Pattern Recognition Exercises
Sheet 4 "Feature Transformation and Extraction"

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File Name:	PR-ES4-Surname.pdf
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1 The Karhunen-Loeve Transform (8 Points)

The correlation matrix of a vector $\boldsymbol{x}$ is given by

$$\boldsymbol{R_x} = \begin{bmatrix} 3 & 1 & 1 \\ 1 & 3 & -1 \\ 1 & -1 & 3 \end{bmatrix}$$

Compute the KL transform of an input vector $\boldsymbol{x} = [x_1, x_2, x_3]^{\mathrm{T}}$. Explain the relevance of the KL transform (Principal Component Analysis) to feature dimensionality reduction in pattern recognition.

2 The Singular Vector Decomposition (8P)

Compute the SVD representation of

$$\boldsymbol{X} = \begin{bmatrix} 1 & 0 \\ 1 & 2 \\ 0 & 1 \end{bmatrix} \quad .$$

Explain its relevance for feature generation.

3 First-Order Statistics Features (7P)

Consider the following binary image array:

$$\boldsymbol{I} = \begin{bmatrix} 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 1 & 0 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 \end{bmatrix}$$

Compute the first and second moments (m_1, m_2) and central moments (μ_1, μ_2) for this image.