陽明交大【人工智慧臨床醫學實務應用系列課程】聯合成果展

Automated Dendritic Spine Detection Using Learning Based Segmentation and Classification Approach

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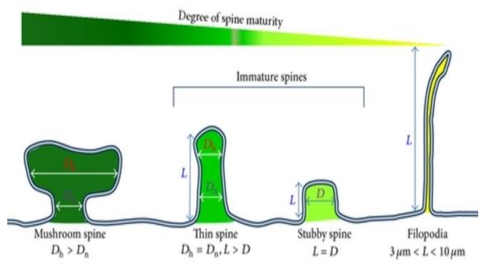
Introduction

Background

Analysis of morphology and composition of dendritic spines are important for studying the neuronal function. However, analysis of dendritic spines is a highly time-consuming manual task and it may prone to bias due to human subjectivity. As a result, we created a total automatic process for spine detection and classification.

Four types of spine



Neural Plasticity,2016

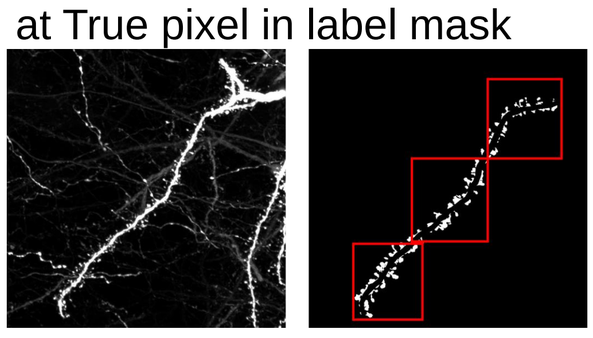
Dataset

- Sample: cortical neurons from embryonic mice brain tissue
- Image acquisition: 3D confocal microscope
- Number of images: 84 images
- Image size: x-y 1024x1024;z-stacks 30~50
- Resolution: x-y 0.078 μm/pixel; z-step 0.42 μm

Spine Detection

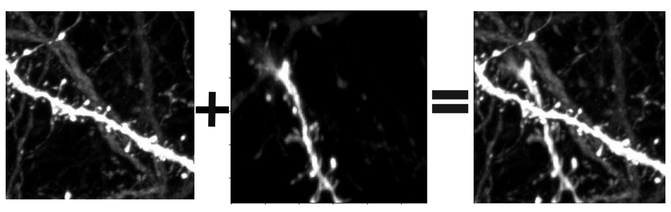
Major Problem: Imprecise labels

- Extract patch images centered at True pixel in label mask



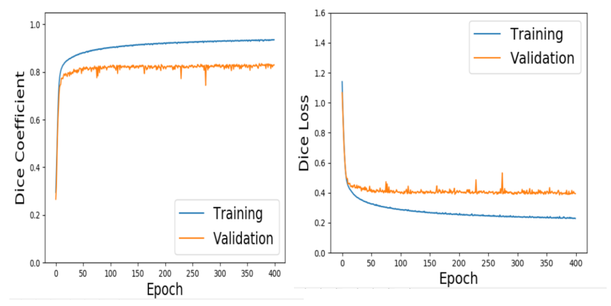
Data augmentation

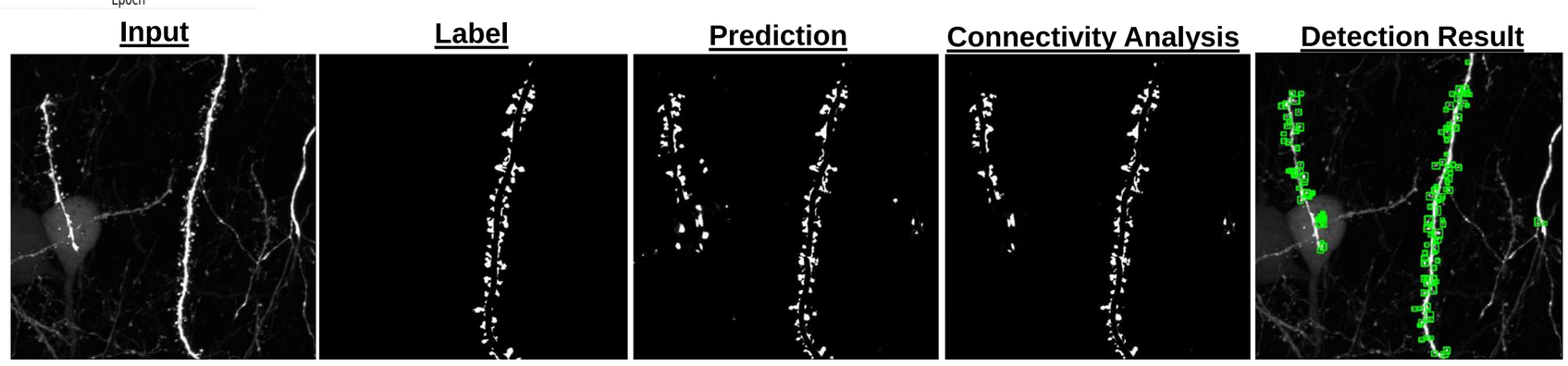
- Perspective transform
- MIP of random patch images



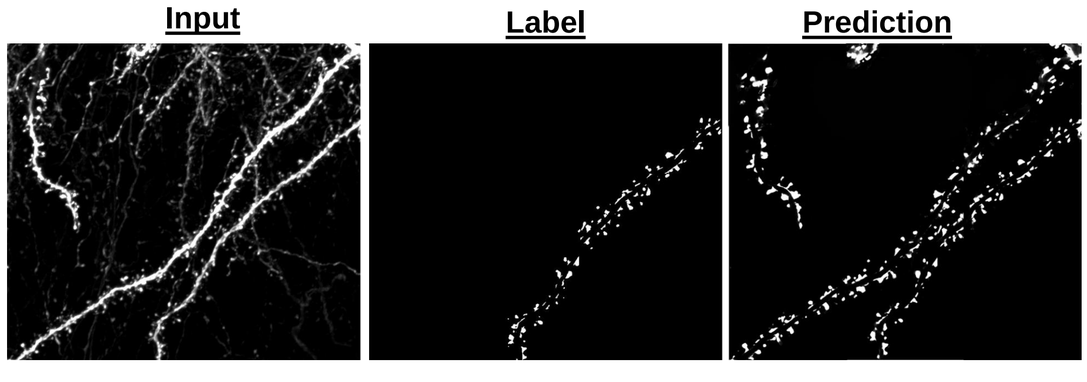
Segmentation Result(U-net)

Validation accuracy:0.84



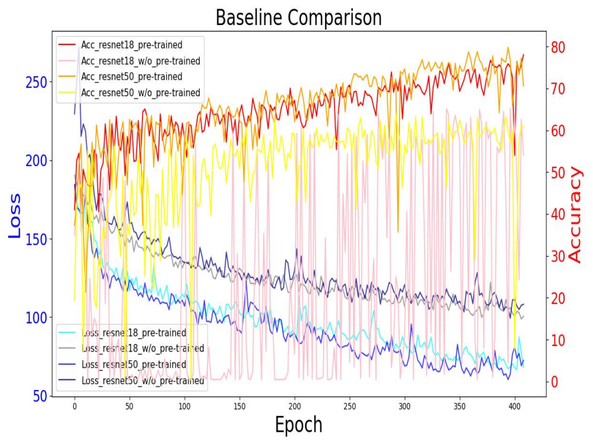


Inference on Complex scenes

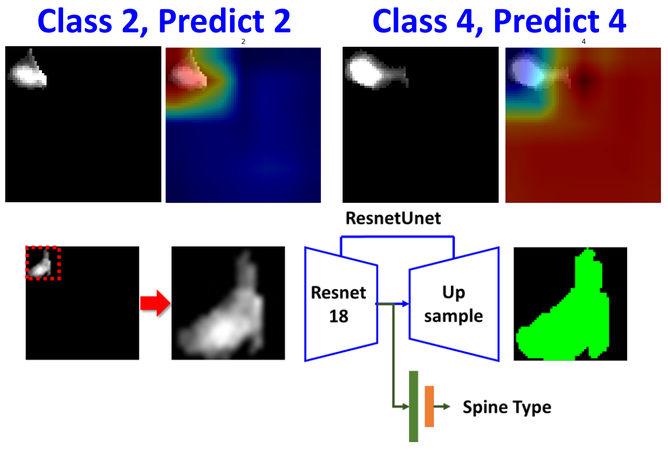


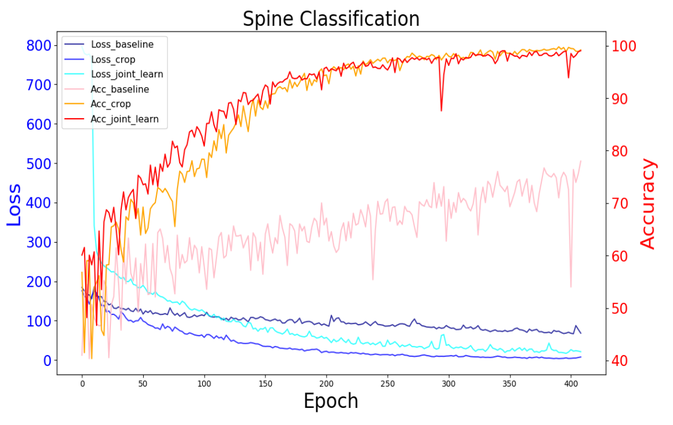
Spine Classification

1. **Baseline model**
   - Resnet 18 with pre-trained (transfer learning) is the best
   - Test accuracy: 72.48 %
2. **Grad-CAM heatmap analysis**
   - Wrong focused area caused by redundant background
3. **Proposed method**
   - Background removed
   - Joint learning
   - Test Accuracy: 92.72 %



Restnet	Acc. train	Acc. test
18 with	78.00 %	67.19 % (72.48 %)
18 w/o	65.23 %	63.67 %
50 with	79.79 %	66.64 % (70.05 %)
50 w/o	63.91 %	62.47 %





Reference

[1] C. Hazirbas, L. Ma, C. Domokos, and D. Cremers, “Fusenet: Incorporating depth into semantic segmentation via fusion-based cnn architecture,” in *Proc. ACCV*, vol. 2, 2016.

[2] Xiao, Xuerong et al. “Automated dendritic spine detection using convolutional neural networks on maximum intensity projected microscopic volumes.” *Journal of Neuroscience Methods* 309 (2018): 25-34.

Acknowledgements

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