));

% prior mu

logprior\_mu = @(mu) log(1);

% prior phi

logprior\_phi = @(phi) log(1);

% prior theta

mu=theta0(ind)+attempt.\*theta1(ind);

lp=-length(zlogy)\*log(sigma)-0.5\*sum((zlogy(:)-mu).^2)/sigma^2;

temp0=logprior\_theta(theta0,mu0,tau0,phi0,child)...

+logprior\_tau(tau0)...

+logprior\_mu(mu0)...

+logprior\_phi(phi0);

temp1=logprior\_theta(theta1,mu1,tau1,phi1,child)...

+logprior\_tau(tau1)...

+logprior\_mu(mu1)...

+logprior\_phi(phi1);

if (sigma>0)&&(tau0>0)&&(tau1>0)

logposterior=lp+temp0+temp1+logprior\_sigma(sigma);

else

logposterior=-inf;

end

end

%-----------------------------------------

function HDIlim = HDIofMCMC(sampleVec,credMass)

sortedPts = sort(sampleVec);

ciIdxInc = floor(credMass\*length(sortedPts)); % number of samples included in CI

nCIs = length(sortedPts) - ciIdxInc; % number of samples NOT included

ciWidth = zeros(1,nCIs);

for ii = 1:nCIs

ciWidth(ii) = sortedPts(ii+ciIdxInc) - sortedPts(ii); % determine credible interval width

end

[~,indx] = min(ciWidth); % the HDI = shortest credible interval

HDImin = sortedPts(indx);

HDImax = sortedPts(indx+ciIdxInc);

HDIlim = [HDImin , HDImax];

end