Transfer Learning for 3D Images

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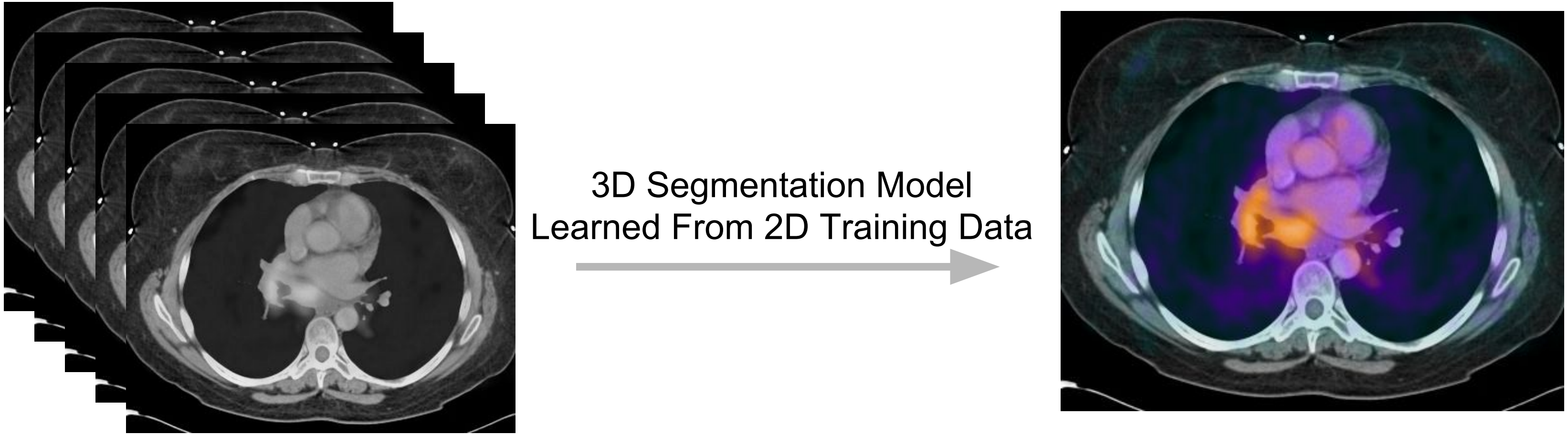
Motivation: Medical Imaging

- Goal: segmentation of 3D scans
- Problem: lack of 3D medical data and pretrained 3D networks

Problem Statement: train model on 2D images, and use transfer learning to apply the model to 3D data

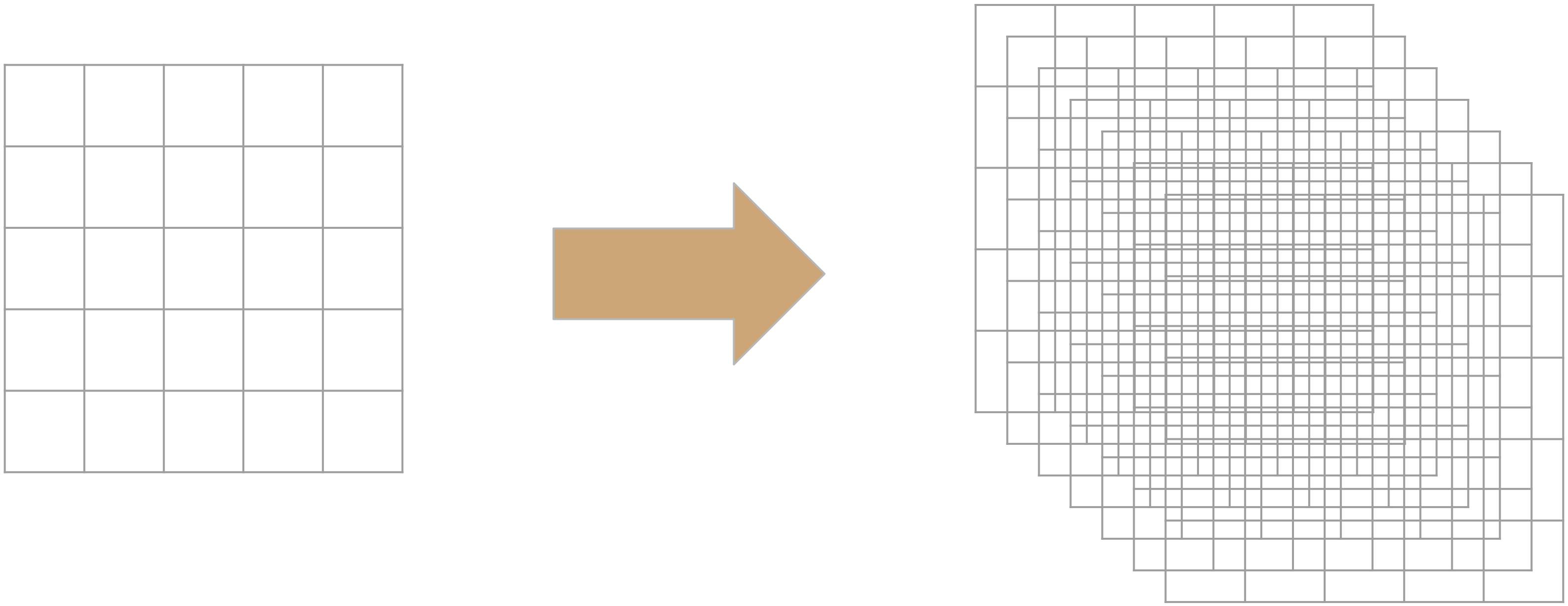


[1]

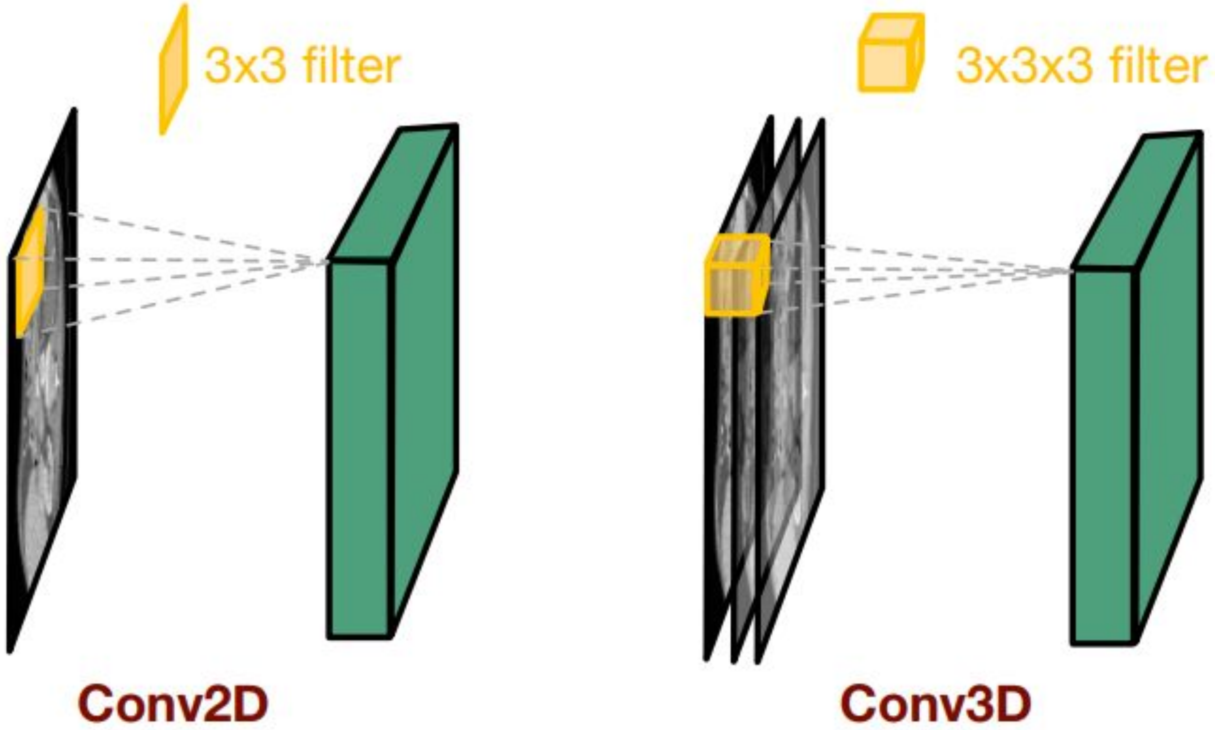
Related Work

- Transfer learning from 2D to 3D for CT scan denoising (GAN) [2]
- No-New-Net (nnU) self-adapting 2D and 3D frameworks for Medical Segmentation Decathlon [4]
- Classification CNN transfer learning from ImageNet to 2D medical computer aided diagnosis [5]
- Quo Vadis, Action Recognition? A New Model and the Kinetics Dataset [6]

Convert 2D filters to 3D filters



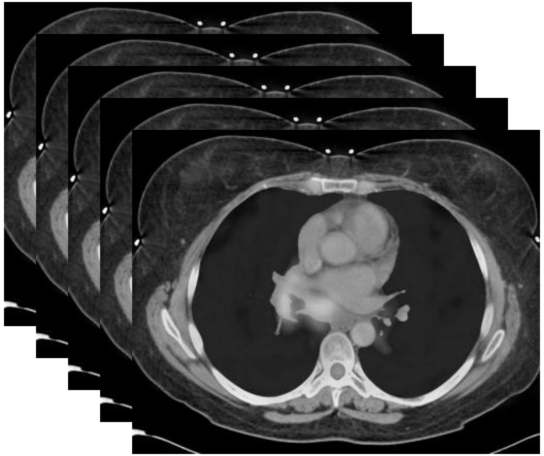
2D filters vs 3D Filters



[2]

Dataset

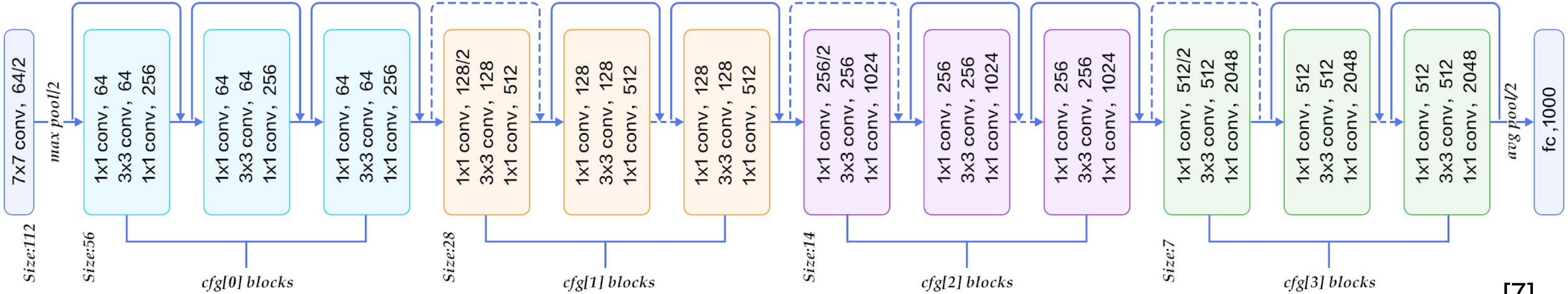
- Pancreas CT scan images from Medical Segmentation Decathlon
- Source: Memorial Sloan Kettering Cancer Institute
- 282 total 3D volumes
- Task: Segment each 3D volume to background, pancreas, tumor



[1]

Approach

- ResNet for image segmentation [3]
    - Pretrained 2D weights on RV-VOC12 (20 classes, ~10,000 images)
- Finetune ResNet on our data
- Baseline: train on 2D slices
- Modified to learn 3D weights by extending the 2D net [2]
- Transfer learning: trained weights on 3D pancreas data set



[7]

Experiments: convert 2D filters to 3D

- Zero weight Initialization

$$W^{(3D)} = \begin{cases} W^{(2D)}, & \text{if } t = 1 \\ O, & \text{otherwise.} \end{cases}$$

- Initialization by Averaging

$$W_t^{(3D)} = \frac{W^{(2D)}}{T}, \forall t \in \{1, ..., T\}$$

- Initializing by Scaling

$$W_t^{(3D)} = \alpha_t * W^{(2D)}, \text{ where } \alpha_t > 0 \text{ and } \sum_{t=1}^{T} \alpha_t = 1$$

[8]

Future Work

- Look into other ways of extending 2D filters to 3D
- Use a pre-trained network that is trained on Medical Data
- Try this method on other data from Medical Decathlon

References

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[2] Y. Z. Q. Y. U. K. M. K. K. L. S. W. C. G. W. Hongming Shan, "3D Convolutional Encoder-Decoder Network for Low-Dose CT via Transfer Learning from a 2D Trained Network," in IEEE TRANSACTIONS ON MEDICAL IMAGING, 2018.
[3] D. a. P. V. a. A. M. a. A. M. a. N. N. Pakhomov, "Deep Residual Learning for Instrument Segmentation in Robotic Surgery," *arXiv preprint arXiv*:1703.08580, 2017.
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[5] H.-C. Shin, H. R. Roth, M. Gao, L. Lu, Z. Xu and J. Y. D. M. R. M. S. Isabella Nogues, "Deep Convolutional Neural Networks for Computer-Aided Detection: CNN Architectures, Dataset Characteristics and Transfer Learning," *IEEE Transactions on Medical Imaging*, vol. 35, no. 5, pp. 1285-1298, 2016.
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[7]J. Utrera, "Deep Learning using Python + Keras (Chapter 3): ResNet," 18 Jun 2018. [Online]. Available: https://www.codeproject.com/Articles/1248963/Deep-Learning-using-Python-plus-Keras-Chapter-Re. [Accessed Dec 2018].
[8] N. S. a. R. S. Elman Mansimov, "Initialization Strategies of Spatio-Temporal Convolutional Neural Networks," 2015.