

The exercises this week involve some old material so you can check your learning and understanding.

### Exercise 1 - Maximum Likelihood Estimator

Assume you are given datapoints  $(x_i)_{i=1}^N$  with  $x_i \in \mathbb{R}$  coming from a Exponential distribution. The probability density function of a exponential distribution is given by  $f(x) = \lambda \exp(-\lambda x)$  with  $x \in \mathbb{R}$ . Derive the maximum likelihood estimator of the parameter  $\lambda$ .

### 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

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

- (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 - Computational Parameter Counting

Use PyTorch to load the `vgg11` 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 4 - Influence Functions

Let  $\hat{\theta}$  and  $\hat{\theta}(\epsilon)$  be as defined in class. Show that the first order Taylor expansion of  $\hat{\theta}(\epsilon)$  around  $\epsilon = 0$  is given by the equation given in class, i.e. by

$$\hat{\theta}(\epsilon) \approx \hat{\theta} + \epsilon \left. \frac{d\hat{\theta}(\epsilon)}{d\epsilon} \right|_{\epsilon=0}.$$