

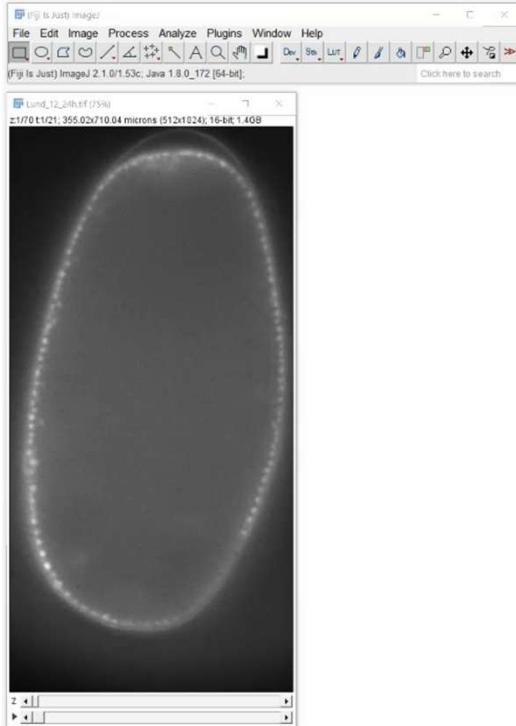
GPU-accelerated Image Data Flow Graphs

Robert Haase

September 2021

Image processing in life-sciences

- State-of-the-art software for more than 20 years: ImageJ / Fiji



2x



ImageJ / Fiji integration for OpenCL



How image processing is supposed to be

(... in my honest opinion)



2x



<https://clij.github.io/assistant>

GPU acceleration + code generation

- After setting up the workflow, generate code!



Special
thanks to
Elisabeth
Kugler!

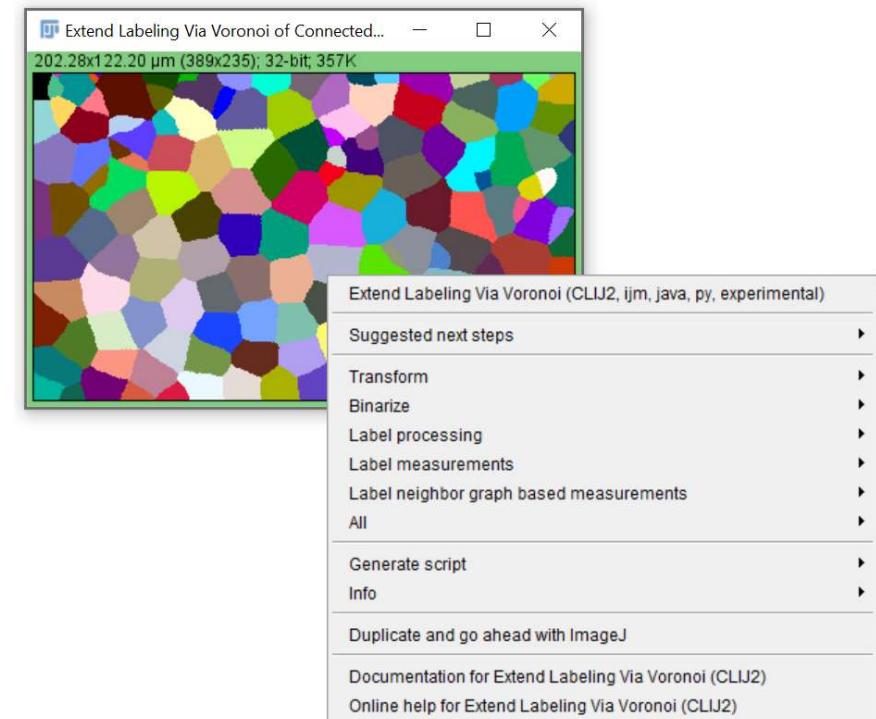
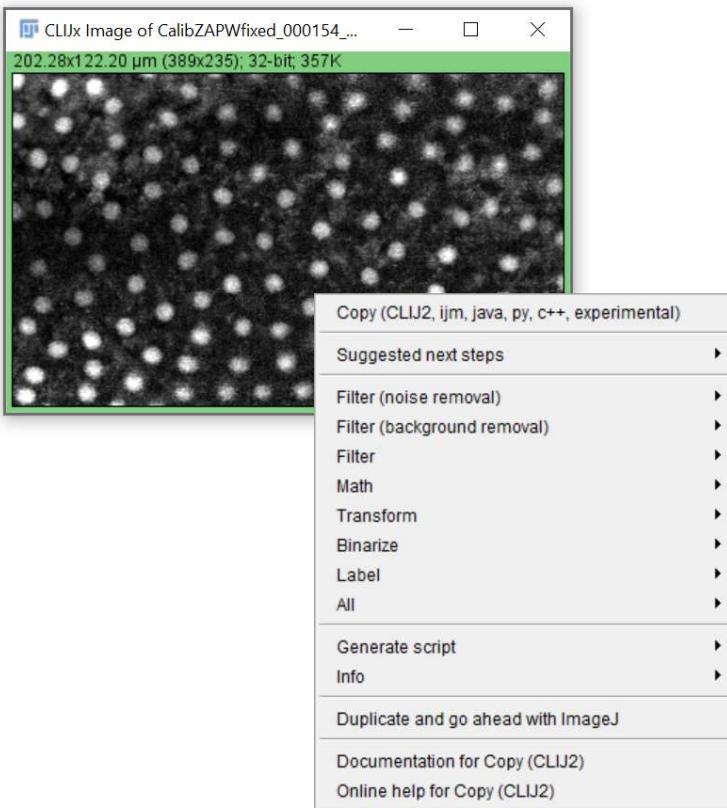


Elisabeth Kugler
@KuglerElisabeth

 @haesleinhuepf Image data source: Elisabeth Kugler; labs of Tim Chico and Paul Armitage, The
@PoLDresden University of Sheffield (UK)" <https://zenodo.org/record/4204839#.X8DCRGj7Q2w>

Image Data Flow Graph design

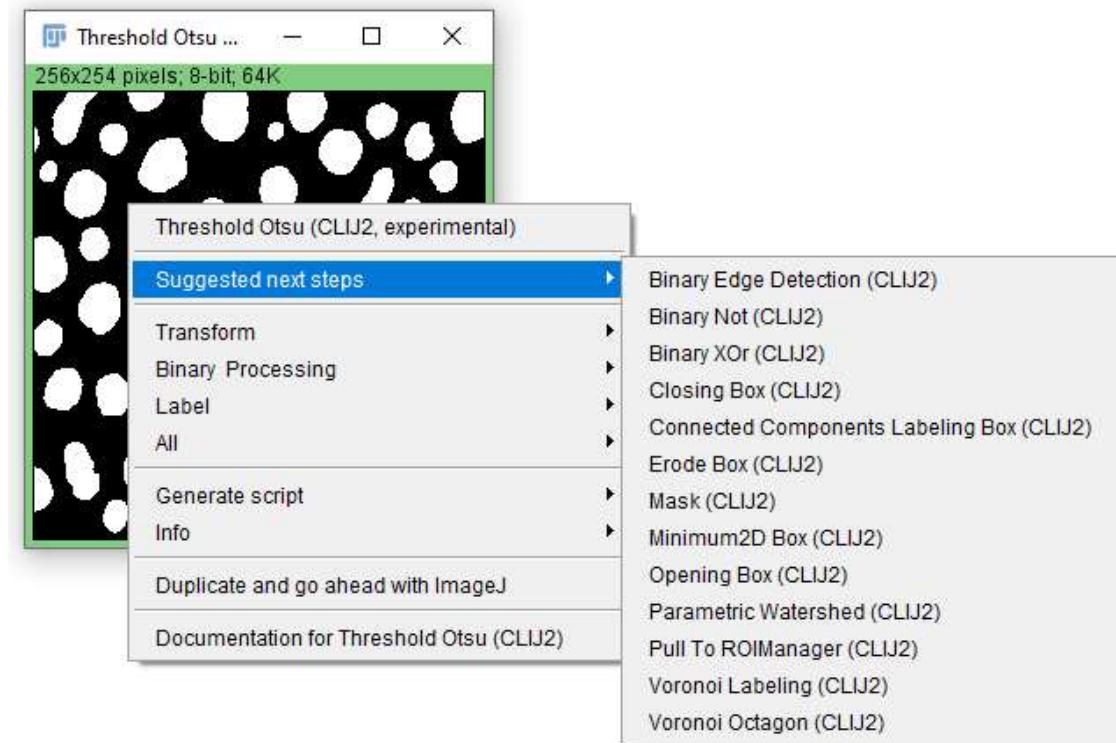
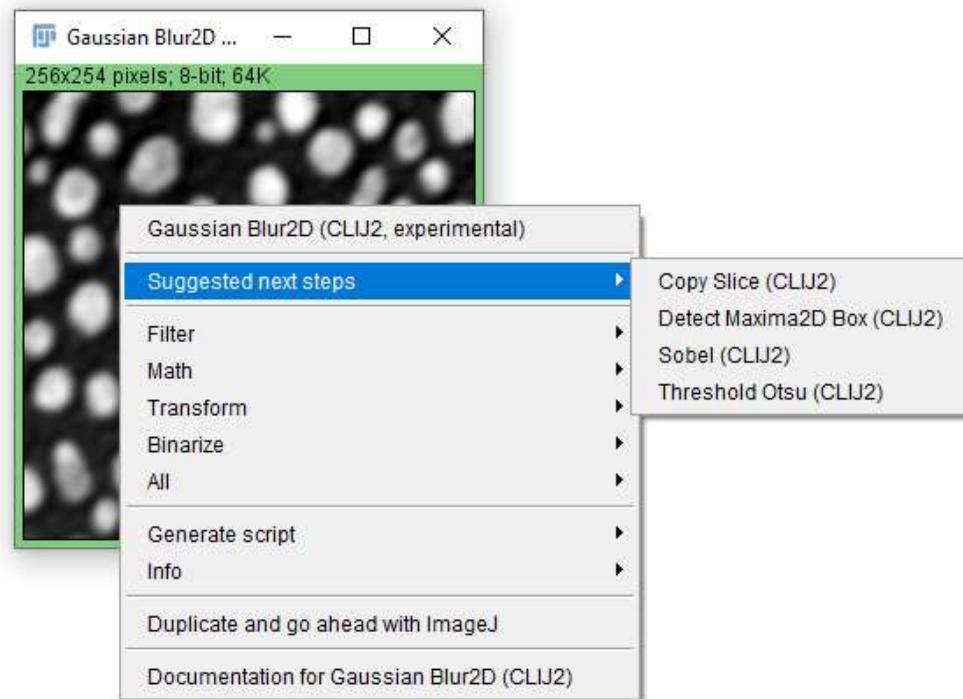
The menu order is intentional: From preprocessing to analysis



<https://clij.github.io/assistant>

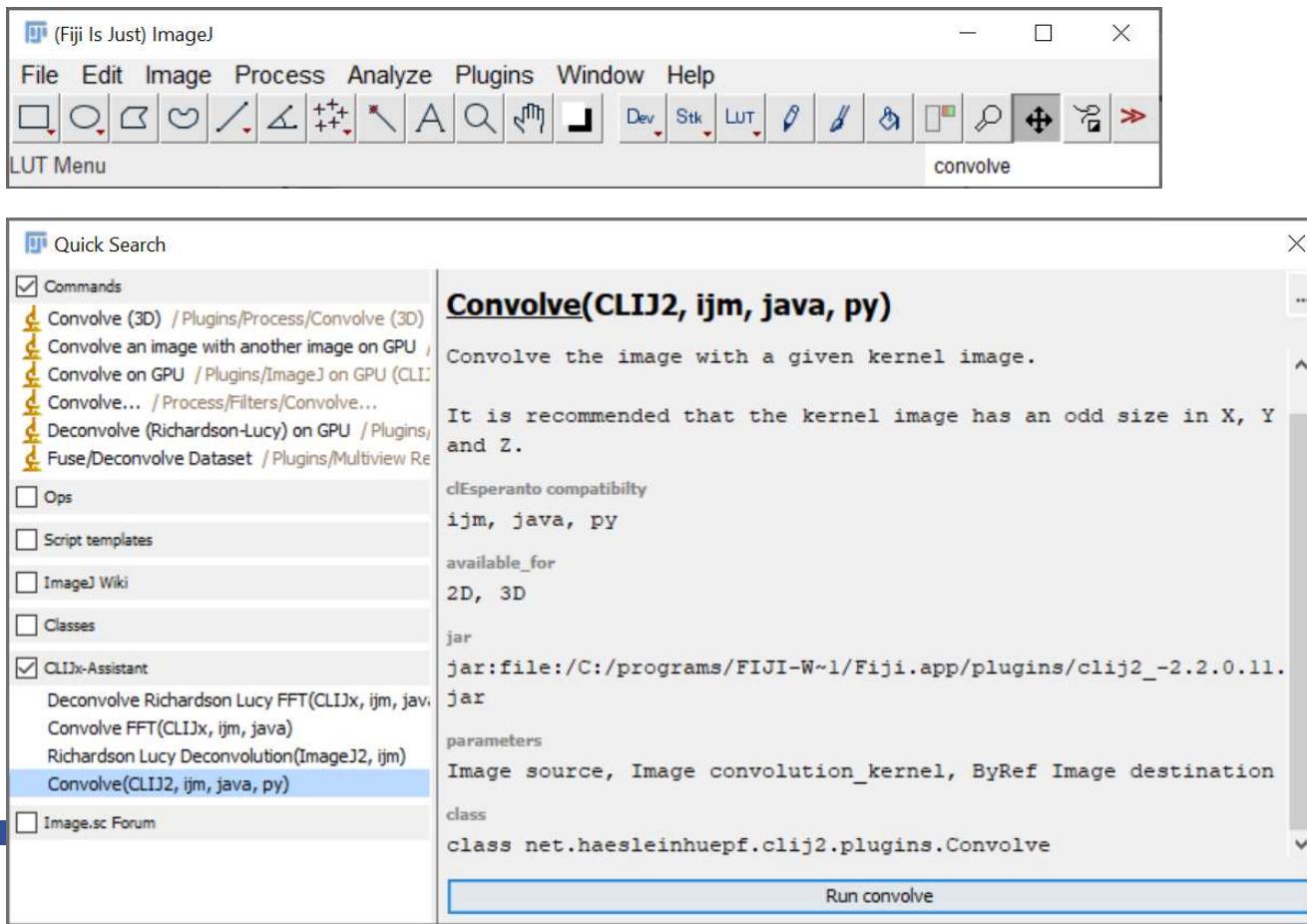
Expert system: Suggestions

Explore suggestions!

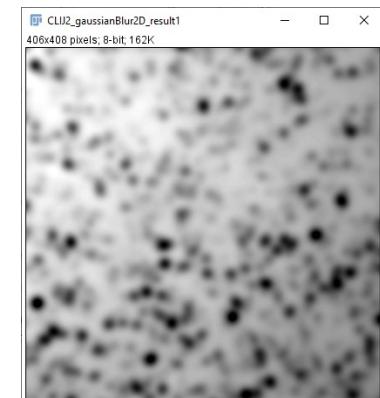
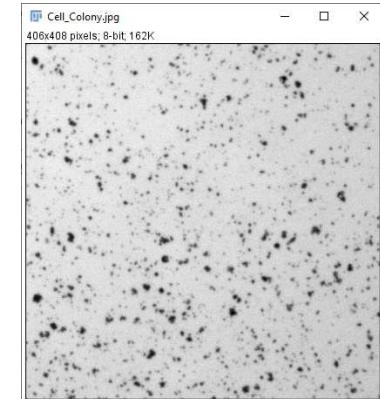


Fiji search bar

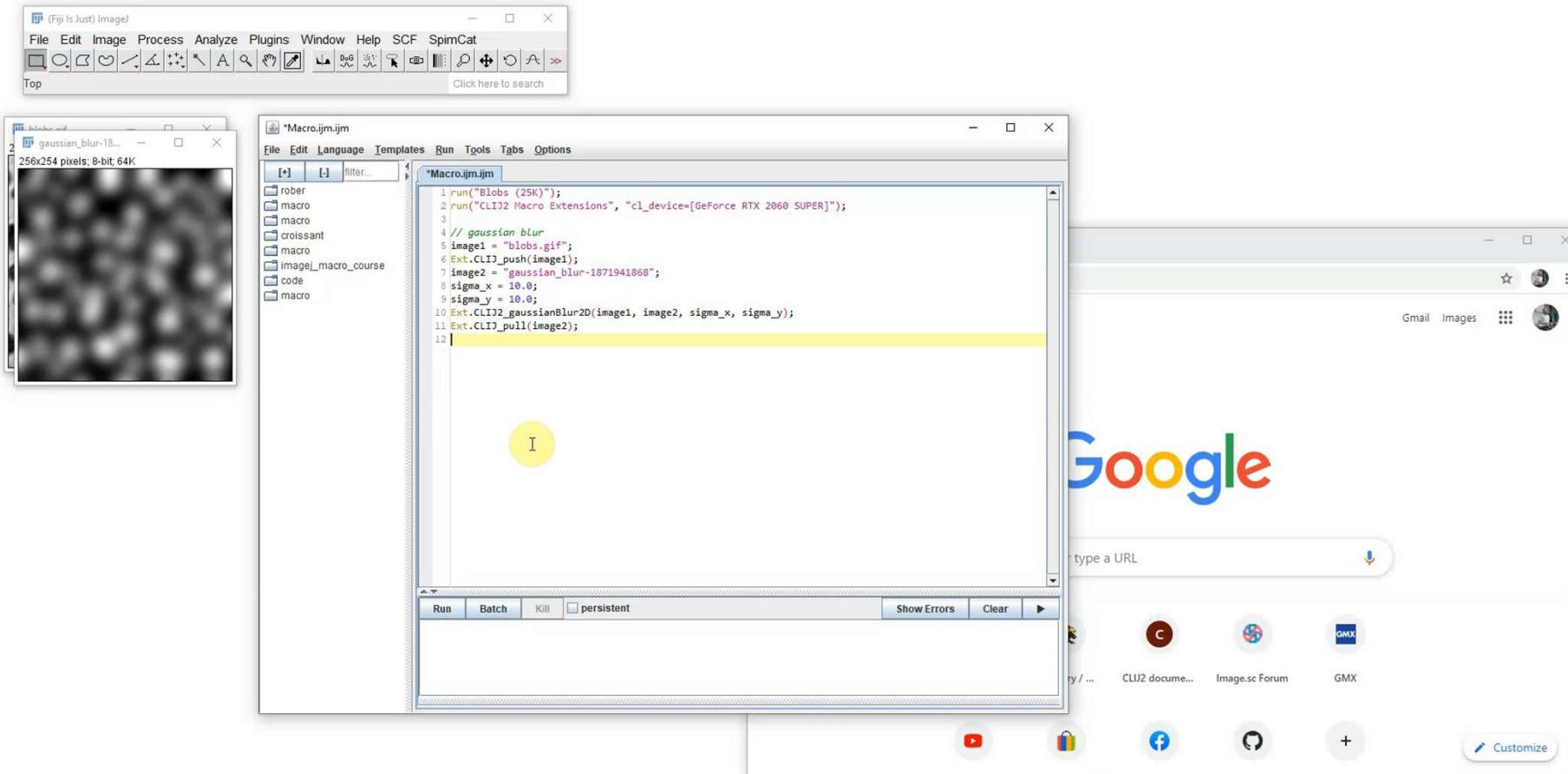
In Fijis search bar result, there is a new category: CLIJx-assistant which offers IDFG operations



CLIJ2: What every ImageJ Macro script must have

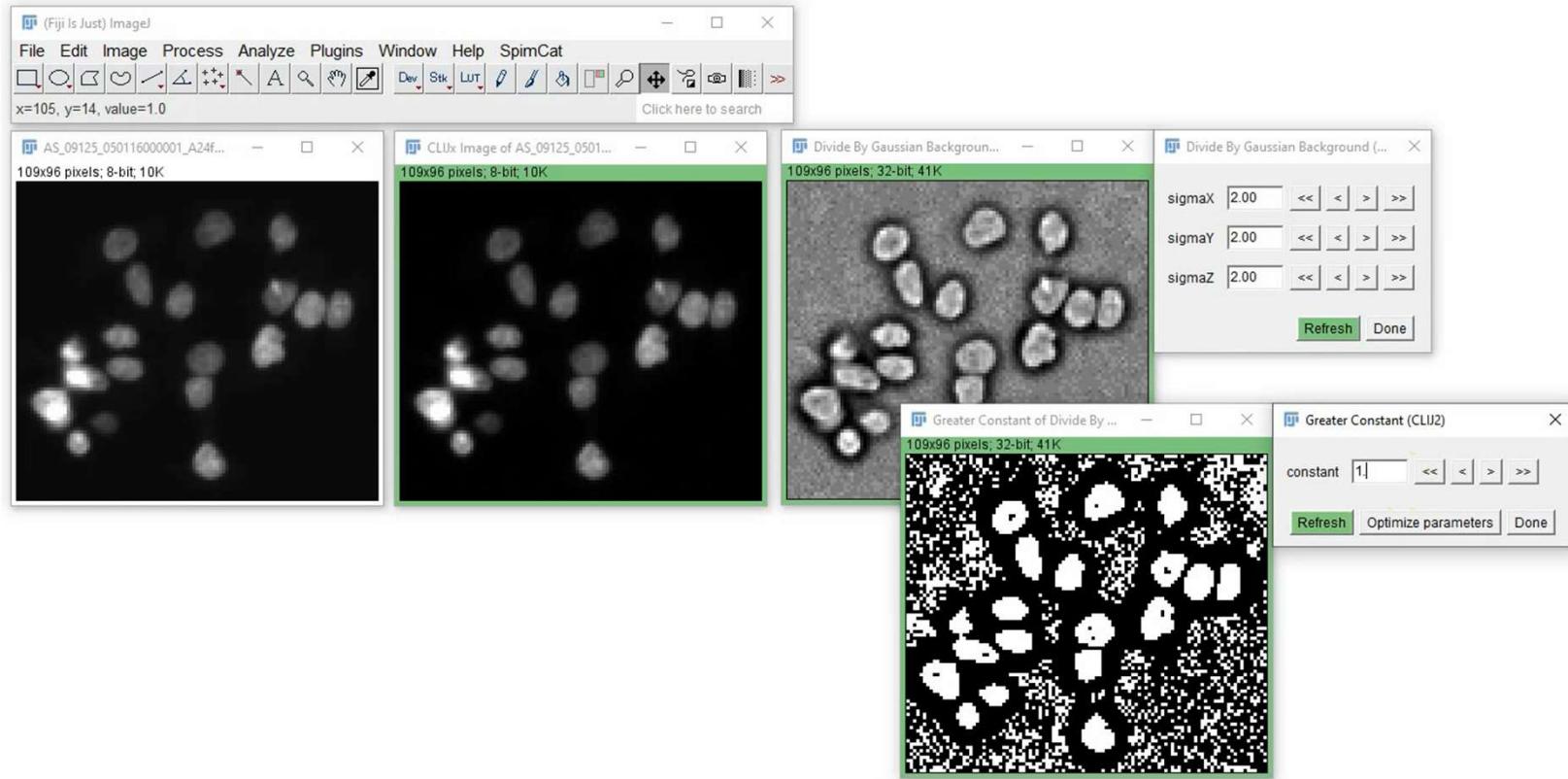


CLIJ2: Macro editing



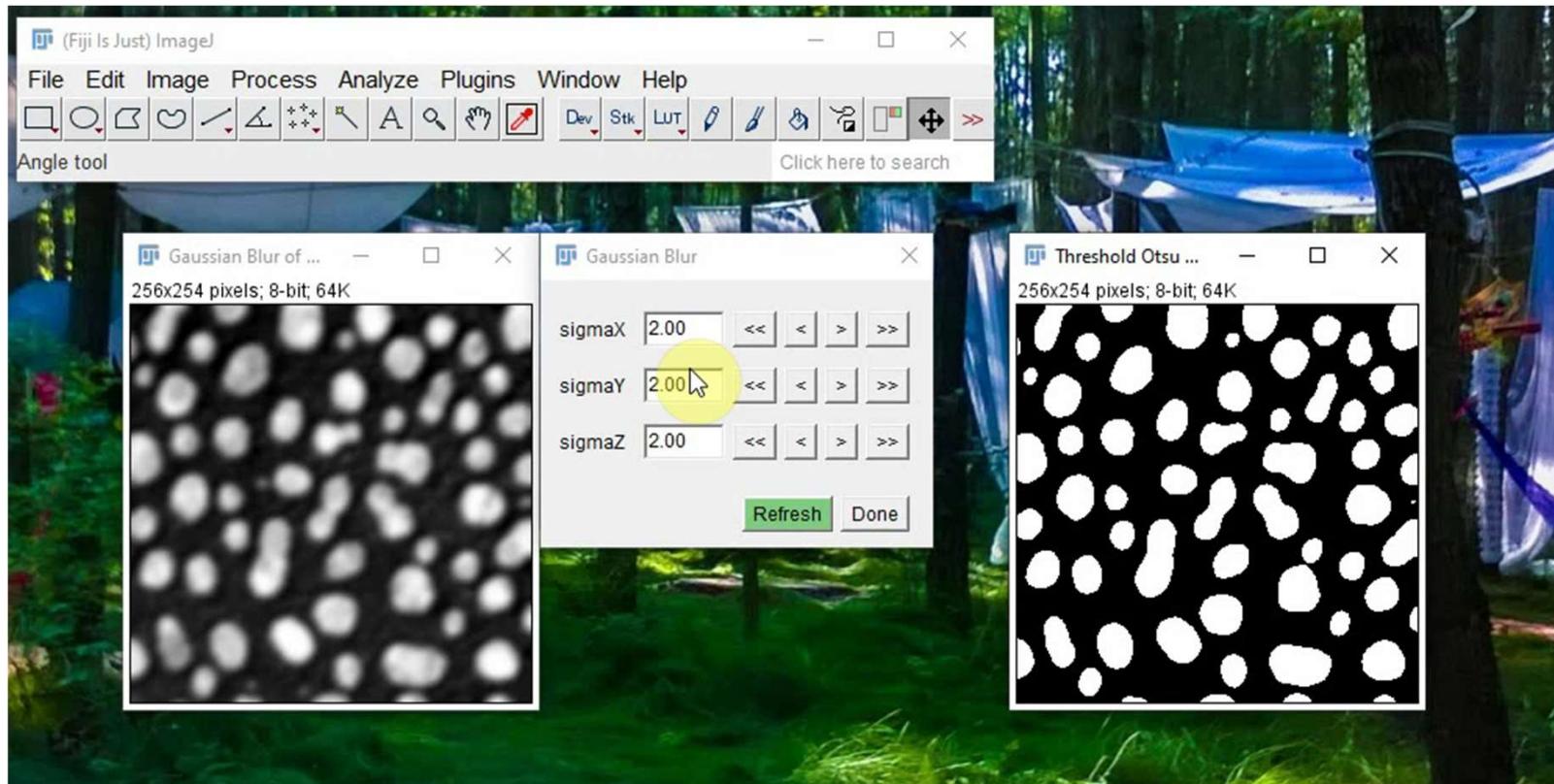
Parameter optimization

If your image data flow graph ends in a binary image, you can optimize numeric parameters automatically.



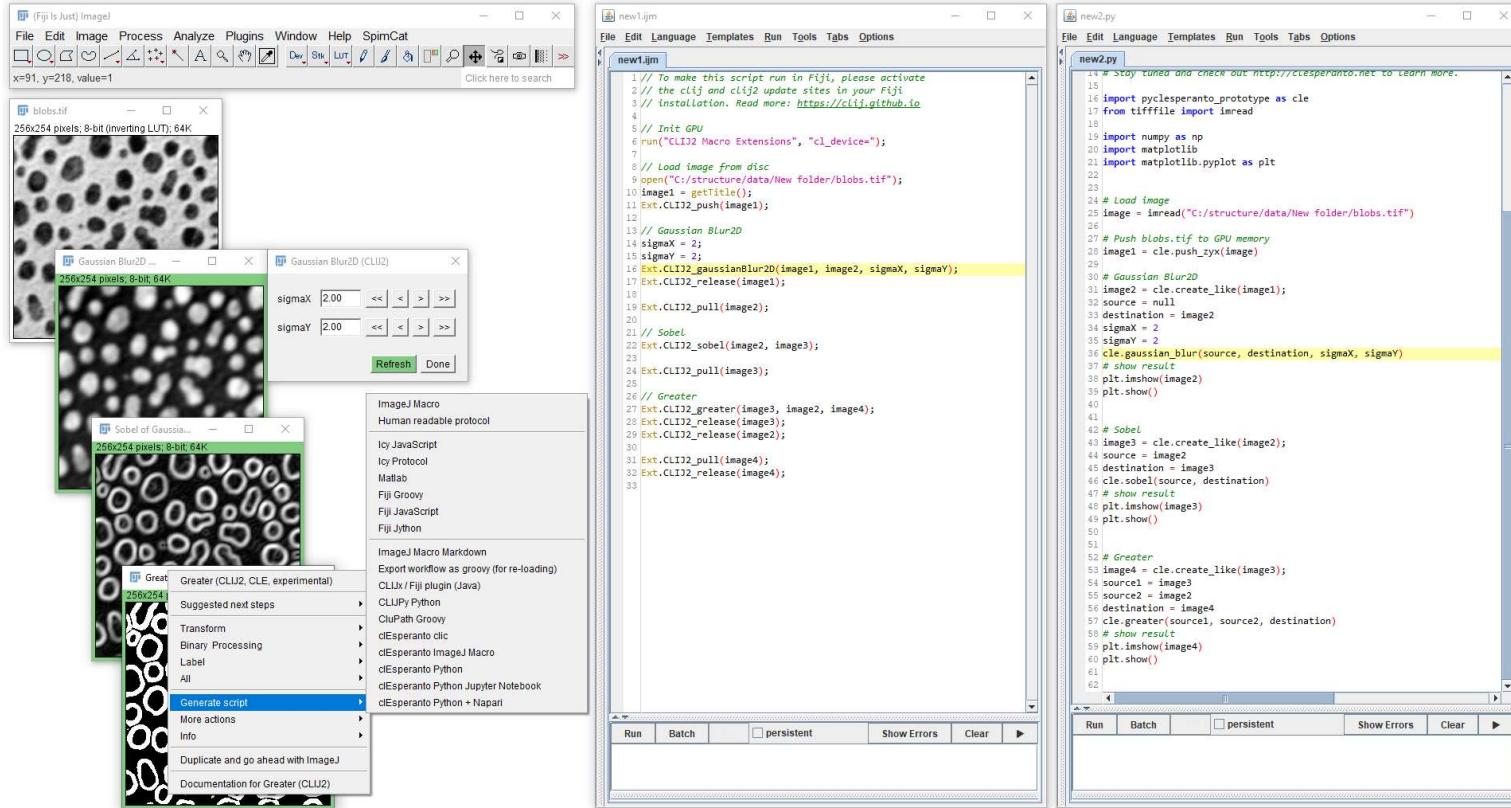
Reset parameters

If you or the optimizer screwed up parameter settings, you can get them back from the history!



clEsperanto script language comparison

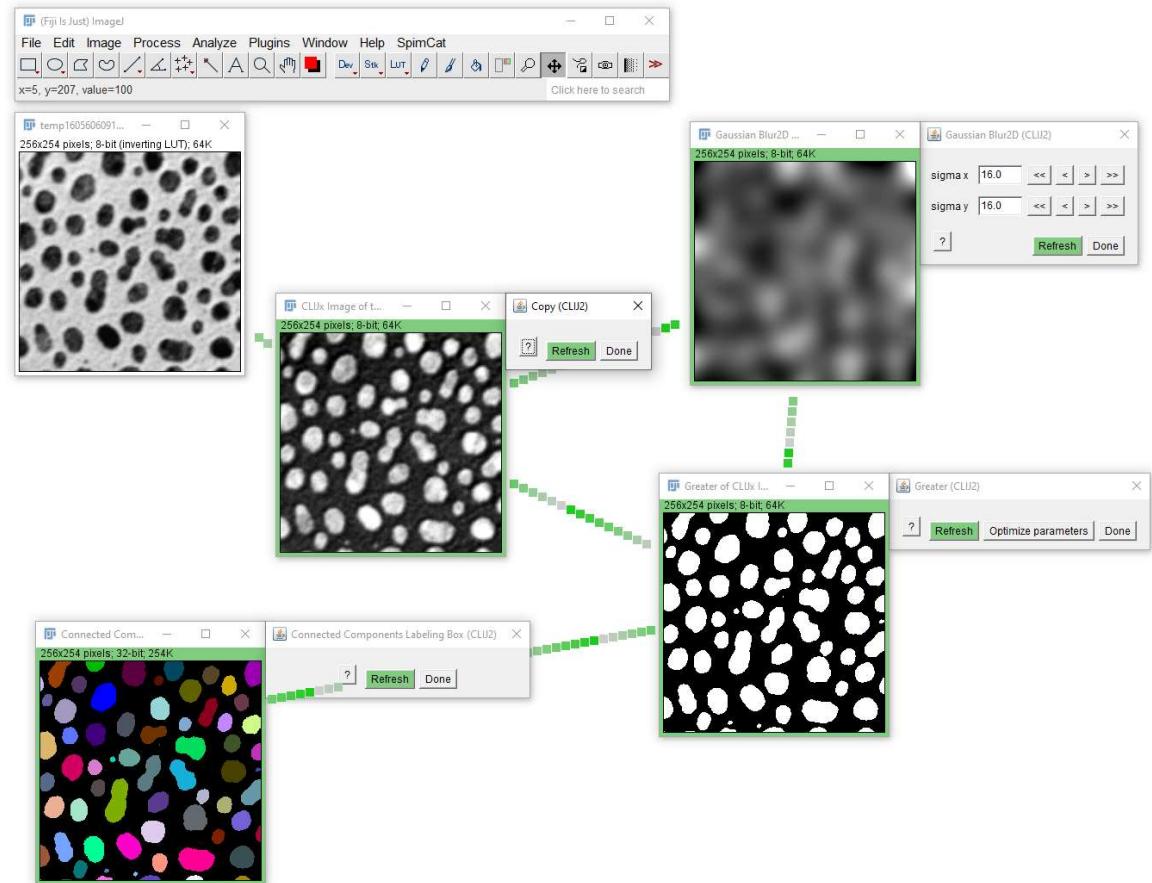
Generate multiple scripts in multiple languages from a given Image Data Flow Graph



Demo: Segment blobs.gif

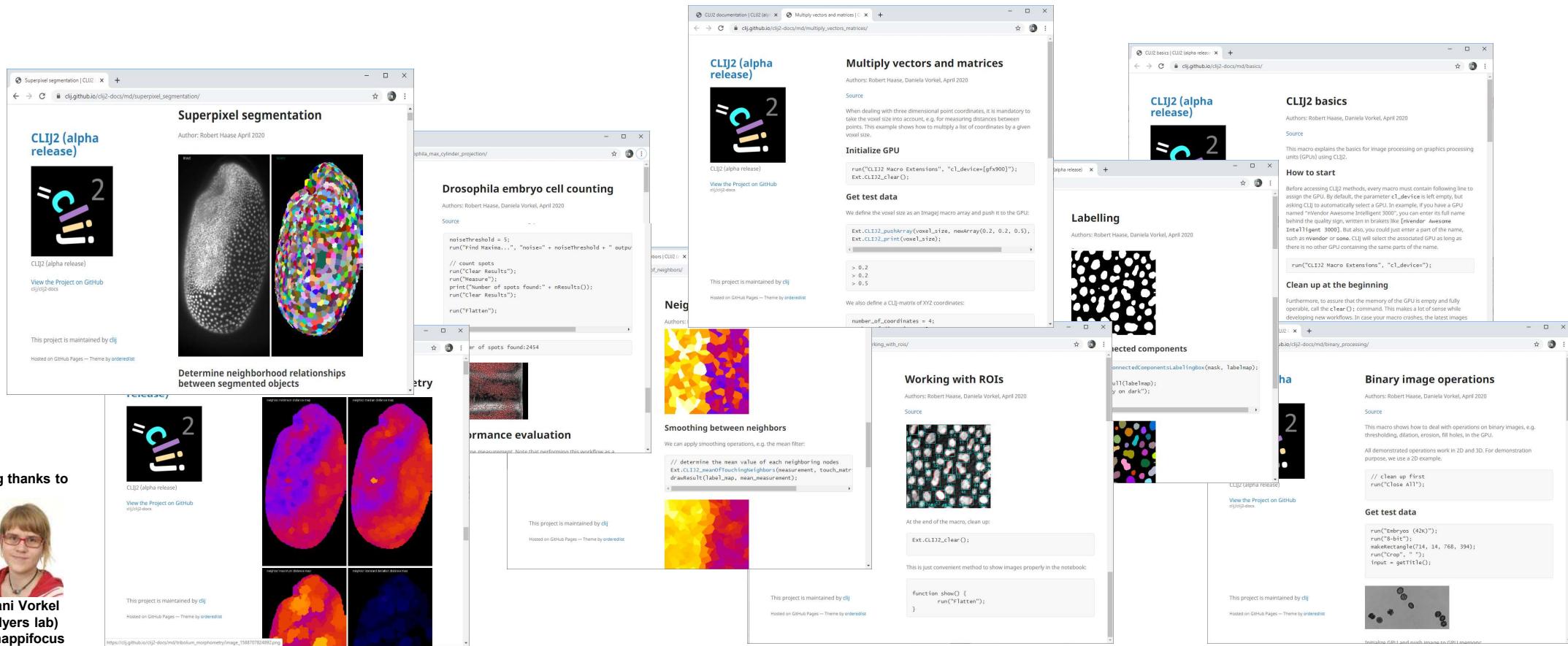
Design a workflow for segmenting blobs.gif (File > Open Samples...)

- Export the workflow as ImageJ Macro script for and Fiji Jython.



Demo: Segment blobs.gif

Online documentation: tutorials



The screenshot displays a collection of online documentation pages for CLIJ2, organized into several sections:

- Superpixel segmentation**: Shows a grayscale image of a cell and its superpixel segmentation.
- Drosophila embryo cell counting**: Shows a grayscale image of a Drosophila embryo and a heatmap of cell counts.
- Performance evaluation**: Shows four heatmaps comparing different distance metrics.
- CLIJ2 basics**: Includes sections for "How to start", "Labeling", "Working with ROIs", and "Binary image operations".
- Multiply vectors and matrices**: Shows code examples for multiplying vectors and matrices.
- Smooth between neighbors**: Shows a heatmap of smoothed data.
- Connected components**: Shows a grayscale image and its corresponding labeled components.
- Working with ROIs**: Shows a grayscale image with ROI measurements.
- Get test data**: Shows a grayscale image of a cell with overlaid annotations.
- CLIJ2 documentation**: A general overview page.

Each page includes a "Source" section with the corresponding CLJ2 macro code.

Big thanks to



Dani Vorkel
(Myers lab)
@happifocus

<https://clij.github.io/>

Online documentation: Cheat sheets

Cheat sheets show the most important methods with input and output parameters visually.

CLIJ2 cheat sheet: ImageJ macro I

GPU-accelerated image processing in Fiji

CLIJ2 cheat sheet: ImageJ macro II

GPU-accelerated image processing in Fiji

CLIJ2 cheat sheet: ImageJ macro III

GPU-accelerated image processing in Fiji

CLIJ2 cheat sheet: ImageJ macro IV

GPU-accelerated image processing in Fiji

CLIJ2 cheat sheet: ImageJ macro II

GPU-accelerated image processing in Fiji

	Operation	Parameters	Result	Dim	Basics / Workflows
Initialize CLIJ		[] HD, GFX or CPU			
Push				2D	
Pull				2D	
Create	1024, 1024, 8			2D	
Convert				2D	
Copy				2D	
Copy slice	50			2D	
Crop	20, 20			2D	
Paste	9, 9			2D	
Release				2D	
Clear				2D	
Rotate by 90 degrees				2D	Spatial transforms
Rotate	, 45, true			2D	
Flip	, true, false			2D	
Translate	, 20, 20			2D	
Affine transform	"center", "center", "center", "center"			2D	
Deform / warp				2D	
Projections				2D	

<https://clij.github.io/clij2-docs> [@haesleinhuepf](#) [@PoLDresden](#)

Operation	Parameters	Result	Dim	Examples
Gaussian blur	, 10, 10		2D 3D	<code>Ext.CLIJ2_gaussianBlur2D(input, result, sigmaX, sigmaY);</code>
Difference of Gaussian	, 2, 2, 20, 20		2D 3D	<code>Ext.CLIJ2_differenceOfGaussian2D(input, result, sigmaX, sigmaY, sigma2X, sigma2Y);</code>
Invert			2D 3D	<code>Ext.CLIJ2_invert(input, result);</code>
Laplace			2D 3D	<code>Ext.CLIJ2_laplaceBox(input, result);</code>
Mean	, 5, 5		2D 3D	<code>Ext.CLIJ2_mean2DBox(input, result, radiusX, radiusY);</code>

Result Dim Examples

- 2D `Ext.CLIJ2_spotsToPointList(binary_spots, pointList);`
- 3D `Ext.CLIJ2_labelledSpotsToPointList(labelled_spots, pointList);`
- 2D `Ext.CLIJ2_generateDistanceMatrix(pointList, pointList);`
- 3D `Ext.CLIJ2_generateTouchMatrix(label_map, touch_matrix);`
- 2D `Ext.CLIJ2_touchMatrixTolash(pointList, touch_matrix, mesh);`
- 3D `Ext.CLIJ2_distanceDataToMatrix(pointList, distance_matrix, mesh, max_distance);`
- 2D `Ext.CLIJ2_meanOfTouchingNeighbors(values, touch_matrix, mean_values);`
- 3D `Ext.CLIJ2_meanOfTouchingNeighbors(touch_matrix, count_vector);`
- 2D `Ext.CLIJ2_statisticsOfBackgroundAndLabeledPixels(image, labelMap);`
- 3D `Ext.CLIJ2_statisticsOfLabeledPixels(input, labelMap);`
- 2D `Ext.CLIJ2_pushResultsTable(image_name);`
- 3D `Ext.CLIJ2_pushResultsTableColumn(image_name, column_name);`
- 2D `Ext.CLIJ2_pullResultsTable(image_name);`
- 3D `CLIJ2_pushArray(image_name, array, width, height, depth);`

Installation instructions

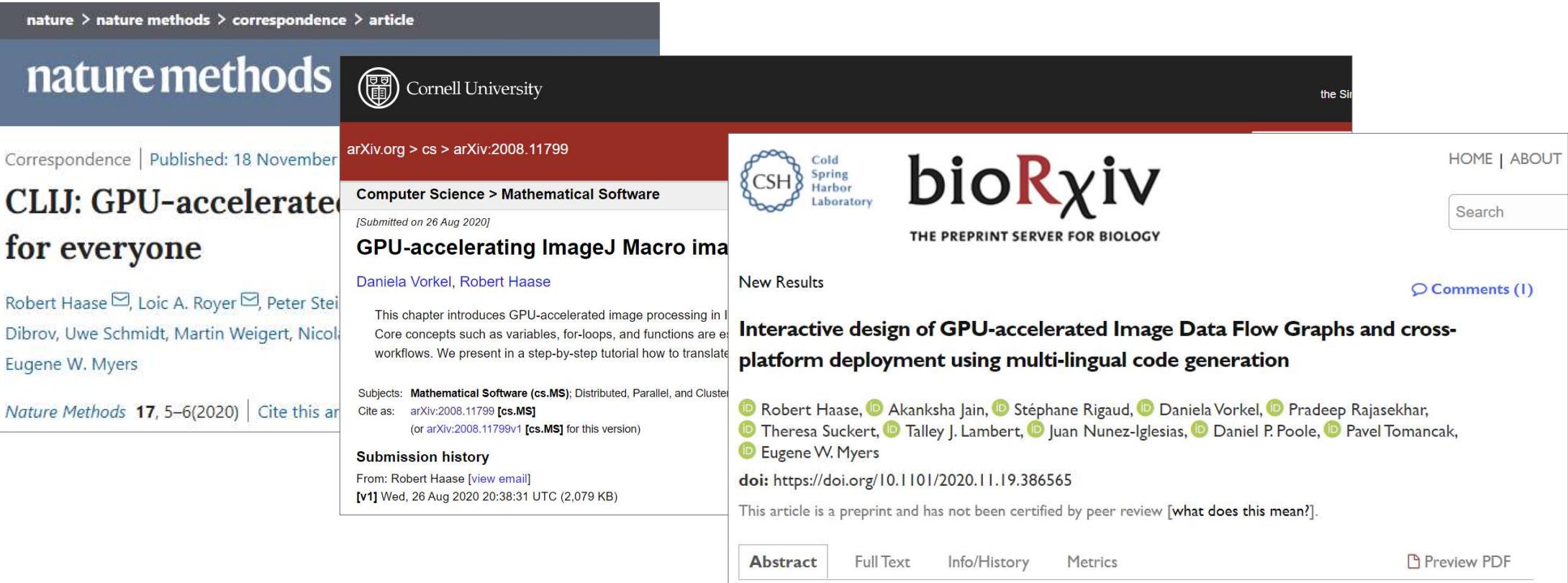
- Install CLIJ2 by activating the "clij" and "clij2" update sites in Fiji.
- Commands listed as "CLIJ" or "clij2" are handled with care. They may change or disappear at any point. To build reliable, reproducible workflows use CLIJ or CLIJ2 commands only.

docs [@haesleinhuepf](#) #clij cheat sheet 2020-04-20

https://clij.github.io/clij2-docs/CLIJ2-cheatsheet_V3.pdf

Last but not least: citability

- If you work with CLIJ and friends, please cite the paper(s). It'll be hard to apply for grants otherwise.



The screenshot shows the bioRxiv preprint page for the paper "CLIJ: GPU-accelerated ImageJ Macro for everyone". The page includes the Cornell University logo, the CSHL logo, and the bioRxiv logo. It displays the abstract, author information, and a list of co-authors. The URL <https://clij.github.io/> is visible at the bottom of the page.

nature > nature methods > correspondence > article

nature methods

Cornell University

Correspondence | Published: 18 November 2020

CLIJ: GPU-accelerated ImageJ Macro for everyone

Robert Haase, Loic A. Royer, Peter Stein, Dibrov, Uwe Schmidt, Martin Weigert, Nicolai Eugen W. Myers

Nature Methods 17, 5–6(2020) | Cite this article

arXiv.org > cs > arXiv:2008.11799

Computer Science > Mathematical Software

[Submitted on 26 Aug 2020]

GPU-accelerating ImageJ Macro images

Daniela Vorkel, Robert Haase

This chapter introduces GPU-accelerated image processing in ImageJ. Core concepts such as variables, for-loops, and functions are explained. We present several workflows. We present in a step-by-step tutorial how to translate workflows. We present in a step-by-step tutorial how to translate workflows. We present in a step-by-step tutorial how to translate workflows.

Subjects: Mathematical Software (cs.MS); Distributed, Parallel, and Cluster Computing (cs.DC)

Cite as: arXiv:2008.11799 [cs.MS] (or arXiv:2008.11799v1 [cs.MS] for this version)

Submission history

From: Robert Haase [view email]

[v1] Wed, 26 Aug 2020 20:38:31 UTC (2,079 KB)

bioRxiv
THE PREPRINT SERVER FOR BIOLOGY

New Results

Comments (1)

Interactive design of GPU-accelerated Image Data Flow Graphs and cross-platform deployment using multi-lingual code generation

Robert Haase, Akanksha Jain, Stéphane Rigaud, Daniela Vorkel, Pradeep Rajasekhar, Theresa Suckert, Talley J. Lambert, Juan Nunez-Iglesias, Daniel P. Poole, Pavel Tomancak, Eugene W. Myers

doi: <https://doi.org/10.1101/2020.11.19.386565>

This article is a preprint and has not been certified by peer review [what does this mean?].

Abstract Full Text Info/History Metrics Preview PDF

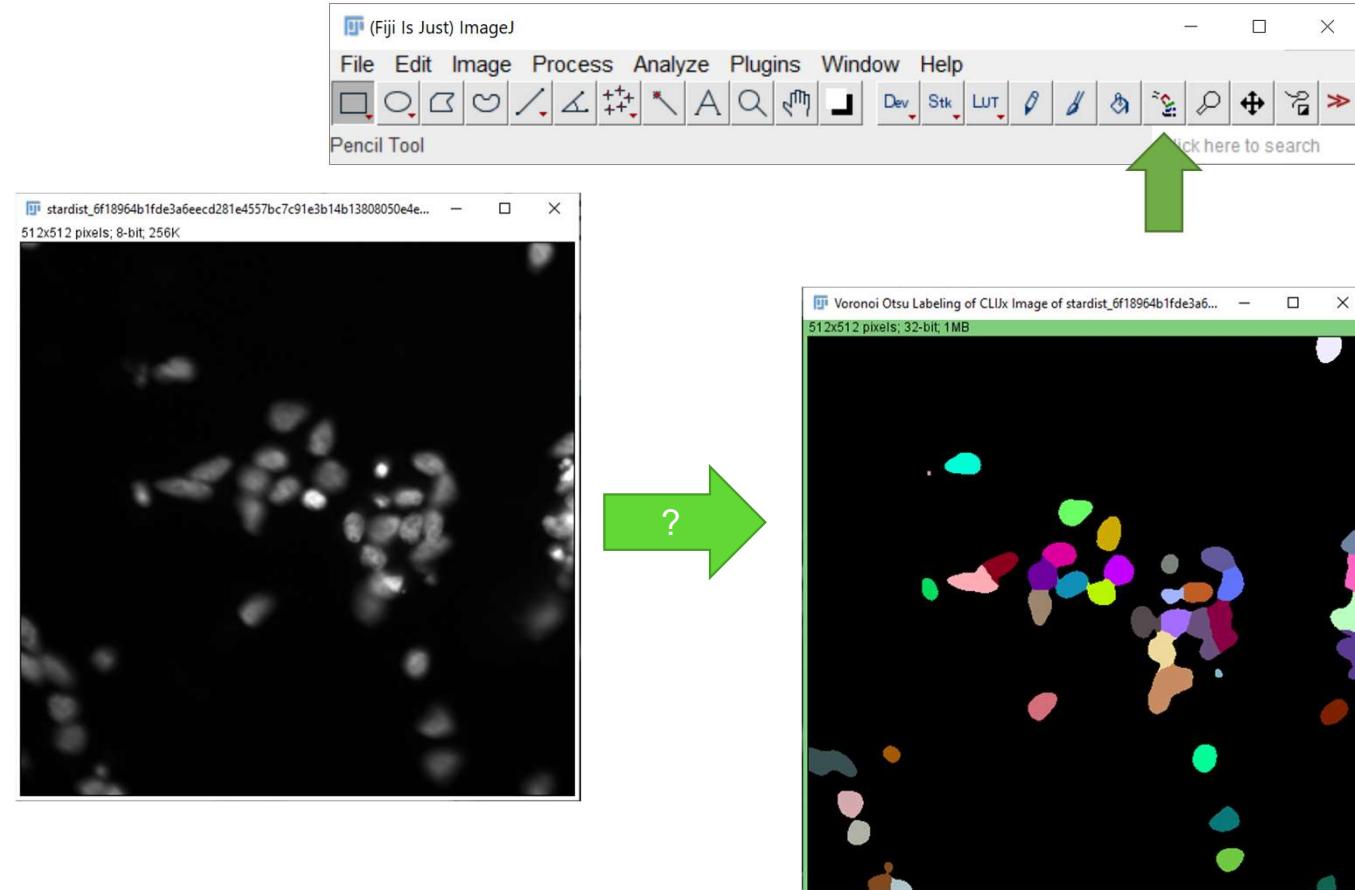
Exercise

Segment a file in this folder using
CLIJ:

- Day3\startdist_data\

Hint: Convert the image first using
menu Image > Type > 8-bit

Optional: Generate a macro
and apply it to all images in
that folder.

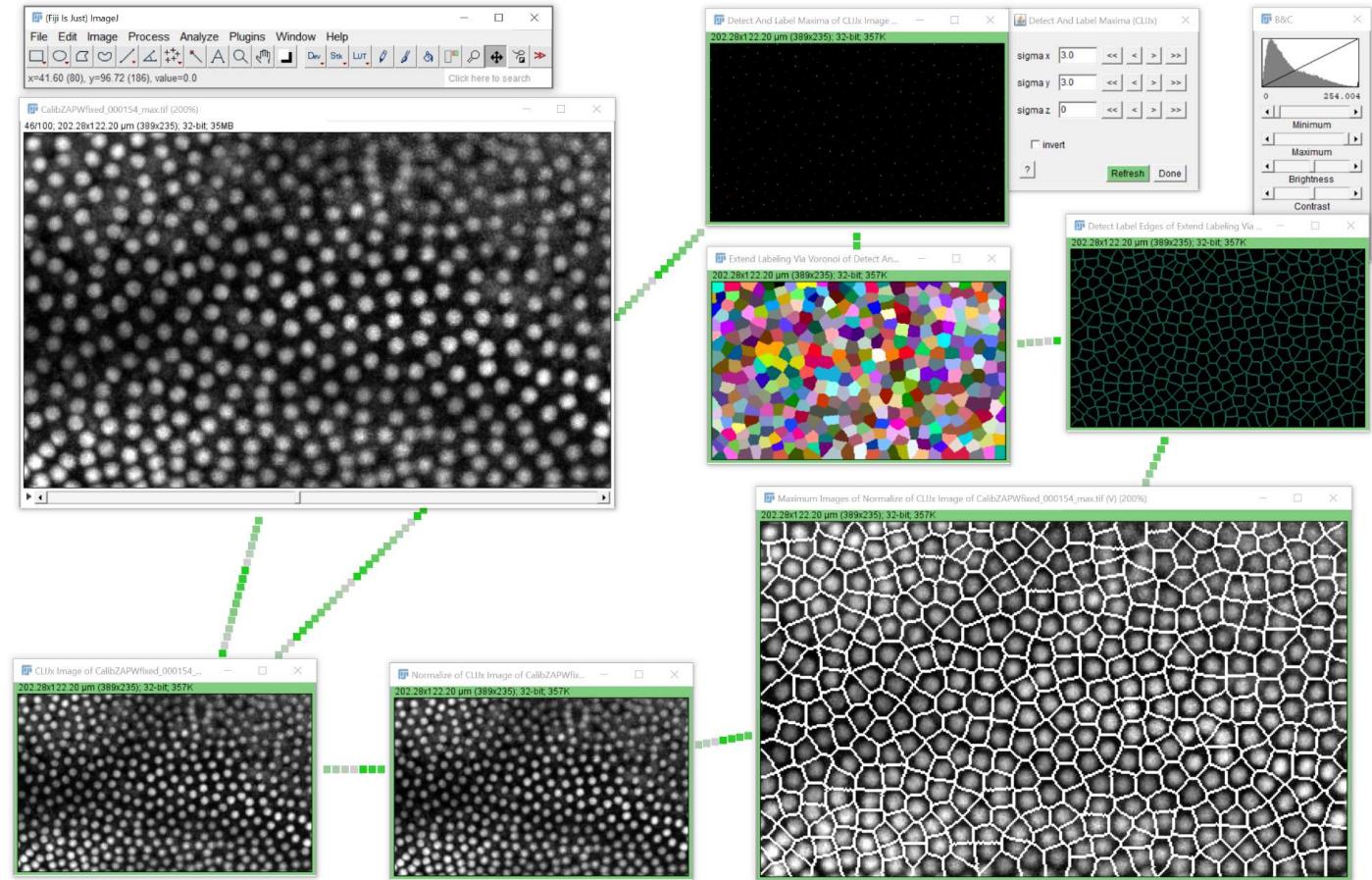


Exercise: Segmentation in time lapse data

Setup a workflow for estimating cell borders between nuclei

Day3\image_data_flow_graphs\
CalibZAPWfixed_000154_max.tif

Export an ImageJ Macro and run it.
Note: This exercise will teach you
how to deal with errors in
generated macro code and how to
build in a for loop to process frames
individually.



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(HMS)
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MPI CBG Core Facilities
• Advanced Imaging Facility
• Light Microscopy Facility
• Scientific Computing
• IT Department
• Fly lab



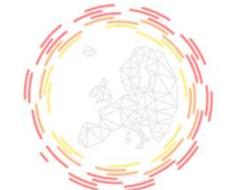
<https://fiji.sc>



<https://napari.dev>



<https://image.sc> <http://eubias.org/>
NEUBIAS/



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DRESDEN
concept



<https://clij.github.io/>

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