ECE 3522: STOCHASTIC PROCESSES IN SIGNALS AND SYSTEMS

COMPUTER ASSIGNMENT (CA) NO. 7: VISUALIZATION

The goal of this assignment is to help you visualize what covariance means in terms of the shape of a pdf. We will rely heavily on MATLAB's 3D visualization tools. We will work exclusively with two random variables.

The tasks to be accomplished are:

1. Generate a large number of random vectors of dimension 2 consisting of two independent uniformly distributed random numbers over the range [0,1]. Estimate the pdf and plot in 3D using MATLAB's functions like surf, mesh or the equivalent. Describe the shape of this plot.
2. Generate a set of Gaussian random vectors that have a 2x2 covariance matrix, estimate the pdf, and plot in 3D. To keep things simple, use a mean of [6,6] for each example. Use the following covariance matrices:

$$Cov(X,Y) = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$Cov(X,Y) = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$Cov(X,Y) = \begin{bmatrix} 5 & 0 \\ 0 & 2 \end{bmatrix}$$

$$Cov(X,Y) = \begin{bmatrix} 1 & 0.5 \\ 0.5 & 1 \end{bmatrix}$$

$$Cov(X,Y) = \begin{bmatrix} 5 & 0.5 \\ 0.5 & 2 \end{bmatrix}$$

Your visualizations of (2) should match what you find in the associated PowerPoint file.

A pdf function of two random variables is a 3D surface where the third dimension represents the value of the pdf (the dependent variable). Correlation implies these functions are skewed. In the case of a Gaussian, the function will be circularly symmetric if the function has no correlation structure. Correlation, which shows up as the off-diagonal components of the covariance matrix, skews the shape so that its support region (found by intersecting the 3D shape with a plane) is an ellipse.