CAIRO UNIVERSITY **DEPT COMPUTER ENG**
FACULTY OF ENGINEERING **Excercize No. 4**
Pattern Classification

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1) Consider the covariance matrix

$$\Sigma = \begin{pmatrix} 2 & 1 \\ 1 & 3 \end{pmatrix}$$

Find the principal components and the eigenvalues. How will we transform and obtain the best feature using the first principal component?

2) Consider a covariance matrix, whose principal component vectors are

$$u(1) = \begin{pmatrix} 1/\sqrt{2} \\ 1/\sqrt{2} \\ 0 \end{pmatrix}$$

$$u(2) = \begin{pmatrix} 1/\sqrt{2} \\ -1/\sqrt{2} \\ 0 \end{pmatrix}$$

$$u(3) = \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}$$

Moreover, let the eigenvalues be respectively

$$\lambda(1) = 2, \qquad \lambda(1) = 0.5, \qquad \lambda(1) = 0.2$$

Find the covariance matrix.

3) Consider a neural network as shown in the figure next page,

where $w_1,\ w_2,\ w_3,\ w_4,\ w_5$ are the weights (there are no biases of added constants $w_{0i} = 0$). Let the input training data be $x_1(m),\ x_2(m),\ m = 1, \ldots, M$, and the target outputs be $d(m),\ \ m = 1, \ldots, M$. Define the error function as: $E_m = (y(m) - d(m))^2$ where $y(m)$ is the network output for pattern m. All neuron functions are the logistic function.

Find the gradient w.r.t. the weights: $\frac{\partial E_m}{\partial w_i}$