

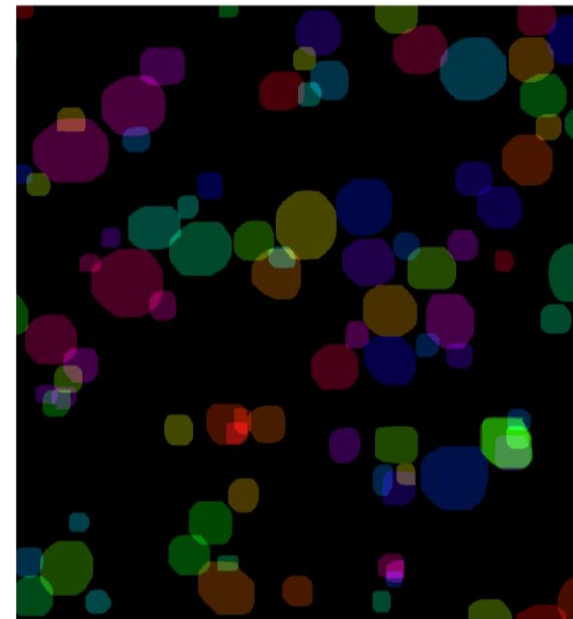
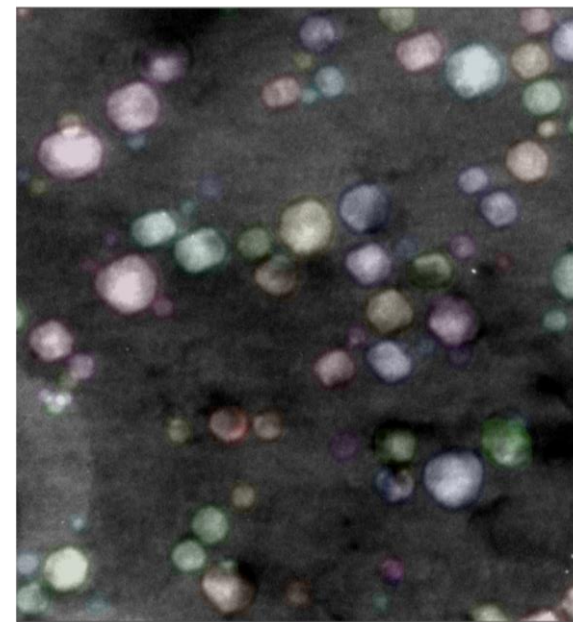
*Deep Learning for Microscopy Image Analysis
in Materials Science: Advancing Research
and Education Workshop*

Data Labeling and Demonstration

Dr. Shradha Agarwal, Tommy Wong

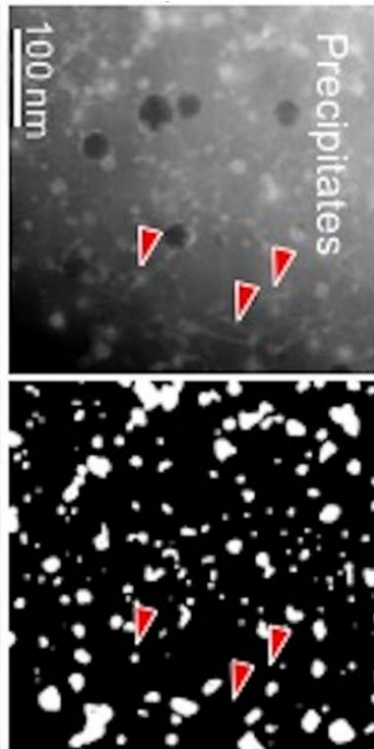
Github: [github.com/shradhautk/AI-
MICROSCOPY-WORKSHOP](https://github.com/shradhautk/AI-MICROSCOPY-WORKSHOP)

Labeling this image took ~ 1 hr, DL
prediction took < 1 min.

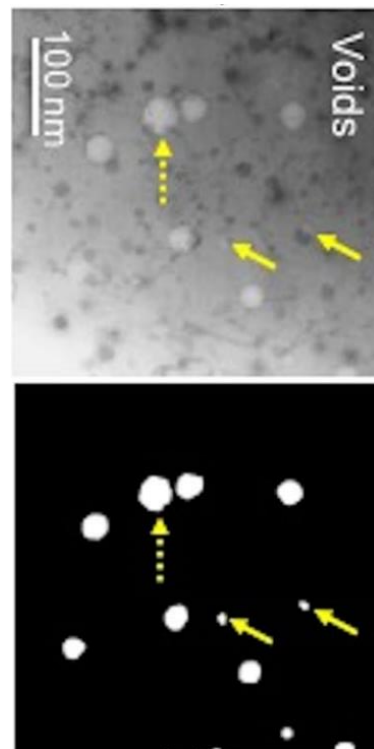


Common defects can be labeled for pixel-wise segmentation

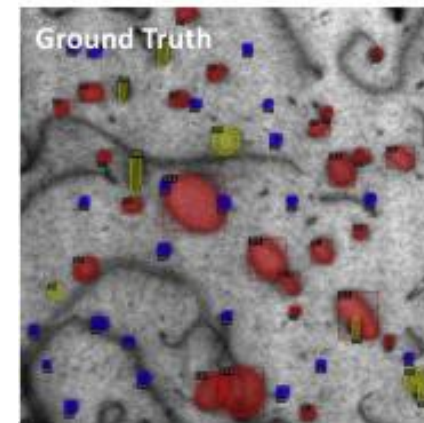
- Segmentation: associating each pixel in an image with a class



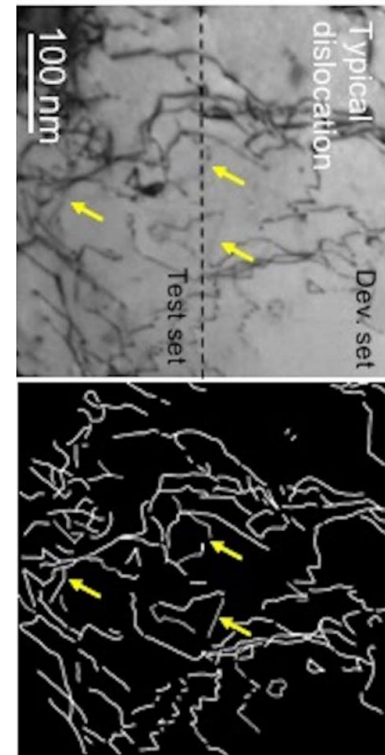
Cavities (bubbles & voids)



Precipitates



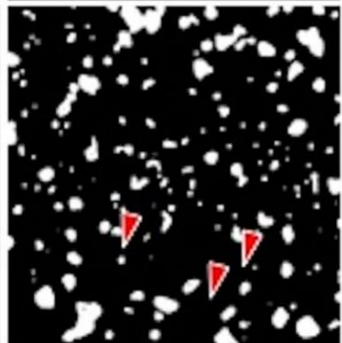
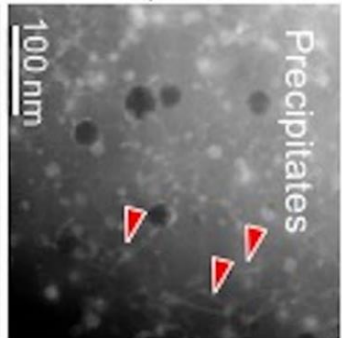
Dislocation loops



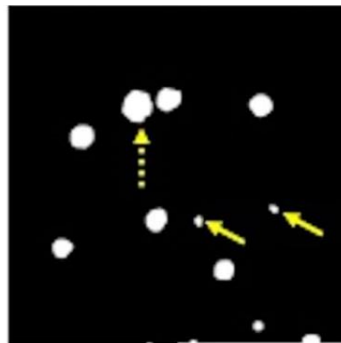
Dislocation lines

Different labeling systems are required for different segmentation algorithms

- Important: labels are usually either 0 or 1

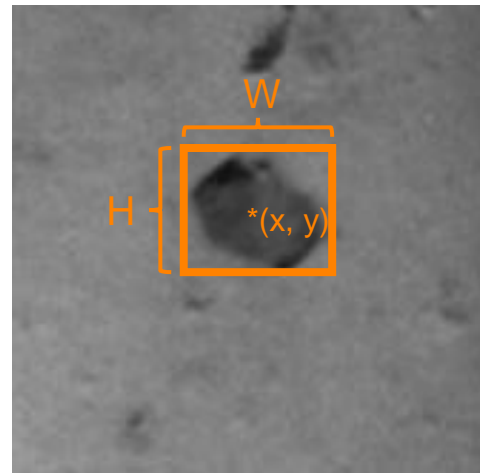


Precipitates



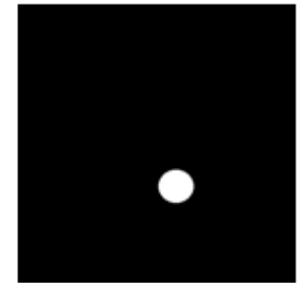
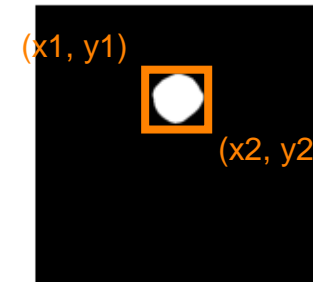
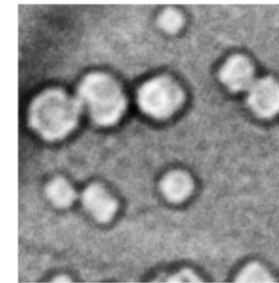
Voids

Semantic segmentation: one-hot encoding (U-Net)



[Class x y W H]

Object identification: bounding box (YOLO)



...

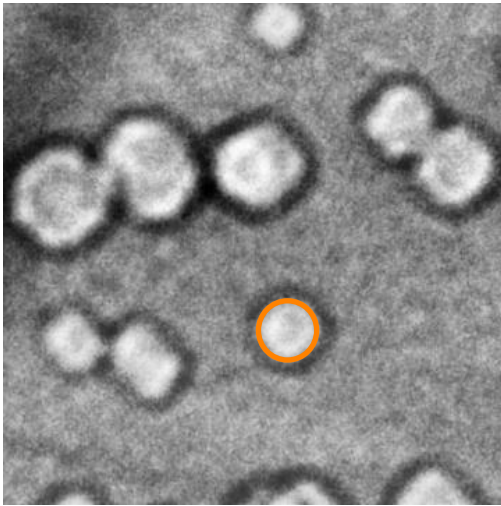
```
Dictionary{  
  'boxes': [x1 y1 x2 y2]  
  'labels': class  
  'masks': feature mask  
}
```

Instance segmentation: label encoding (Mask R-CNN)

Special conventions for labeling cavities and loops

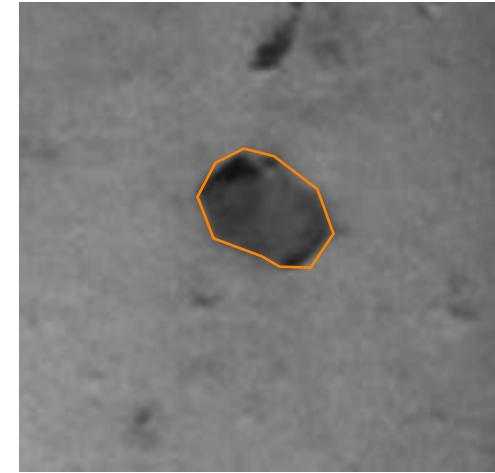
Cavities

- Label the area within the *inner* edge

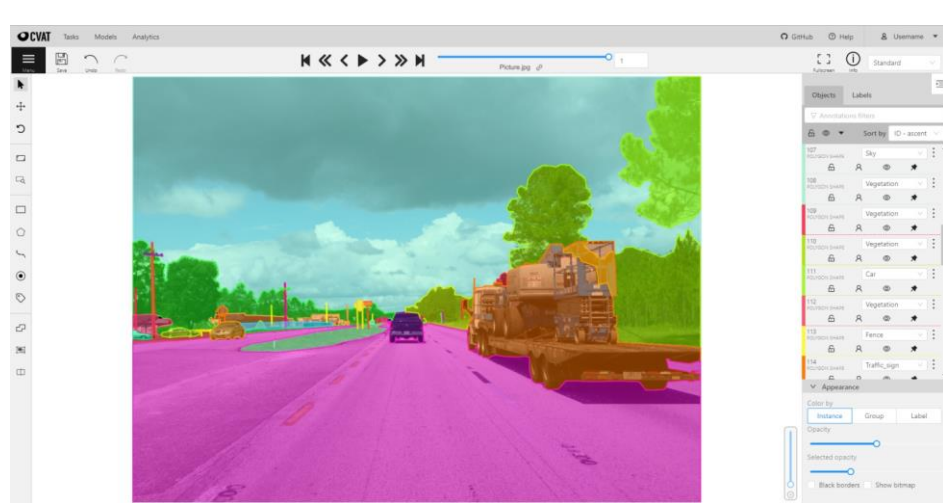


Loops

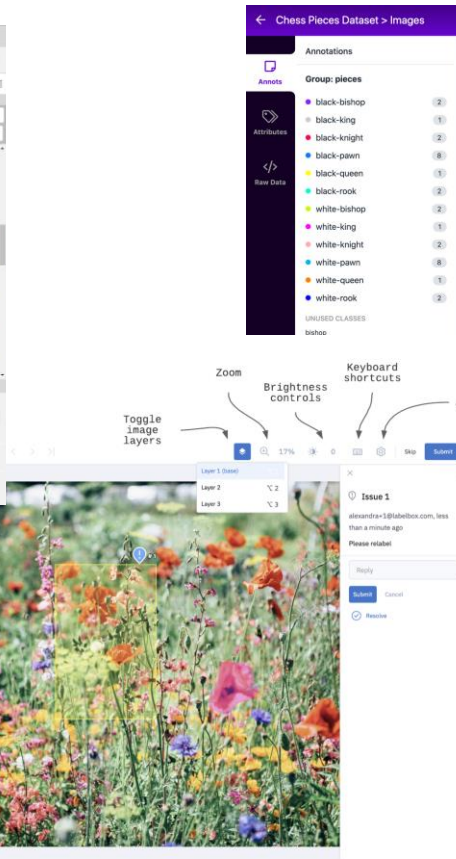
- Label the area within the *outer* edge



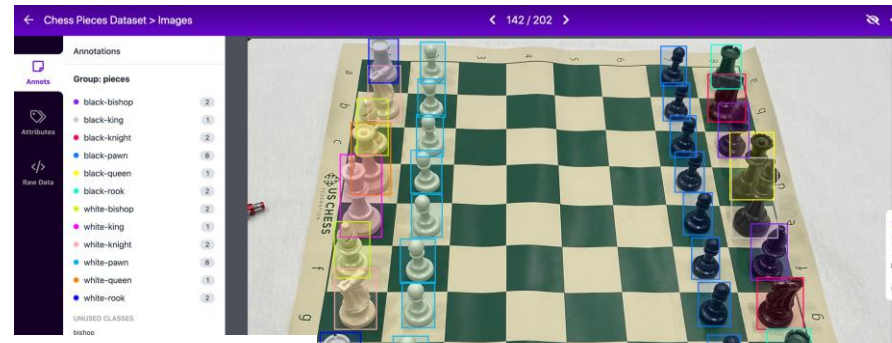
Web-based GUI tools are used for labeling



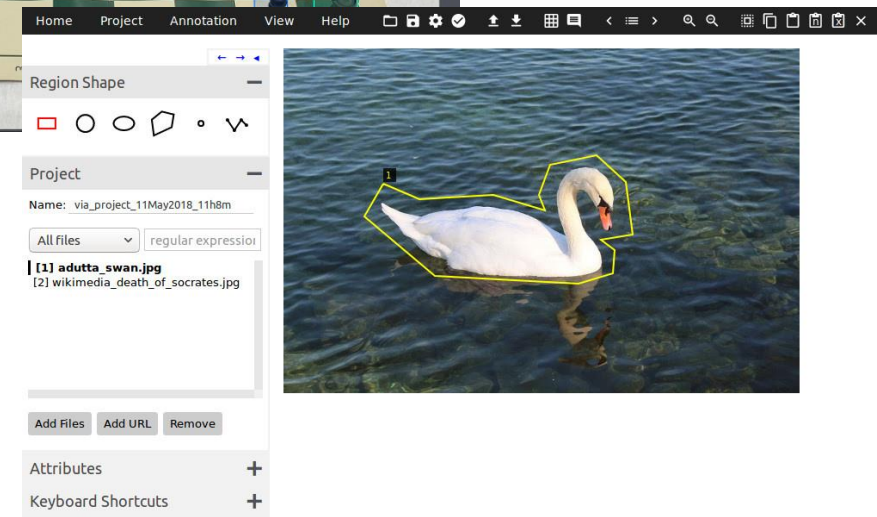
CVAT



Labelbox



Roboflow



VIA

Labeling using Computer Vision Annotation Tool (CVAT)

cvat.ai

Documentation:

github.com/TaSeeMba/cvat/blob/master/cvat/apps/documentation/user_guide.md

CVAT labeling workflow

Important: before labeling, ensure all image data have the same dimensions e.g. 1024x1024



Creating a project and labeling tasks

The image displays three sequential screenshots of the CVAT (Computer Vision Annotation Tool) web interface, illustrating the process of creating a project and labeling task. Each screenshot is marked with a numbered orange circle (1, 2, and 3) and an orange arrow pointing to a specific action.

Screenshot 1: Create a new project
The interface shows the 'Create a new project' form. The 'Name' field is filled with 'DL_for_Microscopy'. Under the 'Labels' section, 'Raw' is selected, and 'Bubble' is chosen as the label type. The 'Submit & Open' button is highlighted with an orange arrow.

Screenshot 2: Create a new task
The interface shows the 'Create a new task' form. The 'Name' field is filled with 'DL_for_Microscopy_eg_img'. The 'Project' field is set to 'DL_for_Microscopy'. The 'Subset' field is set to 'Input subset'. The 'Labels' section shows 'Project labels will be used'. The 'Select files' section shows 'My computer' selected. The 'Submit & Open' button is highlighted with an orange arrow.

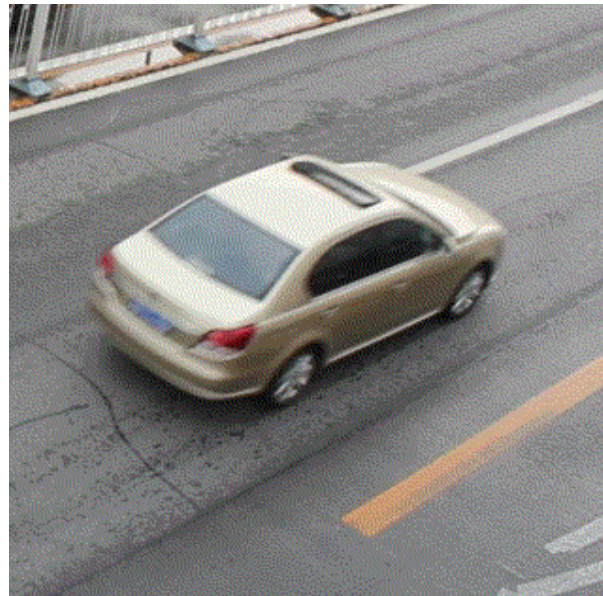
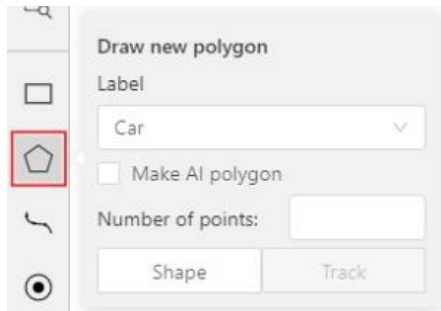
Screenshot 3: Task details
The interface shows the task details for 'DL_for_Microscopy_eg_img'. The task is created by 'tommycwong' on 'June 5th 2023'. The 'Issue Tracker' is 'Not specified'. The 'Subset' is 'Input subset'. The 'Jobs' table shows 0 of 1 jobs. The 'Job #180806' is highlighted with an orange arrow.

Job	Frames	Stage	State	Started on	Duration	Assignee
Job #180806	0-0	annotation	new	June 5th 2023 02:06	a few seconds	Select a user

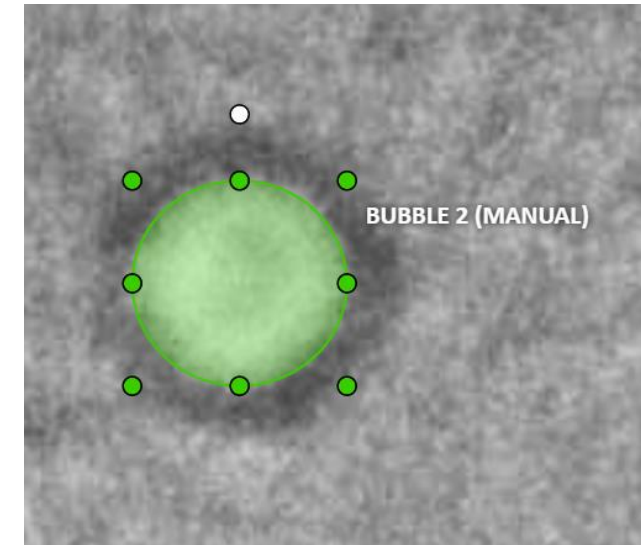
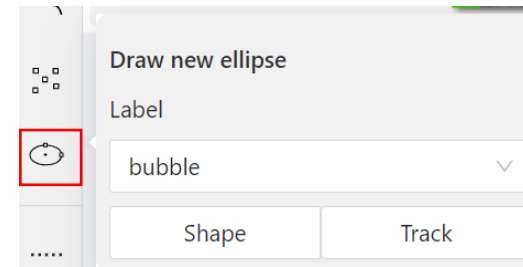
Labeling using polygon and ellipse tools

Remember to click **Save**
Polygon tool

- Hold **Shift** to draw



Ellipse tool



Exporting and parsing labels

Export as .xml

Export job #180806 as a dataset ×

* Export format

[↓](#) CVAT for images 1.1 ▼

☐ Save images

Custom name

.zip

☒ Use default settings ⓘ

Cancel OK

Parsing labels using Python

```
get_imgs(train_img_names)
parse_anno_file(xml, train_img_filename)
get_unet_mask(annos)
get_maskrcnn_mask(annos)
get_maskrcnn_dataset(images=train_imgs,
labels=maskRcnn_masks)
```

Demo: github.com/shradhautk/AI-MICROSCOPY-WORKSHOP/blob/main/Day2_Education_Day/Data_Labeling/DL_for_Microscopy_Data_Labeling.ipynb

```
<image id="0" name="DL_for_Microscopy_Train_eg_img.png" width="512" height="512">
  <ellipse label="Bubble" source="manual" occluded="0" cx="291.95" cy="334.99" rx="32.35" ry="30.94" z_order="0">
  </ellipse>
  <polygon label="Bubble" source="manual" occluded="0" points="282.22,131.08;289.47,135.54;295.61,142.23;300.07,1
  </polygon>
```

Additional notes on labeling

- Cavities/loops should have a concave mask
 - Convex masks are likely occluded concave masks
- Don't leave holes between multiple overlapping masks
- Keep in mind output files: different parsing scripts needed for .xml, .json, etc.