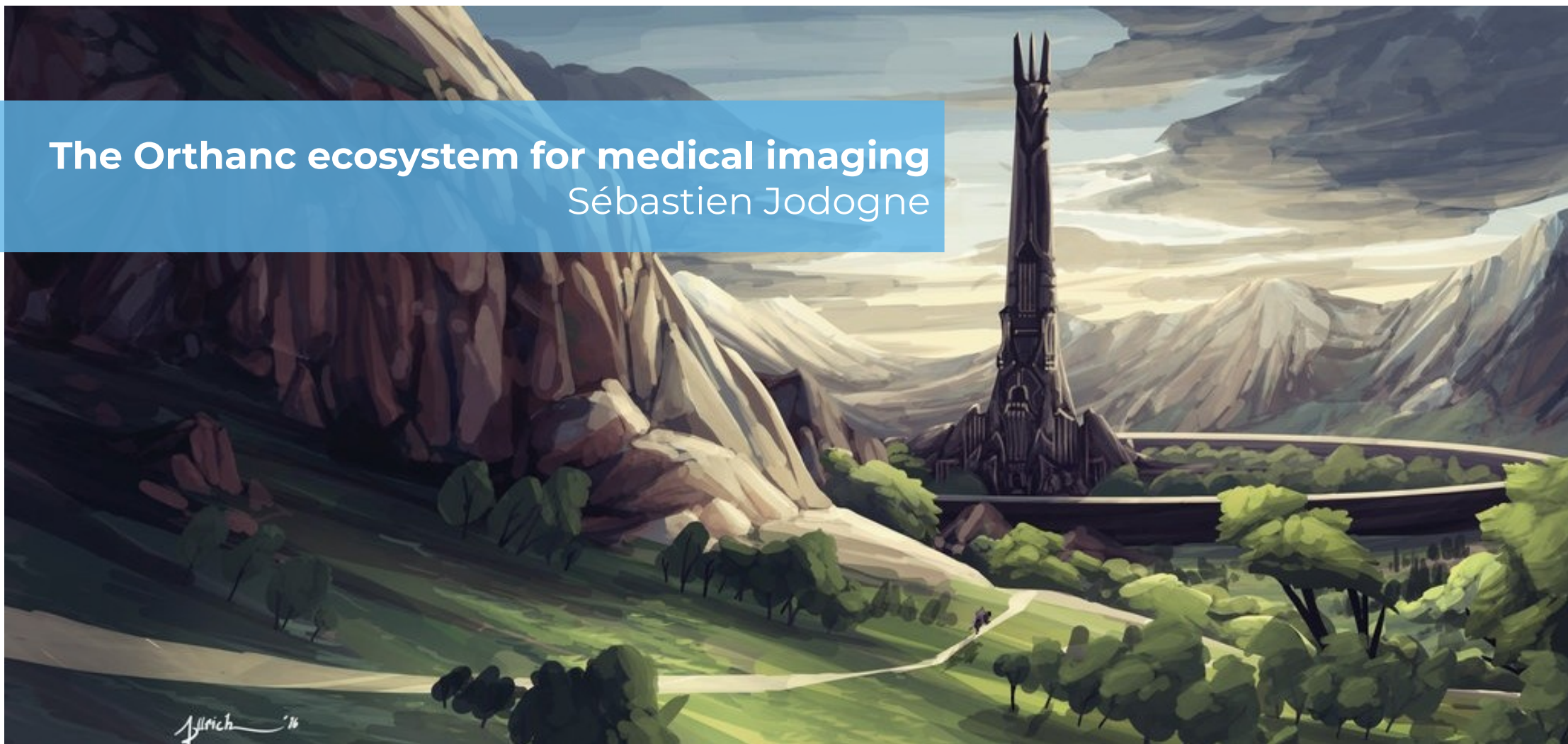
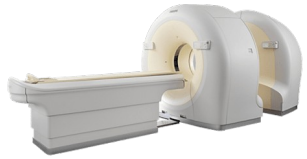


**The Orthanc ecosystem for medical imaging**  
Sébastien Jodogne

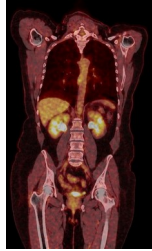


**DICOM**

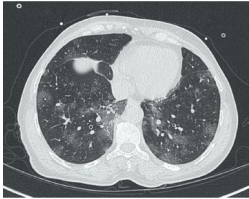
# “Big imaging” workflow inside hospitals



PET



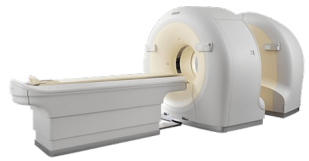
CT



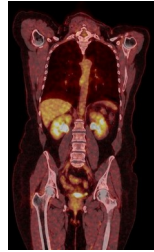
MRI



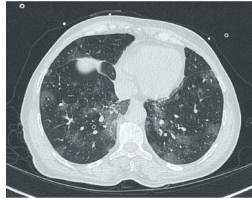
# “Big imaging” workflow inside hospitals



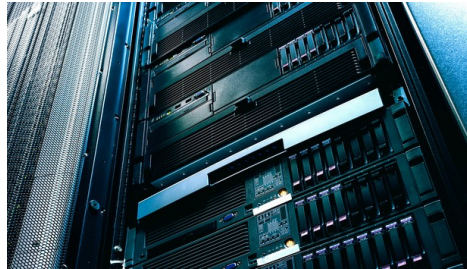
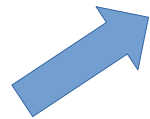
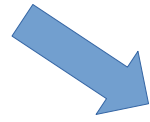
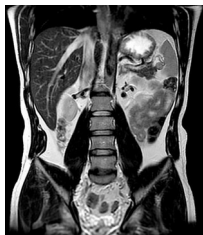
PET



CT



MRI

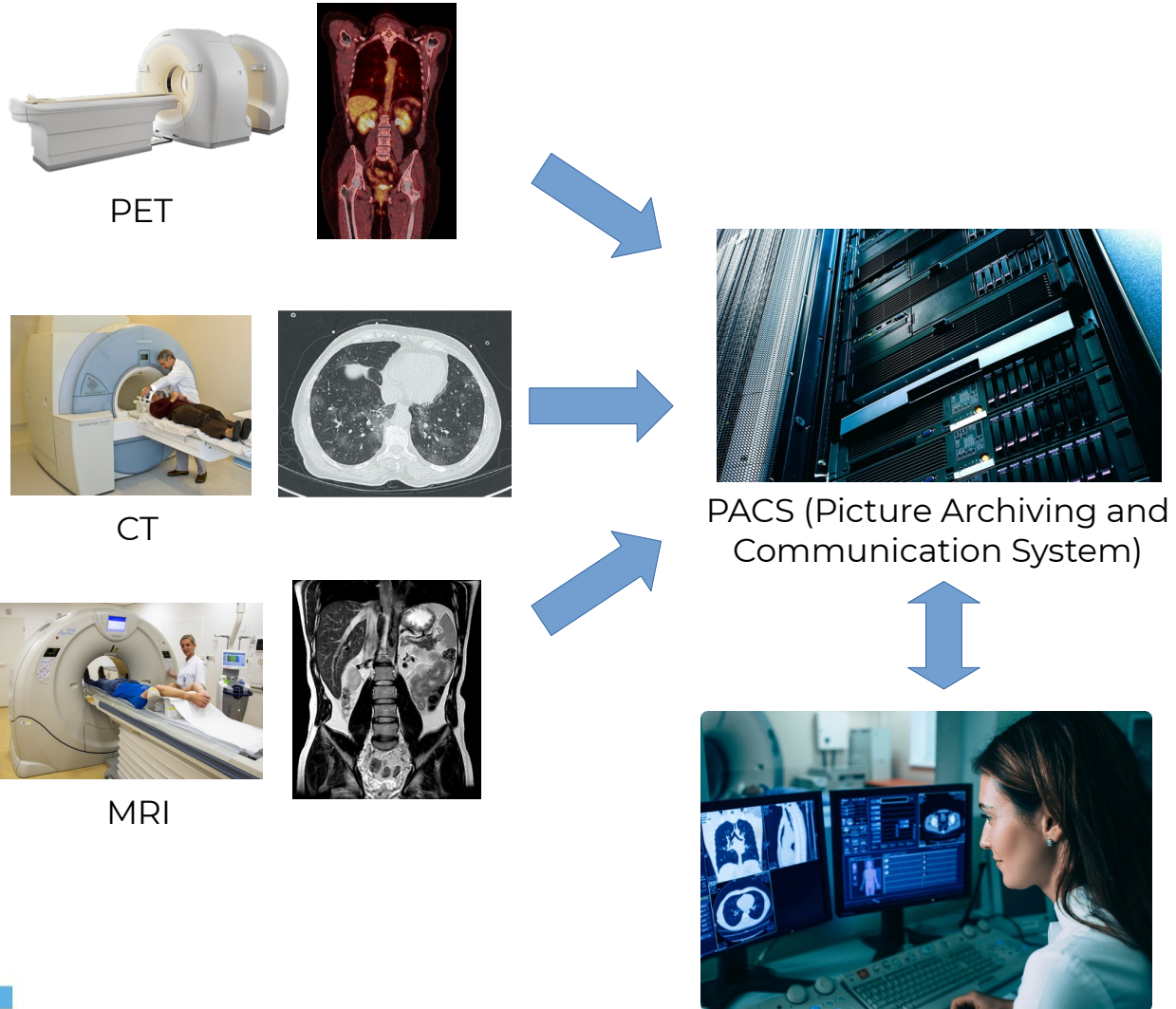


PACS (Picture Archiving and Communication System)

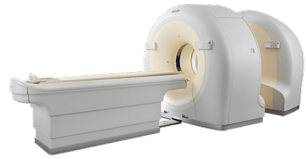




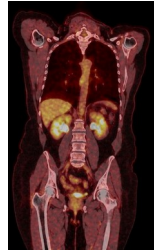
# “Big imaging” workflow inside hospitals



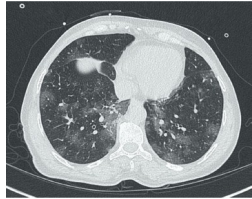
# “Big imaging” workflow inside hospitals



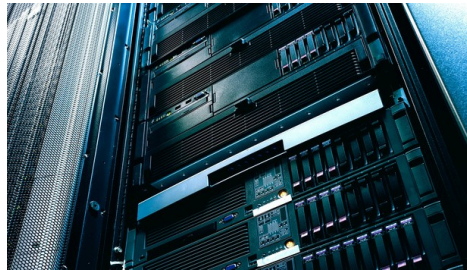
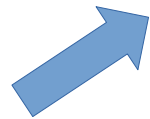
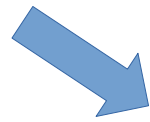
PET



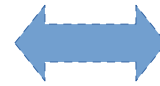
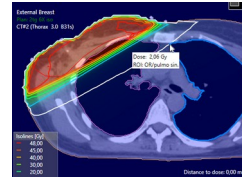
CT



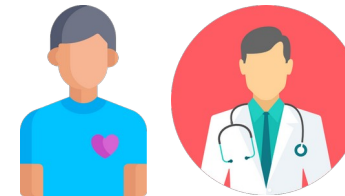
MRI



PACS (Picture Archiving and Communication System)



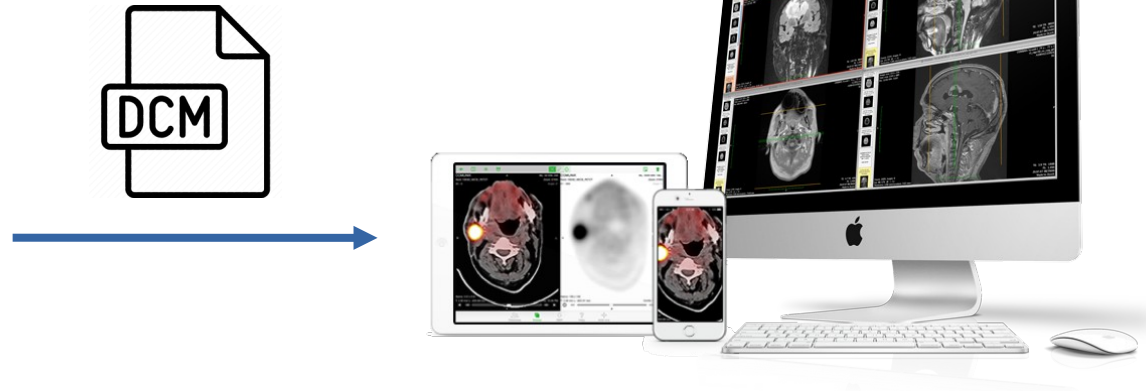
Specialized devices or applications (radiotherapy...)



Web portals (or CDs)



# Interoperability in medical imaging

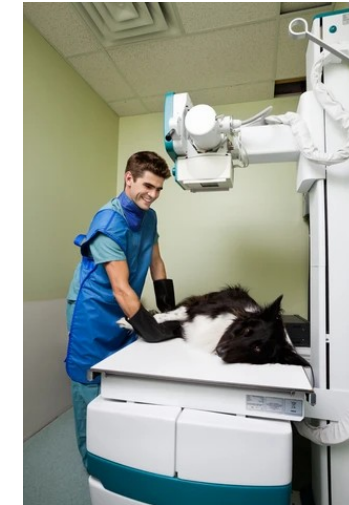
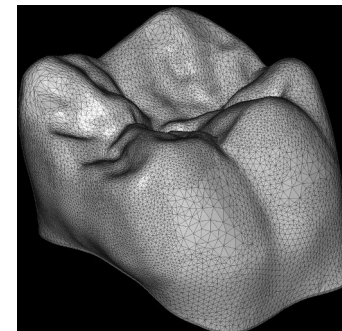
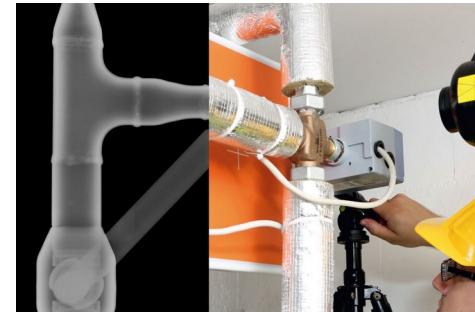
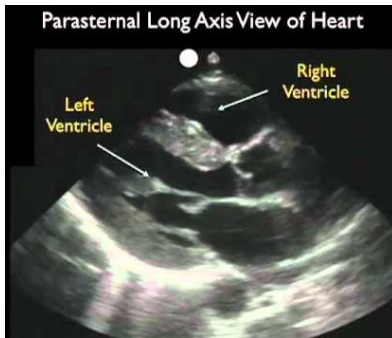
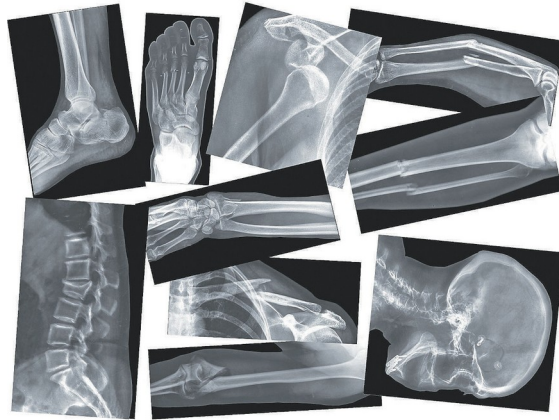


“One **OPEN standard** to rule them all...”





# Also “small imaging” and out of hospitals!



**DICOM is everywhere!  
Every vendor uses it!**







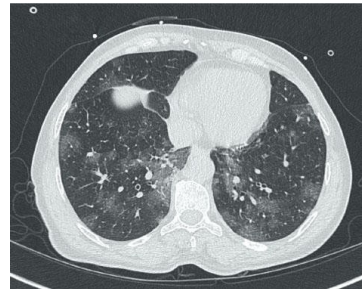
File format



Network protocol



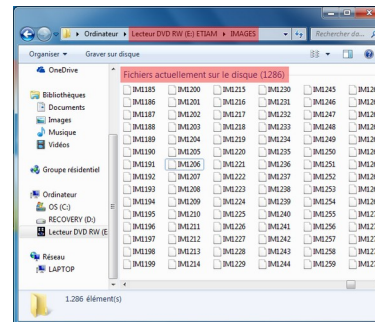
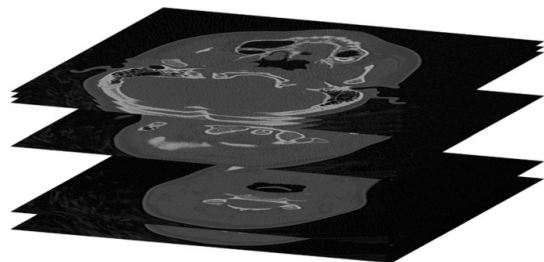
Acquisition data (kind of XML)



One slice of image (kind of PNG)



Early example of Web service: « store / query / retrieve »



Large variations in the volume of one medical image: radiography – 10MB, mammography – 100MB, CT-scan – 500MB, histology – 10GB

**Orthanc**



2011: *“We want to make use of our medical images by ourselves”*



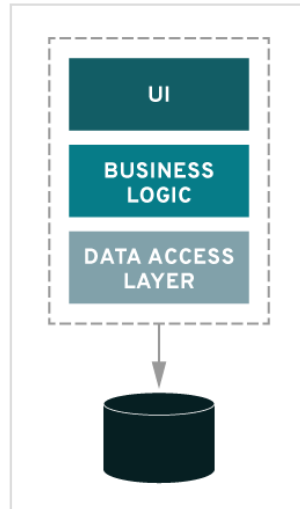
2012: *The first free and open-source DICOM server with a REST API that just **starts out-of-the-box***





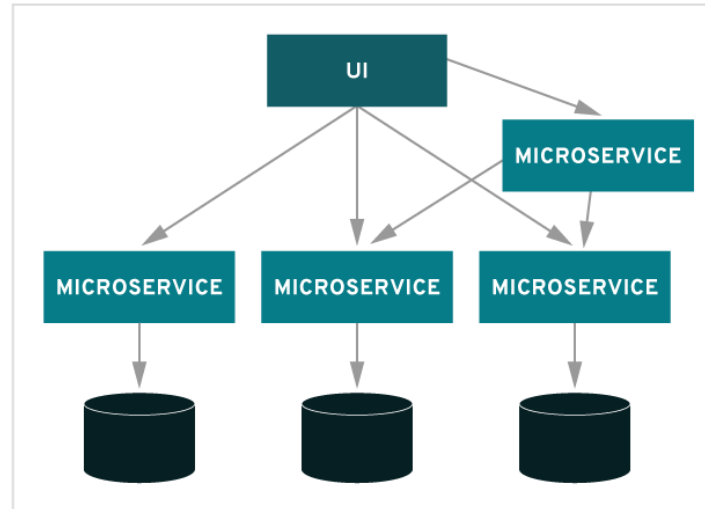
# Basic ideas behind Orthanc

MONOLITHIC



VS.

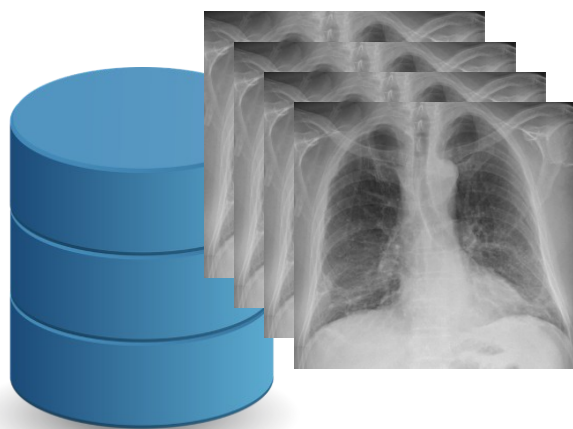
MICROSERVICES



“Let’s create a **microservice (SOA)** for medical imaging that leverages the worldwide **DICOM open standard**”

“Let’s release it as **free software (GPL)**, as it is our responsibility as a University to **share knowledge** and to **foster innovation**”

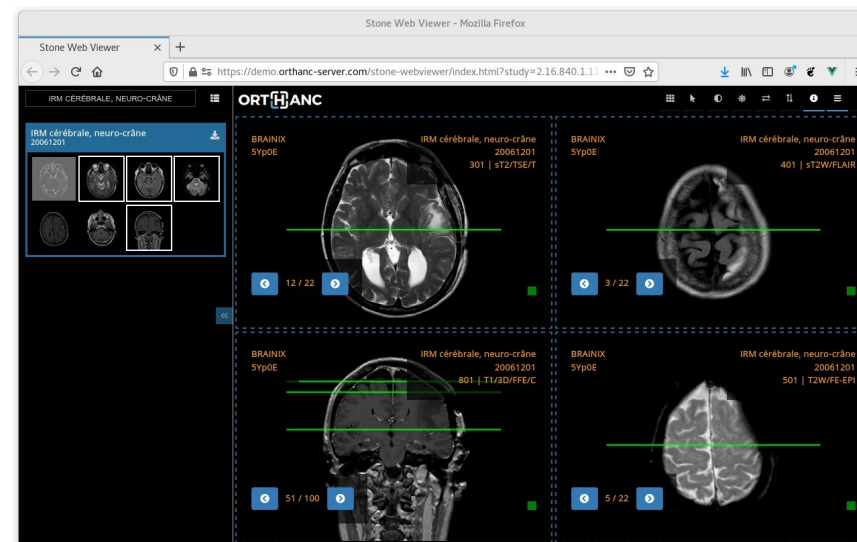
# ORT<sup>H</sup>ANC



Lightweight DICOM server for medical imaging (PACS) used in clinical, industrial, and research setups

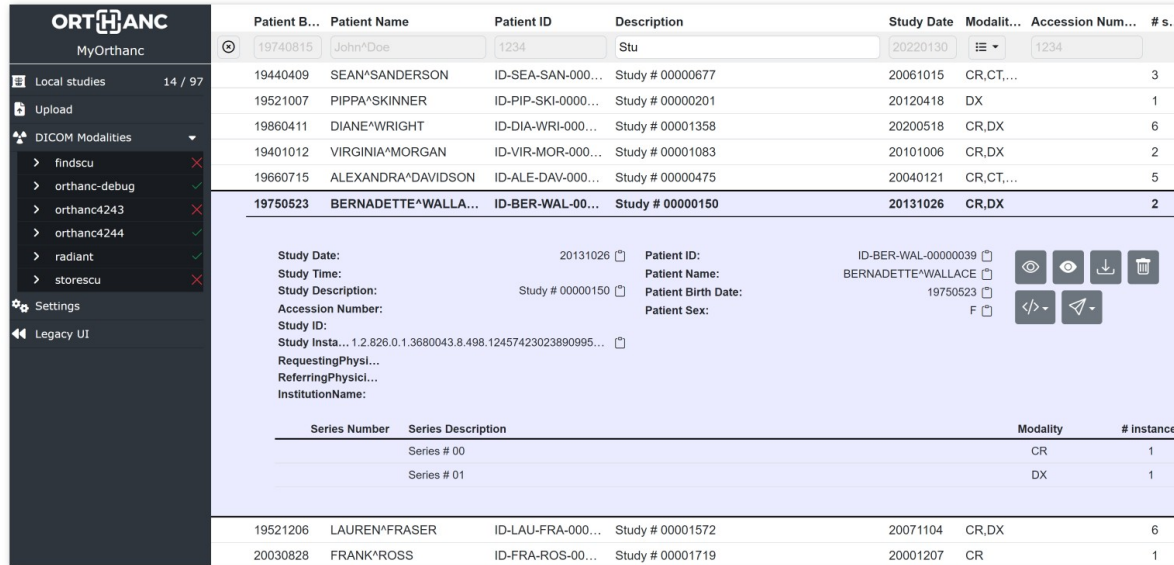


Inter-site exchanges (e.g., for artificial intelligence or multi-site studies)



Teleradiology portals

# Key features of Orthanc



The screenshot shows the Orthanc web interface. On the left is a dark sidebar with navigation options: Local studies (14 / 97), Upload, DICOM Modalities (with sub-items: findscu, orthanc-debug, orthanc4243, orthanc4244, radiant, store SCU), Settings, and Legacy UI. The main area displays a table of studies with columns: Patient B..., Patient Name, Patient ID, Description, Study Date, Modalit..., Accession Num..., and # s... The table lists several studies, with the one for Patient ID 19750523 (BERNADETTE\*WALLA...) selected. Below the table, a detailed view of this study is shown, including fields for Study Date, Study Time, Study Description, Accession Number, Study ID, Study Instance, RequestingPhysician, ReferringPhysician, and InstitutionName. A table below this view shows series information: Series # 00 (Modality: CR, # instances: 1) and Series # 01 (Modality: DX, # instances: 1). At the bottom of the interface, more studies are listed.

Patient B...	Patient Name	Patient ID	Description	Study Date	Modalit...	Accession Num...	# s...
19740815	John*Doe	1234	Stu	20220130		1234	
19440409	SEAN*SANDERSON	ID-SEA-SAN-000...	Study # 00000677	20061015	CR,CT,...		3
19521007	PIPPA*SKINNER	ID-PIP-SKI-0000...	Study # 00000201	20120418	DX		1
19860411	DIANE*WRIGHT	ID-DIA-WRI-000...	Study # 00001358	20200518	CR,DX		6
19401012	VIRGINIA*MORGAN	ID-VIR-MOR-000...	Study # 00001083	20101006	CR,DX		2
19660715	ALEXANDRA*DAVIDSON	ID-ALE-DAV-000...	Study # 00000475	20040121	CR,CT,...		5
19750523	BERNADETTE*WALLA...	ID-BER-WAL-00...	Study # 00000150	20131026	CR,DX		2
19521206	LAUREN*FRASER	ID-LAU-FRA-000...	Study # 00001572	20071104	CR,DX		6
20030828	FRANK*ROSS	ID-FRA-ROS-00...	Study # 00001719	20001207	CR		1



- Reference, **free and open-source** implementation of a DICOM server
- **Lightweight**: Focused on simplicity, portability and small footprint (C++)
- Built-in support of Web technologies (Web interface, **REST API**)
- Highly versatile, extensible and scriptable (**plugins**)
- **Industrial grade (QA), large-scale project** (over 400,000 LOCs)



Lightweight



Rest API



# Integrated Web viewers for teleradiology

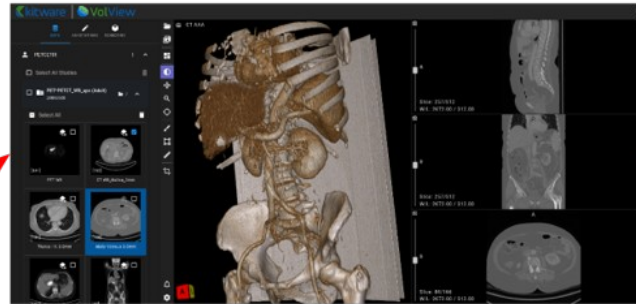


## Orthanc Explorer

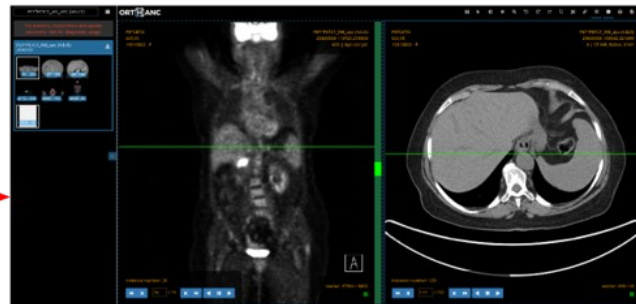
Orthanc Explorer interface showing patient and study details. A red box highlights the 'Add label' section with the following options:

- Open Kitware's VolView
- Stone Web Viewer
- Open OHIF viewer

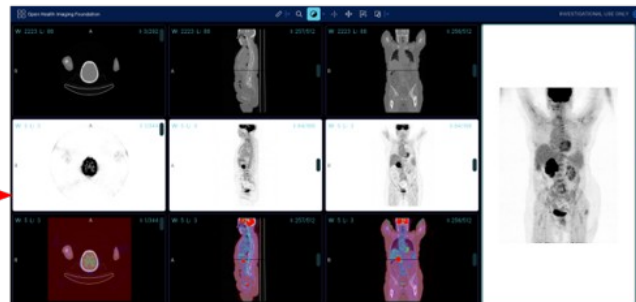
## Kitware VolView



## Stone Web viewer



## OHIF



## Orthanc Explorer 2

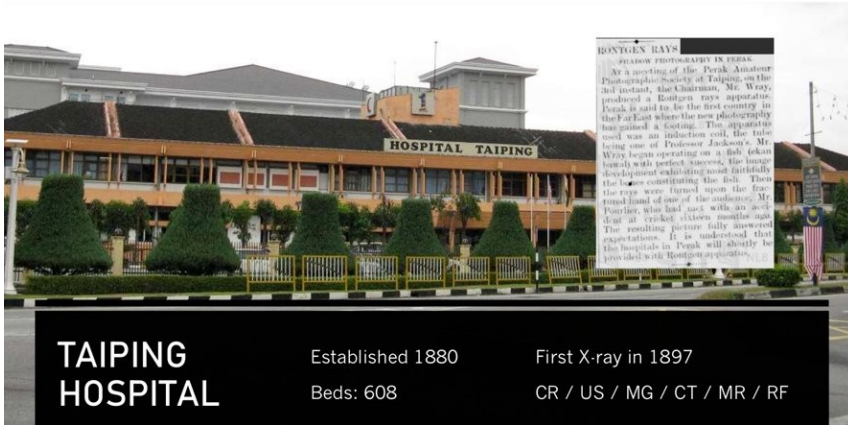
Orthanc Explorer 2 interface showing a list of studies and a table of series. A red box highlights the 'Labels' section with the following options:

- Open Kitware's VolView
- Stone Web Viewer
- Open OHIF viewer

Series...	Series Description	Modality	# 1...
4	CT WB_Native_3mm	CT	292
7	Thorax I.V. 3.0mm	CT	134
9	Abdo-Veineux 3.0mm	CT	166
102	PET WB	PT	344
603	mpr.axial.fusion	CT	162
604	mpr.cor.fusion	CT	50
605	mpr.cor.pet	PT	49



# Hospital PACS in emerging economies (e.g., Malaysia)



100,000+ studies  
2,800,000+ instances  
2.8Tb



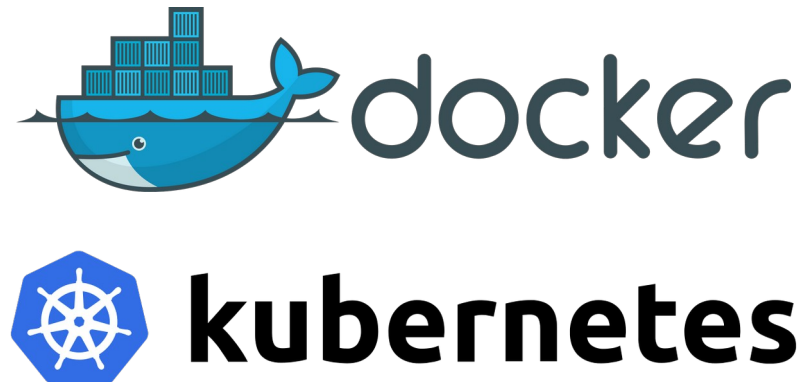
# Installing Orthanc

## Installers / packages for end users



## For developers / sysadmins

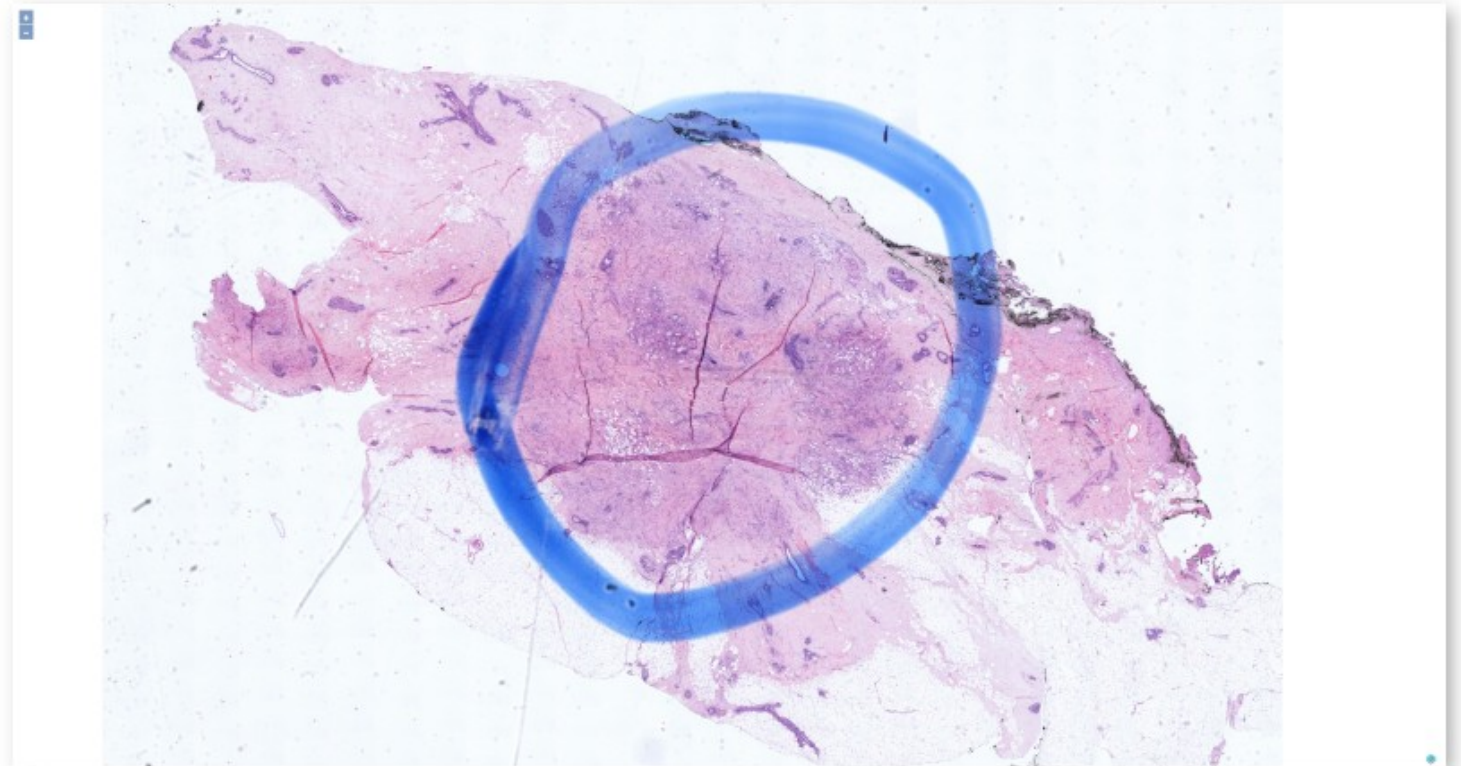
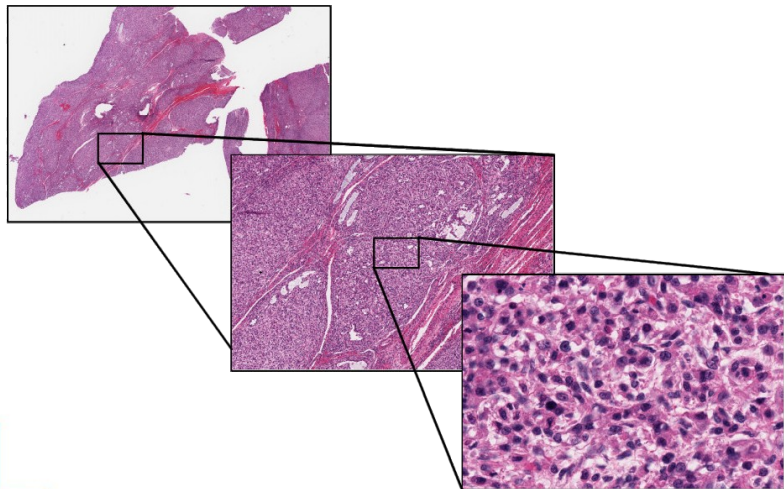
```
$ docker run --rm -t -i -p 8042:8042 \
-p 4242:4242 jodogne/orthanc-plugins:1.12.3
```





**Advanced features**

# Support for digital pathology



# Automating workflows with Orthanc

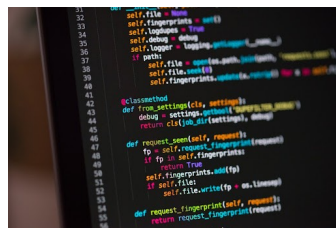
# ORTHANC



Python plugin for Orthanc



Python interpreter



User Python script





# Automating workflows with Orthanc

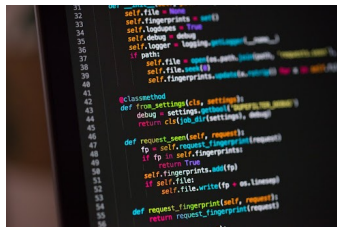
# ORTHANC



Python plugin for Orthanc



Python interpreter



User Python script

```
# This Python plugin implements a basic AI gateway

import orthanc

def OnChange(changeType, level, resource):
    if changeType == orthanc.ChangeType.NEW_INSTANCE:
        # A new DICOM file was received by Orthanc!

        # Anonymize the instance
        anonymized = orthanc.RestApiPost(
            '/instances/%s/anonymize' % resource, '{}')

        # Send the instance to the vendor
        orthanc.RestApiPost(
            '/peers/vendor/store-straight', anonymized)

    orthanc.RegisterOnChangeCallback(OnChange)
```

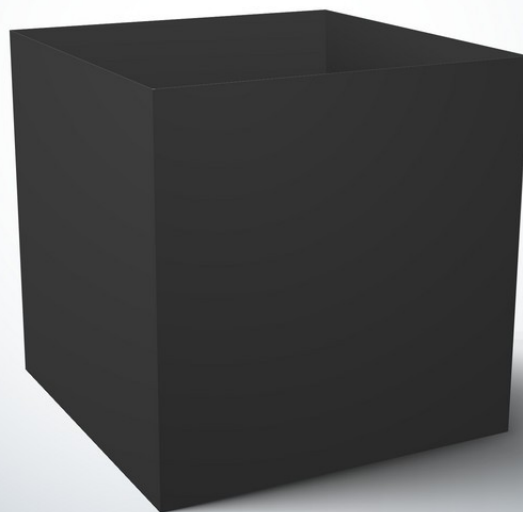
**Physicians are excited about artificial intelligence!**



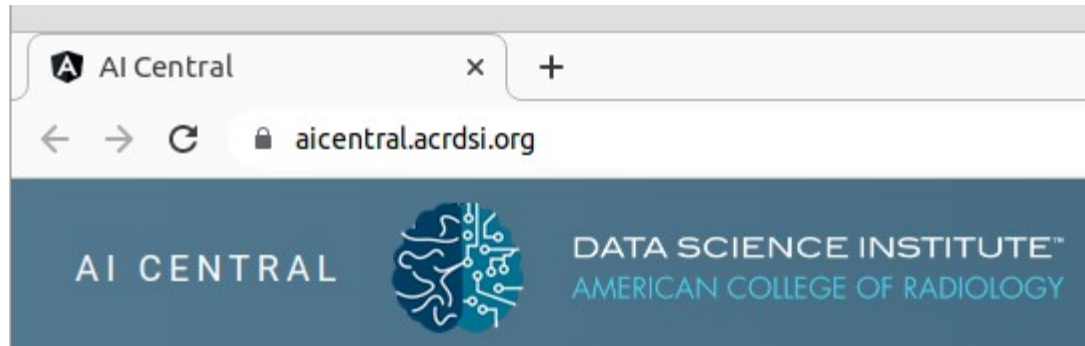
Physicians are excited about artificial intelligence!



**BLACK  
BOX**

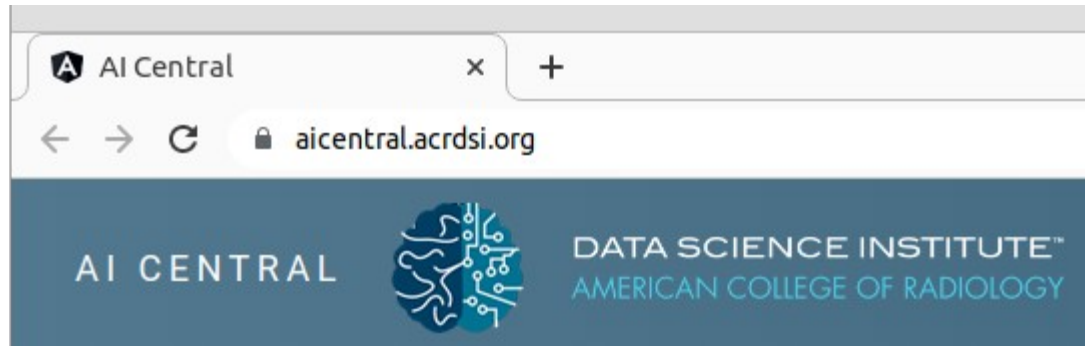




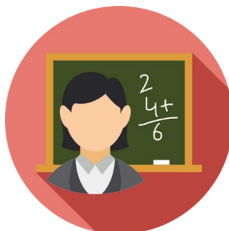


Date Cleared	Product	Company	Type	Finding	BodyArea	Subspecialty	Modality	Age
2022-03-21	<a href="#">BriefCase- CTA</a>	Aidoc Medical, Ltd.	CADt	Aneurysm	Brain	Neuroradiology	CTA	Unspecif
2022-03-14	<a href="#">BriefCase- Ptx</a>	Aidoc Medical, Ltd.	CADt	Pneumothorax	Chest	Chest Imaging	XRAY	Unspecif
2022-03-14	<a href="#">Arterys MICA</a>	Arterys Inc.	Image Processing...	Cardiac measurements	Heart	Cardiac Imaging	MR	Unspecif
2022-03-10	<a href="#">ClearRead Xray Pneum...</a>	Riverain Technologies	CADt	Pneumothorax	Chest	Chest Imaging	XRAY	Adult only
2022-03-07	<a href="#">Syngo.CT Applications</a>	Siemens Healthineers	Image Processing...	Cardiac measurements	All	All	MR	Unspecif
2022-03-01	<a href="#">BoneView</a>	Gleamer	CADe/x	Fracture	Upper Ex...	Musculoskeletal I...	XRAY	Adult only
2022-02-24	<a href="#">Annalise Enterprise CX...</a>	Annalise-AI Pty Ltd.	CADt	Pneumothorax	Chest	Chest Imaging	XRAY	Adult only
2022-02-18	<a href="#">Viz Aneurysm, Viz ANX</a>	Viz. ai, inc.	CADt	Aneurysm	Brain	Neuroradiology	CT	Unspecif
2022-02-18	<a href="#">Deep Learning Image R...</a>	GE Medical Systems	Image Processing...	Image Quality improvement	All	All	CT	Adult and p
2022-02-03	<a href="#">Contour ProtégéAI</a>	Mim Software	Image Processing...	Radiation treatment plann...	All	All	CT,MR	Adult only
2022-01-28	<a href="#">syngo.CT Brain Hemorr...</a>	Siemens Healthineers	CADt	Intracranial hemorrhage	Brain	Neuroradiology	CT	Unspecif
2022-01-19	<a href="#">Follicle Clarity Software</a>	Cycle Clarity	Image Processing...	Ovarian follicles	Ovaries	Women's Imaging	US	Unspecif
2022-01-19	<a href="#">Caption Interpretation ...</a>	Caption Health	Image Processing...	Cardiac flow	Heart	Cardiac Imaging	US	Adult only
2022-01-14	<a href="#">Quantib ND</a>	Quantib BV	Image Processing...	Brain anatomy	Brain	Neuroradiology	MR	Unspecif
2022-01-14	<a href="#">Eclipse II with Smart No...</a>	Carestream	Image Processing...	Image Quality improvement	All	All	XRAY	Adult and p
2022-01-12	<a href="#">UNID Spine Analyzer</a>	MediCREA (Medtronic)	Image Processing...	Surgical Planning	Spine	Musculoskeletal I...	UNSP	Adult and p
2021-12-29	<a href="#">LiverSmart</a>	Resonance Health Analysis ...	Image Processing...	Liver iron deposition, Fatty...	Liver	Abdominal Imaging	MR	Unspecif
2021-12-22	<a href="#">Claritas iPET</a>	Claritas HealthTech Pte. Ltd.	Image Processing...	PET image denoising	Brain	Neuroradiology	PET,CT,MR	Unspecif
2021-12-22	<a href="#">BoneMRI</a>	MRiguidance BV	Image Processing...	Brain anatomy	Brain	Neuroradiology	CT	Adult only

1 To 19 Of 188 Page 1 Of 10

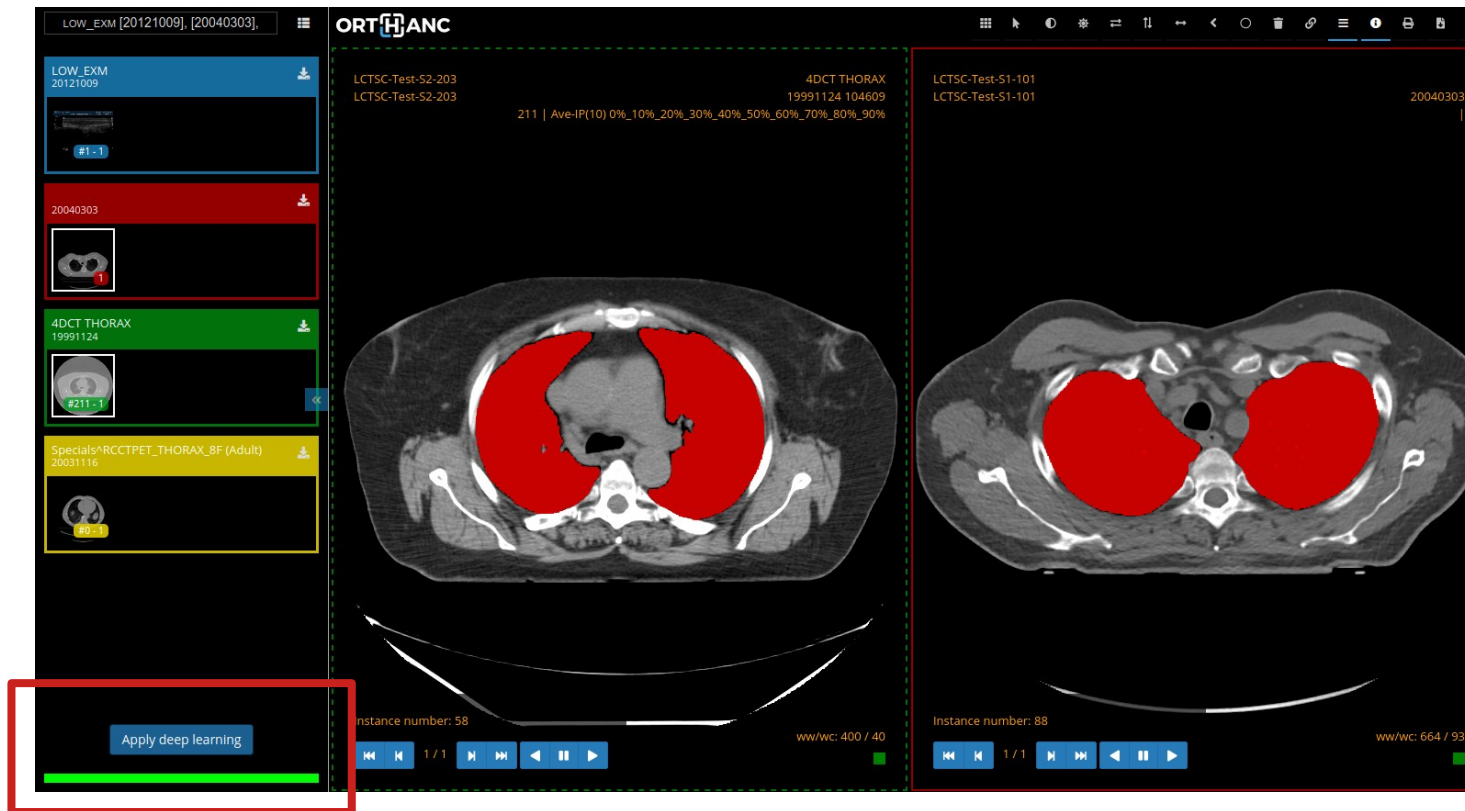


Date Cleared	Product	Company	Type	Finding	BodyArea	Subspecialty	Modality	Age
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2022-03-14	<a href="#">BriefCase- Ptx</a>	Aidoc Medical, Ltd.	CADt	Pneumothorax	Chest	Chest Imaging	XRAY	Unspecif
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2022-03-10	<a href="#">ClearRead Xray Pneum...</a>	Riverain Technologies	CADt	Pneumothorax	Chest	Chest Imaging	XRAY	Adult only
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2022-02-24	<a href="#">Annalise Enterprise CX...</a>	Annalise-AI Pty Ltd.	CADt	Pneumothorax	Chest	Chest Imaging	XRAY	Adult only
2022-02-18	<a href="#">Viz Aneurysm, Viz ANX</a>	Viz. ai, inc.	CADt	Aneurysm	Brain	Neuroradiology	CT	Unspecif
2022-02-18	<a href="#">Deep Learning Image R...</a>	GE Medical Systems	Image Processing...	Image Quality improvement	All	All	CT	Adult and p
2022-02-03	<a href="#">Contour ProtégéAI</a>	Mim Software	Image Processing...	Radiation treatment plann...	All	All	CT,MR	Adult only
2022-01-28	<a href="#">syngo.CT Brain Hemorr...</a>	Siemens Healthineers	CADt	Intracranial hemorrhage	Brain	Neuroradiology	CT	Unspecif
2022-01-19	<a href="#">Follicle Clarity Software</a>	Cycle Clarity	Image Processing...	Ovarian follicles	Ovaries	Women's Imaging	US	Unspecif
2022-01-19	<a href="#">Caption Interpretation ...</a>	Caption Health	Image Processing...	Cardiac flow	Heart	Cardiac Imaging	US	Adult only
2022-01-14	<a href="#">Quantib ND</a>	Quantib BV	Image Processing...	Brain anatomy	Brain	Neuroradiology	MR	Unspecif
2022-01-14	<a href="#">Eclipse II with Smart No...</a>	Carestream	Image Processing...	Image Quality improvement	All	All	XRAY	Adult and p
2022-01-12	<a href="#">UNID Spine Analyzer</a>	MediCREA (Medtronic)	Image Processing...	Surgical Planning	Spine	Musculoskeletal I...	UNSP	Adult and p
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2021-12-22	<a href="#">Claritas iPET</a>	Claritas HealthTech Pte. Ltd.	Image Processing...	PET image denoising	Brain	Neuroradiology	PET,CT,MR	Unspecif
2021-12-22	<a href="#">BoneMRI</a>	MRiguidance BV	Image Processing...	Brain anatomy	Brain	Neuroradiology	CT	Adult only



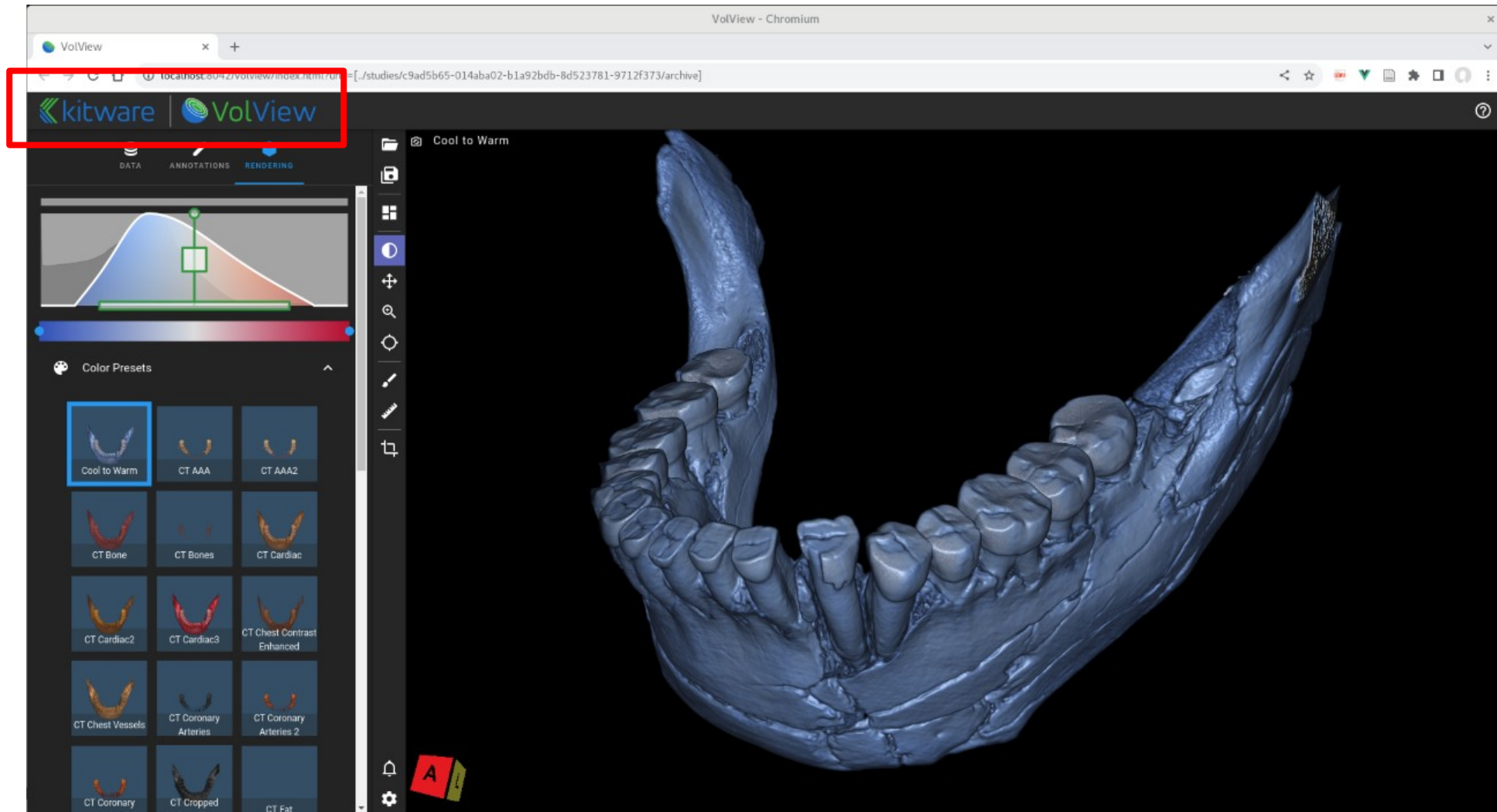
**Urgent need to democratize such a technical knowledge!**

# Bringing deep learning to end users



**The entire computations are done client-side by the Web browser**  
DICOM never leaves the PACS/viewer environment → **Security by design**  
No cloud/on-promise infrastructure required → **Web browser is enough**

# Cultural heritage: Volume rendering of micro-CT





# Viewer for radiotherapy and nuclear medicine



# Conclusions

# Recognized project with worldwide community



2018



2022



2023



2015



2023



# Our mission statement

ORT  ANC



*“Freely share knowledge about medical imaging”*

**...including about artificial intelligence!**



Digital  
Public  
Goods  
Alliance



UCLouvain







UCLouvain