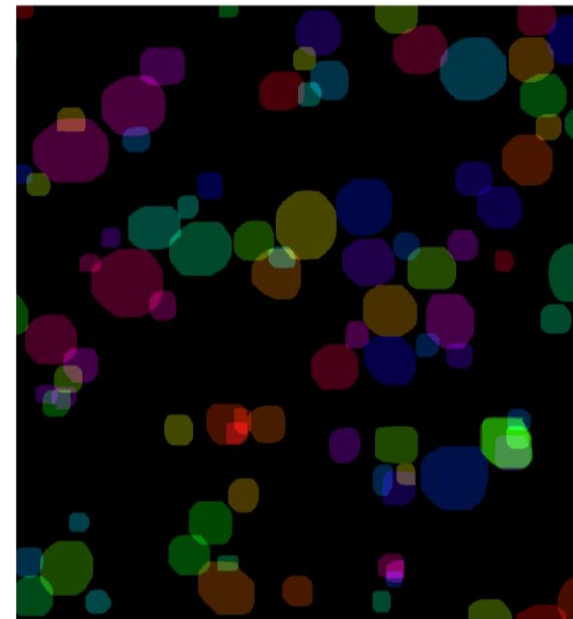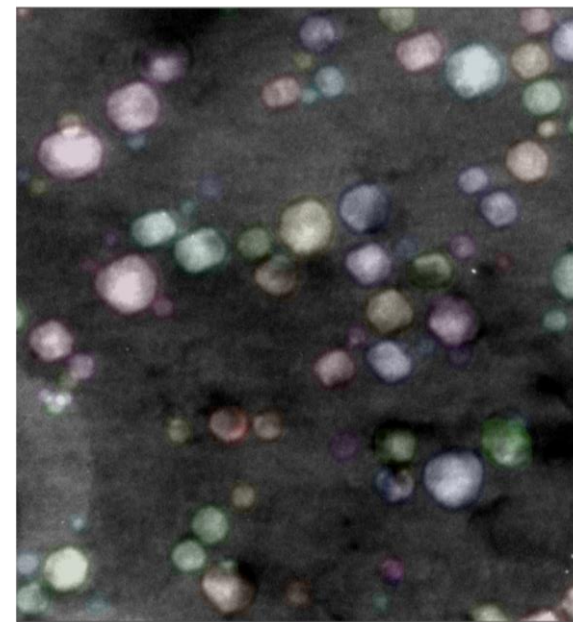*Deep Learning for Microscopy Image Analysis in Materials Science: Advancing Research and Education Workshop*

Data Labeling and Demonstration

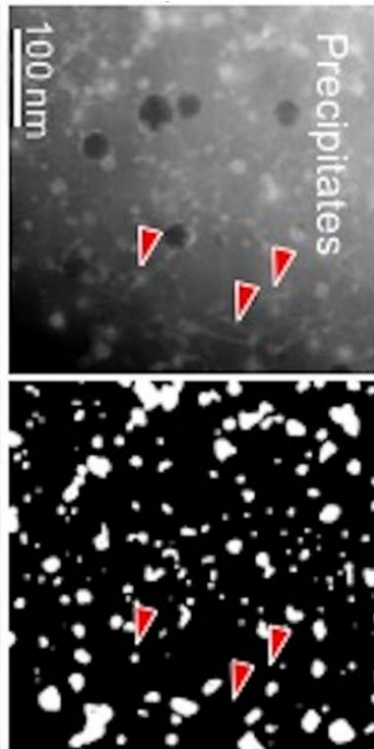Dr. Shradha Agarwal, Tommy Wong

Github: github.com/shradhautk/AI-MICROSCOPY-WORKSHOP

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

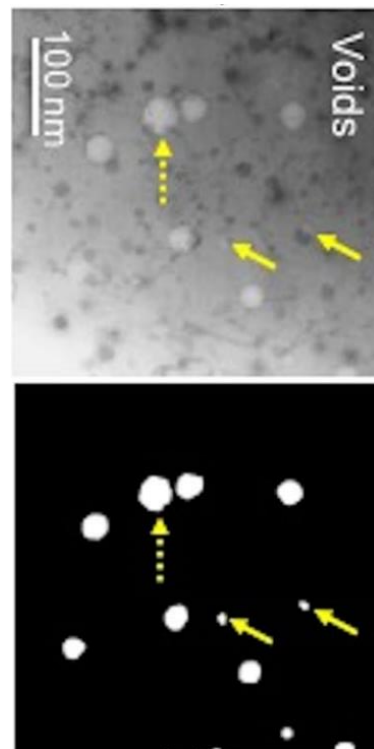THE UNIVERSITY OF TENNESSEE KNOXVILLE

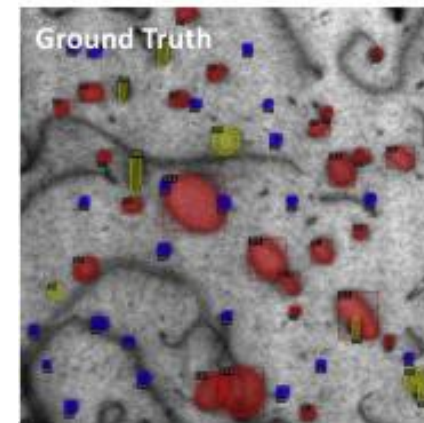# Common defects can be labeled for pixel-wise segmentation

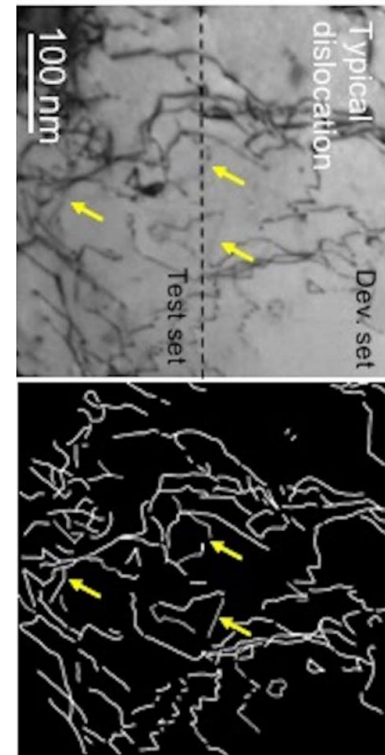- Segmentation: associating each pixel in an image with a class
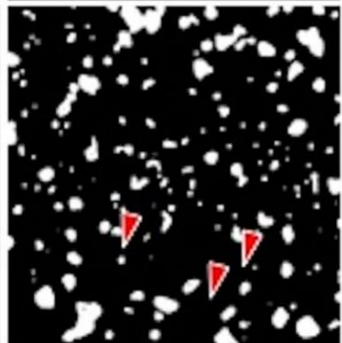

Cavities (bubbles & voids)

Precipitates

Dislocation loops

Dislocation lines

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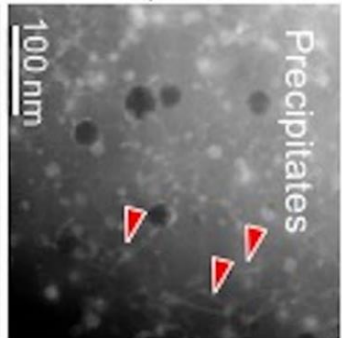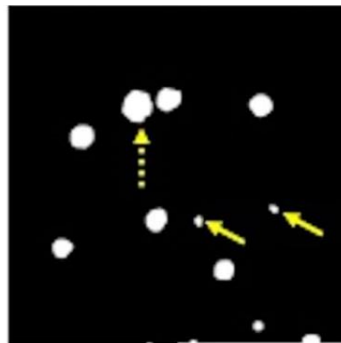
Different labeling systems are required for different segmentation algorithms

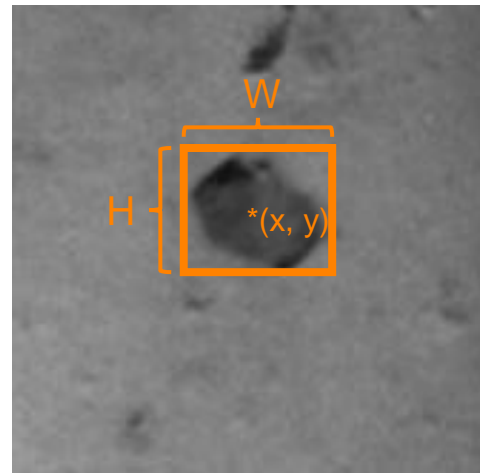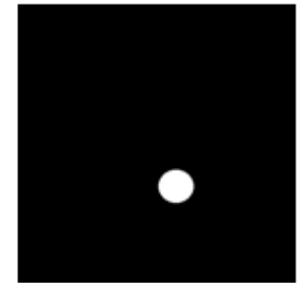- **Important: labels are usually either 0 or 1**

Precipitates
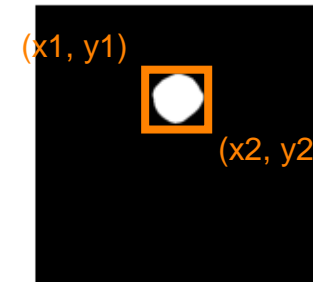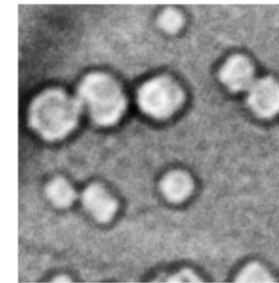
Voids

Semantic segmentation: one-hot encoding (U-Net)
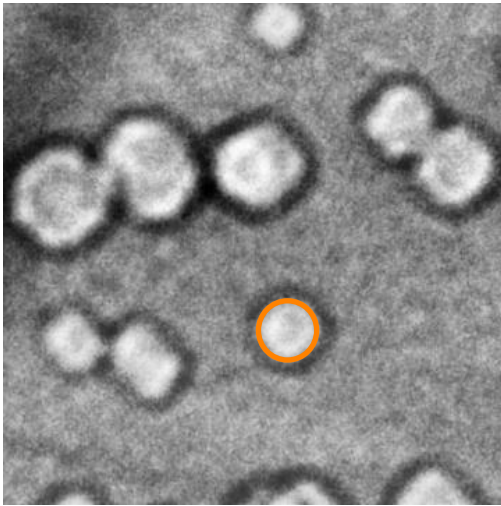
[Class x y W H]

Object identification: bounding box (YOLO)

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

Instance segmentation: label encoding (Mask R-CNN)

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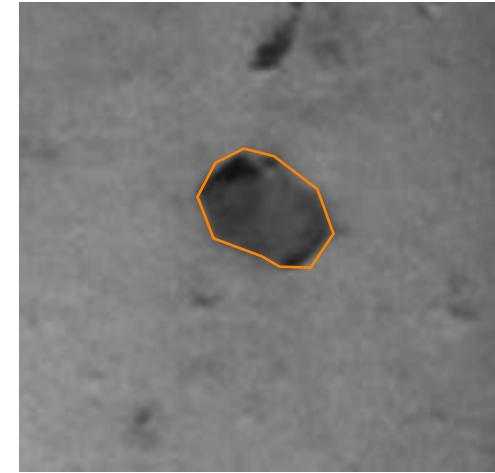# Special conventions for labeling cavities and loops

Cavities

- Label the area within the *inner* edge

Loops

- Label the area within the *outer* edge

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Web-based GUI tools are used for labeling

Roboflow

CVAT

Labelbox

VIA

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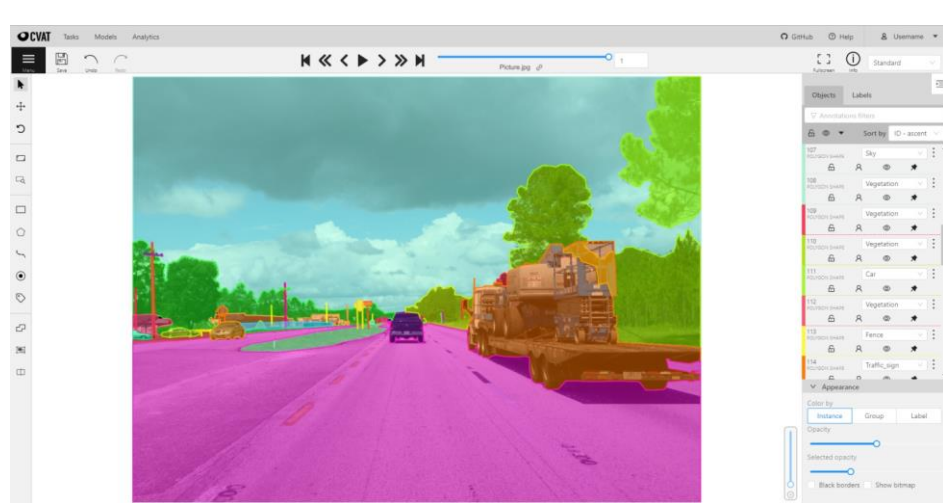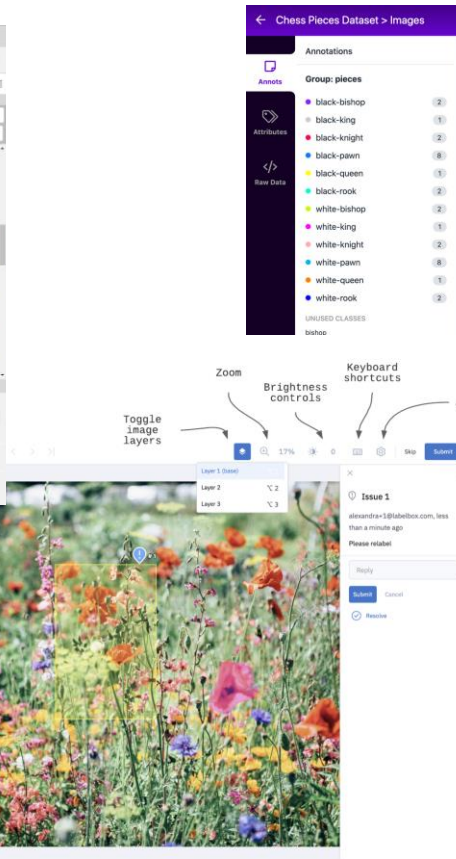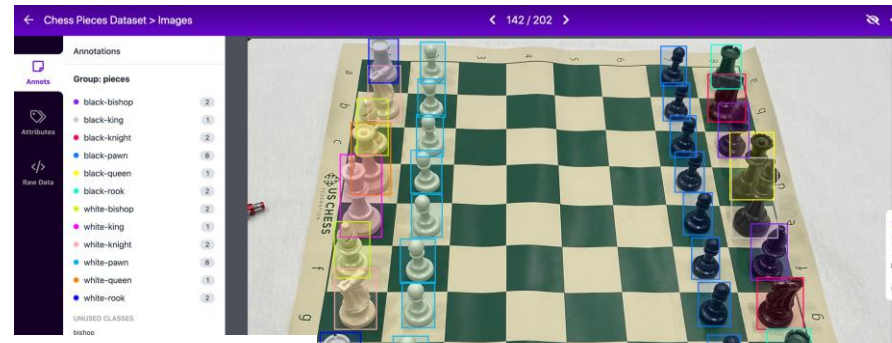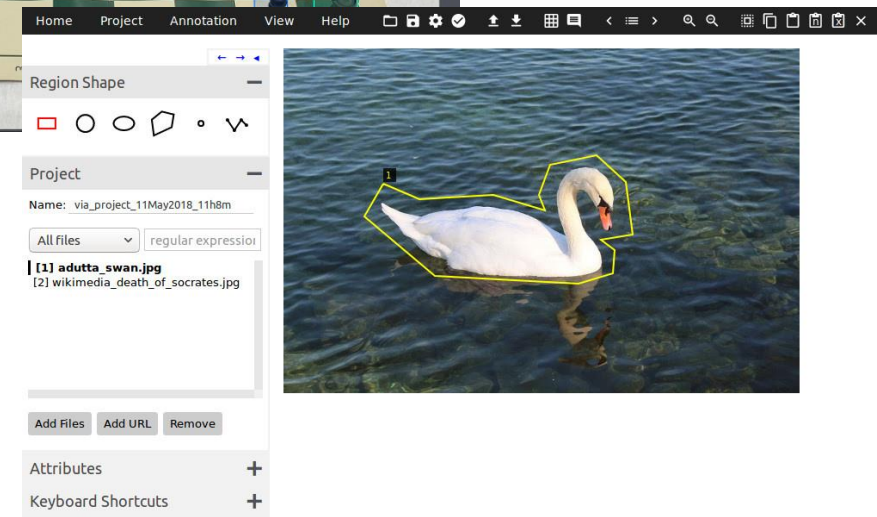
Labeling using Computer Vision Annotation Tool (CVAT)

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

Create project ⟩ Create tasks ⟩ Labeling jobs ⟩ Export labels ⟩ Parse labels using Python

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Creating a project and labeling tasks

Labeling using polygon and ellipse tools

Remember to click **Save**

Polygon tool

Ellipse tool

- Hold **Shift** to draw

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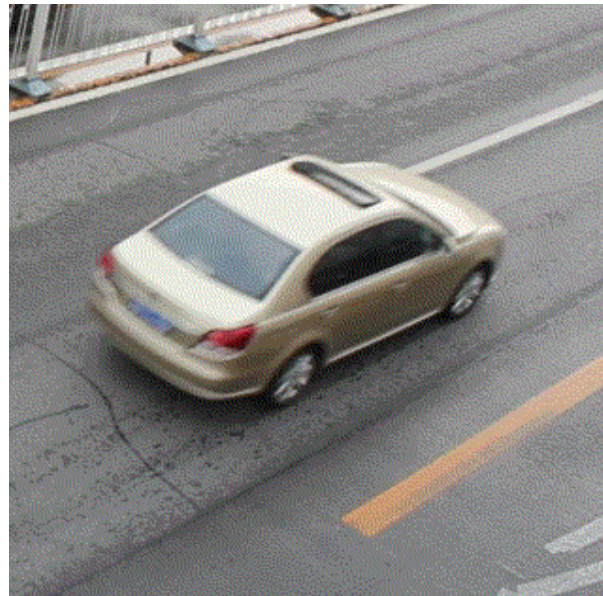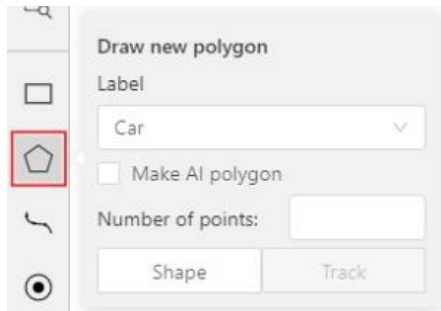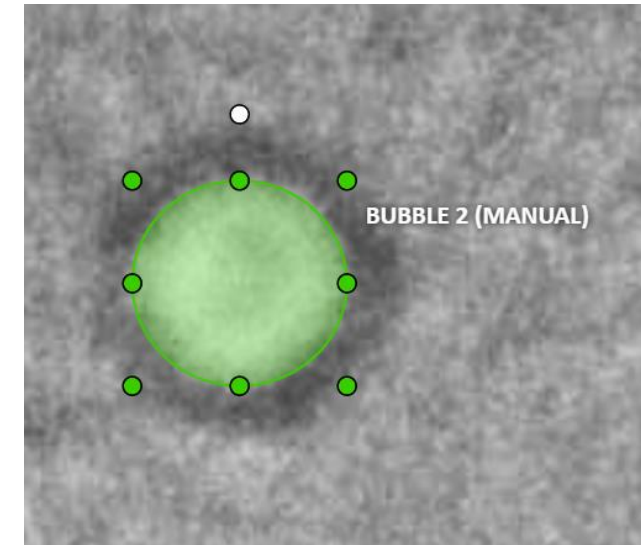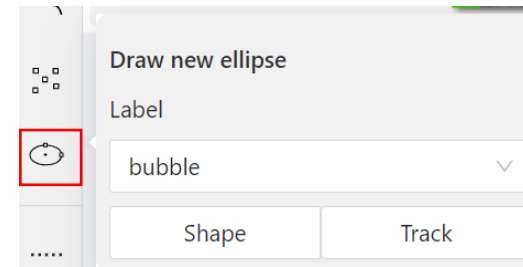
Exporting and parsing labels

Export as .xml

Export job #180806 as a dataset   ✕

* Export format

⬇ CVAT for images 1.1   ⌄

⬤◯ Save images

Custom name

DL_for_Microscopy_Train_eg_lab   .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

```xml
<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.