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CONVOLUTIONAL NEURAL NETWORKS FOR BONE LESION DETECTION IN MEDICAL IMAGING DATA

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Abstract

Bone lesions are one of the symptoms of Multiple Myeloma. Automatic detection of lesions can lead to earlier treatment.
Here, we present an approach to detect bone lesions in computed tomography and magnetic resonance imaging volumes, based on convolutional neural networks and transfer learning. A three channel patch extraction method is introduced.
Finally, a sliding window approach is used to detect lesions in whole body scans.

Patch Extraction

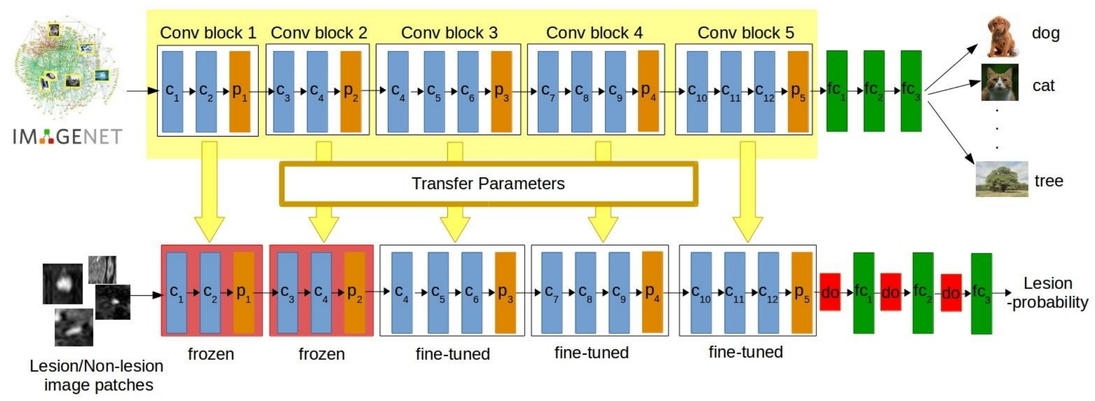
- **Single Channel Patches**: Gray-scale patches are extracted and fed to each input channel of the network
- **Three Channel Patches:** Make use of the three input channels of the CNN used. Different information is encoded into each of the channels.

When using CT the three channel patch extraction encodes a low-attenuation, high-attenuation and a soft tissue window. The combined image patch is shown on the right.

Learning Protocols

The network used is based on the VGG-16 [1] architecture. The CNN is adapted to output a single probability value of seeing a lesion. Dropout [2] is used as a regularization strategy.

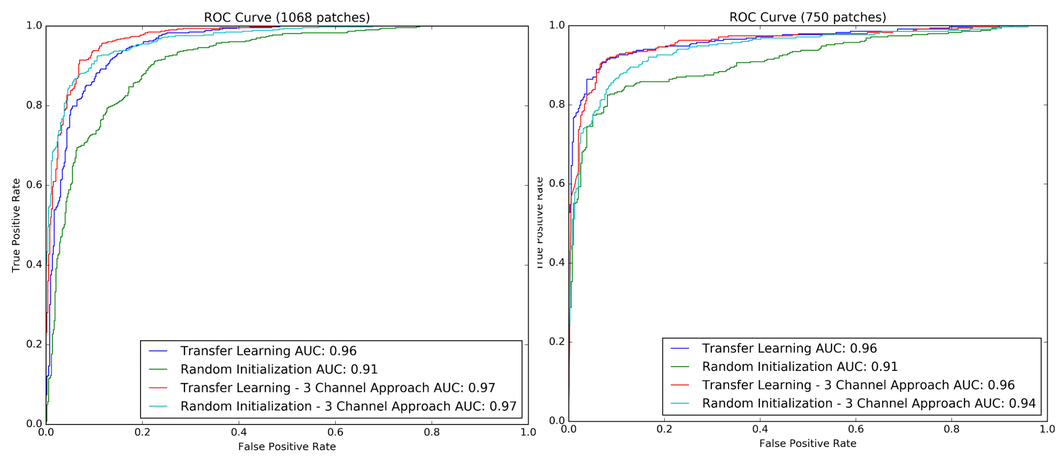
- **Random Initialization** trains the network from scratch on lesion/non-lesion patches.
- **Transfer Learning** transfers knowledge from a source domain (natural image classification) to a target domain. In the target domain (lesion/non-lesion classification) the network is fine-tuned.



Results

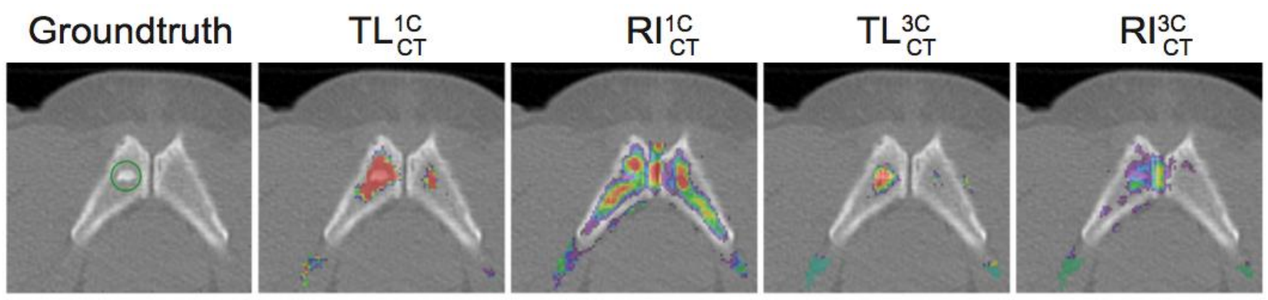
In order to compare results of the different patch extraction strategies as well as the learning protocols four models are trained for each modality:

		Patch extraction	
		Single channel	Three channels
CT	Transfer Learning	$\mathbf{TL}_{CT}^{1C}$	$\mathbf{TL}_{CT}^{3C}$
	Random Initialization	$\mathbf{RI}_{CT}^{1C}$	$\mathbf{RI}_{CT}^{3C}$
MRT	Transfer Learning	$\mathbf{TL}_{MR}^{1C}$	$\mathbf{TL}_{MR}^{3C}$
	Random Initialization	$\mathbf{RI}_{MR}^{1C}$	$\mathbf{RI}_{MR}^{3C}$

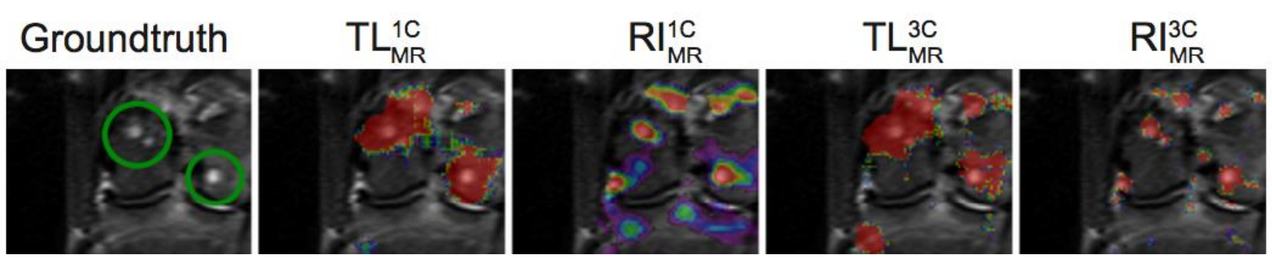


ROC Curve on CT image patches

ROC Curve on MRI image patches



Example for a probability map computed on a CT slice



Example for a probability map computed on a MRI slice

References

[1] Karen Simonyan and Andrew Zisserman. Very deep convolutional networks for large-scale image recognition. In *Proc. International Conference on Learning Representations,* 2015.
[2] Nitish Srivastava, Geoffrey Hinton, Alex Krizhevsky, Ilya Sutskever, and Ruslan Salakhutdinov. Dropout: A Simple Way to Prevent Neural Networks from Overfitting. *Journal of Machine Learning Research*, 15:1929–1958, 2014