Virtual Staining - Prediction of microscopy staining

TERESA SCHEIDT – EDAN70 PROJECT IN ARTIFICIAL INTELLIGENCE

28.05.2021

Agenda

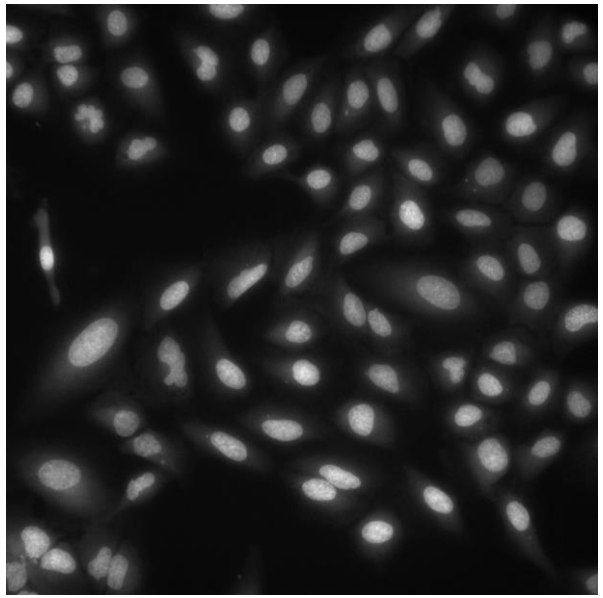
AIM OF THE PROJECT

METHODS

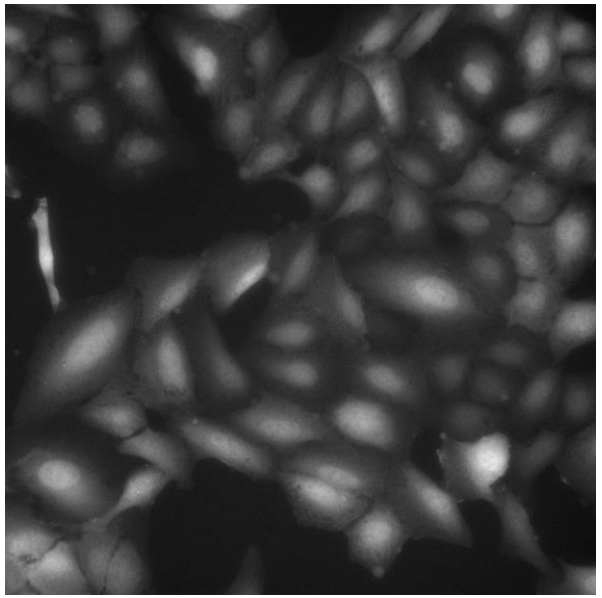
TESTED PARAMETERS

RESULTS

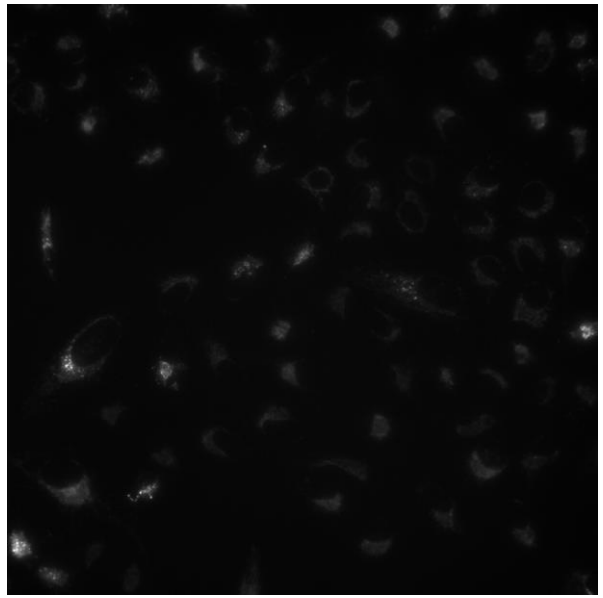
FUTURE WORK



D0



D1



D2

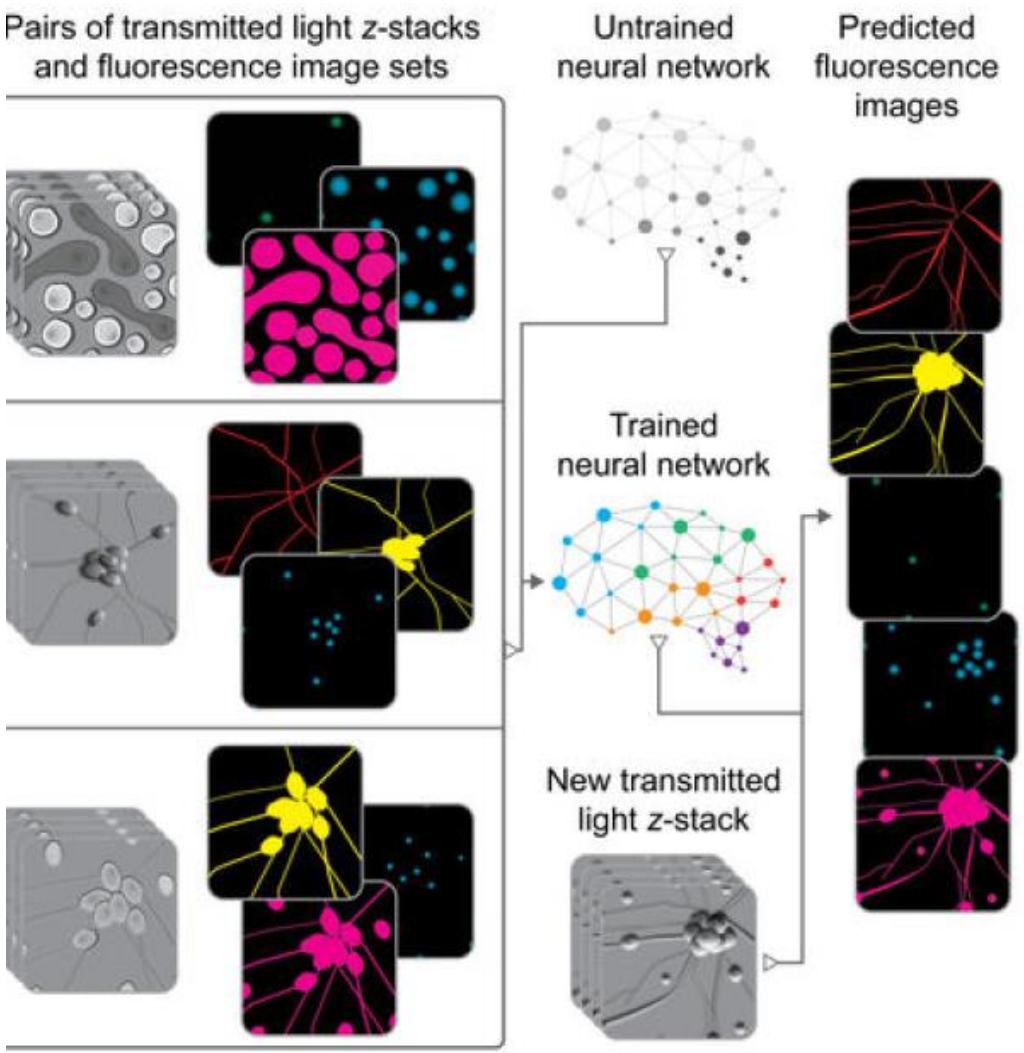
Aim of the project

- Prediction of different fluorescence stainings using an Unet

=> replace costly experiments

Existing methods

- Idea and methods based on “In silico Labeling”[1]
- U-net code based on existing project in research group



1) “In silico labeling: Predicting fluorescent labels in unlabeled images,”, E.M.Christianesen et al.

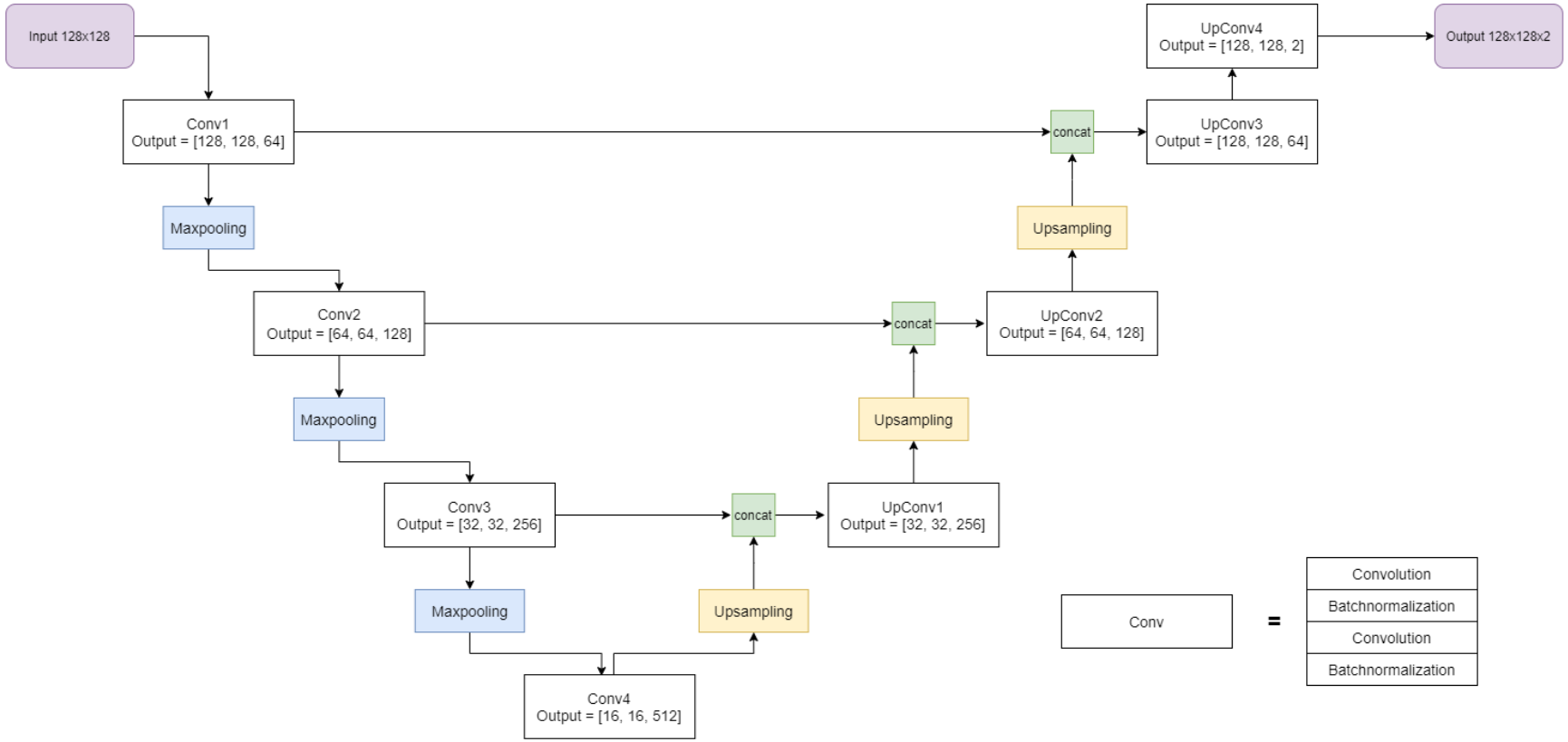
Methods - Preprocessing

- Conversion of C01-format to 16bit png images
- Normalization to mean $\mu = 0$ and standard deviation $\sigma = 1$

$$im_{norm} = \frac{im - \mu}{\sigma}$$

- Recentered Normalization to mean $\mu = 0.5$ and standard deviation $\sigma = 0.125$

$$im_{recenter} = im_{norm} * \sigma + \mu$$



Methods - Prediction

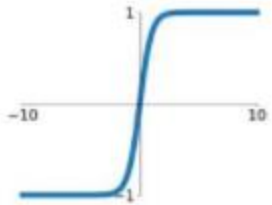
- Trained U-net
- Input: one channel, Output: two channels
- For final image prediction, change input/output size to actual image size

Methods – Training variations

Activation functions: ReLU and tanh

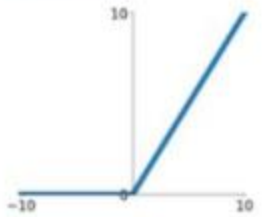
tanh

$\tanh(x)$



ReLU

$\max(0, x)$



Number of training images

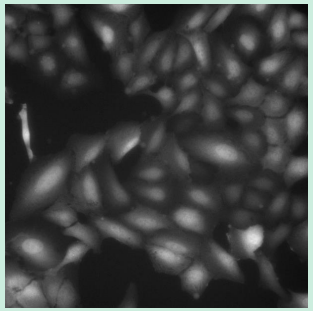
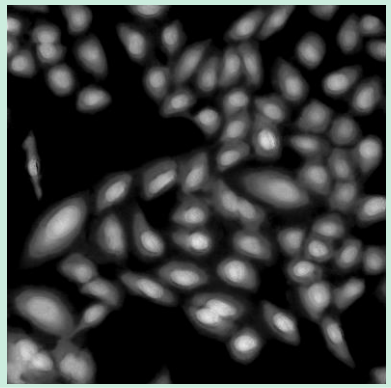
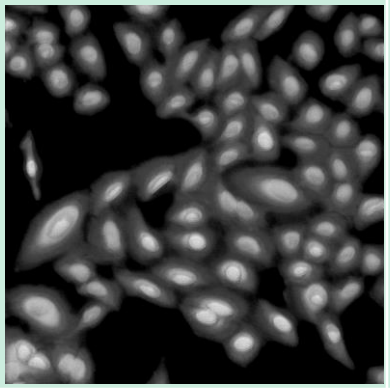
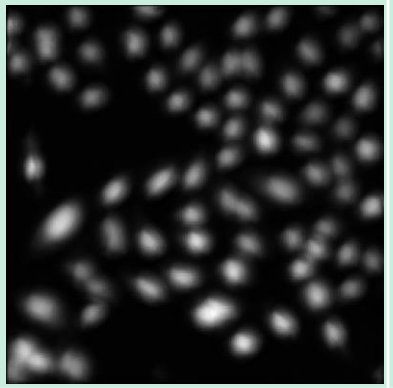
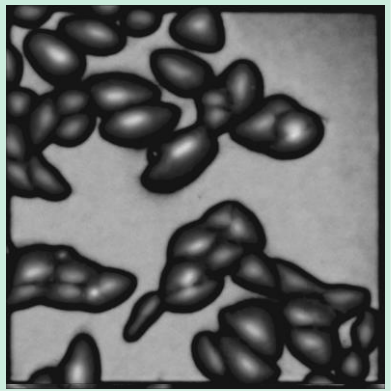
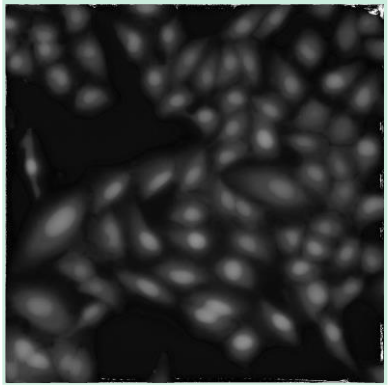
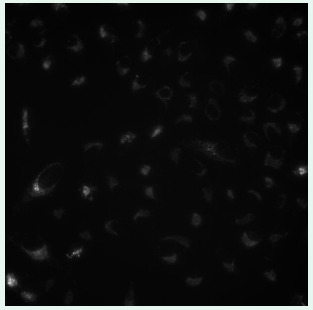
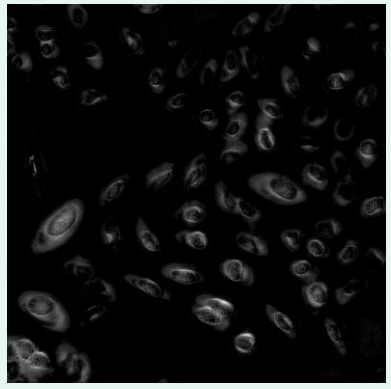
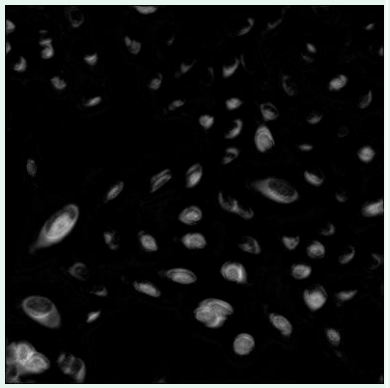
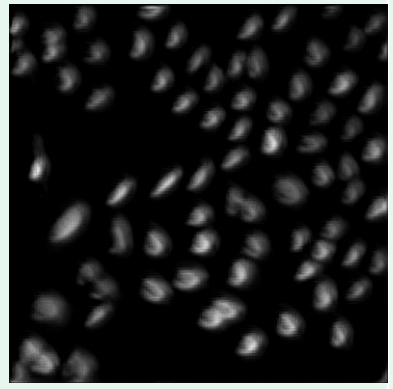
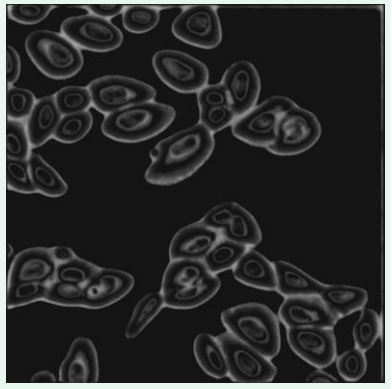
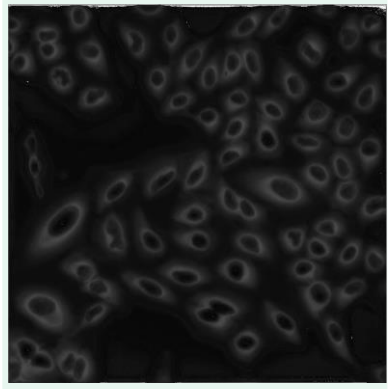
Models trained with:
8, 16, 32, 64, 256 images

Loss functions: mse, ssim

Models trained with:

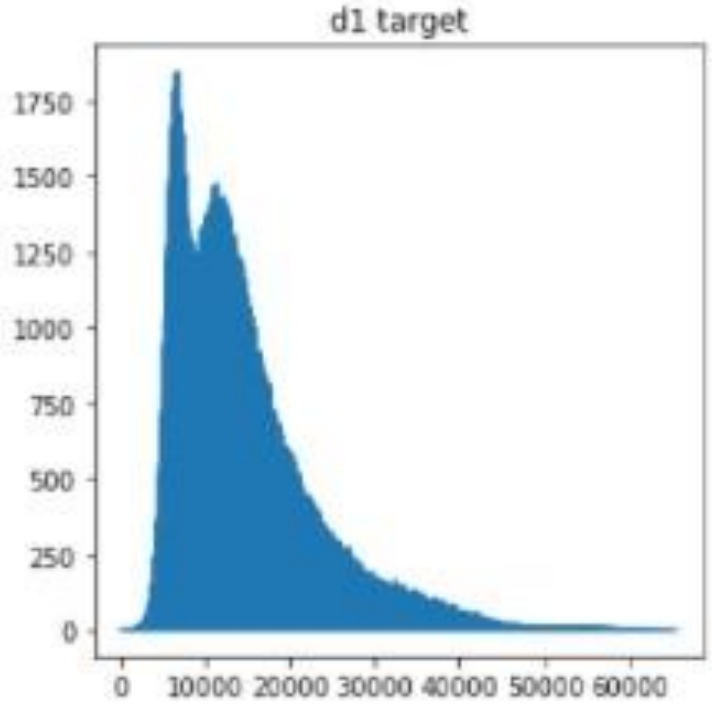
- Mean squared error
- Structural similarity
- Combination of both

Results – Training variations

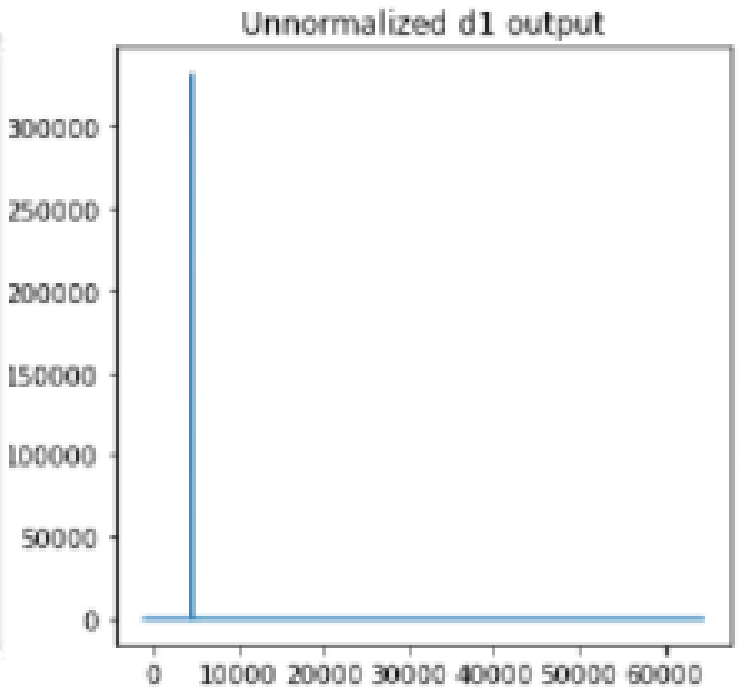
	8 images, mse, ReLU	256 images, mse, ReLU	mse, tanh	ssim, ReLU	sim+mse, ReLU
D1-channel 					
D2-channel 					

Results - Normalization

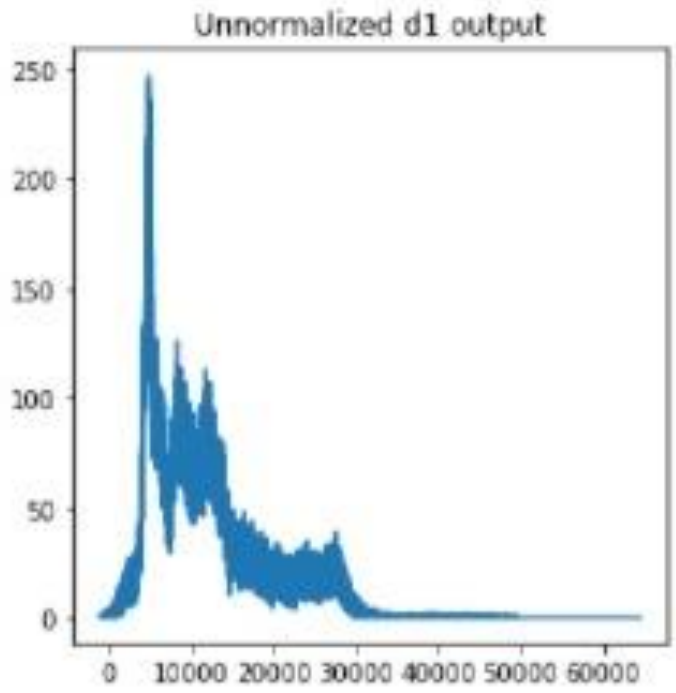
Original images



0-mean normalization



Recentered normalization



Results - Summary

- Localization and size of cells is correct in the predictions
- Prediction of d1 channel seems possible (unclear for d2)
- Best activation function: ReLU
- Loss functions has biggest impact -> more testing required
- Recentered normalization gives right output range of intensities

Future work

- Different network architectures
- Different loss functions
- Train network on a lot more images (10 000 – 1 000 000)

Thank you for listening

Questions?