Exercise 1 - Eigenvalues and Eigenvectors

You are given the following set of eigevalues and eigenvectors. Compute the corresponding matrix.

$\lambda_1 = 1$, $\lambda_2 = 2$, $\mathbf{v}_1 = (\sqrt{0.5}, \sqrt{0.5})^\top$, $\mathbf{v}_2 = (\sqrt{0.5}, -\sqrt{0.5})^\top$.

Exercise 2 - Parameter Counting

Use PyTorch to load the `alexnet` model and automatically compute its number of parameters. Output the number of parameters for each layer and the total number of parameters in the model.

Exercise 3 - Convolutional Layers

Consider the following $4 \times 4 \times 1$ input X and a $2 \times 2 \times 1$ convolutional kernel K with no bias term

$$X = \begin{pmatrix} 1 & 0 & 1 & -1 \\ 1 & 0 & 1 & 0 \\ 0 & 3 & 0 & 1 \\ 1 & -1 & 0 & 1 \end{pmatrix}, \qquad K = \begin{pmatrix} 1, & 2 \\ 0, & 1 \end{pmatrix}$$

(a) What is the output of the convolutional layer for the case of stride 1 and no padding?

(b) What if we have stride 2 and no padding?

(c) What if we have stride 2 and zero-padding of size 1?

Exercise 4 - Scaled Dot-Product Attention

Consider the matrices Q, K, V given by

$$Q = \begin{pmatrix} 1 & 3 \\ 0 & 1 \end{pmatrix}, \quad K = \begin{pmatrix} 1 & 1 \\ 1 & 2 \\ 0 & 1 \end{pmatrix}, \quad V = \begin{pmatrix} 1 & 0 & -2 \\ 2 & 1 & 2 \\ 0 & 3 & -1 \end{pmatrix}.$$

Compute the context matrix C using the scaled dot product attention.