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NVIDIA & King's College London
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https://github.com/Project-MONAI/MONAILabel

Outline:

- What is MONAI Label?
- Why use MONAI Label?
- How to create a MONAI Label App?

  Datastore in file archive

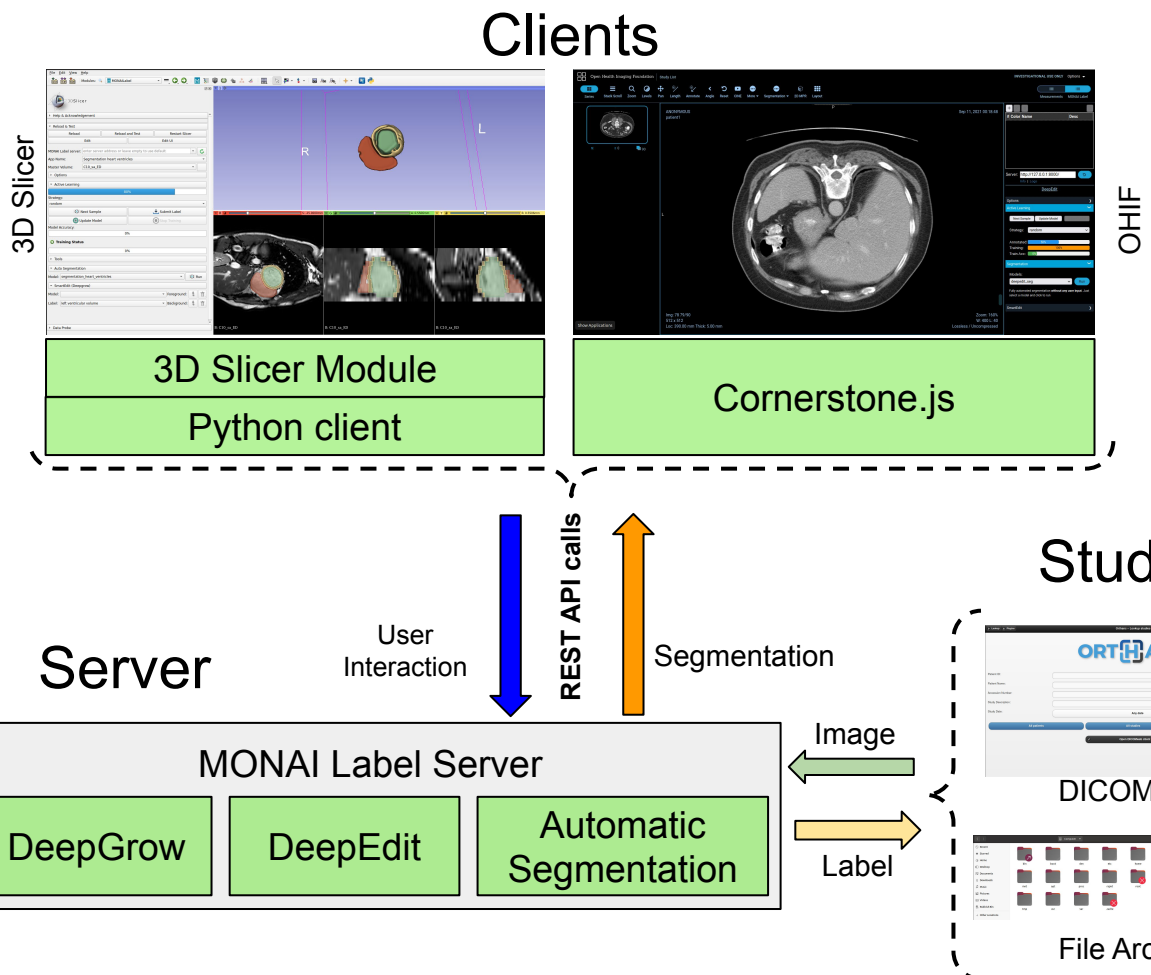
  Heuristic Planner

  Active Learning Strategies
- Scribbles in MONAILabel
- Create your customised Slicer Module
- OHIF + MONAI Label
- Demo

What is MONAI Label?

- An intelligent **open source** image labeling and learning tool that enables users to create annotated datasets and build AI annotation models for clinical evaluation
- Framework for developing and deploying **MONAI Label Apps to train and do inference using** Deep Learning models
- MONAI Label is one of the first frameworks that introduces **Active learning strategies in a software annotation setting**
- It is all Python and can be installed with simple **“pip install monailabel”**
- Supported viewers:
  - **3D Slicer**
  - **Open Health Imaging Foundation (OHIF)**

MONAI Label Infrastructure: server-client system



MONAI Label Infrastructure: REST API calls

Why use MONAI Label?

- **Researcher Perspective:** MONAI Label allows researchers to
    - Create new annotation methods
    - Rapid App prototyping
    - Implement active learning techniques
    - Verify their effectiveness in real-world scenarios
    - Make incremental improvements
    - Readily deploy labeling apps to wider audiences
- **Clinician Perspective:** MONAI Label reduces the time and effort of annotating new datasets
    - Ready-to-use **3DSlicer**
    - Pre-built plugin for **OHIF Viewer**

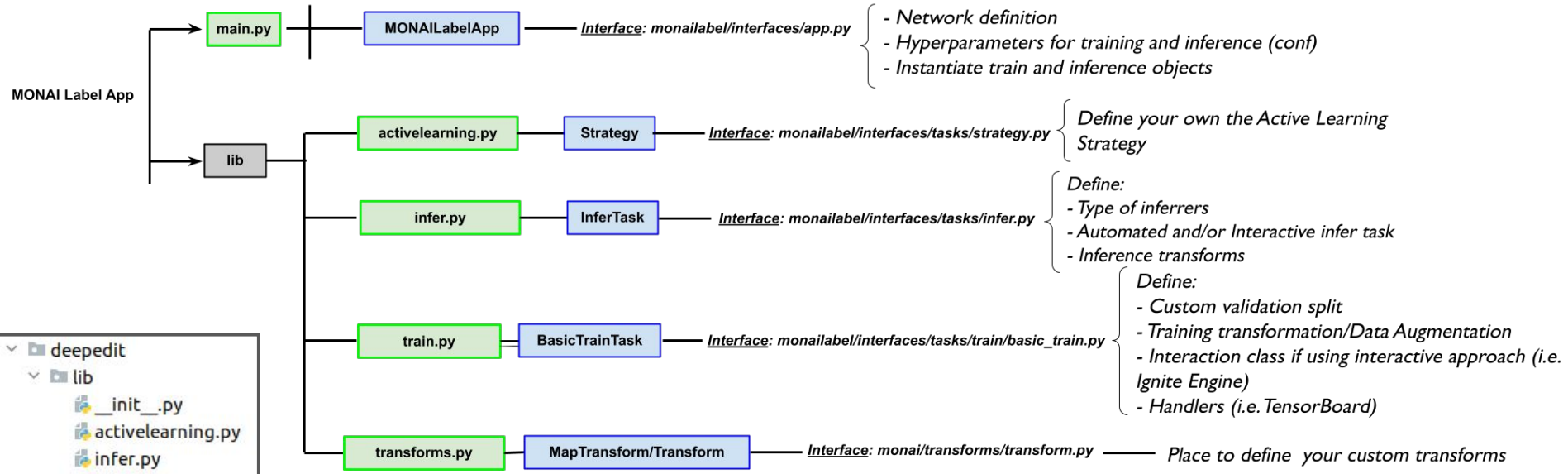
How to create a MONAI Label App?

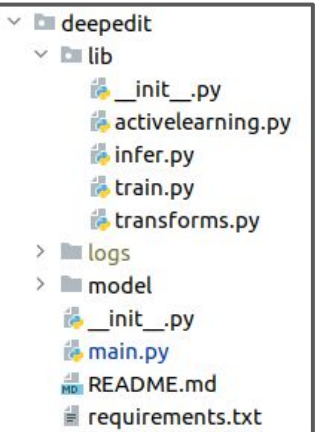
- Select the spatial/intensity transforms to preprocess images for training and inference
- Define the active learning technique use in the labeling app
- Define neural network architecture
- Preprocess scribbles, points, ROI, closed curve, or any input sent to the MONAI Label server through the REST API

Researchers can also use sample apps (i.e. DeepGrow, DeepEdit and UNet) to jumpstart the development of their own custom labeling apps

- For more details check out our tutorial

MONAI Label App Structure





MONAI Label App: Datastore in file archive

```
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
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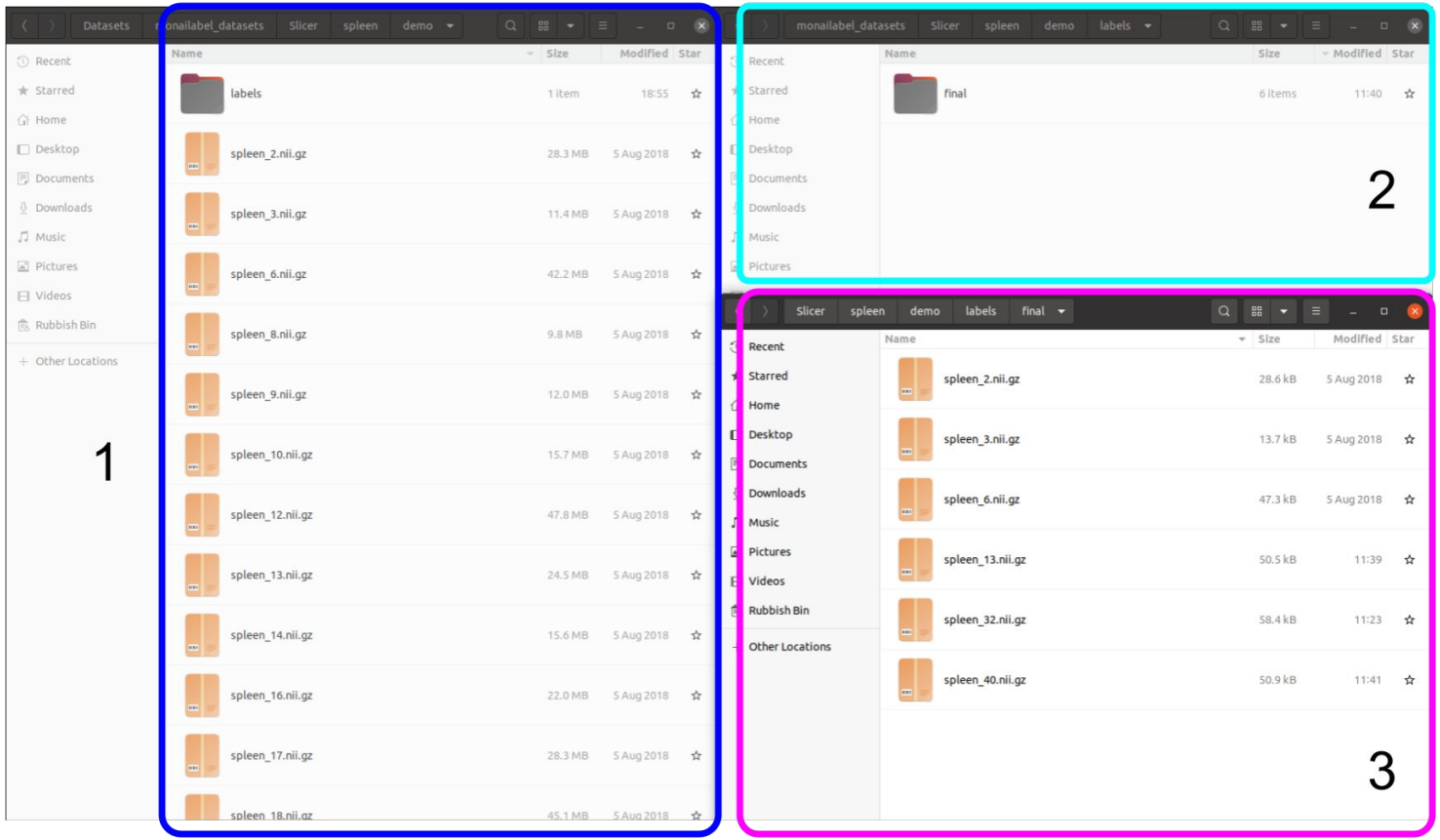
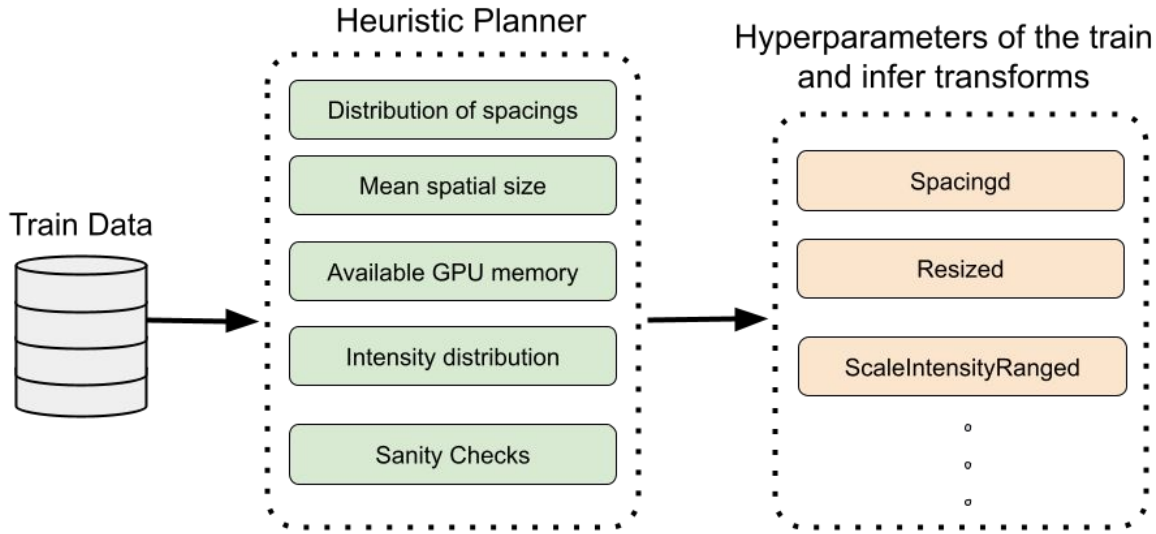
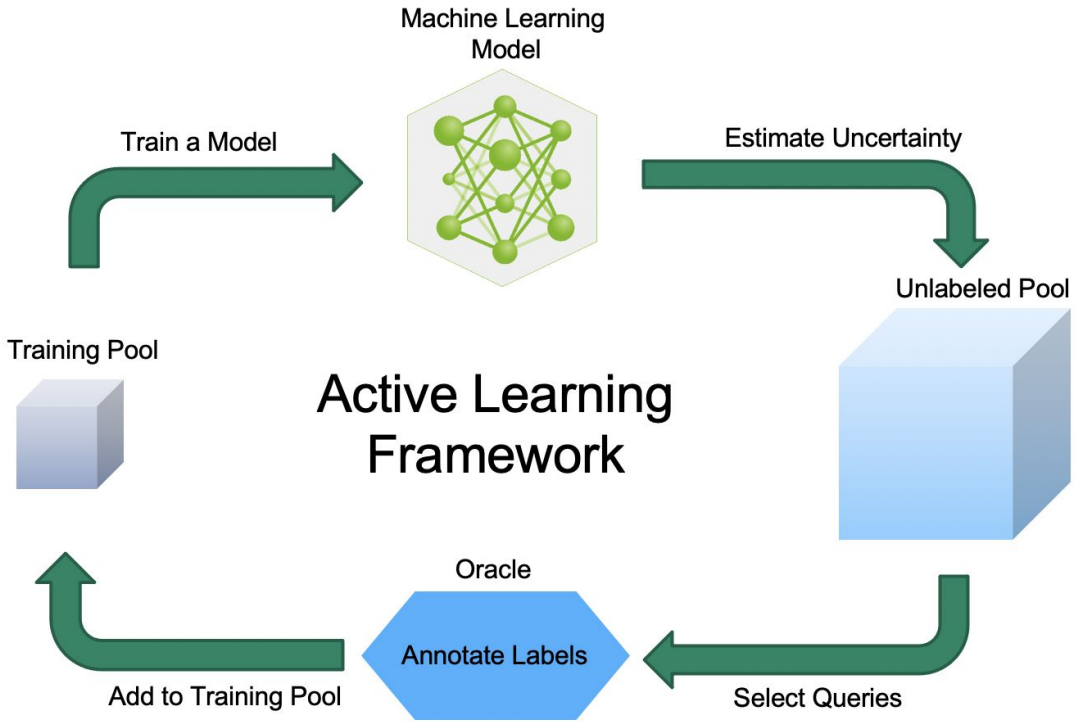


MONAI Label App: ***Heuristic planner***

- Considers available GPU memory to define image spatial size.
- 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.



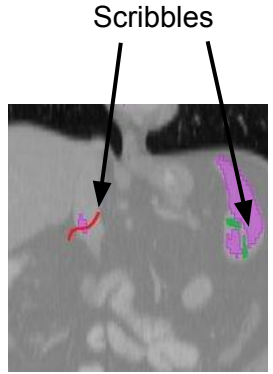
MONAI Label App: ***Active Learning Strategies***



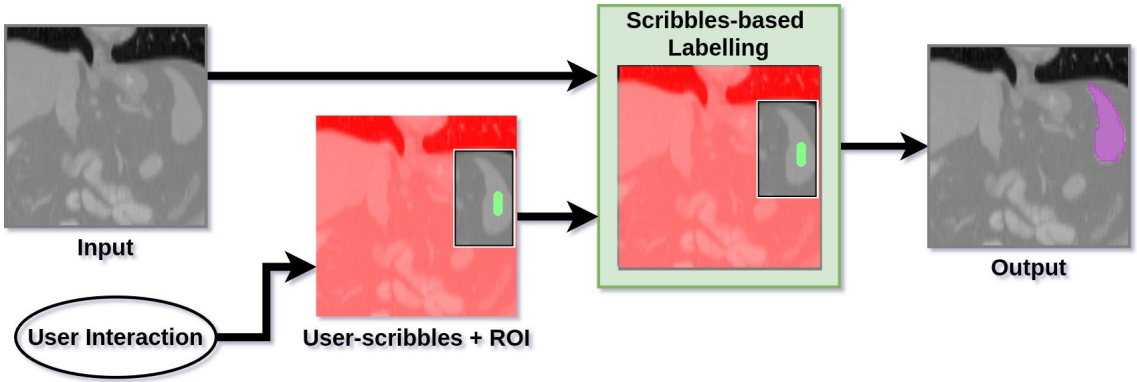
- **Active learning** is a semi-supervised machine learning approach where the algorithm can choose which data it wants to learn from
- Initially, random images are selected to be labeled

  However, random is not always the most efficient.
- After having a pretrained model, uncertainty of each image can be computed. Unlabeled samples that need more attention from the clinician will be selected
- Selection of harder samples or samples that need more attention

Scribbles in MONAILabel



- Scribbles → free-hand line drawings for minimal interaction
- MONAILabel provides two scribbles-based modes:
  - **Scribbles-only**: uses scribbles to generate segmentation labels (demo) [1, 2]
  - **Scribbles-based refinement**: refines labels from a deep learning model [2]

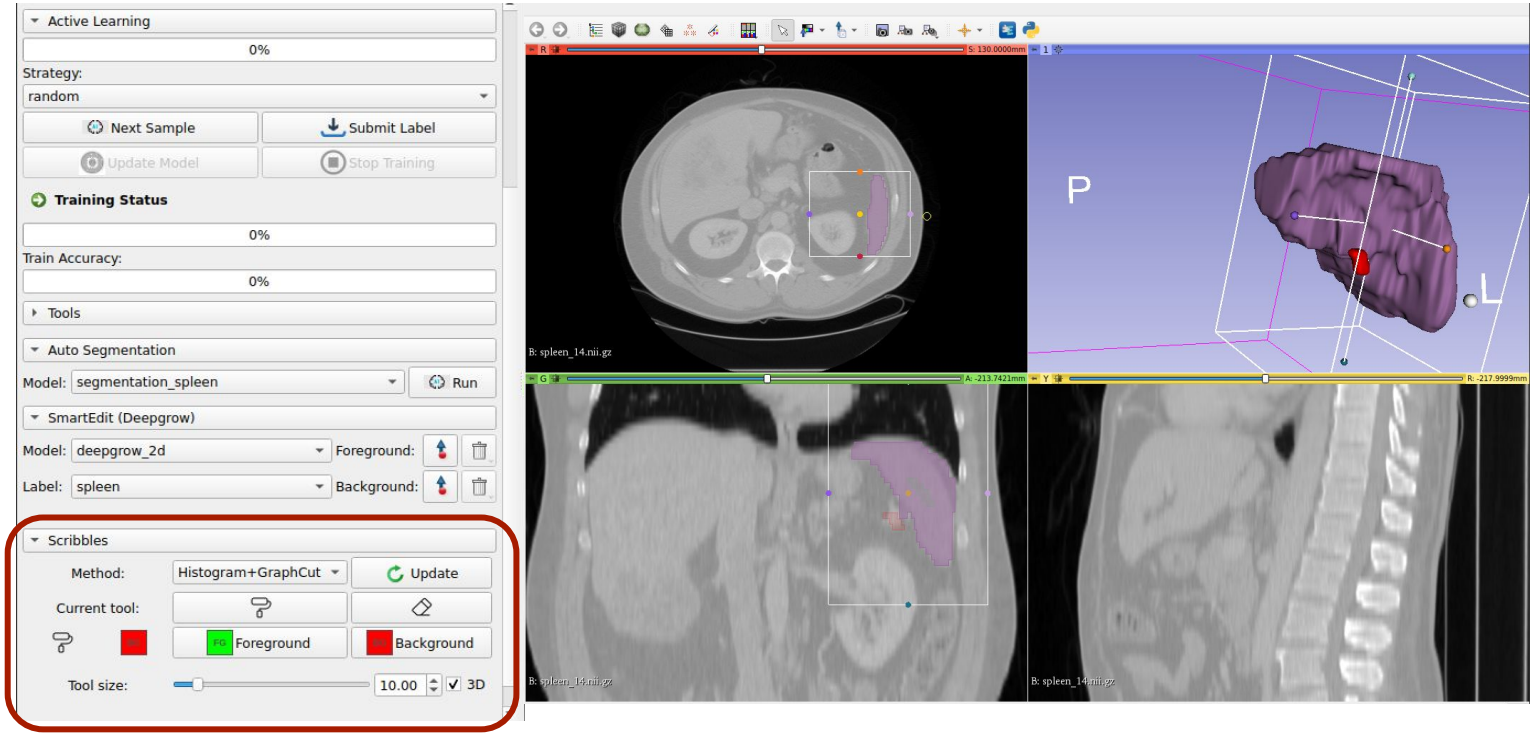


- 3D ROI Bounding box method to efficiently do background selection

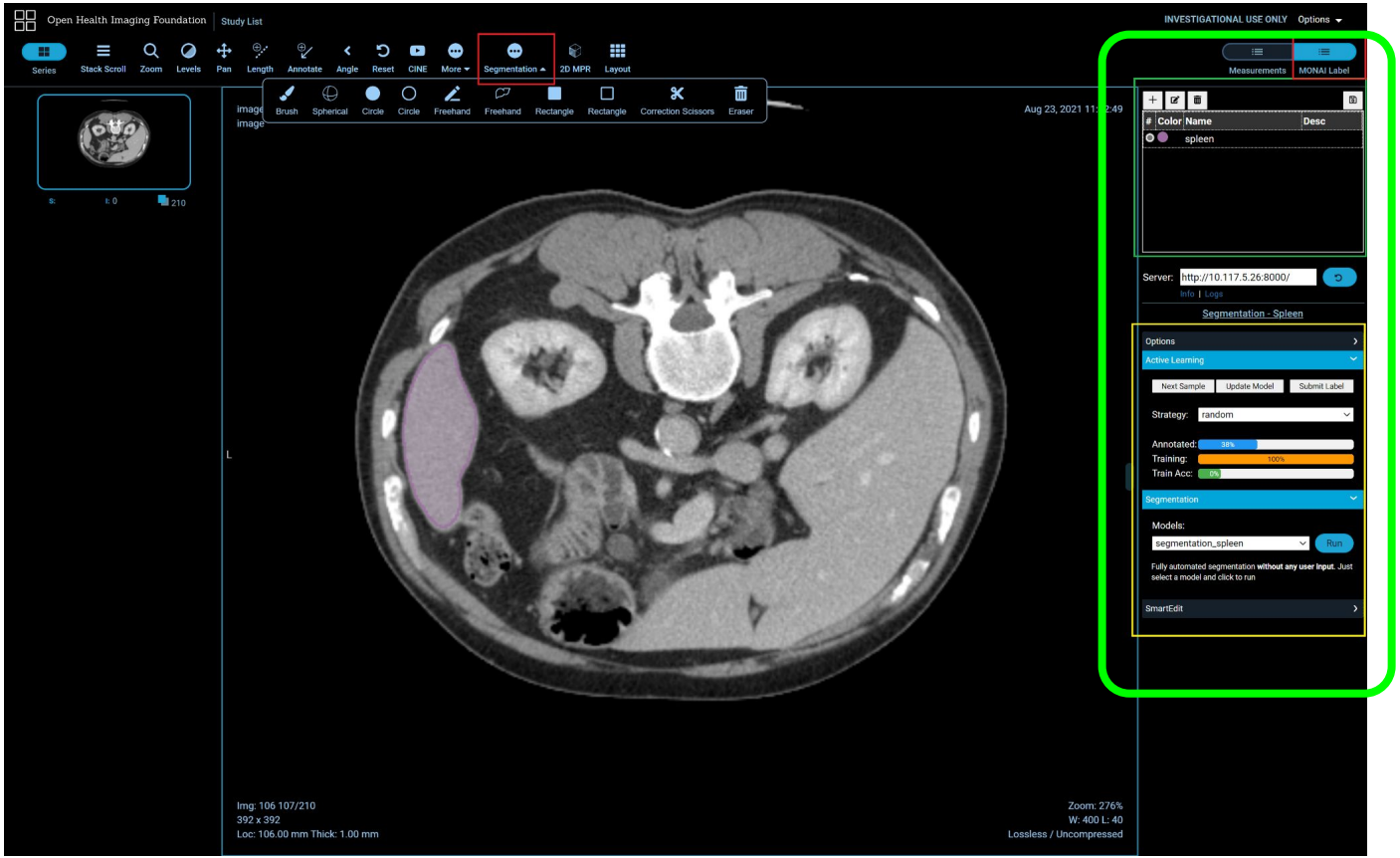
[1] Criminisi, Antonio, et al. "Geos: Geodesic image segmentation." ECCV, 2008.
[2] Wang, Guotai, et al. "Interactive medical image segmentation using deep learning with image-specific fine tuning." IEEE TMI, 2018.

Create your customised Slicer Module

More dynamic extensions! Support different types of interactions such as closed curves.



MONAI Label + OHIF



MONAI Label

Demo

- **Scenario 1:** Cold start - No segmentations available
  1. Start App: monailabel start_server -a ./sample-apps/deepedit/ -s /home/adp20local/Documents/Datasets/monailabel_datasets/Slicer/spleen/demo_scenario1/
  2. Segmentation based on scribbles
  3. Start training in the background

- **Scenario 2:** Interactive segmentation using DeepEdit

  1. Inference
  2. Active Learning Strategy

- **Scenario 3:** Use OHIF and DICOMweb server

  1. Start App using Orthanc DICOMweb server: monailabel start_server -a ./sample-apps/deepedit/ -s http://127.0.0.1:8042/dicom-web
  2. Show images loaded in Orthanc
  3. Use DeepEdit in OHIF

Conclusions and future work:

Conclusion:

- MONAI Label is a open source project that facilitates annotations of 3D medical images.
- MONAI Label is one of the first frameworks that introduces Active learning strategies in a software annotation setting.

Future Work:

- Multimodality support
- Multiple apps under single server
- Self-supervised learning or unsupervised learning algorithms to leverage unlabeled data for better performance.

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Thanks!