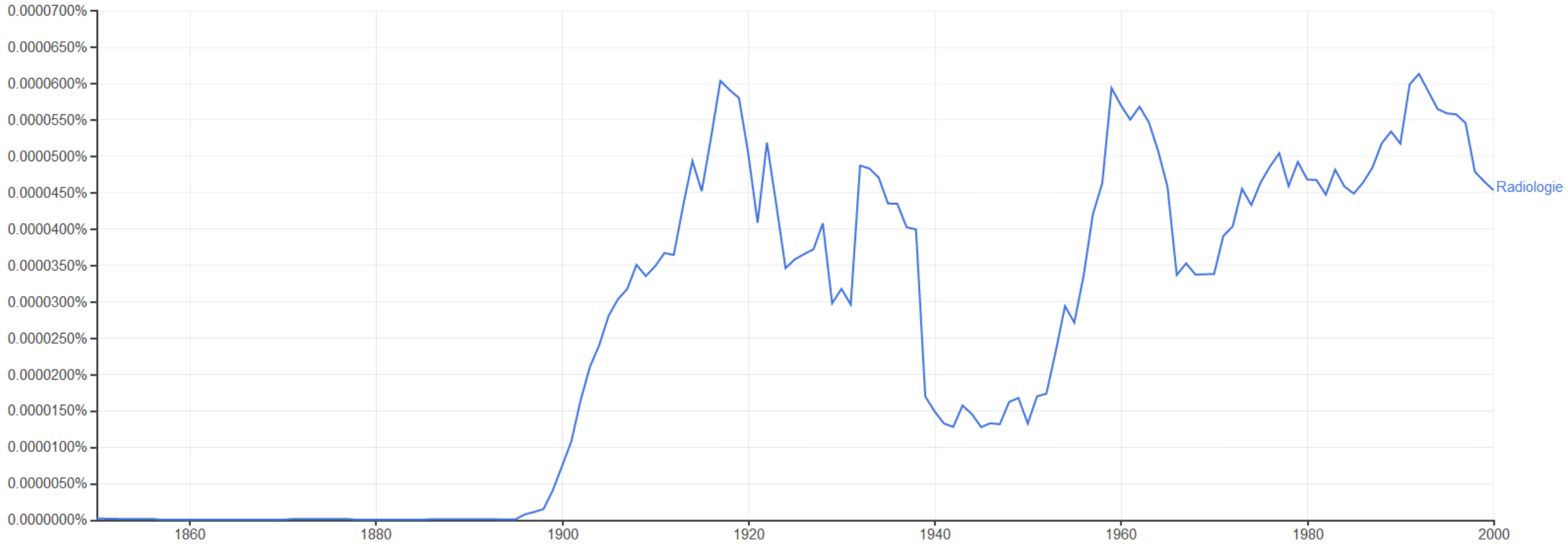
Machine Learning in Radiology

Raphael Meier
University Clinic for Diagnostic and Interventional Neuroradiology,
University Hospital Inselspital, Bern

Google Books Ngram Viewer

Graph these comma-separated phrases: Radiologie case-insensitive

between 1850 and 2000 from the corpus German with smoothing of 3 . Search lots of books



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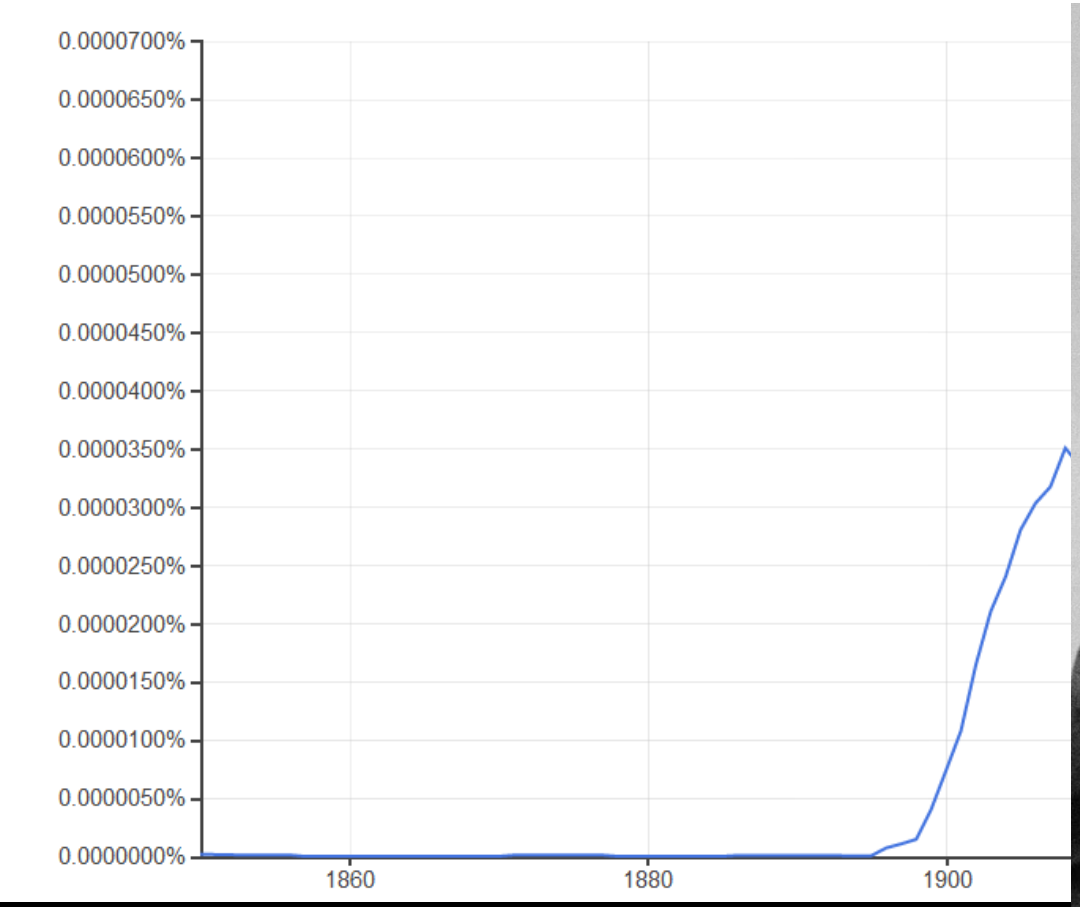

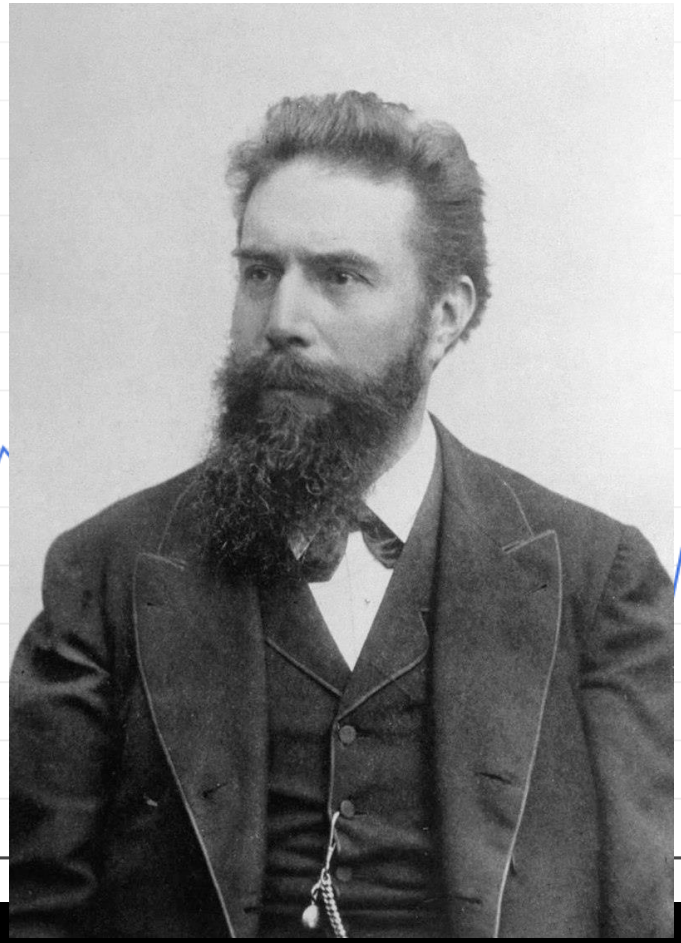

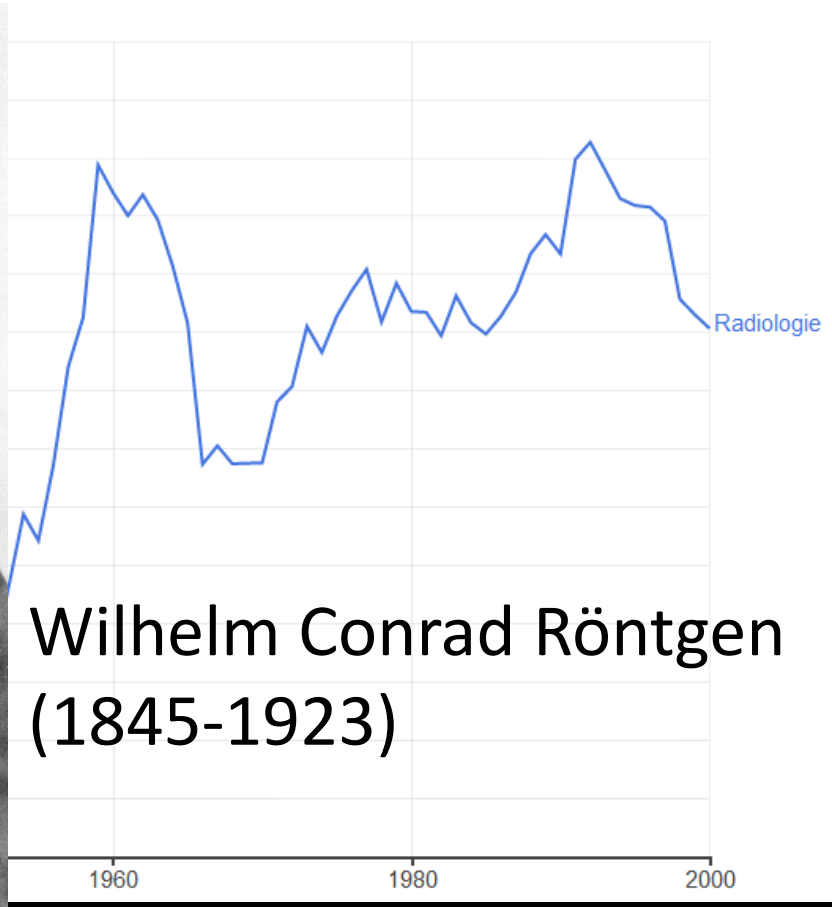

Wilhelm Conrad Röntgen
(1845-1923)

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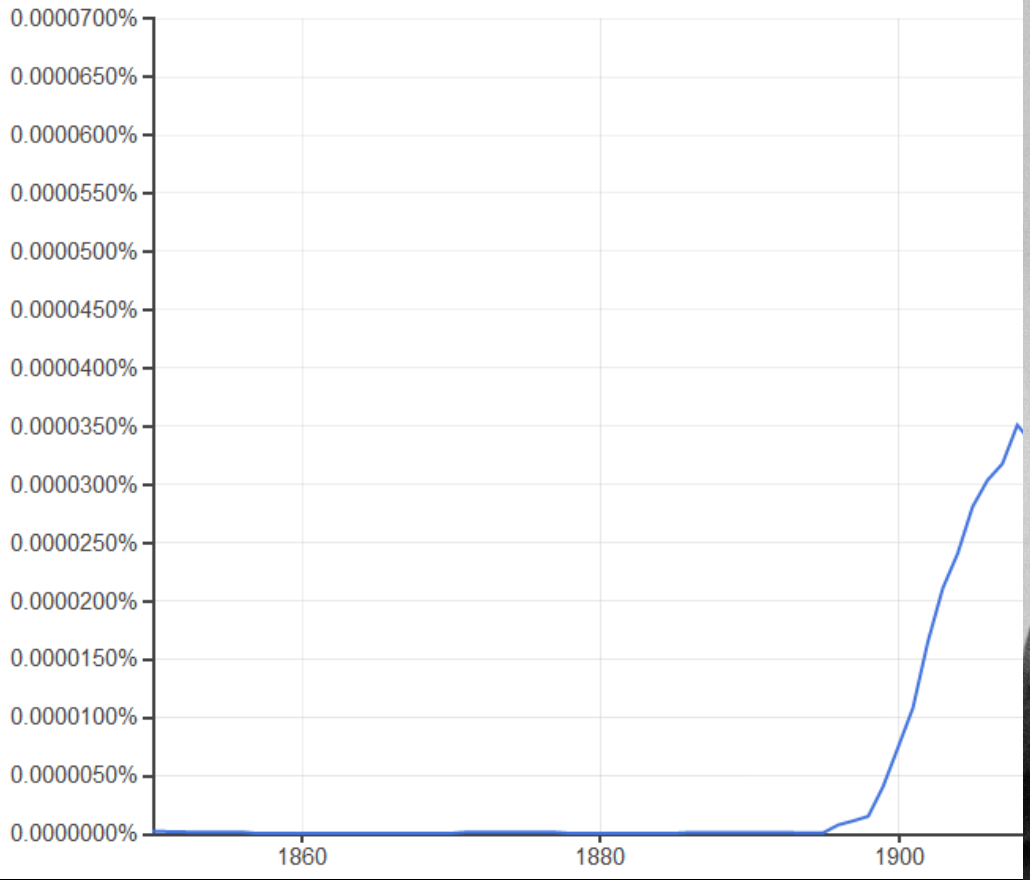

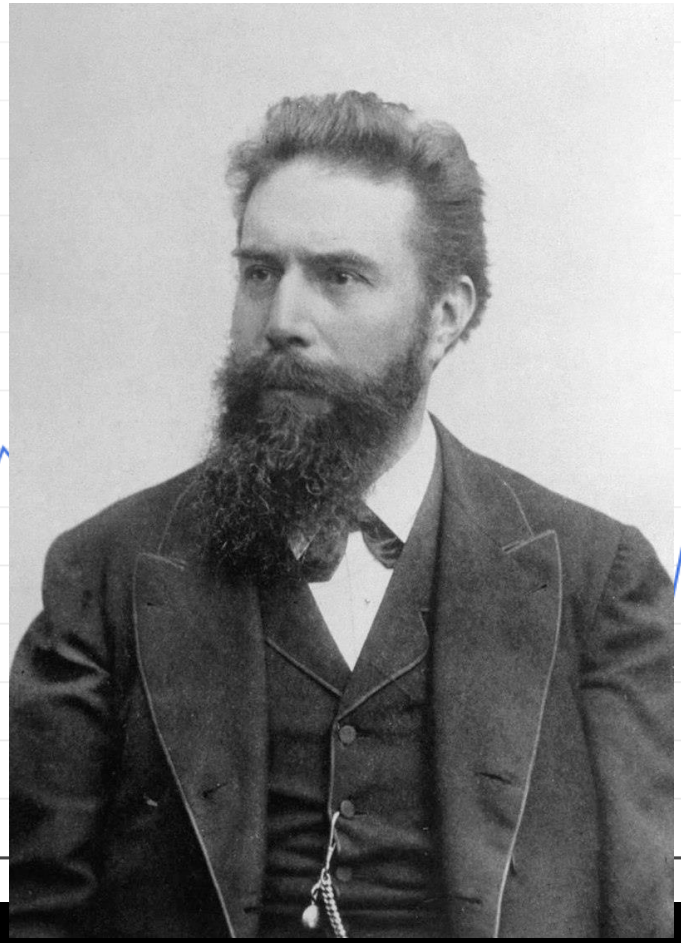

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Source: Wikipedia.org

Google Books Ngram Viewer

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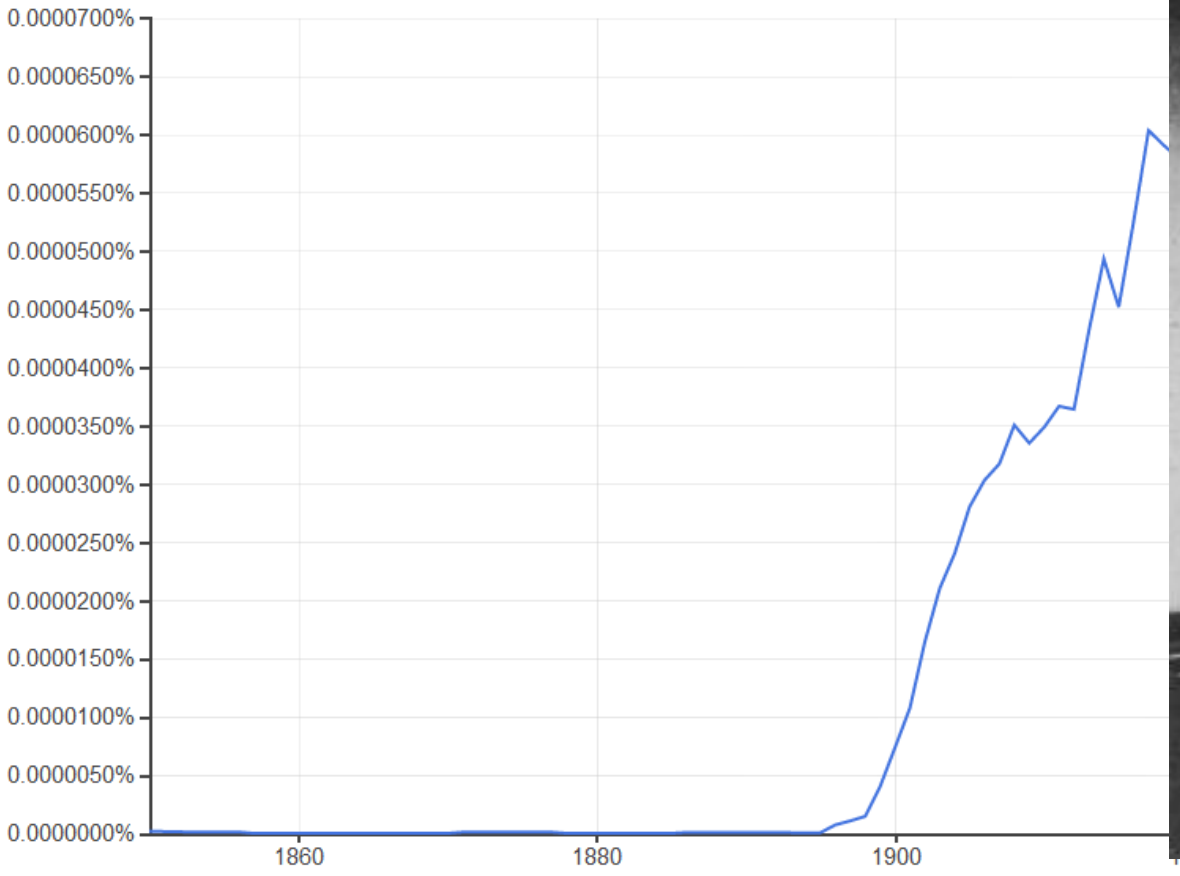
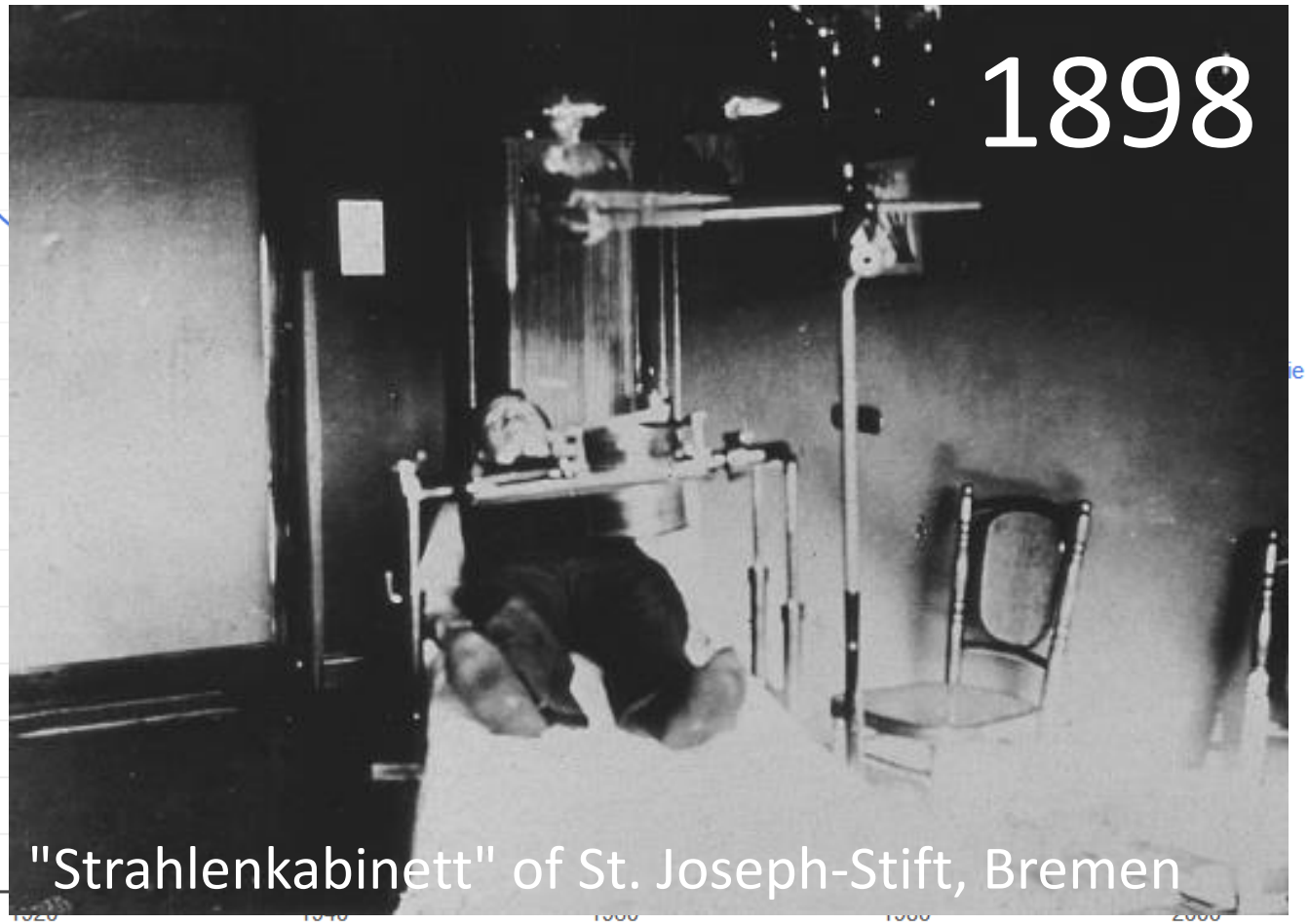
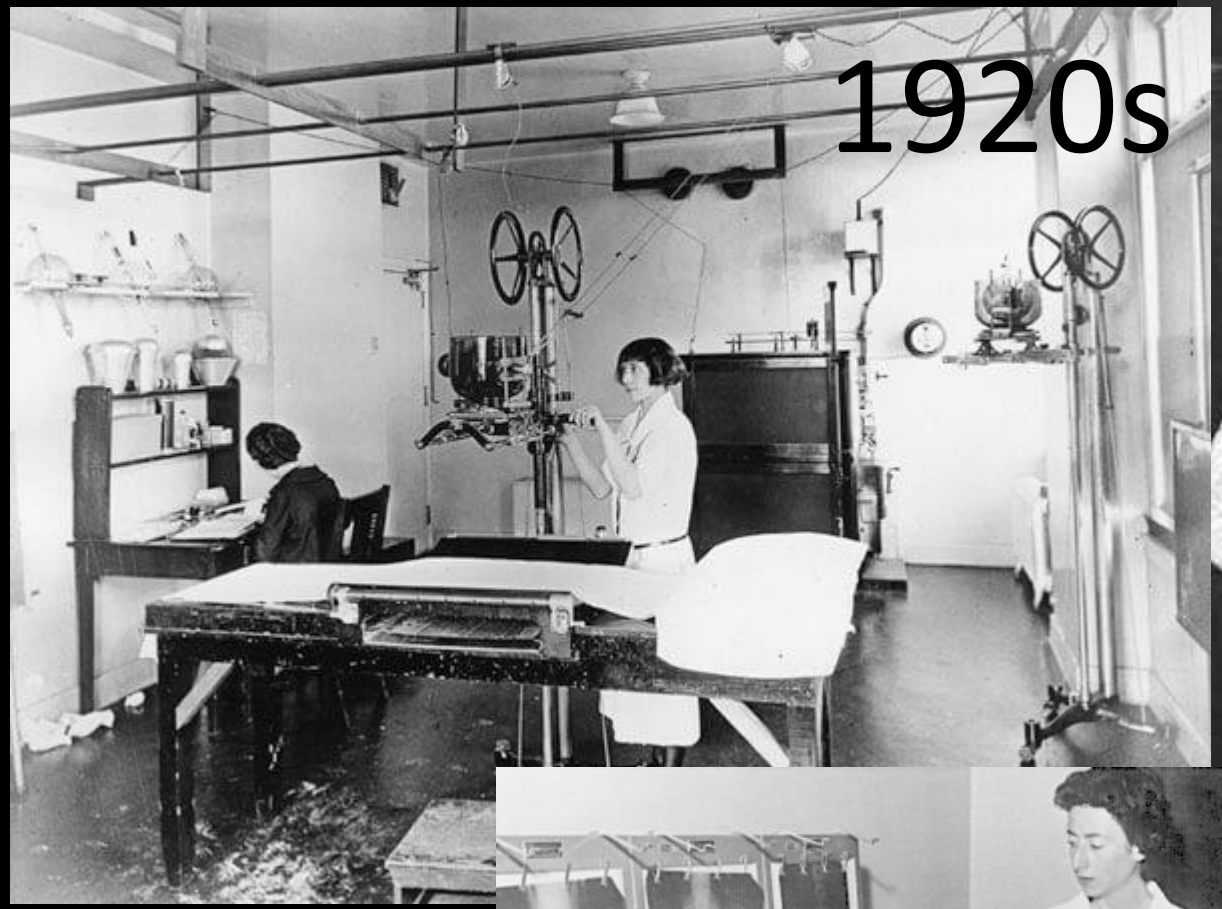
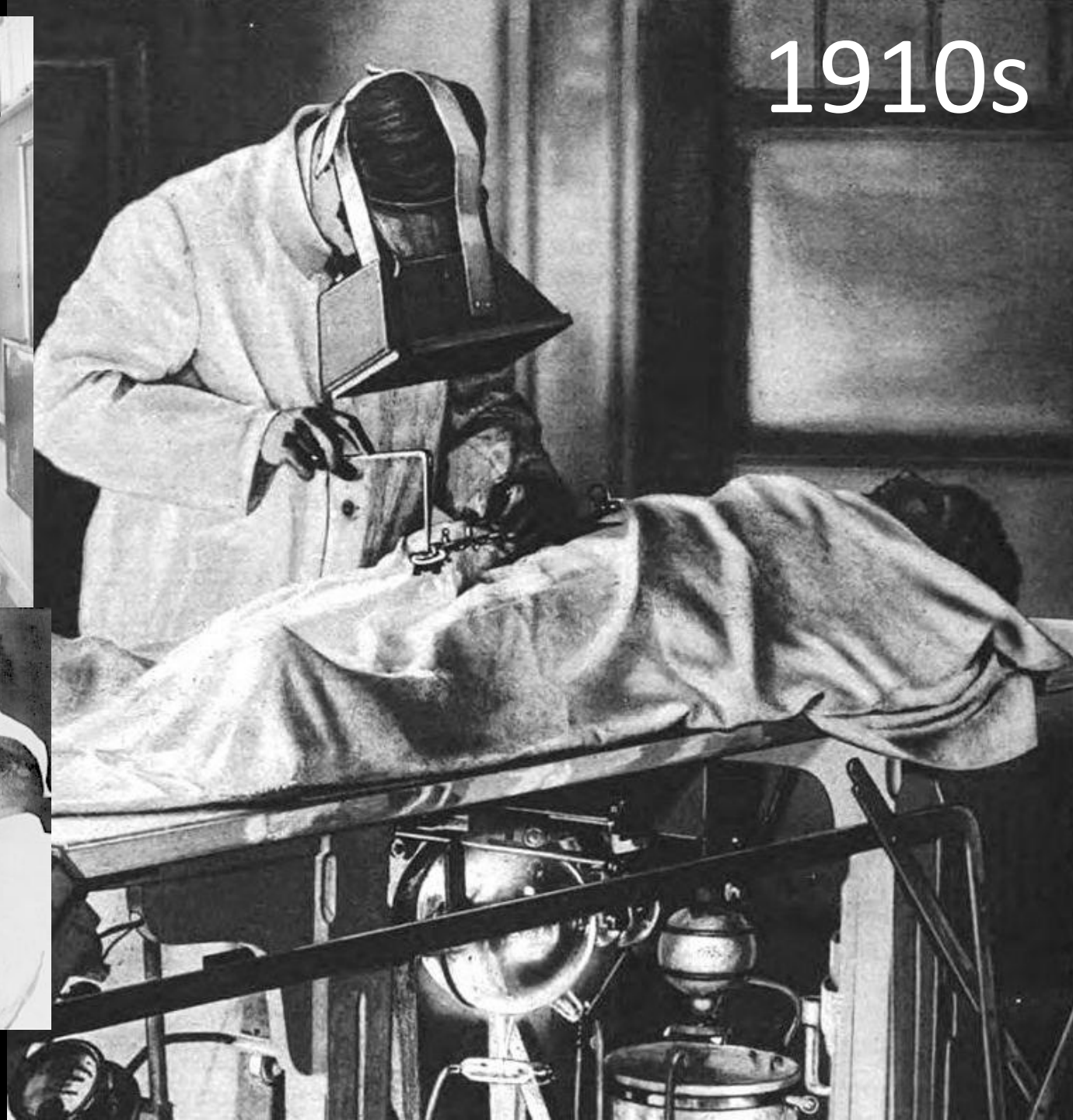


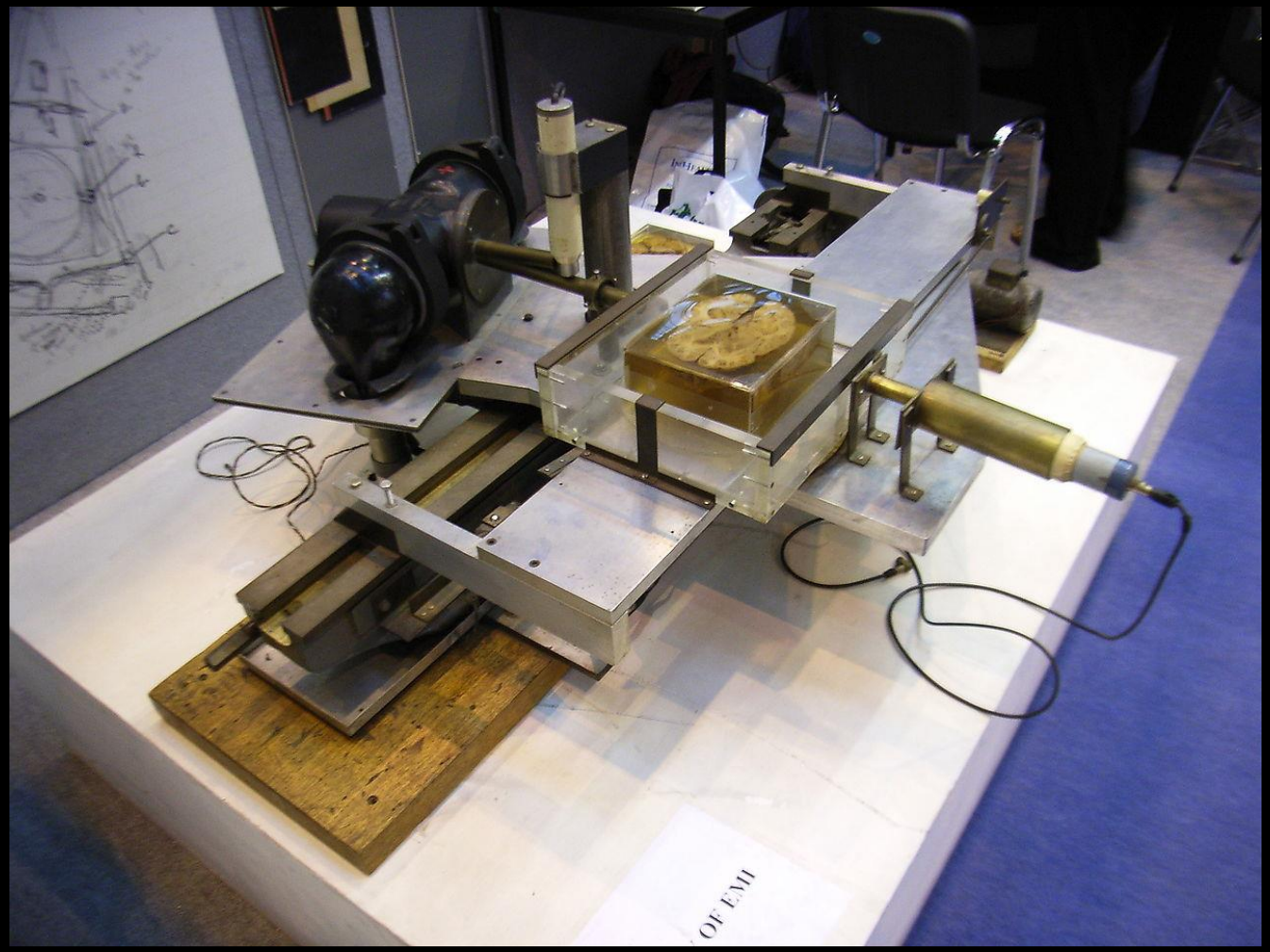


Source: Wikipedia.org

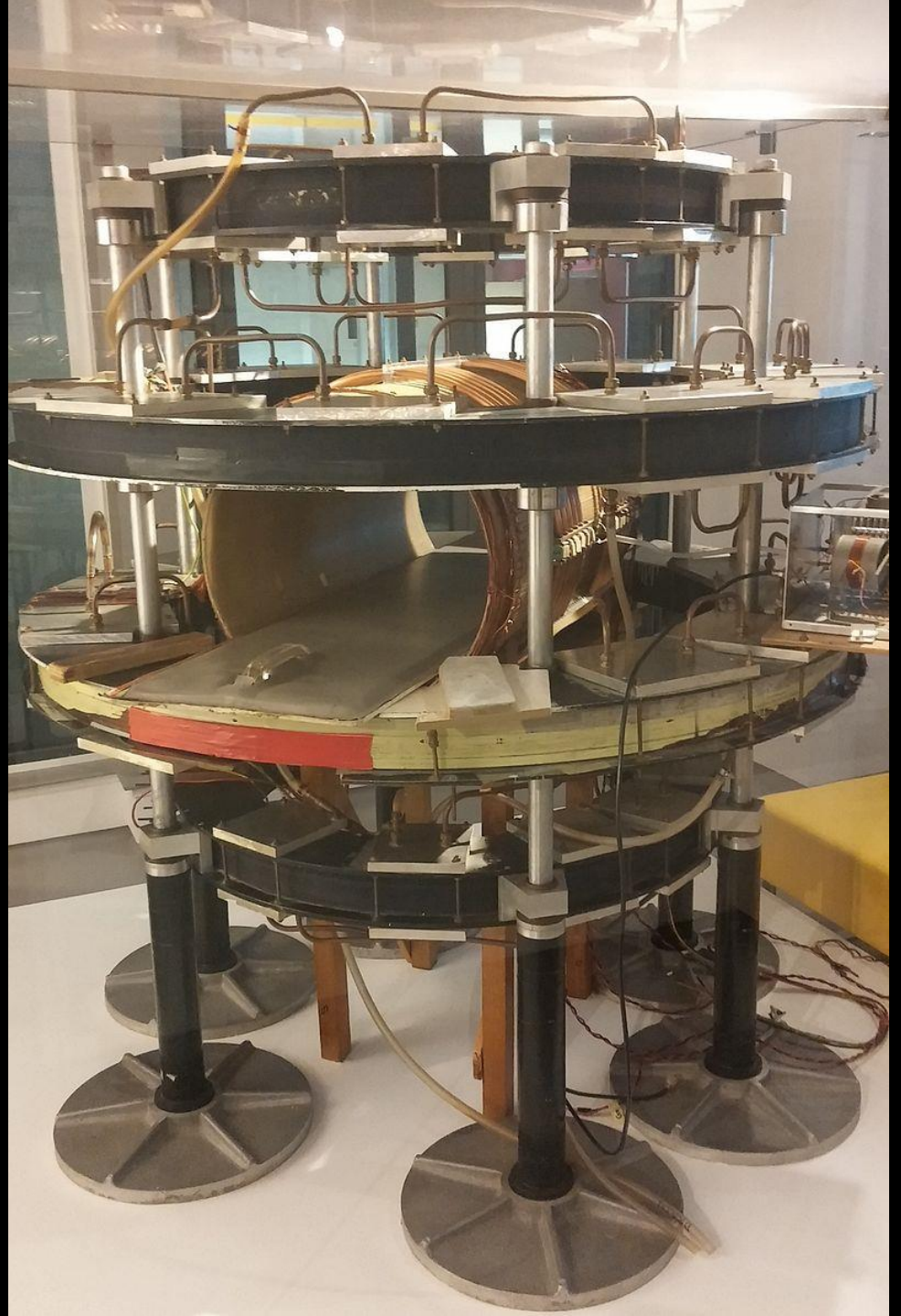




Sources: radiology.ucsf.org; nlm.nih.gov
Radiopedia.org, Case courtesy of Andrew Murphy, Radiopaedia.org, rID: 61493

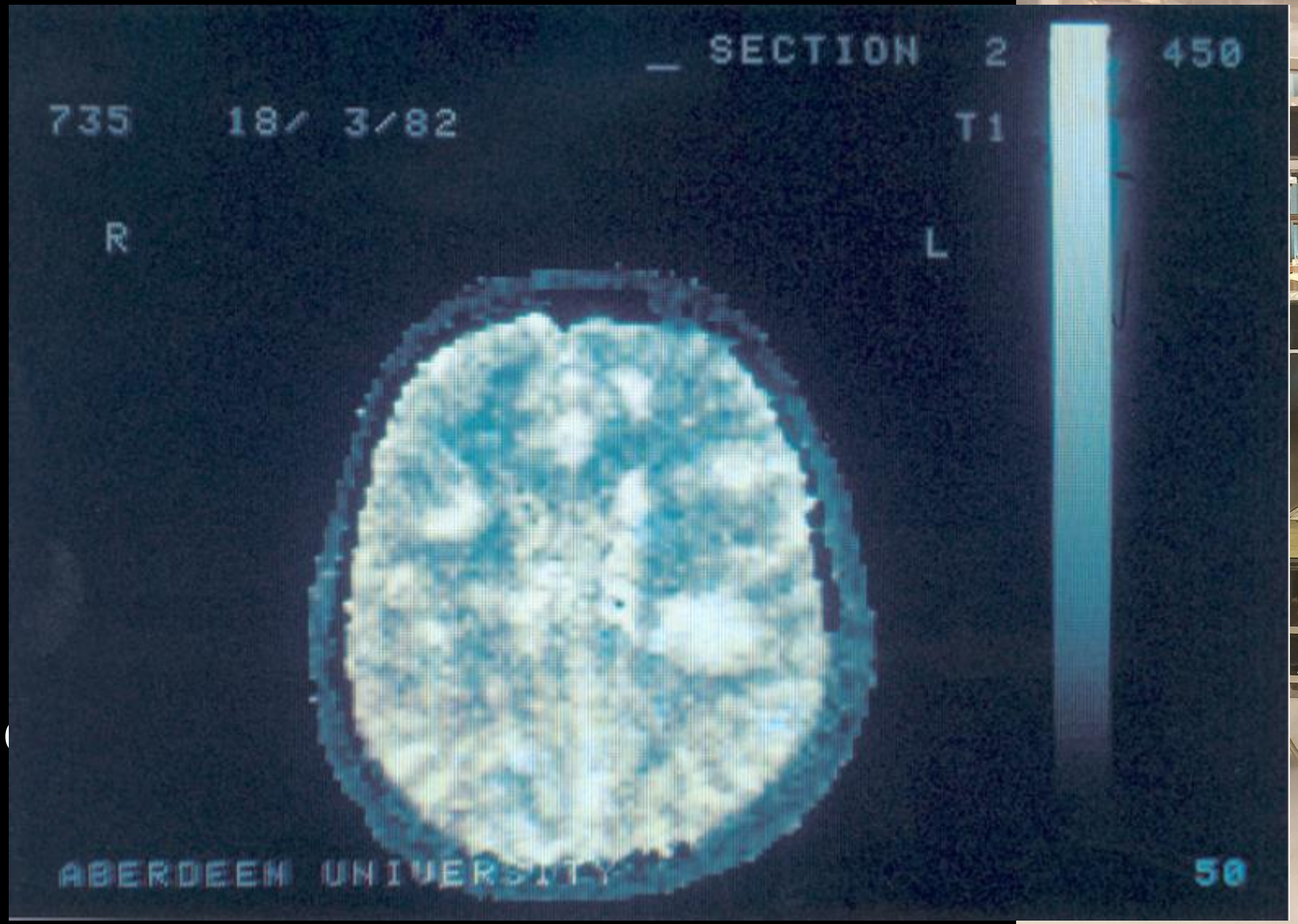


Computerized tomography (prototype, 1961)



Magnetic Resonance Imaging (prototype, 1980)

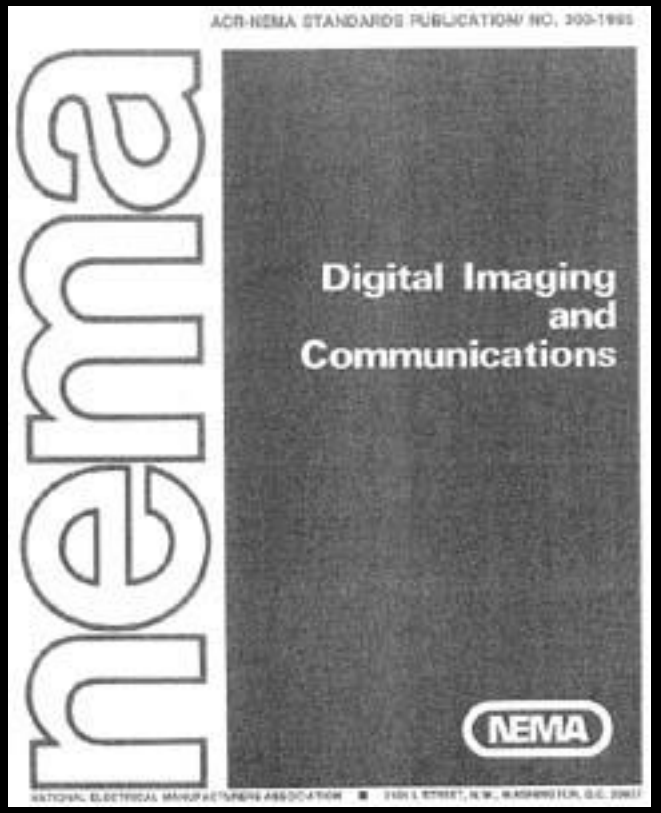
Sources: wikipedia.org



Sources: wikipedia.org; John R Mallard, Phys. Med. Biol. 51 (2006), 2006

1986

1986

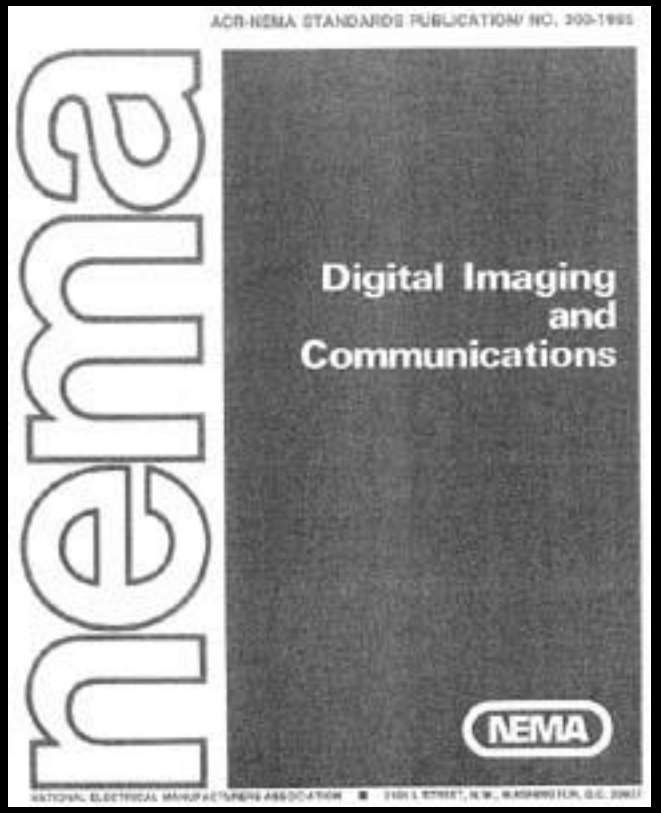


*.dcm

DICOM®
Digital Imaging and Communications in Medicine

Image standard for storing and transmitting medical images

1986



1992 JPEG

*.dcm

DICOM®
Digital Imaging and Communications in Medicine

Image standard for storing and transmitting medical images

Radiology (today)

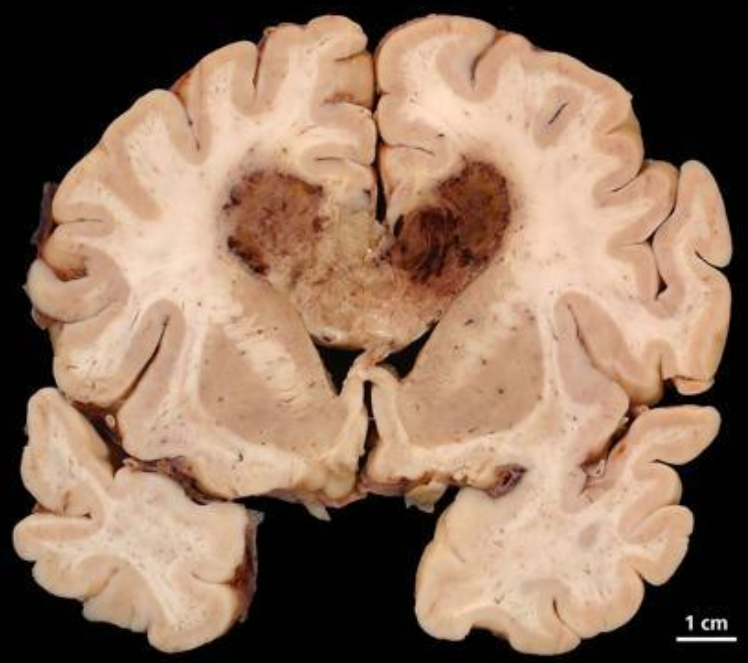
Source: Wikipedia.org

Radiology (today)

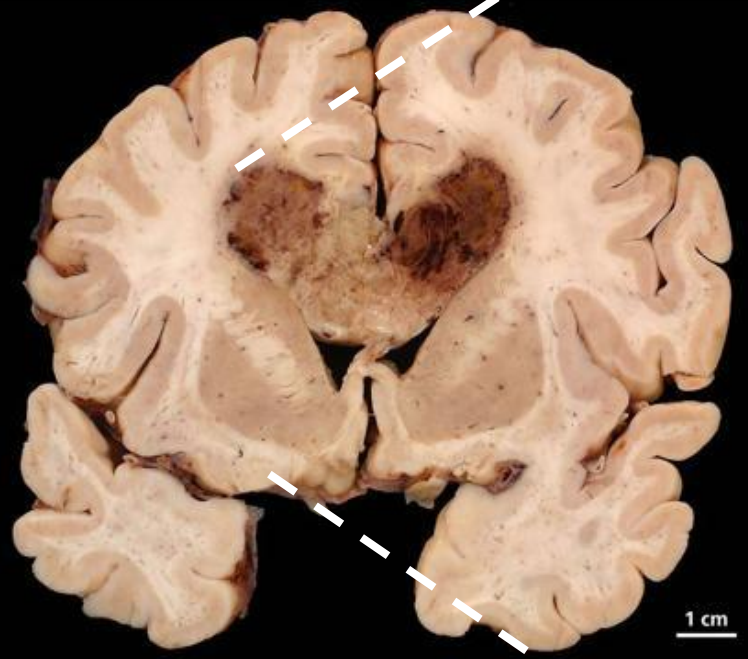
Images, videos, audio, text
(a lot of it)
Digitized workflow

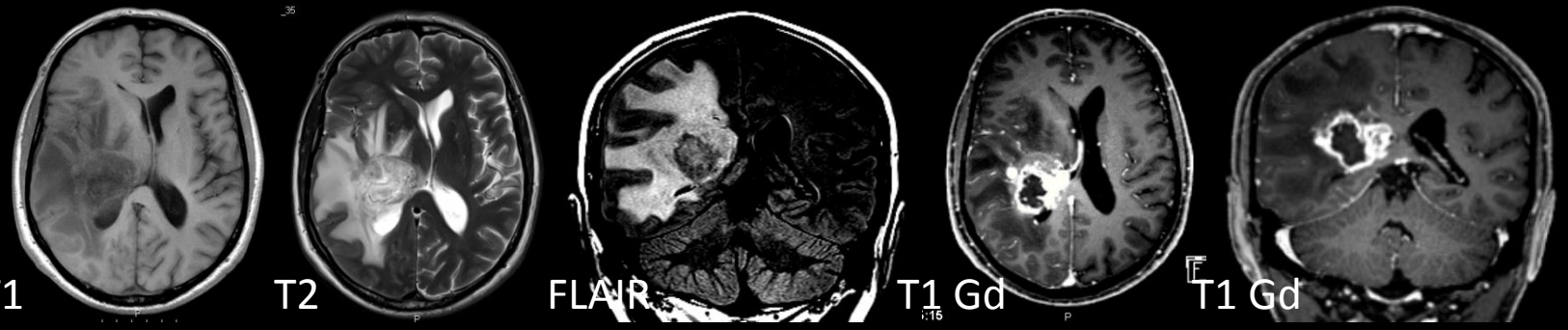
Source: Wikipedia.org

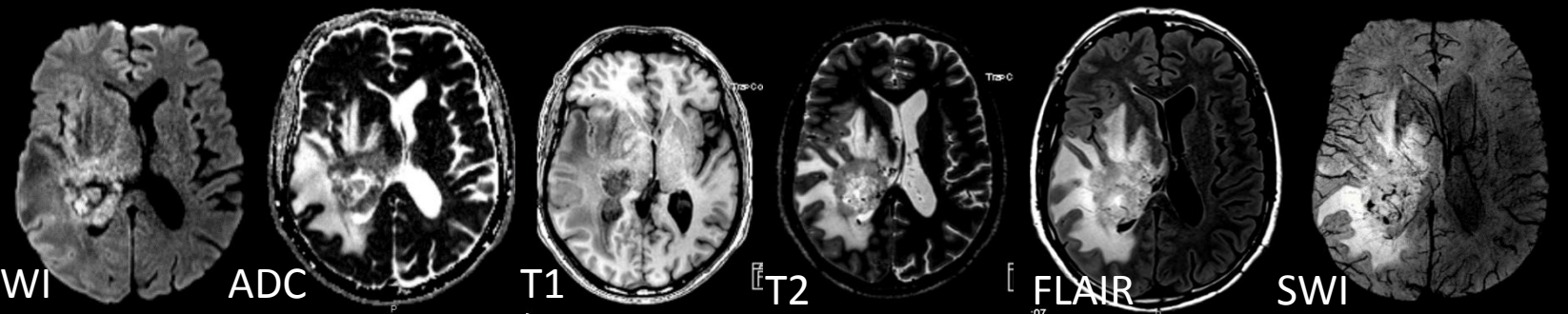
Neuroradiology

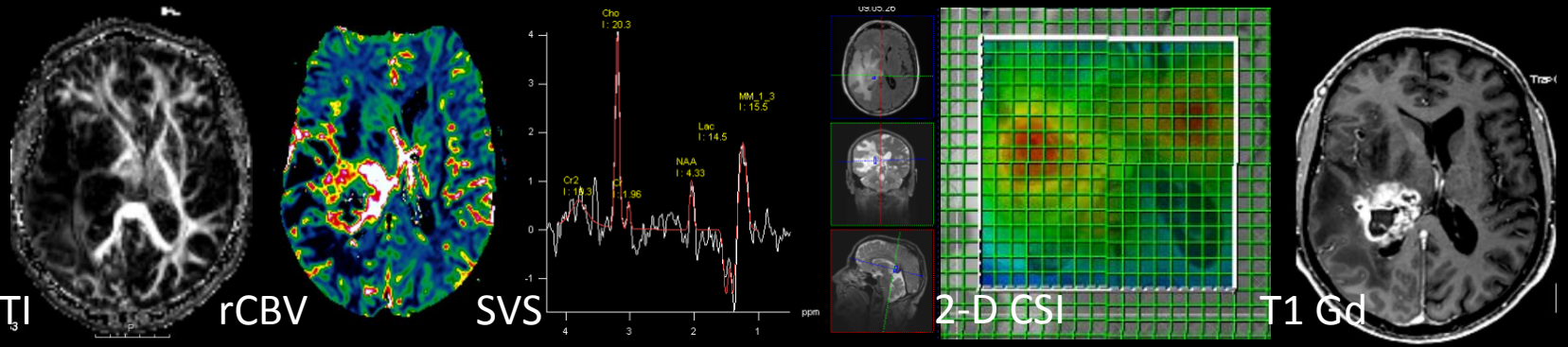


Neuroradiology

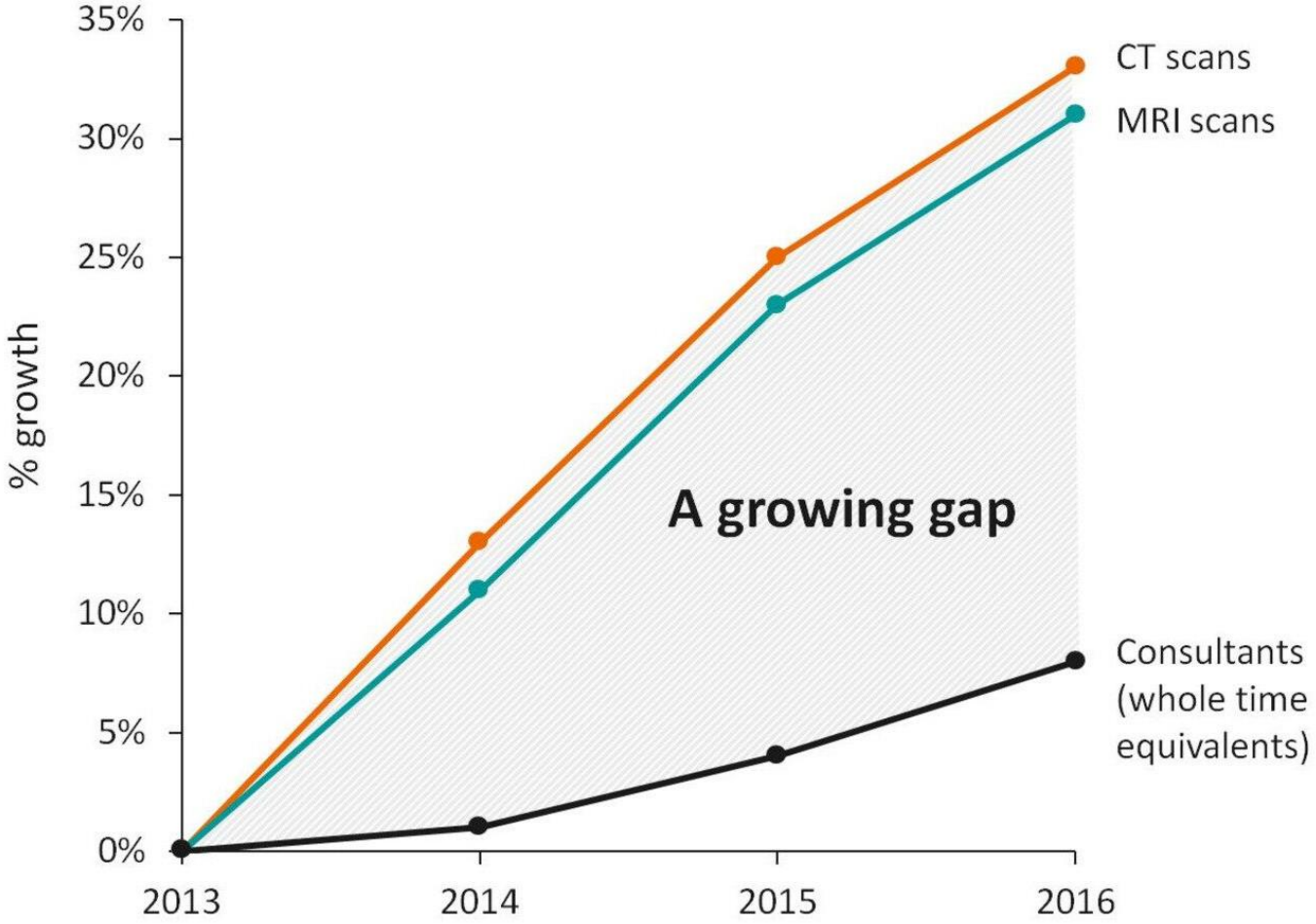




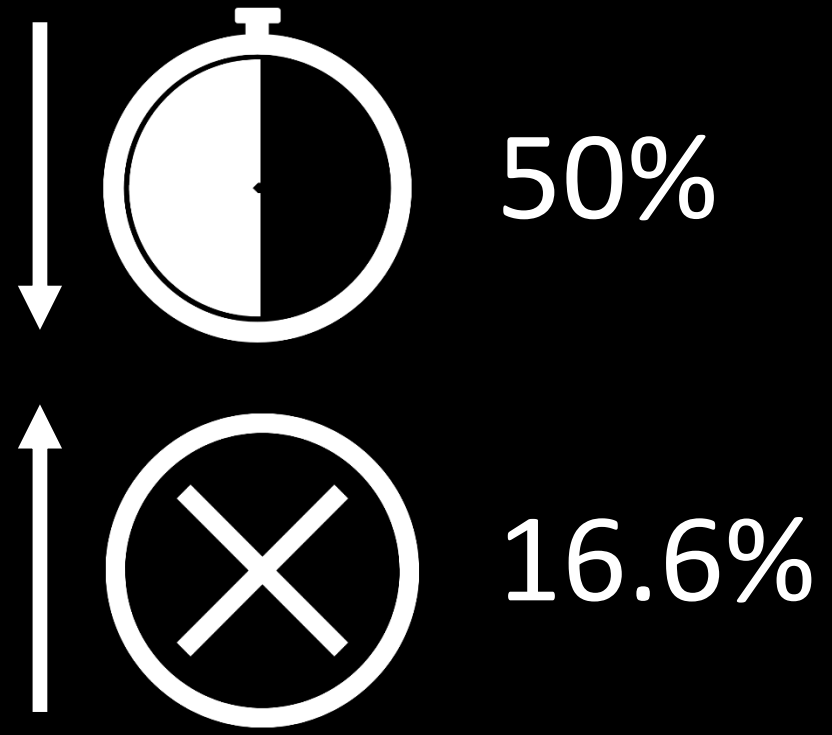




Radiology

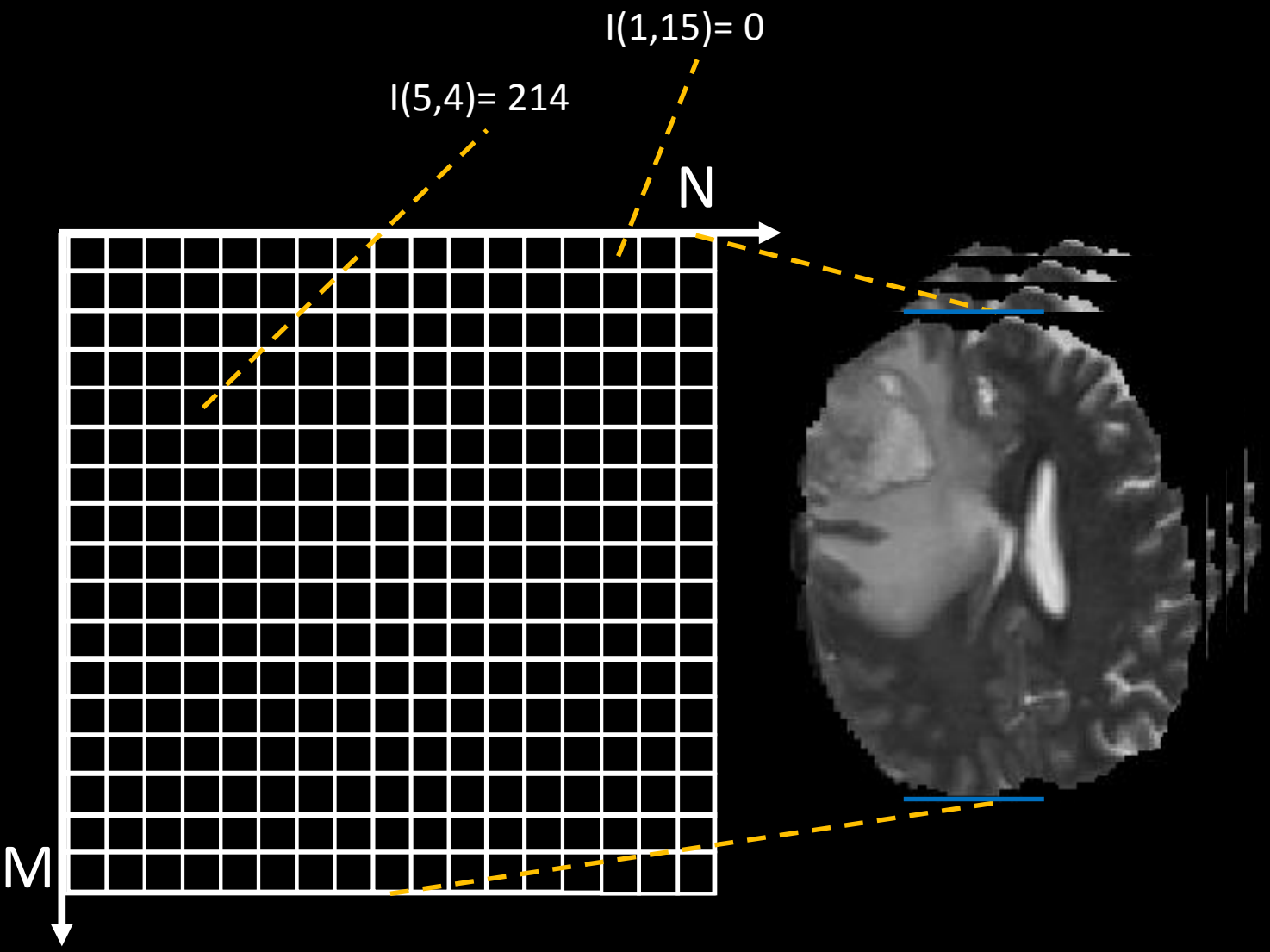


Growth in the number of consultant radiologists and imaging examinations in England

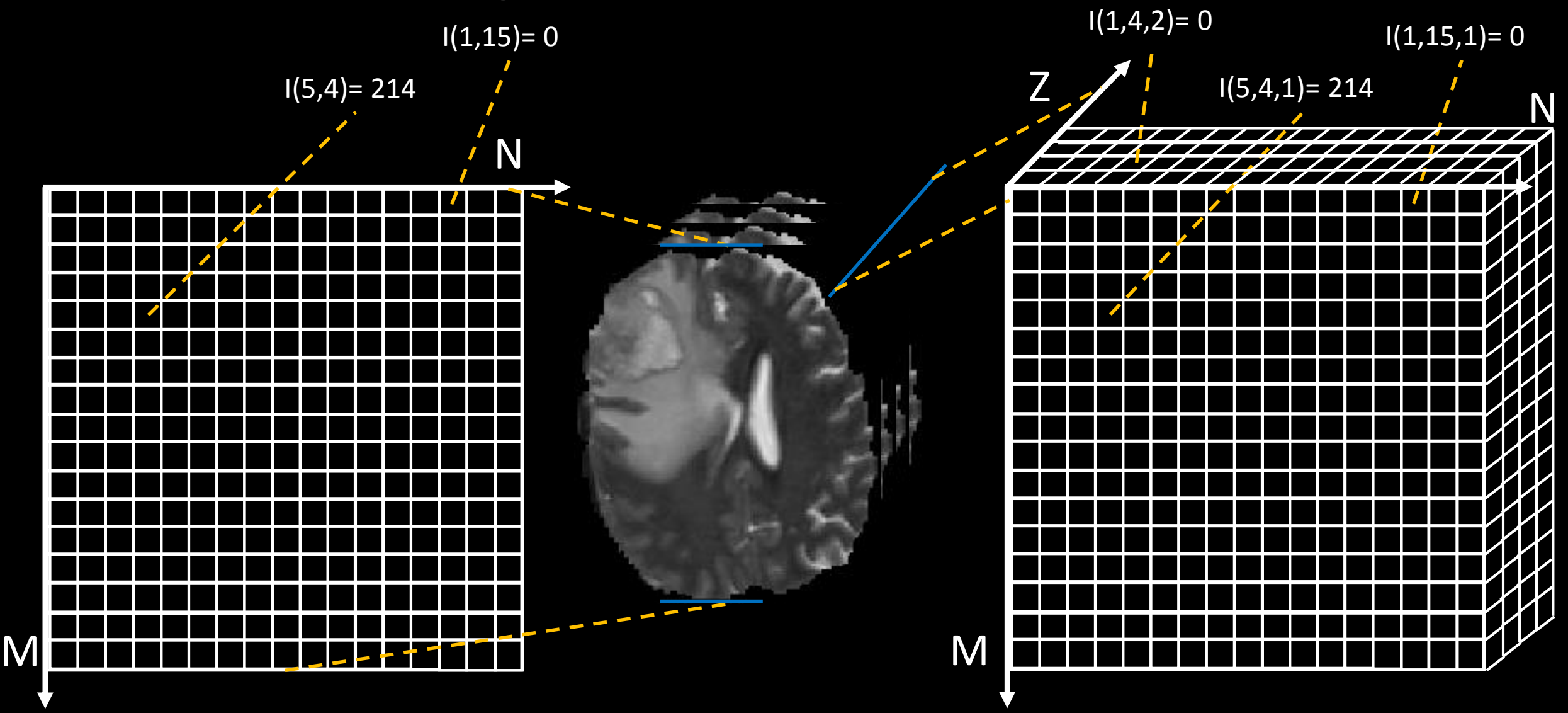


The Royal College of Radiologists (2017): UK workforce census 2016 report
Berlin L: Faster Reporting Speed and Interpretation Errors: Conjecture, Evidence, and Malpractice Implications.

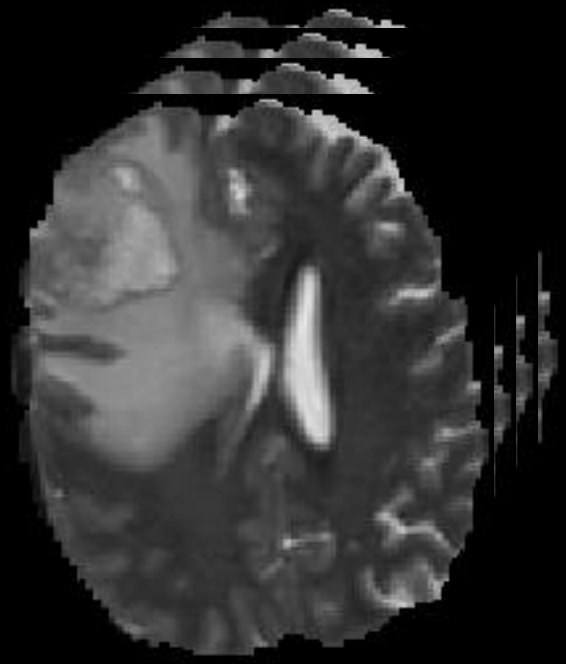
Medical Images



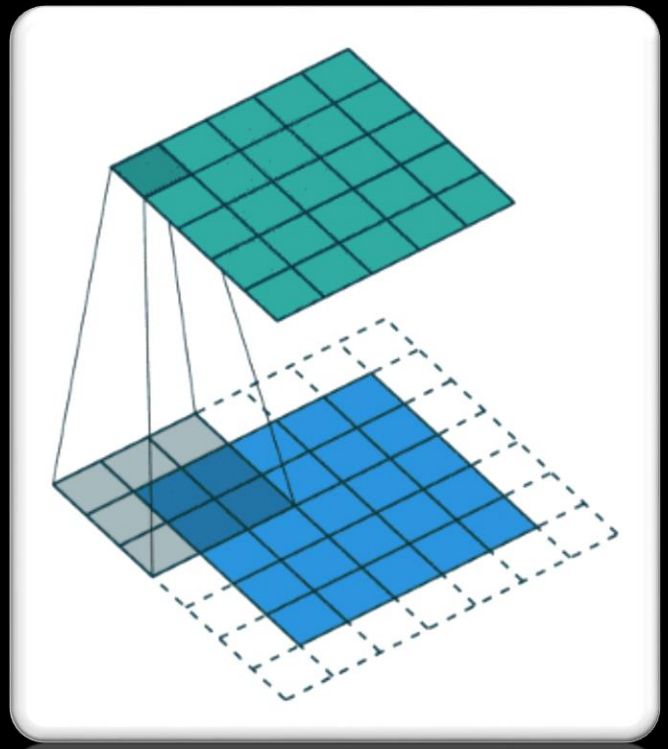
Medical Images



Medical Images

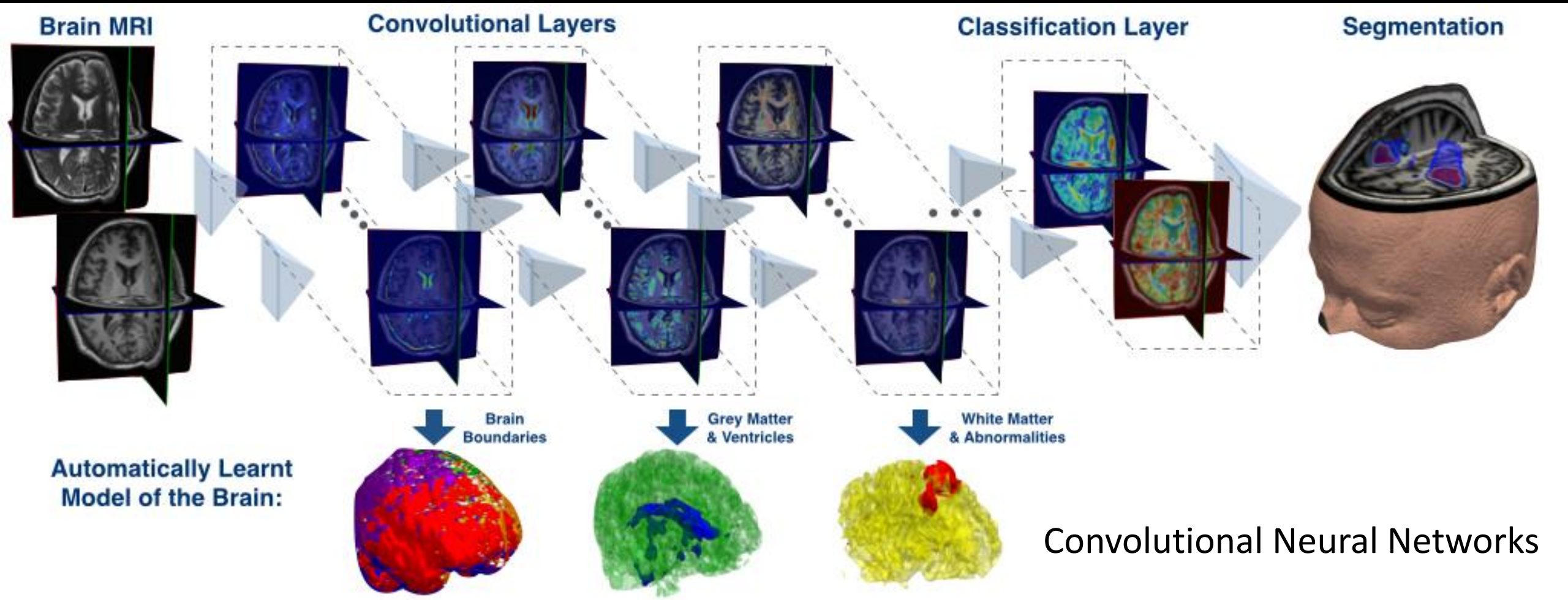


Tensor



Convolutions

Medical Images



Convolutional Neural Networks

Source: https://biomedia.doc.ic.ac.uk/software/deepmedic/

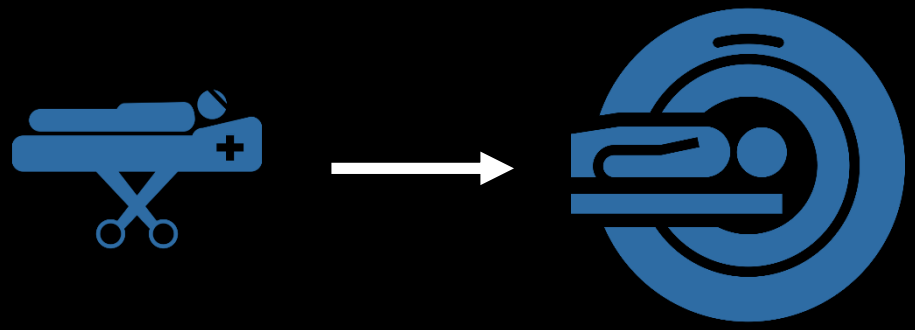
Machine Learning in Neuroradiology

INSELSPITAL
UNIVERSITÄTSSPITAL BERN
HÔPITAL UNIVERSITAIRE DE BERNE

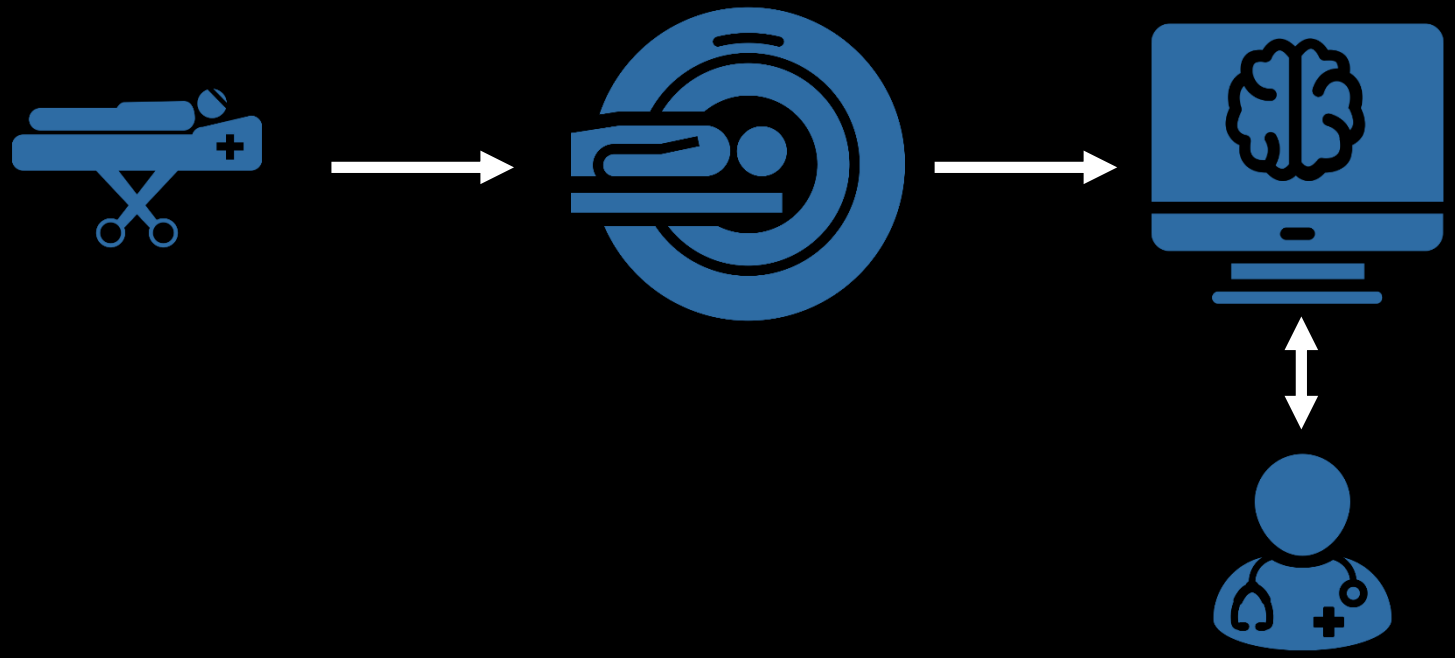
NEUROZENTRUM
Neurocentre | Neurocentro
Inselspital Universitätsspital Bern
Universitäre Psychiatrische Dienste Bern

Neurochirurgie
Neurologie
Neuropädiatrie
Neuroradiologie
Psychiatrie

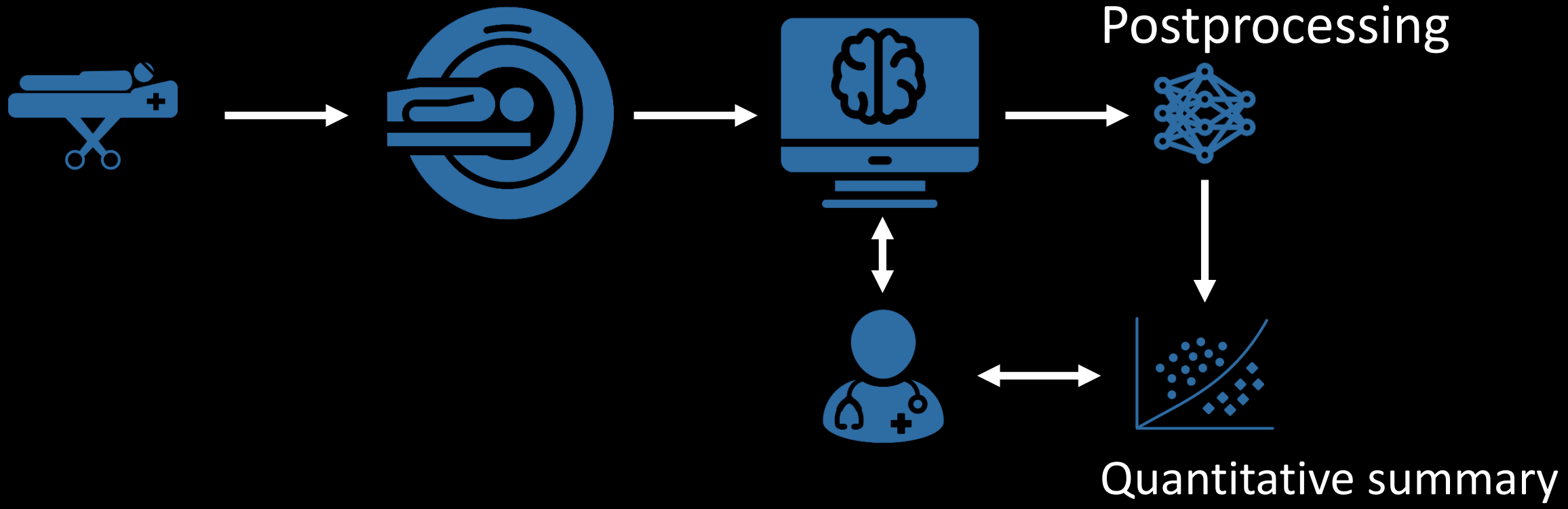
Machine Learning in Neuroradiology



Machine Learning in Neuroradiology



Machine Learning in Neuroradiology



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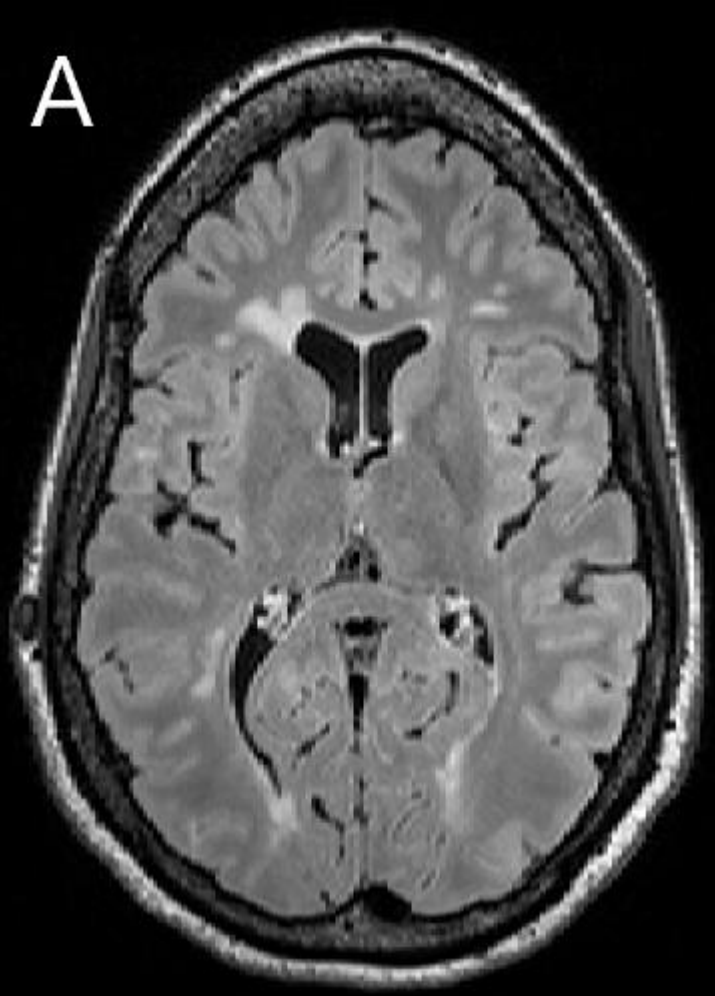

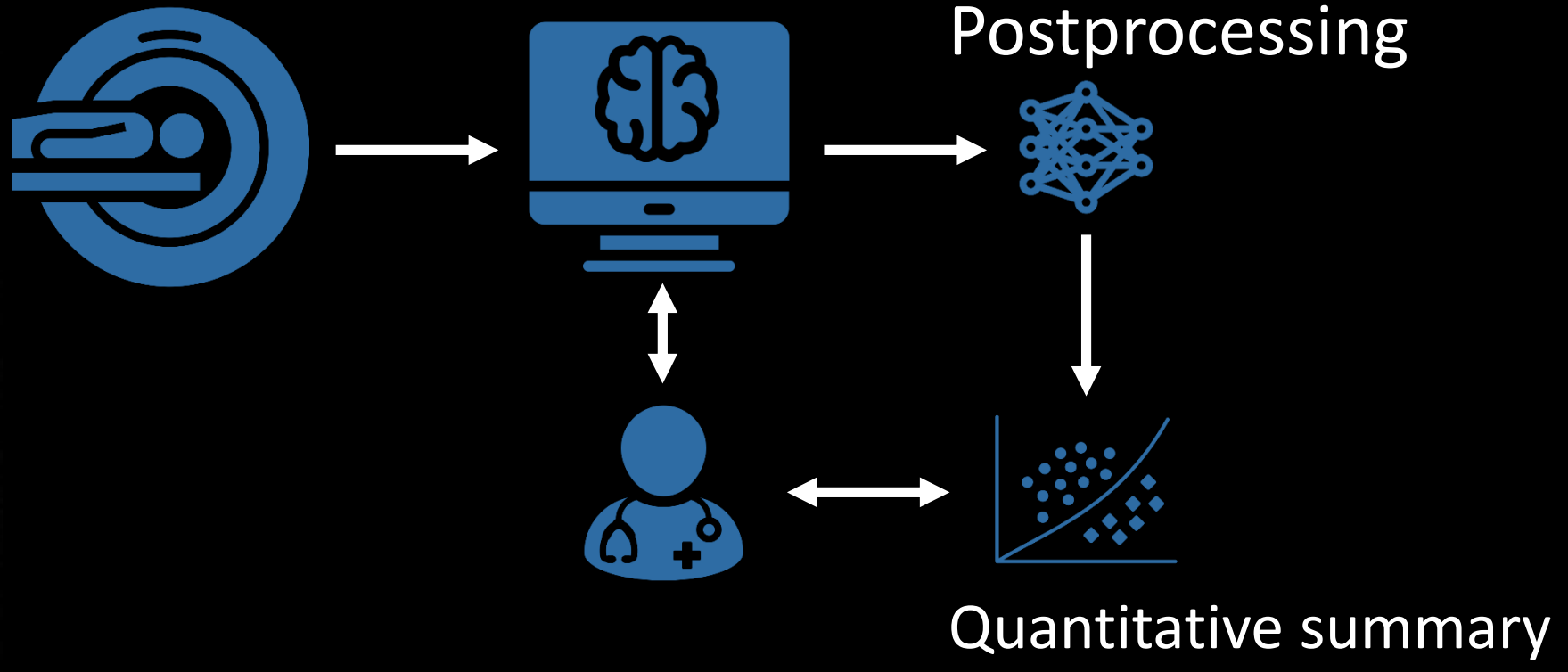

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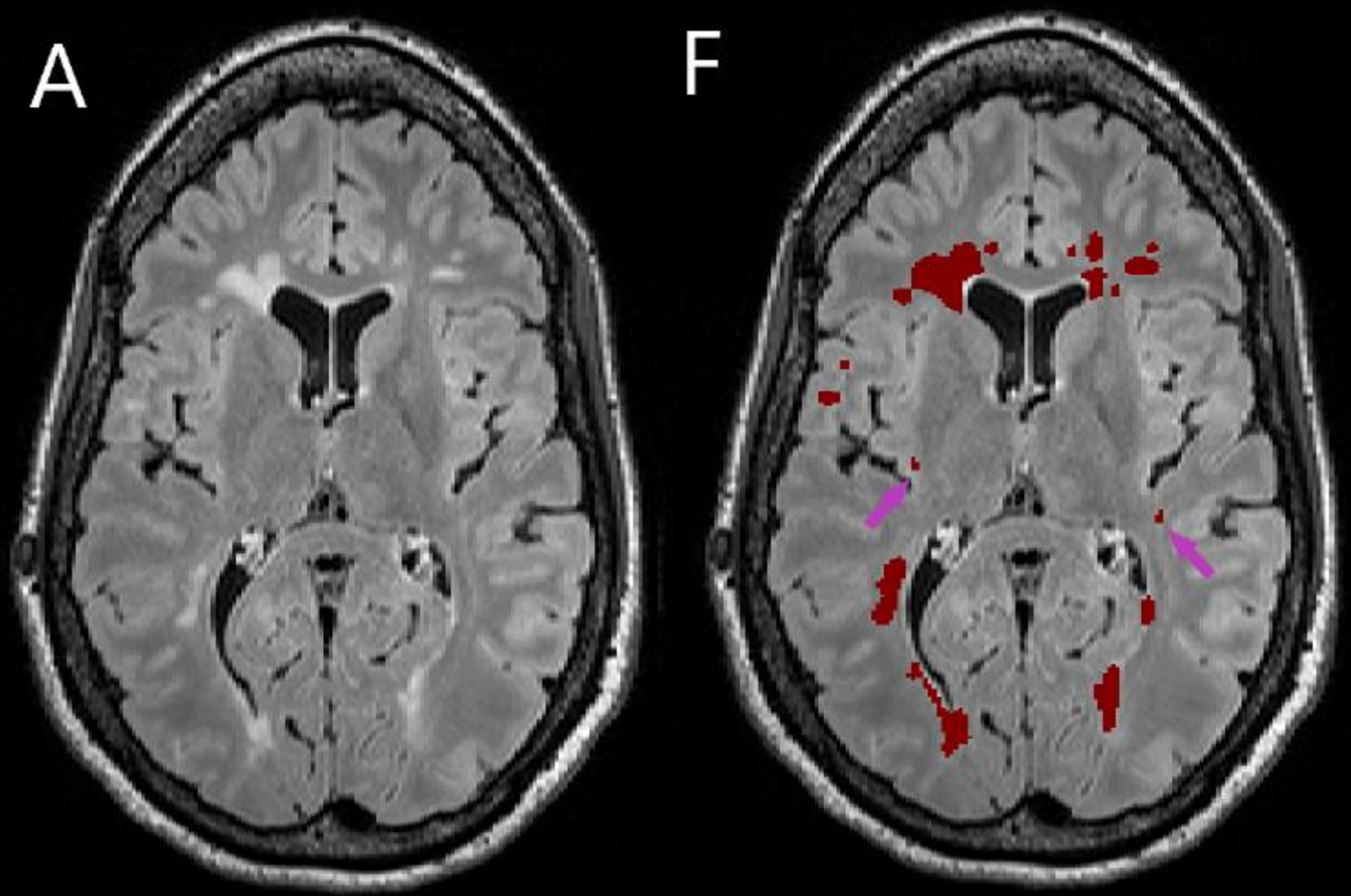
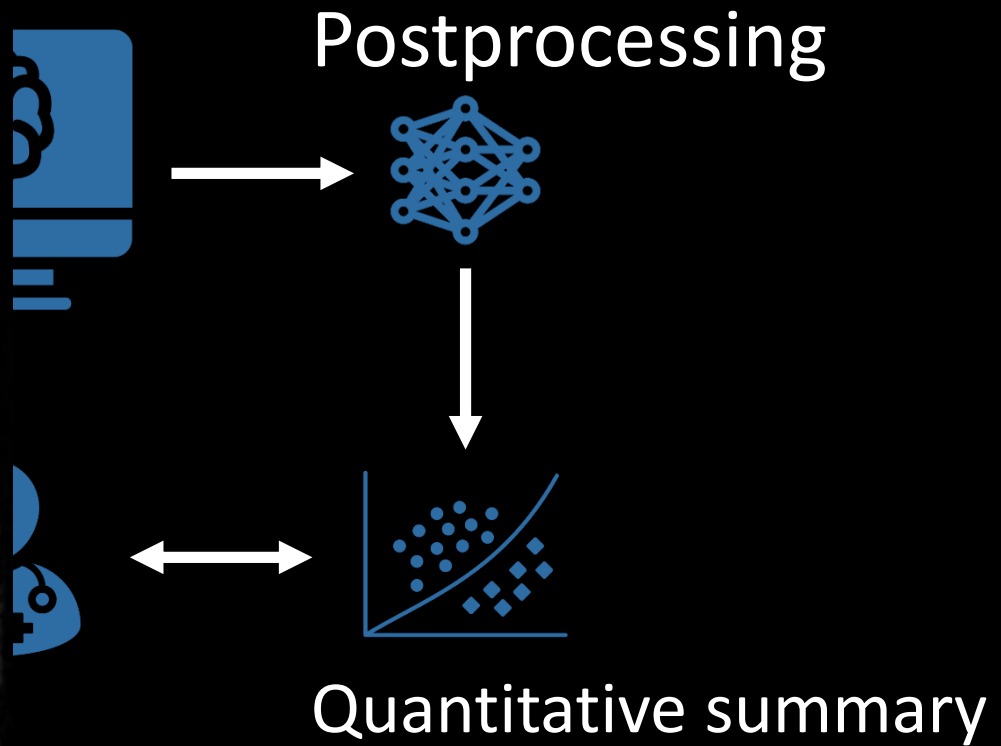
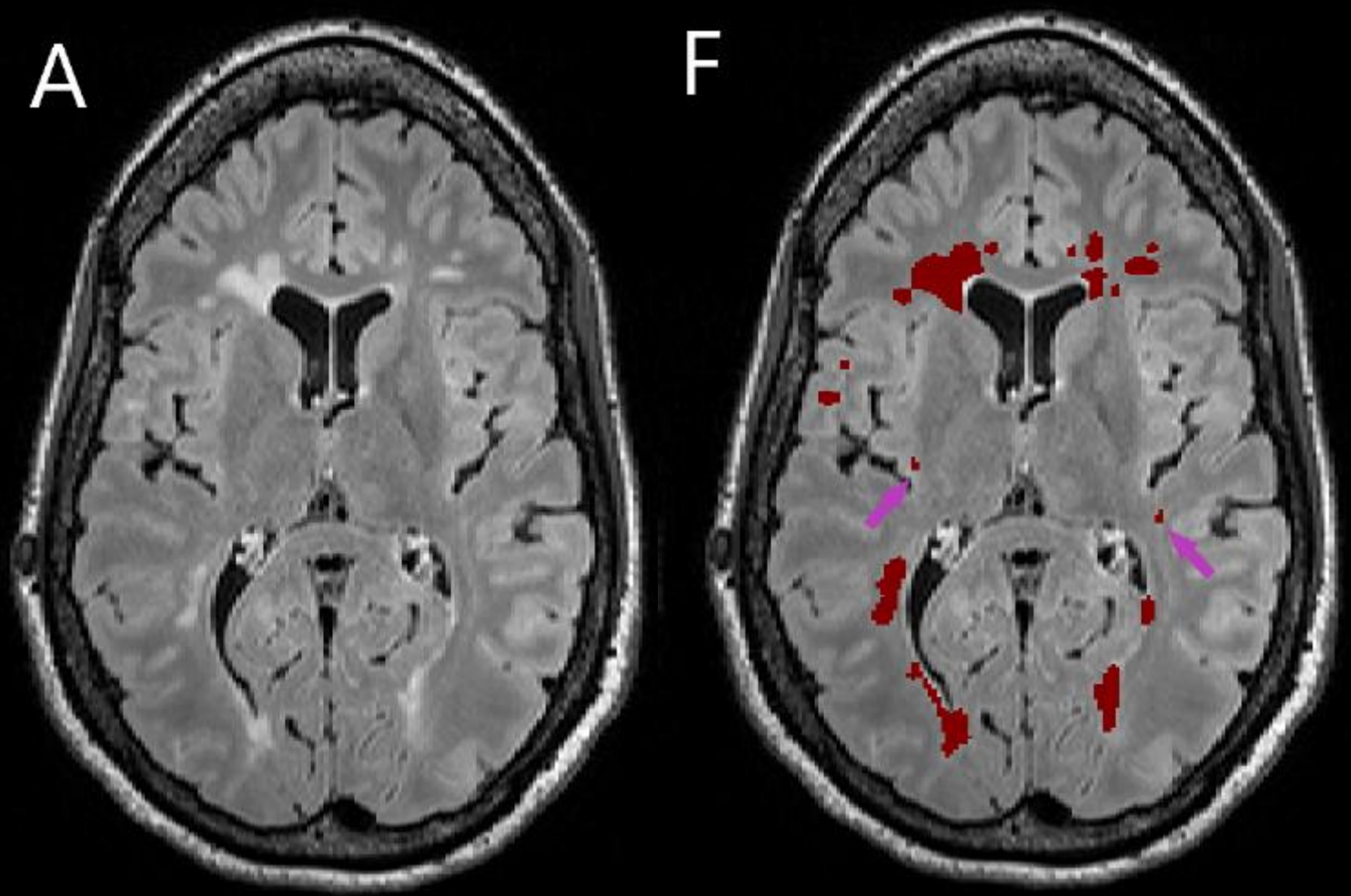




McKinley et al., Simultaneous lesion and neuroanatomy segmentation in Multiple Sclerosis using deep neural networks, arXiv, 2019

Machine Learning in Neuroradiology

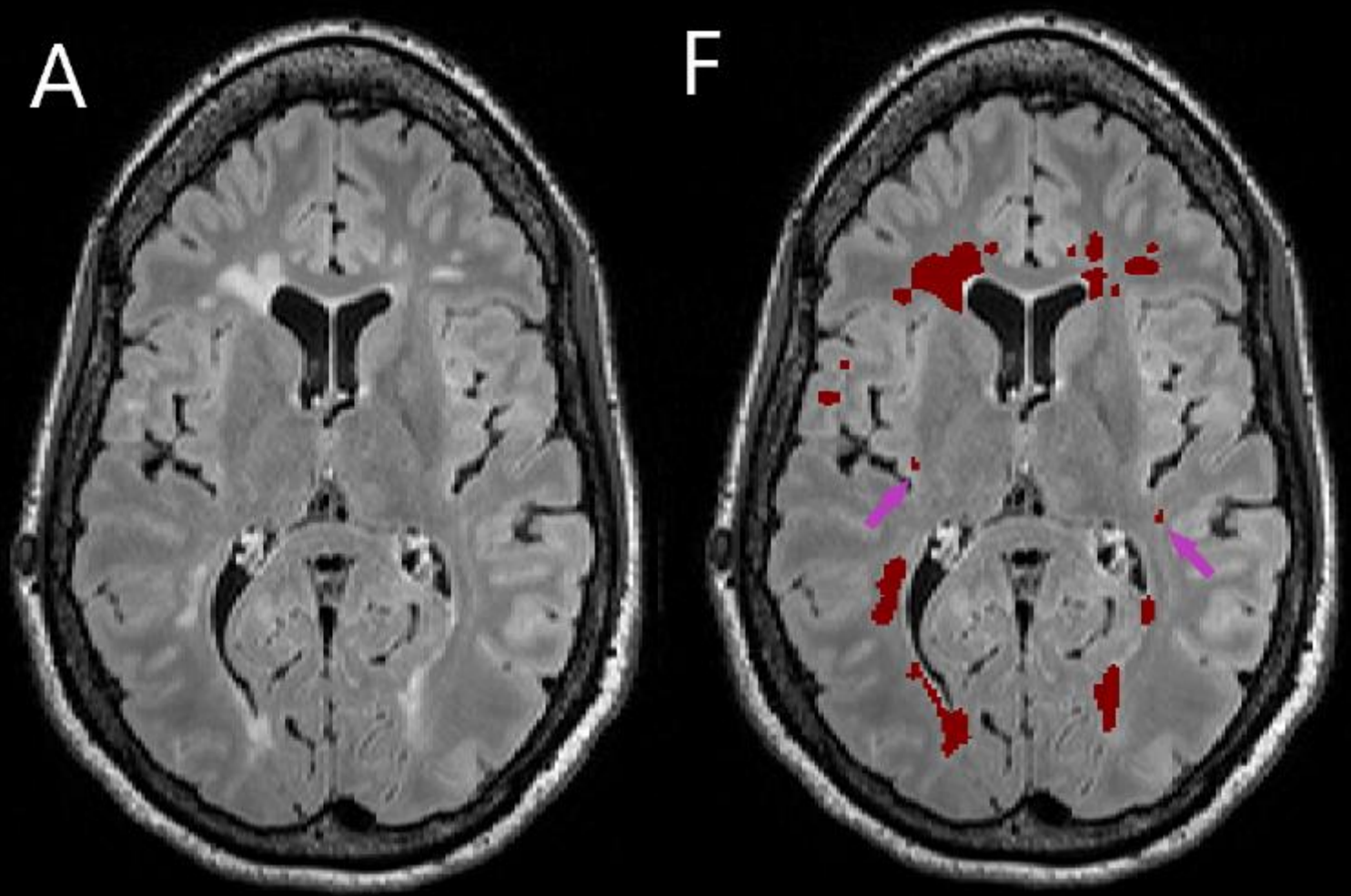


14 MS Lesions, 29.04.2019

24 MS Lesions, 28.10.2019

McKinley et al., Simultaneous lesion and neuroanatomy segmentation in Multiple Sclerosis using deep neural networks, arXiv, 2019

Machine Learning in Neuroradiology



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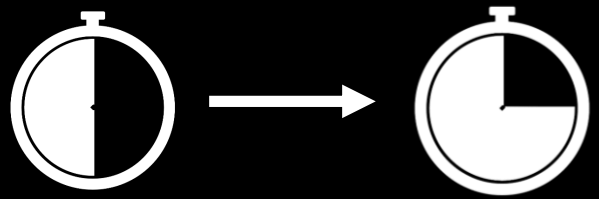
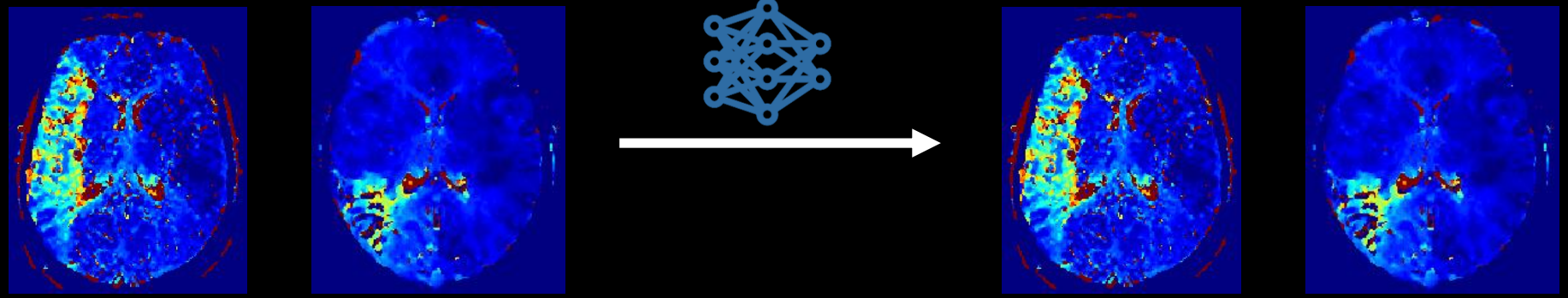


McKinley et al., Simultaneous lesion and neuroanatomy segmentation in Multiple Sclerosis using deep neural networks, arXiv, 2019

ML in Neuroradiology: Applications

50 mL

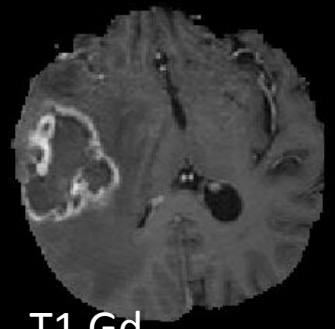
Lesion Quantification



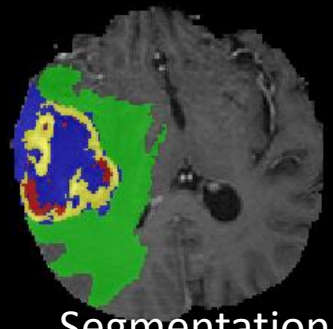
Triage

Meier et al., Nature Scientific Reports, 2016; Meier et al., Radiology: Artificial Intelligence 2019.

ML in Neuroradiology: Applications



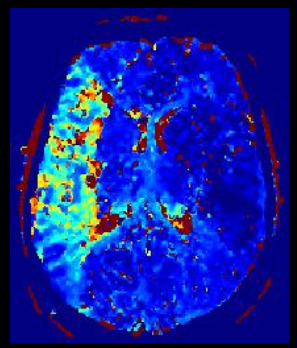
T1 Gd

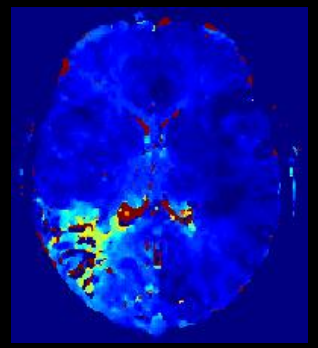


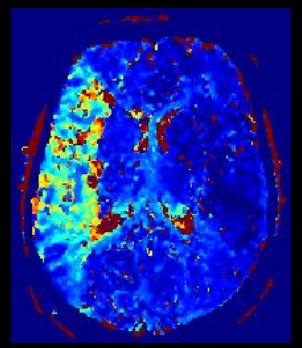
Segmentation

50 mL

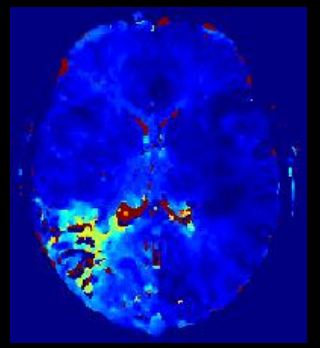
Lesion Quantification







Stroke

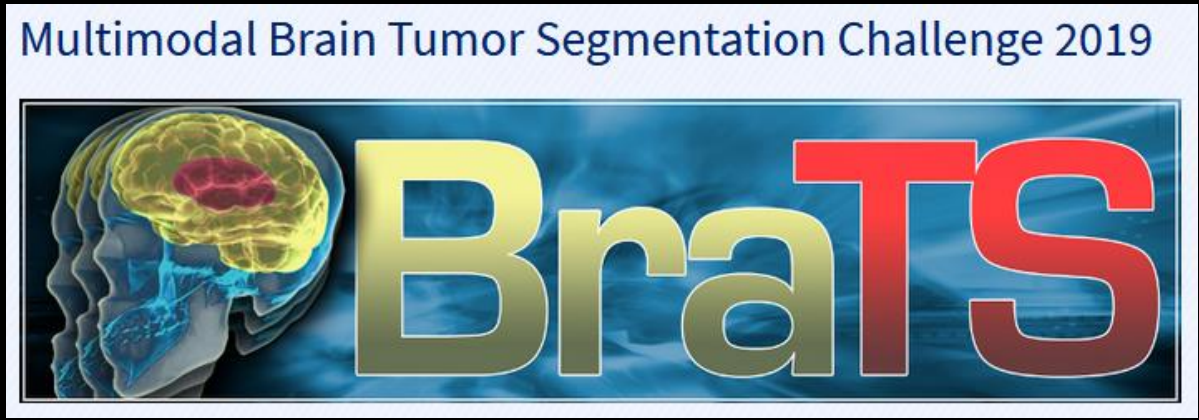


No stroke

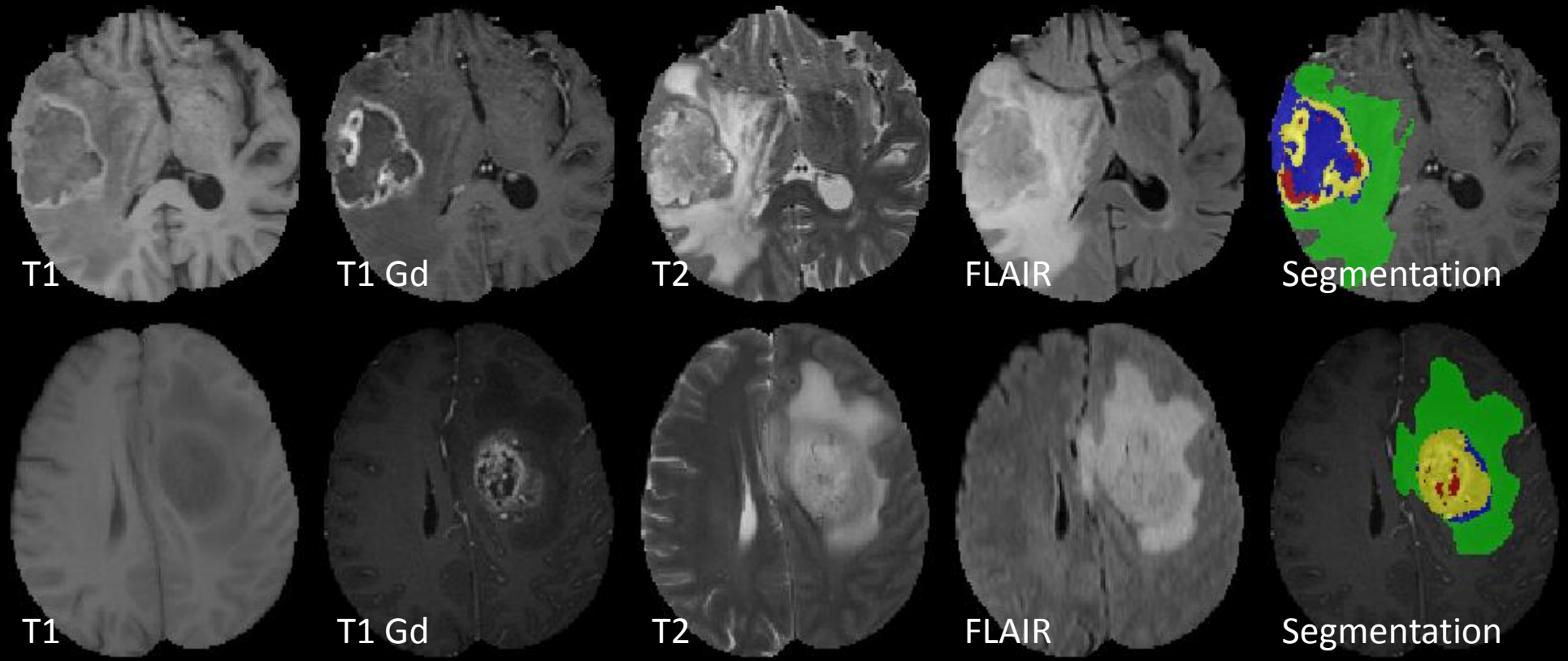
Triage

Meier et al., Nature Scientific Reports, 2016; Meier et al., Radiology: Artificial Intelligence 2019.

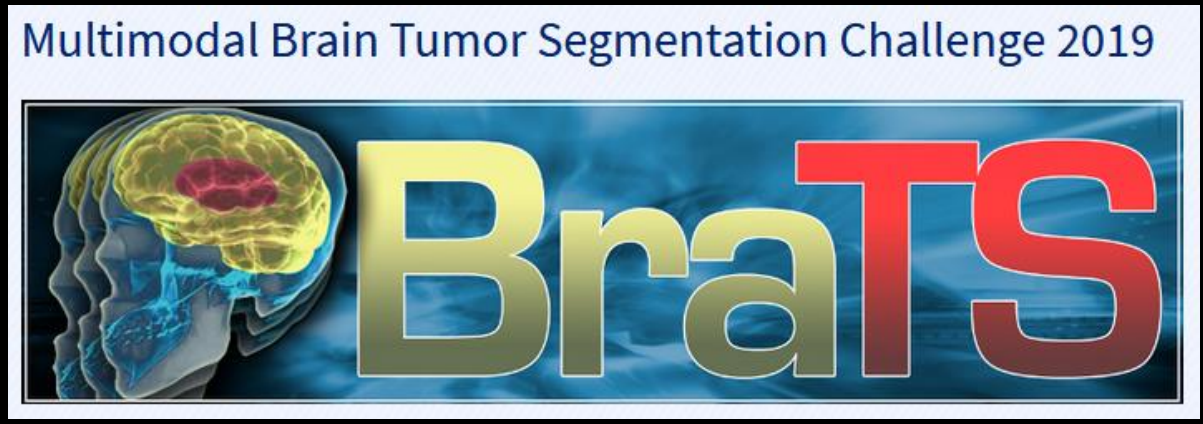
Brain tumor diagnostics



- 70 teams
- Dataset
- Independent validation



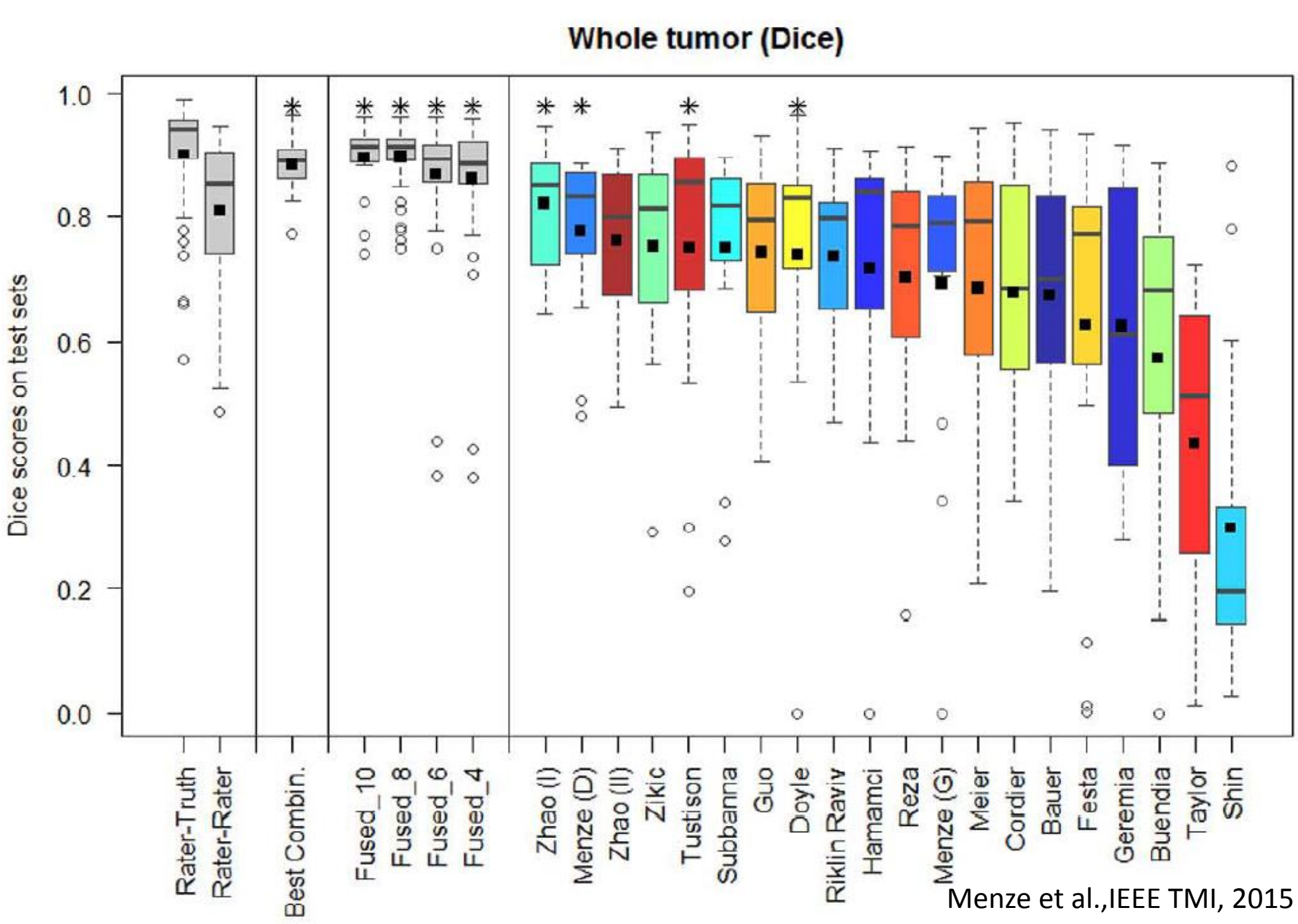
Brain tumor diagnostics



T1 T1 Gd T2 FLAIR Segmentation

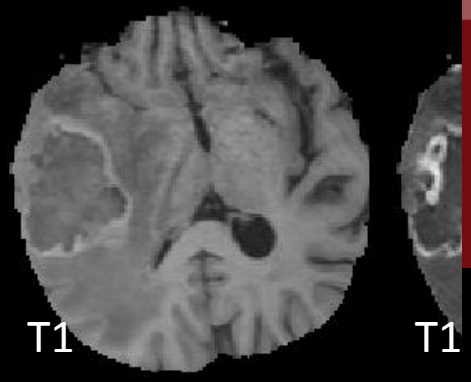
- 70 teams
- Dataset
- Independent validation

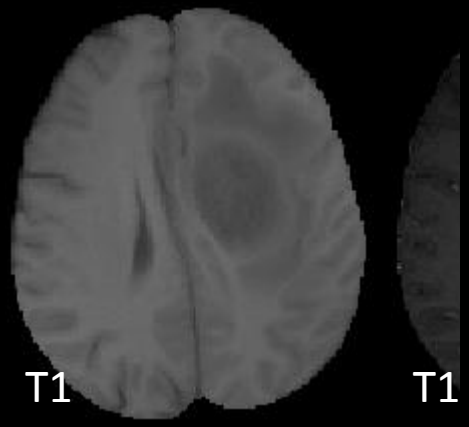
Brain t



Menze et al.,IEEE TMI, 2015

Brain t





THE LANCET
Oncology

ARTICLES | VOLUME 20, ISSUE 5, P728-740, MAY 01, 2019

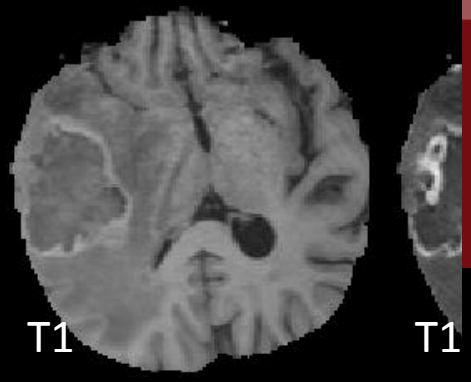
Automated quantitative tumour response assessment of MRI in neuro-oncology with artificial neural networks: a multicentre, retrospective study

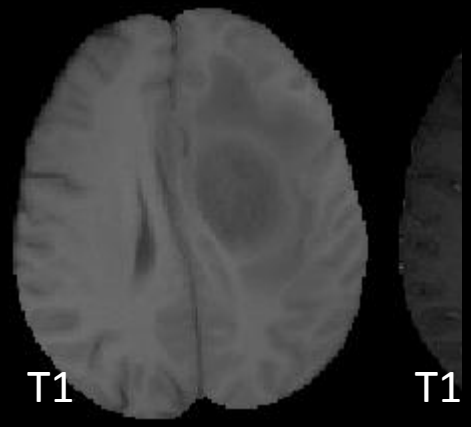
Philipp Kickingereder, MD * • Fabian Isensee, MSc * • Irada Tursunova, MD • Jens Petersen, MSc • Ulf Neuberger, MD • David Bonekamp, MD • et al. Show all authors • Show footnotes

Published: April 02, 2019 • DOI: https://doi.org/10.1016/S1470-2045(19)30098-1 • Check for updates

"Overall, we found that Artificial Neural Networks enabled **objective and automated assessment of tumour response** in neuro-oncology at high throughput and could ultimately serve as a blueprint for the application of ANN in radiology to improve clinical decision making."

Brain t





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Automated quantitative tumour response assessment of MRI in neuro-oncology with artificial neural networks: a multicentre, retrospective study

Philipp Kickingereder, MD * • Fabian Isensee, MSc * • Irada Tursunova, MD • Jens Petersen, MSc • Ulf Neuberger, MD • David Bonekamp, MD • et al. Show all authors • Show footnotes

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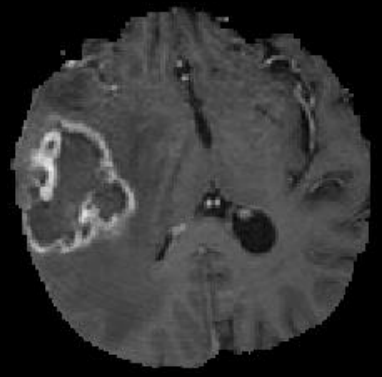
https://grand-challenge.org/

ML Challenges & Opportunities in Radiology

- Huge amounts of data
  - Caveat: Trapped in heterogeneous systems, messy (manual input)



T1-weighted Magnetic Resonance Imaging sequence with gadolinium-based contrast agent

T1c, T1 Gd, T1 Gad, gad, T1, T1-we, T1-contrast, [no value] ...

ML Challenges & Opportunities in Radiology

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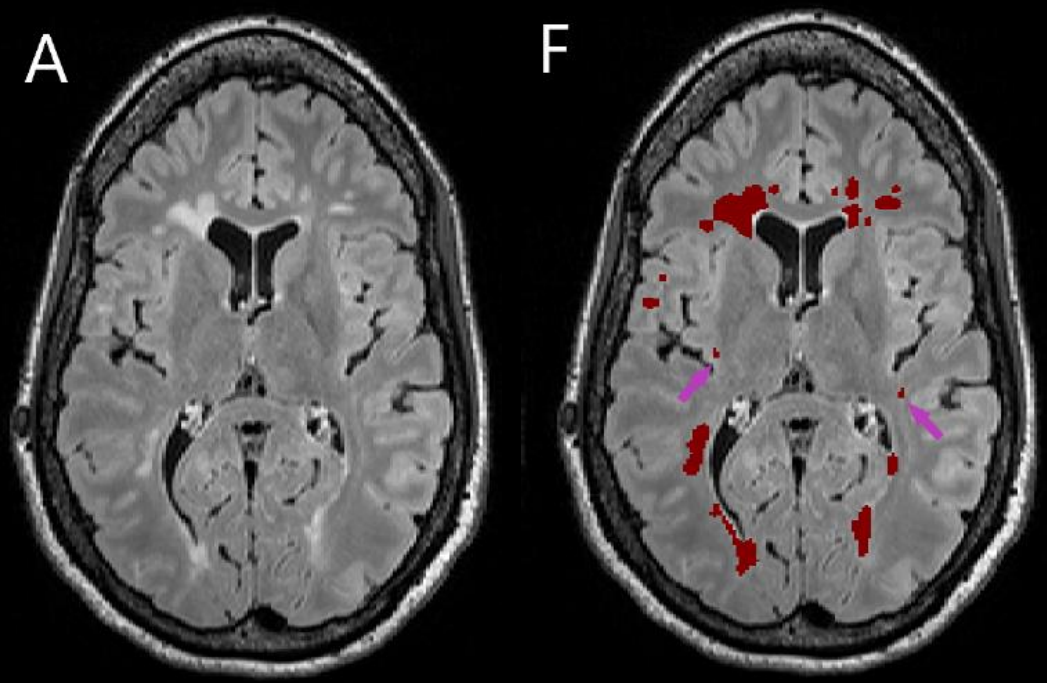
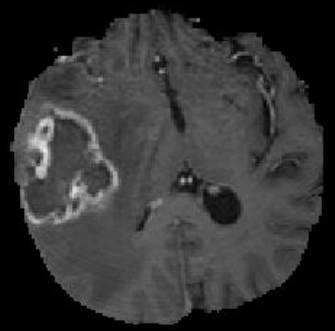
- Large data imbalances (tiny lesions, rare diseases)



ML Challenges & Opportunities in Radiology

- Huge amounts of data
  - Caveat: Trapped in heterogeneous systems, messy (manual input)
- Large data imbalances (tiny lesions, rare diseases)
- Problems more constrained than in computer vision
  - Caveat: Domain knowledge **absolutely** necessary to solve problems



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CAS „Artificial Intelligence in Medical Imaging“

Merci!

Questions?

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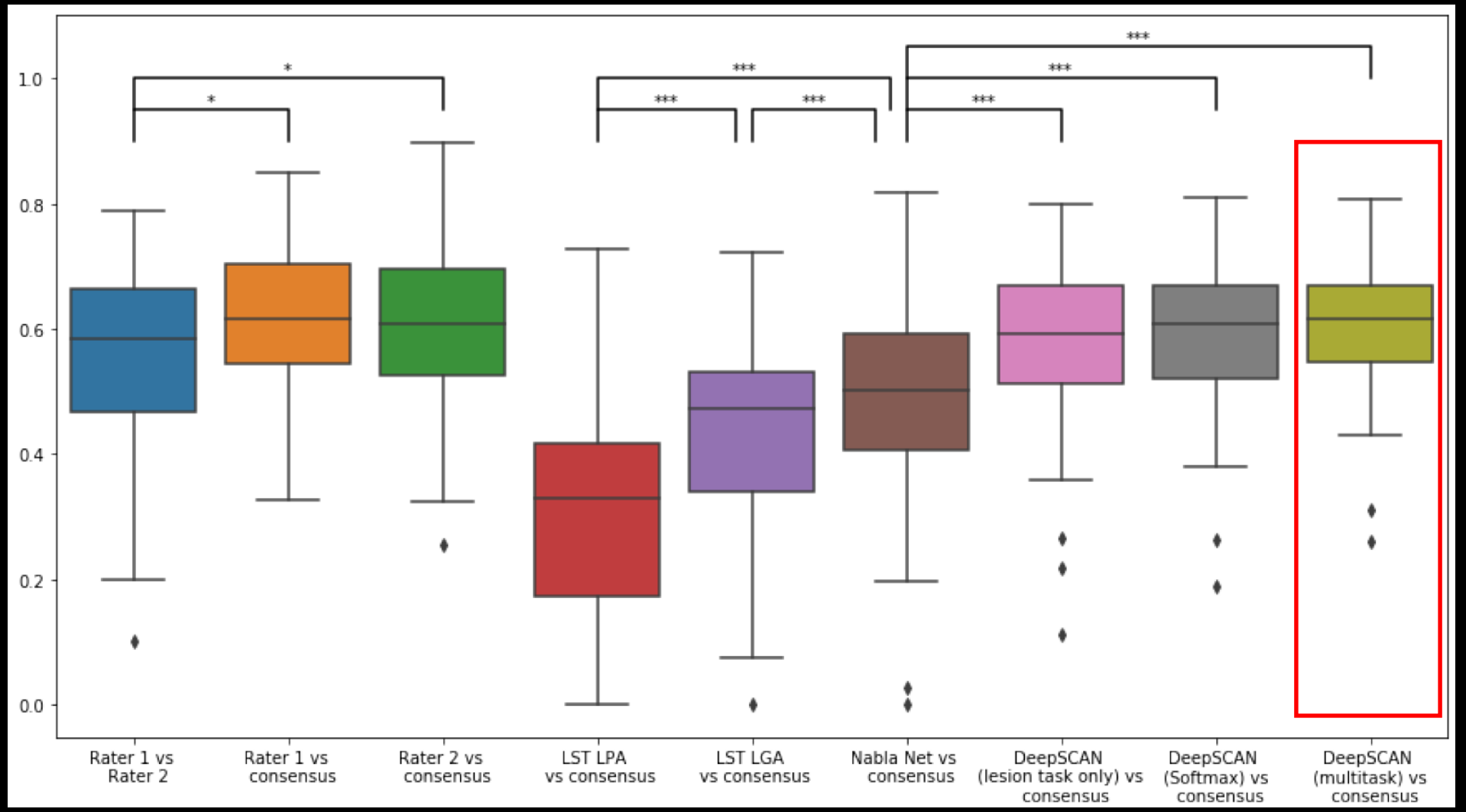
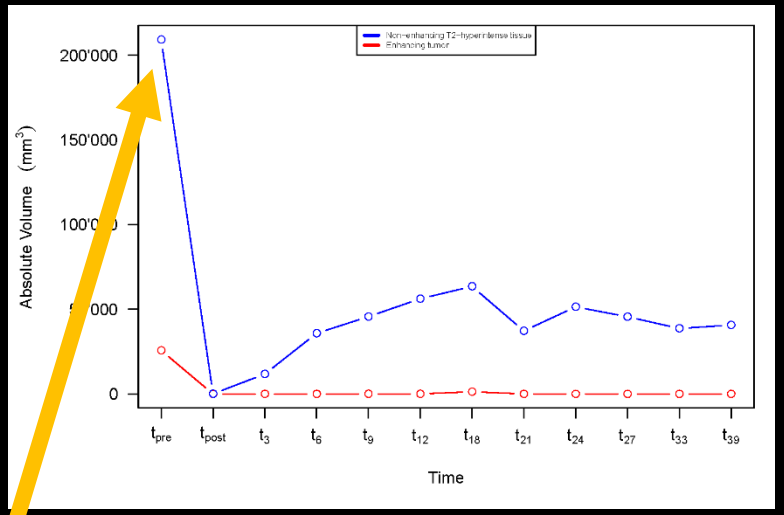
Backup slides: MS Lesion Segmentation



McKinley et al., Simultaneous lesion and neuroanatomy segmentation in Multiple Sclerosis using deep neural networks, arXiv, 2019

Backup: Brain tumor diagnostics



Assessing treatment response