



MISS 2018

Medical Imaging Summer School

3rd International Medical Imaging Summer School:

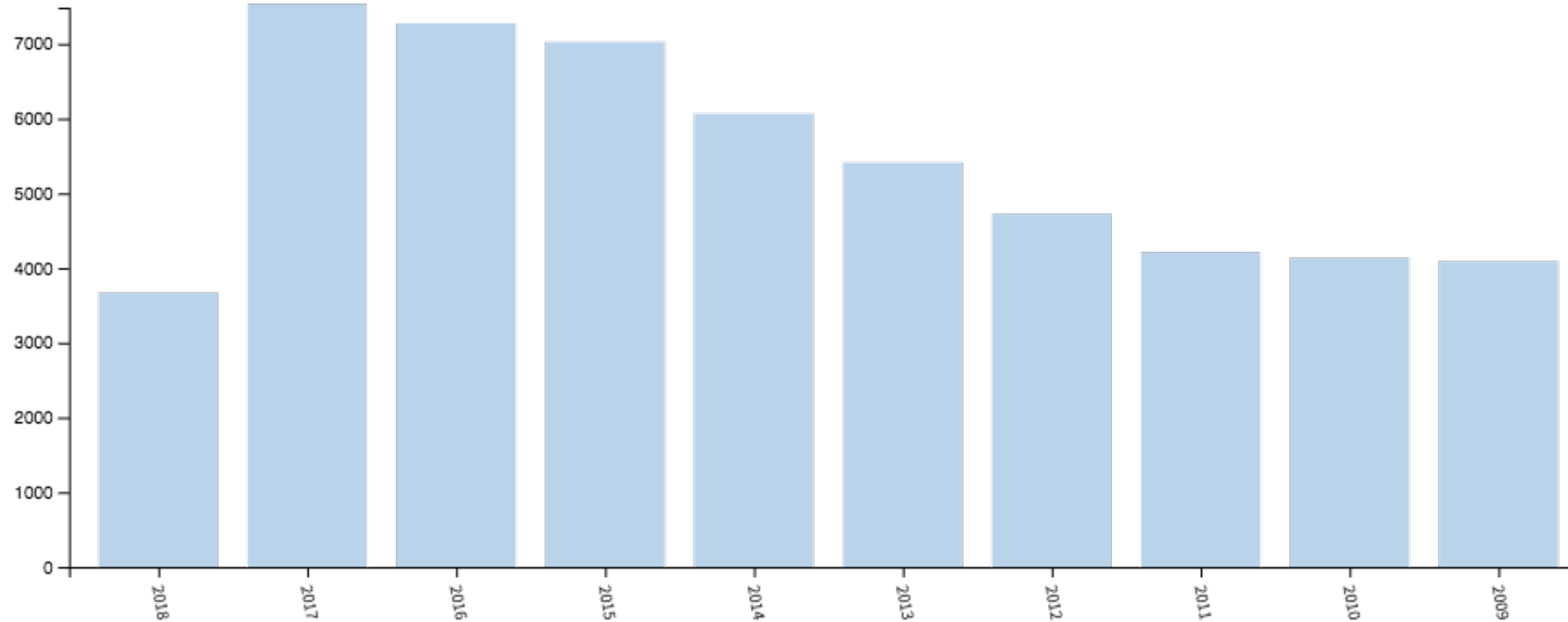
Medical Imaging meets Deep Learning

Introduction and Motivation

- Medical Imaging meets...
 - ... Computer Vision (2014)
 - ... Machine Learning (2016)
 - ... Deep Learning (2018)

- Why?

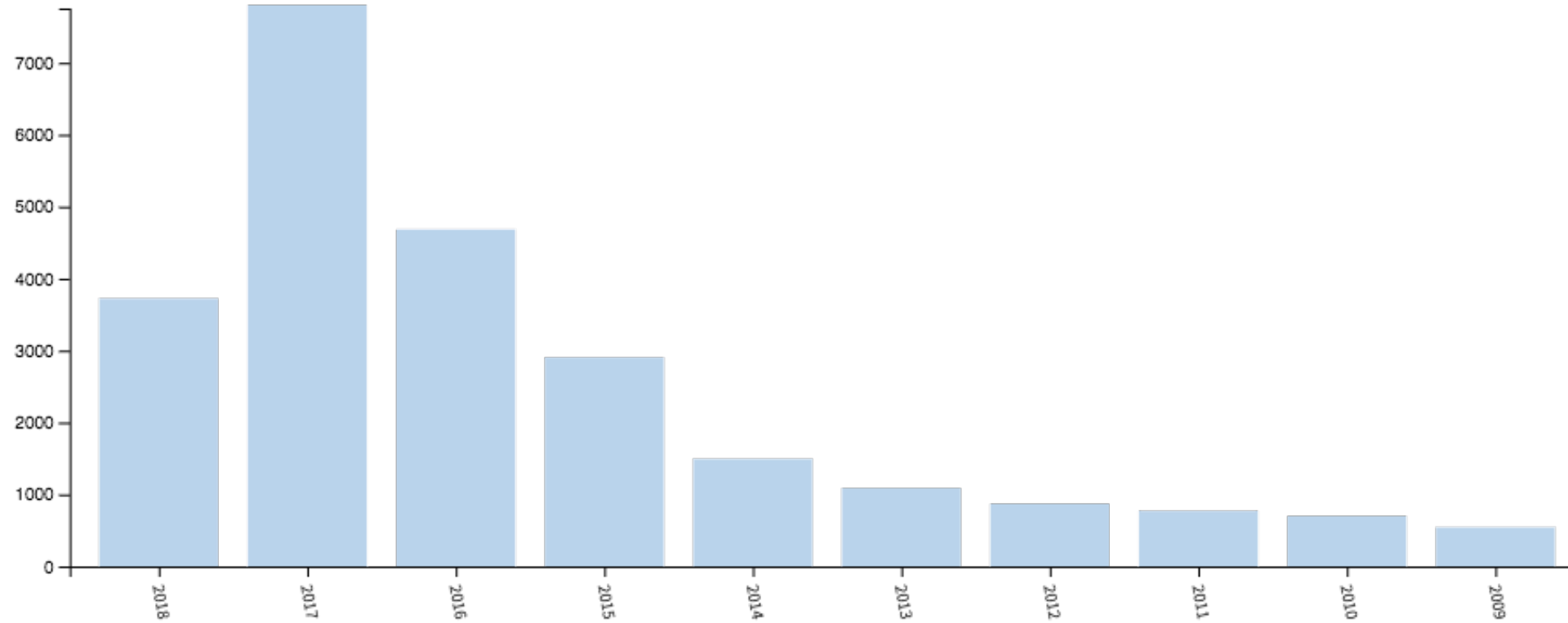
Web of Science: “Medical Imaging”



Showing 84,049 records for TOPIC: (medical imaging)

Date: 28 July 2018

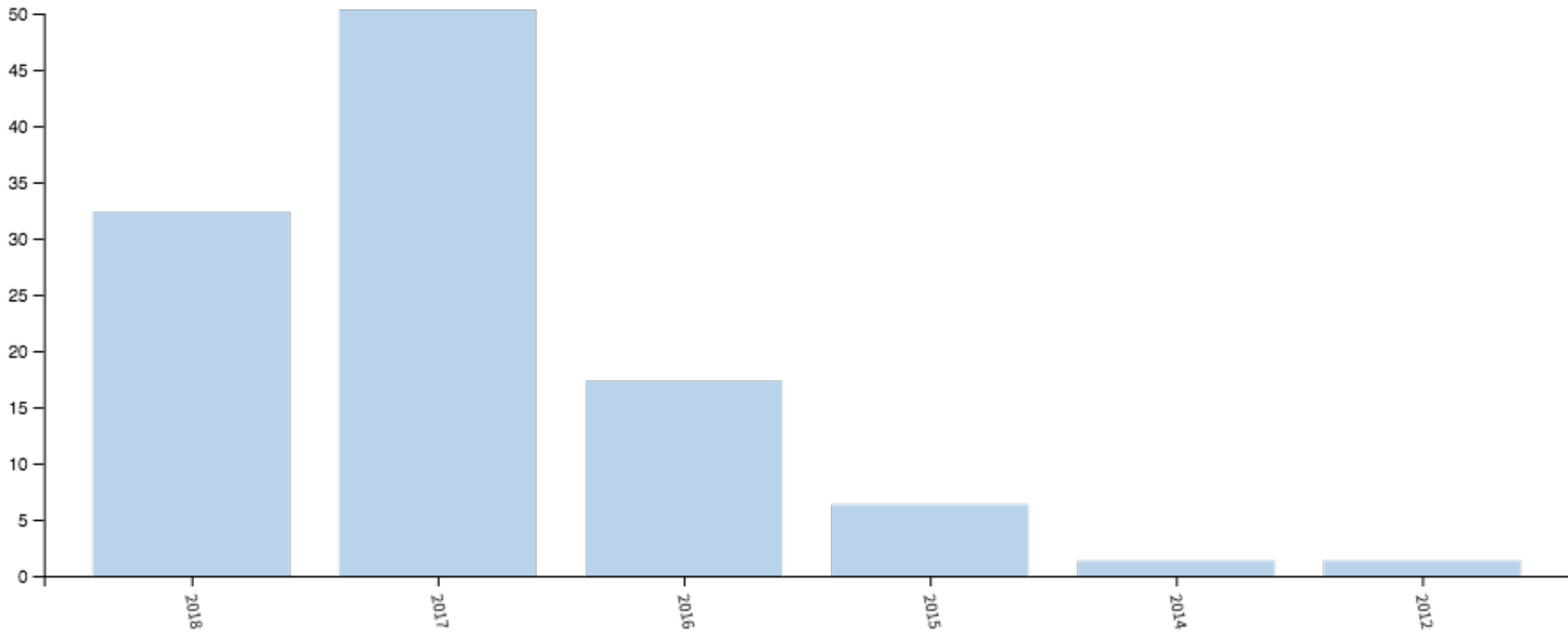
Web of Science: “Deep Learning”



Showing 27,171 records for TOPIC: (deep learning)

Date: 28 July 2018

Web of Science: “Medical Imaging” “Deep Learning”



Showing 107 records for TOPIC: (“medical imaging” “deep learning”) Date: 28 July 2018

Another way of looking at it (2):

- MICCAI: Medical Image Computing and Computer Assisted Interventions – 2018:



Wordle of 373 accepted paper titles (>1000 submissions)

Overview

- **Medical imaging**
 - From Roentgen's X-rays to modern tomographic imaging
- **Key applications and requirements for deep learning**

Medical Imaging: It all began with a picture...



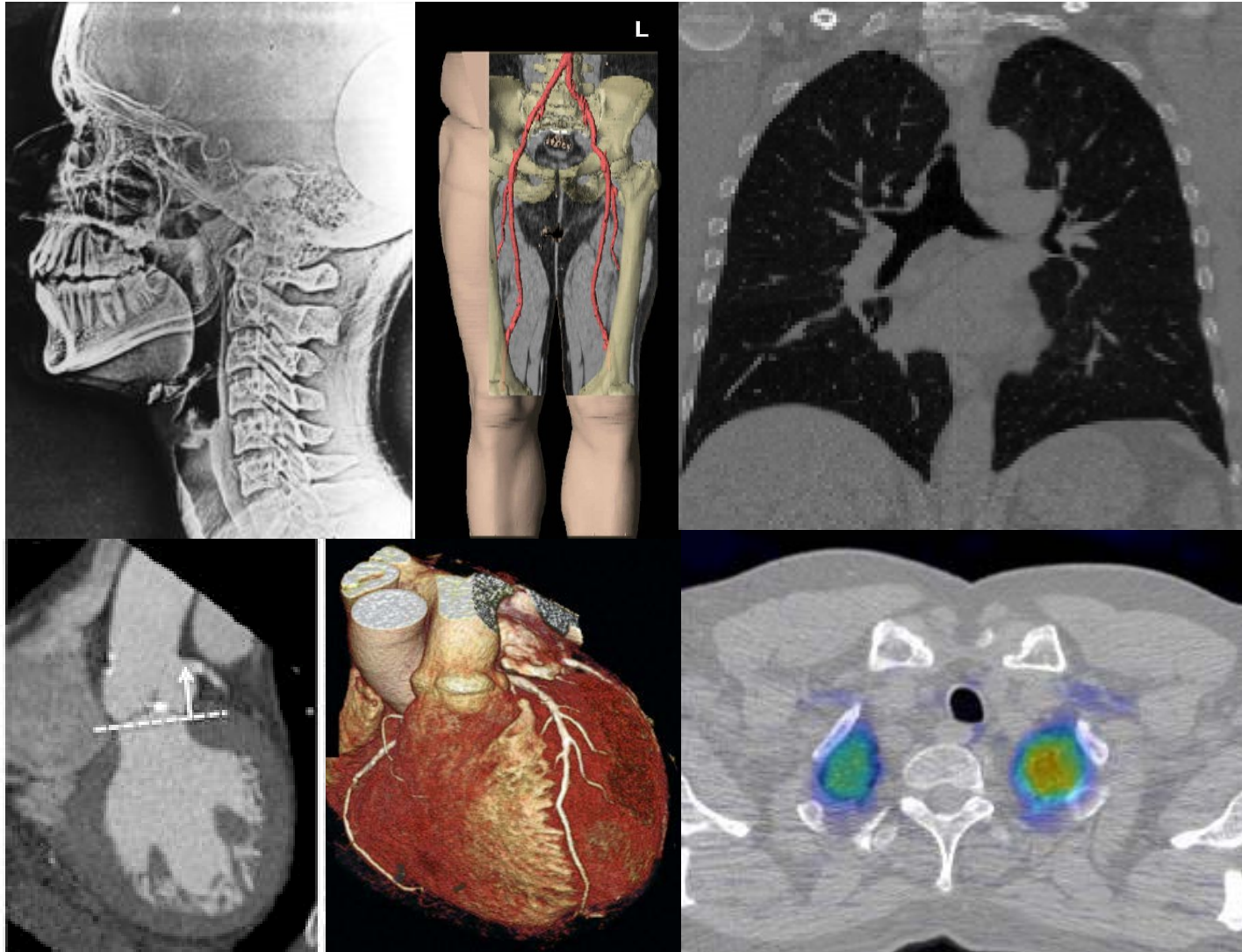
X-ray:
Wilhelm Roentgen 1896

But actually it began much earlier!

Leonardo da Vinci, 1452-1519



CT: From Slices to Volumes + Time



4D Lung CT

Lung CT:
ventilation

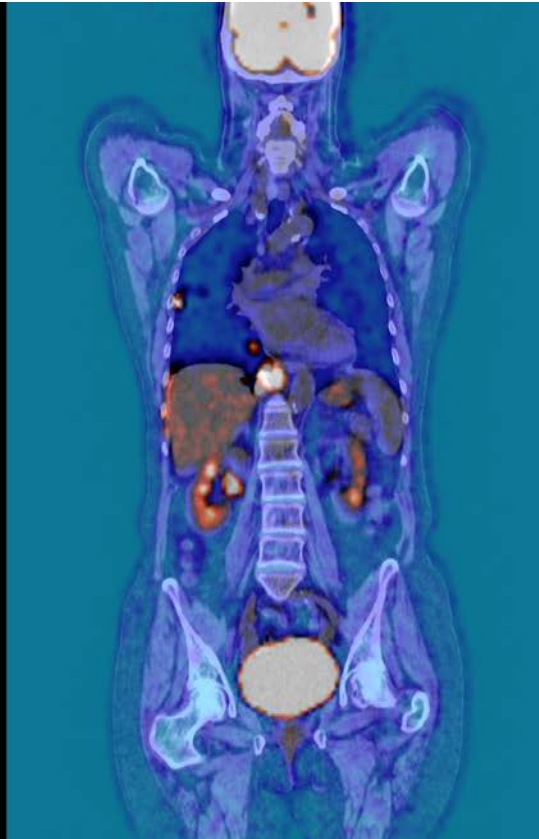
Cardiac CT

Nuclear Imaging (PET and SPECT)

CT



PET



Hybrid imaging: **PET-CT**

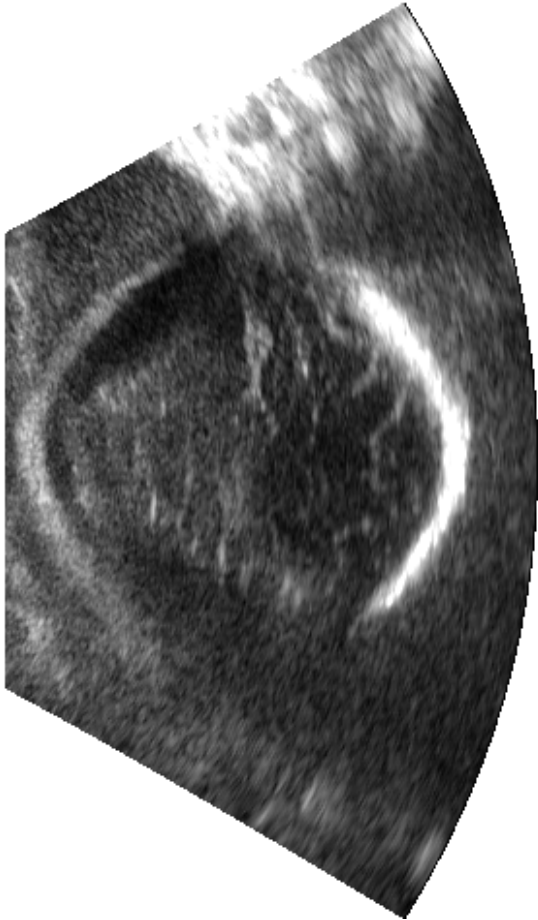
Also: SPECT-CT, MR-PET @[hybrid2020](#) ITN

Ultrasound



Liver carcinoma

Echocardiography



3D fetal ultrasound

Magnetic Resonance Imaging

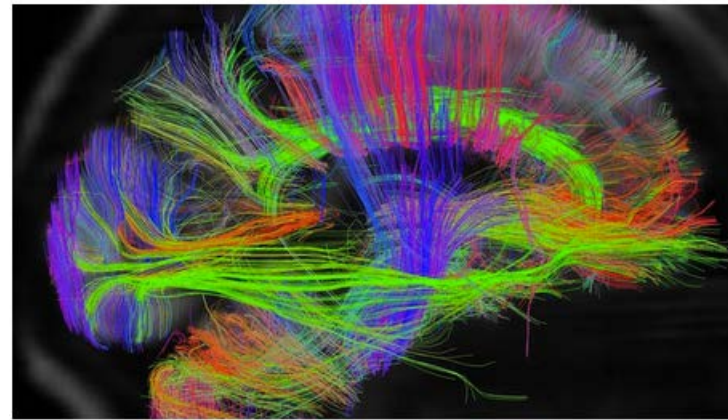
Cardiac cine MRI



Moving target

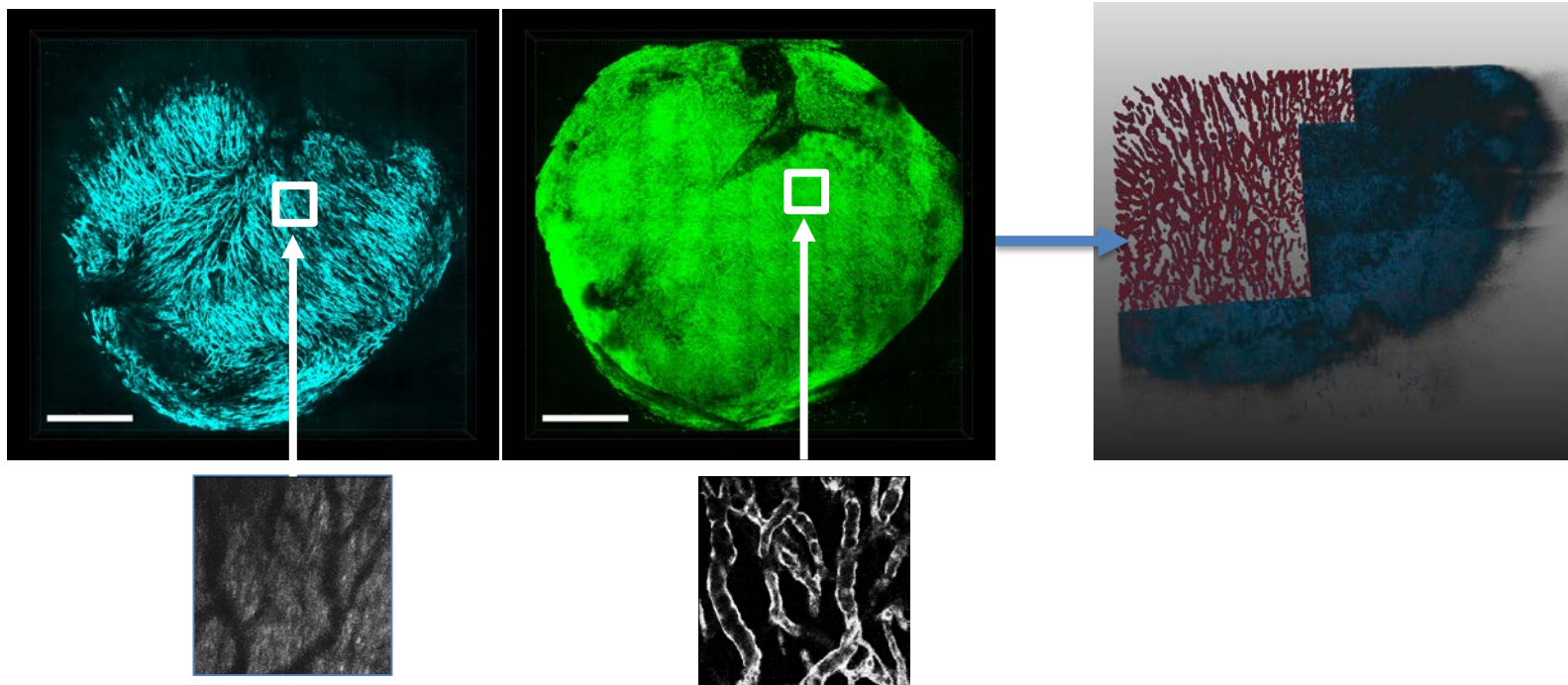


Dynamic contrast enhanced MRI



Human connectome

Microscopy



Each voxel is sized $0.8 \times 0.8 \times 5$ microns³

Each tile is sized 512×512 ; 12×12 tiles per slice, with 30 slices.

=> **>1 billion voxels per volume**

Medical imaging meets deep learning:

- **Complex image data:**
 - Expert annotations not perfect - no “ground truth”
 - Different imaging devices, protocols and manufacturers
 - Patient & disease variability (anatomy, physiology, pathology...)
- **Training data, validation data, test data:**
 - 100’s or 1000’s rather than millions of data sets
 - Imbalanced class problem
 - Dense rather than big data
 - High-dimensional data (3D+time, longitudinal...)
 - Need to be creative (cross validation, data augmentation)

Overview of school

- From the “dark ages”
 - object recognition before deep learning, over
 - mathematics and geometry of deep learning, to
 - adaptive and explainable/understandable deep learning,
- Practical applications in:
 - medical image recognition, segmentation, computer-aided diagnosis, reconstruction, super-resolution, population studies, and surgical interventions and more!

Today's Reading Group

- ***Efficient multi-scale 3D CNN with fully connected CRF for accurate brain lesion segmentation.*** Konstantinos Kamnitsas, Christian Ledig, Virginia F.J. Newcombe, Joanna P. Simpson, Andrew D. Kane, David K. Menon, Daniel Rueckert, Ben Glocker. *Medical Image Analysis* 36 (2017) 61-78, doi.org/10.1016/j.media.2016.10.004
- More dedicated, individual reading groups over Tuesday and Thursday lunchtimes – for your schedule please check:
<http://iplab.dmi.unict.it/miss18/ReadingGroup.htm>

Today's schedule

Monday 30 July 2018

Morning

Registration at the Conference Center - Stabilimento Florio([map](#)) 08:30 - 09:00

✓ Julia Schnabel
Medical Imaging meets Deep Learning: Introduction and Motivation 09:00 - 09:30

[Larry Zitnick](#)
The dark ages: Object Recognition before Deep Learning 09:30 - 10:45

Coffee break 10:45 - 11:15

[Daniel Rueckert](#)
Introduction into CNNs for medical imaging 11:15 - 12:30

[René Vidal](#)
Mathematics of Deep Learning (Part 1) 12:30 - 13:30

Lunch Time 13:30 - 15:00

Afternoon

[René Vidal](#)
Mathematics of Deep Learning (Part 2) 15:00 - 16:15

Coffee break 16:15 - 16:45

Julia Schnabel
Reading Group: How to read - shallow versus deep reading 16:45 - 18:15