

Using convolutional neural networks for supervised classification of ImageStream images

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1. Introduction

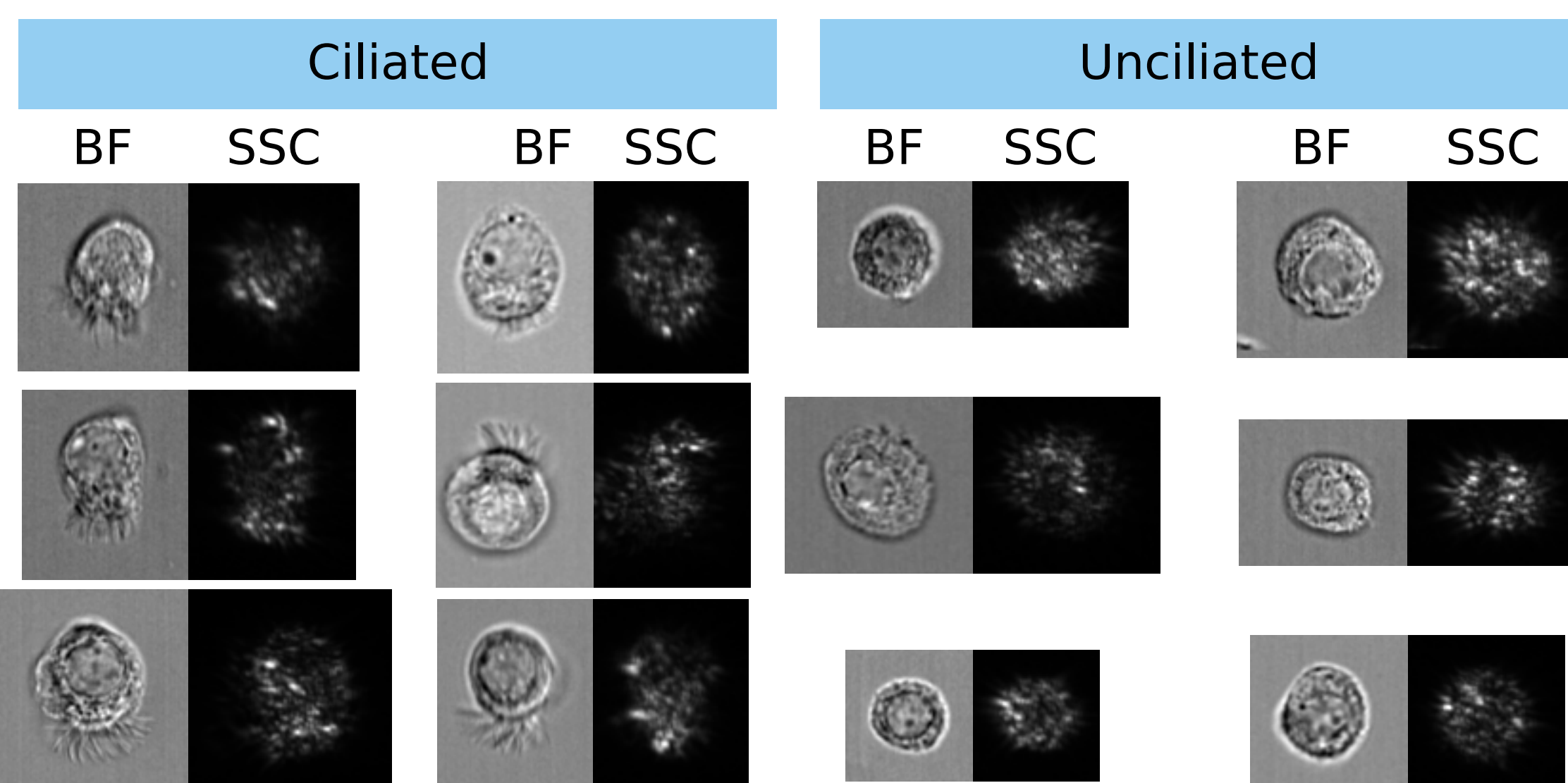
The ImageStream imaging cytometry platform allows us to capture brightfield, scatter, and fluorescence images of thousands of cells per minute. The spatial data generated facilitates the discrimination of cell types based on their morphological, as well as biochemical, differences.

Sometimes, morphologically-distinct cell types are present in a sample, that are difficult to discriminate using manual gating. If humans can identify patterns in images, it's likely that computer vision algorithms, such as convolutional neural networks (convnets) can do the same.

The goal of this project was to set up a pipeline to facilitate the training of convnet machine learning models, to perform supervised classification of ImageStream images, using an example problem.

2. The problem: ciliated or unciliated?

The example problem used to set up and test the pipeline was a simple, binary classification problem: in a mixed sample of ciliated and unciliated epithelial cells, can a convnet be trained to distinguish between them, using only their brightfield (BF) and side scatter (SSC) images?



3. The approach

Manually tag and export images from IDEAS
(unpadded, 8-bit, channels 1, 6, and 9)

Merge channels of each cell into single .tif
(using batch Fiji script)

Split images into train, validate, and test sets
(50:50 split between classes in each)

88 36 30

Reshape images into arrays of 150 x 150 x 3

Train convnet from scratch

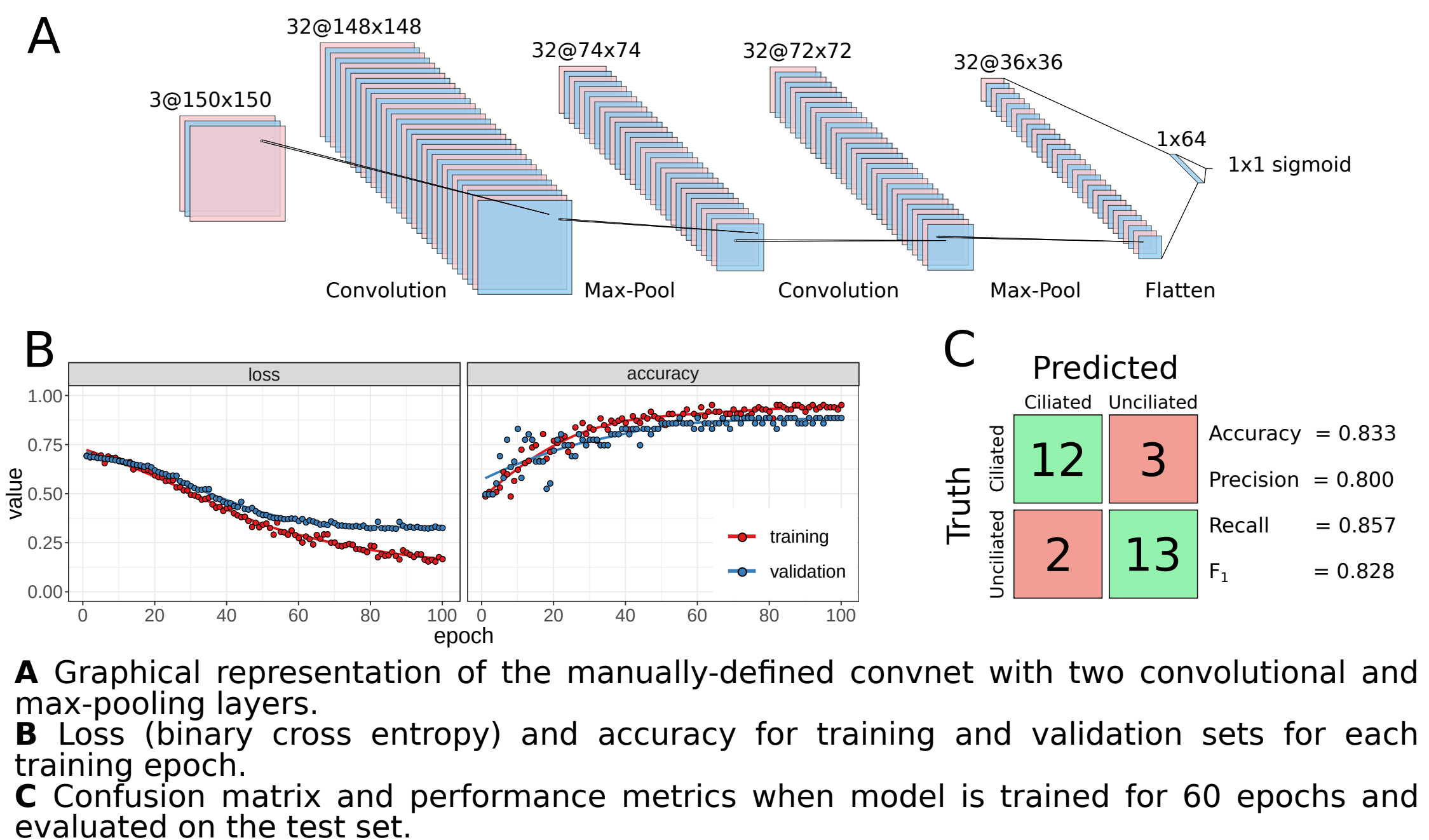
Use pre-trained network to extract image features

without data augmentation with data augmentation

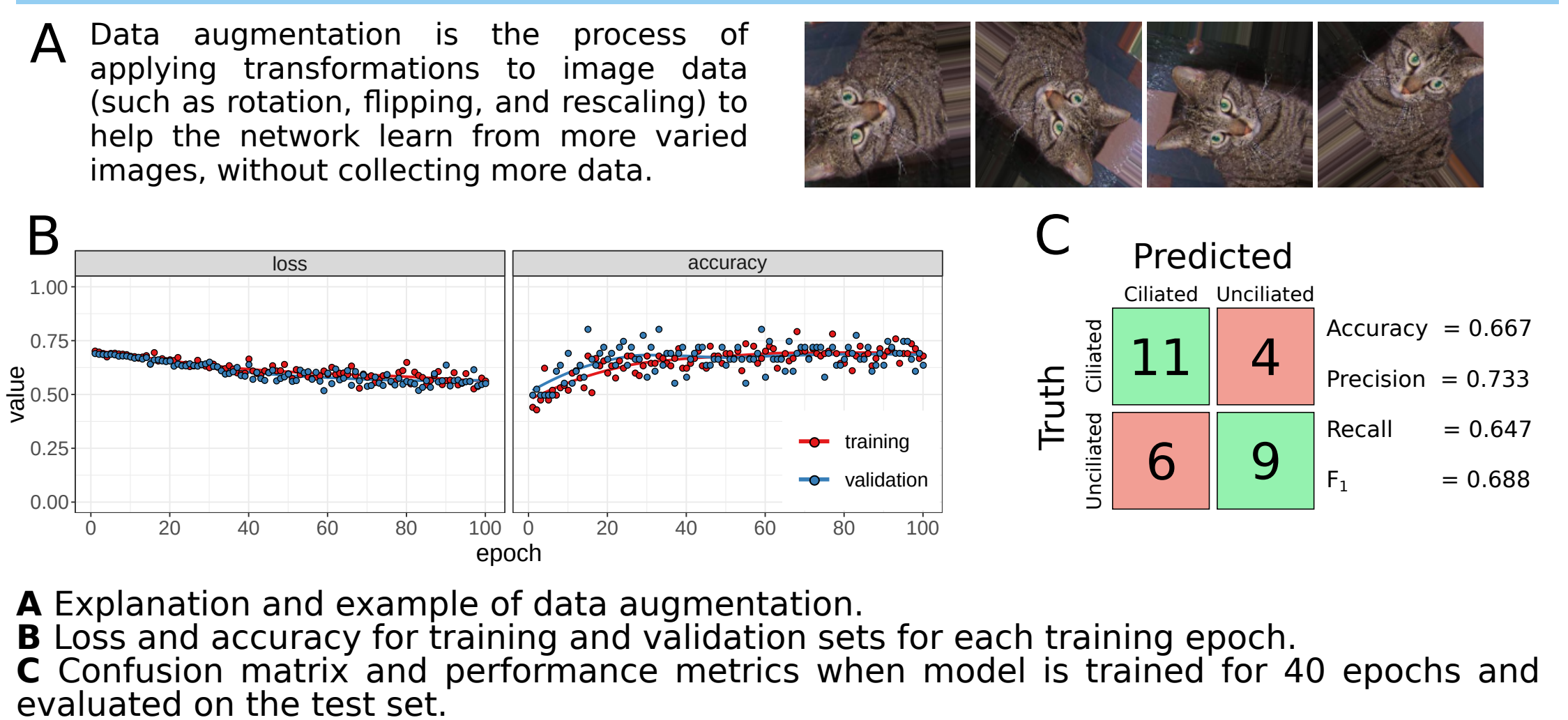
without fine tuning with fine tuning

Compare performance on test set

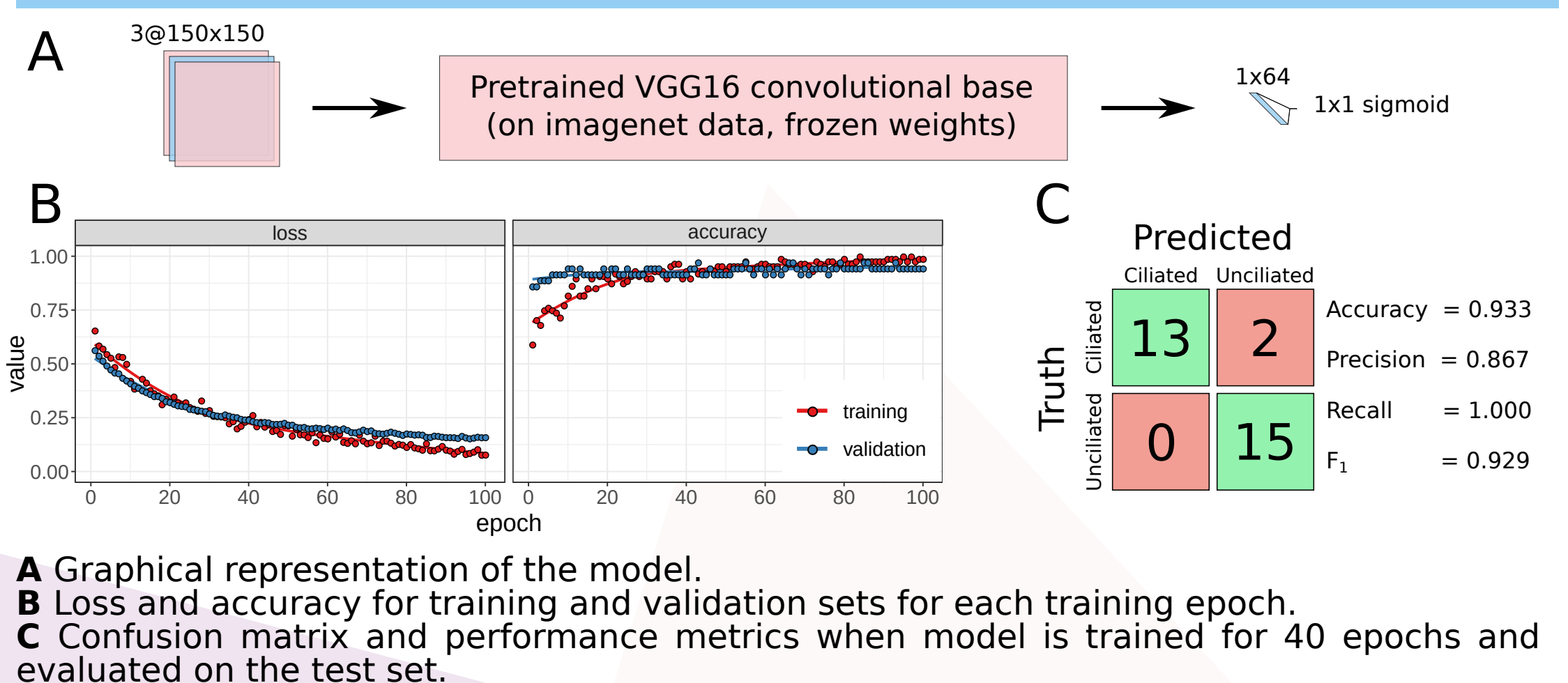
4. Results: training a convnet from scratch



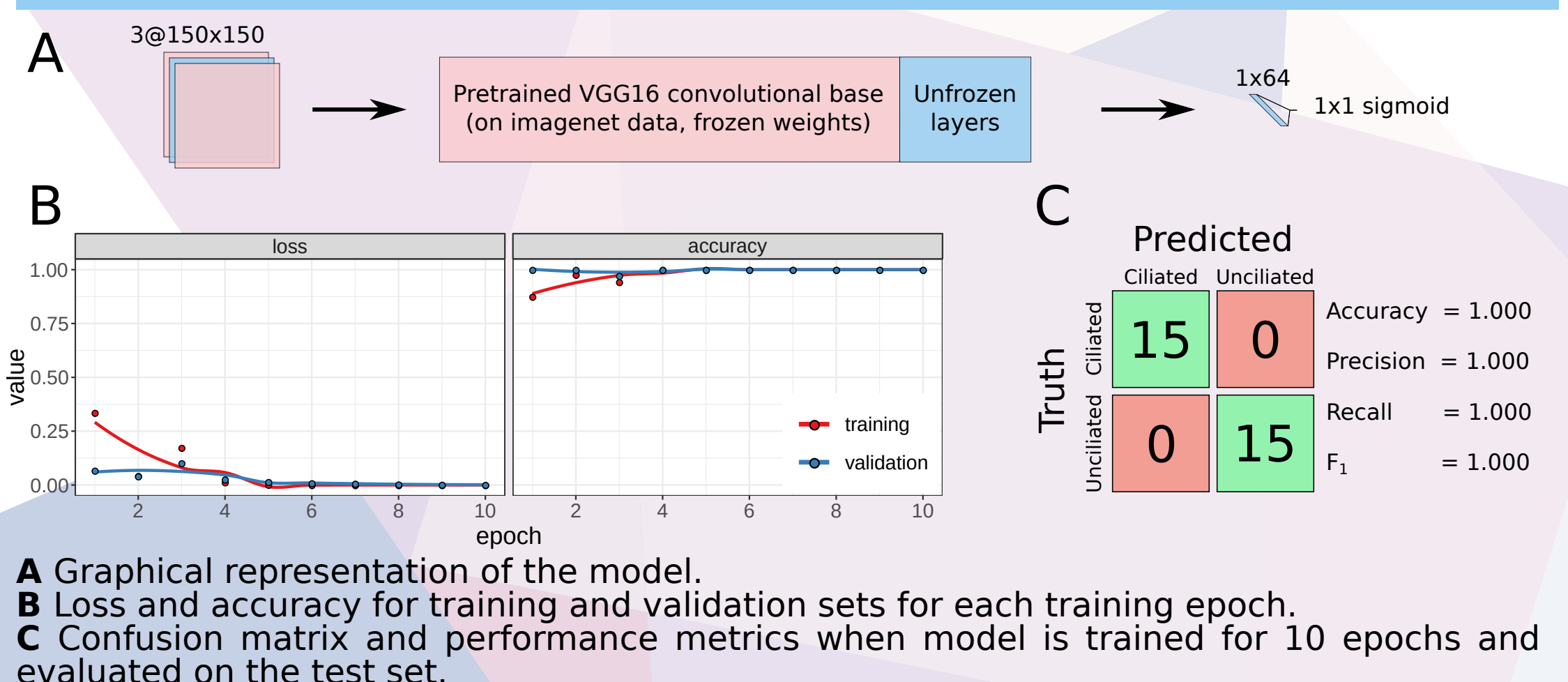
5. Results: including data augmentation



6. Results: using a pre-trained network



7. Results: fine tuning a pre-trained network



8. Conclusions

1. Convnets can learn effective models for supervised classification of ImageStream images
2. Data augmentation deteriorated model fit by introducing bias in the absence of overfitting
3. Using a model pre-trained on a large image dataset is more effective for small datasets
4. Fine tuning a pretrained model gave excellent performance, by tailoring the model to the problem

