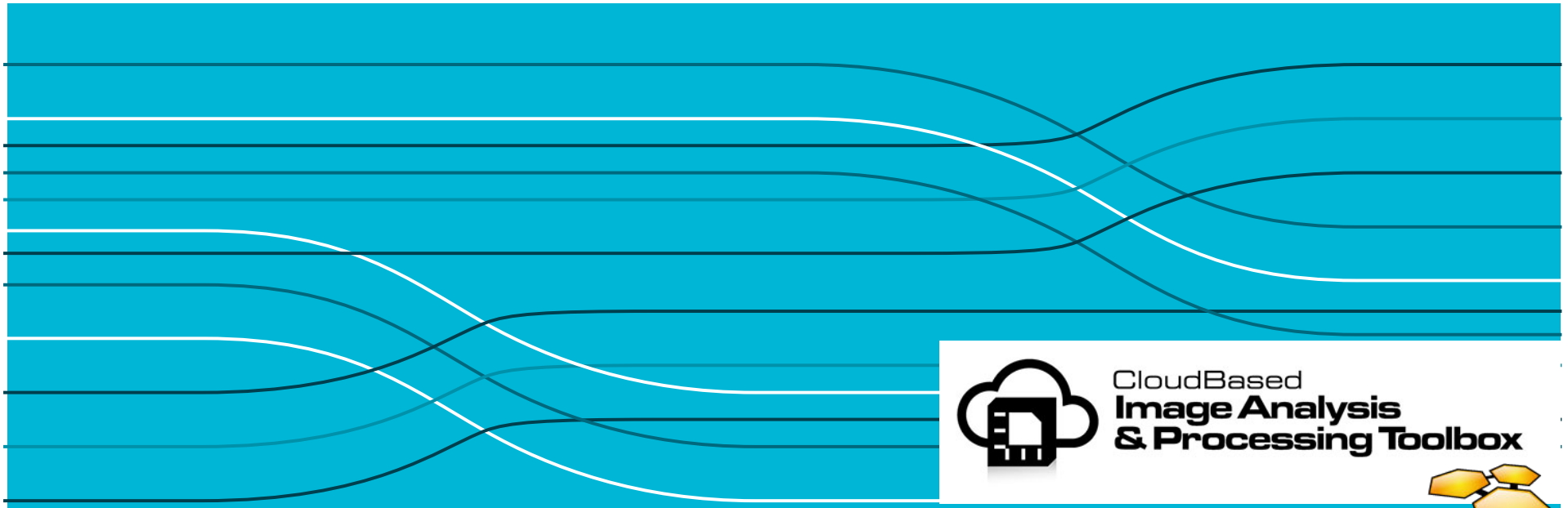

CloudBased
Image Analysis
& Processing Toolbox

Cell Image Analysis with Galaxy

Yulia Arzhaeva

Galaxy Australasia Workshop 2014

CSIRO Computational Informatics
www.csiro.au

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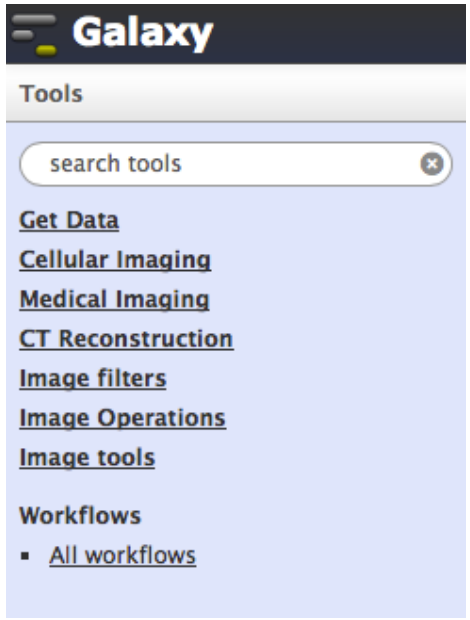
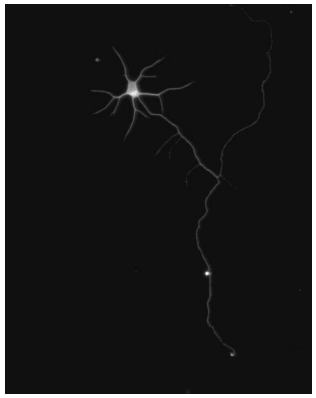
Talk contents

1. CloudBased Image Analysis & Processing Toolbox

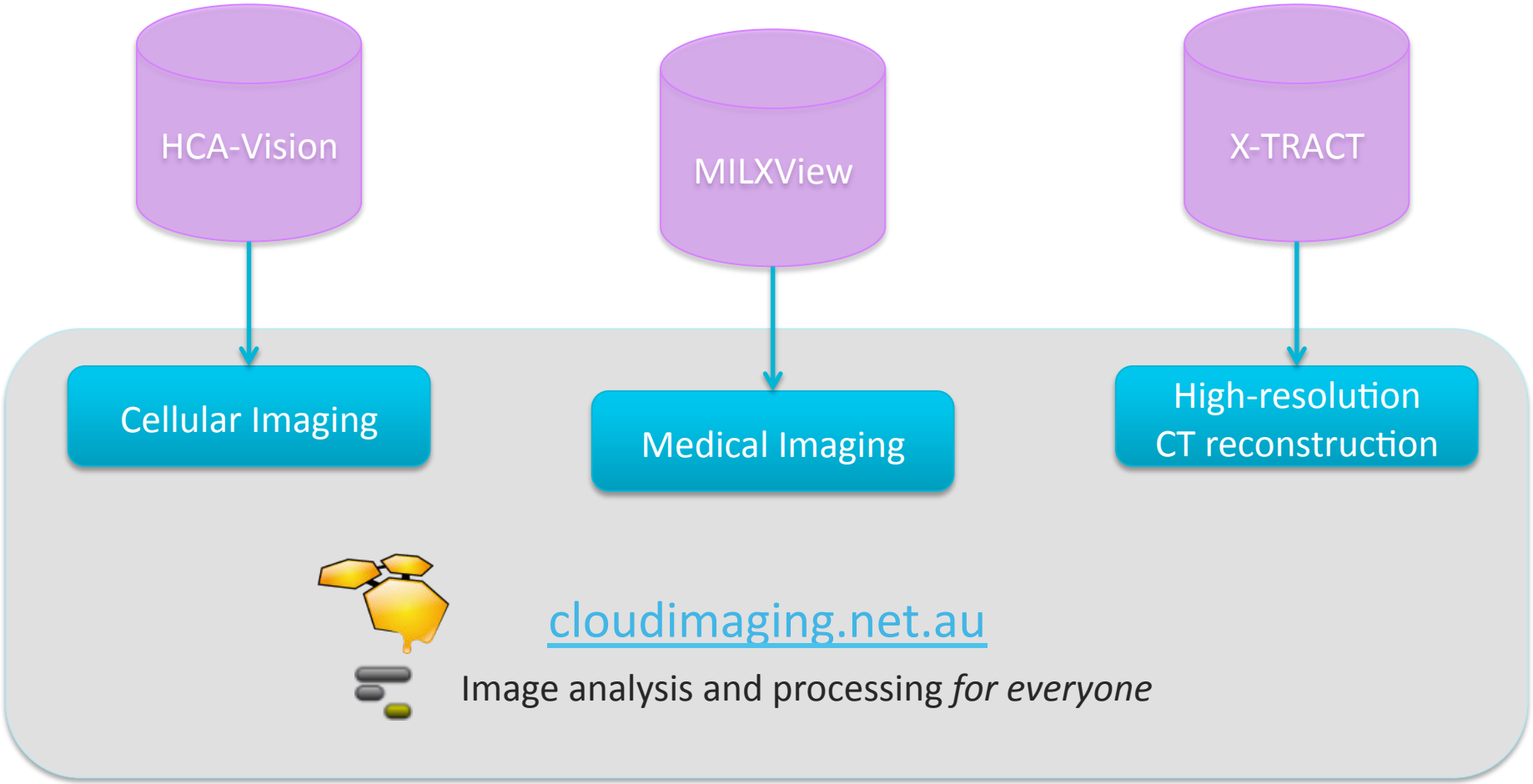
2. Cellular Imaging tools



3. Application :
   quantify complexity of neurites



Cloud-based image analysis and processing



CloudBased Image Analysis & Processing Toolbox

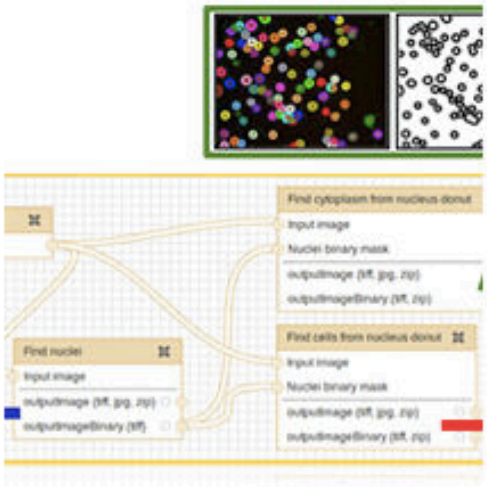
Image Analysis and Processing for *for everyone.*

The Cloud-based Image Analysis and Processing Toolbox project provides access to existing biomedical image processing and analysis tools via remote user-interface using the NeCTAR cloud.

Use Toolbox

Use project's free server

Demo



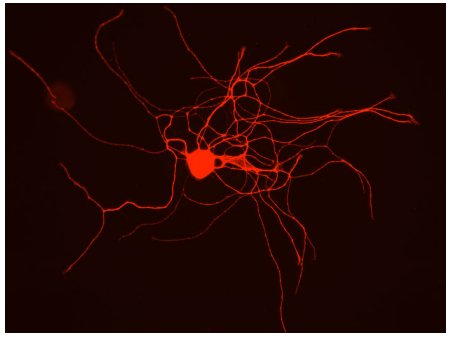
Watch other demos

Project Blog

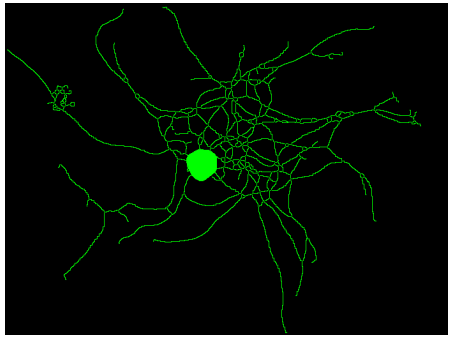
Project Blog

Cell image analysis needs

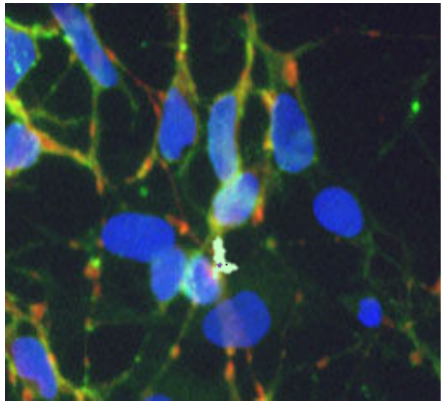
Rat brain neurite outgrowth image



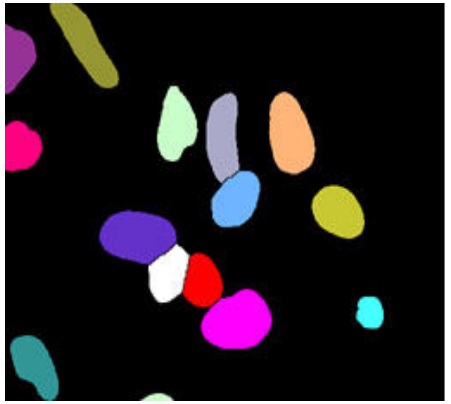
Neurites segmented



Fluorescence microscopy image



Nuclei segmented



Cell statistics

CellNo	Area	Perimeter	TotalNeuriteLength	MaxNeuriteLength	MaxBranchLayer
1	48	28	7.02	7.02	1
2	90	40	333.77	125.89	5
3	64	32	113.79	78.38	2
4	527	124	25.55	25.55	1
5	92	38	0	0	0
6	115	47	26.85	26.85	1
7	157	58	6.33	6.33	1
8	77	38	30.28	23.26	2
9	158	58	141.39	81.66	2
10	130	49	0	0	0
11	79	40	0	0	0
12	374	90	111.33	57.41	2
13	629	153	0	0	0
14	76	32	5.54	5.54	1

Industrial cell screening systems use our software modules

- **ImageXpress®** by Molecular Devices
- **Pathway HT™** by BD Biosciences
- **Opera®** by Perkin Elmer

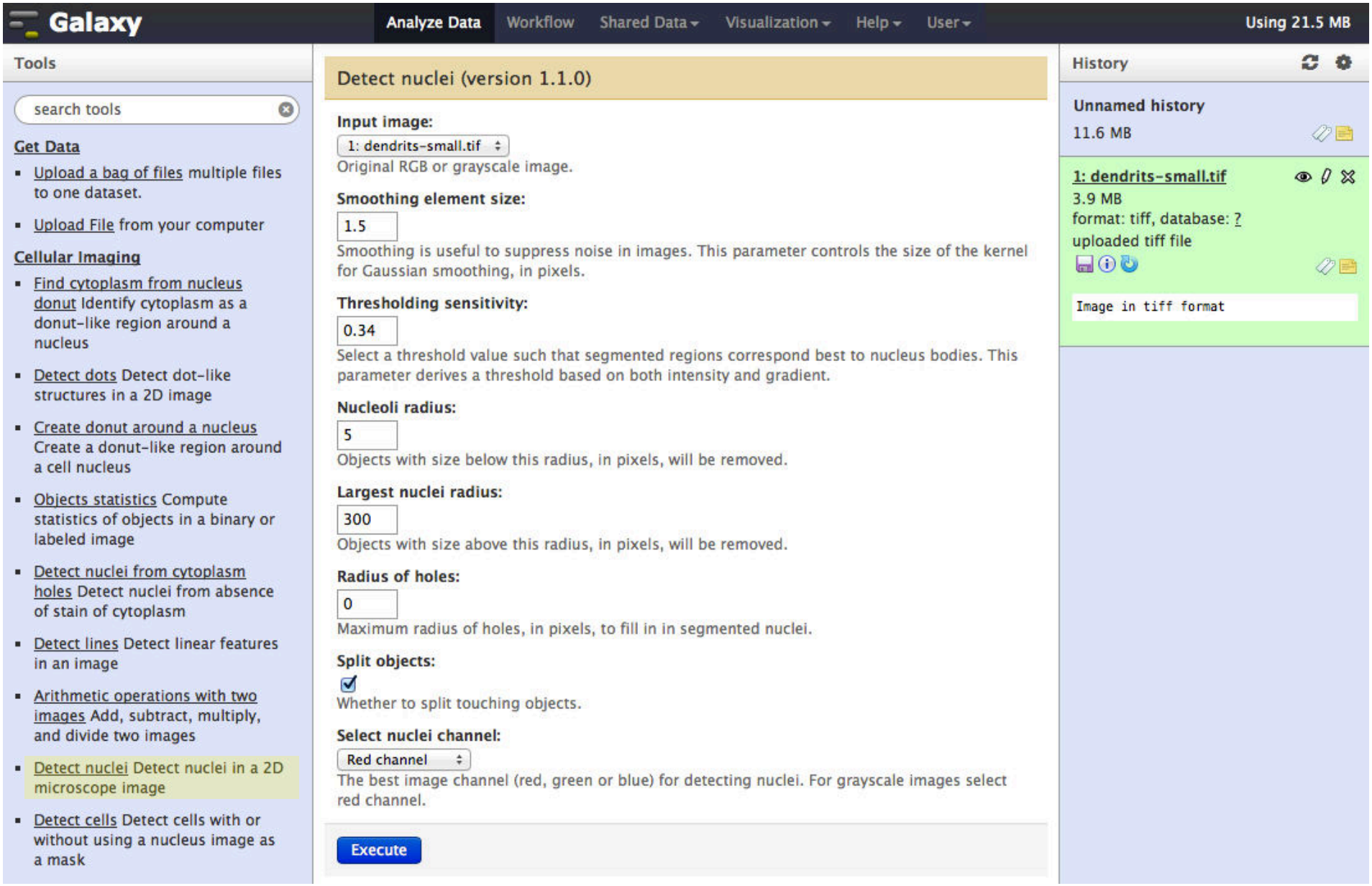
Galaxy Cellular Imaging toolbox

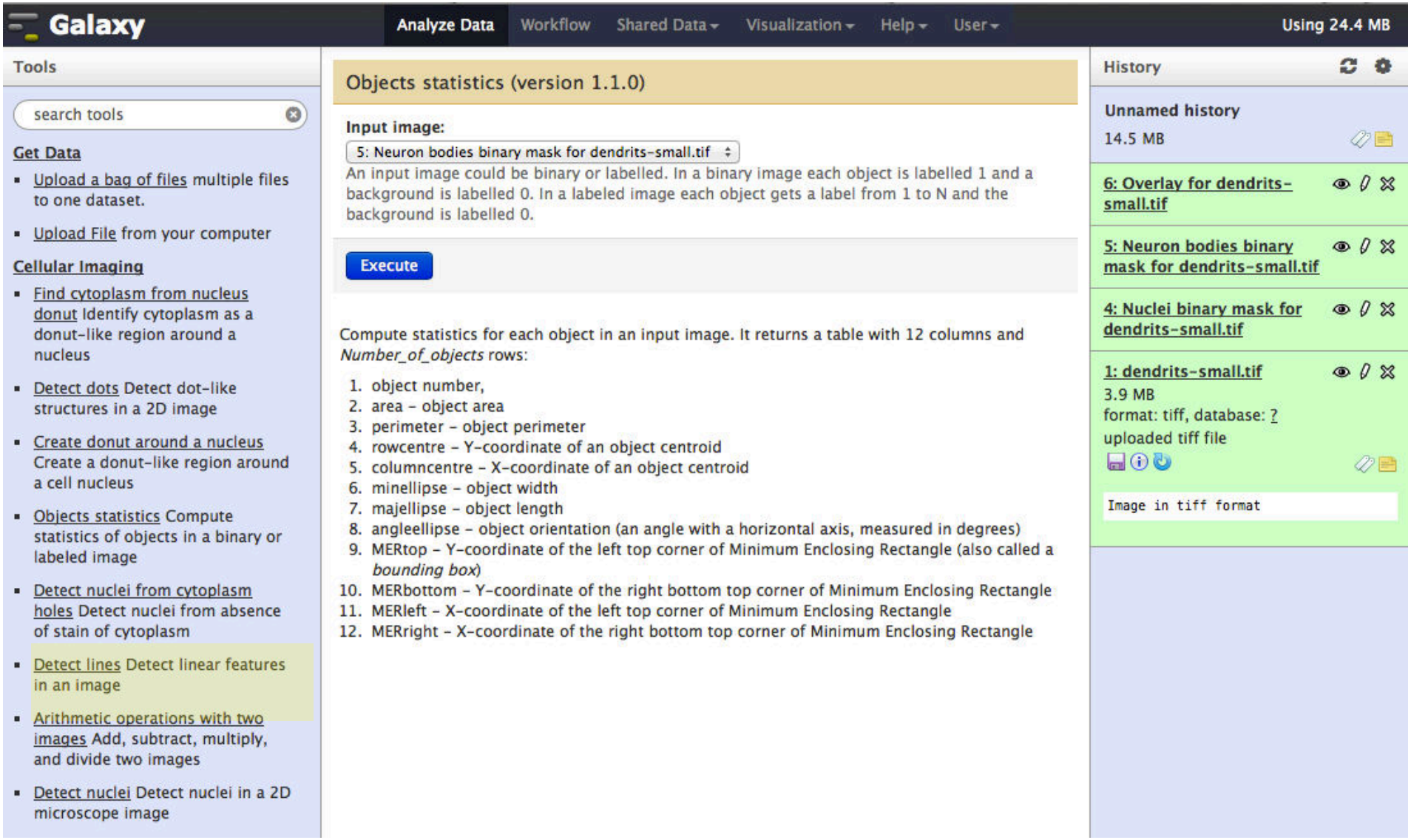
1. Most of HCA-Vision cell analysis functions

- Detect neurons/cells
- Detect nuclei
- Detect neurites
- Detect dots
- Statistics for objects, lines and dots

2. Convenience functions

- Arithmetic and logic operations with images
- Filter objects by morphology attributes (area, elongation, etc)
- Label objects
- Overlay image with labelled mask


Galaxy
Analyze Data
Workflow
Shared Data
Visualization
Help
User
Using 21.5 MB
Tools
search tools
Get Data
Upload a bag of files multiple files to one dataset.
Upload File from your computer
Cellular Imaging
Find cytoplasm from nucleus donut Identify cytoplasm as a donut-like region around a nucleus
Detect dots Detect dot-like structures in a 2D image
Create donut around a nucleus Create a donut-like region around a cell nucleus
Objects statistics Compute statistics of objects in a binary or labeled image
Detect nuclei from cytoplasm holes Detect nuclei from absence of stain of cytoplasm
Detect lines Detect linear features in an image
Arithmetic operations with two images Add, subtract, multiply, and divide two images
Detect nuclei Detect nuclei in a 2D microscope image
Detect cells Detect cells with or without using a nucleus image as a mask
Detect nuclei (version 1.1.0)
Input image:
1: dendrits-small.tif
Original RGB or grayscale image.
Smoothing element size:
1.5
Smoothing is useful to suppress noise in images. This parameter controls the size of the kernel for Gaussian smoothing, in pixels.
Thresholding sensitivity:
0.34
Select a threshold value such that segmented regions correspond best to nucleus bodies. This parameter derives a threshold based on both intensity and gradient.
Nucleoli radius:
5
Objects with size below this radius, in pixels, will be removed.
Largest nuclei radius:
300
Objects with size above this radius, in pixels, will be removed.
Radius of holes:
0
Maximum radius of holes, in pixels, to fill in in segmented nuclei.
Split objects:
Whether to split touching objects.
Select nuclei channel:
Red channel
The best image channel (red, green or blue) for detecting nuclei. For grayscale images select red channel.
Execute
History
Unnamed history
11.6 MB
1: dendrits-small.tif
3.9 MB
format: tiff, database: ?
uploaded tiff file
Image in tiff format


Galaxy
Analyze Data
Workflow
Shared Data
Visualization
Help
User
Using 24.4 MB
Tools
search tools
Get Data
Upload a bag of files multiple files to one dataset.
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Detect nuclei Detect nuclei in a 2D microscope image
Objects statistics (version 1.1.0)
Input image:
5: Neuron bodies binary mask for dendrits-small.tif
An input image could be binary or labelled. In a binary image each object is labelled 1 and a background is labelled 0. In a labeled image each object gets a label from 1 to N and the background is labelled 0.
Execute
Compute statistics for each object in an input image. It returns a table with 12 columns and Number_of_objects rows:
1. object number,
2. area - object area
3. perimeter - object perimeter
4. rowcentre - Y-coordinate of an object centroid
5. columncentre - X-coordinate of an object centroid
6. minellipse - object width
7. majellipse - object length
8. angleellipse - object orientation (an angle with a horizontal axis, measured in degrees)
9. MERtop - Y-coordinate of the left top corner of Minimum Enclosing Rectangle (also called a bounding box)
10. MERbottom - Y-coordinate of the right bottom top corner of Minimum Enclosing Rectangle
11. MERleft - X-coordinate of the left top corner of Minimum Enclosing Rectangle
12. MERright - X-coordinate of the right bottom top corner of Minimum Enclosing Rectangle
History
Unnamed history
14.5 MB
6: Overlay for dendrits-small.tif
5: Neuron bodies binary mask for dendrits-small.tif
4: Nuclei binary mask for dendrits-small.tif
1: dendrits-small.tif
3.9 MB
format: tiff, database: ?
uploaded tiff file
Image in tiff format

Galaxy | Analyze Data | Workflow | Shared Data | Visualization | Help | User

Tools

search tools

Get Data

- Upload a bag of files multiple files to one dataset.
- Upload File from your computer

Cellular Imaging

- Find cytoplasm from nucleus donut Identify cytoplasm as a donut-like region around a nucleus
- Detect dots Detect dot-like structures in a 2D image
- Create donut around a nucleus Create a donut-like region around a cell nucleus
- Objects statistics Compute statistics of objects in a binary or labeled image
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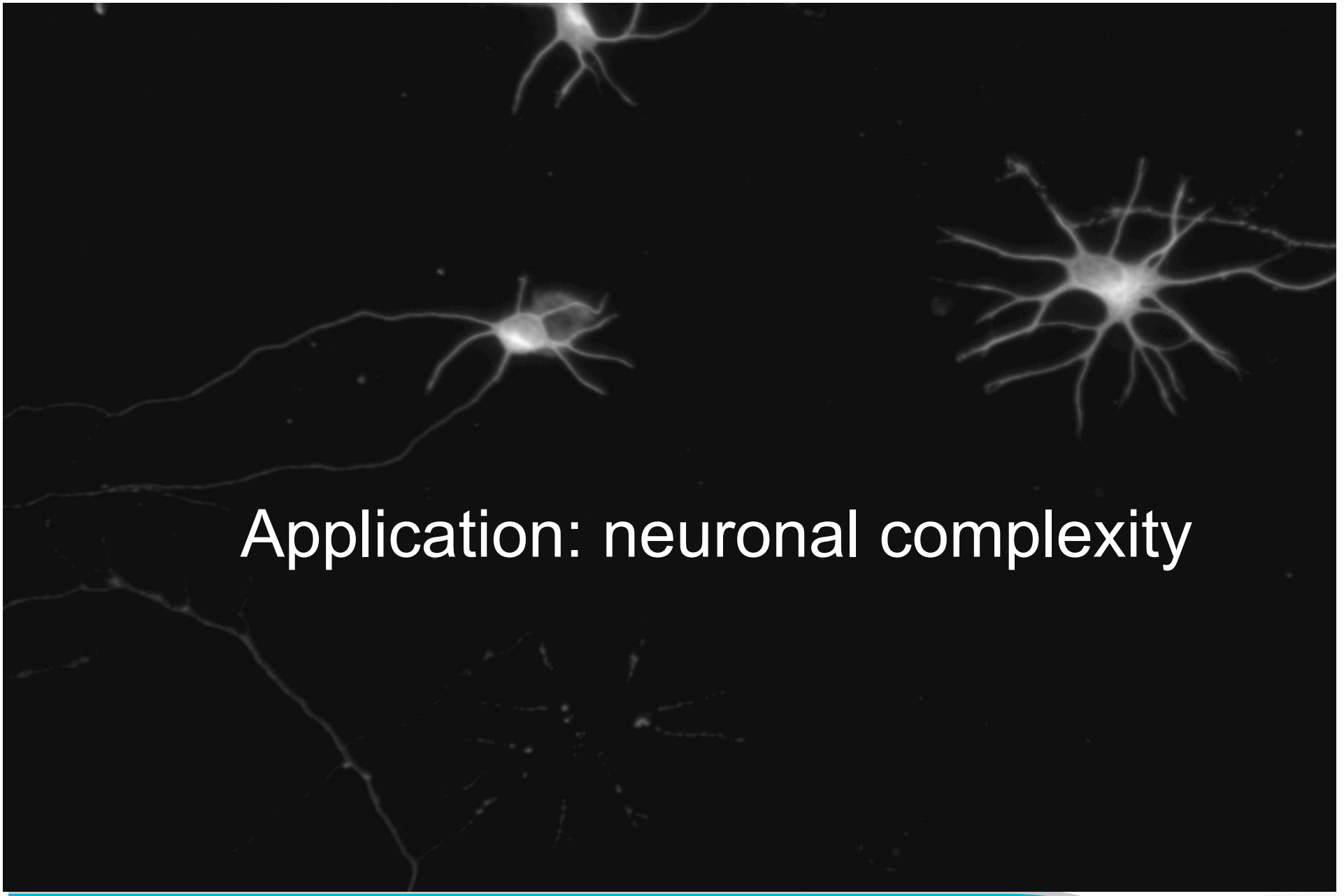
- Detect lines Detect linear features in an image
- Arithmetic operations with two images Add, subtract, multiply, and divide two images
- Detect nuclei Detect nuclei in a 2D microscope image
- Detect cells Detect cells with or without using a nucleus image as a mask
- Overlay image with labelled mask Create a colourful overlay image from an original image and a labelled mask

number	area	perimeter	rowcentre	columncentre	minellipse	majellipse	angleellipse	MERtop	MERbottom	MERleft	MERright
1	1250	172	12.388	174.423	27.5148	58.9309	-5.00511	1	28	145	204
2	449	107	7.49443	345.541	18.0306	33.767	-3.89746	1	17	328	366
3	2405	256	27.4183	368.834	46.2345	69.832	-43.2021	1	62	336	402
4	539	124	7.42115	793.032	15.6475	46.8322	9.99764	1	18	768	812
5	638	126	11.4828	892.182	22.3224	38.8694	-33.9003	1	28	878	914
6	1676	237	35.0024	935.458	41.7682	55.7147	-82.3959	1	61	914	960
7	6053	382	70.7272	265.492	84.5831	91.8653	26.5839	29	113	217	315
8	1538	191	75.6417	169.127	43.1737	45.9412	84.2586	53	101	147	195
9	1960	238	88.6827	727.794	37.2721	69.1666	24.1668	63	115	696	763
10	1568	196	87.4503	992.256	38.5781	53.1005	-37.6794	65	110	966	1018
11	1925	214	98.7823	132.435	44.7846	55.6886	54.08	74	126	105	161
12	1330	178	107.259	190.055	35.3172	48.6098	-60.2497	80	128	170	209
13	2002	235	111.215	1043.57	44.5569	59.1568	13.1276	84	137	1013	1073
14	1834	236	114.432	937.11	38.8714	65.4018	-3.05326	90	134	906	970
15	1614	189	121.127	100.496	40.6281	51.3204	79.542	92	144	80	123
16	1946	210	124.752	495.153	44.3777	56.8216	30.9893	101	150	468	524
17	2138	236	129.522	642.493	48.4438	59.1329	-43.9339	102	160	616	675
18	2290	232	148.239	208.44	45.9648	64.2582	-32.6102	121	175	178	238
19	2189	234	150.273	1032.52	45.0372	63.3237	34.2009	123	178	1003	1062
20	2795	248	159.813	351.989	58.6932	60.9443	-81.7497	127	192	323	381
21	3675	294	166.353	443.78	66.8442	71.0862	26.5248	132	203	410	481
22	2325	236	162.843	773.672	48.0579	63.339	-22.4377	134	187	742	803
23	2657	262	189.868	961.155	53.656	65.3088	-73.3368	152	219	930	990
24	3428	264	192.211	693.137	58.8714	74.5418	-37.4402	161	225	660	728
25	2514	248	194.377	265.574	48.7257	66.6336	-60.7394	164	226	236	293
26	2774	262	196.2	831.35	56.3521	63.6368	-30.8749	164	229	799	862
27	1520	212	200.634	84.4467	30.295	66.2711	51.5178	171	230	60	107
28	1930	206	207.075	618.906	41.6111	59.7872	-61.8117	179	233	593	642
29	1827	208	209.744	177.574	39.484	59.5171	13.5822	188	230	149	208
30	2227	226	232.758	315.546	48.2655	59.2174	58.4577	204	263	290	344
31	2129	246	236.886	555.19	43.8577	65.1904	-45.5434	204	264	521	581
32	2788	308	239.576	750.853	55.4547	70.8689	-69.4013	207	286	718	784
33	1585	200	252.38	226.977	29.8167	69.3156	-73.3237	220	282	207	245
34	2227	224	265.116	435.236	50.1688	57.2798	71.9878	236	295	409	461
35	3257	272	281.958	875.001	58.3221	72.9602	51.856	248	315	837	906
36	2213	214	278.79	568.968	49.207	57.8204	-19.8598	251	303	541	596

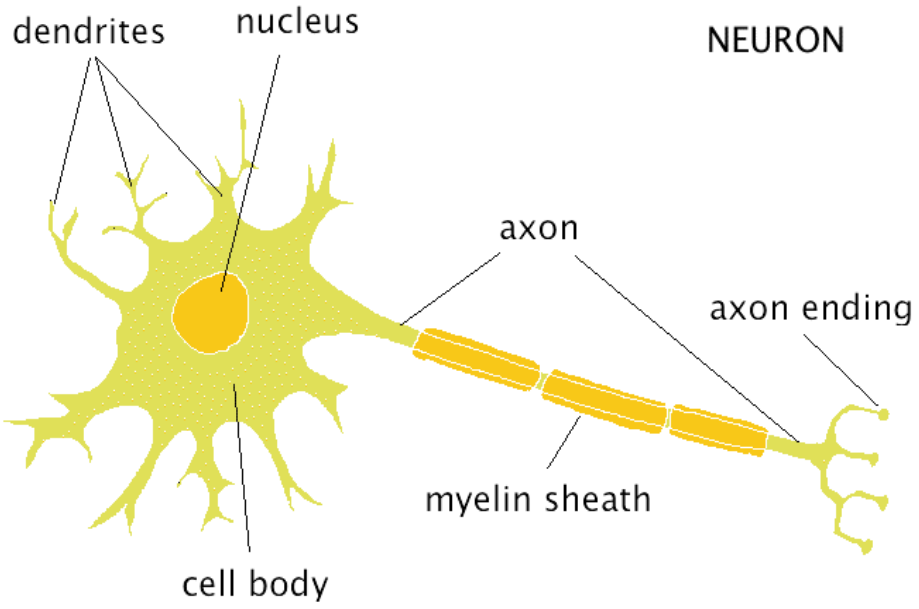
CSIRO



Application: neuronal complexity

Background Biology

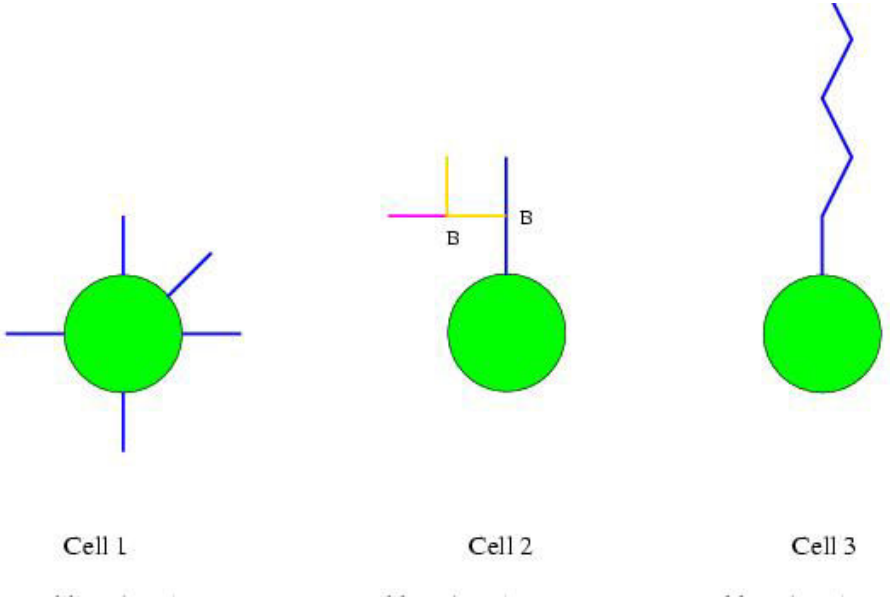
- Neurons are cells which transmit information through electrical or chemical signals
- They are core components of the nervous system (brain and spine)
- Neurons are made up of:
  - A cell body (sometimes called a soma or neuron body)
  - Dendrites (“receivers”)
  - An axon (“a transmitter”)
  - NB. Collectively, dendrites and axons are called neurites



Neuronal Complexity

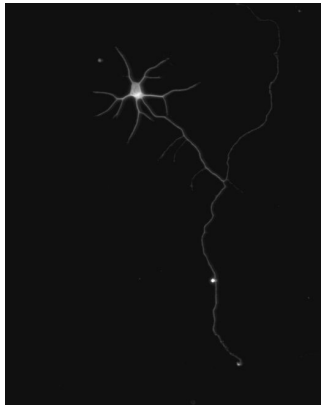
- The impact of a drug on a neurites ability to transmit information is of interest for neuropathological conditions such as Alzheimer's disease
- One way to measure this is to quantify the complexity of neurites

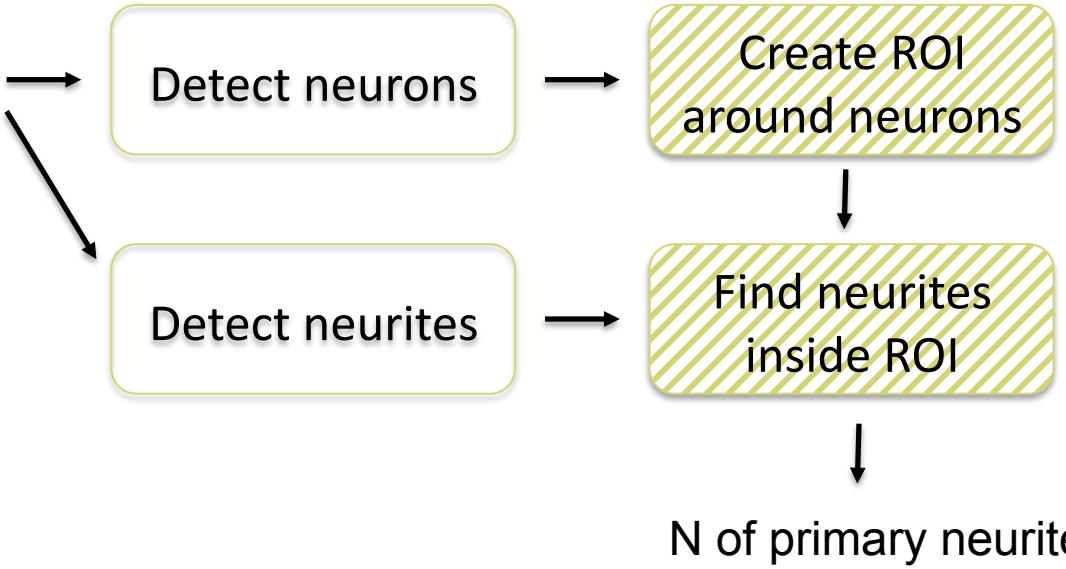
  - Length of neurites
  - Number of intersection points
  - Number of primary neurites



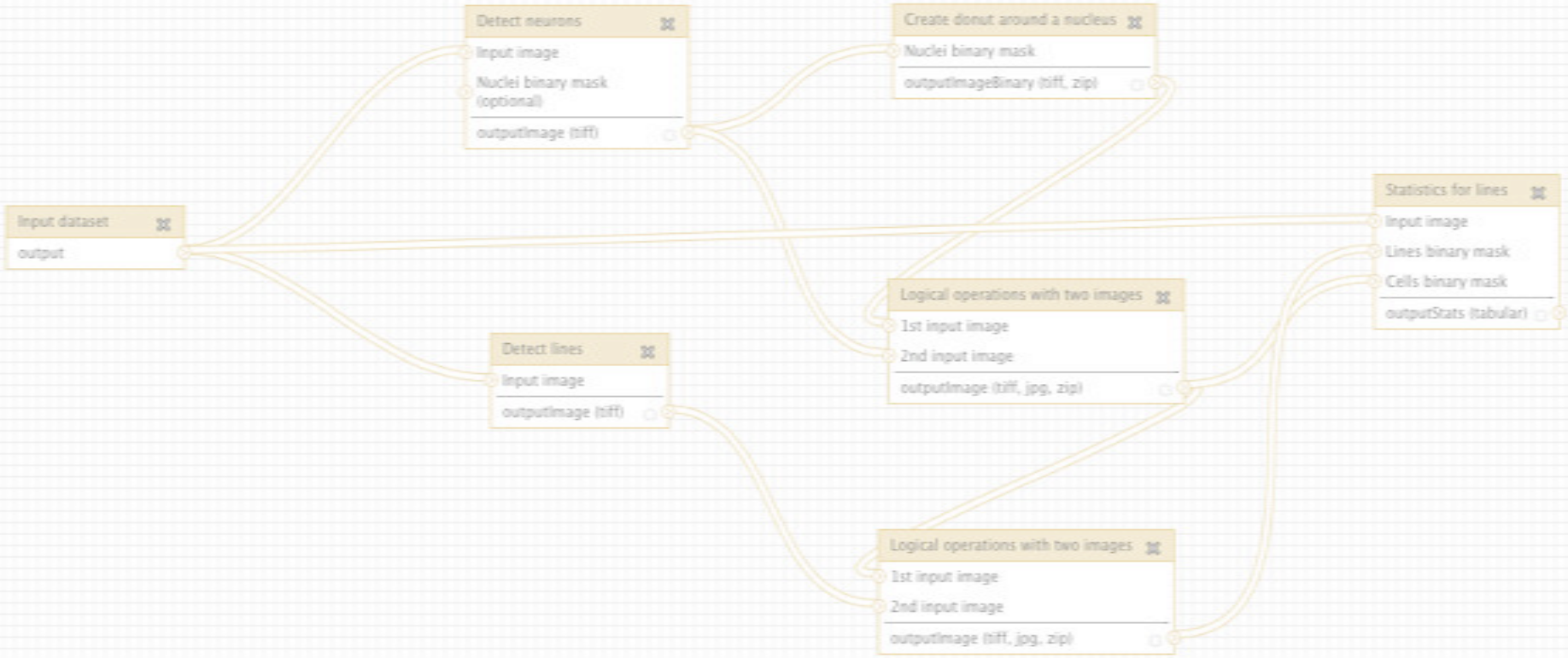
Find primary neurites: an algorithm

Image of neural cells





Demo on cloudimaging.net.au



Thank you

Cloud Based Image Analysis and Processing Project Team:

Tomasz Bednarz, Piotr Szul, Dadong Wang, Yulia Arzhaeva, Shiping Chen, Alex Khassapov, Neil Burdett, Ryan Lagerstrom, John Taylor

W cloudimaging.net.au