An Instance Segmentation Dataset of Yeast Cells in Microstructures

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Introduction

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- Vast majority of SOTA segmentation algorithms use deep networks (*e.g.*,[Stringer et al., 2021])
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We propose the first instance segmentation dataset of brightfield microscopy images including both cells and microstructures.

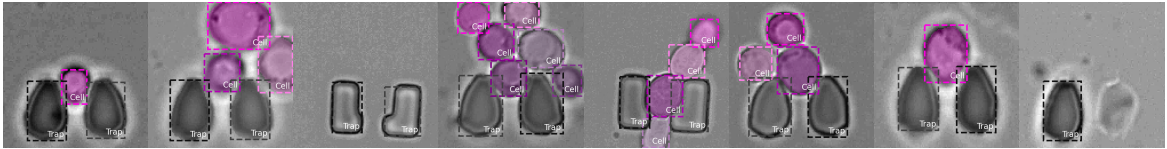
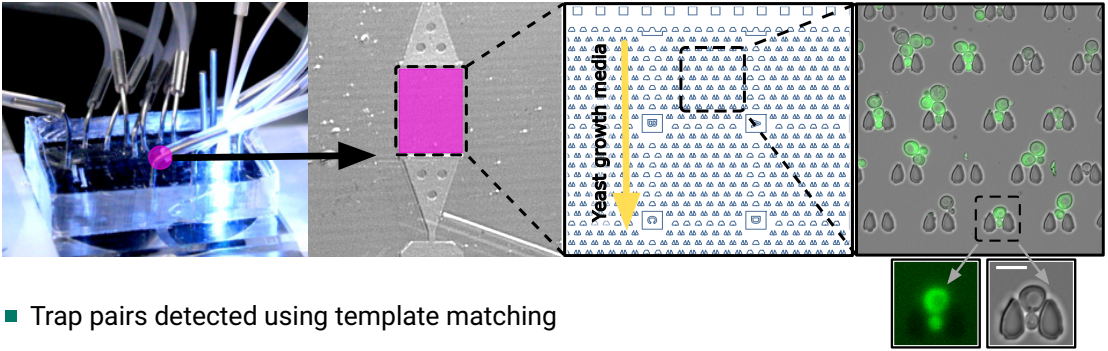


Figure: Samples of our yest cells (■) in microstructures (■) dataset with instance-level annotations.

Biological Application

Time-Lapse Fluorescence Microscopy



- Trap pairs detected using template matching

Figure: TLFM experiment setup [Prangemeier et al., 2020] for single-cell fluorescence measurement.

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Subset 2	Type 2 (*L*)	95	212	190
Full dataset	Type 1 & 2	493	914	971

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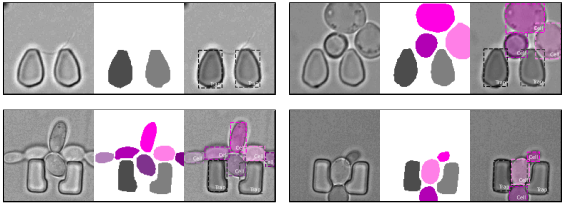

Figure: Brightfield microscopy image (left), instance seg. label (middle), and label-image overlay.

Dataset Split

Split	# images	# cells	# traps	Trap type images 1 *vs.* 2
Training	296	536	582	244/52
Validation	49	108	98	33/16
Test	148	270	291	121/27

Table: Training, validation, and test split.

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- ∼60% training, ∼10% validation, ∼30% test
- We ensure a representative number of both trap types in each set

Performance Evaluation

Semantic-level evaluation

Instance-level evaluation

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Semantic-level evaluation

- Cell class intersection-over-union (IoU)

$$\mathrm{IoU}\left(p_{\mathrm{c}}, g_{\mathrm{c}}\right) = \frac{\left|p_{\mathrm{c}} \cap g_{\mathrm{c}}\right|}{\left|p_{\mathrm{c}} \cup g_{\mathrm{c}}\right|}$$

p_{c}: Segmentation prediction of the cell class

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Instance-level evaluation

- Panoptic quality (PQ) [Kirillov et al., 2019]

$$\mathrm{PQ} = \underbrace{\frac{\sum_{(p,g)\in \mathrm{TP}} \mathrm{IoU}(p,g)}{|\mathrm{TP}|}}_{\text{Segmentation quality (SQ)}} \underbrace{\frac{|\mathrm{TP}|}{|\mathrm{TP}| + \frac{1}{2}|\mathrm{FP}| + \frac{1}{2}|\mathrm{FN}|}}_{\text{Recognition quality (RQ)}}$$

IoU: Intersection-over-union

TP: True positives

FP: False positive

FN: False negative

Additional Data

Unlabeled Video Data

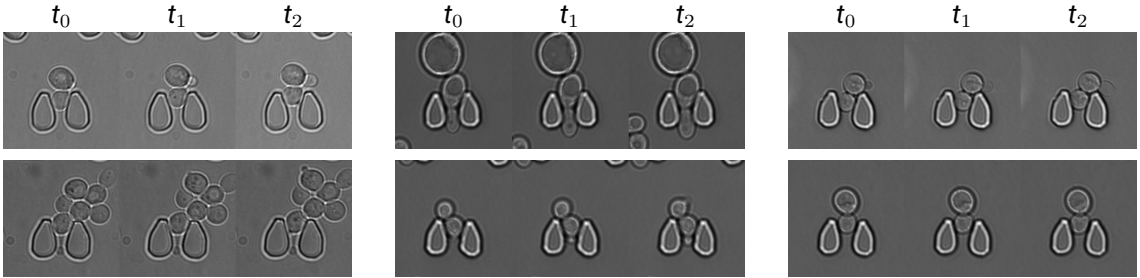

Figure: Unlabeled TLFM video clips with $\Delta t = 10$min [Reich et al., 2021].

Ongoing & Future Work

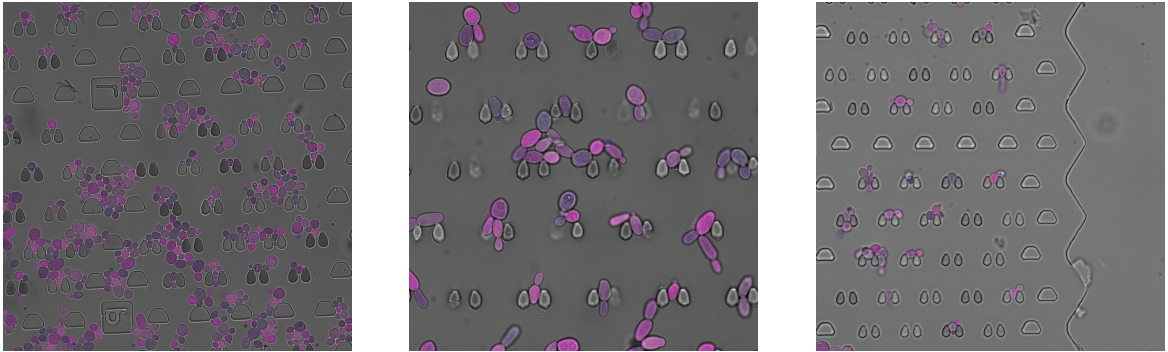

Figure: High-resolution cells in microstructures dataset; currently in preparation.

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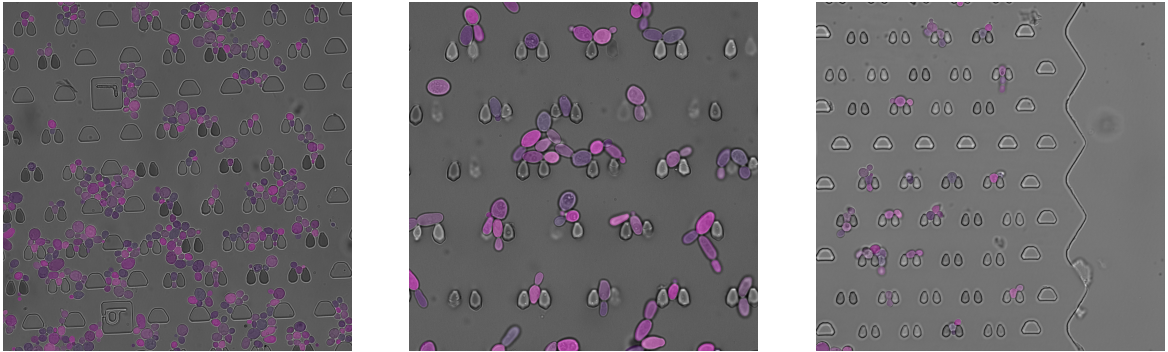

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- **Future work:** Providing temporal labels (video instance segmentation)

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Project page | Code | Data | Video data | Twitter

https://christophreich1996.github.io/yeast_in_microstructures_dataset/

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