

MultiOrg: A Multi-Rater Organoid-Detection Dataset

NeurIPS 2024: Datasets & Benchmarks

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Motivation & Background

What are organoids?

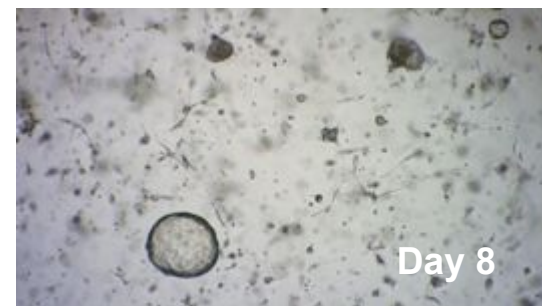
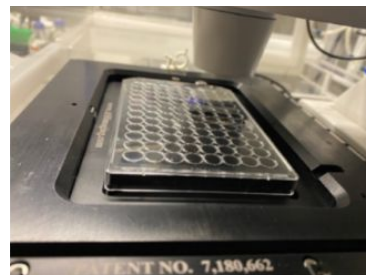
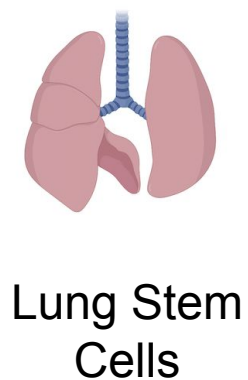


Organoids are used for:

- Disease understanding
- Drug development
- Personalised medicine

How Organoids are made

Growing tiny organs in the lab

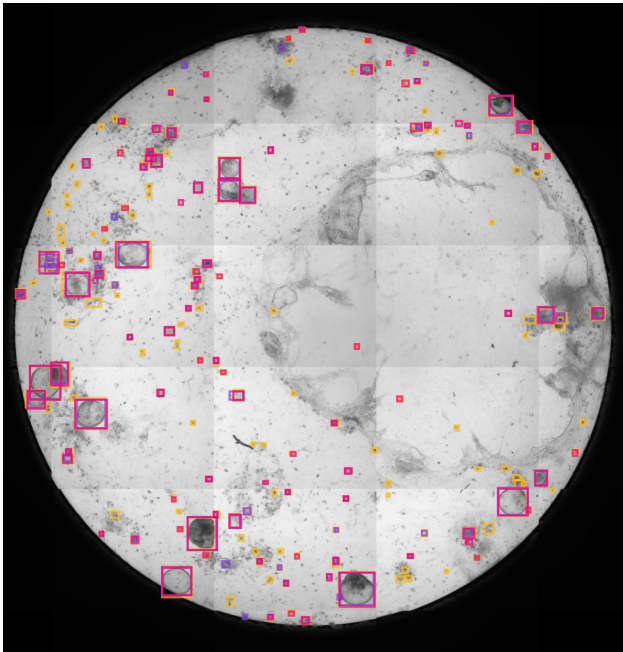


Organoid culture

Image acquisition

Challenges in Organoid Detection

Labeling uncertainty and noise



- Time-consuming manual annotations
- Noise due to artifacts, dead cells and debris
- Large range of organoid sizes
- Organoid clusters

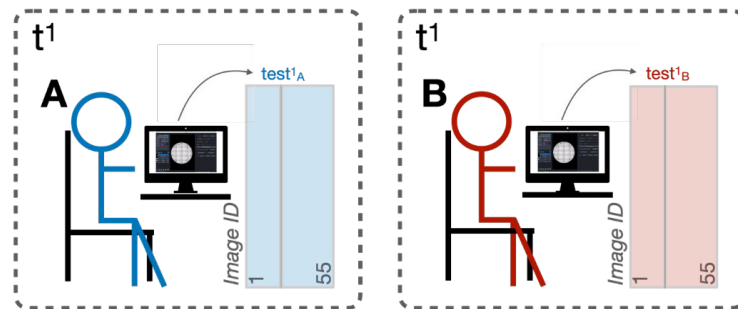
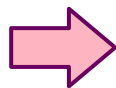
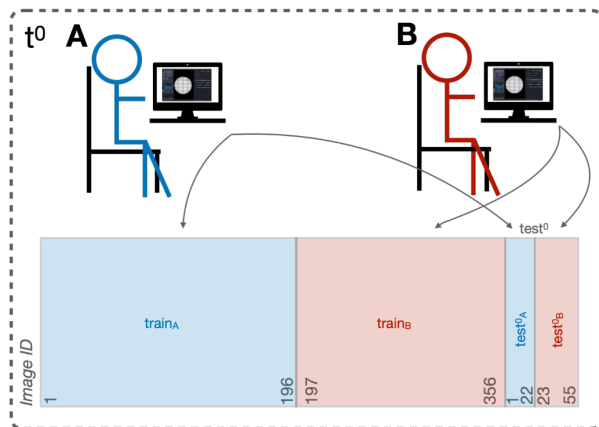
No datasets in organoid detection addressing label uncertainty!

The MultiOrg dataset

Overview

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

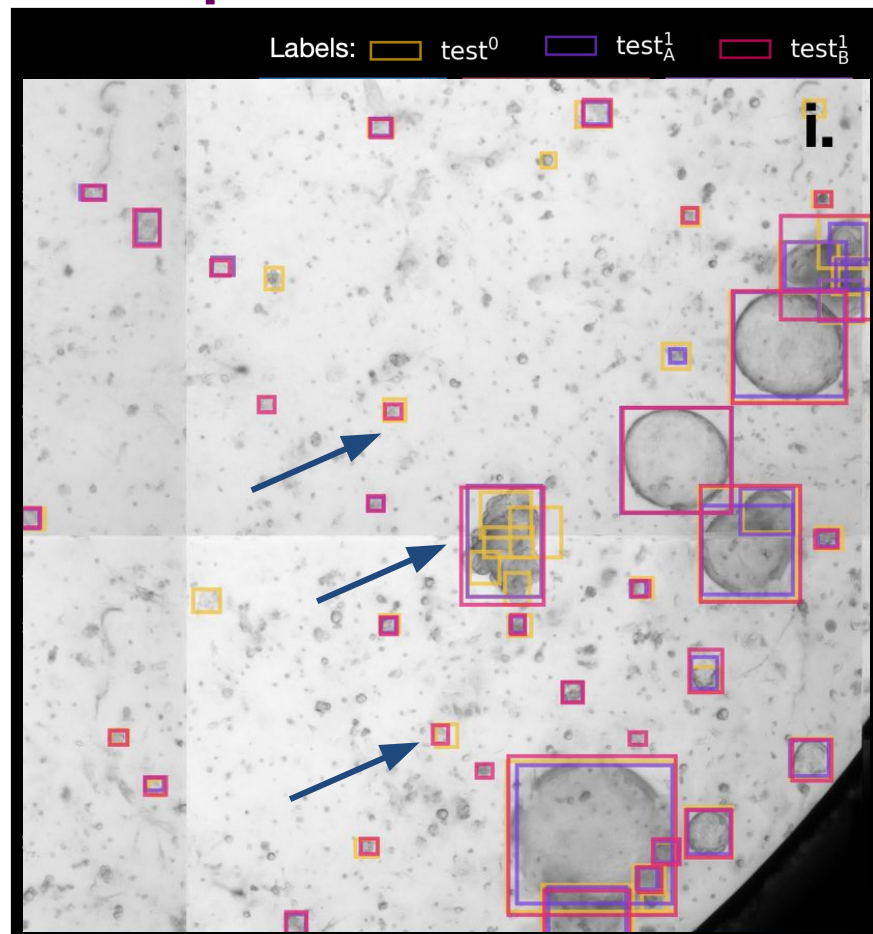
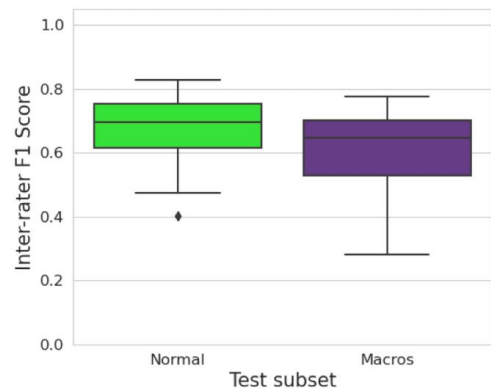
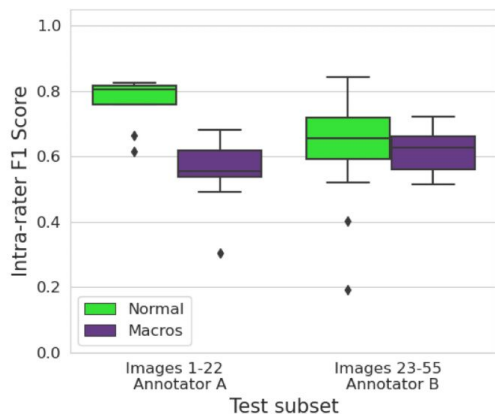
Multi-rater setting



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						
$test_A^0$	8	1,145	14	1,865	22	3,010
$test_B^0$	20	3,020	13	1,493	33	4,513
Total (Label set $test^0$)	28	4,165	27	3,358	55	7,523
Label set $test_A^1$	28	2,748	27	1,981	55	4,729
Label set $test_B^1$	28	2,655	27	2,301	55	4,956

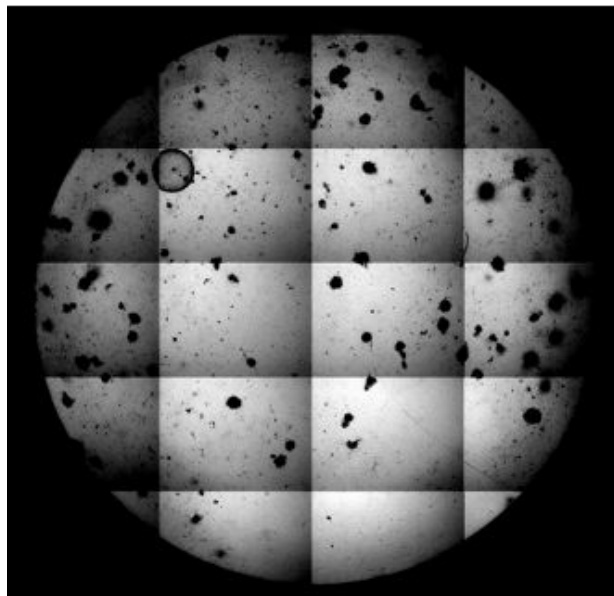
Multi-rater setting at two distinct timepoints

Allows for intra- and inter-rater analyses

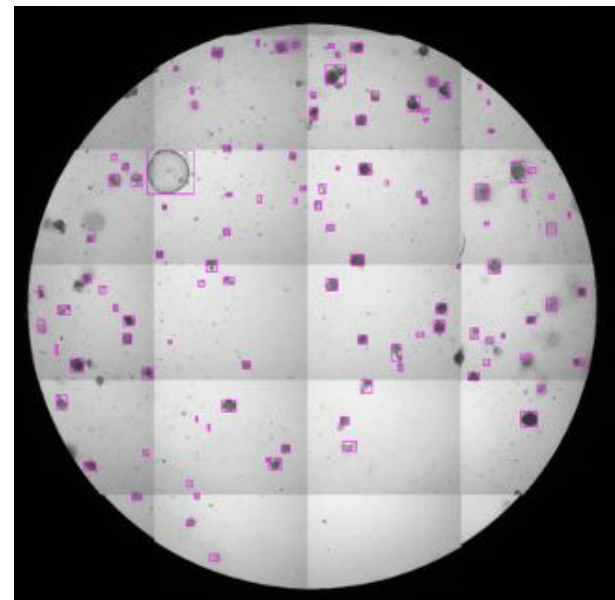


MultiOrg: Model Benchmark

Object-detection models

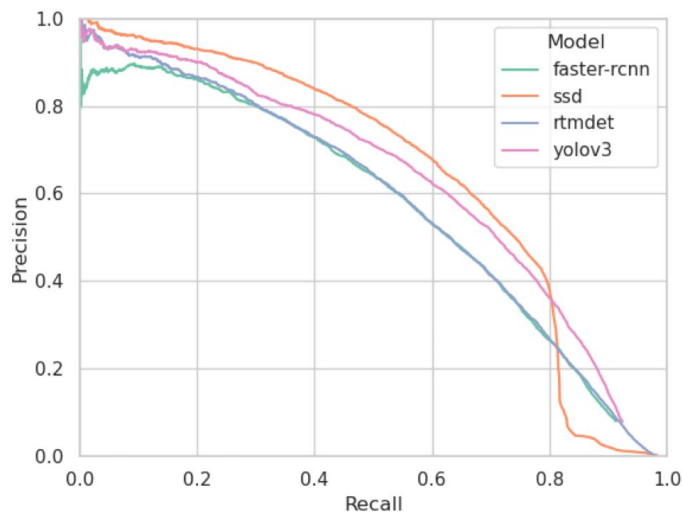


- Faster R-CNN
- SSD
- YOLOv3
- RTMDet



MultiOrg: Model Benchmark

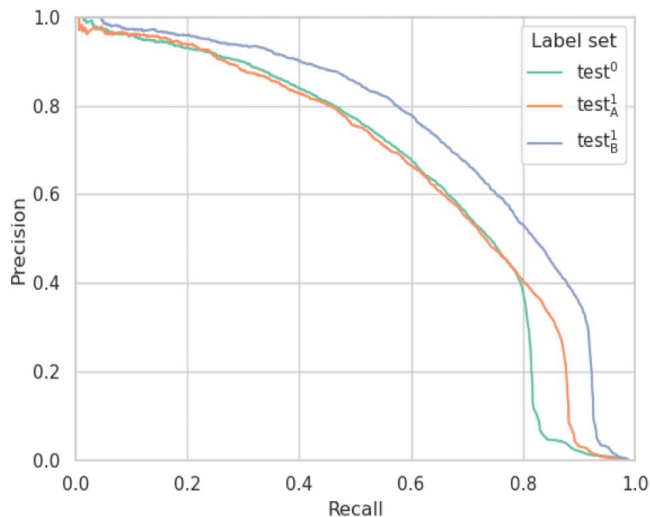
Object Detection Scores



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

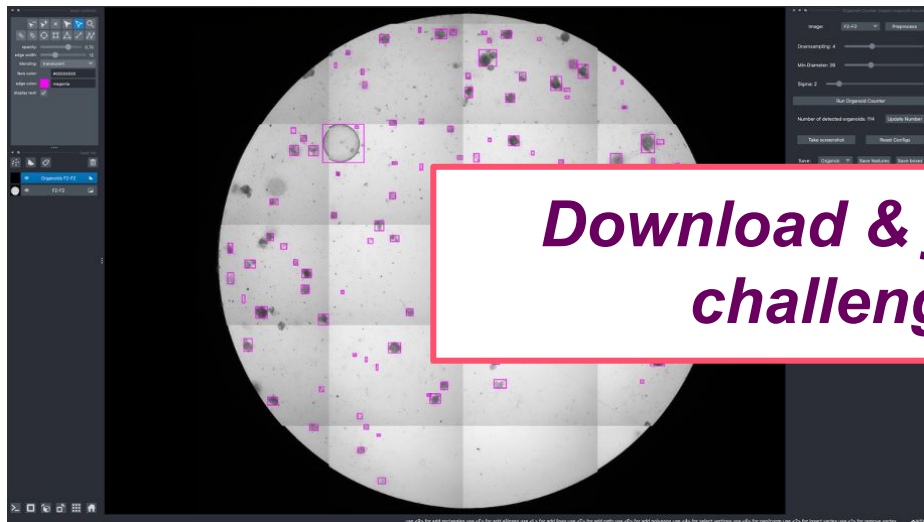
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Precision	$test^0$	0.23	0.61	0.73	0.64
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MultiOrg: Key contributions

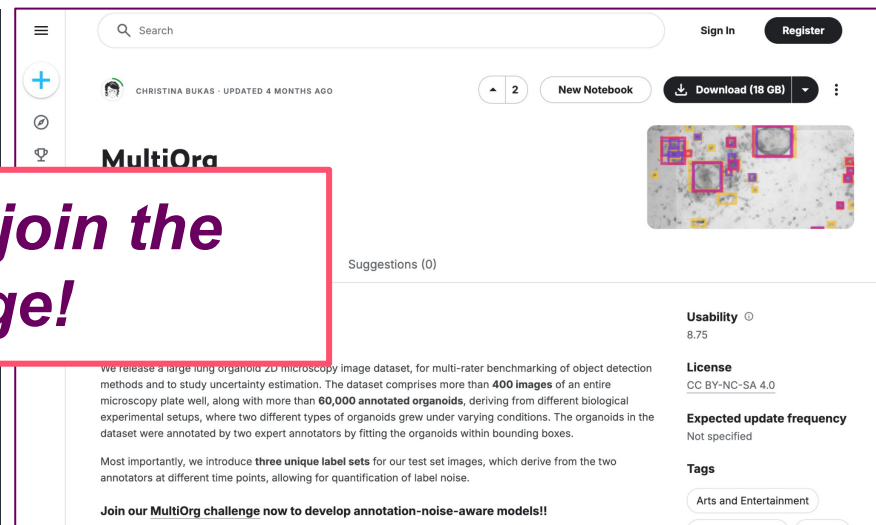
Open-source resources

Napari plugin for the biologist community

Dataset, benchmark & challenge



Download & join the challenge!



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