ADVANCED MACHINE LEARNING SEMINAR

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PIPELINE FOR TRAINING & EVALUATION

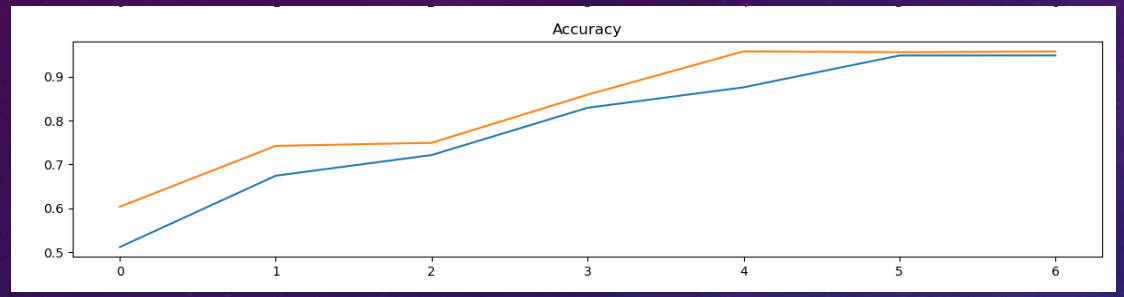
- Supports logging with Weights & Biases
- Easy configuration through CLI arguments
- Example:
  - `python train.py capsnet_2d --epochs 5 --slice_width=28 --dataset=mnist --batch_size=32`

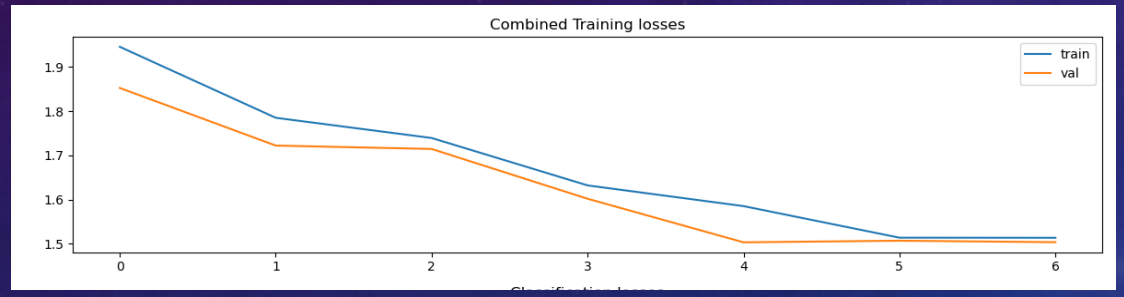
    model (capsnet / resnet) target image size dataset (mnist, lungpetctdx)
- Evaluation with confusion matrix and explainability through SHAP

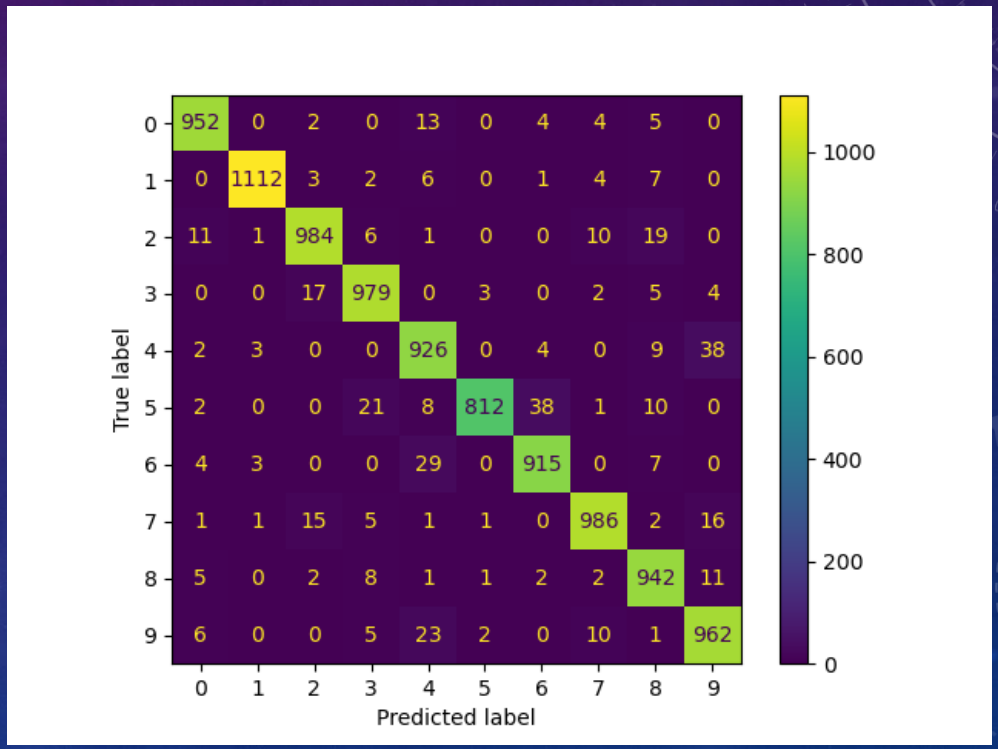
PIPELINE FOR TRAINING & EVALUATION

- CLI arguments:
  - `--epochs EPOCHS`
  - `--max_loaded_samples MAX_LOADED_SAMPLES`
  - `--learning_rate LEARNING_RATE`
  - `--slice_width SLICE_WIDTH`
  - `--batch_size BATCH_SIZE`
  - `--wandb`
  - `--early_stopping`
  - `--class_imbalance {class_weights,undersample,none}`
  - `--dataset {lungpetctx,mnist}`
- + model specific arguments

EVALUATION ON MNIST – RESNET 152



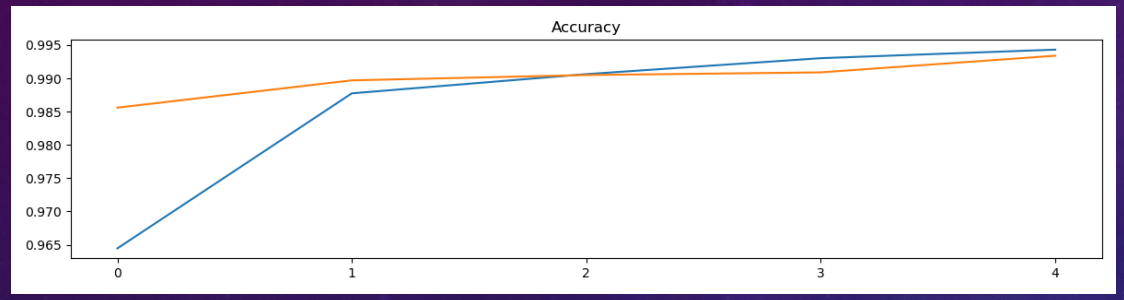


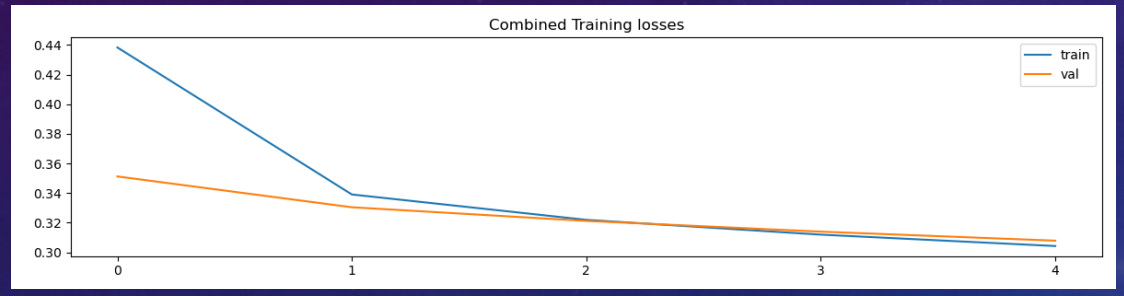


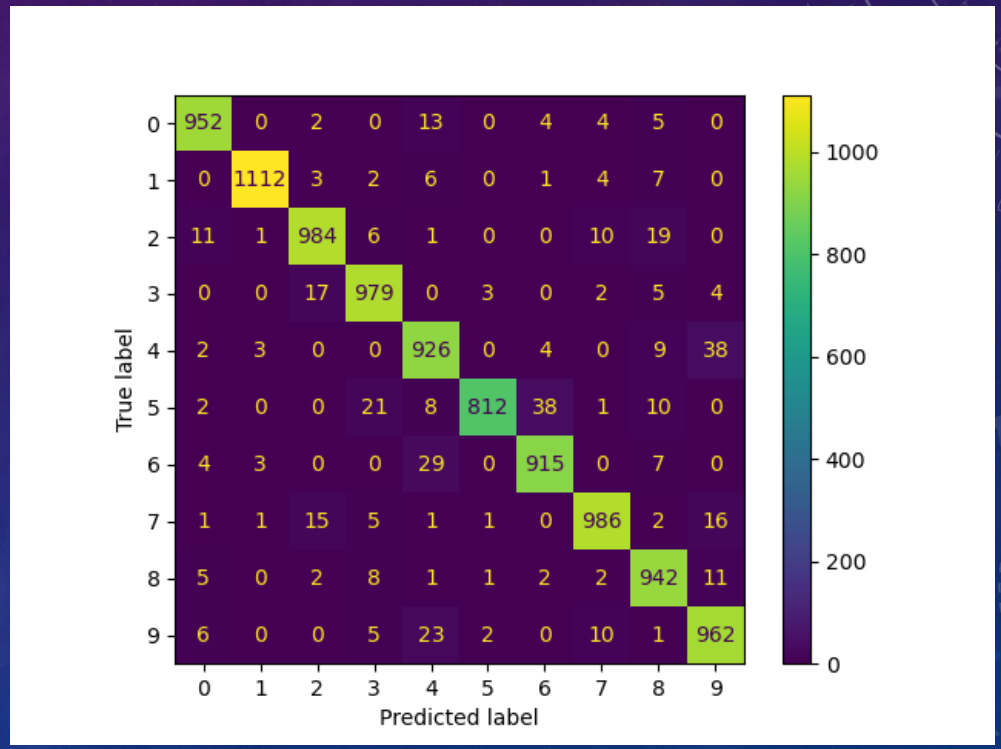
✅ Looks good
Best validation accuracy at ~0.97


```
python train.py resnet_2d --epochs 20 --slice_width=28 --dataset=mnist --batch_size=32
```

EVALUATION ON MNIST – CAPSNET 2D







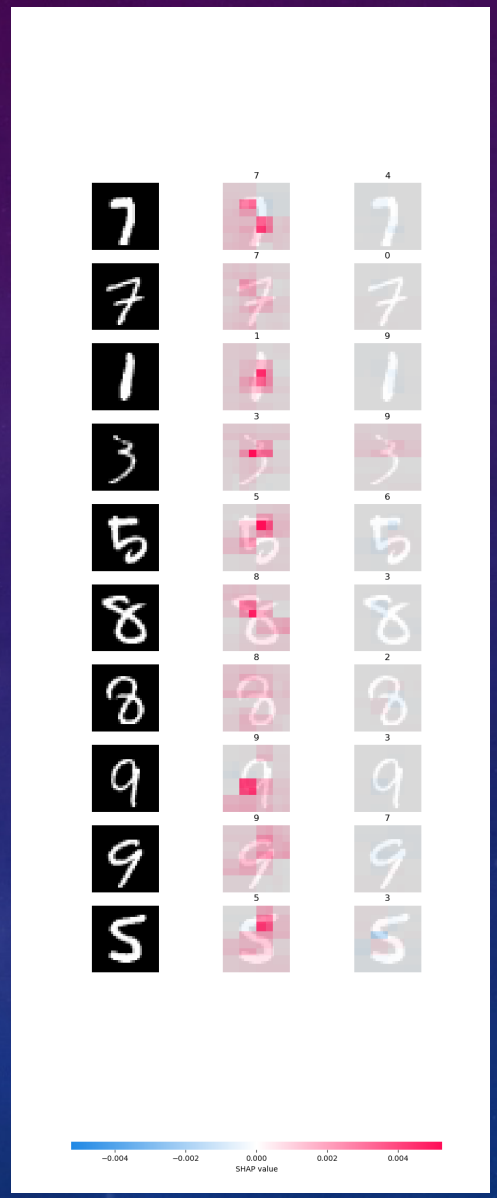
✅ Even better

Best validation accuracy at >0.99, very low loss

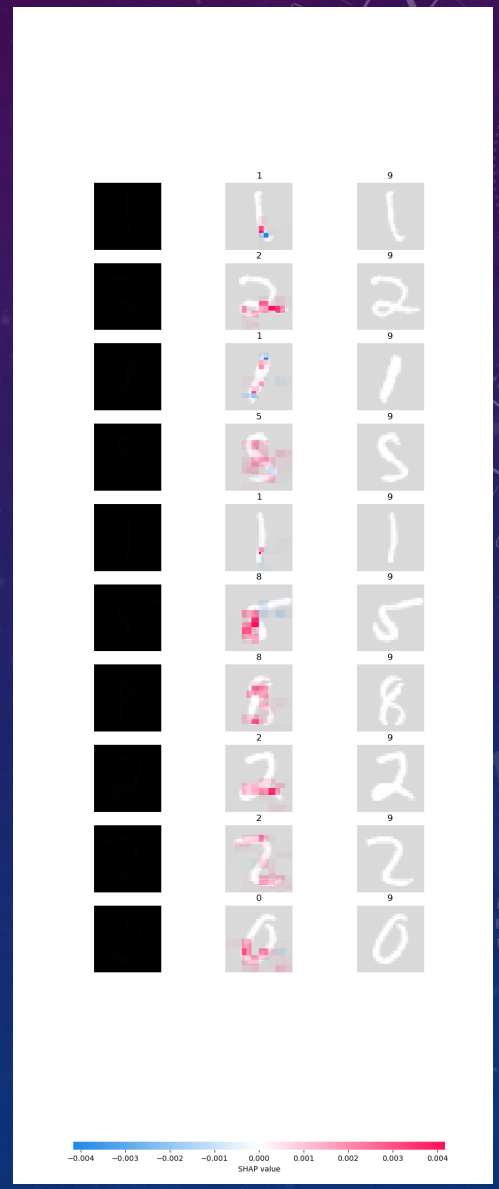

```
python train.py capsnet_2d --epochs 20 --slice_width=28 --dataset=mnist --batch_size=32
```

OBSERVATIONS

- Capsnet has broader attention, while Resnet focusses smaller spots

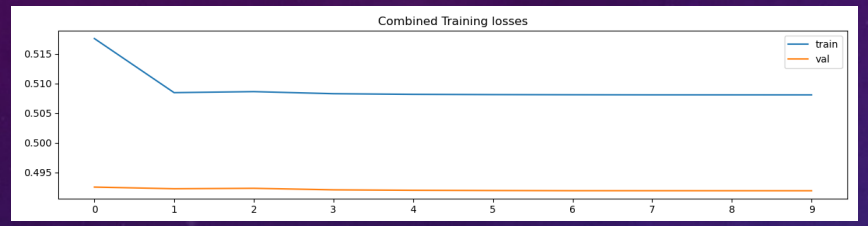


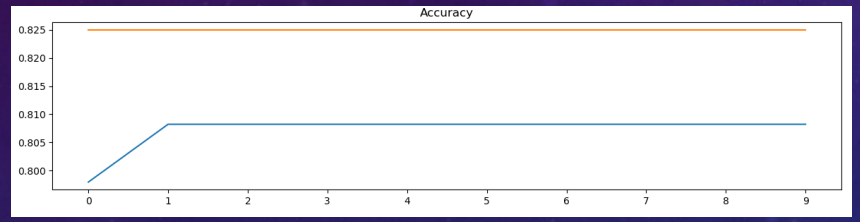
Capsnet



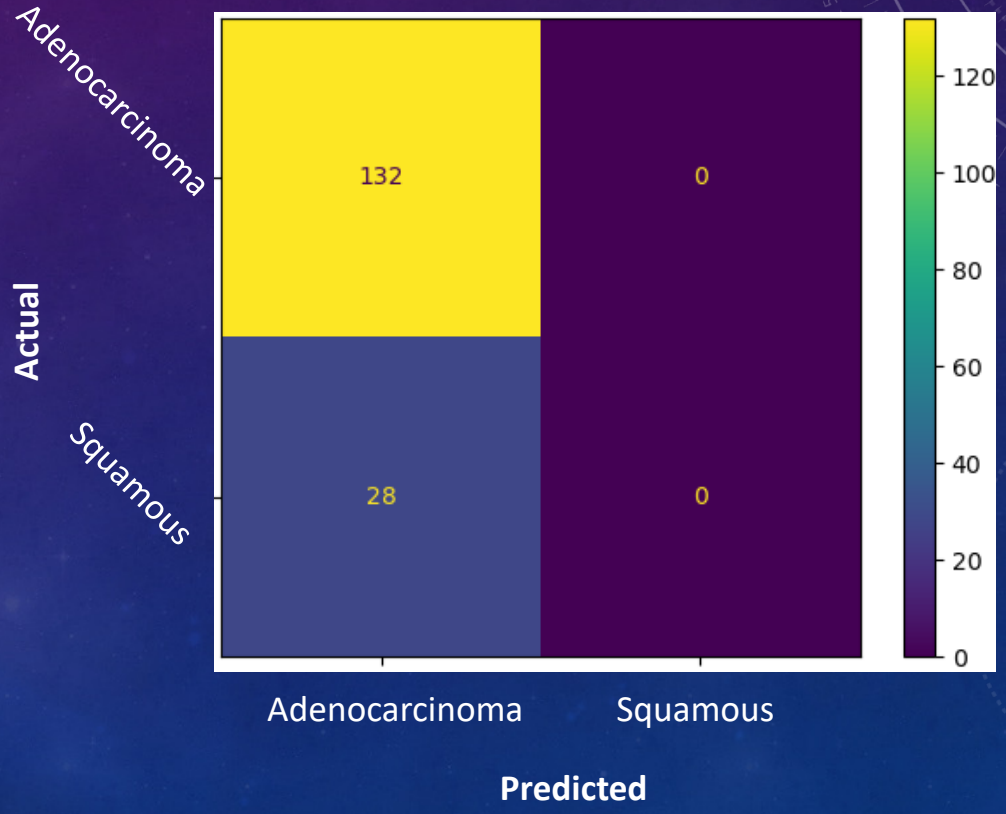
Resnet

EVALUATION ON LUNGPETCTDX – 2D CAPSNET





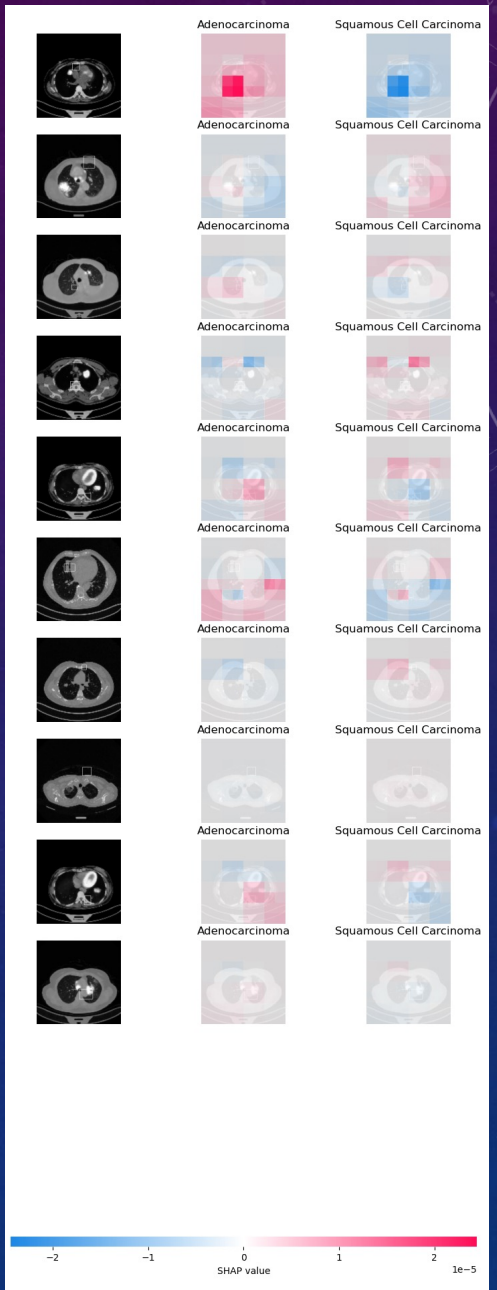
🥶 Does not train at all
- Similar results for Capsnet 3D and Resnet




```
python train.py resnet_2d --epochs 10 --slice_width=128 --dataset=lungpetctdx --batch_size=32
```

EVALUATION ON LUNGPETCTDX

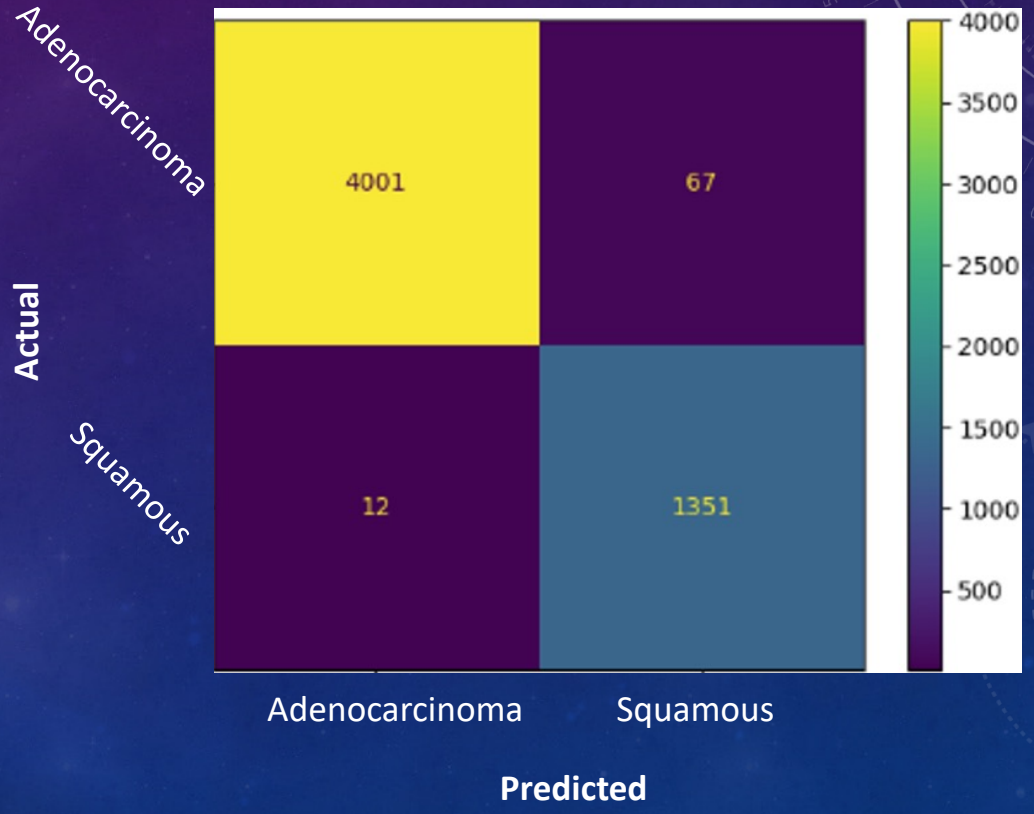
- SHAP value very low for all samples
- „random“ behaviour → not focussing on the tumor
- Changes tried:
  - Different Capsulenet implementation, increasing model complexity
  - Preprocessing (linear & standard normalization, per image or over all)
  - Resizing to higher or lower resolution
  - Different optimizers (Adam, RMSProp, SGD)
  - Hyperparameter optimization
  - Using 3D CT-scans
  - Padding / Cropping to the tumor
  - Various ways to deal with imbalance (Undersampling, class weights, …)
  - Validate on train set
- No significant improvement ☹



Capsnet

DEEP DIVE: RANDOM SPLIT

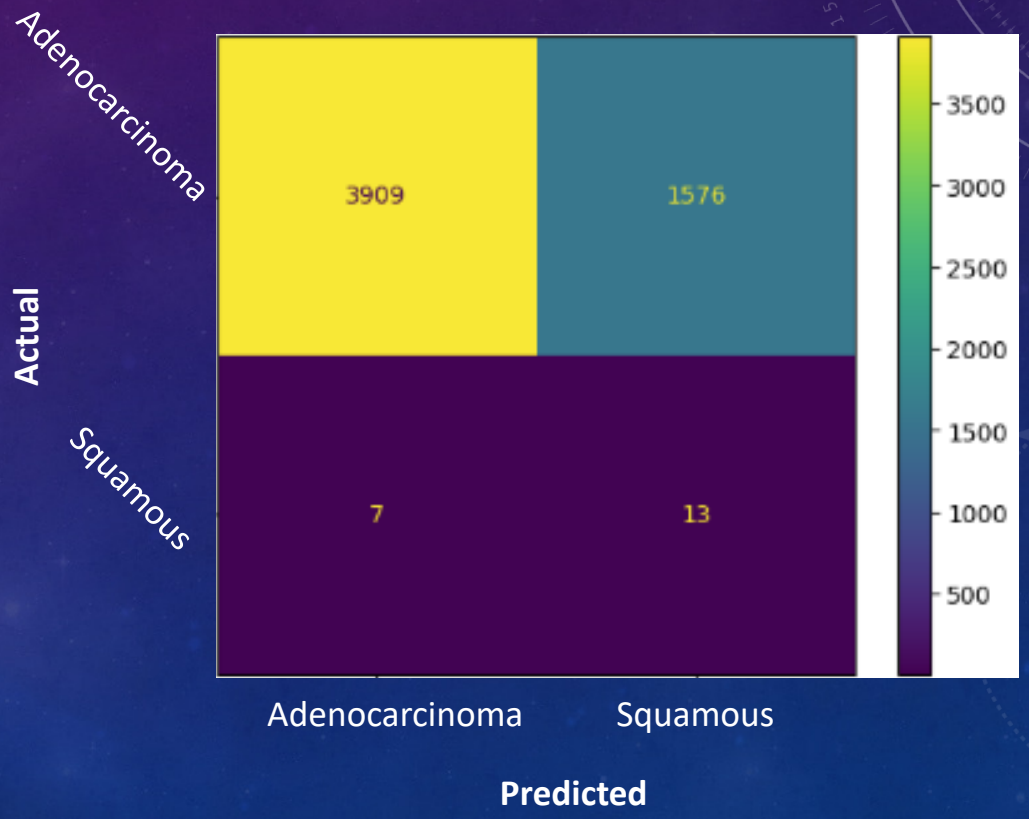
- Model can learn case specific images / features
  - → It performs well
- Model complexity seems to be high enough to remember images
- Training loop is working




```
python train.py capsnet_2d --epochs 10 --slice_width=128 --dataset=lungpetctdx --batch_size=32 --split=random
```

DEEP DIVE: CROPPING TO TUMOR

- The tumor only affects a small part of the whole lung
  - → It might perform better if cropped to only the tumor
  - → Many papers combine segmentation & classfication, we “simulate” the segmentation
- However, does not affect the results
  - This raises the question if classification on the tumor is possible for this dataset




```
python train.py capsnet_2d --epochs=5 --slice_width=128 --learning_rate=0.001 --dataset=lungpetctx
    --early_stopping --batch_size=4 --crop_to_tumor
```

CONCLUSION

- Our Resnet & Capsule Net implementations work
- The dataset might have some issues or need different preprocessing
  - We did not find any paper with repeatability in mind that uses Lung PET-CT-Dx dataset
  - → question remains: can the tumor be classified based only on CT images?

- Whats left:
  - With the new argument parsing, it is very easy to execute experiments with the pipeline
  - It might be a good idea to look for a dataset with repeatable implementation

Thanks for the weekly support and for listening! :)

REFERENCES

- Bonheur, Savinien, et al. "Matwo-capsnet: a multi-label semantic segmentation capsules network." Medical Image Computing and Computer Assisted Intervention–MICCAI 2019: 22nd International Conference, Shenzhen, China, October 13–17, 2019, Proceedings, Part V 22. Springer International Publishing, 2019.
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