Numerical Analysis

Matlab

Question 1

Suppose Z ~ N(u, C) with u = [1 2 3] and $C = \begin{bmatrix} 3 & -1 & 1 \\ -1 & 2 & 0 \\ 1 & 0 & 3 \end{bmatrix}$

Generate M = 10, 000 independent realized Gaussian 3-element vector X drawn from a N(0, I) distribution, where I is a 3x3 identity matrix. Verify that these data have approximately the desired mean and variance.
Find a 3 x 3 matrix G so that Y = GX has the distribution Y ~ N(0, C). Transform the data in part (a) to obtain M samples of Y. Verify that these data have approximately the desired mean and variance.
Transform the data in part (b) to obtain M samples of Z ~ N(u, C). Verify that these data have approximately the desired mean and variance.

```
clear all
close all
clc

u= [0;0;0];
I= eye(3);

% Computing X
for i=1:10000
x(i,:)= mvnrnd(u,I);
end

% Computing mean and Variance of X
mean_x = mean(x)
var_x  = var (x)

% The mean comes approximately 0 while variance comes out to be 1;

C= [3 -1 1; -1 2 0; 1 0 3];

x=transpose(x);

% Y ~ N(0,C);
% Y = GX;
% Y ~ N(0,G(GT));
% G(GT) = C;

G  = chol(C,'lower');

%Comuting Y
for i=1:10000
Y(:,i)  = G*x(:,i);
end
Y= transpose(Y);

% Computing Mean and Variance of Y
mean_y = mean((Y))
var_y  = var ((Y))
```

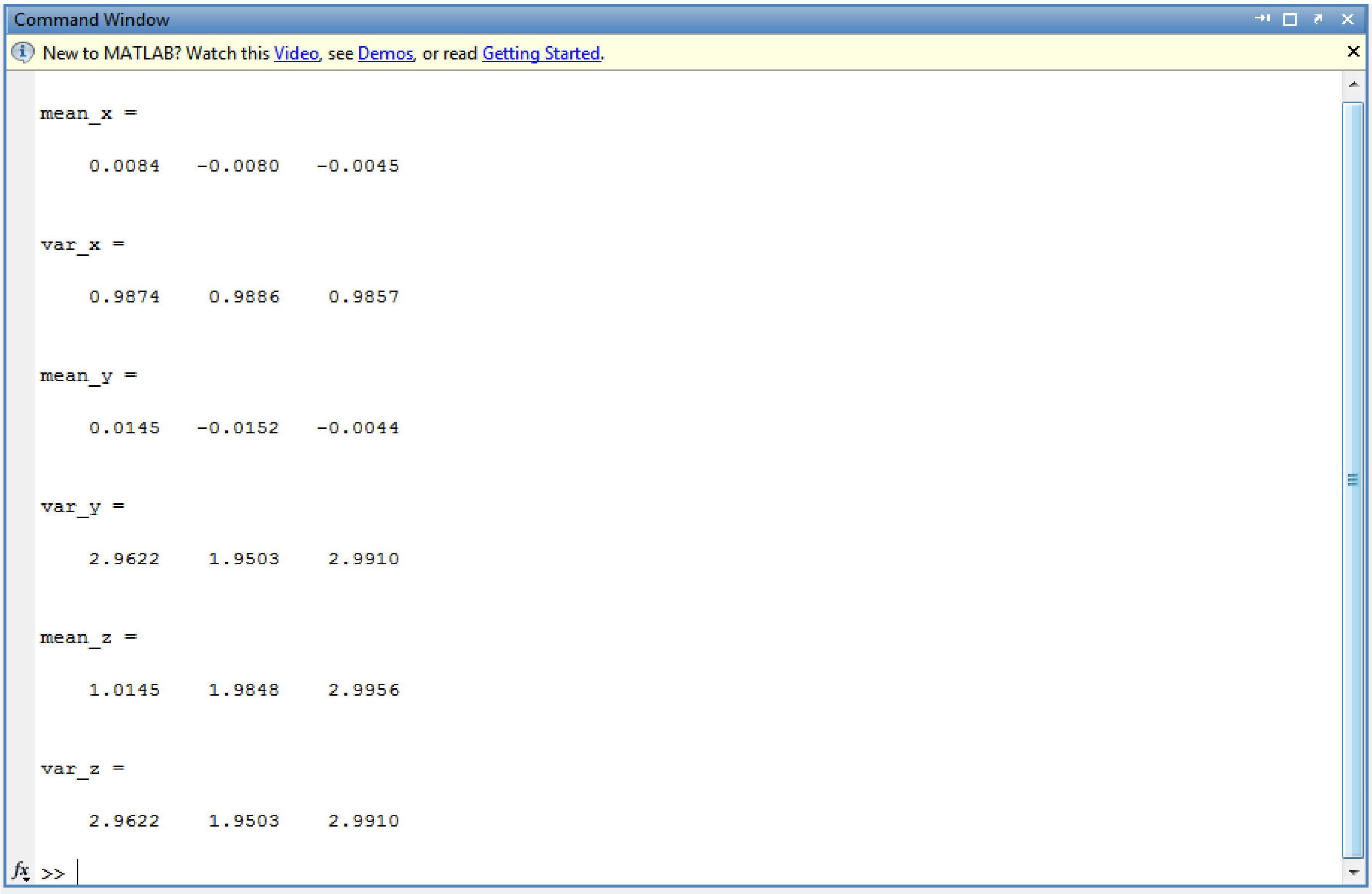
```
% The mean comes approximately 0 while variances comes out to be 3,2 and 3;

% Computing Z
U= [1 2 3];
for i=1:10000
Z(i,1)= Y(i,1)+U(1,1);
Z(i,2)= Y(i,2)+U(1,2);
Z(i,3)= Y(i,3)+U(1,3);
end

% Computing Mean and Variance of Z
mean_z = mean((Z))
var_z  = var ((Z))

% The mean comes approximately 0 while variances comes out to be 3,2 and 3;
```

Results:



Question 2

Data files hw3_x1.dat, hw3_x2.dat and hw3_x3.dat contain, respectively, 1000 independent realized samples of a random vector X = [x1 x2 x3].

a) **Find the covariance matrix C_X of X.**
b) **Find a matrix A so that Y = AX is an uncorrelated random vector, i.e., C_Y is diagonal. (Hint: use the eig command)**
c) **Apply A to the data provided to obtain samples of Y and verify the covariance matrix from these data is approximately diagonal.**

```
clear all
close all
clc

% Reading hw_x1.dat file
fid= fopen('hw3_x1.dat');
x(:,1)=fread(fid);
fclose(fid);

% Reading hw_x1.dat file
fid= fopen('hw3_x2.dat');
x(:,2)=fread(fid);
fclose(fid);

% Reading hw_x1.dat file
fid= fopen('hw3_x3.dat');
x(:,3)=fread(fid);
fclose(fid);

% Computing Eigen Values and Eigen Vector
x;
cov_x = cov(x)
x= transpose(x);
[u d] = eig(cov_x)

cov_y = d
A     = transpose(u)

% Computing Y
for i=1:1000
y(:,i)= A*x(:,i);
end

% Finding Y's Covariance
cov(transpose(y))

% The covariance of Y is approximately Diagonal
```

Results:

Command Window

New to MATLAB? Watch this Video, see Demos, or read Getting Started.

```
cov_x =

  224.6415  217.2423  217.9127
  217.2423  225.2182  217.7080
  217.9127  217.7080  224.8645


u =

    0.6042    0.5496    0.5770
    0.1742   -0.7977    0.5774
   -0.7776    0.2483    0.5776


d =

    6.7956         0         0
         0    7.7784         0
         0         0  660.1502


cov_y =

    6.7956         0         0
         0    7.7784         0
         0         0  660.1502


A =
```