Siamese Tracking of Cell Behaviour Patterns
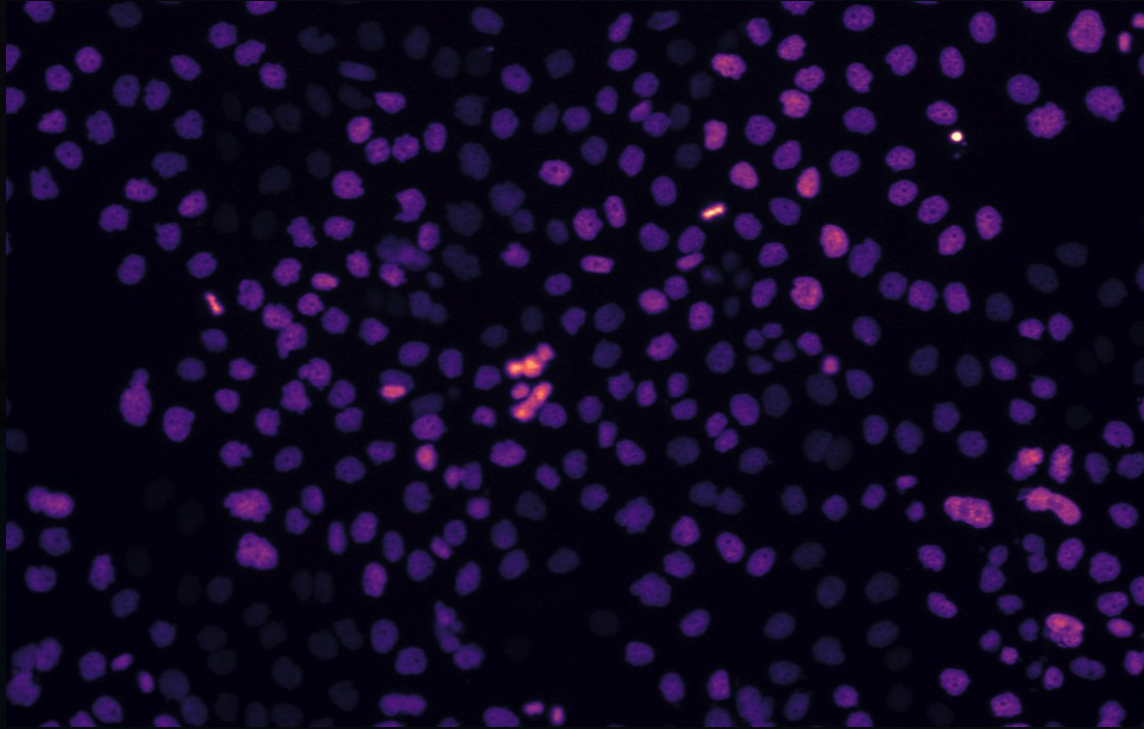
#109, MIDL 2020

University of Amsterdam

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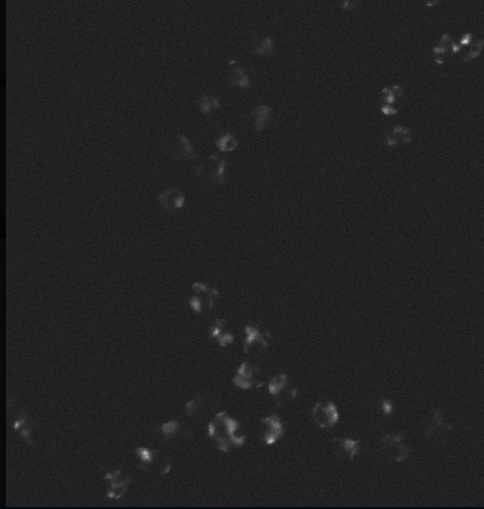
Content

- Motivation
- Problem introduction
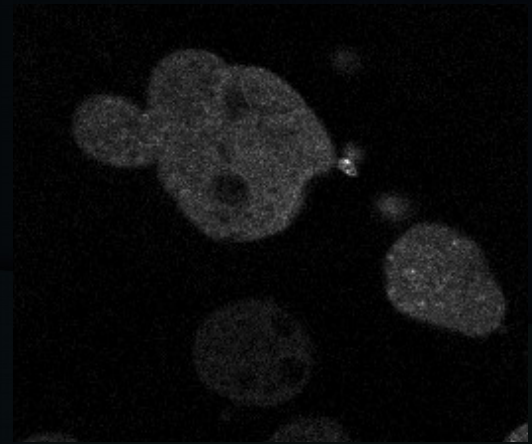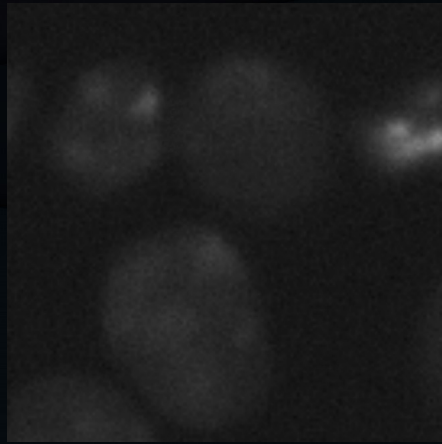- Our solution
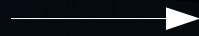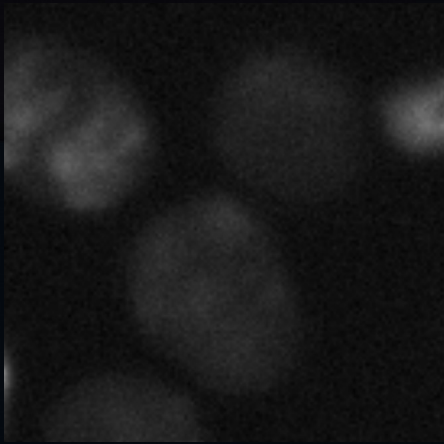- Results

Finding cells

Finding cells

- Impartial Information

Finding cells

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- Fluid/Biological movement

Finding cells

- Impartial Information

- Fluid/Biological movement
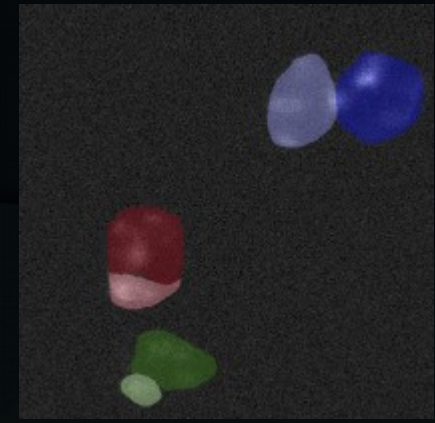
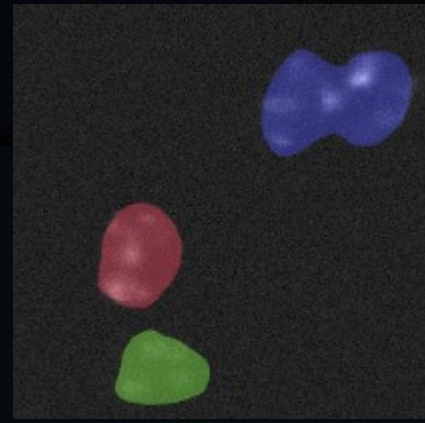- Different cell morphologies

Goal

- Correctly identify cells in frames

- Track them through time

- Identify cell mitosis, collision and apoptosis

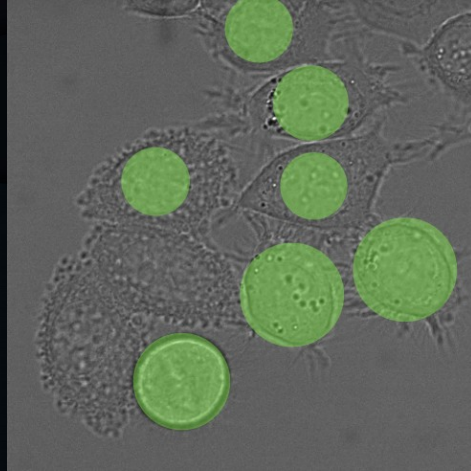# Problem introduction

- Trade-off in segmentation algorithms between:
  - Detecting large cells with non-colliding boundaries
  - Over-segmenting cells to smaller ones
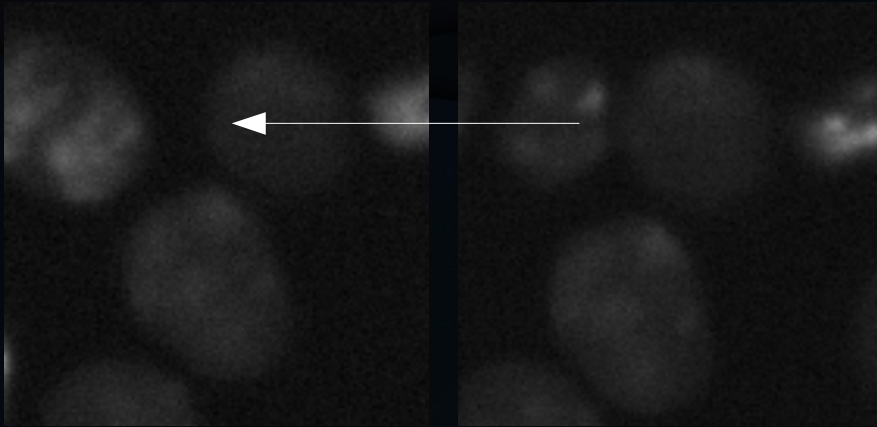
Problem introduction

- Over-parametrised approaches for specific cell morphologies

Problem introduction

- Ignore biological cell behaviour

Collision

Mitosis

Our approach

t-2

t-1

t

Siamese Matching

Re-segmentation
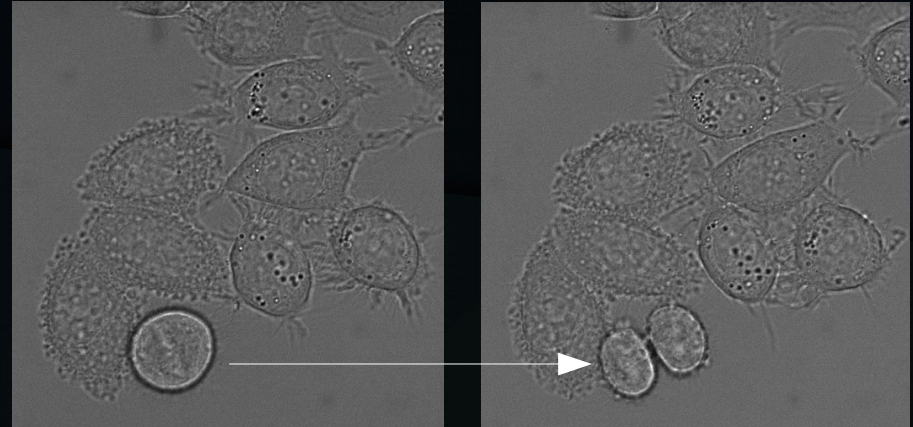
Our approach

- Model cell behaviour:
  - Collision (2 cells collide)
  - Mitosis (1 cell divides into 2)
  - Consider it the same but in opposite temporal direction
  - Cell apoptosis/death (cell does not continue in the next frame

t-2

t-1

t

Siamese Matching

Re-segmentation

Our approach

- ## Model cell behaviour

- ## Siamese matching:

  - Track cells in both the forward and backward direction
  - Matches and corrects the location of the cell to be split
  - Ensures splitting the cell correctly by predicting its location

t-2

t-1

t

Siamese Matching

Re-segmentation

Our approach

- Model cell behaviour

- Siamese matching

- Re-segment collided cells:
  - Use watershed deconvolution with the centroids of the pre-collision cells

t-2

t-1

t

Siamese Matching

Re-segmentation

Results

	DIC-C2DH-HeLa		Fluo-N2DH-SIM+		PhC-C2DL-PSC	
Method	OP_{CSB}	OP_{CTB}	OP_{CSB}	OP_{CTB}	OP_{CSB}	OP_{CTB}
ISBI CTC[1] 3rd entry	0.884	0.848	0.887	0.882	0.808	0.804
ISBI CTC[1] 2nd entry	0.895	0.894	0.890	0.889	0.809	0.804
ISBI CTC[1] 1st entry	**0.912**	**0.909**	0.896	0.895	0.841	0.836
Ours	0.905	0.904	**0.897**	**0.896**	**0.846**	**0.843**

[1]. http://celltrackingchallenge.net/, as of 30th of January

Our approach benefits

- Enhances segmentation performance by re-segmenting and correcting initial predictions

- Robust to morphology variations and fluid/biological cell behaviour

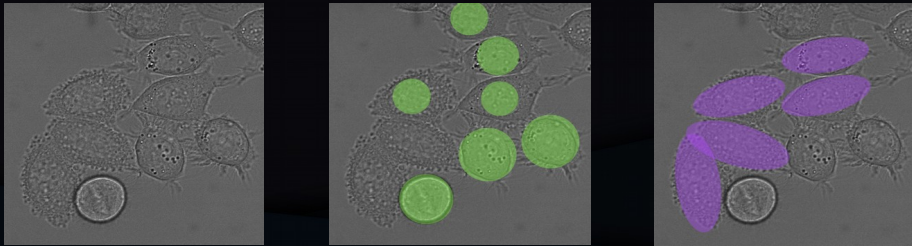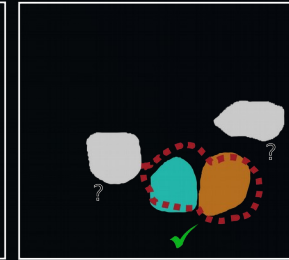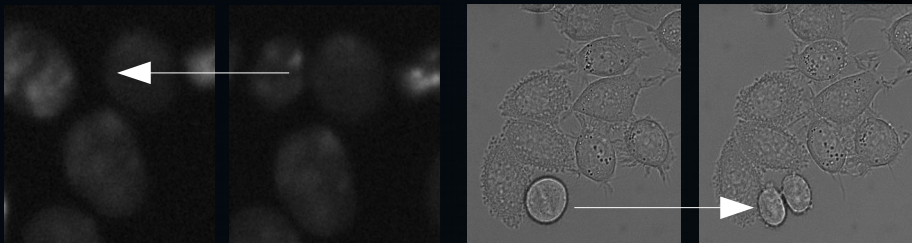- Generalises well across different datasets

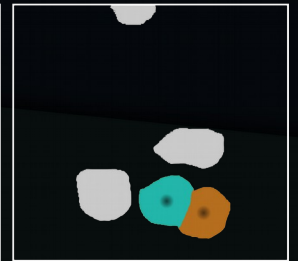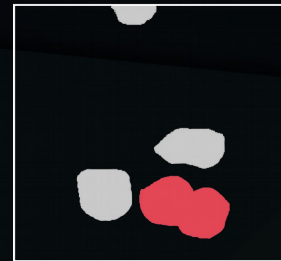# Summary

t-2

t-1

t
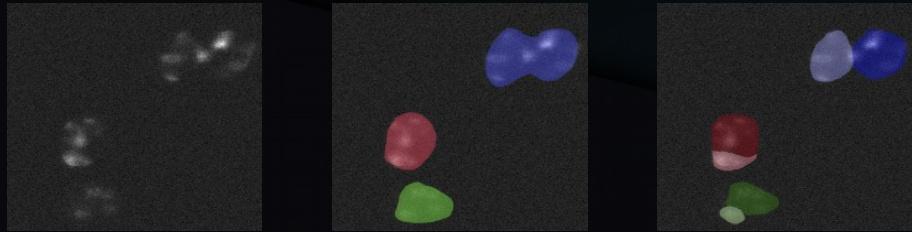
Siamese Matching

Re-segmentation

Thank you for your attention

- Code available at:
  gitlab.com/Baggsy/cell_tracking_2019