Universität des Saarlandes
Prof. Dr. Dietrich Klakow
Lehrstuhl für Signalverarbeitung
NNTI Winter Term 2022/2023

# Exercise Sheet 9

NNTI Tutorial

**Deadline: 18.01.2023 08:00**

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**Exercise 9.1 - Convulational Networks** (2 + 3 + 1 points)

The aim of this exercise is to build upon the theory presented during the lecture. Please limit your answers to 100 words for each question. Feel free to use any additional reading material for the same, but always remember to **cite your sources**.

a) **Architecture of CNN**

I. Briefly describe the CNN architecture and why is this important for image recognition tasks?

II. Can a CNN be used for tasks other than image recognition, such as natural language processing? Justify your answer from a neural-network architecture point of view.

b) **Some Mathematics behind CNN**

I. Write down the equation of how convolution of a given image is computed. Assume the input is an image $I$ of size $H * W$ with $C$ channels. the kernel $K$ has size $N * M$ and the stride is $T * S$, the operation performed is in fact cross-correlation (as usual in convolutional neural networks) and that $O$ output channels are computed.

II. Consider a convolutional layer with 10 filters of size (5×5) with, stride =1 and padding = 2. If the input is an image of size $32 \times 32 \times 3$, what will be the output dimensions?

III. Calculate the number of parameters in the above layer and compare it to the number of parameters a fully connected layer of the same size.

c) **Receptive Field** The effective receptive field $R_k$, defined as the size of the region in the input that produces a feature in the feature map $f_k$, is:

$$R_k = R_{k-1} + (K-1)\prod_{i=1}^{k-1} S_i$$

where $k$ is the depth of layer, $K$ is kernel size and $S$ is the stride.

I. Calculate the receptive field at each layer where $K = 5, S = 1$

II. How does pooling affect the effective receptive field?

**Exercise 9.2 - Coding Exercise** (4 points)

please see the attached *ipynb* notebook

# Submission instructions

The following instructions are mandatory. If you are not following them, tutors can decide to not correct your exercise.

- Please submit the assignment as a **team of two to three** students.
- Write the Microsoft Teams user name, student id and the name of each member of your team on your submission.
- Hand in zip file containing a `single` PDF with your solutions and the completed ipython notebook. Do not include any data or cache files (e.g. __pycache__).
- Important: please name the submitted zip folder and files inside using the format: **Name1_id1_Name2_id2**.
- Your assignment solution must be uploaded by only **one** of your team members to the 'Assignments' tab of the tutorial team (in **Microsoft Teams**). Please remember to press the **Hand In** button after uploading your work.
- If you have any trouble with the submission, contact your tutor **before** the deadline.