

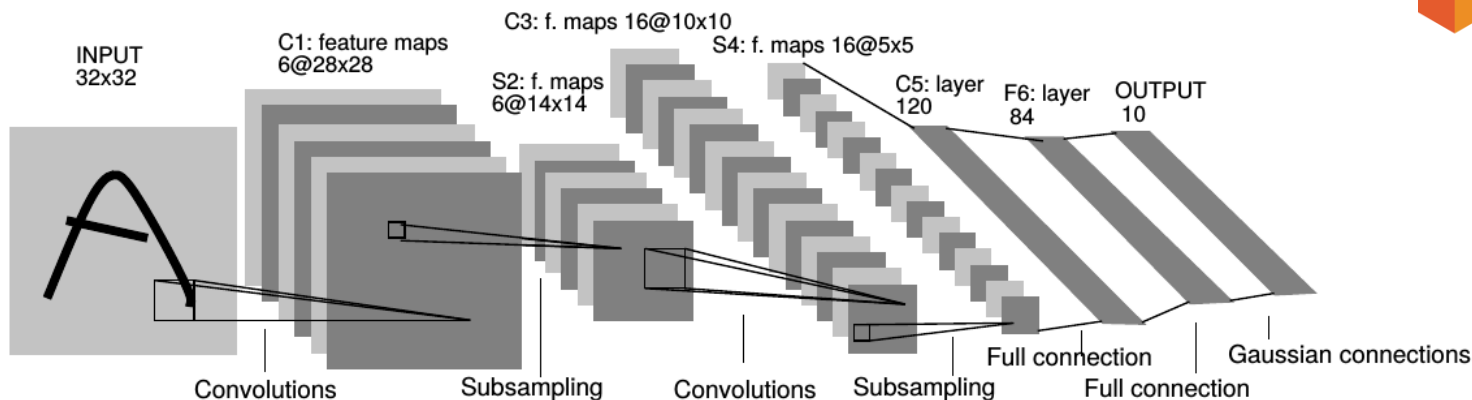
# **Data Science**

# **Survival Skills**

Homework 8

# Homework 8: Machine Learning/AI II

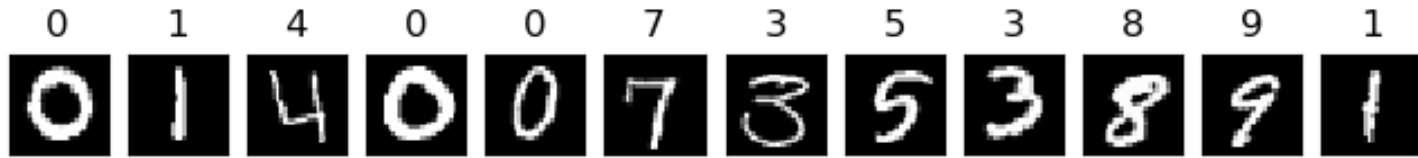
In this week's lecture, we covered the topic Deep Learning. In this homework, you will build a Convolutional Neural Network using TensorFlow.



**Fig. 2.** Architecture of LeNet-5, a convolutional NN, here used for digits recognition. Each plane is a feature map, i.e., a set of units whose weights are constrained to be identical.

# Homework 8: Useful information

- Video: [Why TensorFlow?](#)
- **Keras** is an API for defining a model by layers.  
More info: [tf.keras](#), [Model building with keras](#)
- **MNIST** is a size-normalized database of handwritten digits used very often as example in Machine Learning and Deep Learning



# Homework 8: Tasks 1/4

- Load the MNIST dataset (train and test set) using your Python script or Jupyter notebook. Load it directly from Keras: <https://keras.io/api/datasets/mnist/>
  - Plot a **random** sample and display its **label** in the title.  
Remember to set a suitable colormap!
  - Name five examples of activation functions.
- **Slide:** Screenshot of the random sample
- **Slide:** List of five activation functions

# Homework 8: Tasks 2/4

- Build the following CNN using **tf.keras.Sequential()**

Hint: You can display it using `model.summary()`

Table 1: Each row describes a stage  $i$  with  $\hat{L}_i$  layers, with input resolution  $\langle \hat{H}_i, \hat{W}_i \rangle$  and output channels  $\hat{C}_i$

Stage $i$	Operators $\hat{\mathcal{F}}_i$	Resolution $\hat{H}_i \times \hat{W}_i$	#Channels $\hat{C}_i$	#Layers $\hat{L}_i$
1	Conv3x3 & Relu & Max Pooling	$28 \times 28$	8	3
2	Conv3x3 & Relu & Max Pooling	$14 \times 14$	16	3
3	Conv3x3 & Relu	$7 \times 7$	32	2
4	Flatten	$7 \times 7$	1568	1
5	Dense & Relu & Dropout(0.2)	$1 \times 1568$	128	3
6	Dense & Softmax	$1 \times 128$	10	2

→ **Slide:** Screenshot of your code snippet where you built the model

# Homework 8: Tasks 3/4

- Compile the model using the following parameters:

```
"adam", "sparse_categorical_crossentropy", metrics=['acc']
```

- Answer these questions:

a) What is *adam*?

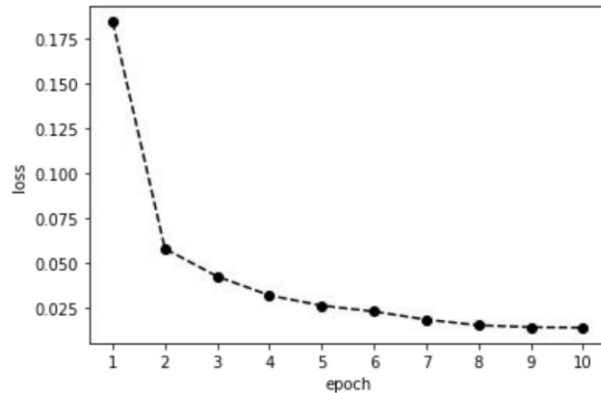
b) What does *sparse\_categorical\_crossentropy* mean?

- Train (fit) the model for 10 epochs. What does „epoch“ mean?

→ **Slide:** Your answers to the above questions

# Homework 8: Tasks 4/4

- Evaluate the performance of your fancy CNN!



- **Slide:** Your plot showing the training loss over the epochs
- **Slide:** The test accuracy your CNN achieves

# Homework 8: Example

Your `tf.keras.Sequential([...])` code

...

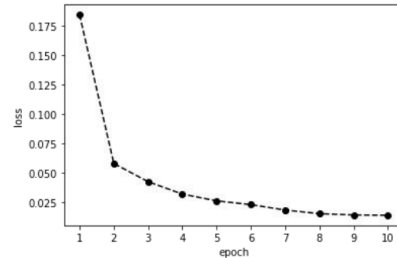
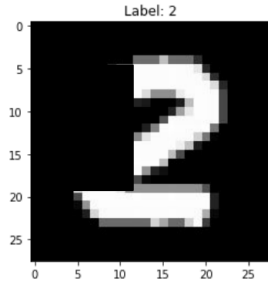
...

Answers to all questions

...

...

...



Report here the final test  
accuracy: 99%



# Homework: Requirements

You must complete **all** homework assignments (**unless otherwise specified**) following these guidelines:

- **One** slide/page.
- **PDF** file format only.
- It has to contain your **name** and **student (matriculation) number** and **IdM** in the down-left corner.
- Font: **Arial**, Font-size: **> 10 Pt.**
- Answer **all** the questions and solve all the tasks requested.
- Be careful with **plagiarism**. Repeated solutions will not be accepted!

**And we are done!**

**Thank you**