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1 a

```
clc
clear
clear all
% givve mean and covarianc
mu_x=[10;0];
Sigma_x = [0.2 0;0 8];
% sensor which can sum  and diff the position
A=[1 1;1 -1];
b=zeros(size(A,1),1);
% Transformation function
f= @(x)[A*x+b];

figure(1);
hold on
grid on
axis equal

% mean, covariance and transformed samples of approxGaussianTransform
[mu_y,Sigma_y,y_s]= approxGaussianTransform(mu_x,Sigma_x,f);
% plot of Transformed samples
scatter(y_s(1,:),y_s(2,:));

%plot of 3sigma and mean
xy=sigmaEllipse2D(mu_y,Sigma_y);
h2=plot(xy(1,:),xy(2,:),'color','#D95319','LineWidth',2);
h2m=plot(mu_y(1), mu_y(2),'*','color',h2.Color,'LineWidth',1);

% mean, covariance and transformed samples of affineGaussianTransform
[mu_y,Sigma_y]= affineGaussianTransform(mu_x,Sigma_x,A,b);

%plot of 3sigma and mean
xy=sigmaEllipse2D(mu_y,Sigma_y);
h3=plot(xy(1,:),xy(2,:),'color','#A2142F','LineWidth',2);
h2m=plot(mu_y(1), mu_y(2),'*','color',h3.Color,'LineWidth',1);

title({'Transformed samples and','3\sigma-ellipses of Gaussian
 Transforms'},'FontSize',14);
xlabel('x-position[m]','FontSize',14);
ylabel('y-position[m]','FontSize',14);
legend('Transformed Samples','approxGT','approxGT
 mean','affineGT','affineGT mean','FontSize',10);
```

1 b

```
clc
clear
clear all
% givve mean and covarianc
mu_x=[10;0];
Sigma_x = [0.2 0;0 8];
% sensor which can sum  and diff the position
A=[1 1;1 -1];
b=zeros(size(A,1),1);

% Transformation function
f= @(x)[sqrt((x(1,:).^2)+(x(2,:).^2));atan2(x(2,:),x(1,:))];

figure(2);
hold on
grid on
axis equal

% mean, covariance and transformed samples of approxGaussianTransform
[mu_y,Sigma_y,y_s]= approxGaussianTransform(mu_x,Sigma_x,f);
% plot of Transformed samples
scatter(y_s(1,:),y_s(2,:));

% mean, covariance and transformed samples of approxGaussianTransform
xy=sigmaEllipse2D(mu_y,Sigma_y);
h2=plot(xy(1,:),xy(2,:),'color','#D95319','LineWidth',2);
h2m=plot(mu_y(1), mu_y(2),'*','color',h2.Color,'LineWidth',1);


title({'Transformed samples and','3\sigma-ellipses of Gaussian
 Transforms'},'FontSize',14);
xlabel('x-position[m]','FontSize',14);
ylabel('y-position[m]','FontSize',14);
legend('Transformed Samples','approxGT','approxGT
 mean','FontSize',14);
```

2

```
%a

%Given parameters
mu_x_H = 1.1; mu_x_K = 1;
sigma2_x = 0.5^2;
y_H = 1; y_K = 2;
sigma2_r_H = 0.2^2; sigma2_r_K = 1;

% jointGaussian
[mu_H_joint, Sigma_H_joint] = jointGaussian(mu_x_H, sigma2_x,
 sigma2_r_H); %Hafjell
```

```
[mu_K_joint, Sigma_K_joint] = jointGaussian(mu_x_K, sigma2_x,
 sigma2_r_K); %Kvitfjell

% visualize and plots for Hafjell
xy_H = sigmaEllipse2D( mu_H_joint, Sigma_H_joint, level, npoints );

figure(); hold on; axis equal;
plot(mu_H_joint(1), mu_H_joint(2), '*');
plot(xy_H(1,:),xy_H(2,:),'LineWidth',1);
title("JointDistributionH"); xlabel('x'); ylabel('y');
 legend('mean','ellipse_H');

% visualize and plots for Kvitfjell
xy_K = sigmaEllipse2D( mu_K_joint, Sigma_K_joint, level, npoints );

figure(); hold on; axis equal;
plot(mu_K_joint(1), mu_K_joint(2), '*');
plot(xy_K(1,:),xy_K(2,:),'LineWidth',1);
title("JointDistributionK"); xlabel('x'); ylabel('y');
 legend('mean','ellipse_K');

%slope random picked x = 2,2.5
result = find(xy_K(1,:)==2);
idx = xy_K(1,:)==5;

%b

% posteriorGaussian
[mu_H_post, Sigma_H_post] = posteriorGaussian(mu_x_H, sigma2_x, y_H,
 sigma2_r_H);
[mu_K_post, Sigma_K_post] = posteriorGaussian(mu_x_K, sigma2_x, y_K,
 sigma2_r_K);

% plots for Hafjell
% https://in.mathworks.com/matlabcentral/answers/49898-probability-
density-function-plot
x = mu_H_post-(4*sqrt(Sigma_H_post)):0.01:mu_H_post
+(4*sqrt(Sigma_H_post));
y = normpdf(x,mu_H_post,sqrt(Sigma_H_post));
figure(); plot(x,y); title("PosteriorDistributionH"); xlabel('x');
 ylabel('p(x|y)');

% plots for Kvitfjell
x = mu_K_post-(4*sqrt(Sigma_K_post)):0.01:mu_K_post
+(4*sqrt(Sigma_K_post));
y = normpdf(x,mu_K_post,sqrt(Sigma_K_post));
figure(); plot(x,y); title("PosteriorDistributionK"); xlabel('x');
 ylabel('p(x|y)');
```

3

```
%a
```

```
%Given parameters
w = [0.1 0.9]'; mu = [1 1]'; sigma2 = [0.5 9];
x = linspace(-10, 10, 100);
y = (0.1 * normpdf(x, 1, sqrt(0.5))) + (0.9 * normpdf(x, 1, sqrt(9)));
[max1, max_pos] = max(y);
MAP  = x(max_pos);
MMSEEst = gaussMixMMSEEst( w, mu, sigma2 );
[min1, min_pos] = min(abs(x-MMSEEst));
MMSE = y(min_pos);

% plots
figure(); hold on; axis square;
plot(x,y);
plot(MMSEEst,MMSE,'o');
plot(MAP,max1,'*');
line([MMSEEst MMSEEst],[0 0.2],'LineStyle','--');
title("PosteriorDistribution"); xlabel('x'); ylabel('p(x|y)');
 legend('p(x|y)','MMSEEst','MAPEst');

%b

%Given parameters
w = [0.49 0.51]'; mu = [5 -5]'; sigma2 = [2 2];

x = linspace(-10, 10, 100);
y = (0.49*normpdf(x, 5, sqrt(2))) + (0.51*normpdf(x, -5, sqrt(2)));

[max1, max_pos] = max(y);
MAP  = x(max_pos);
MMSEEst = gaussMixMMSEEst( w, mu, sigma2 );
[min1, min_pos] = min(abs(x-MMSEEst));
MMSE = y(min_pos);

% plots
figure(); hold on; axis square;
plot(x,y);
plot(MMSEEst,MMSE,'o');
plot(MAP,max1,'*');
line([MMSEEst MMSEEst],[0 0.2],'LineStyle','--');
title("PosteriorDistribution"); xlabel('x'); ylabel('p(x|y)');
 legend('p(x|y)','MMSEEst','MAPEst');

%c

%Given parameters
w = [0.4 0.6]'; mu = [1 2]'; sigma2 = [2 1];

x = linspace(-10, 10, 100);
y = (0.4*normpdf(x, 1, 2)) + (0.6*normpdf(x, 2, 1));

[max1, max_pos] = max(y);
MAP  = x(max_pos);
MMSEEst = gaussMixMMSEEst( w, mu, sigma2 );
[min1, min_pos] = min(abs(x-MMSEEst));
```

```
MMSE = y(min_pos);

% plots
figure(); hold on; axis square;
plot(x,y);
plot(MMSEEst,MMSE,'o');
plot(MAP,max1,'*');
line([MMSEEst MMSEEst],[0 0.35],'LineStyle','--');
title("PosteriorDistribution"); xlabel('x'); ylabel('p(x|y)');
 legend('p(x|y)','MMSEEst','MAPEst');

options = struct('format', 'pdf', 'evalCode',false);
publish('affineGaussianTransform.m', options);
publish('approxGaussianTransform.m', options);
publish('gaussMixMMSEEst.m', options);
publish('jointGaussian.m', options);
publish('posteriorGaussian.m', options);
publish('sigmaEllipse2D.m', options);
```

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