Object Recognition

Computer Vision – Exercise 4

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Tasks

- Task 1: Bag of Visual Words (60 pts)
- Task 2: (VGG style) CNN-based image classification (40 pts)

Task 1: Bag of Visual Words

Positive (1)

Negative (0)

Images

Feature extraction

Codebook construction

Codebook / dictionary: visual words

Bag-of-words vector encoding

Train image classifier

Image classification

Binary label: 0/1 ?

Step 1: Dictionary learning

Step 2: Bag-of-words vector encoding

Step 3: Image classification

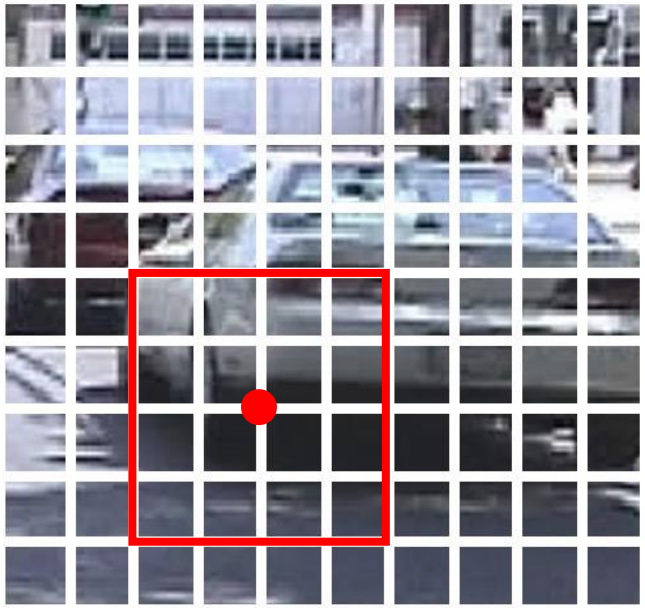
Dataset

- **Training set:**
- 50 images – with car, back view
- 50 images – without car

- **Testing set:**
- 49 images – with car, back view
- 50 images – without car

Local Feature Extraction

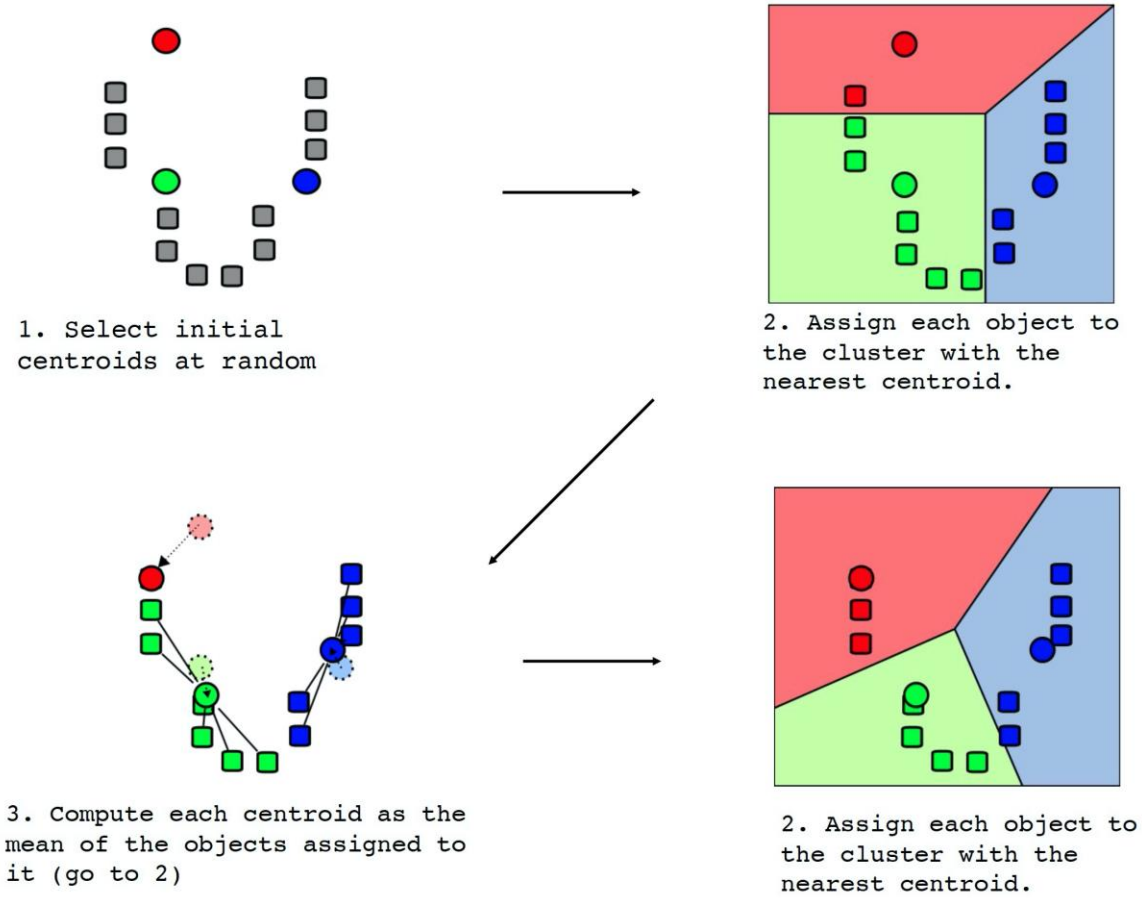
- Feature detector:
  - points on a grid
  - dense sampling
  - sample 100 grid points (10x10)



- Feature descriptor:
  - histogram of oriented gradients (HOG) descriptor
  - Defined over 4x4 cells around each grid point
  - Each cell: an 8-bin histogram of gradient orientations
  - → a 128-d feature descriptor for each grid point

Codebook Construction

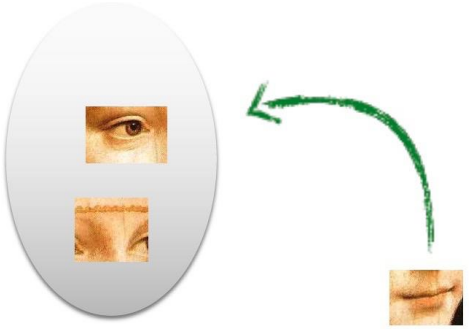
- Codebook/dictionary construction:
  - Clustering by **K-Means**
  - Repeat for a number of iterations
  - Cluster center: '**visual words**'
  - Ideally: an object part = 1 visual word
  - Question: what is the suitable k?



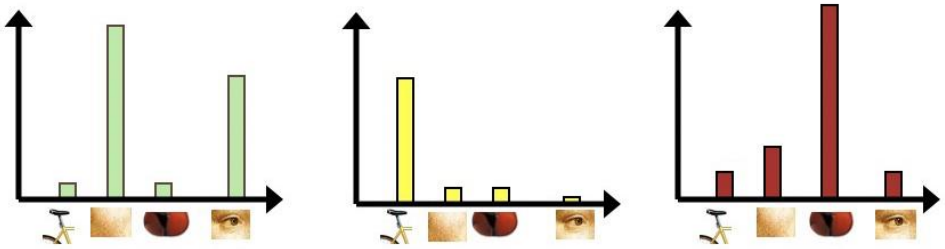
Bag-of-Words Vector Encoding

Histograms of visual words:

1) Each image feature assigned to a visual word



2) For count # of visual word occurrences

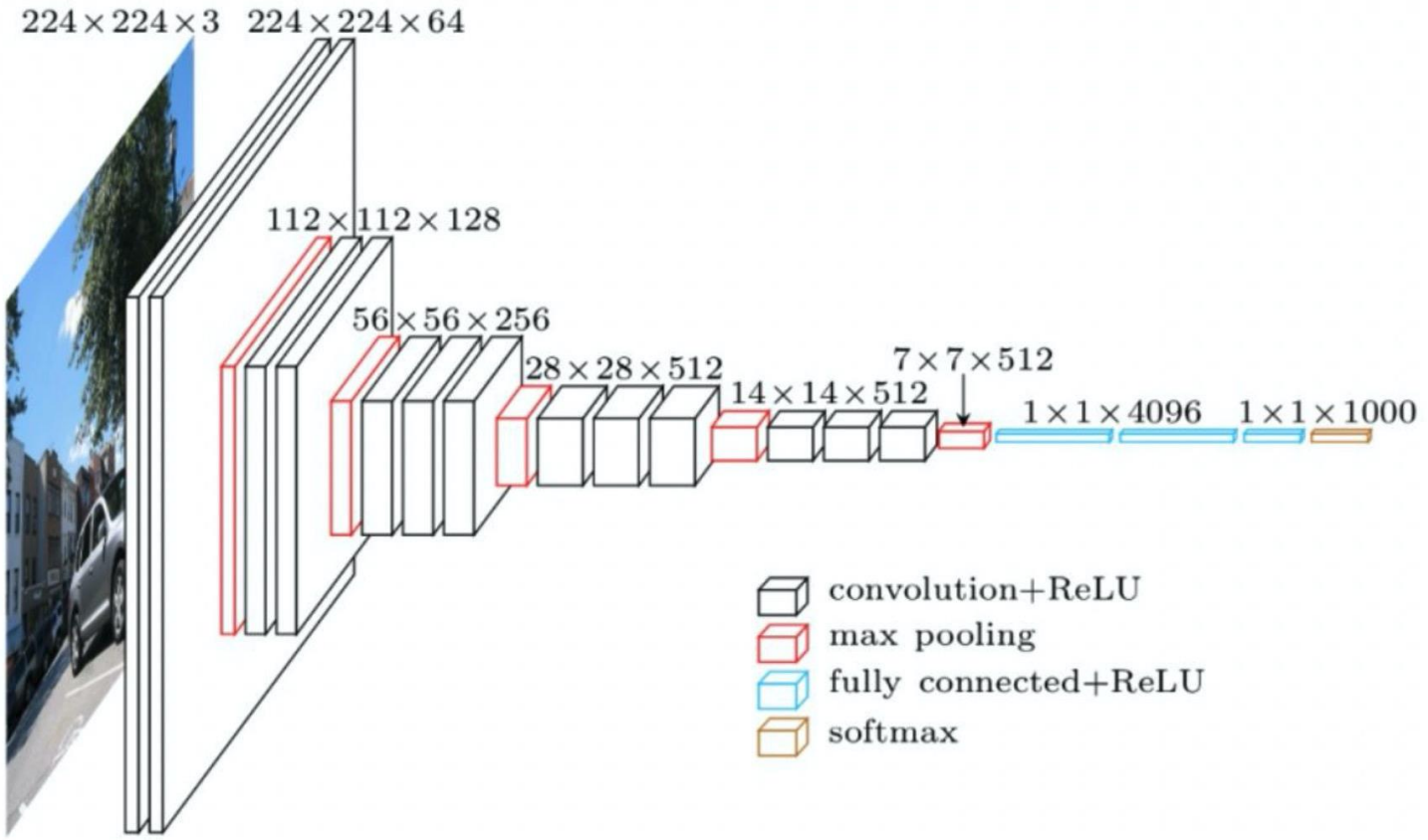


Nearest neighbor classification

- Training:
  - generate bag-of-words histogram for each training image

- Testing:
  - Given a test image → bag-of-words histogram
  - Find its nearest neighbor training histogram
  - Predict: assign it the category of this nearest training image (0/1)

Task 2: CNN-based image classification

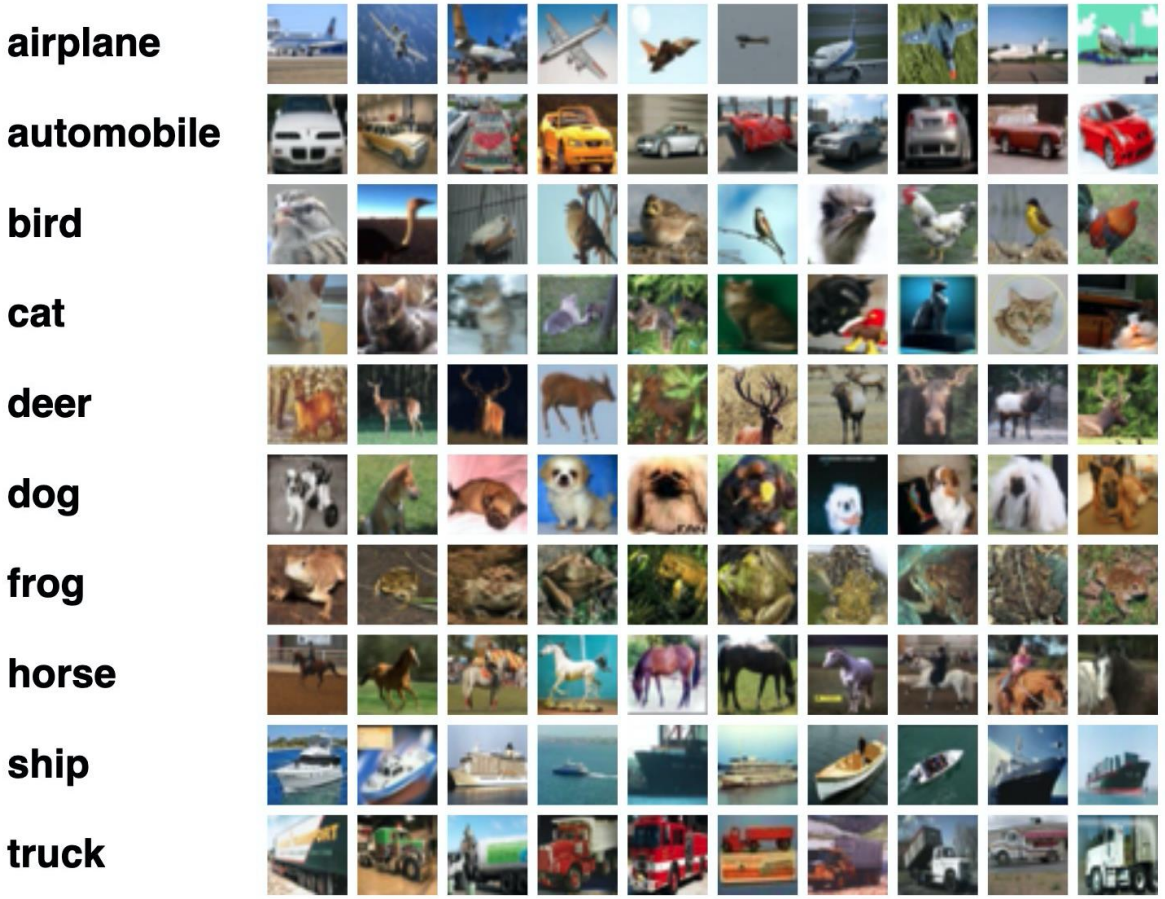


p_{car}
p_{road}
p_{human}
p_{sky}
p_{dog}
…

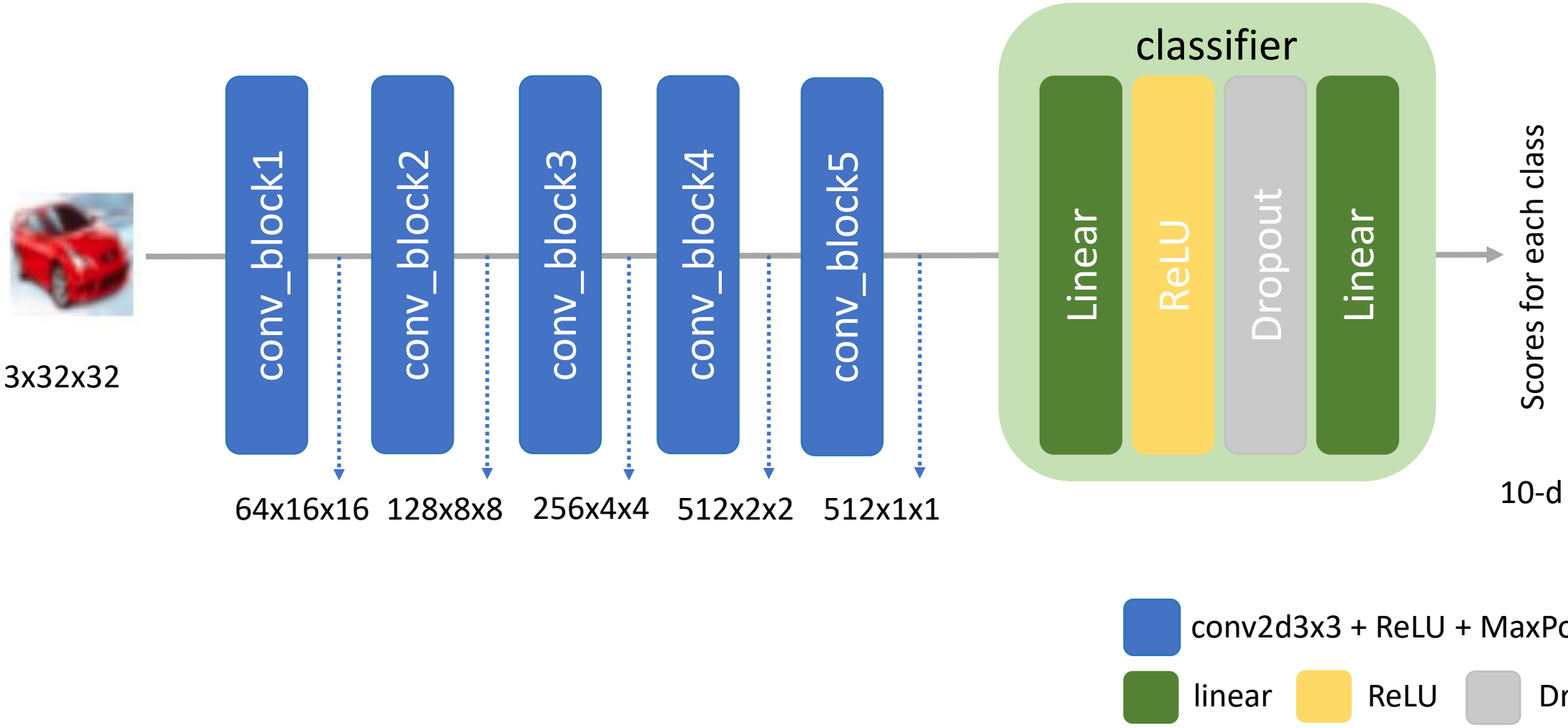
VGG16 (https://arxiv.org/pdf/1409.1556.pdf)

CIFAR-10 Dataset

- 10 image classes
- 50000 training images
- 10000 testing images
- Image resolution: 32x32



Simplified VGG

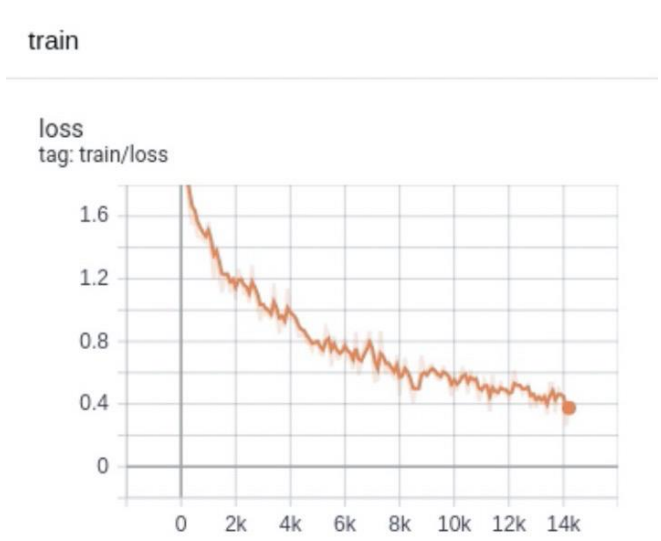


Basic Modules

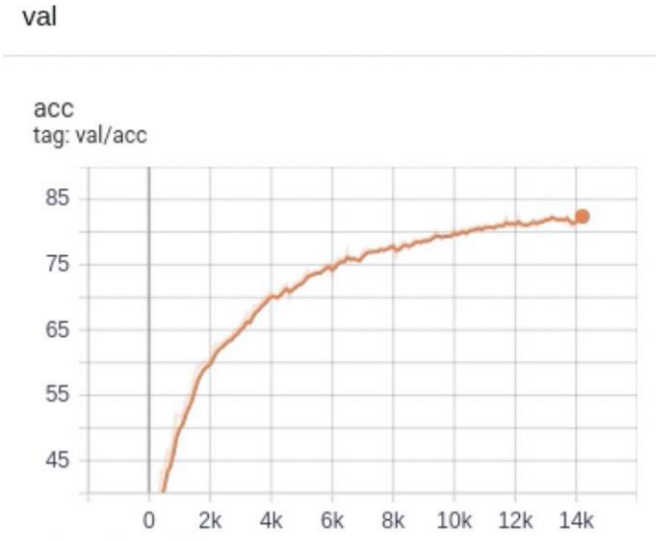
- Conv2d
  - https://pytorch.org/docs/stable/generated/torch.nn.Conv2d.html
- MaxPool2d
  - https://pytorch.org/docs/stable/generated/torch.nn.MaxPool2d.html
- ReLU
  - https://pytorch.org/docs/stable/generated/torch.nn.ReLU.html
- Linear
  - https://pytorch.org/docs/stable/generated/torch.nn.Linear.html

Training

- Loss: cross_entropy
- Train models / logs saved in `runs/xxxxx`
  - `xxxxx:` a random ID for each experiment
- Check Tensorboard logs:
  - `tensorboard –logdir runs`



Training loss (40 epochs)



Validation accuracy (40 epochs)

Hand-in

- Assignment 4 is due **10.11.2023** noon (11:59 am)
- All source code (excluding `data` folder)
- `runs/xxxxx` folder for VGG model training:
  - `events.out.tfevents…`
  - `last_model.pkl`
  - `params.json`
  - `run_XXXX_XX_XX_XX_XX_XX.log`
- A short report explaining:
  - implementations / results / tensorboard screenshot
- **Please zip all files into one single file for submission**