MultiOrg: A Multi-Rater Organoid-Detection Dataset

NeurIPS 2024: Datasets & Benchmarks

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Motivation & Background

What are organoids?

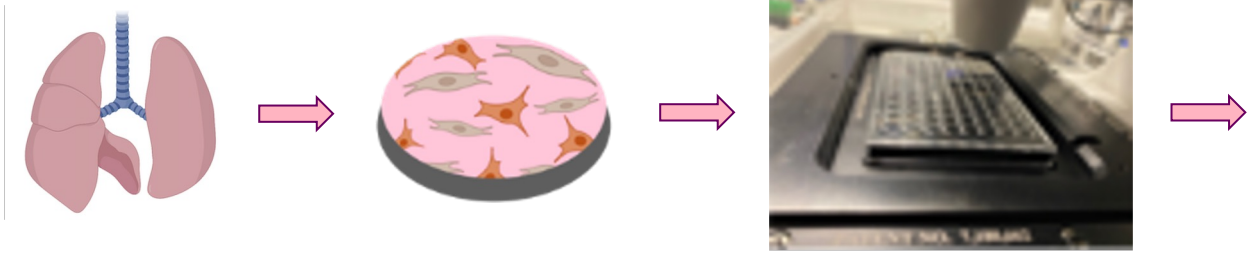
Image generated using https://deepai.org/

Organoids are used for:

- Disease understanding
- Drug development
- Personalised medicine

How Organoids are made

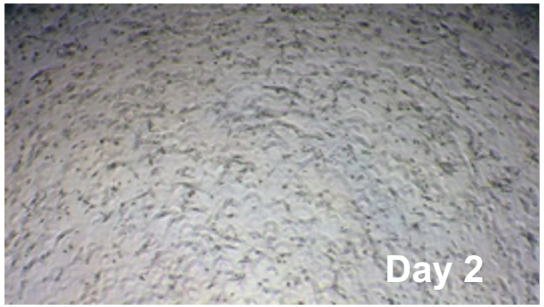
Growing tiny organs in the lab

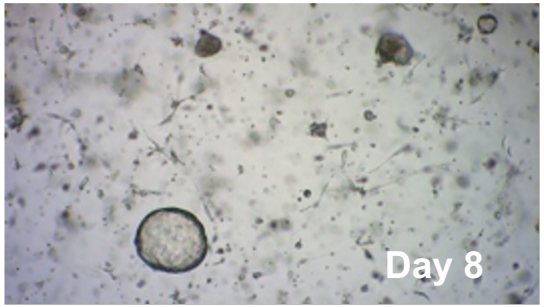


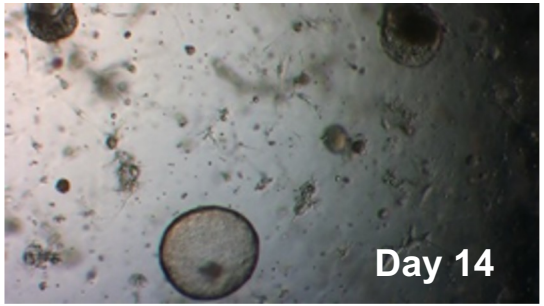
Lung Stem Cells

Organoid culture

Image acquisition

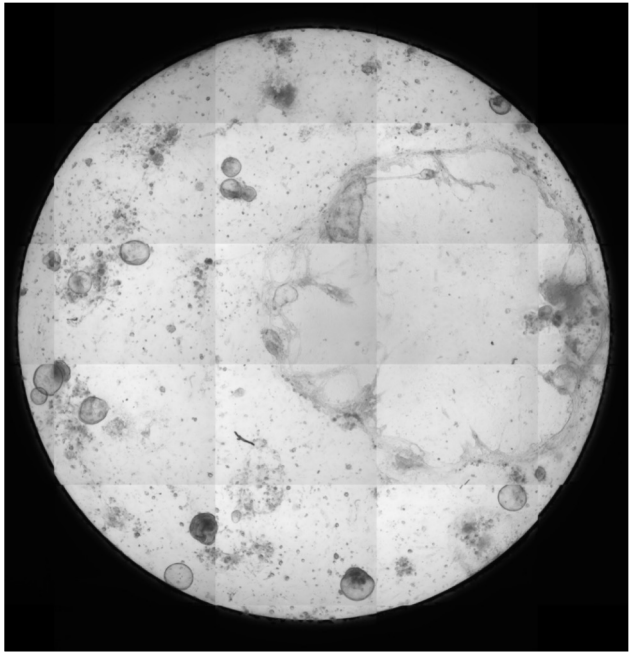






Challenges in Organoid Detection

Labeling uncertainty and noise



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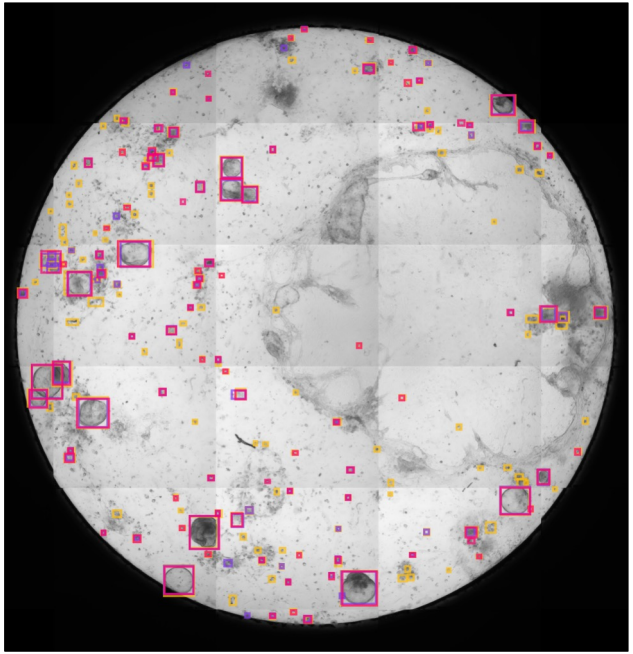

- Time-consuming manual annotations

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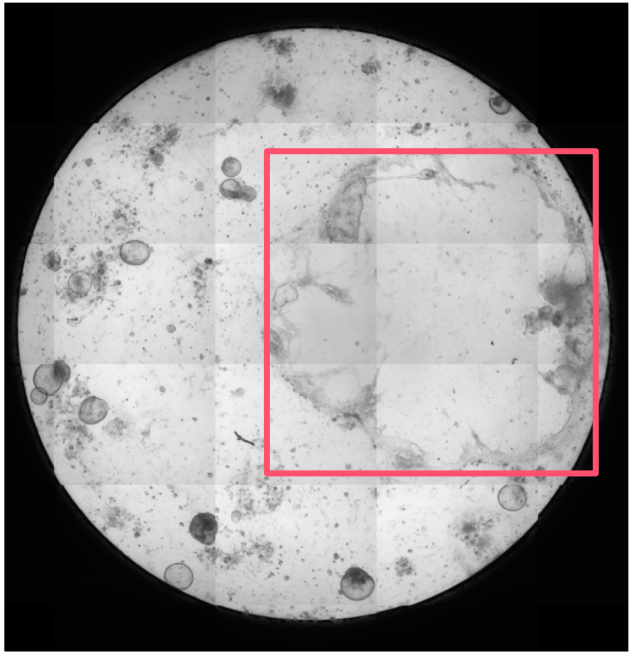

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- Noise due to artifacts, dead cells and debris

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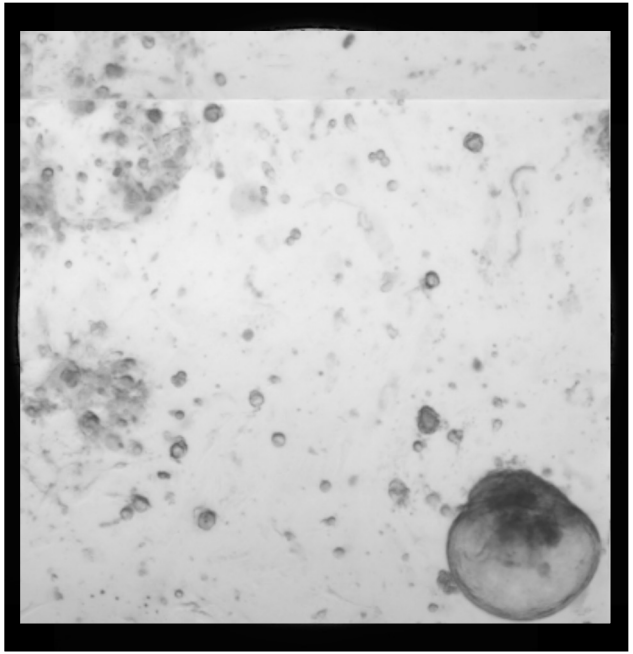

- Time-consuming manual annotations
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- Large range of organoid sizes

Challenges in Organoid Detection

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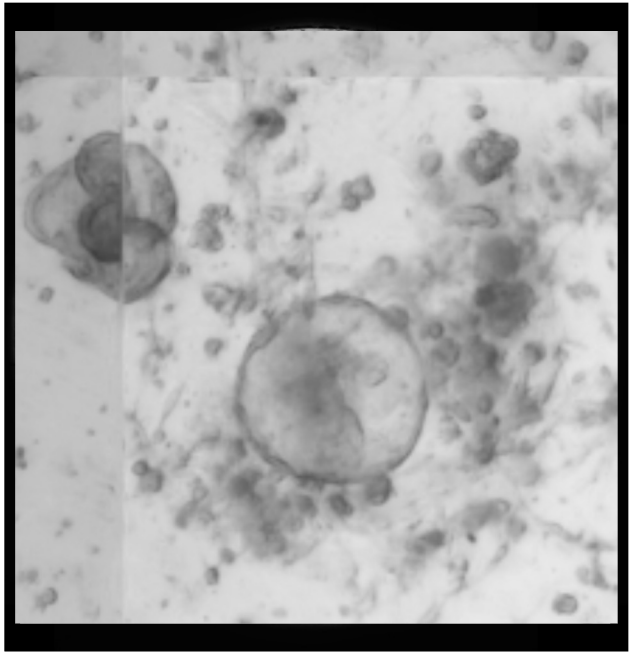

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- Organoid clusters

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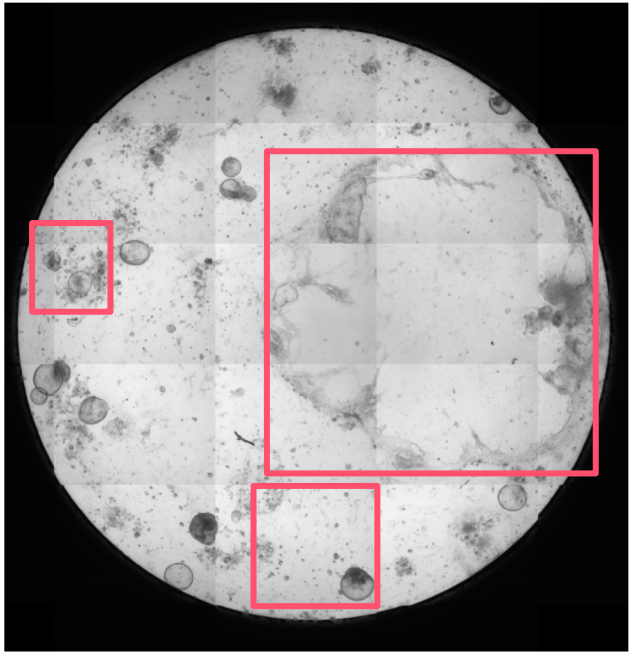

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No datasets in organoid detection addressing label uncertainty!

The MultiOrg dataset

Overview

- 400+ 2D microscopy images

Study Type	Normal		Macros		Combined	
	# Images	# Organoids	# Images	# Organoids	# Images	# Organoids
Train set						
$train_A$	181	30,710	15	2,669	196	33,379
$train_B$	135	20,263	25	1,781	160	22,044
Total	**316**	**50,973**	**40**	**4,450**	**356**	**55,423**
Test set						
$test^0_A$	8	1,145	14	1,865	22	3,010
$test^0_B$	20	3,020	13	1,493	33	4,513
Total (Label set $test^0$)	**28**	**4,165**	**27**	**3,358**	**55**	**7,523**

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The MultiOrg dataset

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- 400+ 2D microscopy images
- 60,000+ organoid annotations
- Three expert labels on the test set

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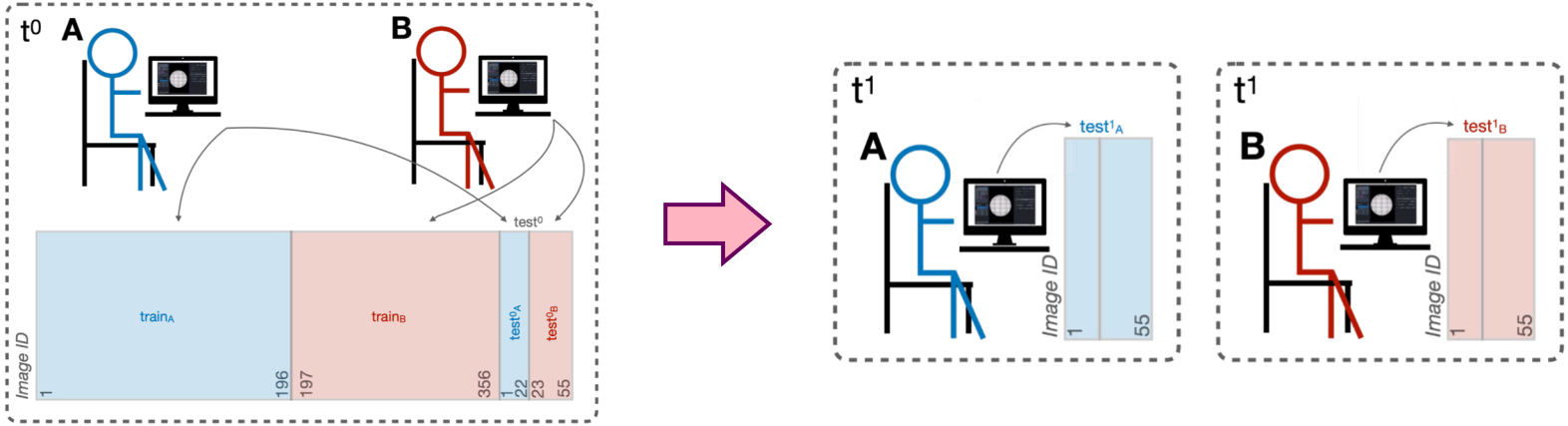
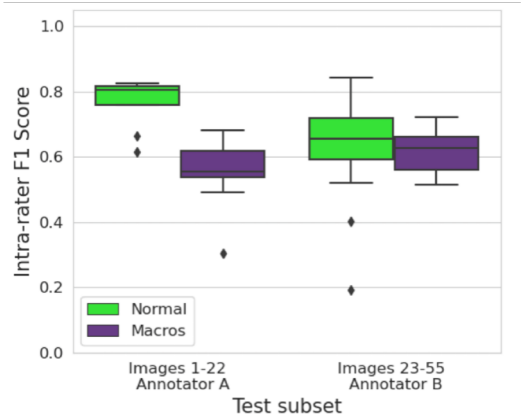
Label set $test^1_A$	**28**	**2,748**	**27**	**1,981**	**55**	**4,729**
Label set $test^1_B$	**28**	**2,655**	**27**	**2,301**	**55**	**4,956**

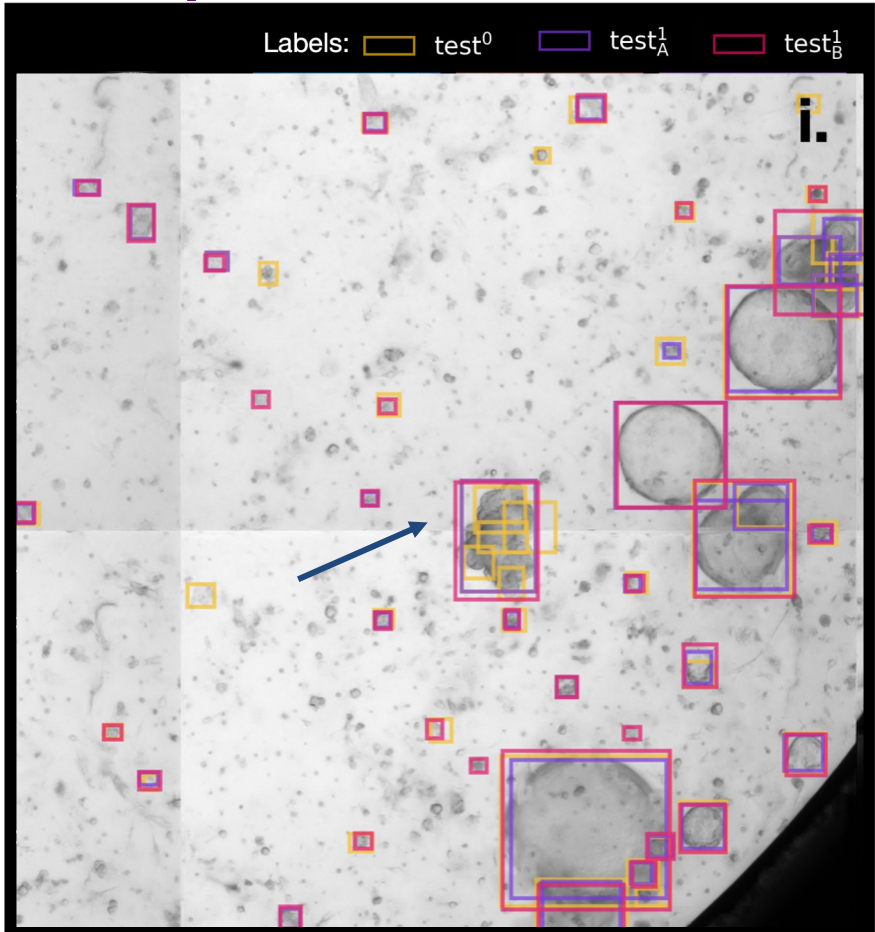
Multi-rater setting



Multi-rater setting at two distinct timepoints

Allows for intra- and inter-rater analyses





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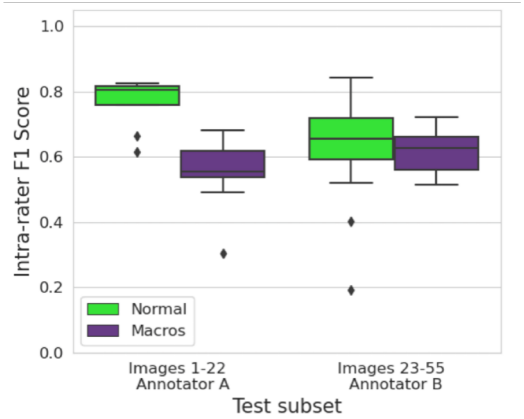
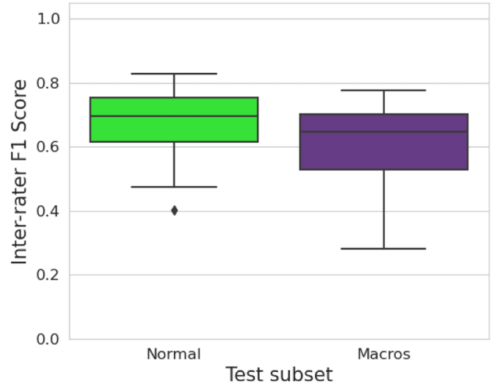
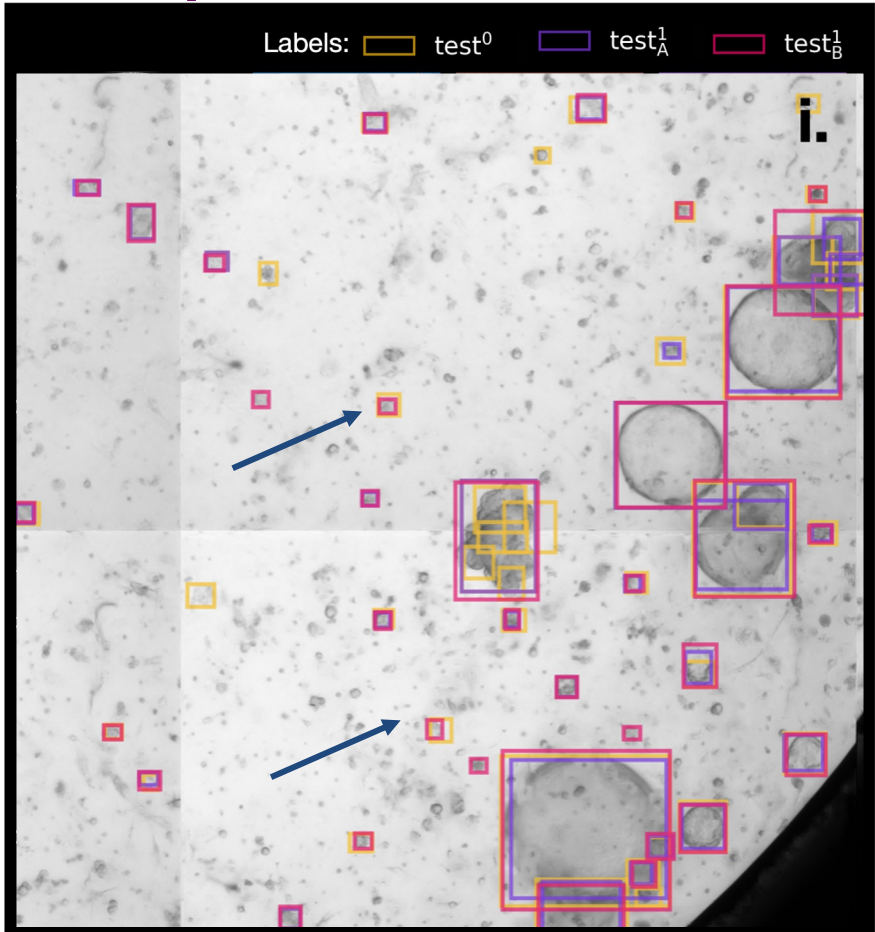
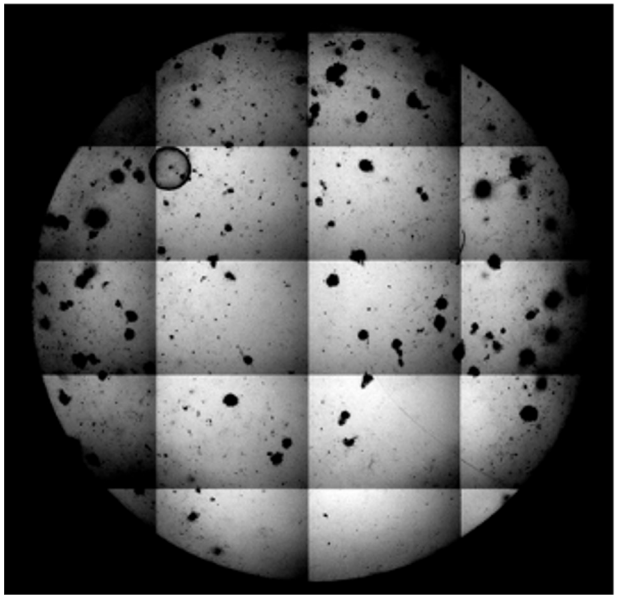




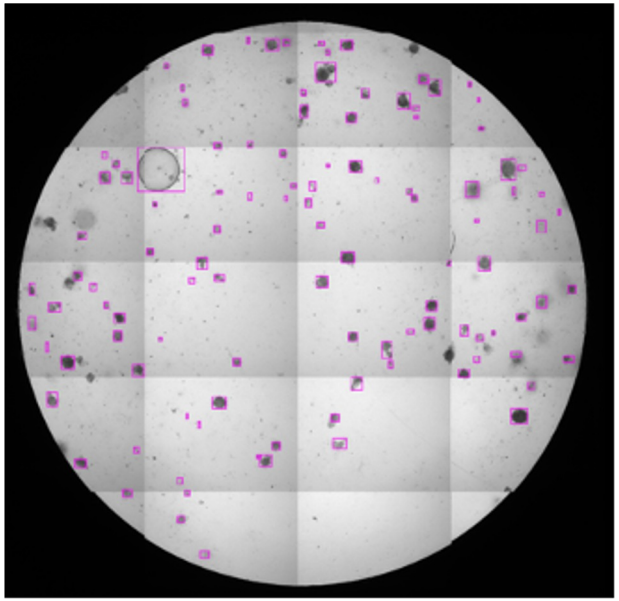


MultiOrg: Model Benchmark

Object-detection models



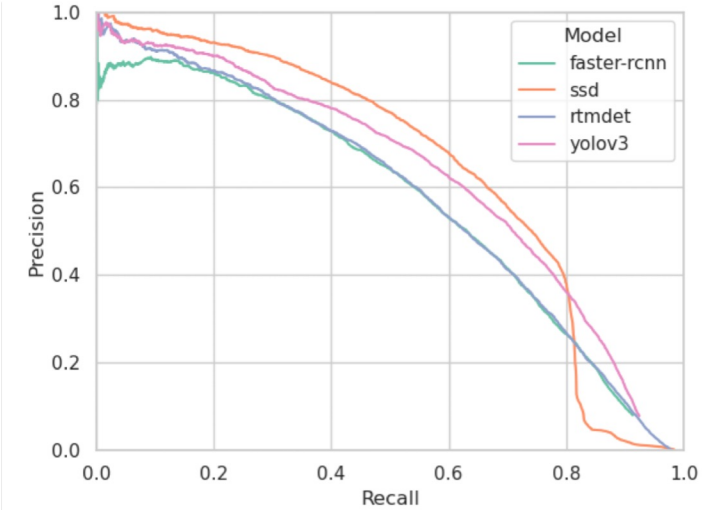
- Faster R-CNN
- SSD
- YOLOv3
- RTMDet



https://www.kaggle.com/code/christinabukas/multiorg-detection-benchmark

MultiOrg: Model Benchmark

Object Detection Scores

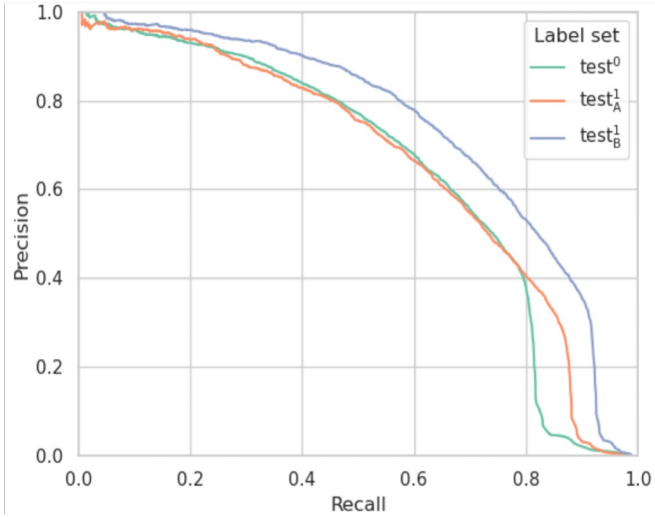


PR curves of all models on $test^0$

Metric	Label set	Faster R-CNN	SSD	YOLOv3	RTMDet
Precision	$test^0$	0.23	0.61	**0.73**	0.64
	$test^1_A$	0.16	0.44	0.58	0.54
	$test^1_B$	0.18	0.50	0.67	0.56
	mean	**0.19**	**0.52**	**0.66**	**0.58**
Recall	$test^0$	0.84	0.67	0.48	0.51
	$test^1_A$	0.92	0.78	0.62	0.69
	$test^1_B$	**0.97**	0.83	0.67	0.68
	mean	**0.91**	**0.76**	**0.59**	**0.63**
F1-score	$test^0$	0.36	0.64	0.58	0.57
	$test^1_A$	0.27	0.57	0.60	0.61
	$test^1_B$	0.30	0.62	**0.67**	0.62
	mean	**0.31**	**0.61**	**0.62**	**0.60**
mAP@0.5IoU (%)	$test^0$	56.56	64.40	62.55	57.71
	$test^1_A$	57.09	65.79	61.11	63.87
	$test^1_B$	68.36	**73.88**	70.25	63.23
	mean	**60.67**	**68.09**	**64.64**	**61.60**
mAP@0.75IoU (%)	$test^0$	17.48	21.81	19.15	22.56
	$test^1_A$	23.53	23.42	19.13	30.13
	$test^1_B$	**46.98**	**46.48**	39.01	32.85
	mean	**29.33**	**30.57**	**25.76**	**28.51**

MultiOrg: Model Benchmark

Object Detection Scores



PR curves of SSD model on all label sets

Metric	Label set	Faster R-CNN	SSD	YOLOv3	RTMDet
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	$test^1_A$	0.16	0.44	0.58	0.54
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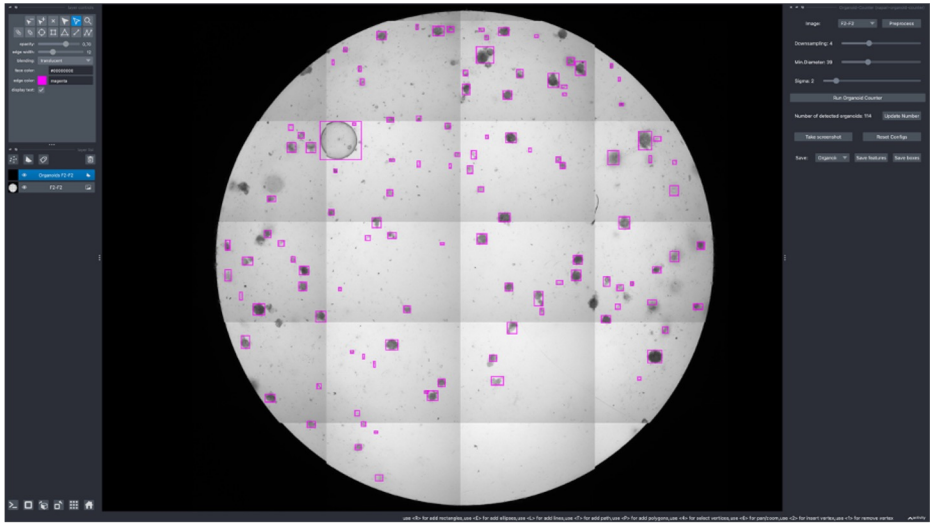
MultiOrg: Key contributions

Open-source resources

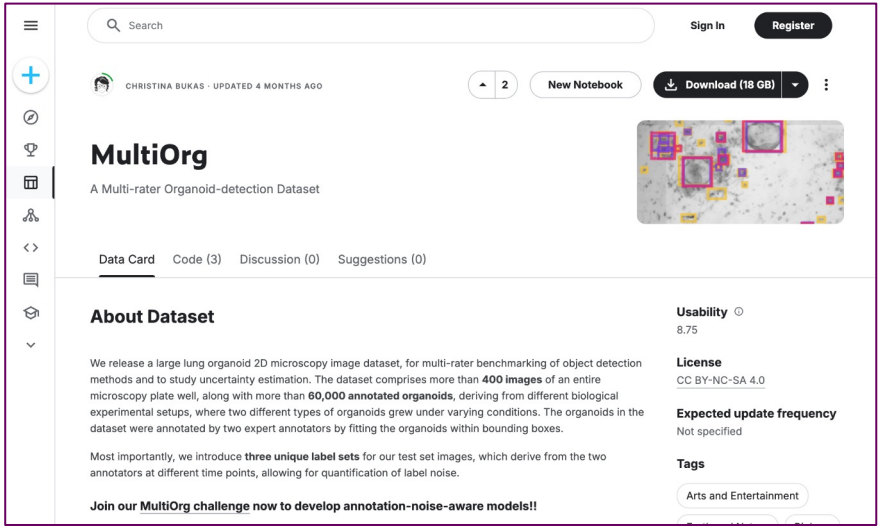
SCAN ME

Napari plugin for the biologist community



https://github.com/HelmholtzAI-Consultants-Munich/napari-organoid-counter

Dataset, benchmark & challenge



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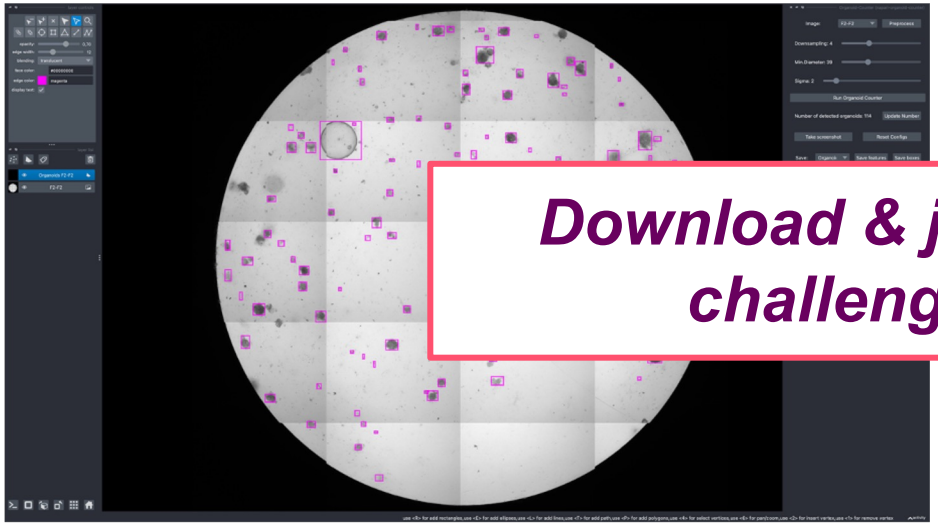

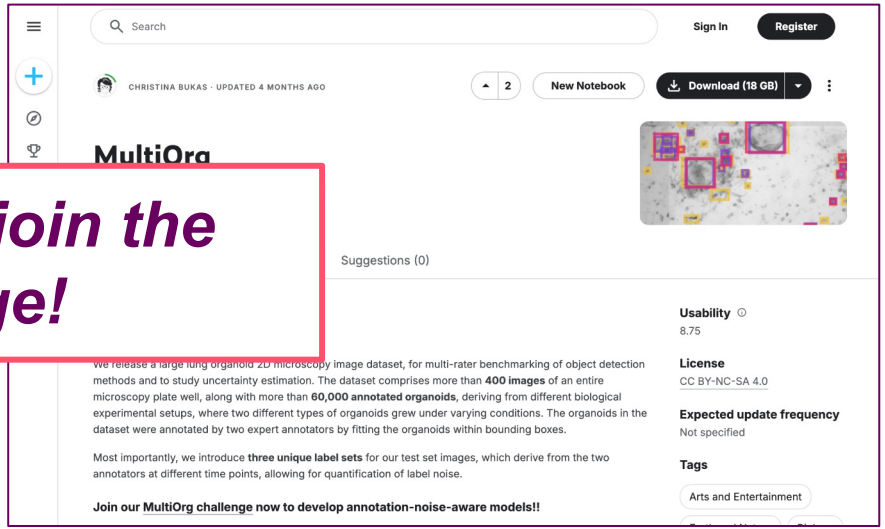

Download & join the challenge!

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