

# Machine Learning Methods for Magnetic Resonance Imaging Analysis

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# MRI scan



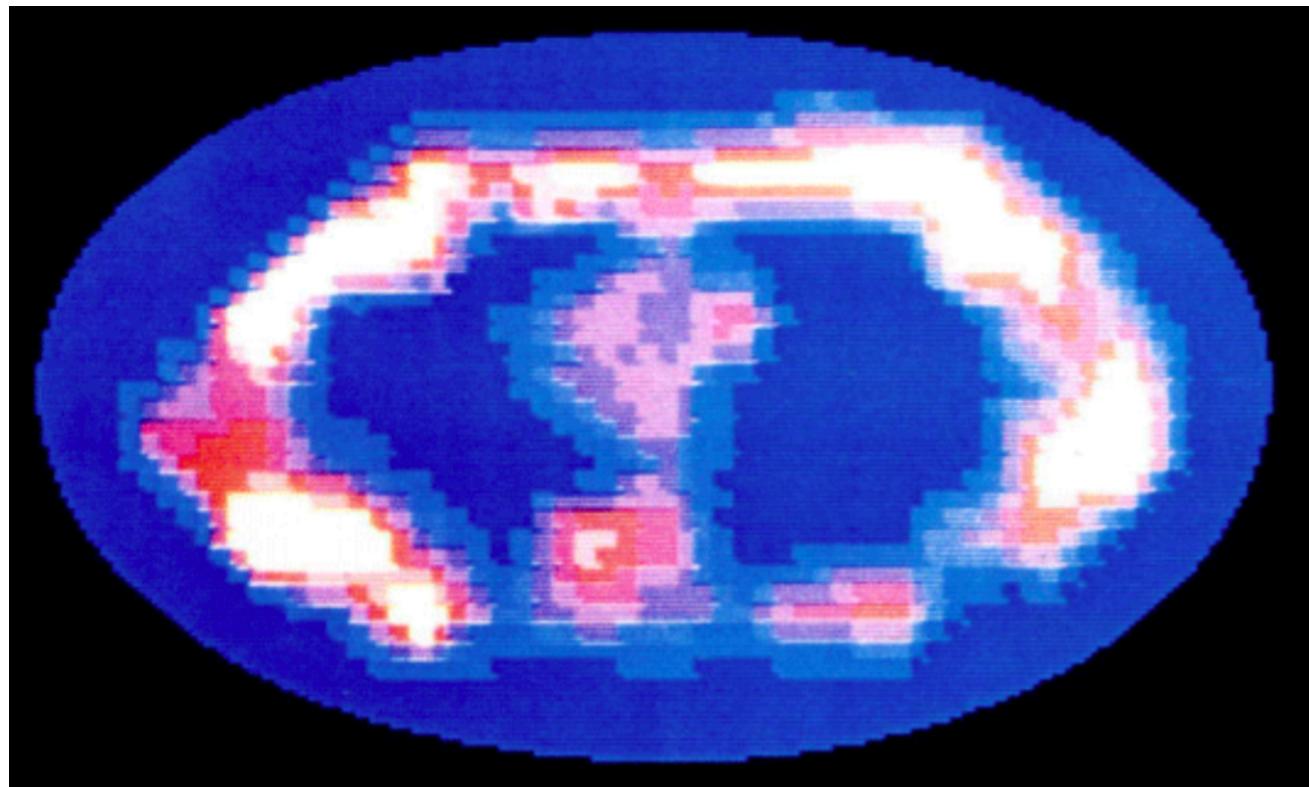
# History of Magnetic Resonance Imaging

- MRI — medical imaging technique used in radiology to form pictures of the anatomy and the physiological processes of the body.
- Originally called NMRI (nuclear magnetic resonance imaging).
- Paul C. Lauterbur — first true MR image (Nature, 1973).
- Peter Mansfield — first image of a human body part, a finger (1977), developed technique that led to scans taking seconds rather than hours and produce clearer images.
- Raymond V. Damadian — first whole-body MR image (1977).
- Vladislav Ivanov — unacknowledged inventor.
- Nobel prize in 2003 — Peter Mansfield and Paul Lauterbur for their discoveries concerning magnetic resonance imaging.

# First MR image of human finger (1977)



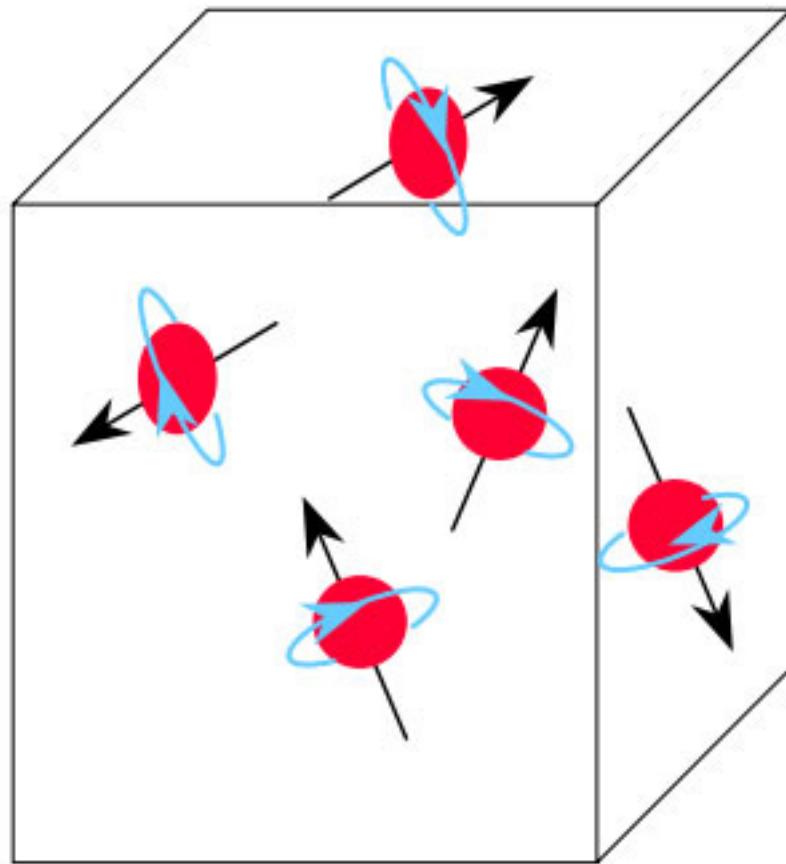
# First MR image scan of human body (1977)



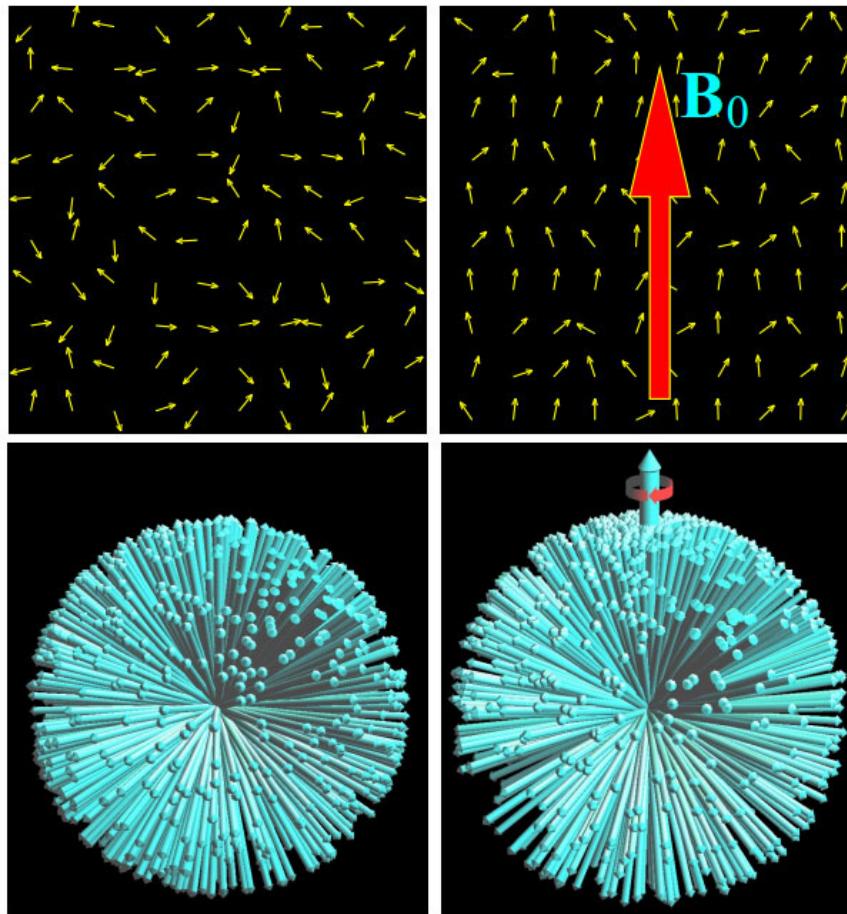
# Magnetic Resonance Imaging Usage

- Material science,
- Archaeology,
- Engineering,
- Medicine:
  - Disease detection throughout the body (neurological diseases, musculoskeletal system diseases ...)
  - Tumors, cysts and other abnormalities,
  - Injuries and abnormalities of the joints (back, knee ...)
  - Diseases of the liver and other abdominal organs.
  - Certain types of heart problems.
  - Anomalies of the brain and spinal cord.
  - Measurement of blood or cerebrospinal fluid flow velocity.

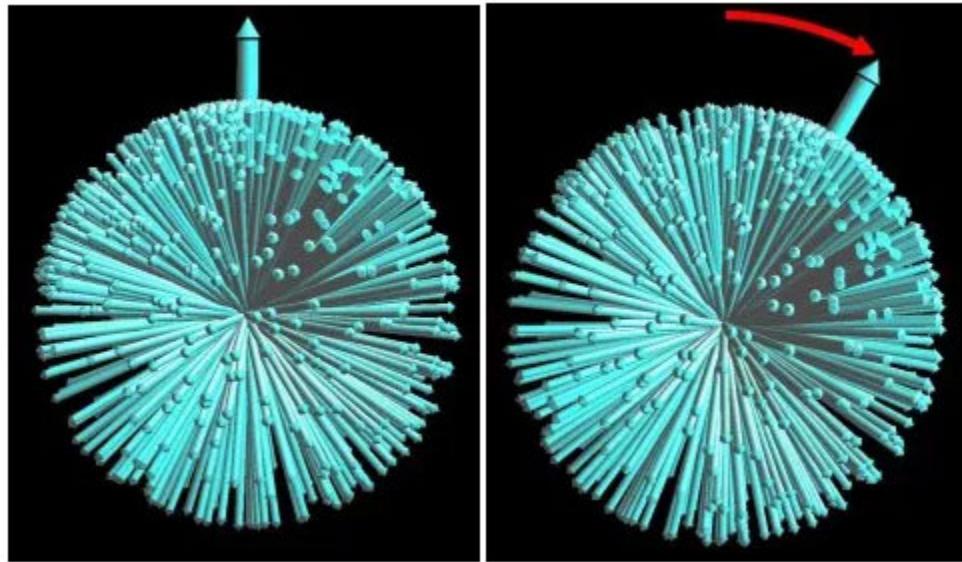
# Principles of Magnetic Resonance Imaging



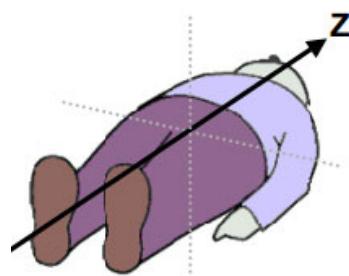
# Principles of Magnetic Resonance Imaging



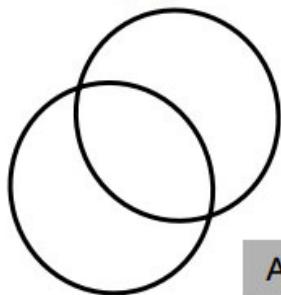
# Principles of Magnetic Resonance Imaging



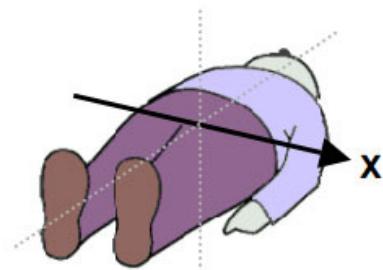
# Principles of Magnetic Resonance Imaging



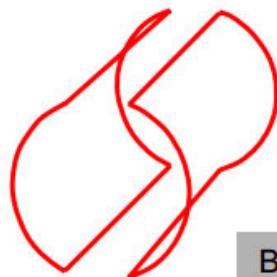
Z Градиент



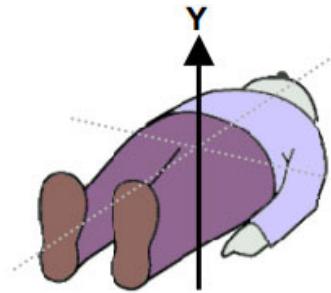
A



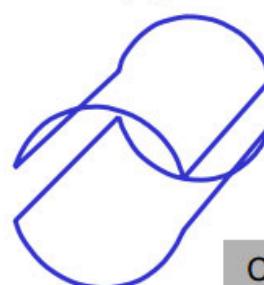
X Градиент



B

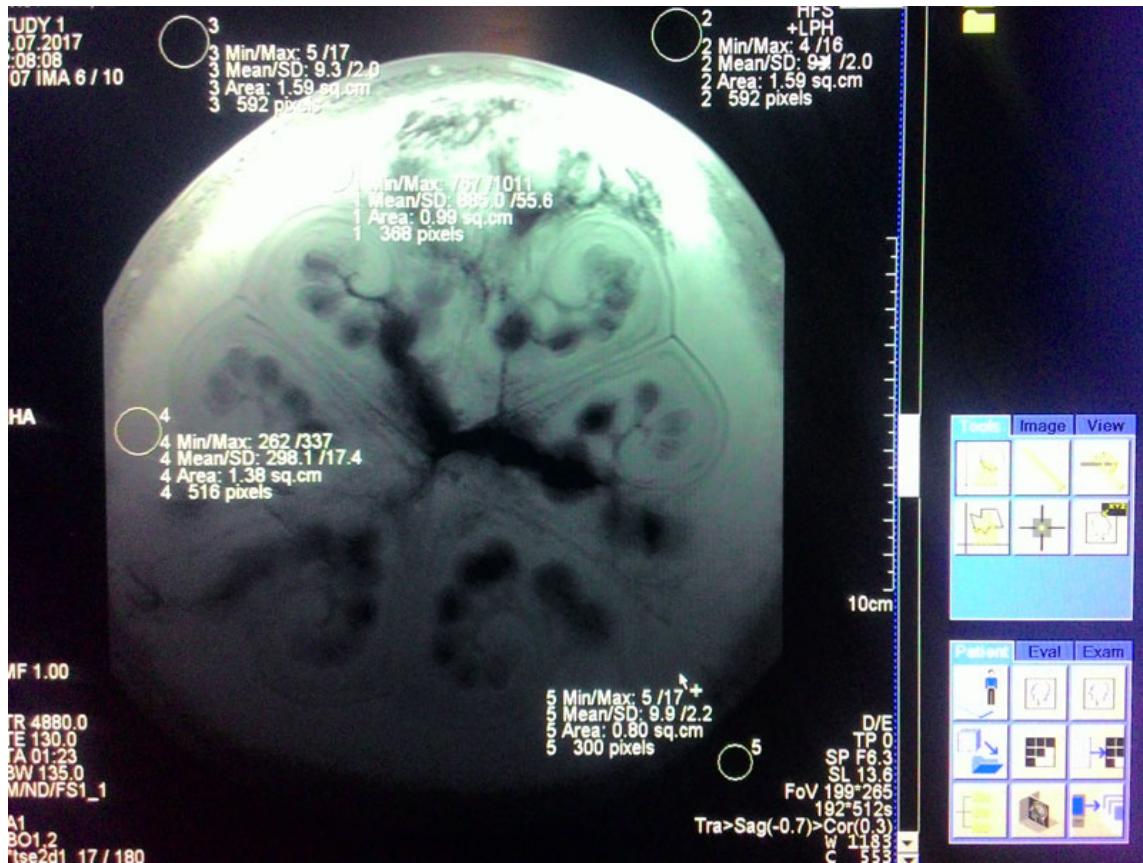


Y Градиент



C

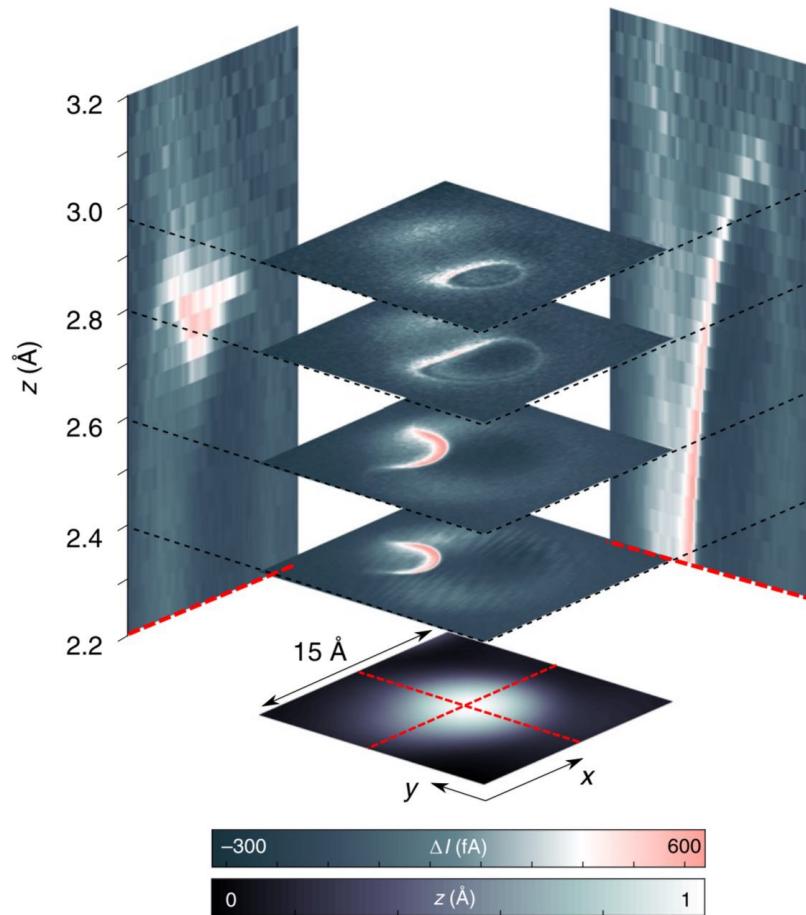
# MRI scan of watermelon



# Parasagittal MRI of head

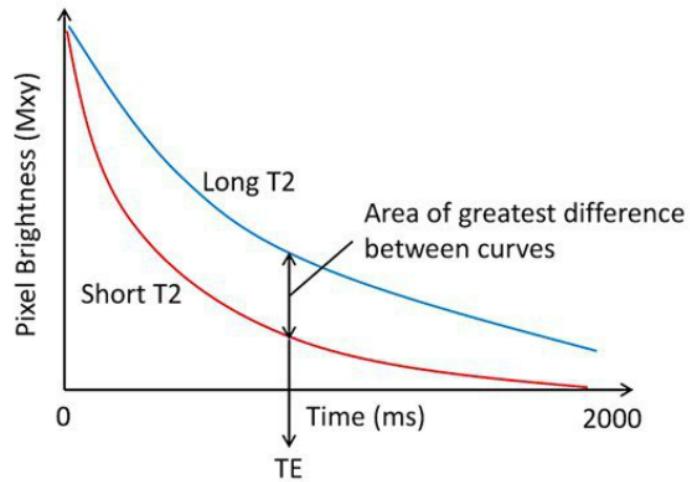
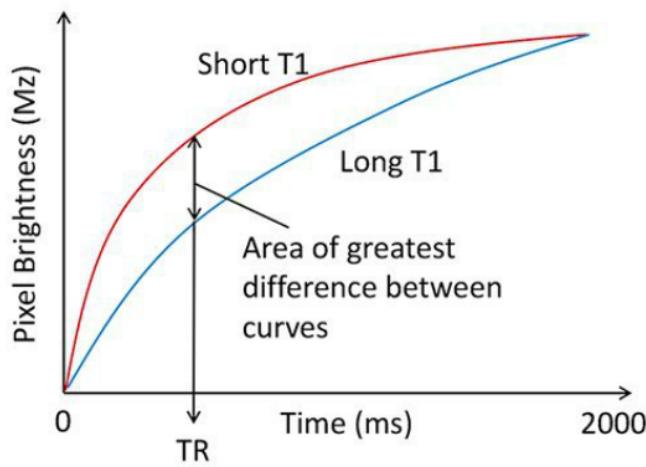
# MRI of beating heart

# MRI of single atoms on a surface



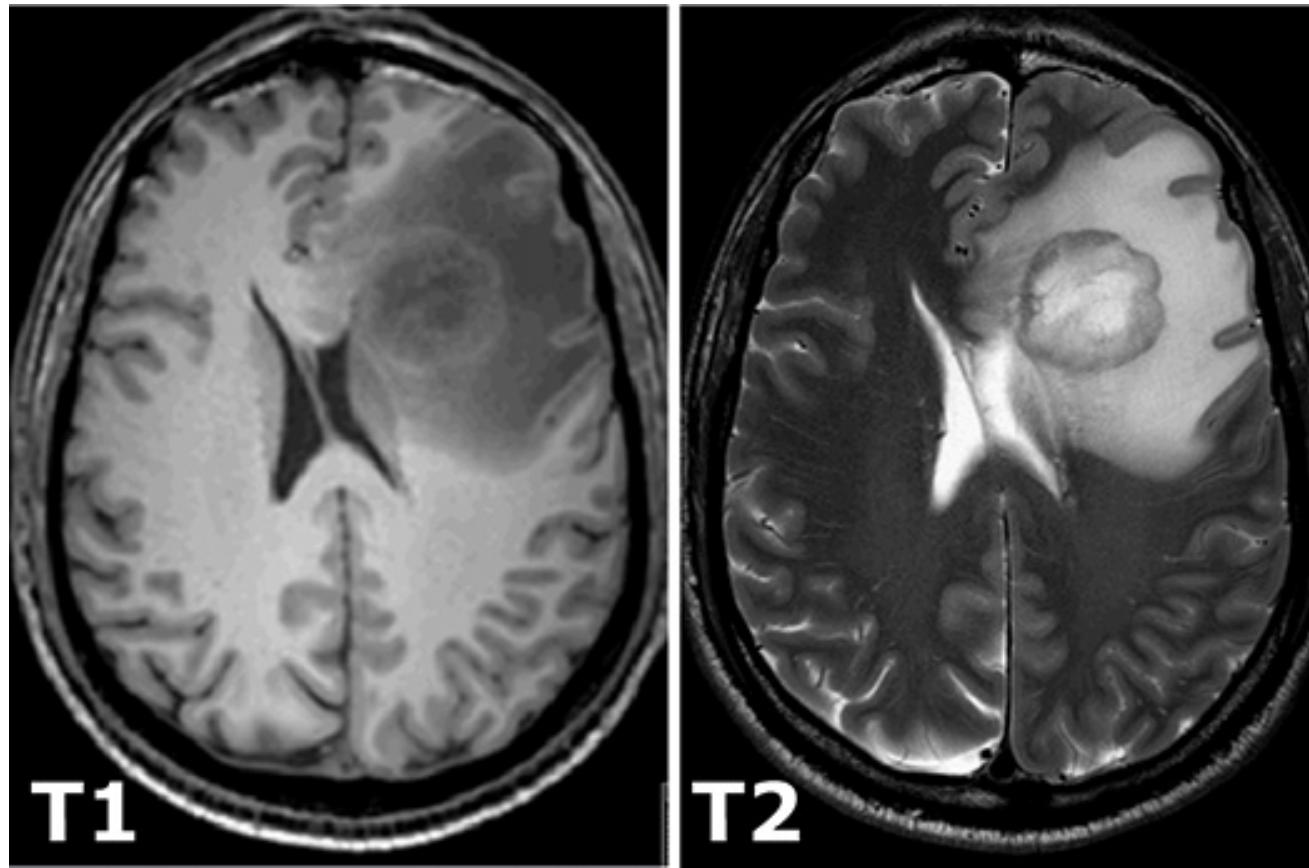
# T1 and T2

T1 — longitudinal relaxation time,  
T2 — transverse relaxation time.



TR — repetition time,  
TE — time of echo.

## T1 and T2

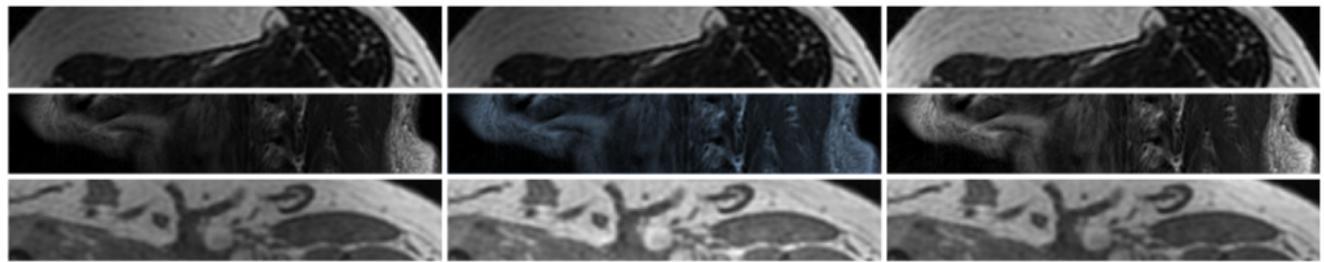


# T1 and T2

Tissue	T1-Weighted	T2-Weighted
CSF	Dark	Bright
White Matter	Light	Dark Gray
Cortex	Gray	Light Gray
Fat (within bone marrow)	Bright	Light
Inflammation (infection, demyelination)	Dark	Bright

# Denoising and other improvements

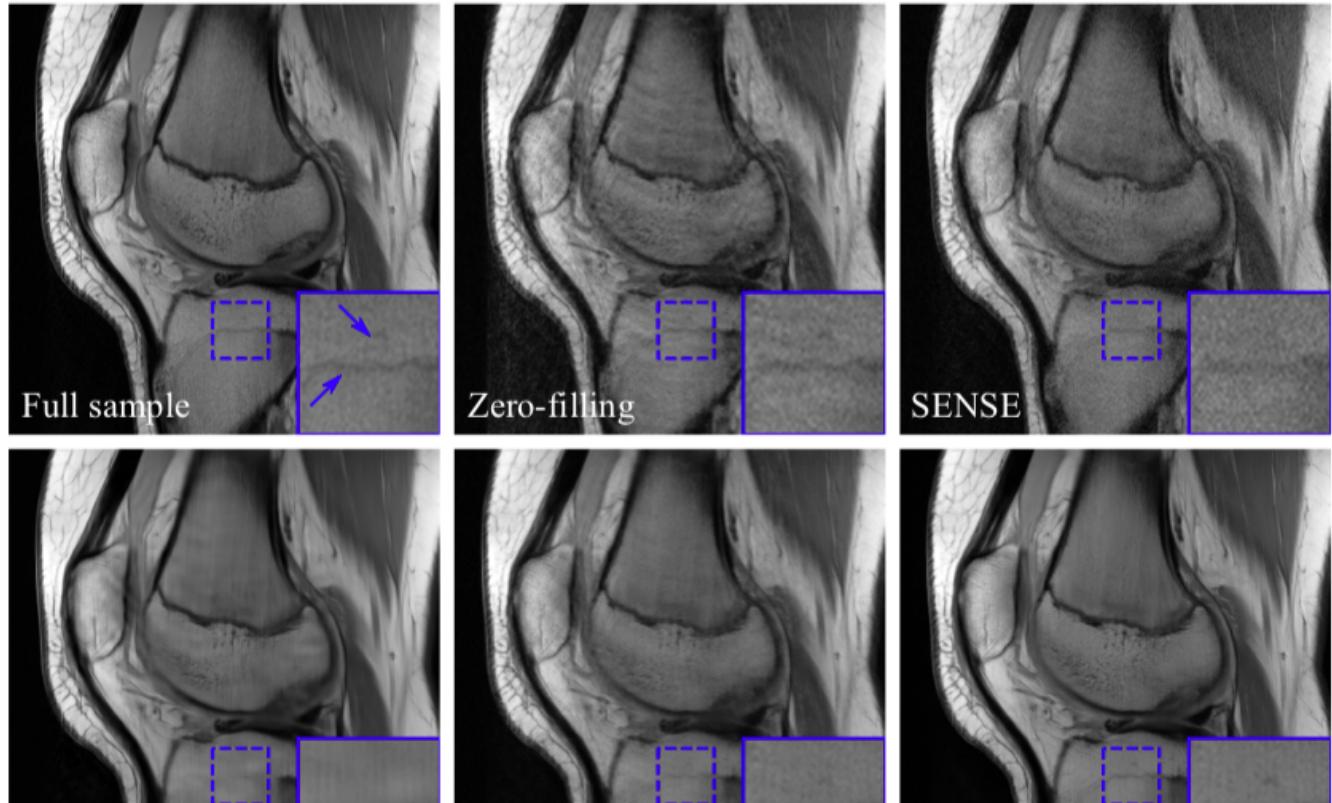
- A Generalized Network for MRI Intensity Normalization.



- Attention Guided Metal Artifact Correction in MRI using Deep Neural Networks

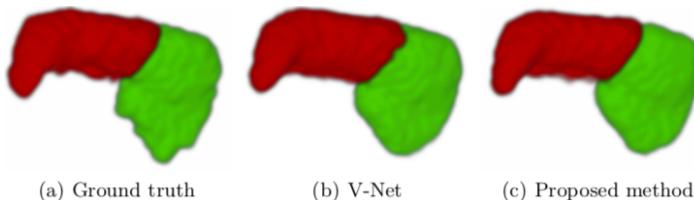
# Denoising and other improvements

- Consensus Neural Network for Medical Imaging  
Denoising with Only Noisy Training Samples



# Segmentation

- Dilated deeply supervised networks for hippocampus segmentation in MRI.



- Automatic Liver and Tumor Segmentation of CT and MRI Volumes Using Cascaded Fully Convolutional Neural Networks

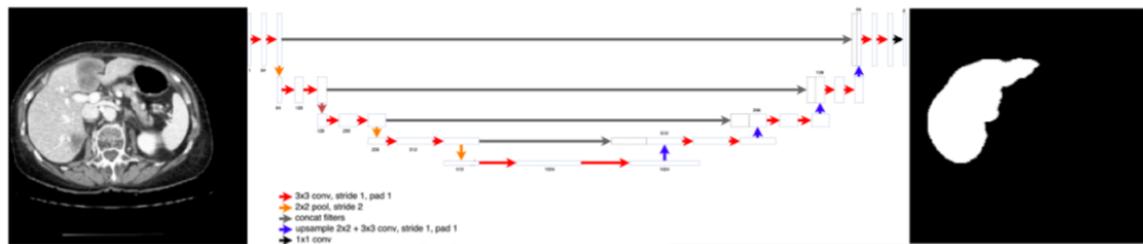
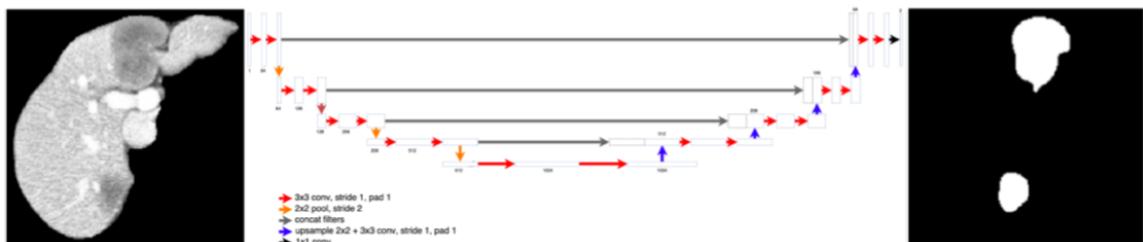
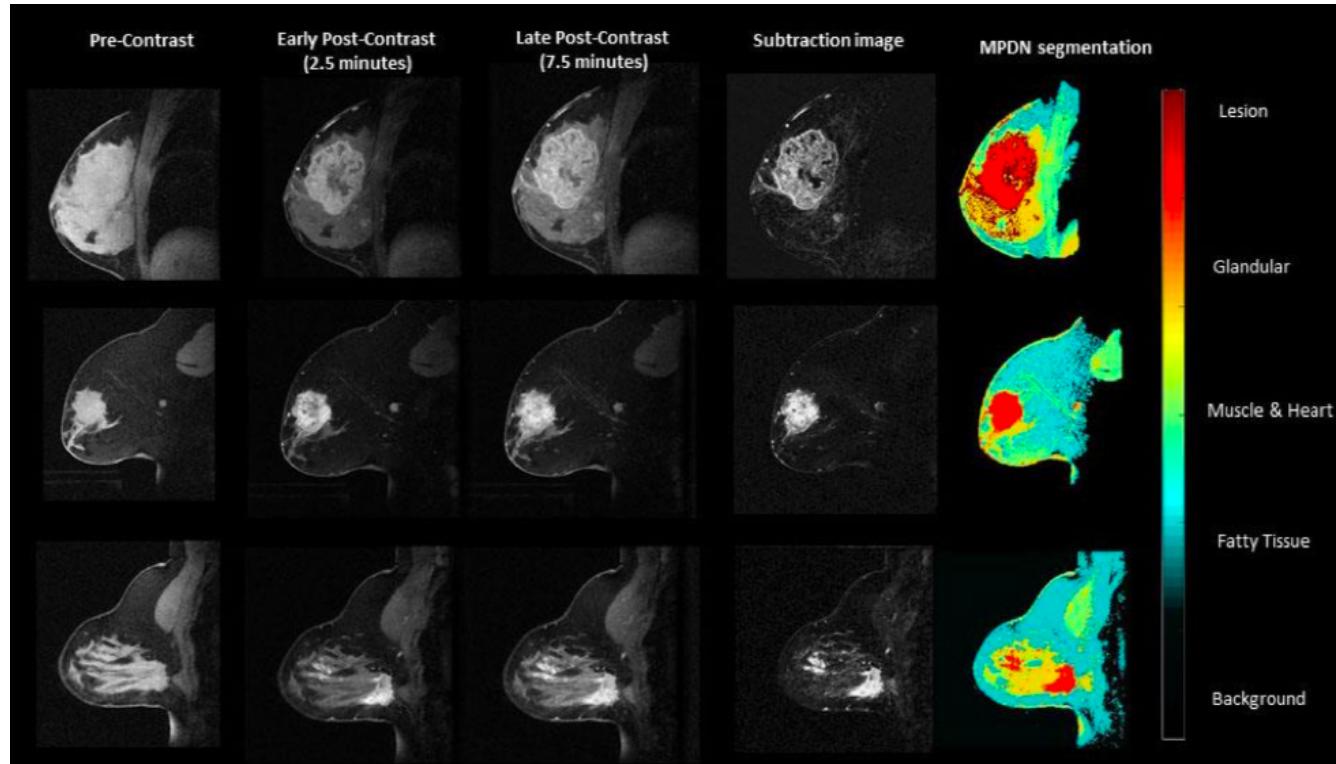


Figure 5: Step 1 of Cascaded FCN: The first U-Net learns to segment livers from a CT slice.



# Tumor detection

- Multiparametric Deep Learning Tissue Signatures for a Radiological Biomarker of Breast Cancer.



# Generating of new scans

- Medical Image Synthesis for Data Augmentation and Anonymization using Generative Adversarial Networks.

