StarDist

Object Detection with Star-convex Shapes

Uwe Schmidt, Martin Weigert, Coleman Broaddus, and Gene Myers.
Cell Detection with Star-convex Polygons.
International Conference on Medical Image Computing and Computer-Assisted Intervention (MICCAI), Granada, Spain, September 2018.

Martin Weigert, Uwe Schmidt, Robert Haase, Ko Sugawara, and Gene Myers.
Star-convex Polyhedra for 3D Object Detection and Segmentation in Microscopy.
The IEEE Winter Conference on Applications of Computer Vision (WACV), Snowmass Village, Colorado, March 2020

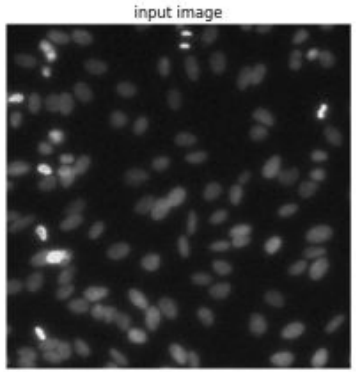
Motivation

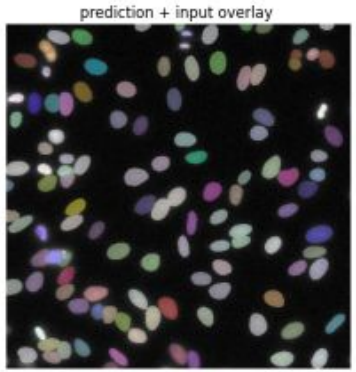
& what to learn

- What is StarDist?
- The main idea
- Why to use StarDist
- How to use it in FIJI
- Other software plugins

What is StarDist?

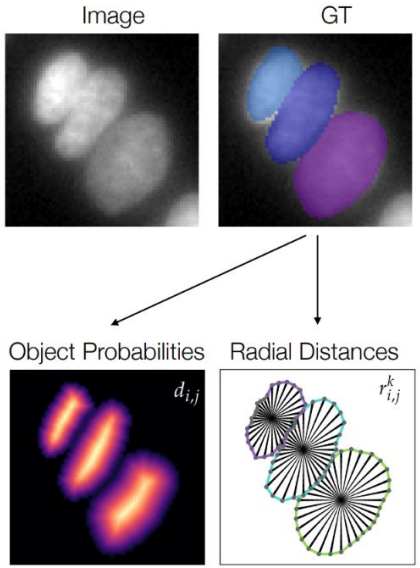
- Deep learning tool designed to localize cell nuclei.
- Available as:
  - Package for training custom prediction model (Python).
  - Pretrained model ready to use.
  - Plugin(s) using pre-trained models.

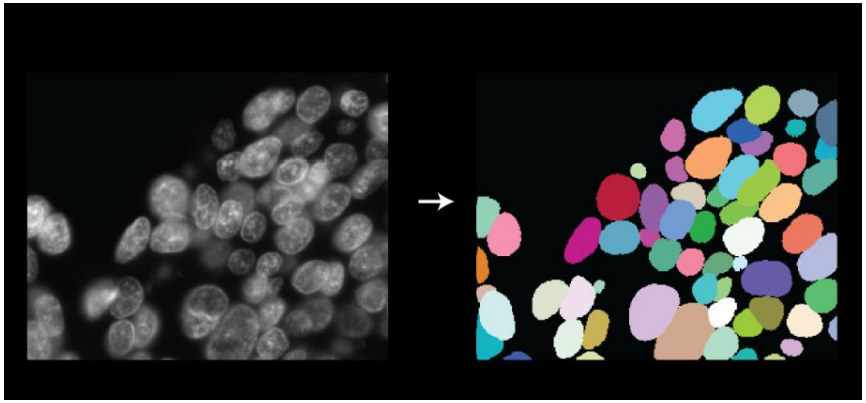




How it works

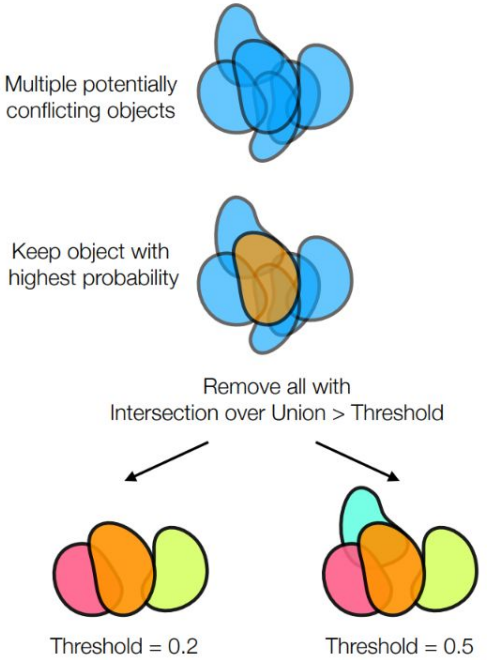
- Tool designed to localize cell nuclei via star-convex polygons.
- Similar to methods that directly predict shapes for each object of interest.





How it works

- Segmentation based on Star-Convex objects.
- Capability to handle intersection/overlapping objects.

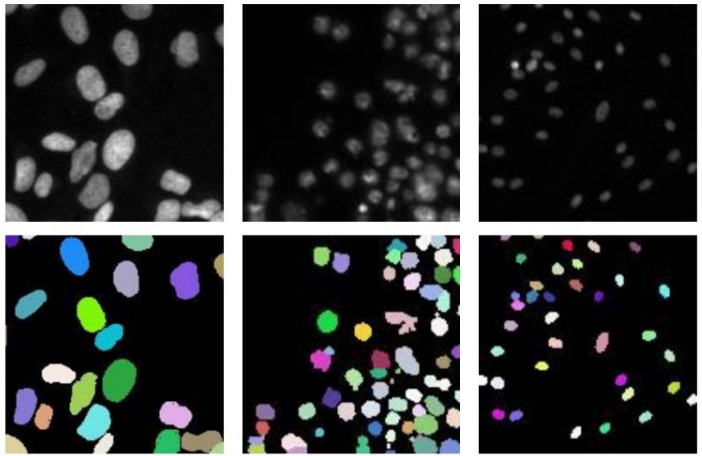


Why to use StarDist

- Easy to use.
- Can detect overlapping objects.
- Robust to intensity changes.
- Usable for both 2D and 3D data.
- Available as plugin.
- Available models are widely usable.
- Possibility to retrain model for specific data.

Pretrained models

Fluorescence Microscopy
Single Channel

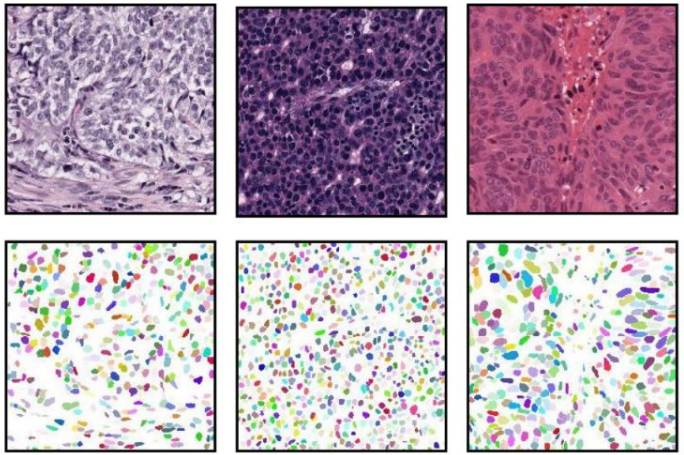


Data Science Bowl 2018

Caicedo et al. (2018)

~ 600 images (2D)
~ 20k annotations

Histopathology
RGB H&E



MoNuSeg

Kumar et al (2017)

~ 30 Images (2D)
~ 22k annotations

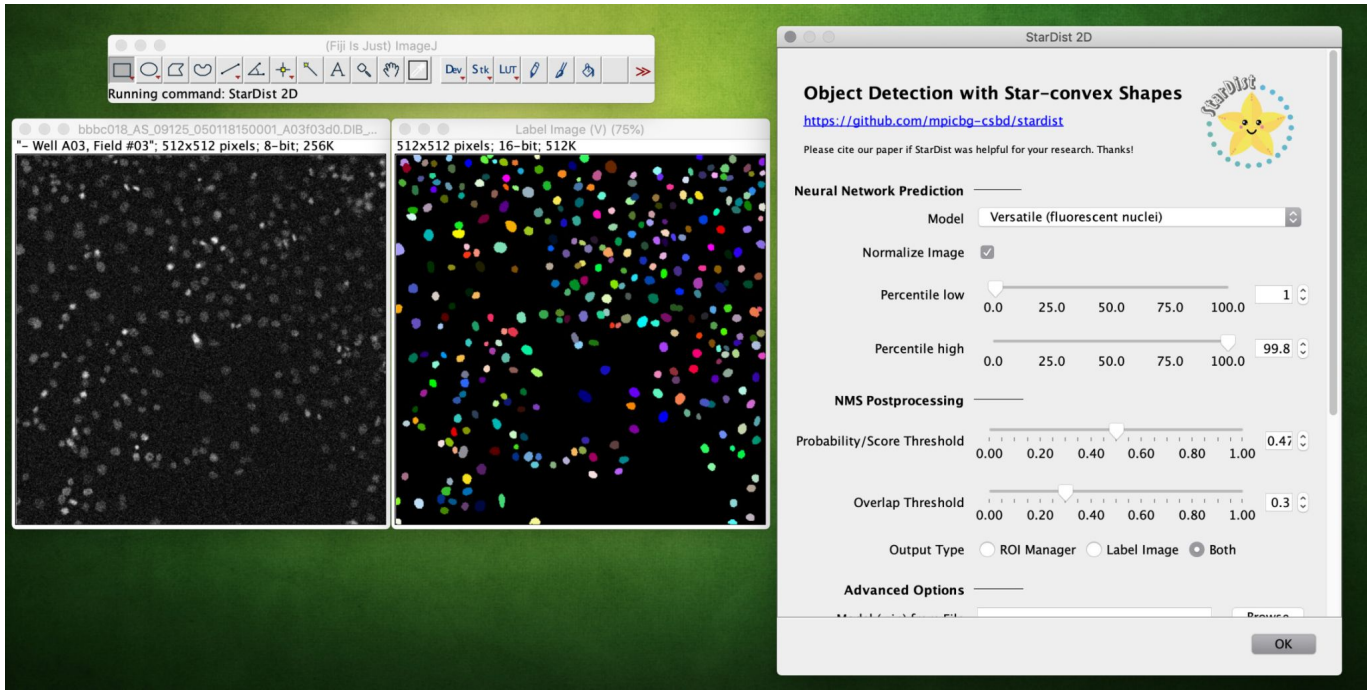
Examples

- What is in Imagej/FIJI.
  - 2 models
- Basic settings.
- DIfference of overlap settings (synthetic images).

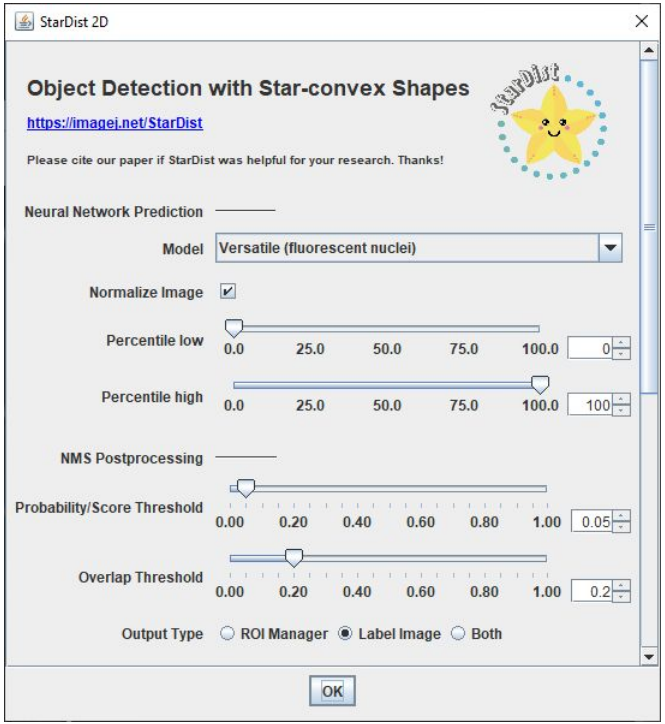
Examples - Overview

Plugin currently supports only 2D images.

2 models:
Versatile (fluorescent nuclei)
Versatile (H&E nuclei)

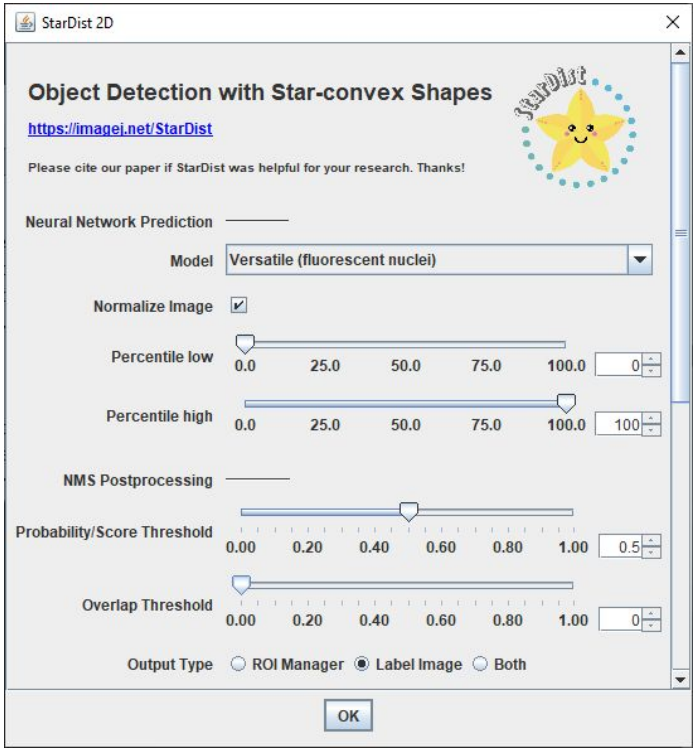


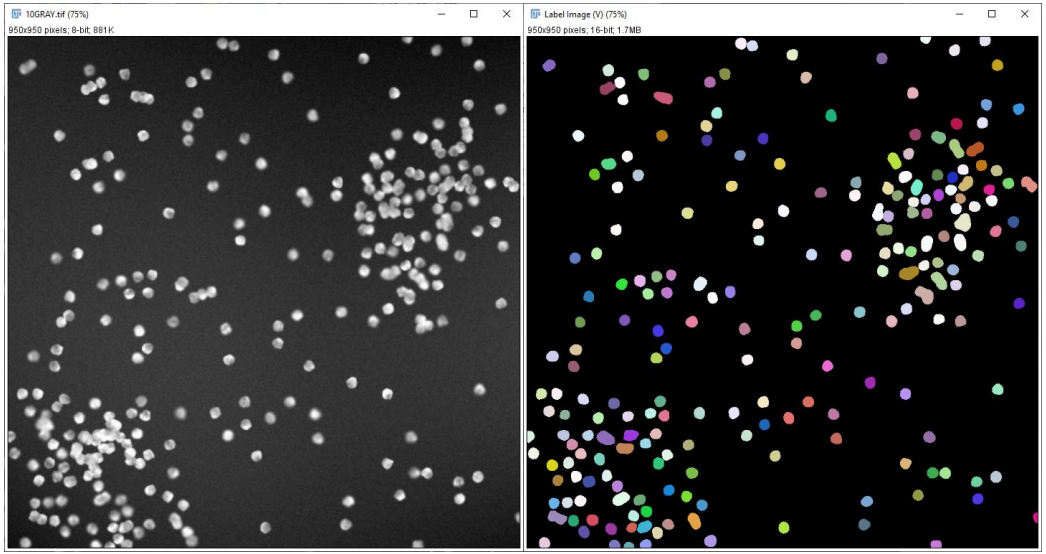
Examples - Settings



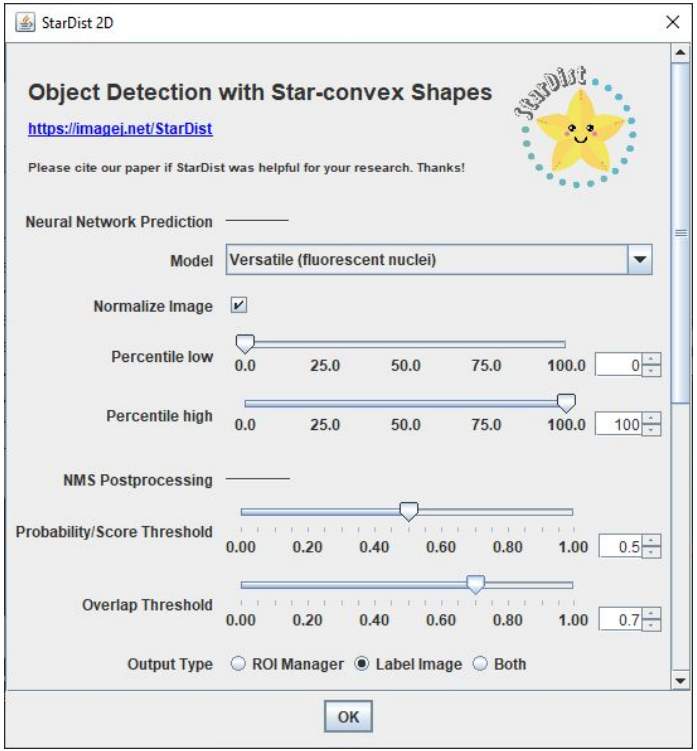
- Preprocessing settings
  - Normalization of image values.
  - Correction of “underexposure”.
  - Correction of “overexposure”.
- StarDist settings
  - Probability Threshold - how sure we want to be in detection of object.
  - Overlap Threshold - how much overlap we want to allow.

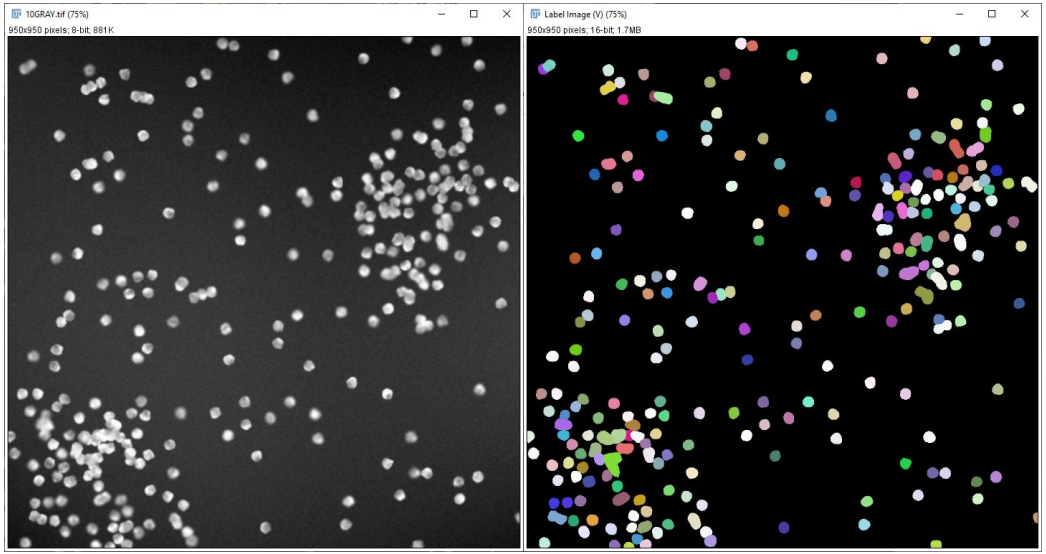
Examples - Overlap



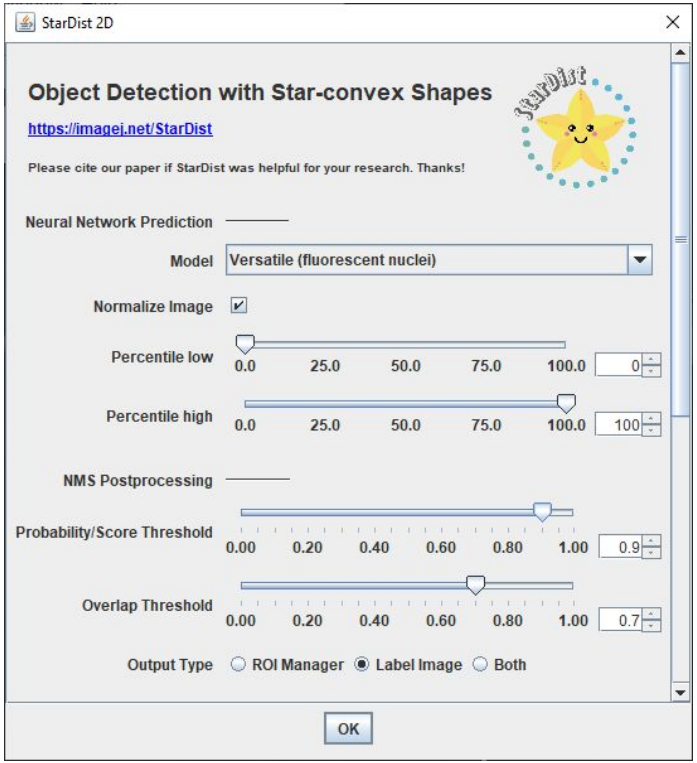


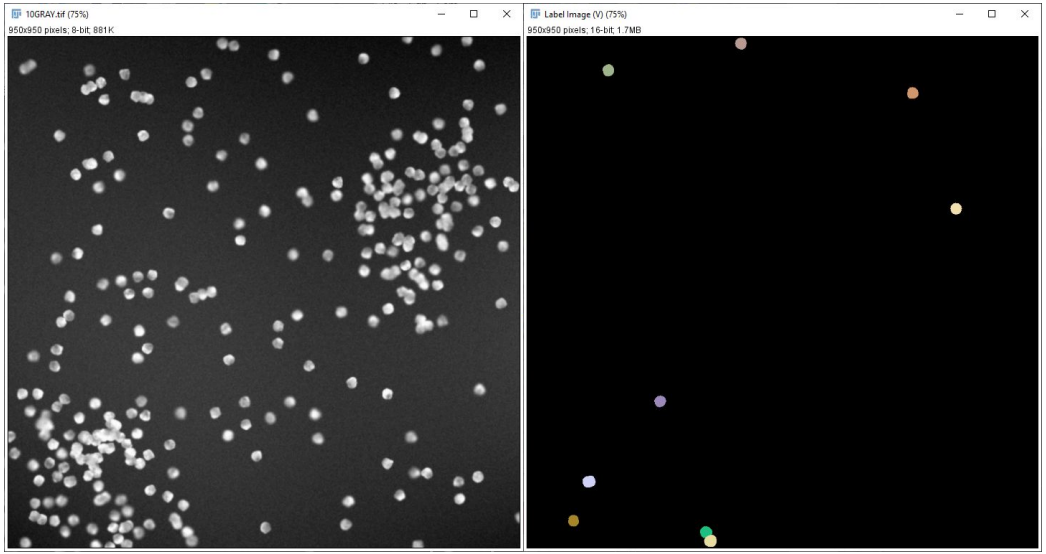
Examples - Overlap





Examples - Overlap + Probability





Plugins

ImageJ/Fiji
Scriptable ImageJ/Fiji plugin that can be used to run pretrained StarDist models on 2D or 2D+time images.

Napari
Plugin for the Python-based multi-dimensional image viewer napari. It directly uses the StarDist Python package and works for 2D and 3D images.

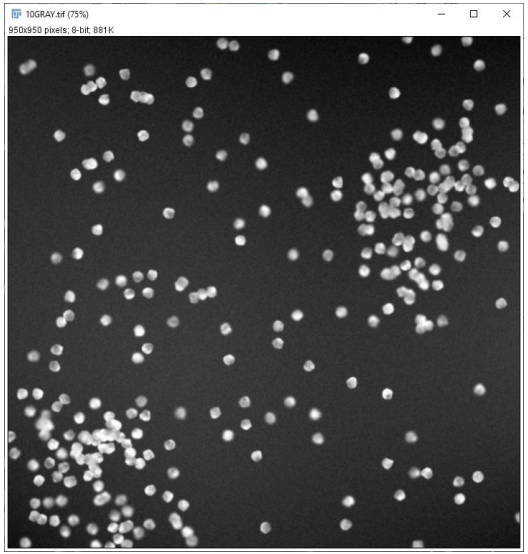
QuPath
Inspired by the Fiji plugin, Pete Bankhead made a custom implementation of StarDist 2D for QuPath to use pretrained models.

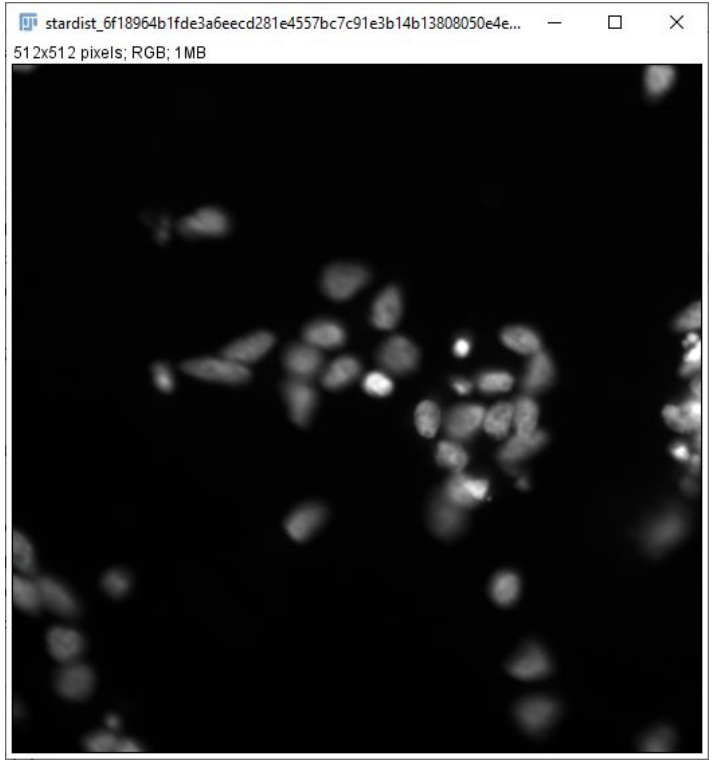
Icy
Based on the Fiji plugin, Deborah Schmidt made a StarDist 2D plugin for Icy to use pretrained models.

KNIME
Stefan Helfrich has modified the Fiji plugin to be compatible with KNIME.

Hands on

- Get familiar with StarDist Plugin.
- Analyze synthetic data with 0.45 overlap.
- Analyze real data.





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- ImageJ/Fiji plugin for StarDist: https://imagej.net/plugins/stardist