Deep Learning based Automatic Quality Control of MRSI

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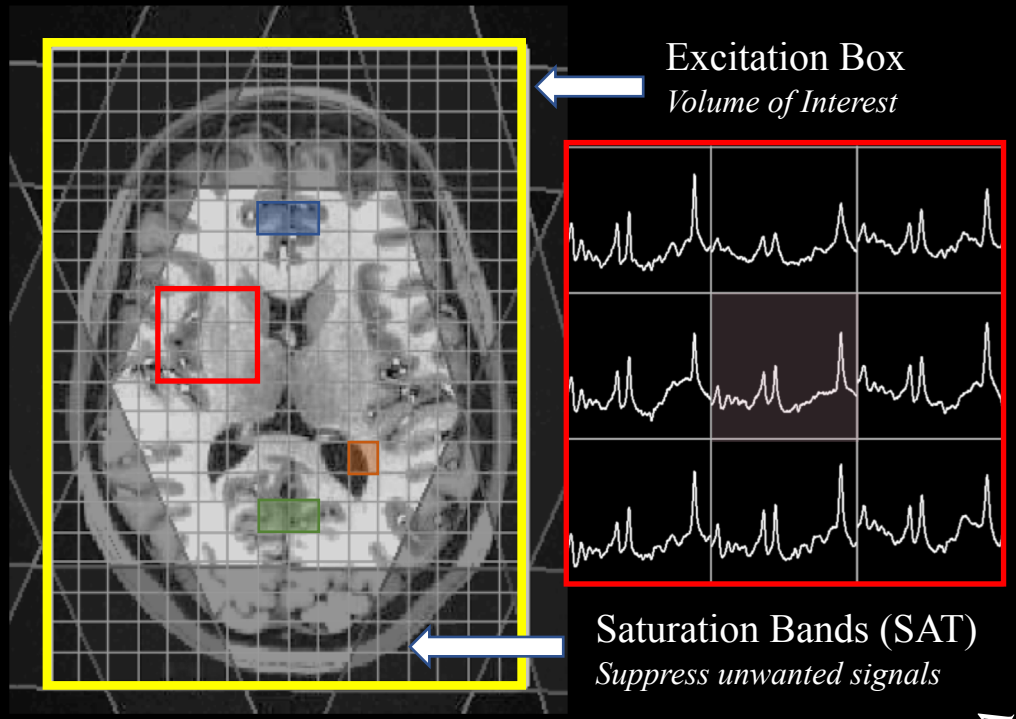
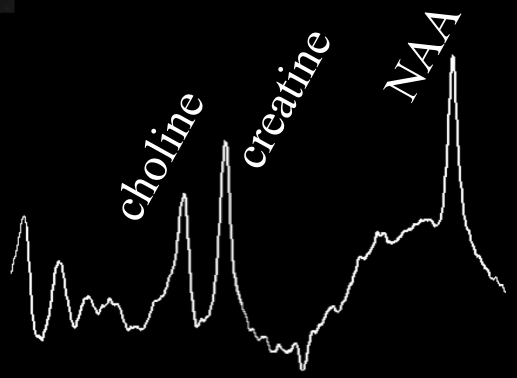
Department of Radiology & Biomedical imaging

Introduction



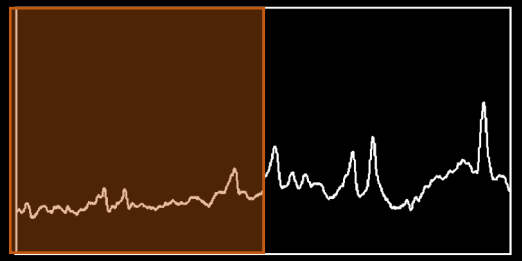
MR Spectroscopic Imaging (MRSI)

noninvasive tool for investigating normal and abnormal brain metabolism

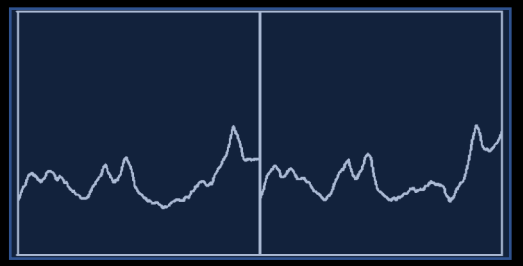


Artifacts in MRSI

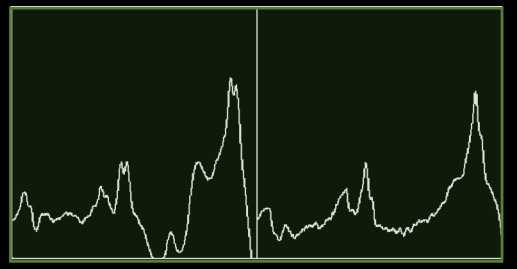
- **Tissue boundary**



- **Inhomogeneity**



- **Insufficient Lipid suppression**



- **Water suppression**
- **Low SNR**
- **Post-processing errors …**

The purpose of this study is to develop a deep learning model to automatically filter spectra with artifacts in healthy controls and patients, greatly decreasing the time to review spectra quality.

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Methods

Population	# Scans	Scanner	# Bad[1]	# Usable	Brain Atlas?
Healthy Controls	10	7T	2051	2330	yes
Major Depressive Disorder	10	7T	1698	2374	yes
Multiple Sclerosis	10	7T	2433	1547	yes
Parkinson's Disease	10	7T	2641	1689	yes
Brain Tumor	10	3T	2418	2557	no

usable voxels: 10497

bad voxels: 11241

Total voxels: 21738

[1] Within the excited volume, bad voxels were defined by using LcModel CRLB, brain mask, and manual selection by Dr. Yan Li.

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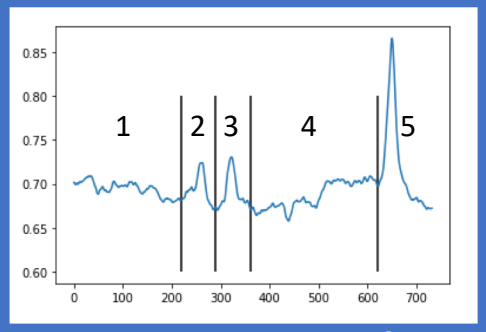
Methods

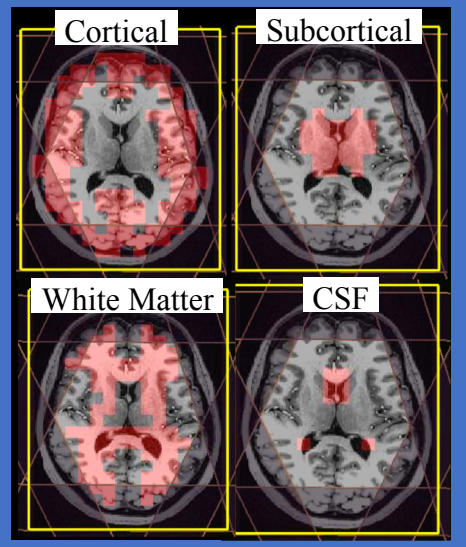
Processed Spectra Data

Scale spectrum arrays, separate into 5 regions



Position: One-Hot Encoded Vector

Input: Spectrum Position



Input: region 1

Input: region 2

Input: region 5

Convolutional Layers

Concatenate

Dense Layers

Output Probability

Label: [1.0, 0.0] = [usable, bad]

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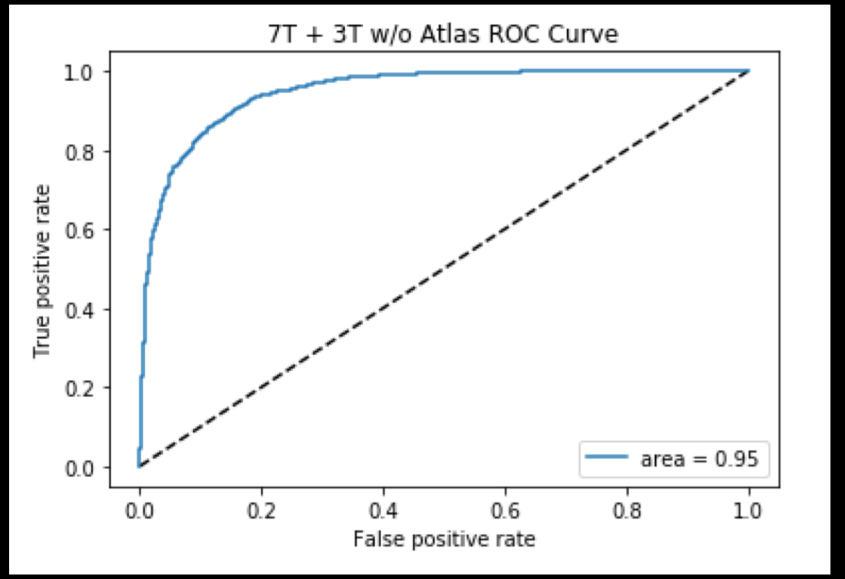
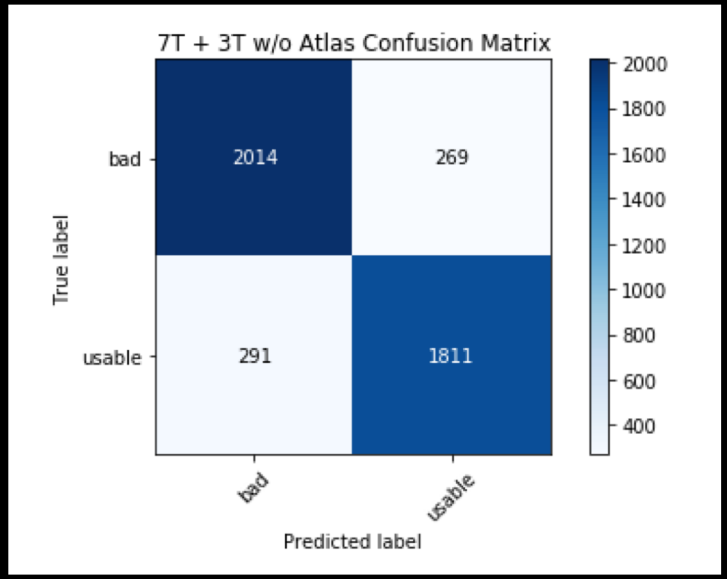
Results





Models	# Training Datasets	# Training voxels	Evaluation Datasets	Accuracy	ROC AUC	Sensitivity	Specificity
7T w/o brain atlas	32	10, 200	8	0.89	0.95	0.90	0.88
7T w/ brain atlas	32	10, 200	8	0.88	0.95	0.90	0.86
7T + 3T w/o brain atlas	40	13, 014	10	0.87	0.95	0.86	0.88
Published paper[2]					0.95		

[2]"A Convolutional Neural Network to Filter Artifacts in Spectroscopic Magnetic Resonance Imaging" (2018) – Gurbani et al.

Discussion

The model trained with brain atlas information (7T w/ brain atlas), when compared to the model without brain atlas (7T w/o brain atlas), barely saw a change in overall metrics.

We have developed a model (7T + 3T w/o brain atlas), with metrics comparable to published papers, that is able to filter artifacts in MRSI for a variety of patients with different scan types.