ZELDA:
a 3D Image Segmentation and Parent-Child relation plugin for Microscopy Image Analysis in napari

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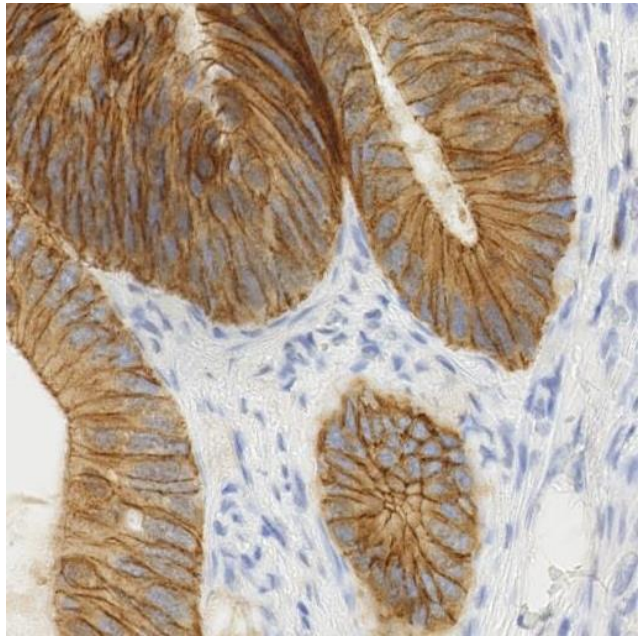
https://github.com/RoccoDAnt/napari-zelda

Image data science for with Python and Napari

11 August 2023

Example of scripting: IPython console

Obtain segmented region outlines



```
from skimage import data
from skimage.color import rgb2gray
from skimage import filters

viewer.add_image(data.immunohistochemistry(), rgb=True, blending='additive')
binary=rgb2gray(viewer.layers[0].data)>0.6
edge_sobel = filters.sobel(binary)
viewer.add_image(edge_sobel, blending='additive', colormap='yellow')
```

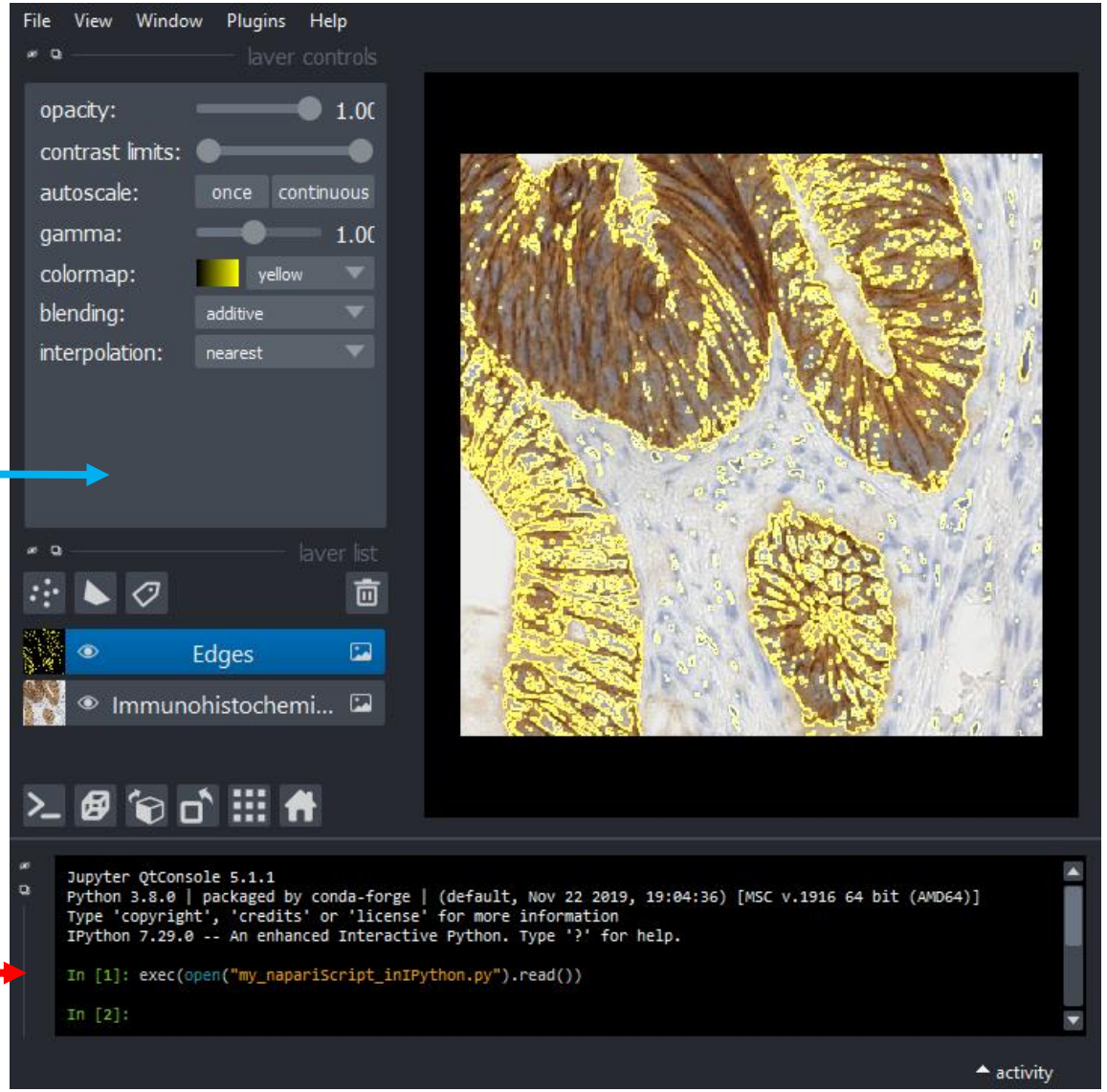


Fig. 2, https://analyticalscience.wiley.com/do/10.1002/was.0004000232

What biologists want?

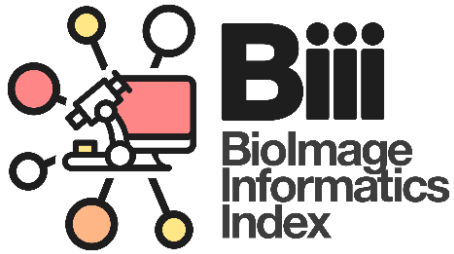
"open-source point and click software"

"better software
for "3D/Volume" and "Tissue/Histology" analysis"

COBA survey

Jamali et al. 2022. *Biological Imaging, 1*, E4. doi:10.1017/S2633903X21000039

The lexicon of BIA

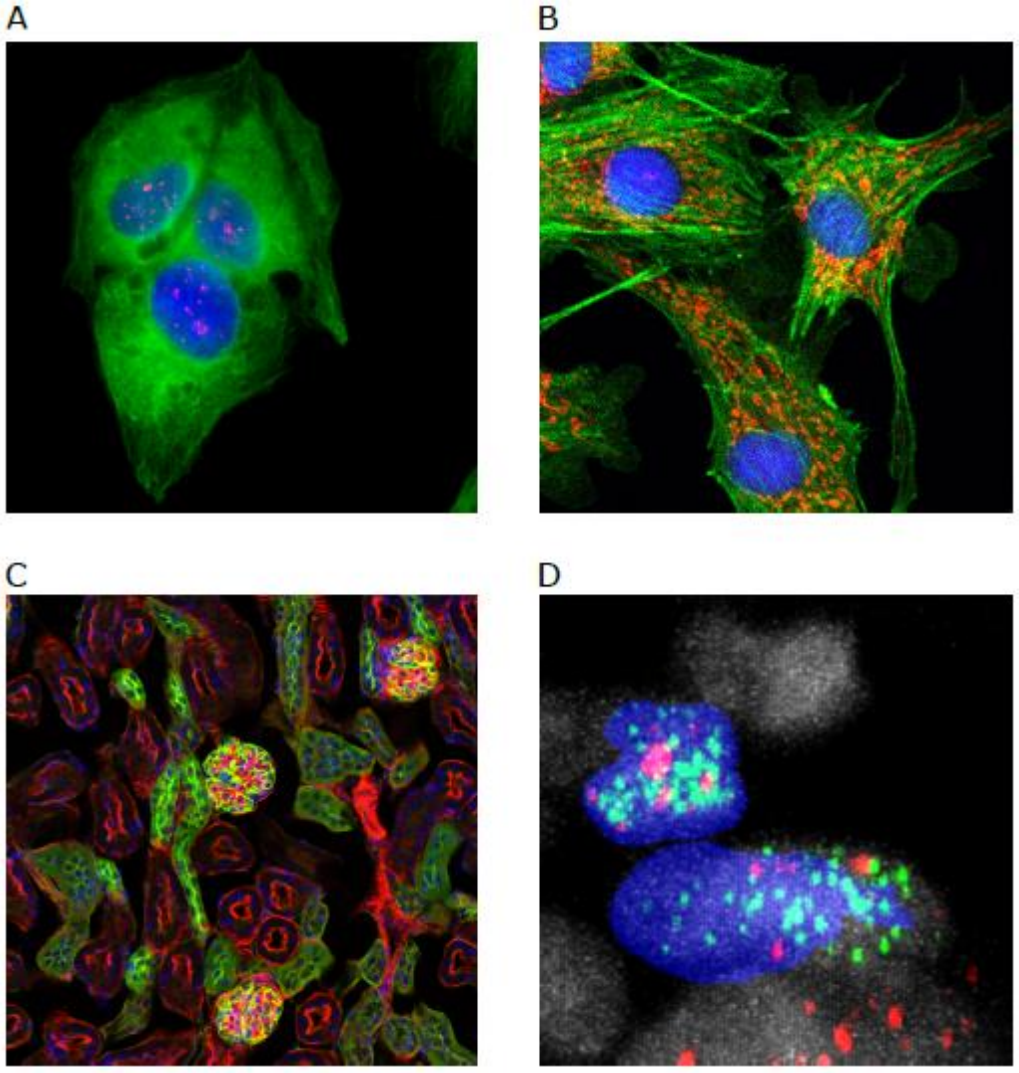


"information about tools is non-uniform
and often focuses on technicalities"

"aim to help bioimage analysts to identify and edit workflows"

biii.eu

Some common bioimage analysis problem



(A) **"2D counting"**

(B) **"2D segmentation"** and **"parent-child relation"**.

(C) **"3D cell counting"** or **"3D object segmentation"**

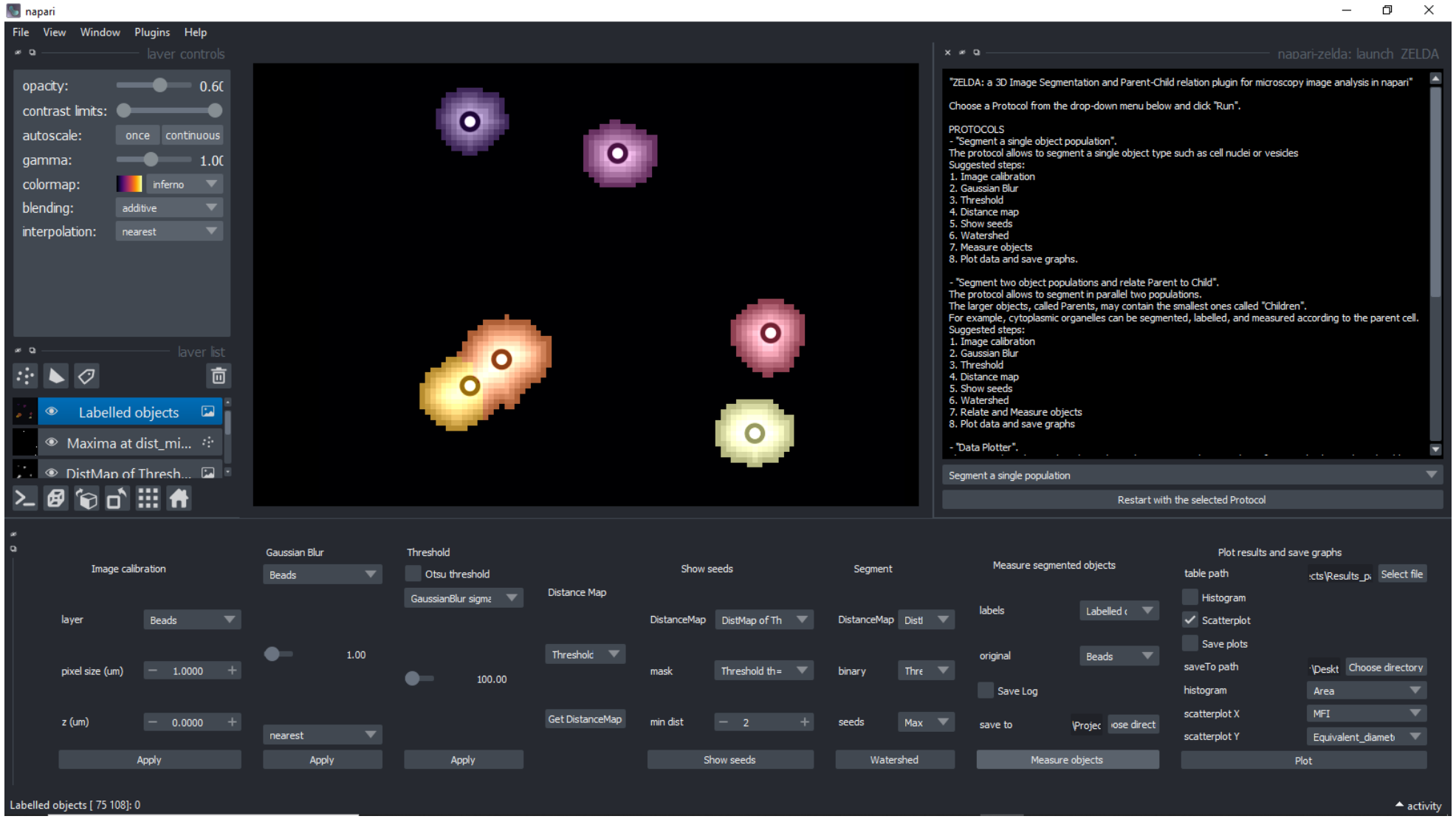
(D) **"3D object segmentation"** and **"parent-child relation"**

D'Antuono, Rocco, and Giuseppina Pisignano. 2022.
"ZELDA: A 3D Image Segmentation and Parent-Child Relation Plugin for Microscopy Image Analysis in Napari."
Frontiers in Computer Science 3: 115. https://doi.org/10.3389/fcomp.2021.796117

https://github.com/RoccoDAnt/napari-zelda

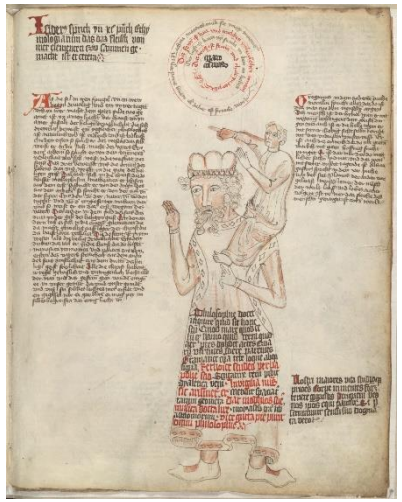
Software features:

- Guided segmentation
- Graphical workflow
- Versatile
  (**3D**,
  Parent-Child,
  Workflow composition,
  Automatic data plotter)
- Reasonably Limited!
- Benchmarked (**2D/3D**)



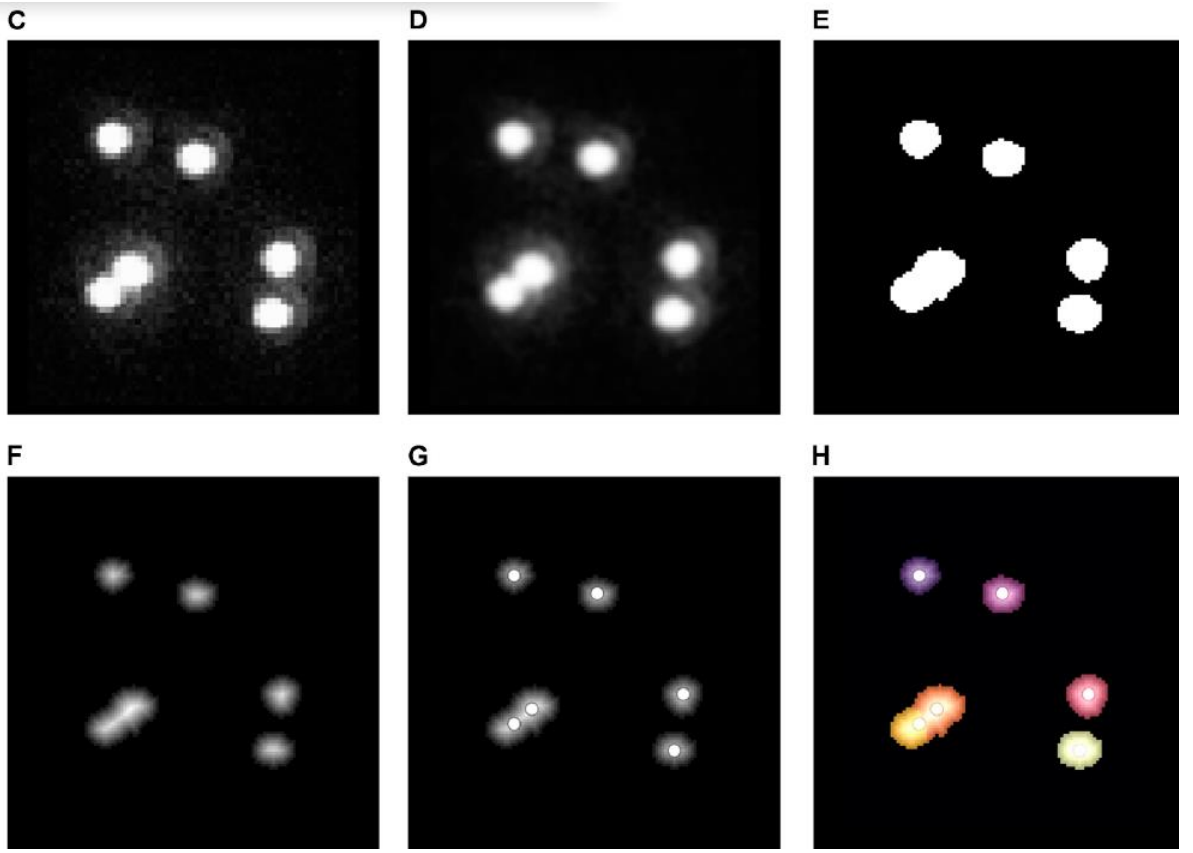
Segmentation algorithm for a single population of "objects"

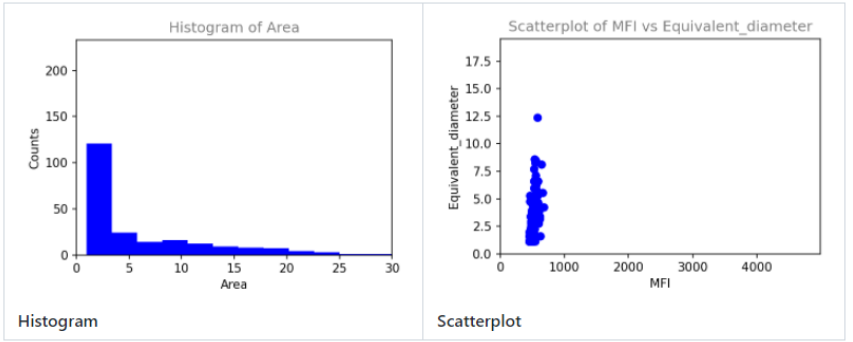
https://github.com/RoccoDAnt/napari-zelda



From wikimedia.org

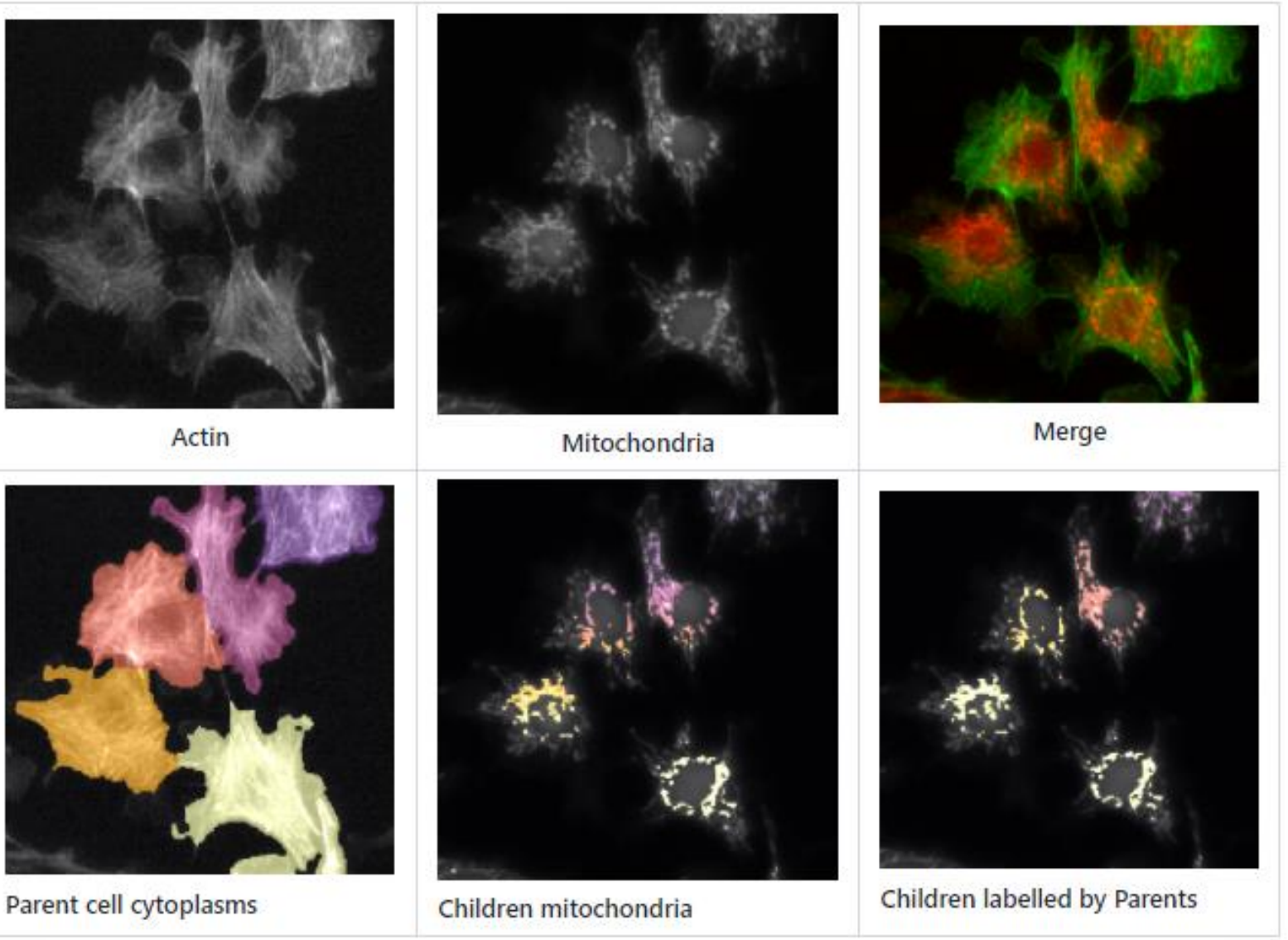
"standing on the sholders [sic] of Giants:":
- MorphoLibJ (Legland et al., 2016)
- CellProfiler (McQuin et al., 2018)
- Scikit-Image (Walt et al. 2014)
- …



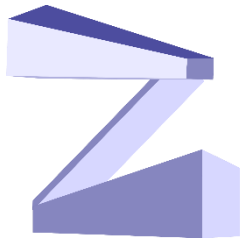


https://github.com/RoccoDAnt/napari-zelda

Parent-Child relation



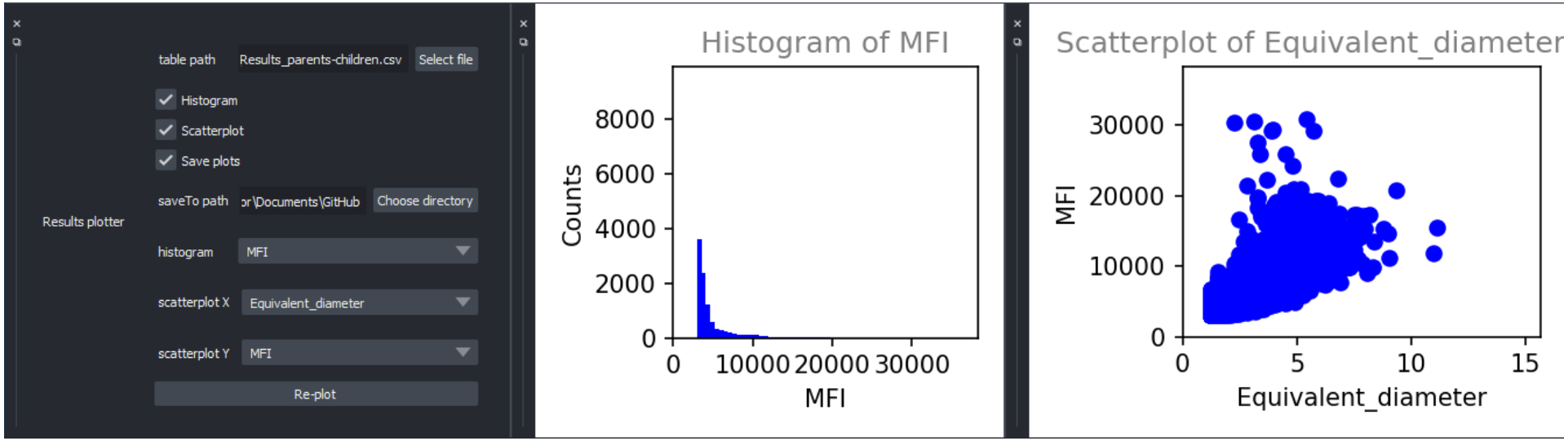
Parent objects	GB: sigma=2.0-> Th_parents=60.0-> DistMap-> Maxima: min_dist=10
Children objects	GB: sigma=0.3-> Th_children=450.0 -> DistMap-> Maxima: min_dist=2



Data Plotter

https://github.com/RoccoDAnt/napari-zelda

Parent_label	Area	Equivalent_diameter	MFI
4	61524	44.50092806	21400.02779
6	51327	41.89248994	22328.22453
0	99	5.214739423	19818.31818
5	7704	22.263476	20383.78855
5	7771.5	22.32830885	20670.41228
4	74502	47.43259198	24658.9672
5	99049.5	52.15608401	24016.61083
5	56317.5	43.20844824	22260.36548
1	73584	47.23696771	24755.67967
6	77463	48.05283162	25165.21064
5	13725	26.98930273	22365.67377

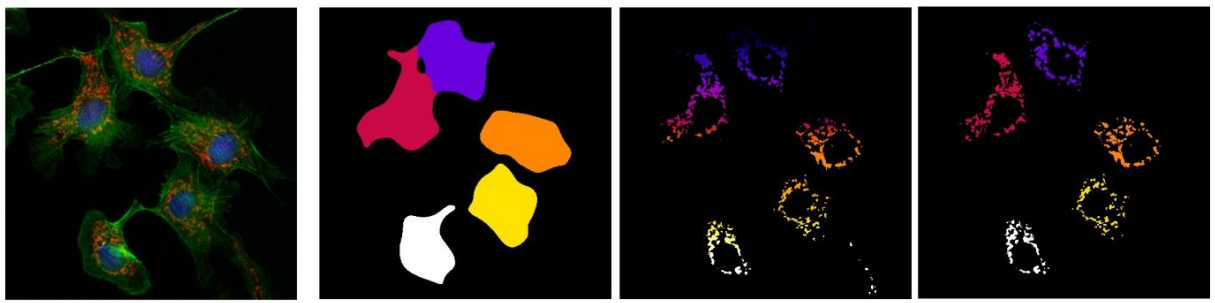


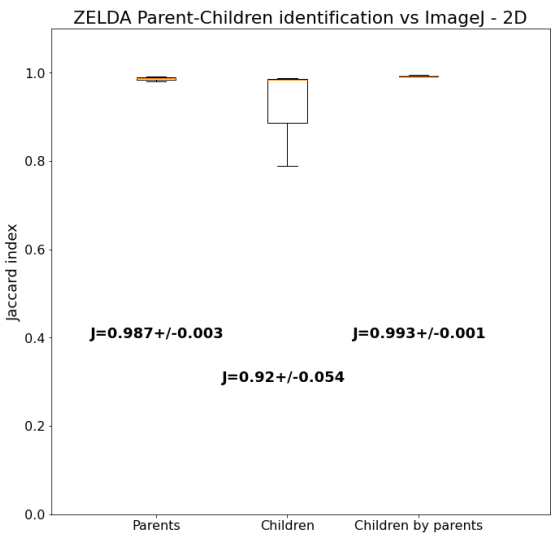
matplotlib.backends.backend_qt5agg
(https://matplotlib.org/2.2.2/_modules/matplotlib/backends/backend_qt5agg.html)

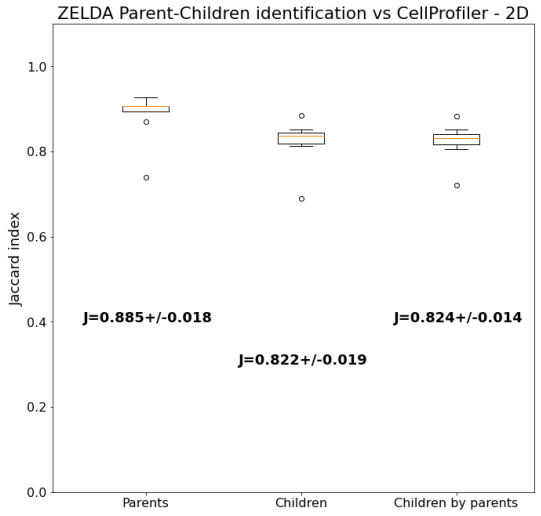
Benchmarked against ImageJ and CellProfiler

https://github.com/RoccoDAnt/napari-zelda

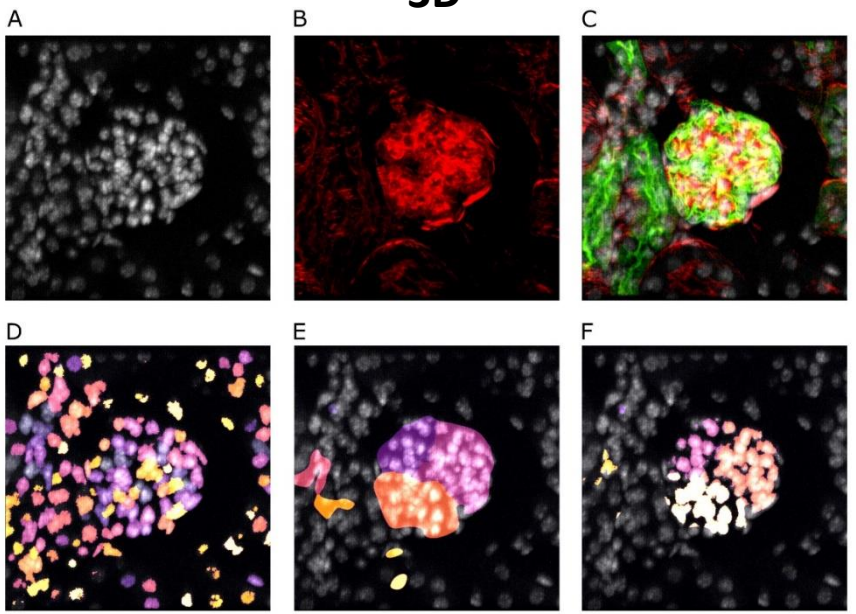
2D

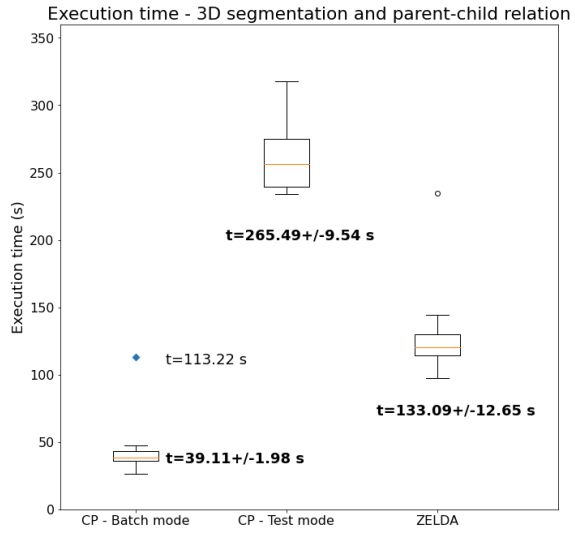


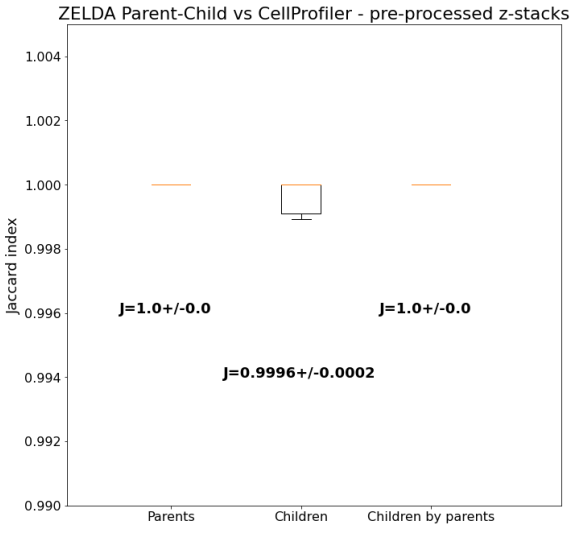




3D

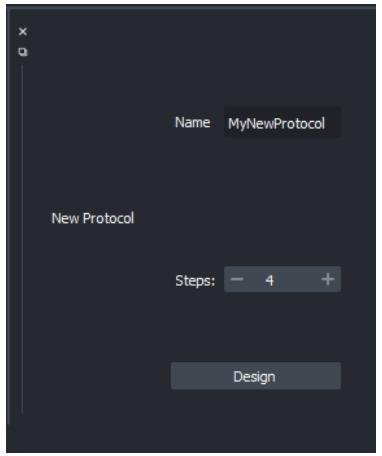


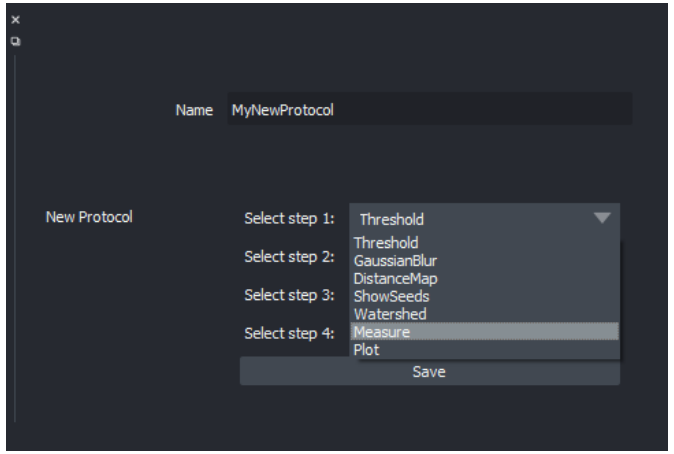




Workflow design and sharing

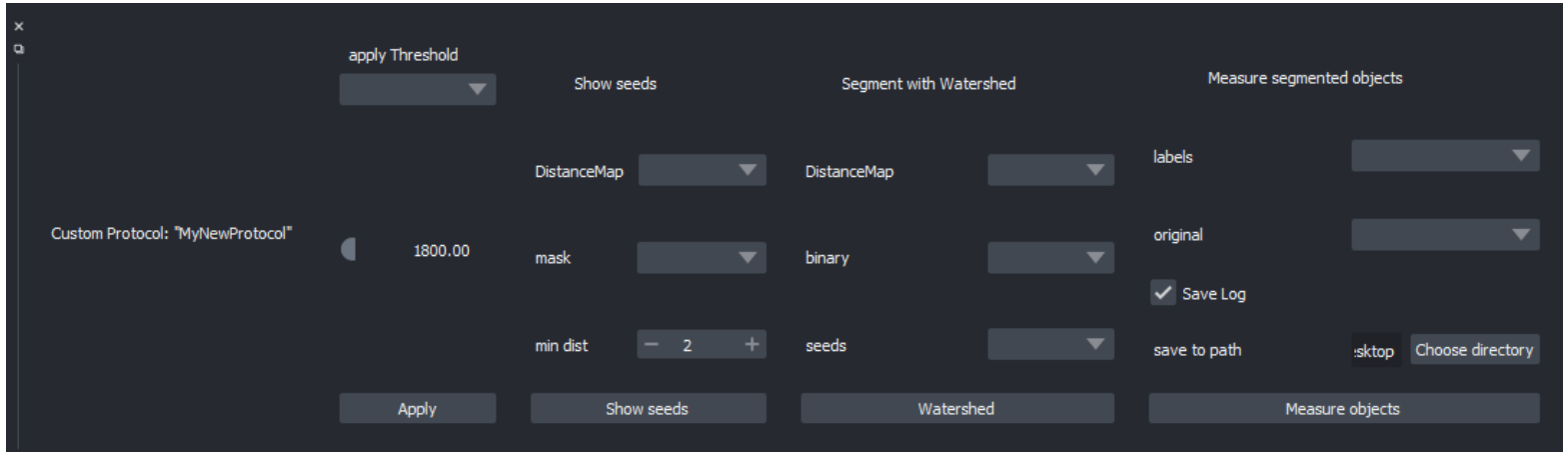
https://github.com/RoccoDAnt/napari-zelda

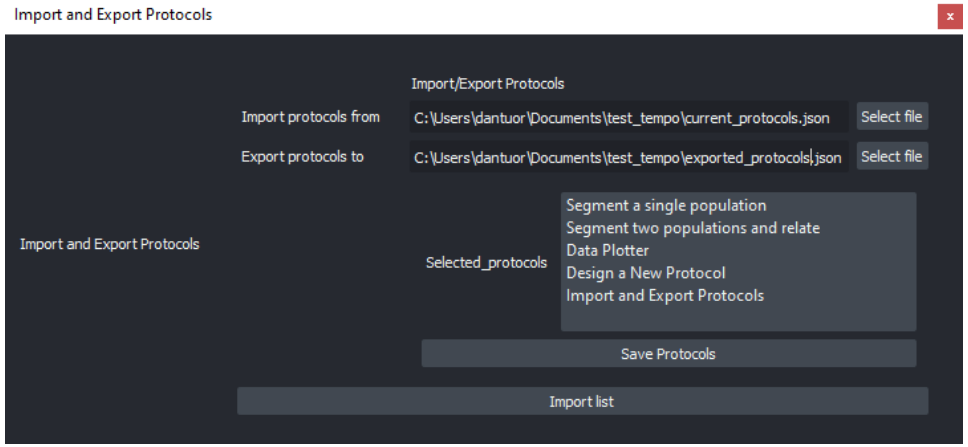





```
{
    "name": "MyNewProtocol",
    "widget": "MyNewProtocol_protocol_widget",
    "steps": [
        {
            "step_number": 1,
            "step_name": "Threshold"
        },
        {
            "step_number": 2,
            "step_name": "ShowSeeds"
        },
        {
            "step_number": 3,
            "step_name": "Watershed"
        },
        {
            "step_number": 4,
            "step_name": "Measure"
        }
    ]
}
```


Newly designed protocol (from .json file)





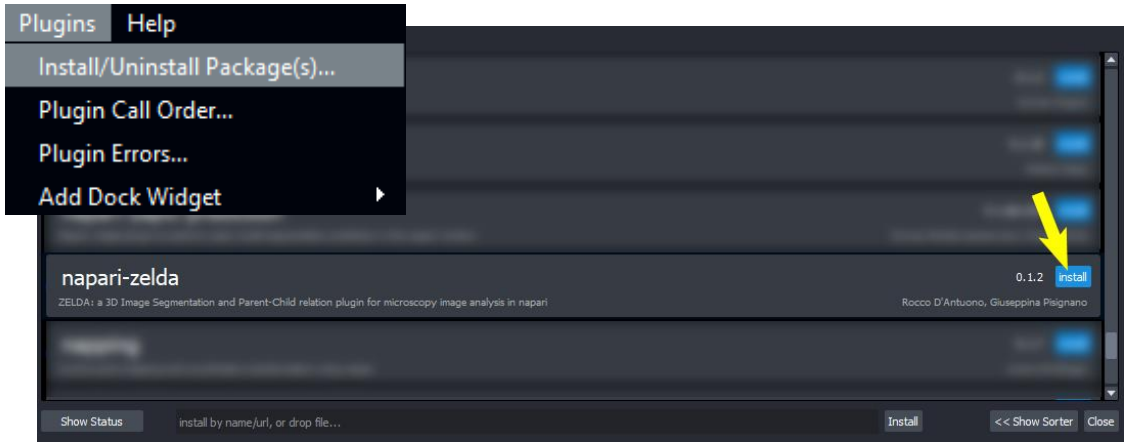
TRY IT OUT!

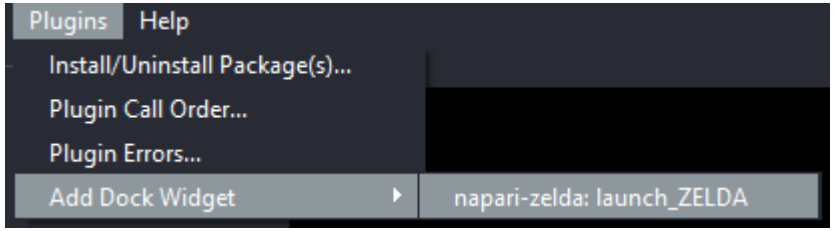
https://github.com/RoccoDAnt/napari-zelda

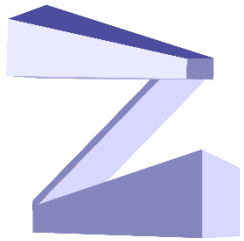
1. Install napari

```
conda create -y -n napari-env python=3.8
conda activate napari-env
pip install "napari[all]"
```

2. Install ZELDA plugin







https://github.com/RoccoDAnt/napari-zelda

Acknowledgements:

- **Giuseppina Pisignano** (University of Bath)

- **Reviewers and Editors** for having asked many useful improvements

- First users: **Ana Stojiljković** (University of Bern), **Ewelina Bartoszek** (University of Basel), **Peter Carlton** (Kyoto University)

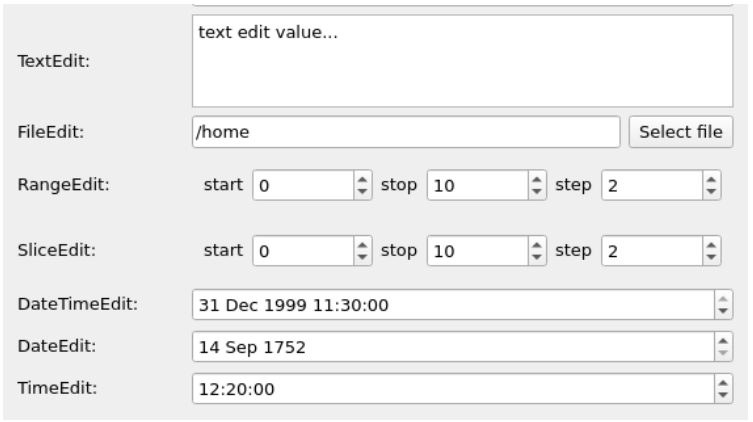
Read more:

D'Antuono R and Pisignano G (2022)
ZELDA: A 3D Image Segmentation and Parent-Child Relation Plugin for Microscopy Image Analysis in *napari*.
Front. Comput. Sci. 3:796117. doi: 10.3389/fcomp.2021.796117

References

https://github.com/RoccoDAnt/napari-zelda

magicgui



https://napari.org/magicgui/

```
full_name [Napari Developer]: Ramon y Cajal
email [yourname@example.com]: ramon@cajal.es
github_username_or_organization [githubuser]: neuronz52
# NOTE: for packages whose primary purpose is to be a napari
plugin, we
# recommend using the 'napari-' prefix in the package name.
# If your package provides functionality outside of napari, you
may
# choose to leave napari out of the name.
plugin_name [napari-foobar]: napari-growth-cone-finder
module_name [growth_cone_finder]:
napari_growth_cone_finder
short_description [A simple plugin to use with napari]:
# you can select from various plugin template examples
include_reader_plugin [y]:
include_writer_plugin [y]:
include_dock_widget_plugin [y]:
include_function_plugin [y]:

Select docs_tool:
1 - mkdocs
2 - sphinx
3 - none
Choose from 1, 2, 3 [1]: 3
Select license:
1 - BSD-3
2 - MIT
3 - Mozilla Public License 2.0
4 - Apache Software License 2.0
5 - GNU LGPL v3.0
6 - GNU GPL v3.0
Choose from 1, 2, 3, 4, 5, 6 (1, 2, 3, 4, 5, 6) [1]:
INFO:post_gen_project:Moving files for mkdocs.
```

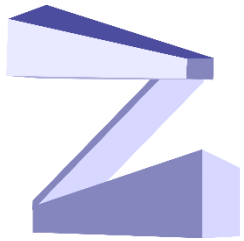
https://github.com/napari/cookiecutter-napari-plugin

scikit-image image processing in python
pandas
matplotlib
NumPy

The cornucopia of open-source software

python Package Index

https://pypi.org/



Additional slide on magicgui

https://github.com/RoccoDAnt/napari-zelda

Graphical User Interface:

- magicgui

- cookie-cutter plugin

- pypi.org

```python
@magicgui(labels=False,
          label={'widget_type':'Label', 'value':"Threshold"},
          Otsu={'widget_type':'CheckBox','name':'Otsu_threshold'},
          threshold={'widget_type': 'FloatSlider', "max": 65535.0, 'min':0.0},
          call_button="Apply",
          persist=True
          )
def threshold_one_pop(viewer: 'napari.Viewer', label, Otsu, layer: Image, threshold: int = 1)-> napari.types.ImageData:
    if layer:
        if Otsu==True:
            threshold = skimage.filters.threshold_otsu(np.array(layer.data))
            print(threshold)
        th=layer.data>threshold
        viewer.add_image(th, scale=layer.scale, name='Threshold th='+str(threshold)+' of '+str(layer.name))

```