OVERCOMING DATA SILOS:
THE AI COLLABORATION TOOLKIT FOR HEALTH DATA

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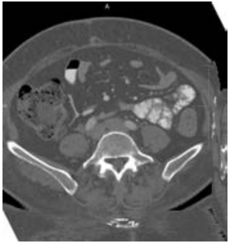
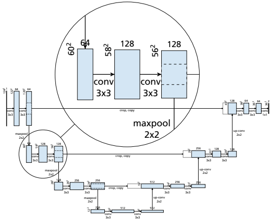
Research & Development of Data-Driven Algorithms

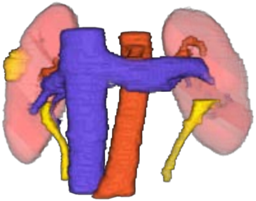
Example: Extraction of Kidney Anatomy

AI algorithm for assessment of renal cancer:

- Input: CA-CT (computer tomography) images of renal region
- Output: geometry of important anatomy (kidneys, tumors, vessels)





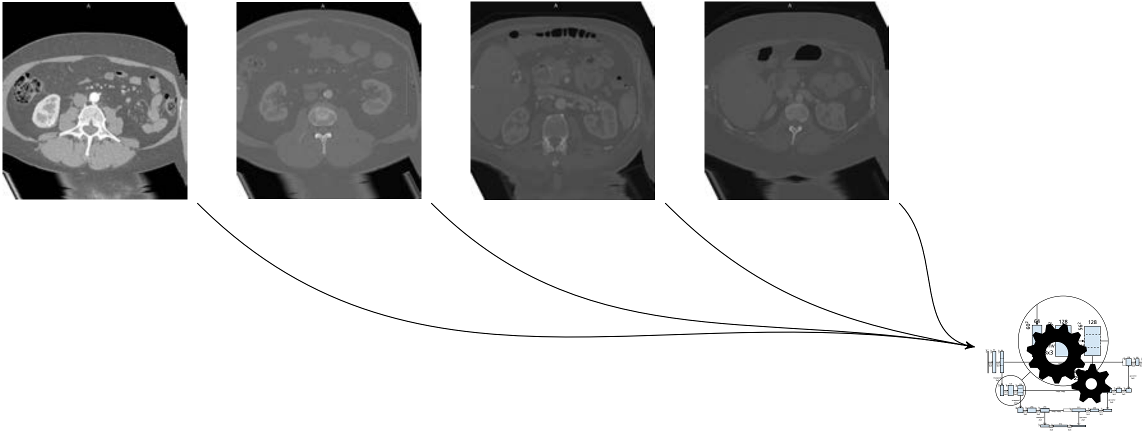


Goal: automatic measurements, quantitative assessment

Data used in the following: 2021 Kidney and Kidney Tumor Segmentation Challenge (KiTS 21)

Pipeline for Training an AI (Supervised Learning)

Now how does the AI learn how to extract anatomy?



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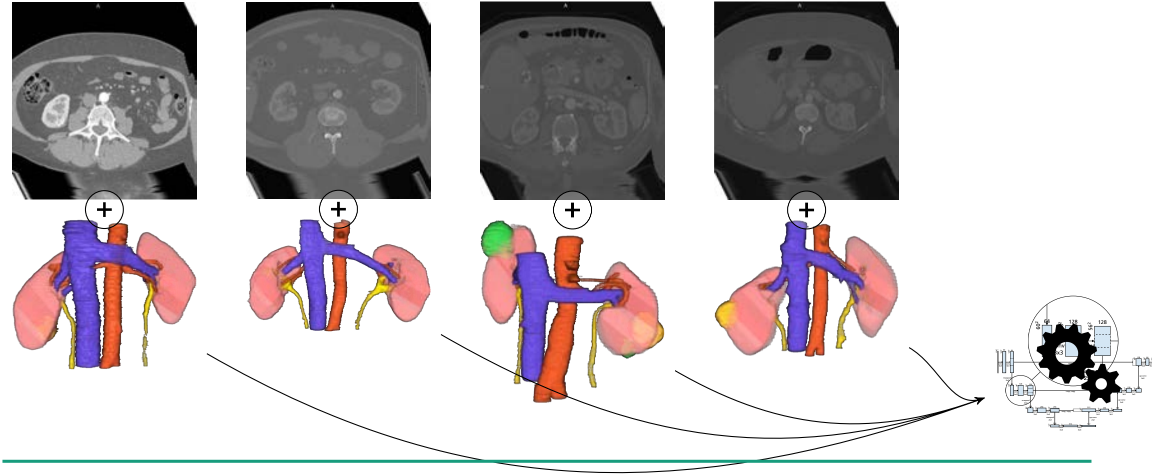

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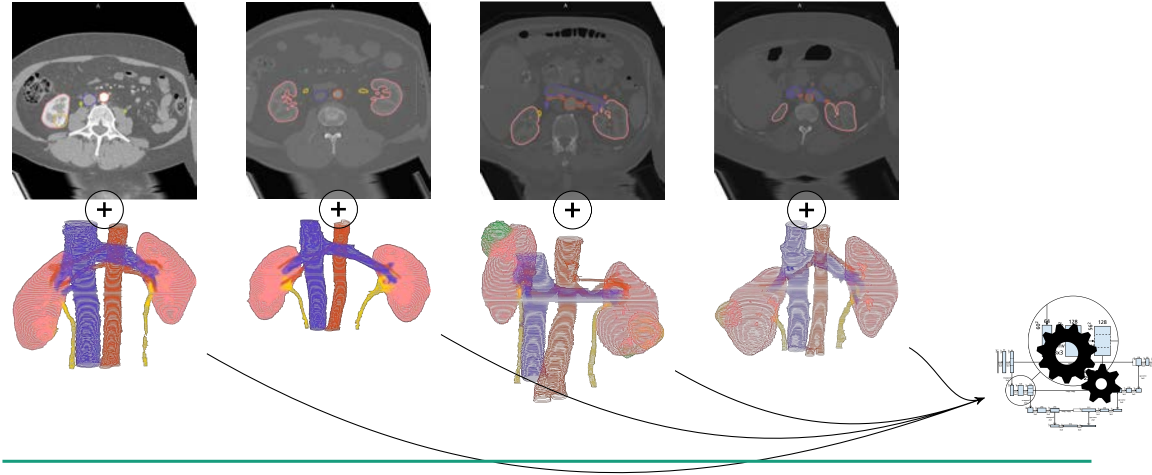
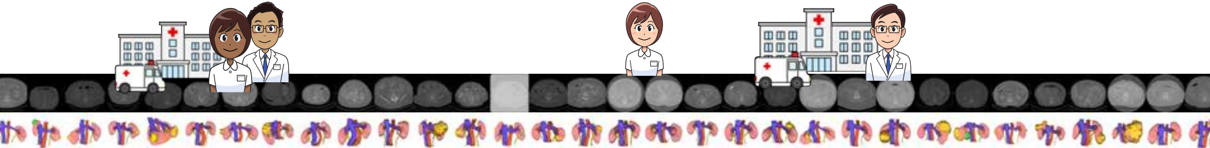


Complexities of Collaborative R&D

Sounds simple? In practice,

- data collected by doctors, needs to be accessible to technical scientists
  - anonymization has to be applied to data leaving the hospital
  - algorithm results or application prototypes have to be shared
- data needs to be reviewed / weeded out by both physicians and AI specialists
- annotations take a lot of time and need to be reviewed by experts
- data comes in batches, numbers increase over time
- problematic cases excluded at any time, annotations may need corrections, …

⇒ AI models are trained on *different versions* of curated data



PURPOSE / SCOPE

Our toolkit speeds up collaborative R&D of data-driven algorithms

Professional tooling for large, multi-site data collection & curation

Data curation

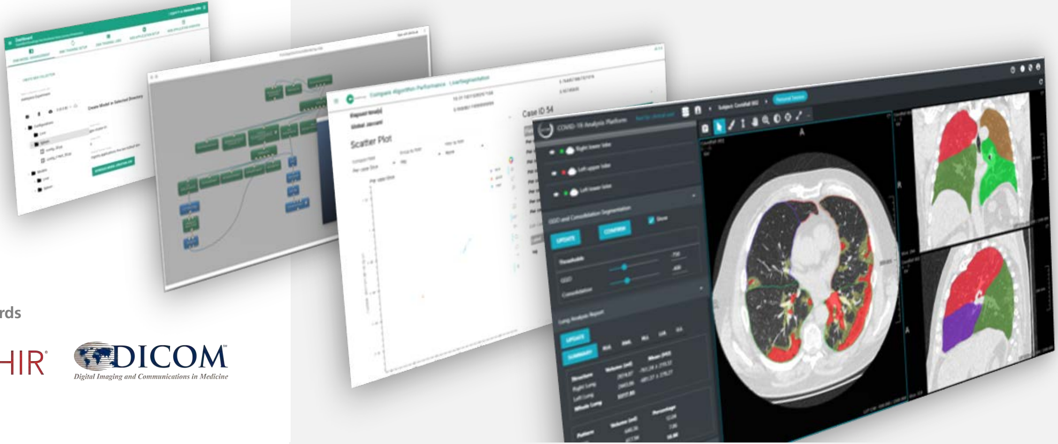
- Viewing
- Filtering
- Annotation

AI dev

- Model training
- Model evaluation

Application prototypes

- Clinical evaluation
- Workflow and UX assessment



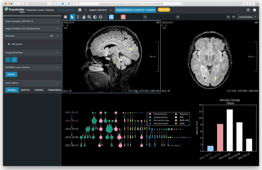
Based on standards

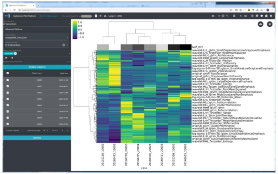
HL7 FHIR

DICOM
Digital Imaging and Communications in Medicine

SATORI – A Highly Customizable Annotation Tool

Main frontend visible to clinical users



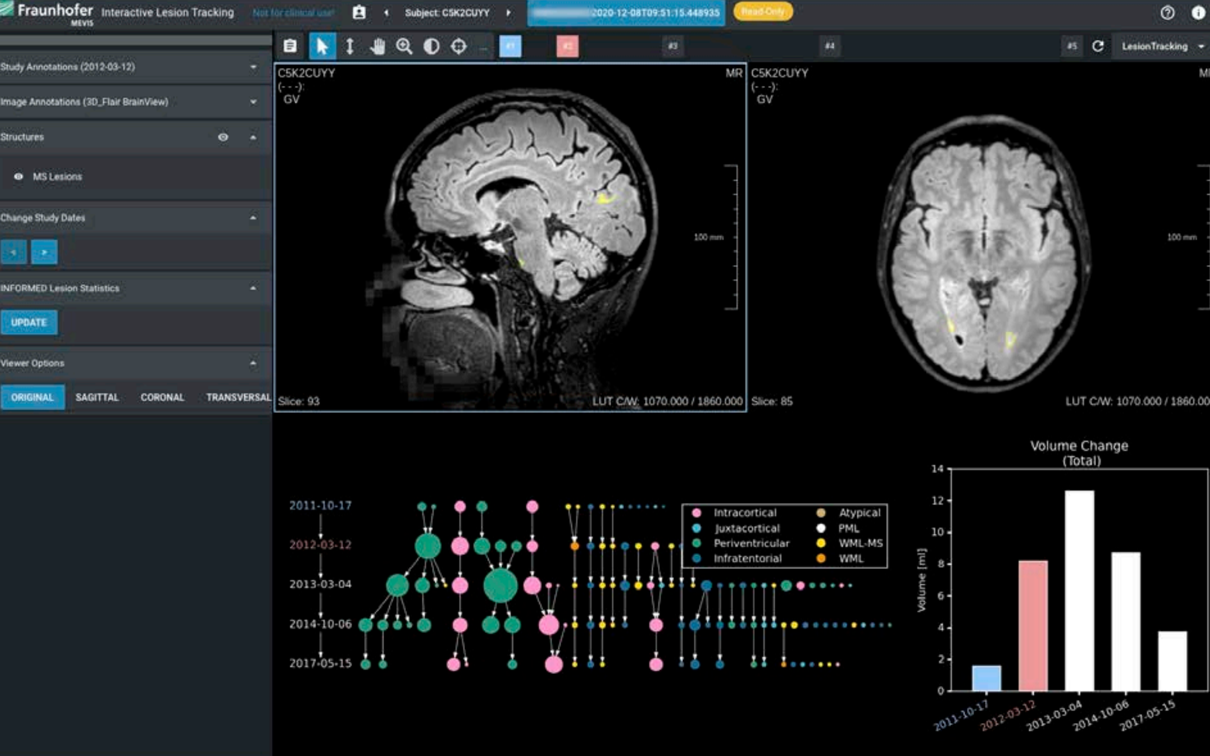


Basic Features

- Import / Export in many formats (DICOM, SEG, NIfTI, …)
- Automatic categorization, tagging and preprocessing
- User and group management, private / shared sessions, audit mode
- Customizable hangings and layouts
- Structured annotations (subject / study / image / structure)
- Efficient segmentation and correction of structures

Advanced Features through extensibility

- Smooth transition towards application prototypes
- Deployment options (MEVIS, on site, cluster, cloud, …)
- Direct connection to Deep Learning



Fraunhofer
MEVIS
Interactive Lesion Tracking
Subject: C5K2CUYY
2020-12-08T09:51:15.448935
Study Annotations (2012-03-12)
Image Annotations (3D_Flair BrainView)
Structures
MS Lesions
Change Study Dates
INFORMED Lesion Statistics
UPDATE
Viewer Options
ORIGINAL
SAGITTAL
CORONAL
TRANSVERSAL
#3
#4
#5
LesionTracking
C5K2CUYY
GV
MR
Slice: 93
LUT C/W: 1070.000 / 1860.000
Slice: 85
LUT C/W: 1070.000 / 1860.00
100 mm
2011-10-17
2012-03-12
2013-03-04
2014-10-06
2017-05-15
Intracortical
Juxtacortical
Periventricular
Infratentorial
Atypical
PML
WML-MS
WML
Volume Change
(Total)
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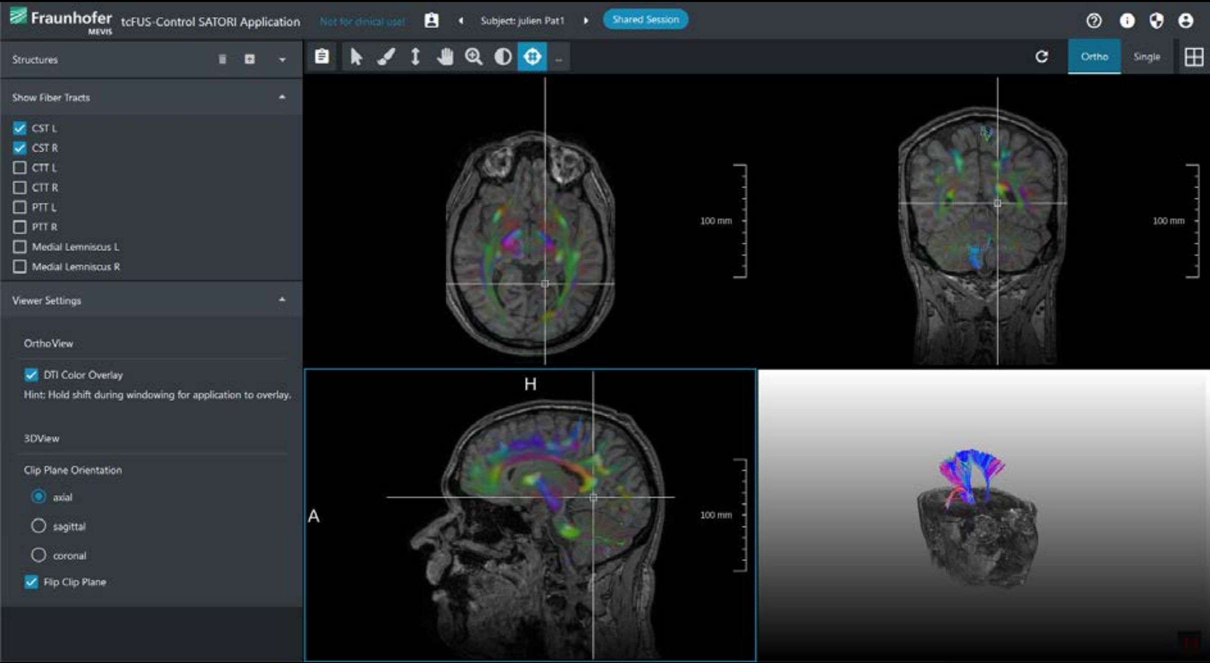
4
6
8
10
12
14


Fraunhofer
MEVIS
tcFUS-Control SATORI Application
Not for clinical use!
Subject: julien Pat1
Shared Session
Structures
Ortho
Single
Show Fiber Tracts
CST L
CST R
CTT L
CTT R
PTT L
PTT R
Medial Lemniscus L
Medial Lemniscus R
Viewer Settings
OrthoView
DTI Color Overlay
Hint: Hold shift during windowing for application to overlay.
3DView
Clip Plane Orientation
axial
sagittal
coronal
Flip Clip Plane
100 mm
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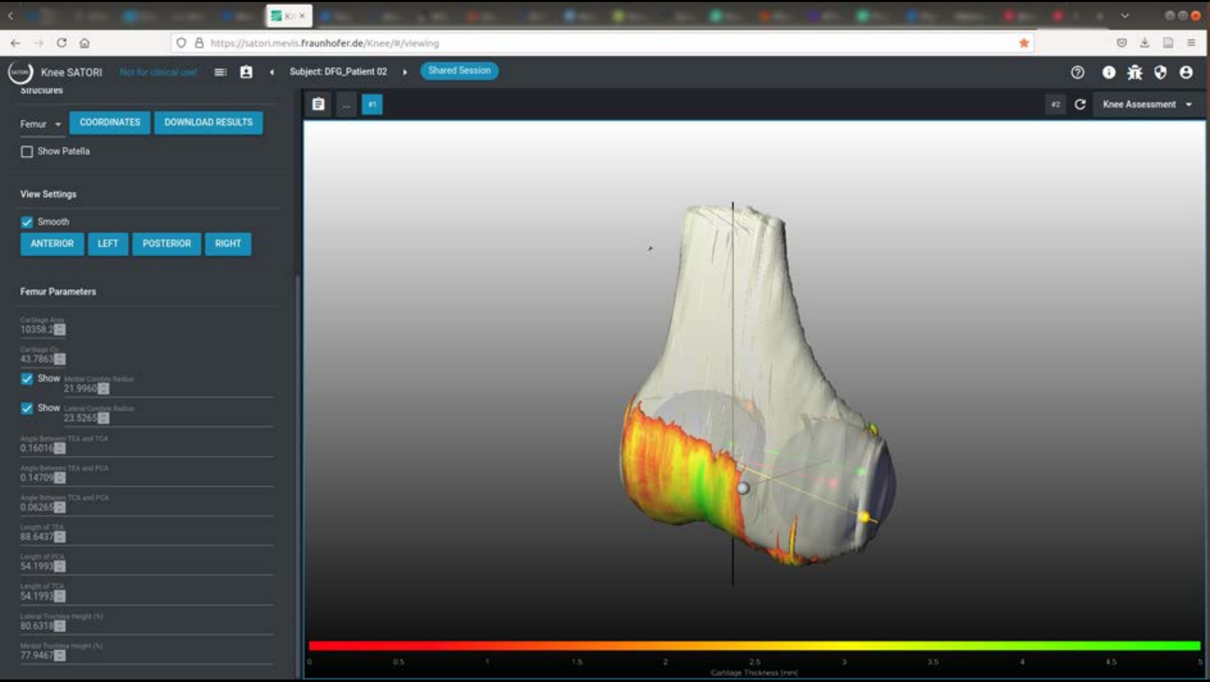
A
100 mm


https://satori.mevis.fraunhofer.de/Knee/#/viewing
Knee SATORI
Not for clinical use!
Subject: DFG_Patient 02
Shared Session
Knee Assessment
Structures
Femur
COORDINATES
DOWNLOAD RESULTS
Show Patella
View Settings
Smooth
ANTERIOR
LEFT
POSTERIOR
RIGHT
Femur Parameters
10358.2
43.7863
Show
21.9960
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23.5265
0.16016
0.14709
0.06265
88.6437
54.1993
54.1993
80.6318
77.9467
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0.5
1
1.5
2
2.5
3
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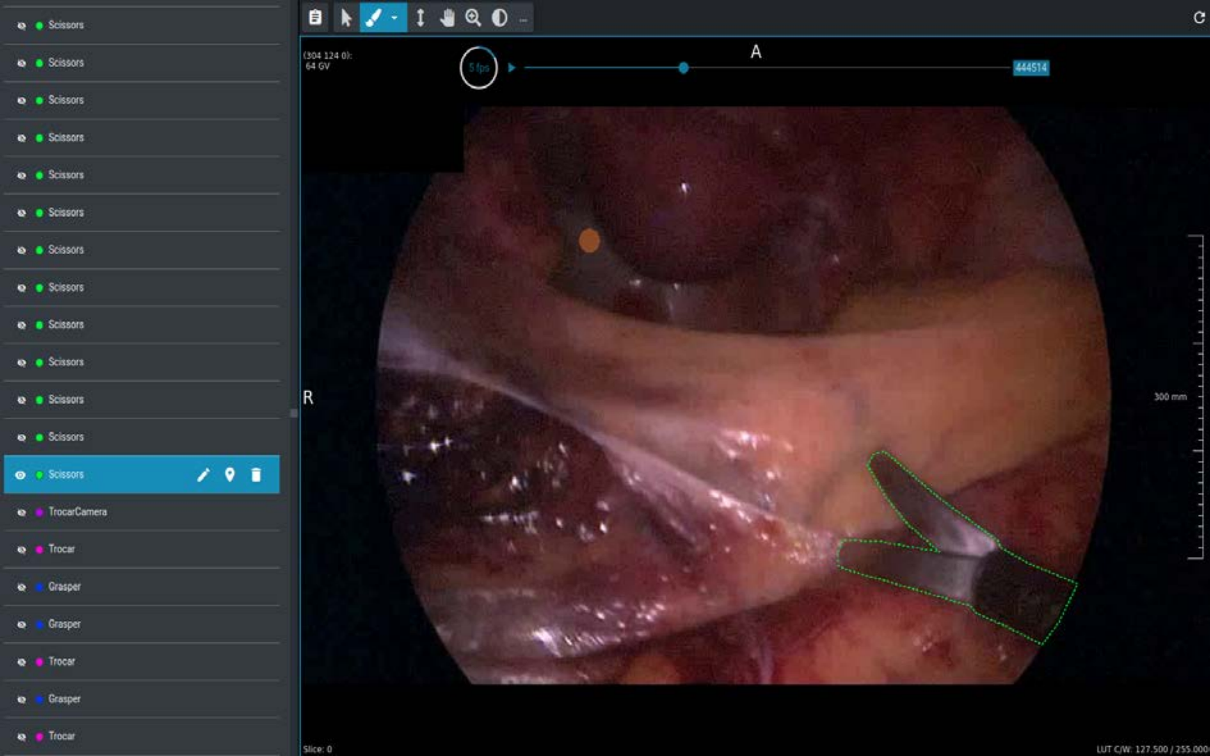
4
4.5
5


Scissors
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Trocar
(304 124 0):
64 GV
5 fps
444514
A
R
300 mm
Slice: 0
LUT C/W: 127.500 / 255.000

Radiomics Pilot Platform
localhost:8088/#/radiomicsAnalysis
Radiomics Pilot Platform
Not for clinical use!
You are logged in as
Subject: 10001
LV Epicardium
Advanced Options
exampleMR_5mm.yaml
LV Endocardium
LVEF-MRT
RETRIEVE SUBJECTS
Subject name
Study time
10002
2013-11-18
10002
2016-04-22
10001
2013-12-09
10001
2014-06-03
20003
2016-04-11
20003
2016-07-18
20004
2016-07-05
20004
2016-09-20
8 records selected.
Records per page:
10
1-8 of 8
ANALYZE
1.6
0.8
0.0
−0.8
−1.6
lvef_mrt
wavelet-LLL_gldm_SmallDependenceLowGrayLevelEmphasis
wavelet-LHL_firstorder_RootMeanSquared
wavelet-HLH_glrlm_RunVariance
wavelet-HHH_glszm_LargeAreaEmphasis
wavelet-LLH_firstorder_Median
wavelet-LHH_firstorder_Uniformity
wavelet-LHH_glcm_InverseVariance
log-sigma-5-0-mm-3D_glszm_SmallAreaLowGrayLevelEmphasis
wavelet-LHL_glszm_ZoneVariance
original_glrlm_RunVariance
original_gldm_GrayLevelNonUniformity
log-sigma-3-0-mm-3D_glcm_InverseVariance
wavelet-HLL_gldm_LargeDependenceEmphasis
wavelet-LHH_firstorder_Energy
wavelet-HLL_glszm_LowGrayLevelZoneEmphasis
wavelet-LHH_firstorder_RootMeanSquared
wavelet-HHL_glszm_SmallAreaLowGrayLevelEmphasis
wavelet-LLH_glrlm_HighGrayLevelRunEmphasis
log-sigma-3-0-mm-3D_firstorder_Mean
wavelet-LHL_firstorder_Range
wavelet-HLL_glcm_Autocorrelation
wavelet-HLL_glcm_ClusterProminence
wavelet-HHH_glcm_Idmn
wavelet-HHH_glcm_Autocorrelation
wavelet-LHH_firstorder_Range
wavelet-LLL_glcm_JointAverage
wavelet-HLH_firstorder_RobustMeanAbsoluteDeviation
wavelet-LHH_firstorder_MeanAbsoluteDeviation
wavelet-HHH_firstorder_90Percentile
original_glcm_ClusterProminence
wavelet-LLH_gldm_GrayLevelVariance
wavelet-LHH_gldm_DependenceEntropy
log-sigma-3-0-mm-3D_gldm_SmallDependenceEmphasis
wavelet-LLH_glrlm_RunPercentage
original_glrlm_RunLengthNonUniformityNormalized
wavelet-HHL_firstorder_Entropy
20131118_10002
20160422_10002
20160718_20003
20160705_20004
20160920_20004
20160411_20003
20131209_10001
20140603_10001
case

Technology Goal 1: In-Situ Correction

Only dynamically learning AI appears really "intelligent"

Long history of application prototypes with manual correction facilities

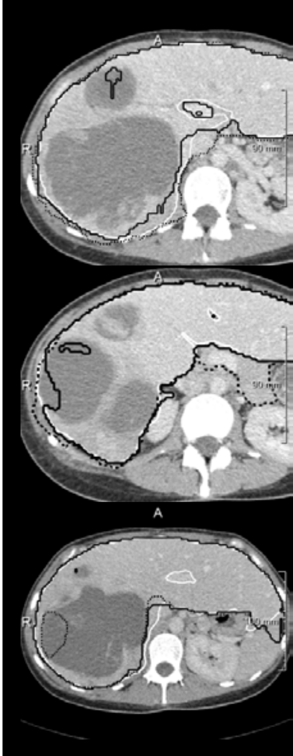
- Doctors become frustrated when software repeats the same mistake again and again

Our highly integrated web-based AI collaboration toolkit makes these corrections more sustainable

- Corrections enter data pool…
- …undergo review / curation…
- …and can be used for training / evaluation.

Thought on Deep Learning

We expect corrections to be *particularly valuable*!

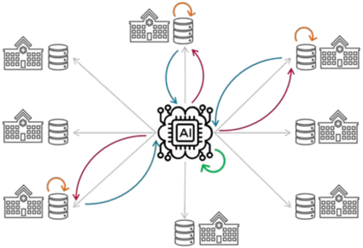


Technology Goal 2: Federated Learning

Because multi-centric data is key to robust AI & real-world applicability

Toolkit supports on-site deployment

⇒ **data does not have to leave the hospital**



Trained models may travel, though

- for evaluation / application
- for learning on data from multiple sites

Our toolkit provides interfaces also for models

- goal: supporting real-time communication betw. hospitals

Problem dimensions

- hurdles for data sharing
- firewalled IT (as a consequence)
- training strategies

Conclusions

We are building an AI Collaboration Toolkit with integrated platform components for

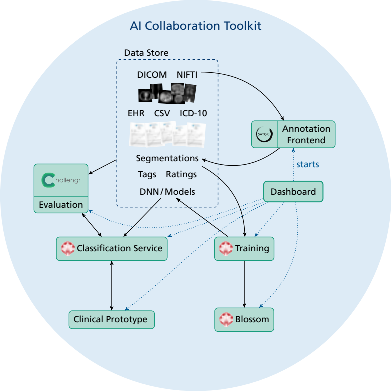
- data curation
- AI research & development
- custom application prototypes

Integration enables

- dynamically learning AI and
- federated learning

The toolkit is used in ongoing projects, internally and with various partners

- RACOON-SATORI currently deployed to all German UMC (NUM)



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