Regulations

We ask you to include your solutions (the code with every file needed) in a **zip folder** and upload it on Moodle. Include the names of all members (not more than 3) on top of your jupyter notebook as a markdown cell. **The submission deadline** is 22 of November **before** the beginning of the class on **Wednesday at 09:14**. For clarification on the code, please try to include comments in order for it to be understandable.

1 Implementing Approximate CNN

Preparation:
The second homework will build upon the CNN that has been introduced in the exercise group. Take a look at that and make sure you understand what has been done. We will give you a small overview of the content of the exercise group, you can however take a look at it yourself.

A CNN is a neural network architecture designed for visual data processing, excelling in tasks like image recognition, object detection, and classification.

- **Convolutional Layers:** Extract spatial features through convolution operations, capturing local patterns.
- **Pooling Layers:** Downsample data, reducing computation and preserving important features.
- **Activation Functions:** Introduce non-linearity (e.g., ReLU) for richer feature representation.
- **Fully Connected Layers:** Connect neurons across layers for complex relationships and high-level understanding.

Convolution Operation

In the convolutional layer, a small filter (kernel) slides over the input data, performing element-wise multiplications and aggregating results. This operation captures local features, allowing the network to automatically learn hierarchical representations.

1.1 Subtask 1: Implement an Approximate Version of the CNN from the Exercise Group

The code given in the exercise group already has the `t=1` in the definition of the functions present. That parameter should be used to vary the Multiplier (or look-up table). Depending on the parameter `t`, you should use a more course Multiplier, meaning that we approximate more. The accurate Multiplier is done as last time while the approximate Multipliers are given in the resource folder on Moodle. If you are unsure how to feel about the approximate Multipliers just check the `Approximate Multipliers.pdf` on Moodle.

```
Multiplier=np.zeros([256,256])
for i in range(-128,128):
    for j in range(-128,128):
        Multiplier[i+128,j+128]=i*j

Multiplier_Approx0=Multiplier
Multiplier_Approx1=np.load("Approximate Mult1.npy")
...
```

1.2 Subtask 2: Plot the Errors

Just like in the exercise group, plot the error of the CNN against different approximate Multipliers.

1.3 Subtask 3: F1 Score for the Number ’7’

Calculate the F1 score for the number ’7’ for different approximate Multipliers.

1.4 Subtask 4: Go take a Walk...

... or enjoy the evening with your friends. Seriously, winter is depressing as it is.