Introduction

- Deep learning segmentation yields unprecedented results. Unfortunately, the images and objects to segment can be very different from one application to the other. Pre-trained models might behave poorly on new applications.
- We explore the feasibility of online training of a convolutional neural network from scratch with annotations given on the fly. We designed a user-friendly graphical interface that allows sketching a few zones of interest and training various architectures.
- Starting from random weights, the neural network adaptively learns to segment the objects of interest with the user provided corrections. In the spirit of deep image prior [UVL18], we show that for various applications very few annotations are enough to train lightweight networks.

Data

- The data can be a 2D grayscale or RGB image, whatever the format.
- The interface is trained on a single image and processes it.

Comparisons with Ilastik - Synthetic data

A software with a very similar spirit, but different backbone is Ilastik [SSKH11]. Can this approach differentiate shapes, textures, colors?

For our method, we used a randomly initialized U-Net composed of a single layer of 64 filters of size 5 and of a skip connection composed of 10 filters of size 5 too.

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<th>Ilastik</th>
<th>Our method</th>
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<td>Textures</td>
<td>0.97</td>
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<td>Shapes</td>
<td>0.98</td>
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<td>Colors</td>
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Table 1: Comparison of the performances of Ilastik and our method in terms of DICE

The neural network has a DICE similar to Ilastik, with a small decrease related to less precise edges. Yet, it returns far less spurious details and more pleasant details.

Comparison with Ilastik - Real data

The histology image has been processed using a 4-layer network whereas 2 layers were sufficient to process the cells image.

<table>
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<th>Ilastik</th>
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<td>Figure 8: Cells example</td>
<td>Figure 9: Labels</td>
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<td>Figure 10: Our result</td>
<td>Figure 11: Ilastik result</td>
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Conclusion & Future Work

- A simple CNN trained from very few annotations starting from random weights provides results which are on par with more established random forest models.
- Contrarily to popular beliefs, very small amount of annotation might be enough to train neural nets for simple tasks.
- The design of problem-dependent architecture (e.g. edge, filament, dot detection) is a difficult issue, yet to be explored.
- From a computation time point of view, Ilastik [SSKH11] is for now faster (2.3 ×).
- A possible solution to improve the segmentation of contiguous objects such as cells would be to develop an architecture based on heat maps similar to the one of Cellpose [SWMP21].
- Another great feature we would like to add would be the 3D image processing.
- Napari integration looks natural and might come soon.

Related Work


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