Tutorial: MONAI LABEL

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@ University of Florida

Agenda

- What is MONAI?
- What is MONAI Label?
- How to create a MONAI Label App?
- MONAI Label Success Story
- How to use MONAI Label on HiperGator? Radiology demo
- Quick Pathology demo on local workstation
- Resources

WHAT IS MONAI?

Medical Open Network for AI

Project MONAI

- a collaborative open-source initiative
- founded at MICCAI 2019
- establish and standardize the best practices for deep learning in healthcare imaging to accelerate the pace of innovation.

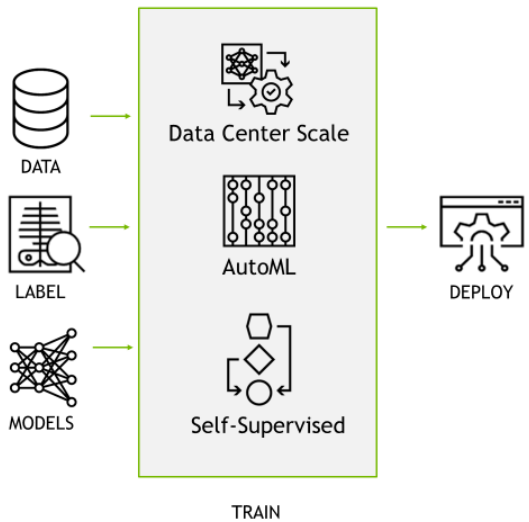
MONAI

World's Most Advanced Framework for Medical AI

428,000 Downloads of MONAI Core

STATE-OF-THE-ART AI

From Data to Deployment Dev Tools



GLOBAL ECOSYSTEM

Community Lead | Accessibility

World Leading Contributors

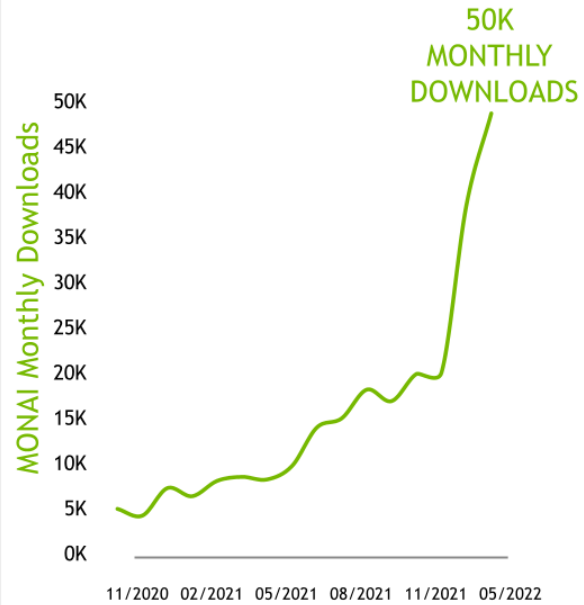
AI CENTRE for Value Based Healthcare · dkfz. German Cancer Research Center · Frederick National Laboratory for Cancer Research · IOWA · King's College London · kitware · Mayo Clinic · Mass General Brigham · Guy's and St Thomas' NHS Foundation Trust · NVIDIA · Technische Universität München · UCSF · ci² center for intelligent imaging · Universitätsklinikum Essen · Vanderbilt University · WARWICK

Integration Partners

Amazon SageMaker · Microsoft · Google Cloud Platform · mlflow · 3DSlicer · Open Health Imaging Foundation · Answer · quantiphi Solving What Matters

EXPONENTIAL GROWTH

Accelerating Open Research



R&D MOMENTUM

Publishing to Production

Top 30+

Research Medical Centers
Published over 138 Papers

AI CENTRE for Value Based Healthcare — **AIDE: A NEW OPERATING SYSTEM FOR THE HOSPITAL**

MAYO CLINIC — **EXPERIENCES WITH ALGORITHM DEPLOYMENT IN HEALTHCARE SETTINGS**

aws — **ACCELERATE YOUR MEDICAL IMAGING RESEARCH WITH MONAI ON AWS**

WHAT IS MONAI?

Accelerate Pace of Research Innovation With a Common Foundation

AI-assisted image labeling tool

MONAI Label v0.4

deep learning training

MONAI Core v0.9

create applications from models
in minutes

MONAI Deploy App SDK v0.3

Coming Soon!

MONAI Stream

MONAI Label

AI-assisted image labeling tool

What is MONAI Label?

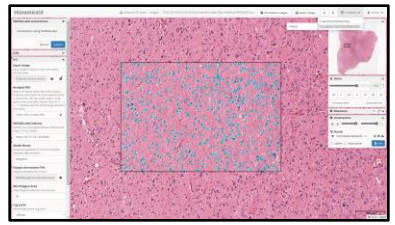
Infrastructure: client-server system

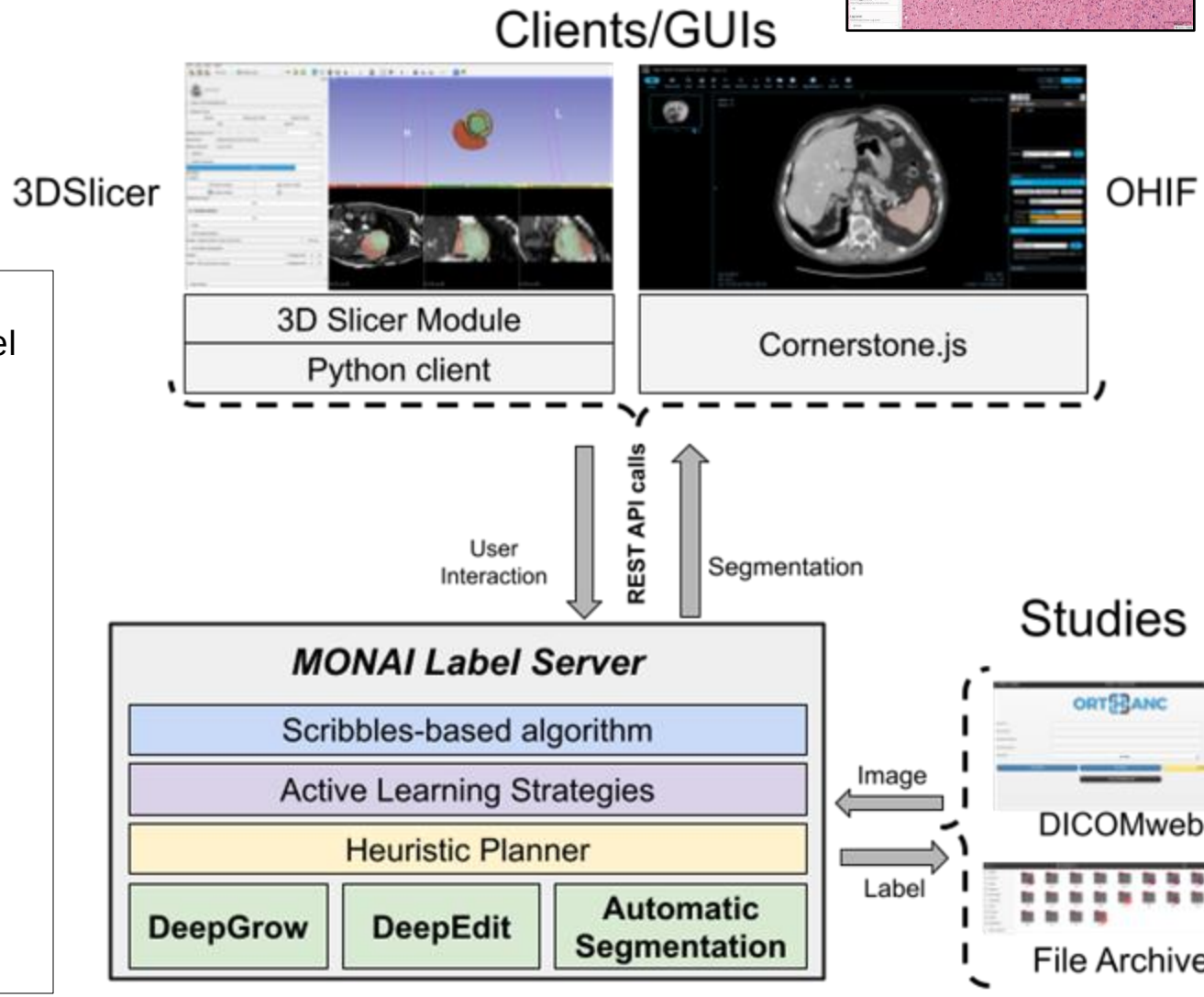
Three main parts
- MONAI Label server
- Datastore
- Clients/GUIs

Clinician
- Annotate datasets by sample apps, w/wo pre-trained model
  - Build AI annotation models by just submitting labels
  - Less time and effort
- Pre-built plugins for image viewers

Researcher/Developer
- Create new MONAI LABEL apps, e.g.,
  - Implement new annotation methods
  - Implement new active learning techniques
- Rapid app prototyping
  - Make incremental improvements to sample apps
  - Verify effectiveness in real-world scenarios
  - Deploy MONAI Label Apps to wider audiences

Pathology viewers: QuPath, DSA, CVAT





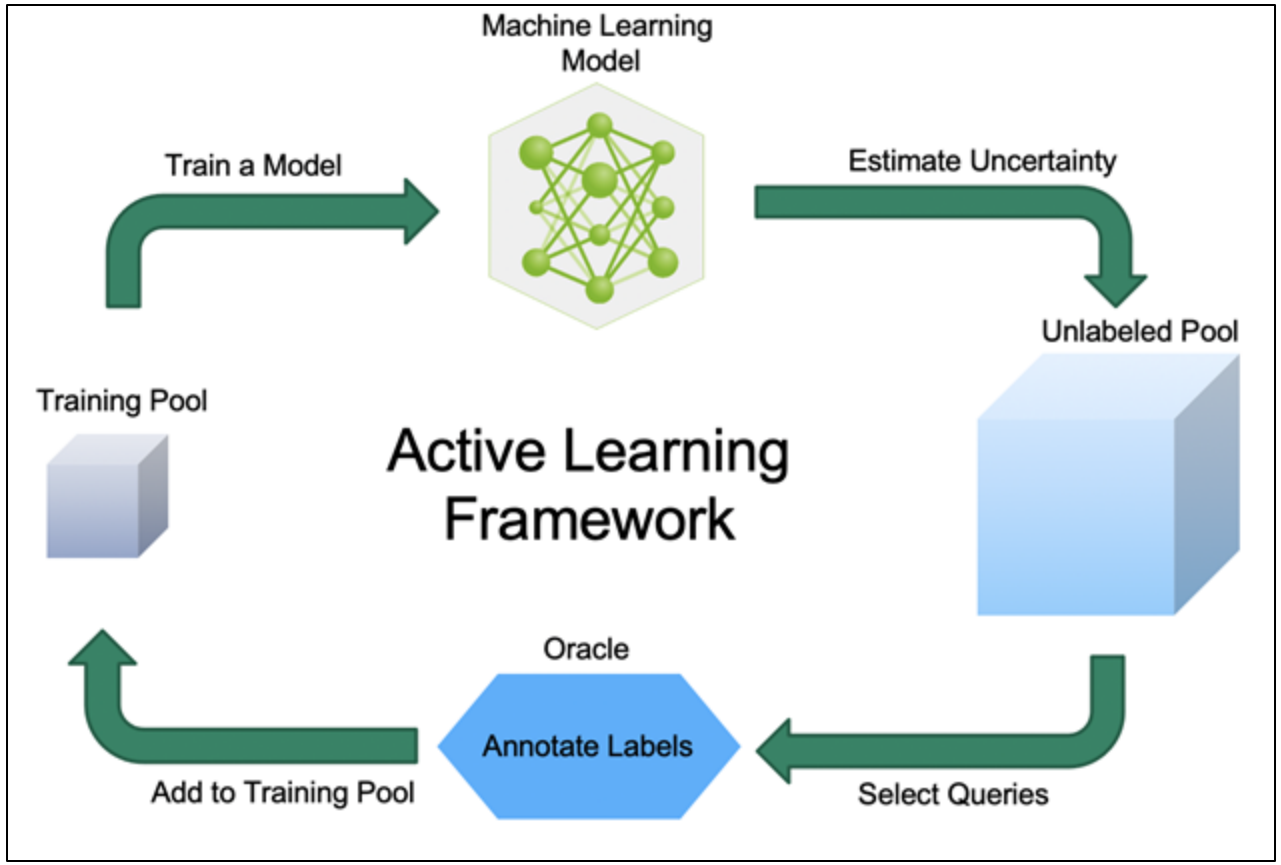
What is MONAI Label?

Server: Active Learning Strategies

- **Why use Active Learning Strategies?**
  - Random selection is not always the most efficient.
  - A semi-supervised machine learning approach where the algorithm can choose which data it wants to learn from
  - E.g., train on harder/more uncertain ones first.

- **Strategies available in MONAI Label**
  - Aleatoric Uncertainty (based on Test-Time Augmentation)
  - Epistemic Uncertainty

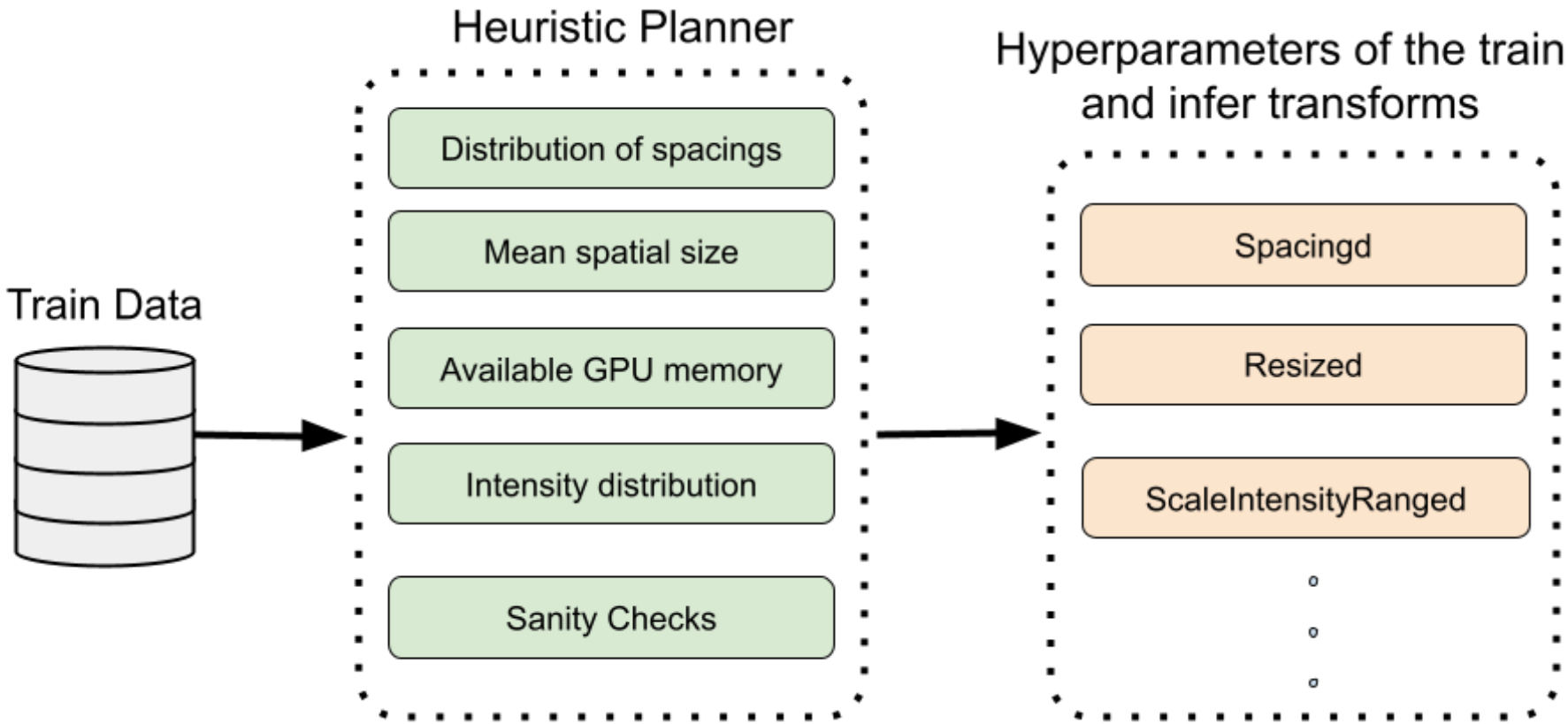
- **After having a pretrained model**
  - Uncertainty of each image is computed.
  - Unlabeled samples that are harder/need more attention from the clinician will be selected.



What is MONAI Label?

Server: Heuristic Planner

- Defines image spatial size based on available GPU memory.
- Defines training transforms based on GPU memory, average spatial size and spacing of datastore.
- Performs sanity checks before starting training.
- Shows warning in case images are multimodality or multilabel.



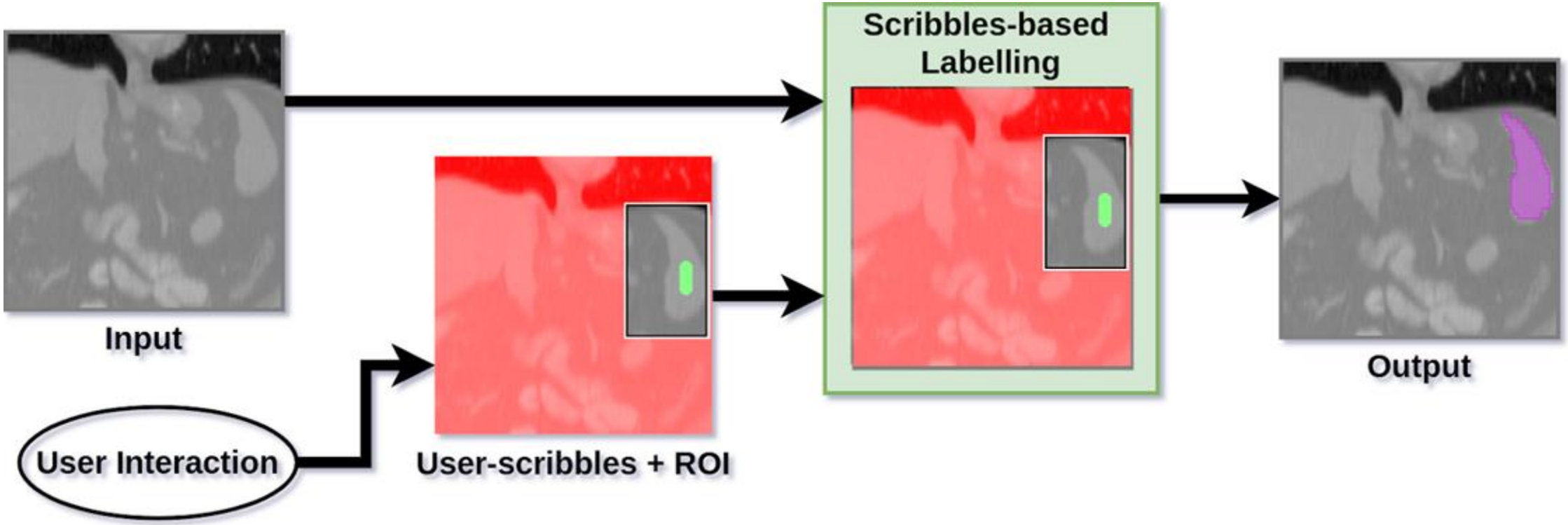
What is MONAI Label?

Server: Scribbles-based algorithms

- **Scribbles:** free-hand line drawings for minimal interaction

- **Two scribbles-based modes in MONAI Label**
  - Scribbles-only: uses scribbles to generate segmentation labels [1, 2]
  - Scribbles-based refinement: refines labels inferred by a deep learning model [2]

[1] Criminisi, Antonio, et al. "Geos: Geodesic image segmentation." ECCV, 2008.
[2] Wang, Guotai, et al. "Interactive medical image segmentation using deep learning with image-specific fine tuning." IEEE TMI, 2018.



What is MONAI Label?

Datastore

```
labels
└── final
    ├── spleen_13.nii.gz
    ├── spleen_2.nii.gz
    ├── spleen_32.nii.gz
    ├── spleen_3.nii.gz
    ├── spleen_40.nii.gz
    └── spleen_6.nii.gz
spleen_10.nii.gz
spleen_12.nii.gz
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spleen_46.nii.gz
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spleen_8.nii.gz
spleen_9.nii.gz
```
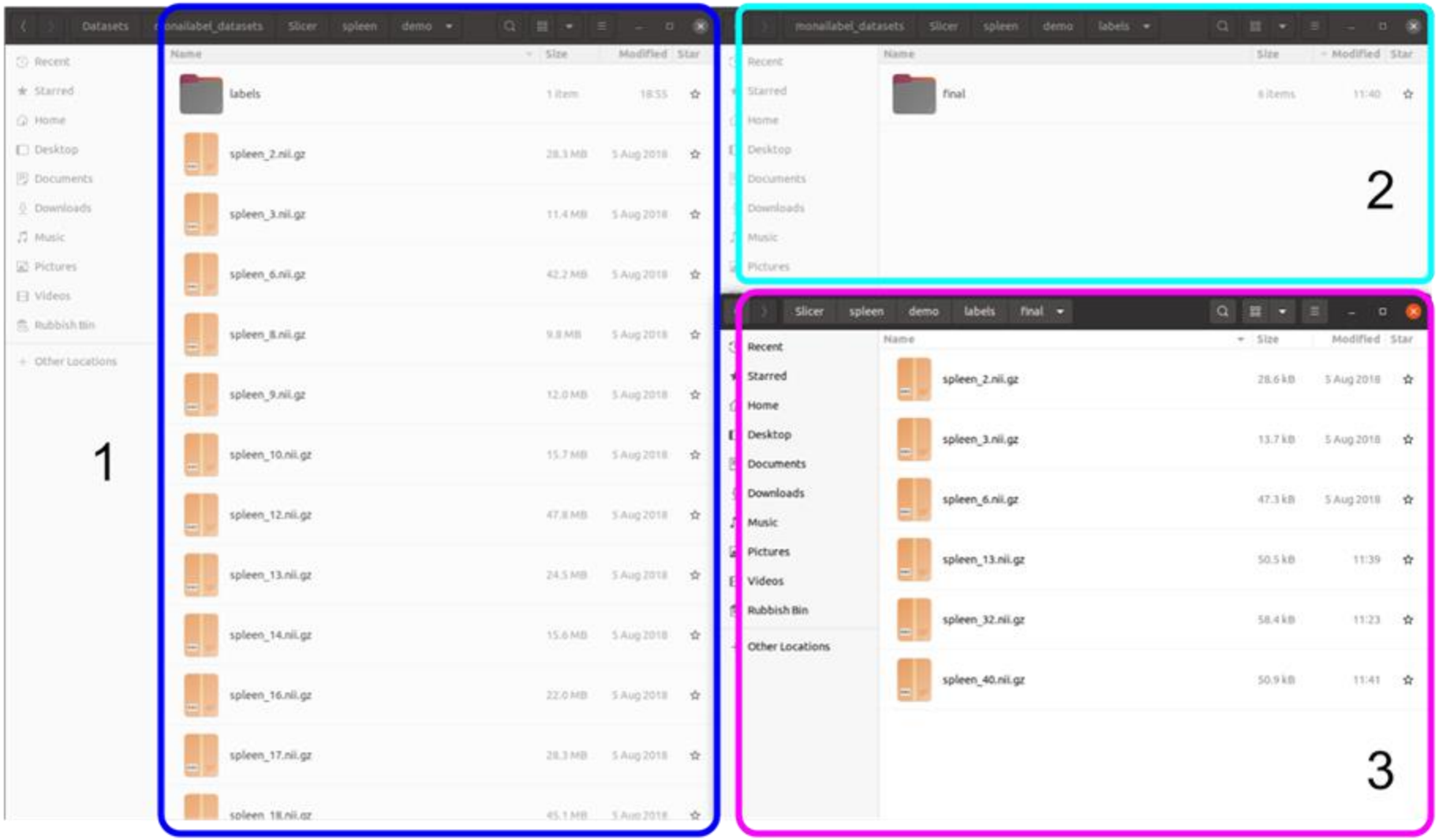
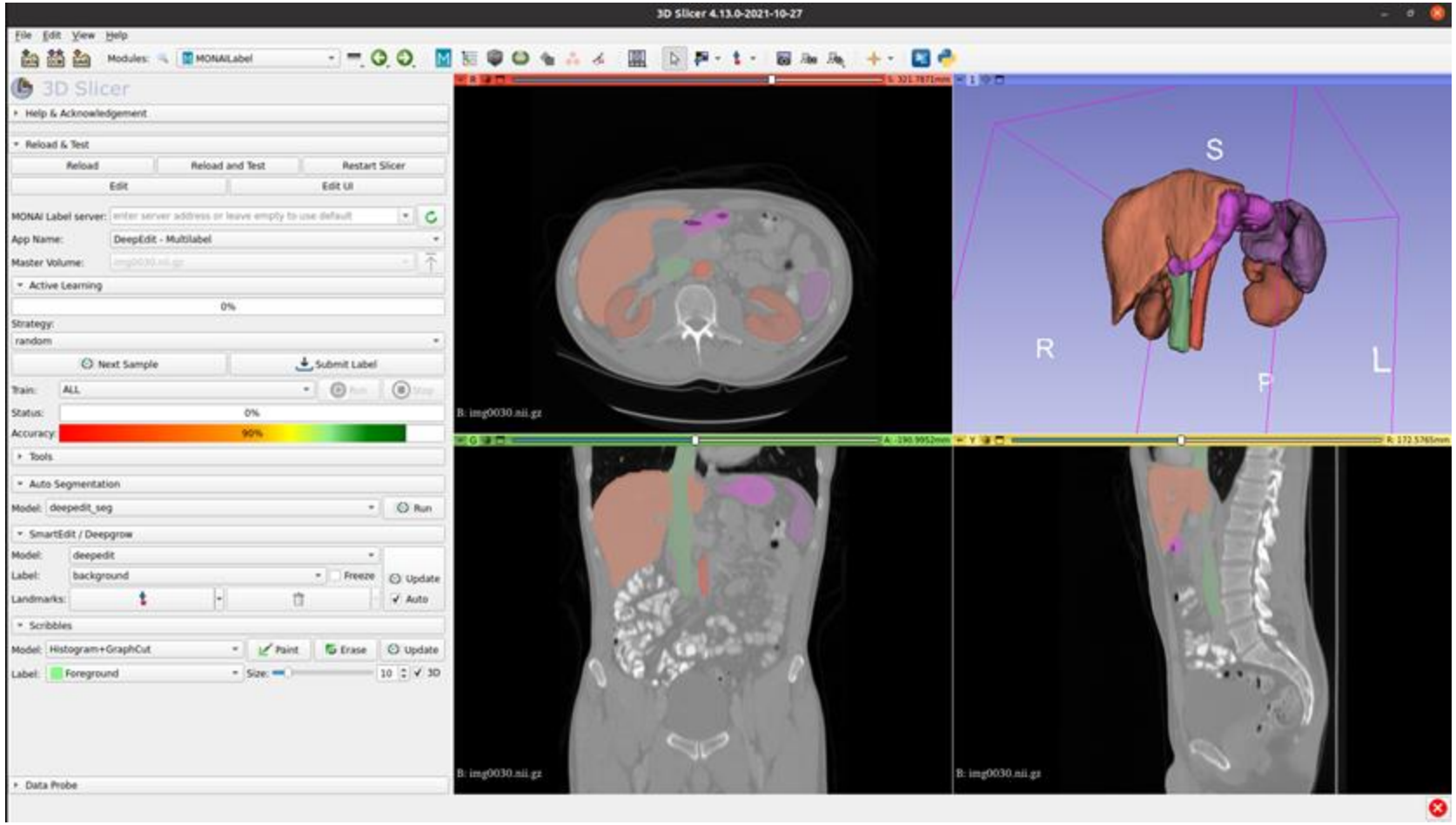



What is MONAI Label?

Client: 3DSlicer

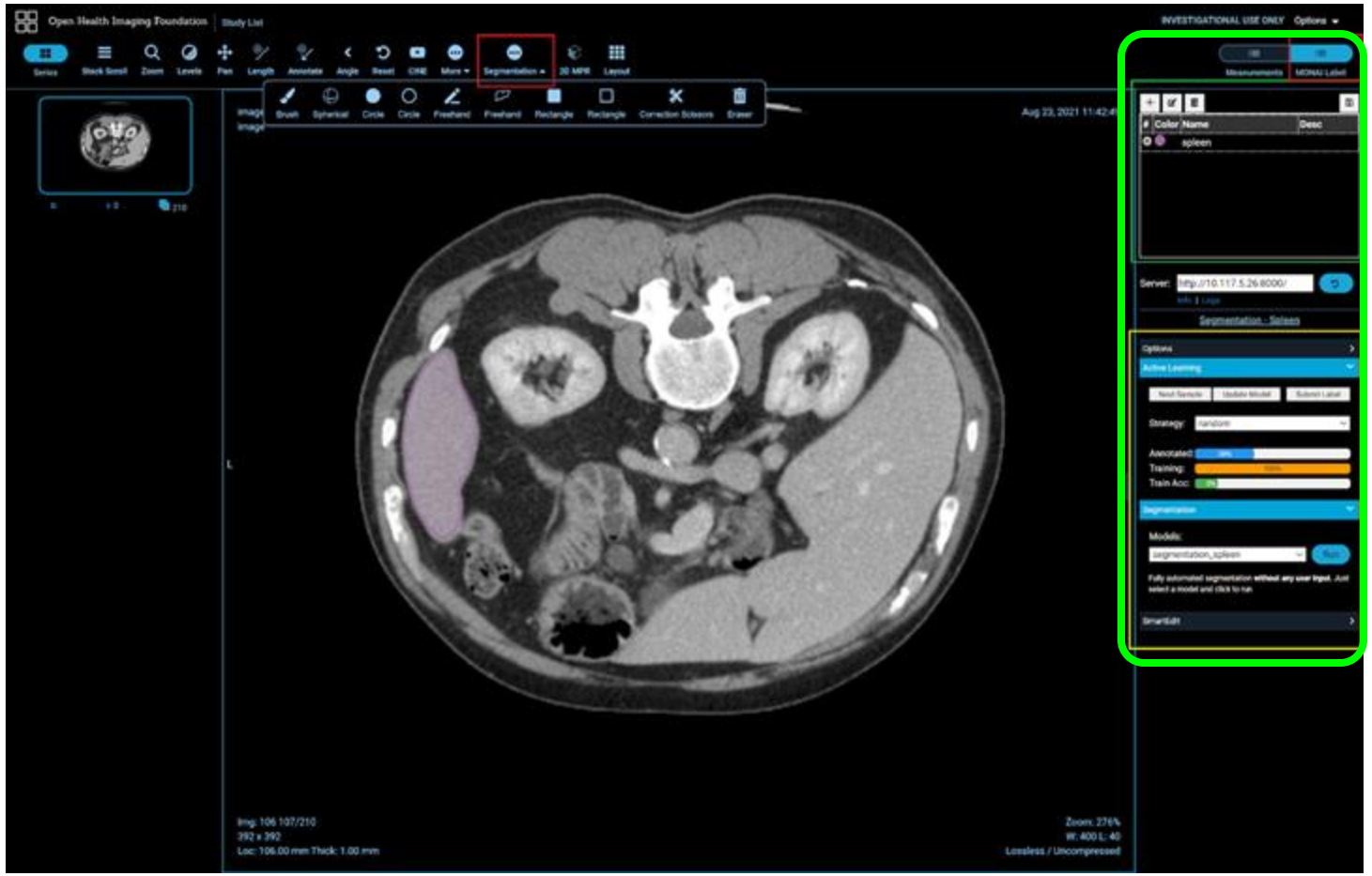
- Open-source
- User-friendly
- Supportive community
- Many manual annotation tools
- Easy to customize
- Ready-to-use MONAI Label plugin



What is MONAI Label?

Client: OHIF viewer (Open Health Imaging Foundation)

- Open-source
- Web-based viewer
- Works out-of-the-box with Image Archives that support DICOMWeb, e.g., Orthanc.
- Beautiful user interface (UI) designed with extensibility in mind.
- Pre-built with MONAI Label
- accessible at http://127.0.0.1:8000/ohif/ when you start monailabel server connecting to local/remote dicom-web storage.



How to create a MONAI Label App?

Start from sample apps

baa201e643 ▾ MONAILabel / sample-apps / Go to file

SachidanandAlle Slicer fixes (#477) ... ✓ 6427c81 on Oct 30, 2021 History

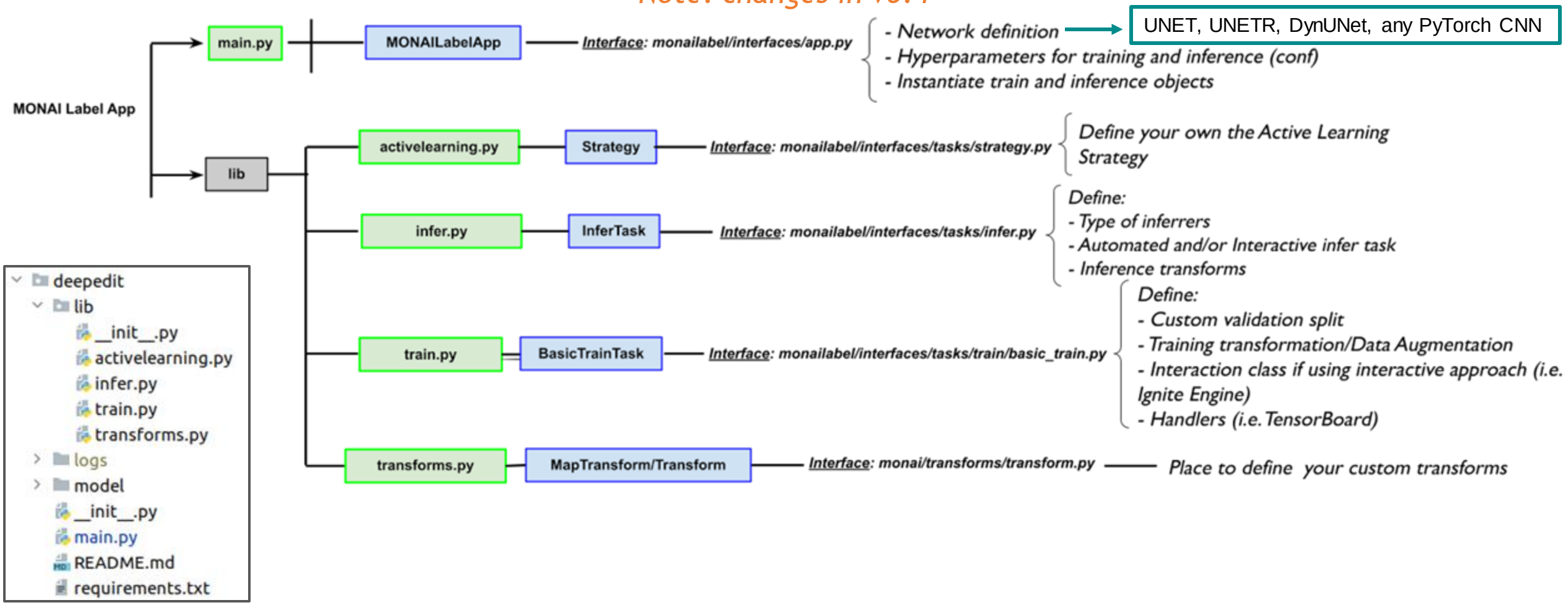
..

deepedit	Fix label switch issue with deepedit/deepgrow (#474)	4 months ago
deepedit_multilabel	Slicer fixes (#477)	4 months ago
deepgrow	Fix ScalingIntensity issues in Scribbles for different modalities (MR...	4 months ago
deepgrow_left_atrium	Fix ScalingIntensity issues in Scribbles for different modalities (MR...	4 months ago
segmentation	Fix ScalingIntensity issues in Scribbles for different modalities (MR...	4 months ago
segmentation_left_atrium	Fix ScalingIntensity issues in Scribbles for different modalities (MR...	4 months ago
segmentation_spleen	Fix ScalingIntensity issues in Scribbles for different modalities (MR...	4 months ago
README.md	Add Epistemic strategy to DeepEdit App (#369)	5 months ago

How to create a MONAI Label App?

MONAI Label App Structure

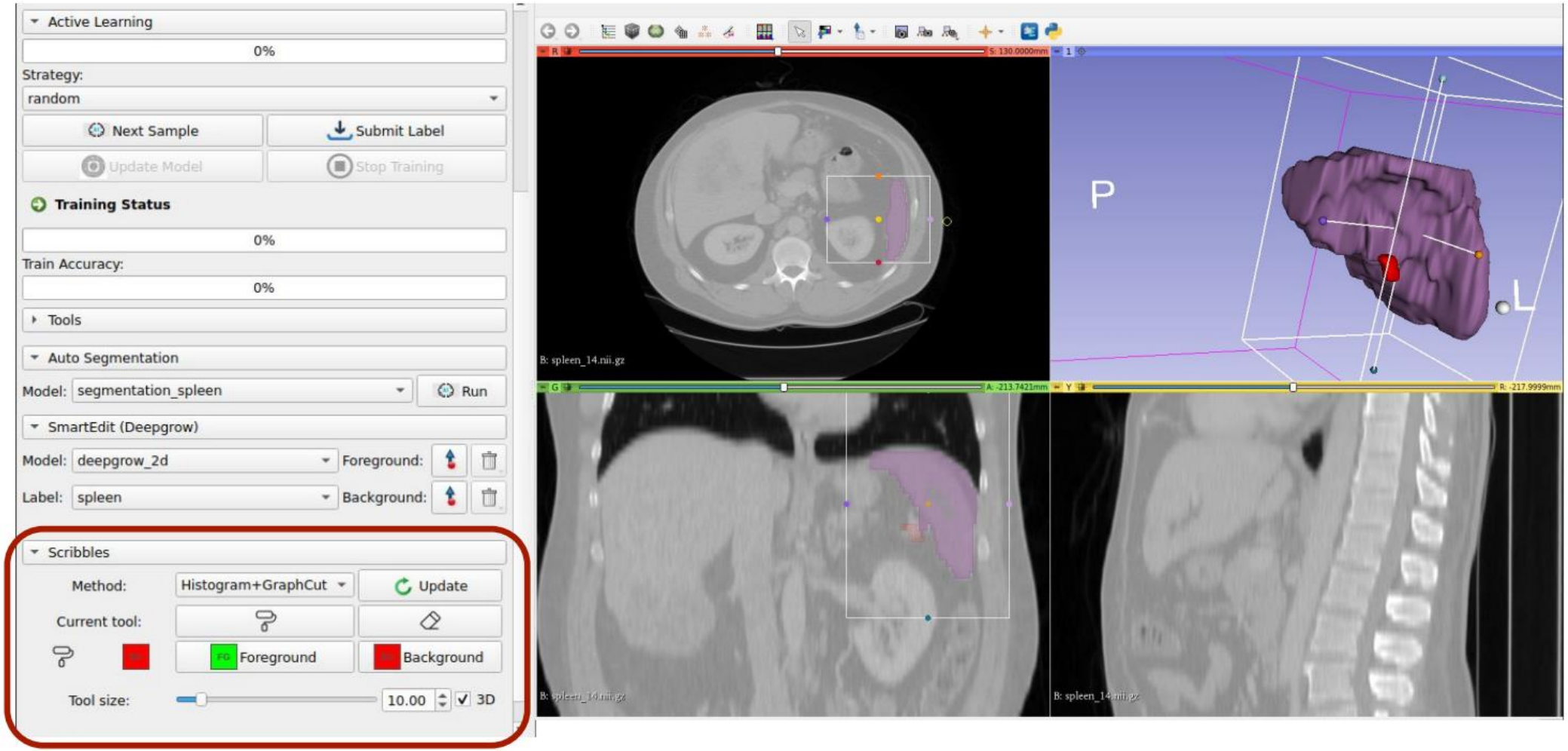
Note: changes in v0.4



How to create a MONAI Label App?

Create interactions in client plugin

Can support different types of interactions, e.g., **closed curves**.



How to create a MONAI Label App?

Integrate to other viewers

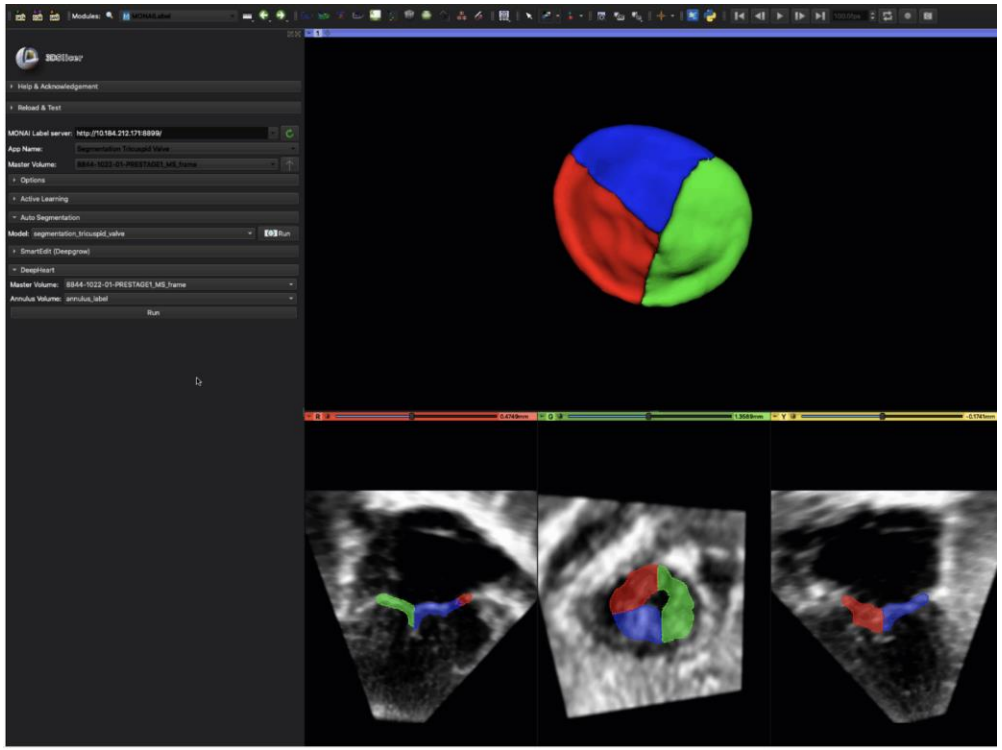
- REST API for Clients http://127.0.0.1:8000/

- Requirement for the viewer:
  - can REST API calls to the server
  - commercial viewers might not allow you to modify

MONAI Label Success Story

Children's Hospital of Philadelphia

*"Open-source frameworks like Project MONAI provide a **standardized, transparent, and reproducible template** for the creation of, and deployment of medical imaged-focused machine learning models, potentiating efforts such as ours. They allow us to **focus on investigating novel algorithms and their application, rather than developing and maintaining software infrastructure.** This in turn has **accelerated research progress** which we are actively translating into tools of practical relevance to the pediatric community we serve" – Dr. Matthew Jolley, MD, CHOP*



- Creation of a MONAI Label app for leaflet segmentation of heart valves in 3D echocardiographic (3DE) images.
- Require standardized way of collaborating between clinical and research teams.
- Next steps: Deploy this model as a MONAI Label application on a public facing server at CHOP where clinicians can directly interface with the model and trigger a training loop for adaptation.

How to use MONAI Label on HiperGator?

Demo

Tutorial https://github.com/hw-ju/monai_uf_tutorials/tree/main/monailabel

Quick Pathology demo on local workstation

Demo

Pathology apps https://github.com/Project-MONAI/MONAILabel/tree/main/sample-apps/pathology

Resources

HiperGator

- Become a HiperGator user (request HiperGator accounts, trials, submit purchase forms, etc) https://www.rc.ufl.edu/get-started/hipergator/

- How to use HiperGator?
  - UFRC wiki https://help.rc.ufl.edu/doc/UFRC_Help_and_Documentation
  - Open OnDemand https://help.rc.ufl.edu/doc/Open_OnDemand

- Need more help?
  - Submit a ticket https://support.rc.ufl.edu
  - Doc on getting help https://help.rc.ufl.edu/doc/Get_Help

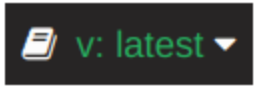
Resources

MONAI Label

MUST WATCH!
Keep adding!

- MONAI Label Deep Dive series (e.g., multi-label, 3DSlicer plugin settings) https://www.youtube.com/playlist?list=PLtoSVSQ2XzyD4lc-lAacFBzOdv5Ou-9IA

- Doc https://docs.monai.io/projects/label/en/latest/whatsnew.html (choose the correct version at the lower-right button)



- MONAI Label repo https://github.com/Project-MONAI/MONAILabel (ask questions & make suggestions at `Discussion` tab)
- MONAI Label wiki https://github.com/Project-MONAI/MONAILabel/wiki
- Quick start https://github.com/Project-MONAI/MONAILabel/blob/main/README.md
- Active Learning https://github.com/Project-MONAI/MONAILabel/wiki/Active-Learning
- FAQ https://github.com/Project-MONAI/MONAILabel/wiki/FAQ
- Report bugs\ask questions\request new features\provide any feedback
  - Issues tab https://github.com/Project-MONAI/MONAILabel/issues
  - Discussion tab https://github.com/Project-MONAI/MONAILabel/discussions

- MONAI Label session recording from MICCAI MONAI Bootcamp 2021
  https://www.youtube.com/watch?v=o8HipCgSZIw&list=PLtoSVSQ2XzyCobzE6NvwjNpITsQyPUtfs&index=11&t=1819s

- 3DSlicer doc for the basics https://slicer.readthedocs.io/en/latest/user_guide/getting_started.html
- 3DSlicer doc for module Segment Editor https://slicer.readthedocs.io/en/latest/user_guide/modules/segmenteditor.html
- 3DSlicer 10min segmentation tutorial https://www.youtube.com/watch?v=BJoIexIvtGo&t=2s

Resources

MONAI sessions @GTC 2022

- AI-assisted Annotation for Continuous Learning with MONAI Label [DLIT2098]
- Developing for the AI Medical Project Life Cycle: MONAI Community Developer Meetup [SE2174]
- Accelerate your research with MONAI on AWS [S42397]
- Design, Train, and Evaluate Domain-specialized Health-care Imaging AI Models with MONAI [DLIT2097]
- Creating Inference Applications for the Medical AI Project Life Cycle using MONAI Deploy [DLIT2099]
- HCLS Dev Summit: Building an Open-source Foundation to Fuel R&D Innovation [S42639]
- Experiences in Algorithm Deployment in Large Healthcare Settings and Continuous Learning [S41923] Mayo Clinic
- Scientific Process of Building AI Models (Presented by Quantiphi, Inc.) [S42426] Quantiphi, Inc.
- AI Building Blocks for Industry 4.0 (Presented by Supermicro) [S42564] Super Micro Computer, Inc.

Thanks!

Q&A

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