

# Fine tuning U-Net for ultrasound image segmentation: which layers?

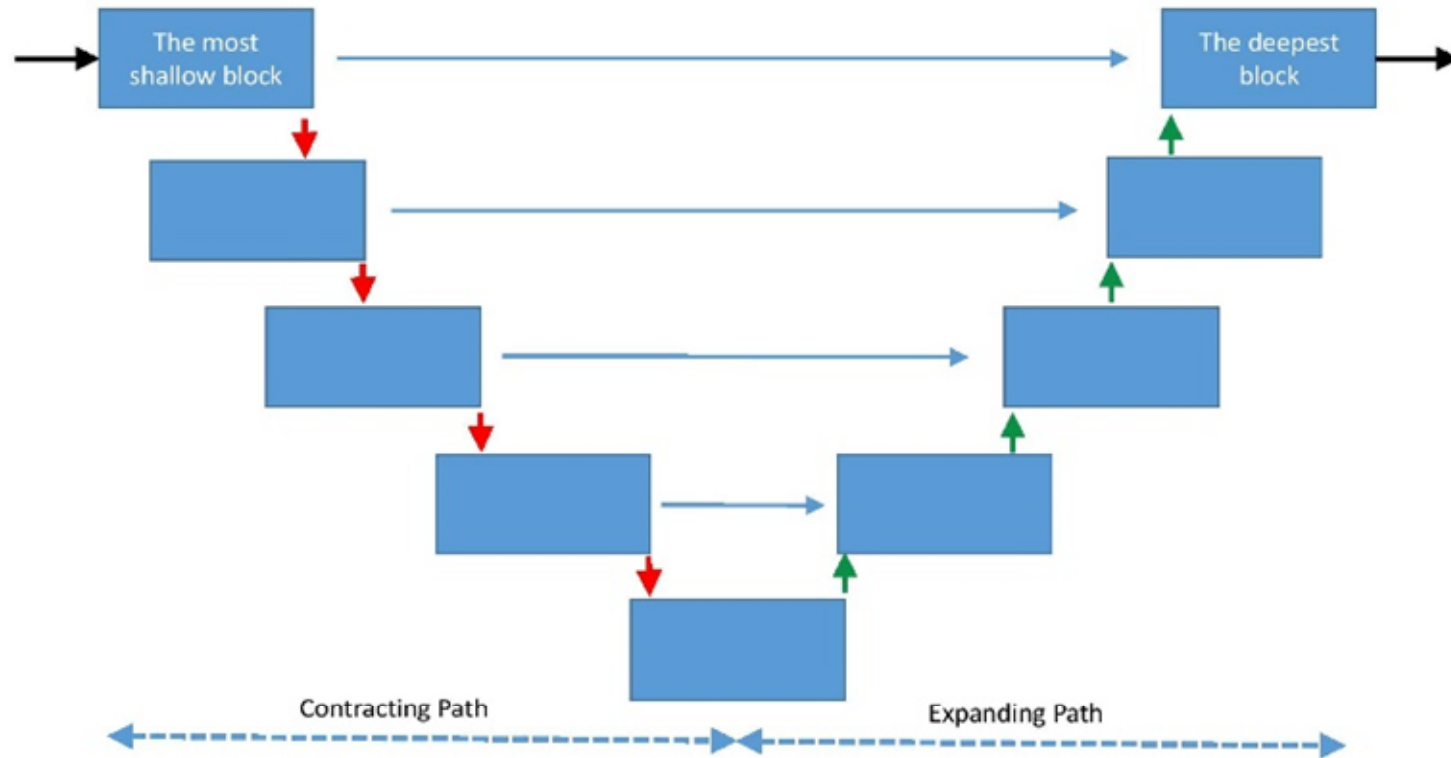
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# Introduction

- Medical image processing
  - Annotated data is scarce and expensive
  - Training a deep convolutional neural network (CNN) from scratch is challenging
- A solution could be transfer learning
  - Training the network on a large dataset and then fine-tuning for another application

But the question is how, and for which layers the fine-tuning should be done?

# U-Net: A fast and precise solution for medical image segmentation



# Methods

- Pre-training the network by natural images
- Fine-tuning the contracting and expanding paths
- Fine-tuning layer by layer in two directions
  - From shallow to deep layers
  - From deep to shallow layers

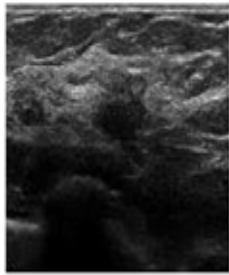
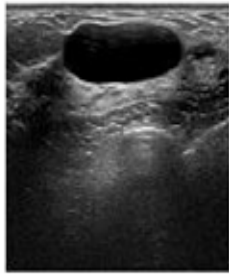
# Results

Ground truth

Pre-trained network

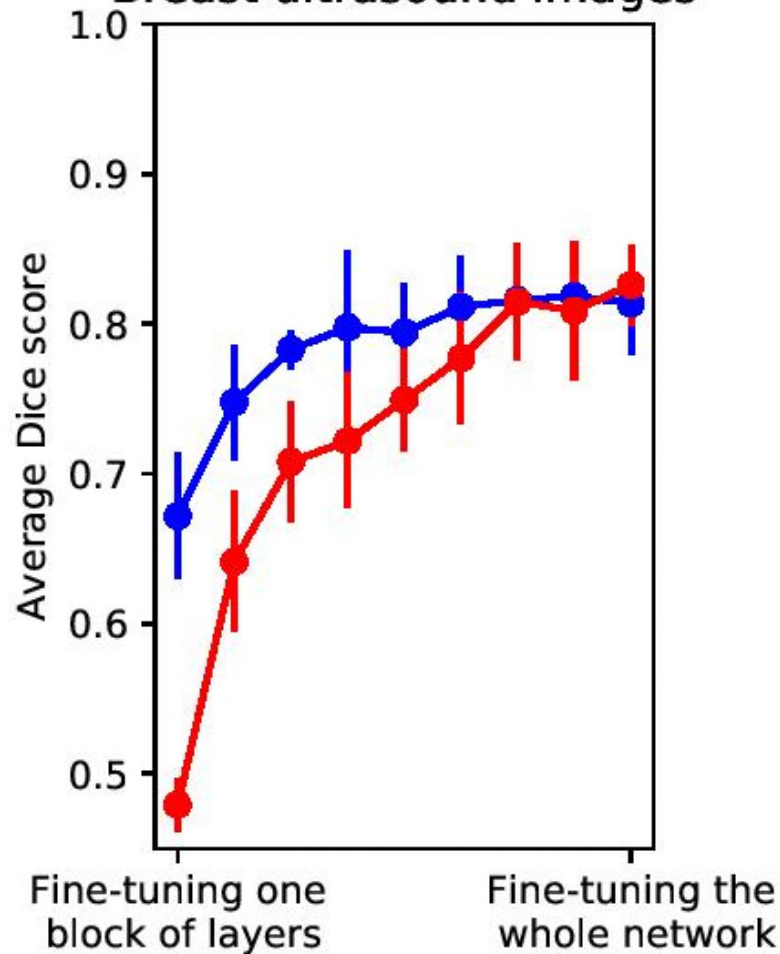
Fine-tuning expanding path

Fine-tuning contracting path

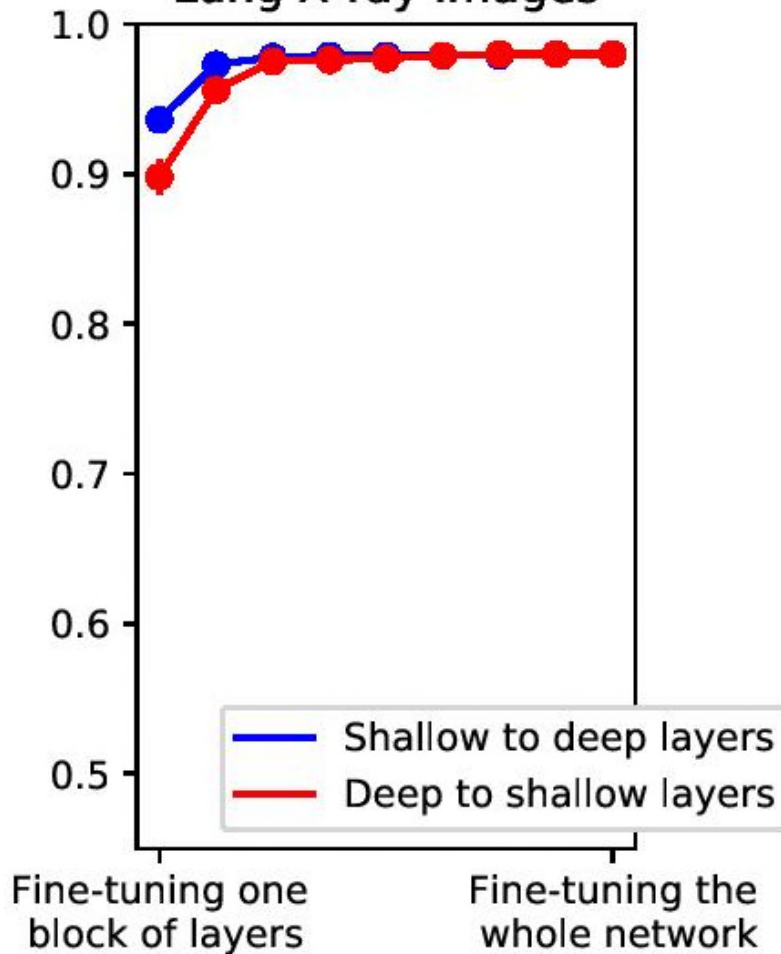


# Results

### Breast ultrasound images



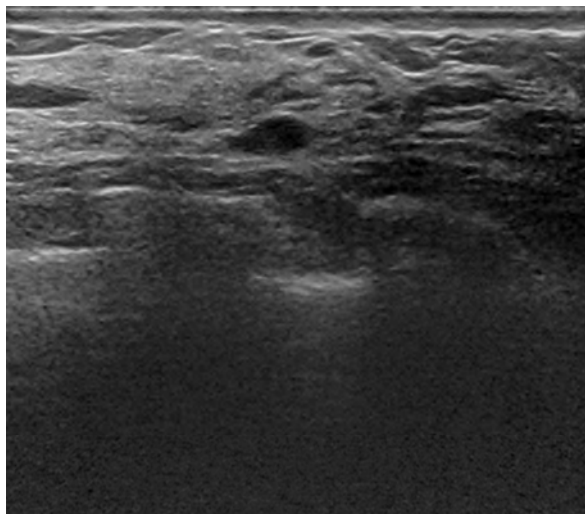
### Lung X-ray images



# Conclusion

- In breast ultrasound image segmentation using U-Net, fine-tuning shallow layers of a pre-trained network outperforms fine-tuning deep layers, when a small number of images are available.
- It could be due to the presence of specific low-level patterns such as speckles in this modality, which are associated with shallow layers of the network.
- The behaviour on non-ultrasound data is similar to previously reported results, therefore, we believe the primary cause of the differences are due to the character of the image.

Ultrasound



X-Ray

