



PMSD 2022 Final Presentation

# CVAT for Medical Imaging

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from HERA-MI



# Medical Problem?

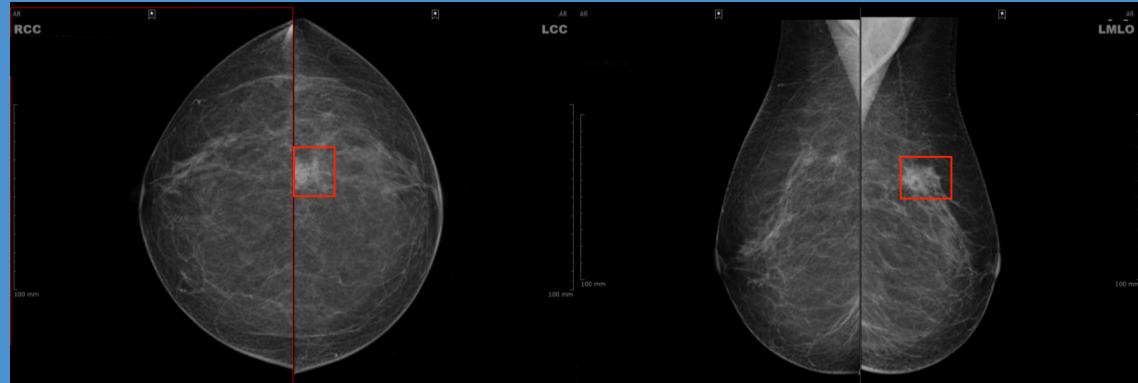
- Analysis of medical images (MRT, CT, Radiology etc.)
- MRT of the lumbar spine
  - resulted in 7% significant errors
  - Identification of 70 different specific error types
  - The "**misinterpretation**" was the most frequent error group with **50%**

Schorlemmer, C. & Thimansson, E. (2014). Fehler in Befunden von MRT der Lendenwirbelsäule: Fehler-Prävalenz und Fehler-Typen (S 01). Georg Thieme Verlag.  
<https://doi.org/10.1055/s-0034-1373340>



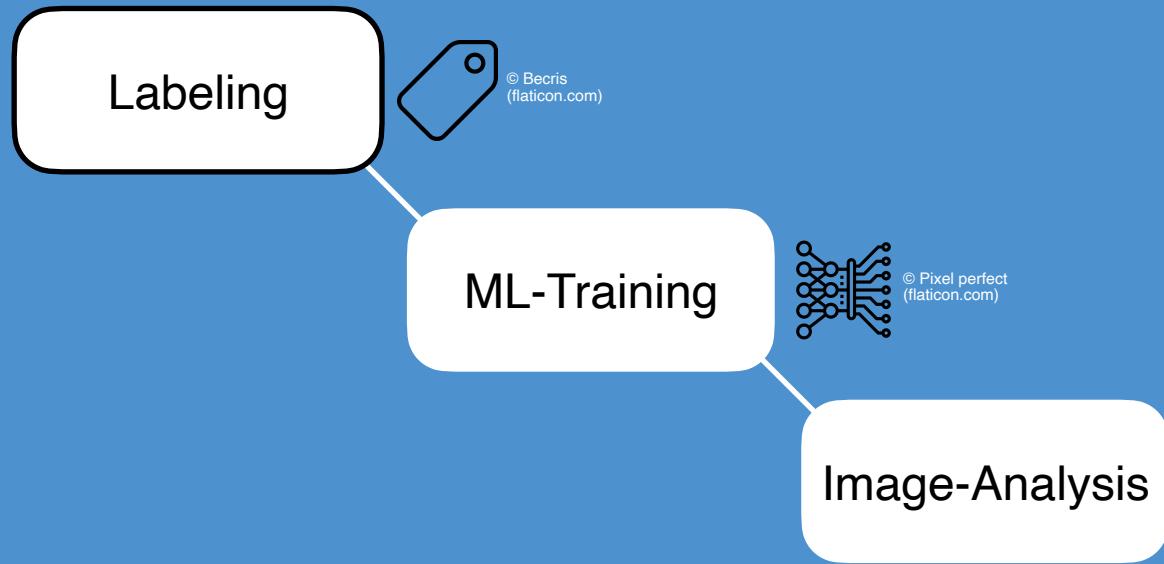
# Current problem

- CT, MRT, DBT etc images are of 3D nature
- Linking the annotations on different acquisitions
- Usability for medical approaches



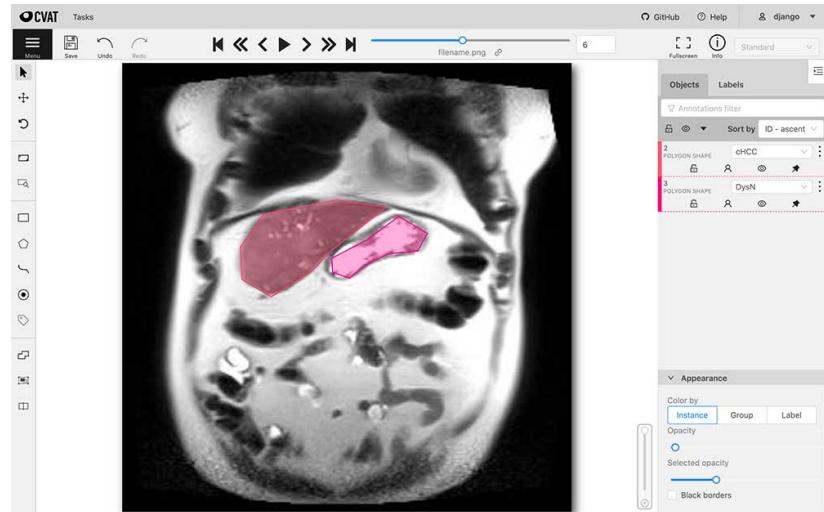
<https://lh3.googleusercontent.com/QKkg01n6LW8KzqUePgflmuqv13l28M16P6OVf5LSKDQDQ-CgEV-ykaQ-QdgGvVS5CAurpEc=s170>

# Solution:



# CVAT

- Open source by Intel, web-based image and video annotation tool
- Labeling data for computer vision algorithms
- Object detection
- Image classification
- Image segmentation



CVAT. (2021, 22. Juni). Documentation. Abgerufen am 6. Mai 2022, von <https://openvinotoolkit.github.io/cvat/docs/>

<https://hacarus.com/wp-content/uploads/2020/07/annotation.jpg>



# Error potential / problems with annotating in CVAT

- Different versions of the DICOM format : (Import problems)
- Linking annotations in a series of (MRT, CT, DBT etc )-slices : (Annotation problems)
- Working with multiple series : (Error potential)
- Working with complex datasets : (Error potential)
- User tracking within annotations : (Error potential)
- No auto save : (Error potential)



# Goal of the work

3D image review

DICOM to png  
Python

Stacking Images via  
MP4

Annotating in the MP4

Increase usability I

Warning when  
series changed  
TypeScript

Automatically  
stop tracking  
JavaScript

Auto-save  
TypeScript

Increase usability II

Link user-IDs and  
annotations  
JavaScript

Display user-ID  
in labels list  
TypeScript

Export user-ID  
JavaScript



# Problem: 3D image structure

- DICOM is a medical image data structure
- DICOM data cannot be uploaded to CVAT

```
Dataset.file_meta ---  
(0002, 0000) File Meta Information Group Length UL: 196  
(0002, 0001) File Meta Information Version OB: b'\x00\x01'  
(0002, 0002) Media Storage SOP Class UID UI: MR Image Storage  
(0002, 0003) Media Storage SOP Instance UID UI: 1.3.6.1.4.1.14519.5.2.1.7695.1700.339004455858213566053687905915  
(0002, 0010) Transfer Syntax UID UI: Explicit VR Little Endian  
(0002, 0012) Implementation Class UID UI: 1.2.40.0.13.1.1.1  
(0002, 0013) Implementation Version Name SH: 'dcn4che-1.4.35'  
  
(0008, 0005) Specific Character Set CS: 'ISO_IR 100'  
(0008, 0008) Image Type CS: ['ORIGINAL', 'PRIMARY', 'OTHER']  
(0008, 0016) SOP Class UID UI: MR Image Storage  
(0008, 0018) SOP Instance UID UI: 1.3.6.1.4.1.14519.5.2.1.7695.1700.339004455858213566053687905915  
(0008, 0020) Study Date DA: '19841013'  
(0008, 0021) Series Date DA: '19841013'  
(0008, 0022) Acquisition Date DA: '19841013'  
(0008, 0023) Content Date DA: '19841013'  
(0008, 0030) Study Time TM: '105956'  
(0008, 0031) Series Time TM: '110335'  
(0008, 0032) Acquisition Time TM: '110336'  
(0008, 0033) Content Time TM: '110336'  
(0008, 0050) Accession Number SH: '7233919053094807'  
(0008, 0060) Modality CS: 'MR'  
(0008, 0070) Manufacturer LO: 'GE MEDICAL SYSTEMS'  
(0008, 0090) Referring Physician's Name PN: ''  
...  
(0043, 1038) [User data 25...User data 48 {User4 FL: Array of 24 elements  
(0043, 1039) [Stop_int_6... stop_int_9] IS: [0, 0, 0, 0, 0]  
(0043, 1060) [Stop_int_10...stop_int_17] IS: [0, 0, 0, 10, 0, 0, 0, 0]  
(0043, 106f) [Scanner Table Entry (single gradie DS: [0, 0, 0, 0]  
(7fe0, 0010) Pixel Data OW: Array of 131072 elements
```

Own Figure

3D image review

DICOM to png  
Python

Stacking Images via  
MP4

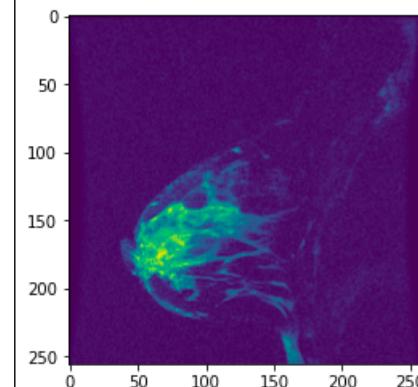
Annotating in the MP4

# Solution:

- DICOM to Numpy Array to png

```
Dataset.file_meta ---  
(0002, 0000) File Meta Information Group Length UL: 196  
(0002, 0001) File Meta Information Version OB: b'\x00\x01'  
(0002, 0002) Media Storage SOP Class UID UI: MR Image Storage  
(0002, 0003) Media Storage SOP Instance UID UI: 1.3.6.1.4.1.14519.5.2.1.7695.1700.339004455858213566053687905915  
(0002, 0010) Transfer Syntax UID UI: Explicit VR Little Endian  
(0002, 0012) Implementation Class UID UI: 1.2.40.0.13.1.1.1  
(0002, 0013) Implementation Version Name SH: 'dcm4che-1.4.35'  
  
(0008, 0005) Specific Character Set CS: 'ISO_IR 100'  
(0008, 0008) Image Type CS: ['ORIGINAL', 'PRIMARY', 'OTHER']  
(0008, 0016) SOP Class UID UI: MR Image Storage  
(0008, 0018) SOP Instance UID UI: 1.3.6.1.4.1.14519.5.2.1.7695.1700.339004455858213566053687905915  
(0008, 0020) Study Date DA: '19841013'  
(0008, 0021) Series Date DA: '19841013'  
(0008, 0022) Acquisition Date DA: '19841013'  
(0008, 0023) Content Date DA: '19841013'  
(0008, 0030) Study Time TM: '105956'  
(0008, 0031) Series Time TM: '110335'  
(0008, 0032) Acquisition Time TM: '110336'  
(0008, 0033) Content Time TM: '110336'  
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(0008, 0090) Referring Physician's Name PN: ''  
...  
(0043, 1038) [User data 25...User data 48 {User4 FL: Array of 24 elements  
(0043, 1039) [Stop_int_6... stop_int_9] IS: [0, 0, 0, 0, 0]  
(0043, 1060) [Stop_int_10...stop_int_17] IS: [0, 0, 0, 10, 0, 0, 0, 0]  
(0043, 106f) [Scanner Table Entry (single gradie DS: [0, 0, 0, 0]  
(7fe0, 0010) Pixel Data OW: Array of 131072 elements
```

Own Figure



Own Figure

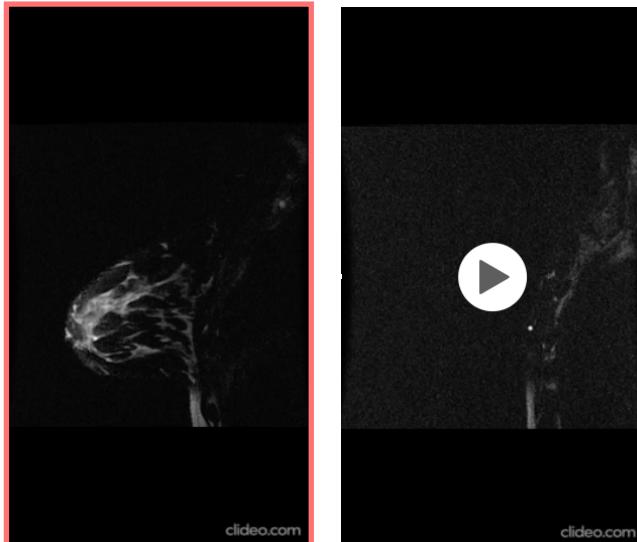
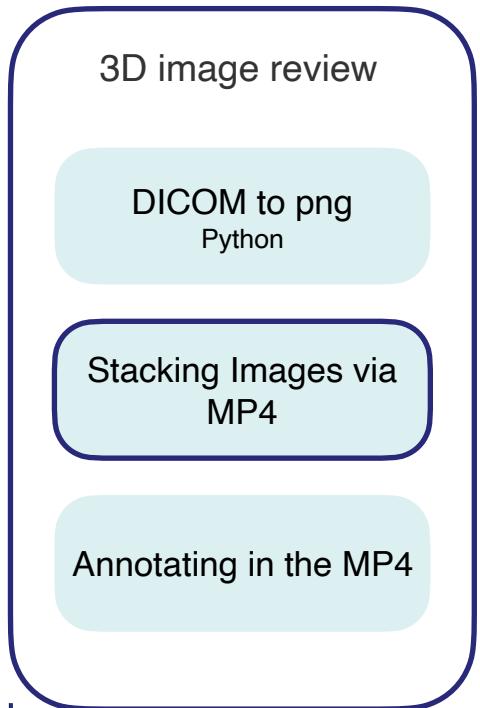
3D image review

DICOM to png  
Python

Stacking Images via  
MP4

Annotating in the MP4

# Solution: „Stacking“ a series of PNGs



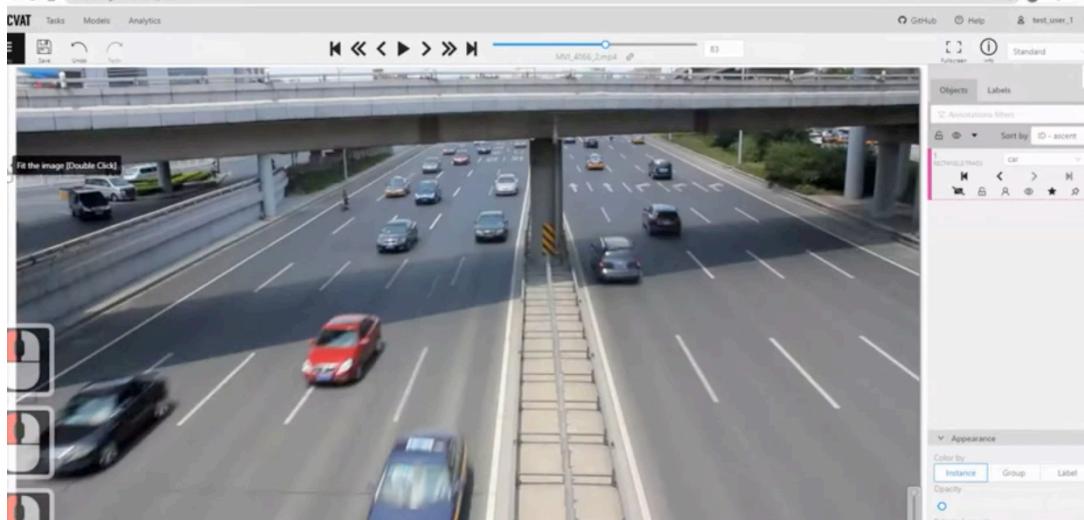
*Note for pdf  
"MP4 of slices"*

Own Figure



# Solution: 3D linking labels via object tracking

- CVAT cannot handle 3D-stack annotations  
But video annotations



<https://www.youtube.com/watch?v=Hc3oudNuDsY>

3D image review

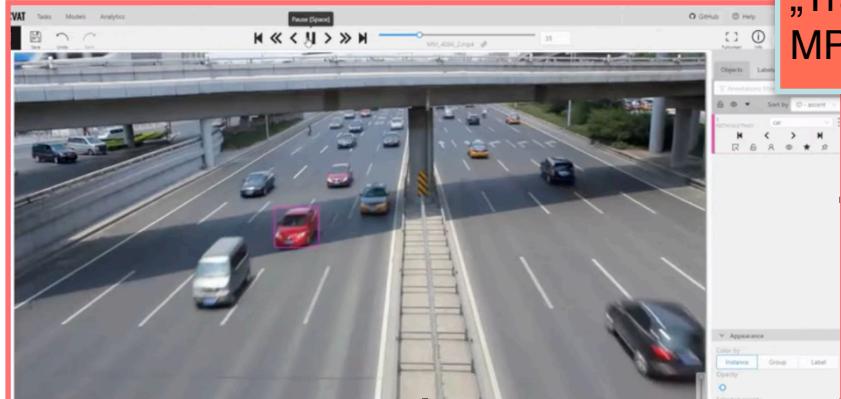
DICOM to png  
Python

Stacking Images via  
MP4

Annotating in the MP4



*Note for pdf  
„Tracking in  
MP4 files“*



# Problem: Usability

- currently no overview of different studies in CVAT

manifest-1653216312611	31.05.2022, 21:29	-- Ordner
ISPY1	31.05.2022, 21:29	-- Ordner
ISPY1_1001	31.05.2022, 21:29	-- Ordner
10-13-1984...NI UE-73116	31.05.2022, 21:29	-- Ordner
> 1.000000...-OUT-55843	31.05.2022, 21:29	-- Ordner
> 1.000000...eport-9.285	31.05.2022, 21:28	-- Ordner
2.000000...cator-51186	31.05.2022, 21:28	-- Ordner
1-01.dcm	31.05.2022, 21:27	135 KB DICOM
1-02.dcm	31.05.2022, 21:27	135 KB DICOM
1-03.dcm	31.05.2022, 21:27	135 KB DICOM
1-04.dcm	31.05.2022, 21:27	135 KB DICOM
1-05.dcm	31.05.2022, 21:27	135 KB DICOM
1-06.dcm	31.05.2022, 21:27	135 KB DICOM
1-07.dcm	31.05.2022, 21:27	135 KB DICOM
1-08.dcm	31.05.2022, 21:27	135 KB DICOM
1-09.dcm	31.05.2022, 21:27	135 KB DICOM
1-10.dcm	31.05.2022, 21:27	135 KB DICOM
1-11.dcm	31.05.2022, 21:27	135 KB DICOM
1-12.dcm	31.05.2022, 21:27	135 KB DICOM
1-13.dcm	31.05.2022, 21:27	135 KB DICOM
1-14.dcm	31.05.2022, 21:27	135 KB DICOM
1-15.dcm	31.05.2022, 21:27	135 KB DICOM
3.000000...ital-05705	31.05.2022, 21:28	-- Ordner
1-01.dcm	31.05.2022, 21:28	135 KB DICOM
1-02.dcm	31.05.2022, 21:28	135 KB DICOM
1-03.dcm	31.05.2022, 21:28	135 KB DICOM
1-04.dcm	31.05.2022, 21:28	135 KB DICOM
1-05.dcm	31.05.2022, 21:28	135 KB DICOM
1-06.dcm	31.05.2022, 21:28	135 KB DICOM
1-07.dcm	31.05.2022, 21:28	135 KB DICOM
1-08.dcm	31.05.2022, 21:28	135 KB DICOM
1-09.dcm	31.05.2022, 21:28	135 KB DICOM
1-10.dcm	31.05.2022, 21:28	135 KB DICOM

Own Figure

Increase usability I

Warning when series changed

Automatically stop tracking  
JavaScript

Auto-save  
TypeScript

# Solution:



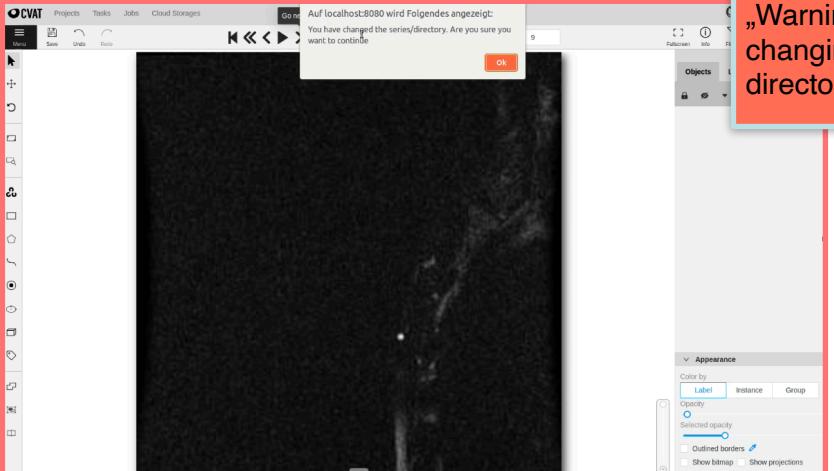
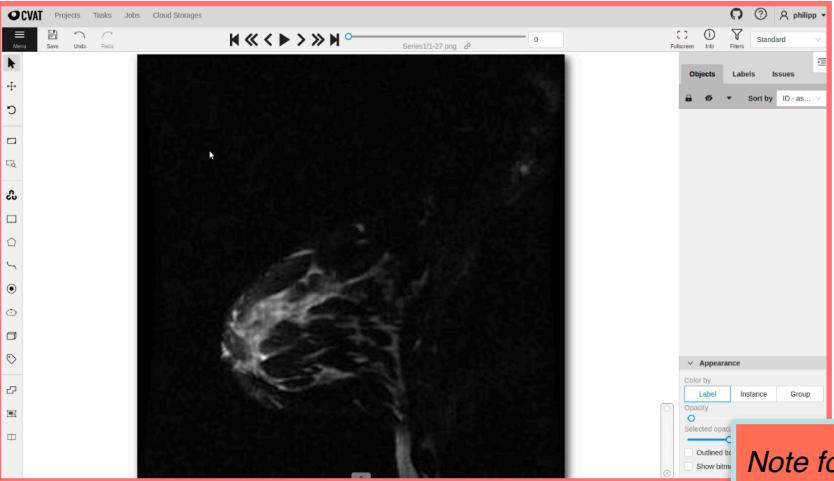
Increase usability I

Warning when series  
changed

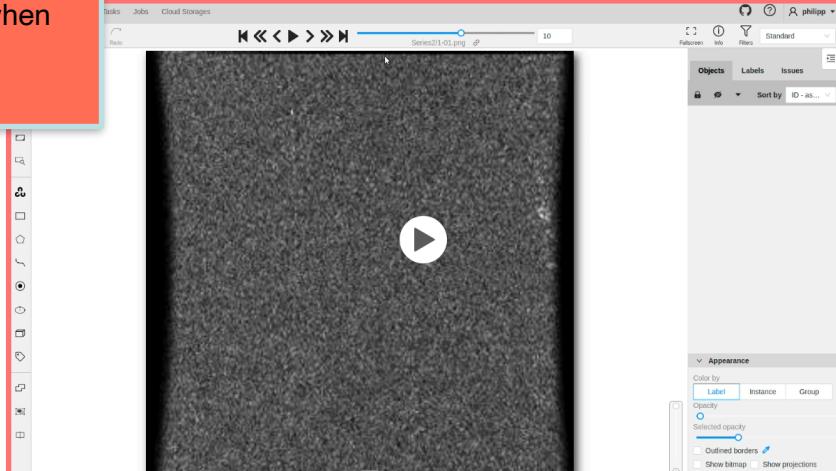
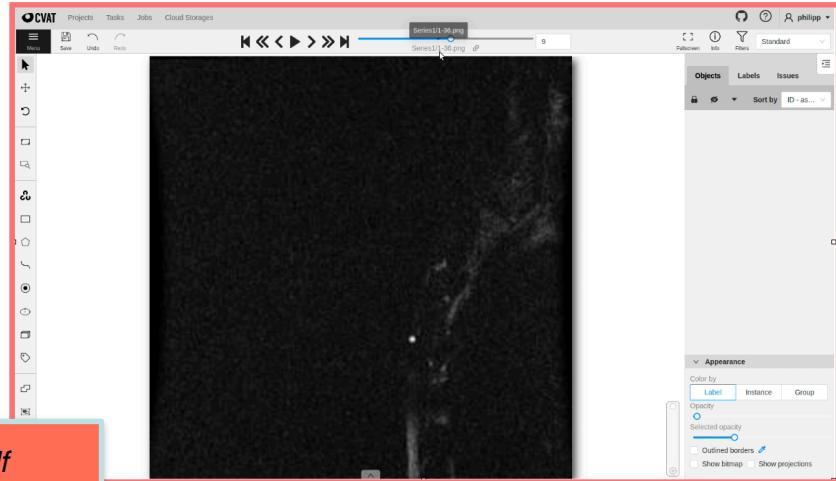
Automatically  
stop tracking  
JavaScript

Auto-save  
TypeScript





*Note for pdf  
„Warning when  
changing  
directory“*



# Solution: (in progress)

The screenshot shows the CVAT (Computer Vision Annotation Tool) interface. At the top, there are navigation links for 'Projects', 'Tasks' (which is the active tab), 'Jobs', and 'Cloud Storages'. The main area displays a search bar with placeholder 'Search ...' and a magnifying glass icon. Below the search bar are filter options: 'Sort by' (dropdown), 'Quick filters' (dropdown), 'Filter' (dropdown), 'Clear filters' (button), and a '+' button. A user profile icon and a search bar for 'philipp' are also present. The main content area shows a single task entry: '#2: cvat\_FrontEnd\_Test' (Pending status, 0 of 1 jobs). It includes a 'Open' button and an 'Actions' dropdown menu. At the bottom, there are navigation buttons for page 1 of 1.

Increase usability I

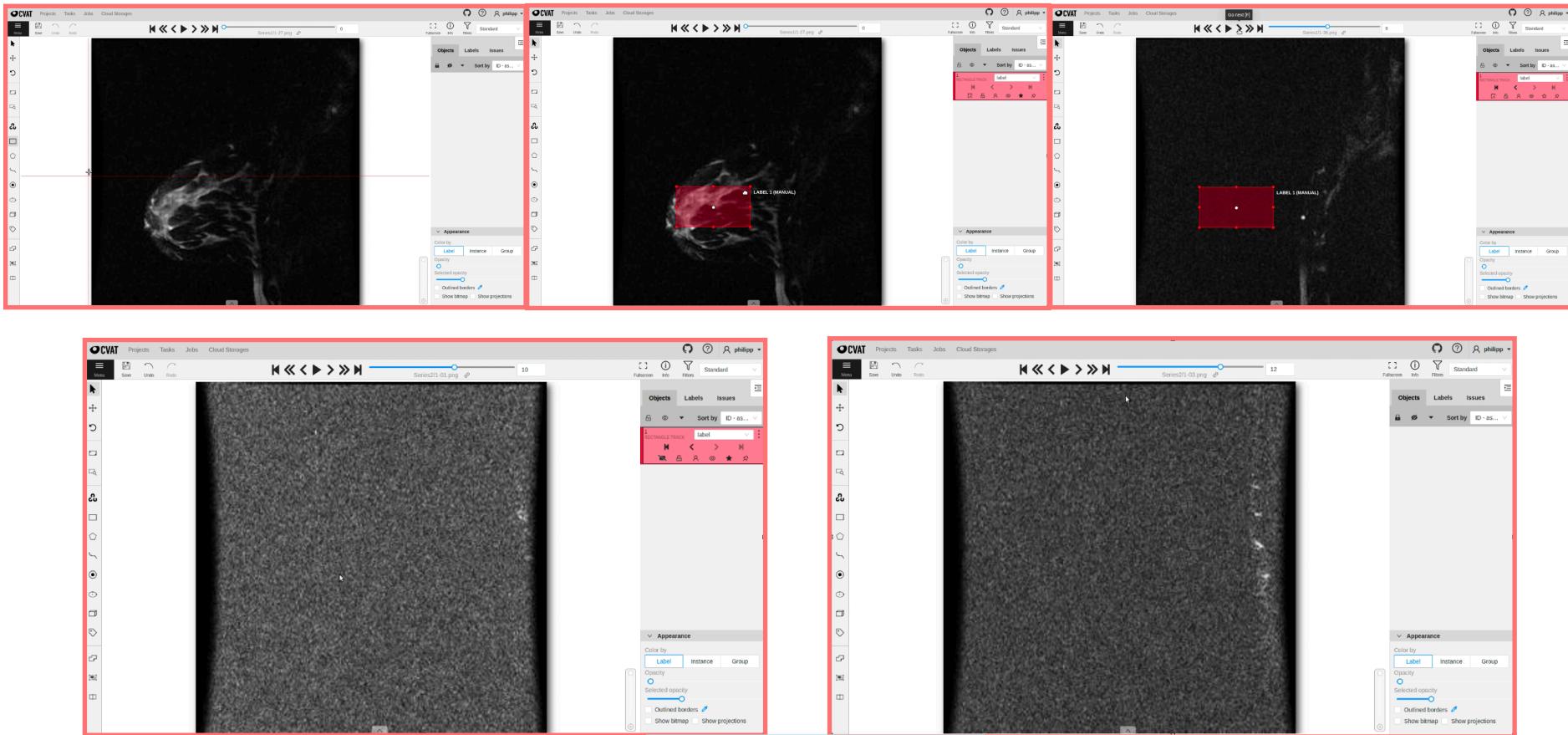
Warning when  
series changed  
TypeScript

Automatically stop  
tracking

Auto-save  
TypeScript

Own Figure

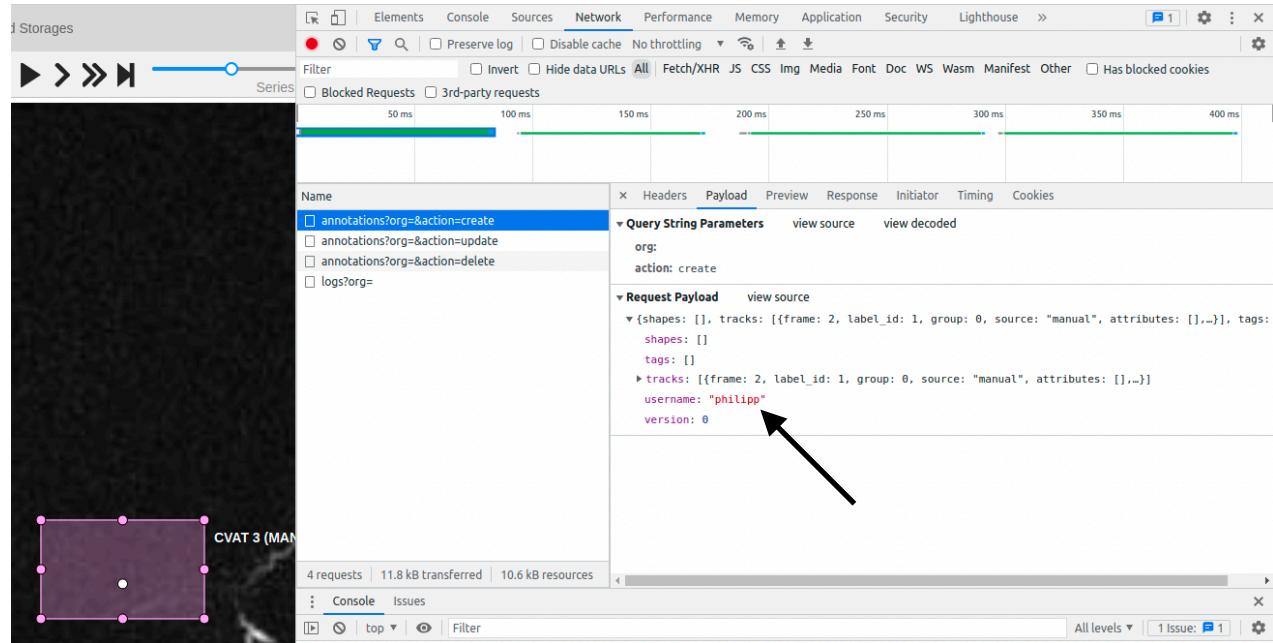




Note for pdf  
„Automatically end tracking  
when change directory“



# Solution:



Own Figure

Increase usability II

Link user-IDs and annotations

Display user-ID in labels list  
TypeScript

Export user-ID  
JavaScript



# Progress:

DONE

IN  
PROGRESS

TODO

3D image review

DICOM to png  
Python

Stacking Images via  
MP4

Annotating in the MP4

Increase usability I

Warning when  
series changed  
TypeScript

Automatically  
stop tracking  
JavaScript

Auto-save  
TypeScript

Increase usability II

Link user-IDs and  
annotations  
JavaScript

Display user-ID  
in labels list  
TypeScript

Export user-ID  
JavaScript



# GANTT

## CVAT

### CVAT web application

Requirements Presentation

### 3D image review

DICOM to Numpy

DICOM to PNG

PNG series to MP4 research

MP4 tracking research

### Increase Usability I

Setup CVAT docker

Warning when series changed

Automatically stop tracking

Auto-save

Intermediate Presentation

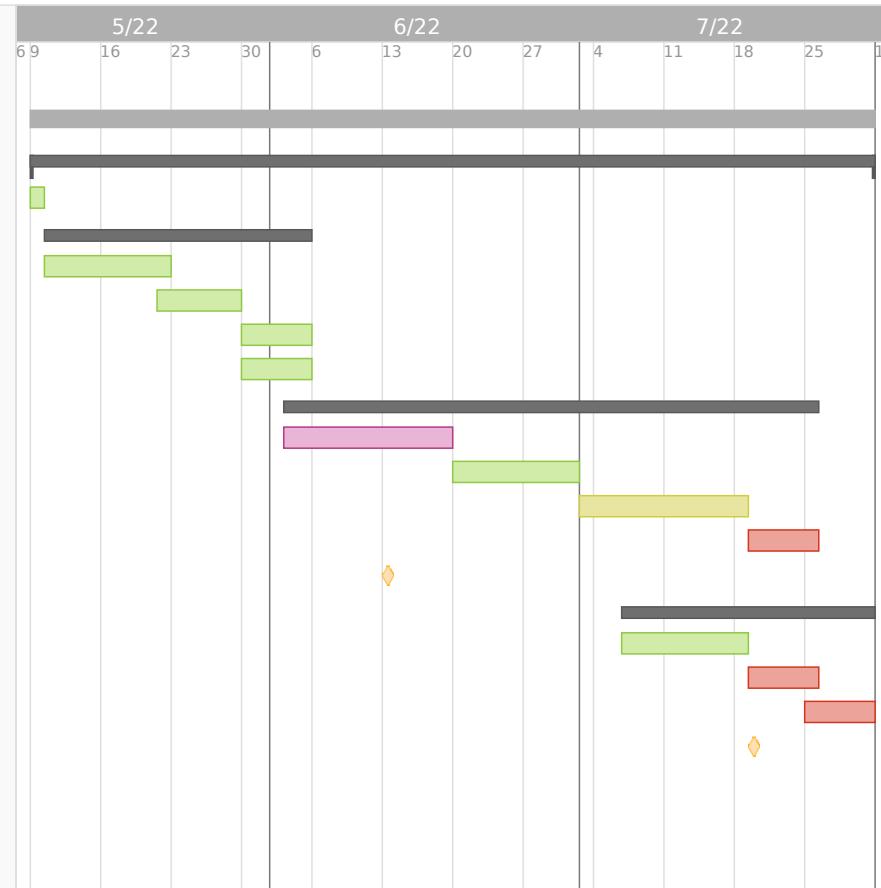
### Increase usability II

Link user-IDs

Label within a group

Export user-ID

Final Presentation



Own Figure



# Achievements and problems

- **DICOM file format**
    - Understanding different formats and structures
    - Learn to use pydicom methods
  - **FrontEnd-React**
    - Highly improve react knowledge
  - **CVAT**
    - Broad knowledge of this program and its code
    - Learn about error potential by annotating
- ⋮
- **DICOM**
    - Challenging format
  - **Docker**
    - Configuration of the .yml file
  - **FrontEnd-React**
    - States and props in class components
  - **CVAT**
    - Very complex structure of code to jump in





PMSD 2022 Final Presentation

# CVAT for Medical Imaging

By Philipp Knestel

Special thanks to:

Mickael Tardy

Vanessa Gonzalez