

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

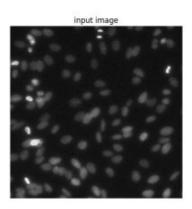
& what to learn

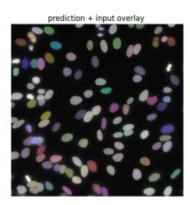
- What is StarDist?
- The main idea
- Why to use StarDist
- How to use it in FIJI
- Other software plugins

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.

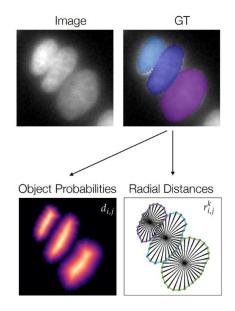


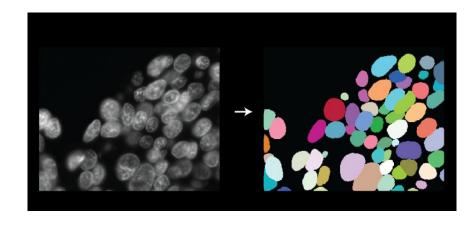




How it works

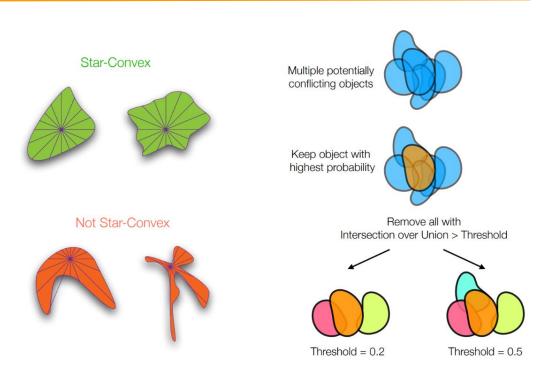
- Tool designed to localize cell nuclei via star-convex polygons.
- Similar to methods that directly predict shapes for each object of interest.





How it works

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

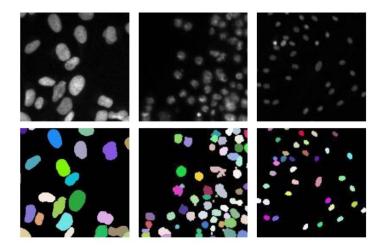


Why to use StarDist

- 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

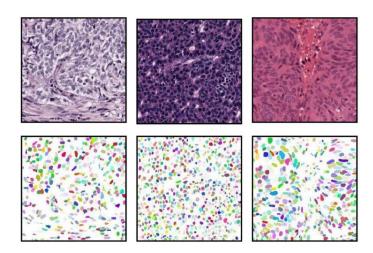
Fluorescence Microscopy Single Channel



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

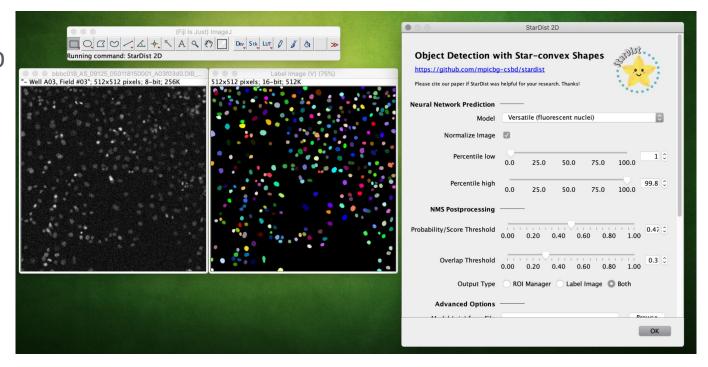
Examples

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

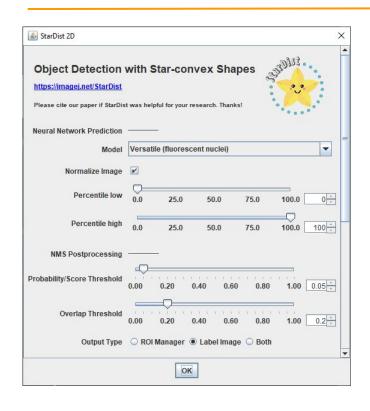
Examples - Overview

Plugin currently supports only 2D images.

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



Examples - Settings



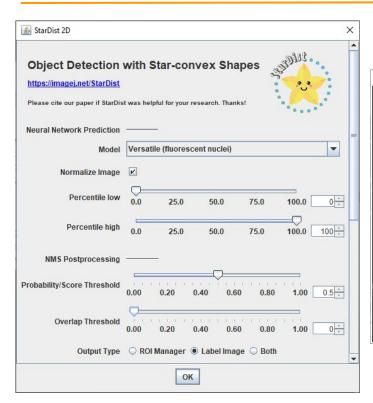
Preprocessing settings

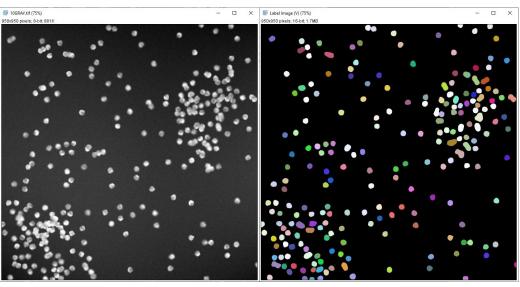
- Normalization of image values.
- Correction of "underexposure".
- Correction of "overexposure".

StarDist settings

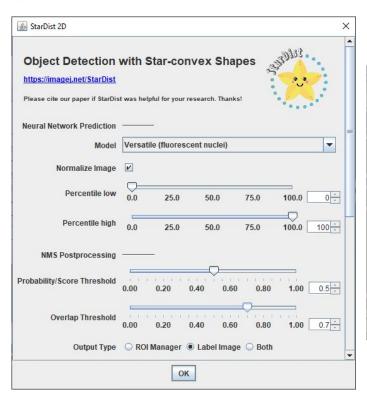
- Probability Threshold how sure we want to be in detection of object.
- Overlap Threshold how much overlap we want to allow.

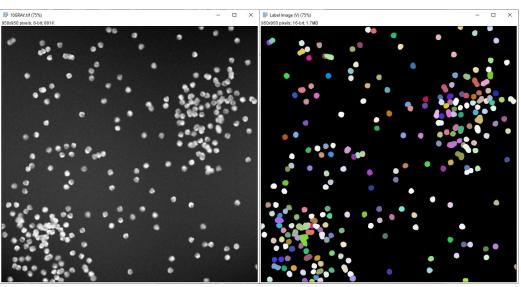
Examples - Overlap



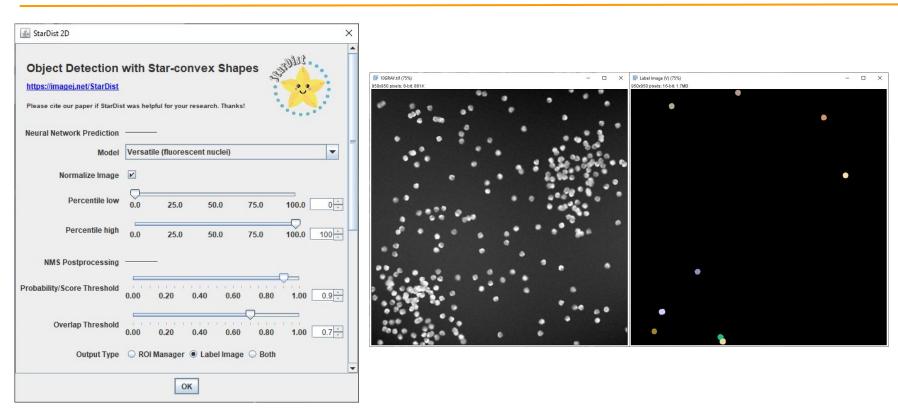


Examples - Overlap





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.





References

- Uwe Schmidt, Martin Weigert, Coleman Broaddus, and Gene Myers.
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- Martin Weigert, Uwe Schmidt, Robert Haase, Ko Sugawara, and Gene Myers.
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 The IEEE Winter Conference on Applications of Computer Vision (WACV),
 Snowmass Village, Colorado, March 2020
- ImageJ/Fiji plugin for StarDist: https://imagej.net/plugins/stardist