Virtual Staining - Prediction of microscopy staining

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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. Christiansen et al.
Methods - Preprocessing

• Conversion of C01-format to 16bit png images
• Normalization to mean $\mu = 0$ and standard deviation $\sigma = 1$
  \[ im_{\text{norm}} = \frac{im - \mu}{\sigma} \]
• Recentered Normalization to mean $\mu = 0.5$ and standard deviation $\sigma = 0.125$
  \[ im_{\text{recenter}} = im_{\text{norm}} \cdot \sigma + \mu \]
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

Number of training images

Loss functions: mse, ssim

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

Models trained with:
- Mean squared error
- Structural similarity
- Combination of both
## Results – Training variations

<table>
<thead>
<tr>
<th></th>
<th>8 images, mse, ReLU</th>
<th>256 images, mse, ReLU</th>
<th>mse, tanh</th>
<th>ssim, ReLU</th>
<th>sim+mse, ReLU</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D1-channel</strong></td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image2" alt="Image" /></td>
<td><img src="image3" alt="Image" /></td>
<td><img src="image4" alt="Image" /></td>
<td><img src="image5" alt="Image" /></td>
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<tr>
<td><strong>D2-channel</strong></td>
<td><img src="image6" alt="Image" /></td>
<td><img src="image7" alt="Image" /></td>
<td><img src="image8" alt="Image" /></td>
<td><img src="image9" alt="Image" /></td>
<td><img src="image10" alt="Image" /></td>
</tr>
</tbody>
</table>
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?