

### Exercise 1 - Co-occurrence Matrix

Write a co-occurrence matrix for the following sentence:

“A bird in the hand is worth two in the bush.”

Count each word only if it appears directly after the reference word. Is the co-occurrence matrix unique?

### Exercise 2 - 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

$$X = \begin{pmatrix} 1 & 0 & -2 & 1 \\ 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 1 \\ -3 & 4 & 0 & 0 \end{pmatrix}, \quad K = \begin{pmatrix} 2 & 1 \\ 0 & 1 \end{pmatrix}$$

- (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 3 - Sizes in MLPs Refresher

You are given an MLP with ReLU activations. It has 3 layers consisting of 5, 10, and 5 neurons respectively. The input is a vector of size 10. How many parameters does this network have?

### Exercise 4 - Sizes in CNNs

You are given a neural network with the following architecture:

Input: 100 x 100 x 3 Image

Layers:

1. Conv(in\_channels=3, out\_channels=5, kernel\_size=3, stride=1, padding=0)
2. MaxPool2d(kernel\_size=2, stride=2, padding=0)
3. Conv(in\_channels=5, out\_channels=10, kernel\_size=3, stride=1, padding=0)
4. MaxPool2d(kernel\_size=2, stride=2, padding=0)
5. Conv(in\_channels=10, out\_channels=5, kernel\_size=3, stride=1, padding=0)
6. Flatten()
7. MLP(neurons=20)
8. MLP(neurons=10)

- (a) What is the dimensionality of the activations after each layer.
- (b) How many parameters does this network have?