Vaa3D workshop series

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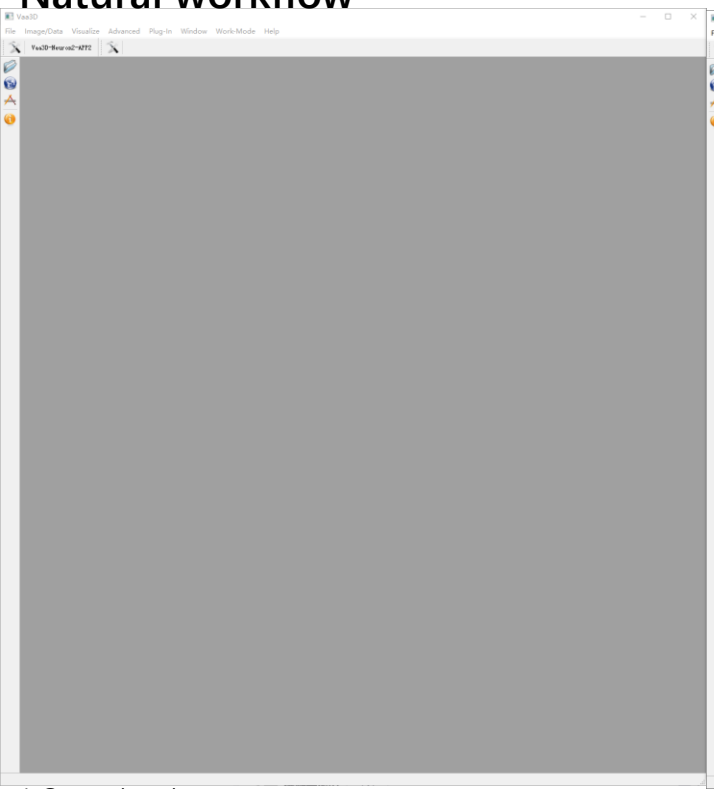
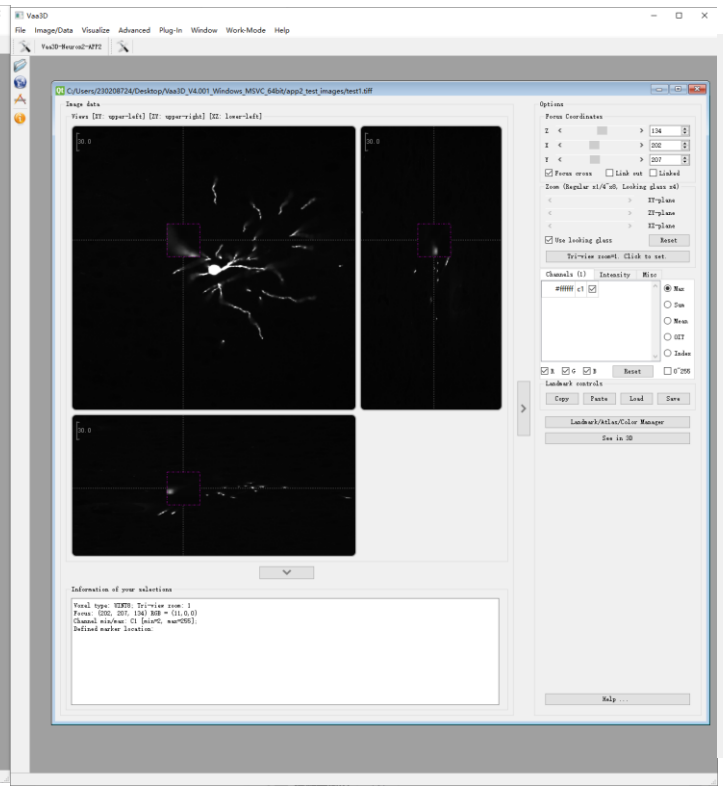
Vaa3D basic usage

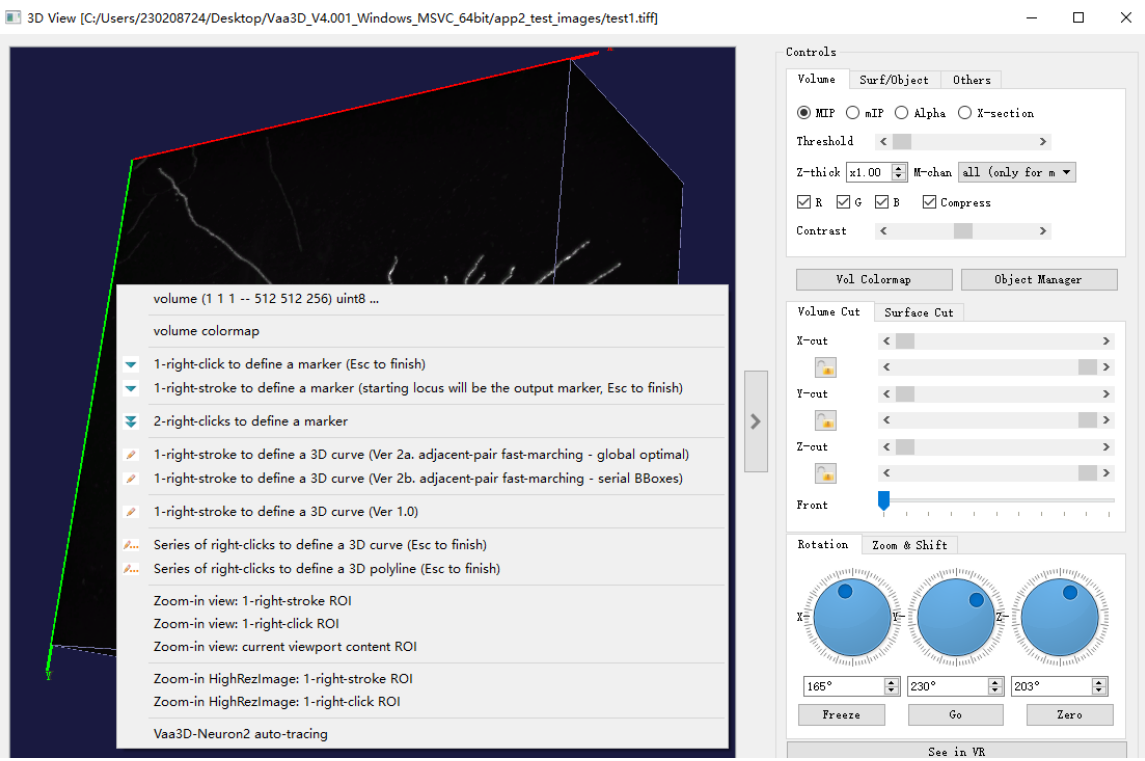
Vaa3D neuron tracing algorithms extension

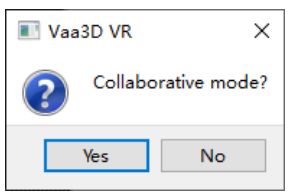
Vaa3D basic usage

Version information
Supported file types
Natural workflow









1 Open the picture
Read the 3D neuron Image through File -- open-image (shortcut key Ctrl + O).
2 Main interface operation
After opening the picture, enter the main interface of three view section;
The upper left corner of the main interface is the three view sections, focusing positions of each section can be changed through the mouse wheel;
Options area is on the right of the main interface, its main features are Focus Coordinates, Zoom, Channels, Looking Glass, Landmark Controls, See in 3D;
The Information of Your Selections text box is displayed on the lower part of the main page. Information about the basic Information, current focus, and Marker Information is displayed in the text box.
3 3D interface operation
On the home screen, click the See in 3D option, or use the title bar Visualize - 3D Viewer for Entire Image (shortcut key Ctrl + V) to enter 3D view mode. The 3D interface can rotate the image by holding down the left button of the mouse, select the image by right-clicking the mouse, and zoom the image by the scroll wheel;
On the right side of the 3D interface is the Controls area, which has the main functions of image and content options, XYZ three-axis Cut option, rotation and zooming option and "See in VR", etc.
4 VR interface operation
To use VR, you need SteamVR software support, and then click the "See in VR" button on the image to enter VR mode.

Vaa3D basic usage

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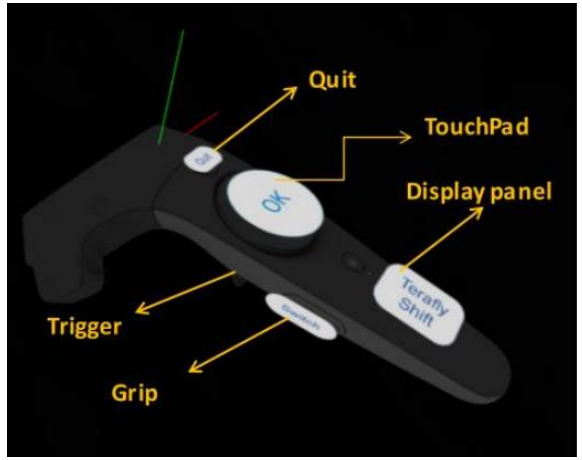
Short Keys

Keyboard operations
Mouse operations
Special debugging keys
For 3D view window short keys
For neuron tracing/editing short keys
For VR

LeftController



Grip

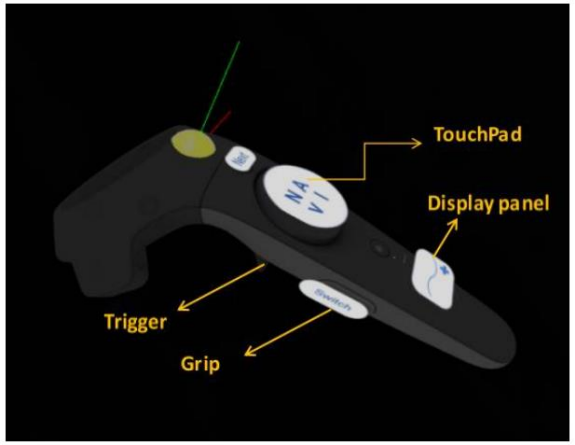
Mode 1:Terafly Shift
Mode 2:Terafly Zoom
Mode 3:Contrast
Mode 4: Undo/Redo
Mode 5:Surface Mode
Mode 6:Change Color
Mode 7:Freeze View
Mode 8:Line Width
Mode 9:Auto Rotation

Grip:You can switch the controller mode with the grip
TouchPad:Used to control the current mode
DisplayPanel:Used to show what mode is currently in
Trigger:Press the trigger to bind the neuron and controller. This function allows neurons to move along with your left controller. If you are too far away from the neuron or want to look at it from a different angle of view, you can try this function.

DisplayPanel

Mode 1 Create a maker at the front of the controller. Makers are usually used to mark different branches or cell body.(with different color)
Mode 2 Delete the maker generated by mode 1\
Mode 3 A powerful function, it can generate lines along controller, The lines can automatically track nearby neuronsMode (if Virtual Finger is on)
Mode 4 Delete trackling line by putting the controller on the line generated by a mode
Mode 5 If you have some deviation in the line, Press and hold the trigger near the node you want to edit, drag the corresponding node to the current position of the controller, and release the trigger to update the node position.
Mode 6 If you have some deviation in the line, Press and hold the trigger near the node you want to edit, drag the corresponding node to the current position of the controller, and release the trigger to update the node position.

RightController



Mode 1 in TouchPad

Mode 2 in TouchPad

Mode 3 in TouchPad

Vaa3D basic usage

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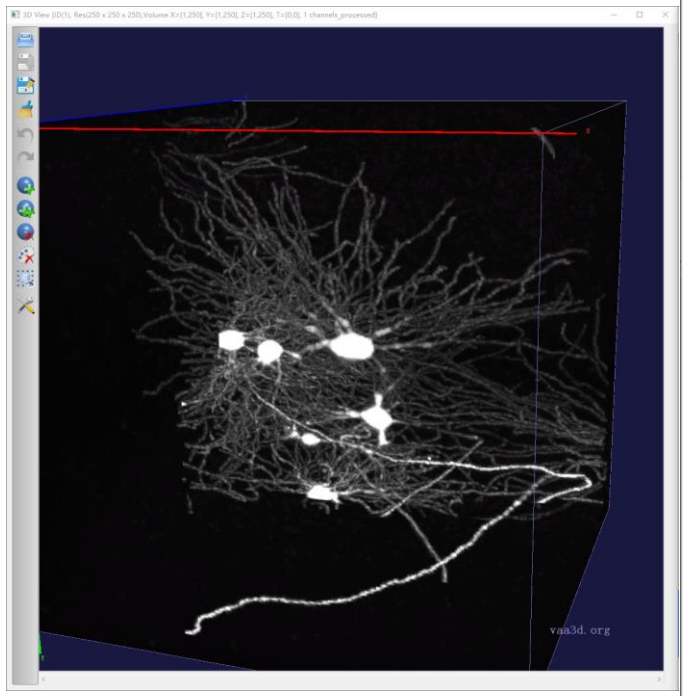
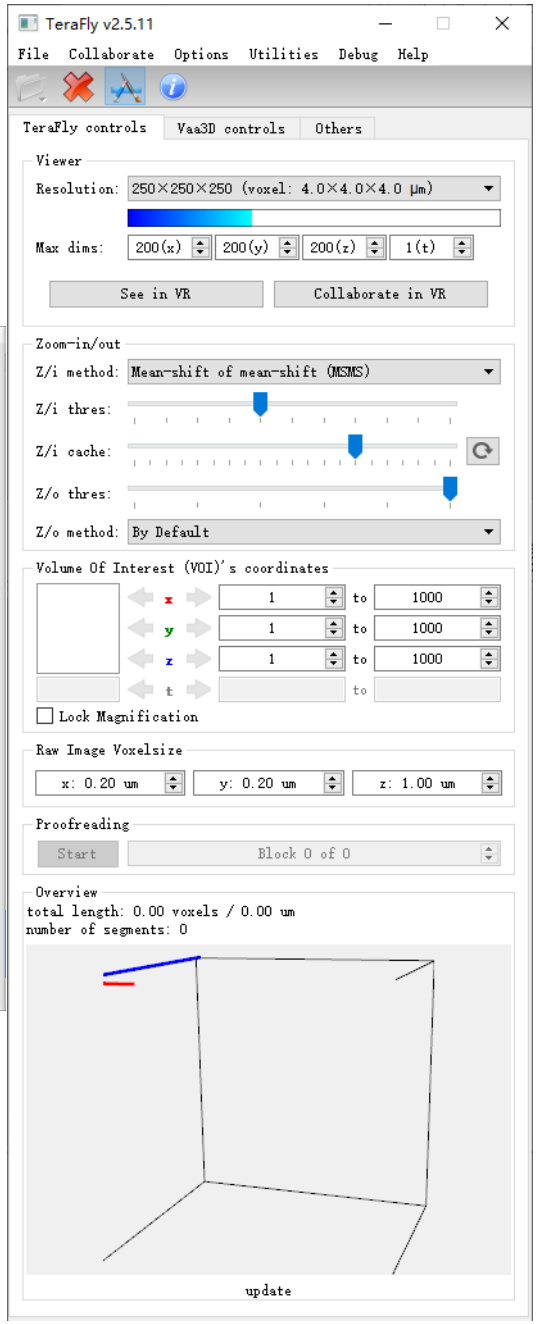
TeraFly

Basic operations of TeraFly enter TeraFly mode through the title bar -- Advanced -- big-image-data -- TeraFly.In the TeraFly control interface, select the TeraFly folder through File -- open-Terafly-image.Control and select Resolution through the mouse wheel, Zoom option and TeraFly control interface - Viewer - Resolution.





Plugin

enable plugin--create plugin--use plugin

We can write our own plug-in to support vAA3D, which requires us to download and compile Qt4;Git Clone Vaa3D_external and vaa3D_toolsOwn C++ compiler (e.g. GCC).
We can write our own plug-in code on QtCreator, which is structured as plugin.h;The plugin. CPP;The plugin. Pro.
Using the Vaa3D_plugin_creator GUI, we can generate this template, then simply write our code and compile to generate the.so/.dll file to add to vaa3D.

Vaa3D basic usage

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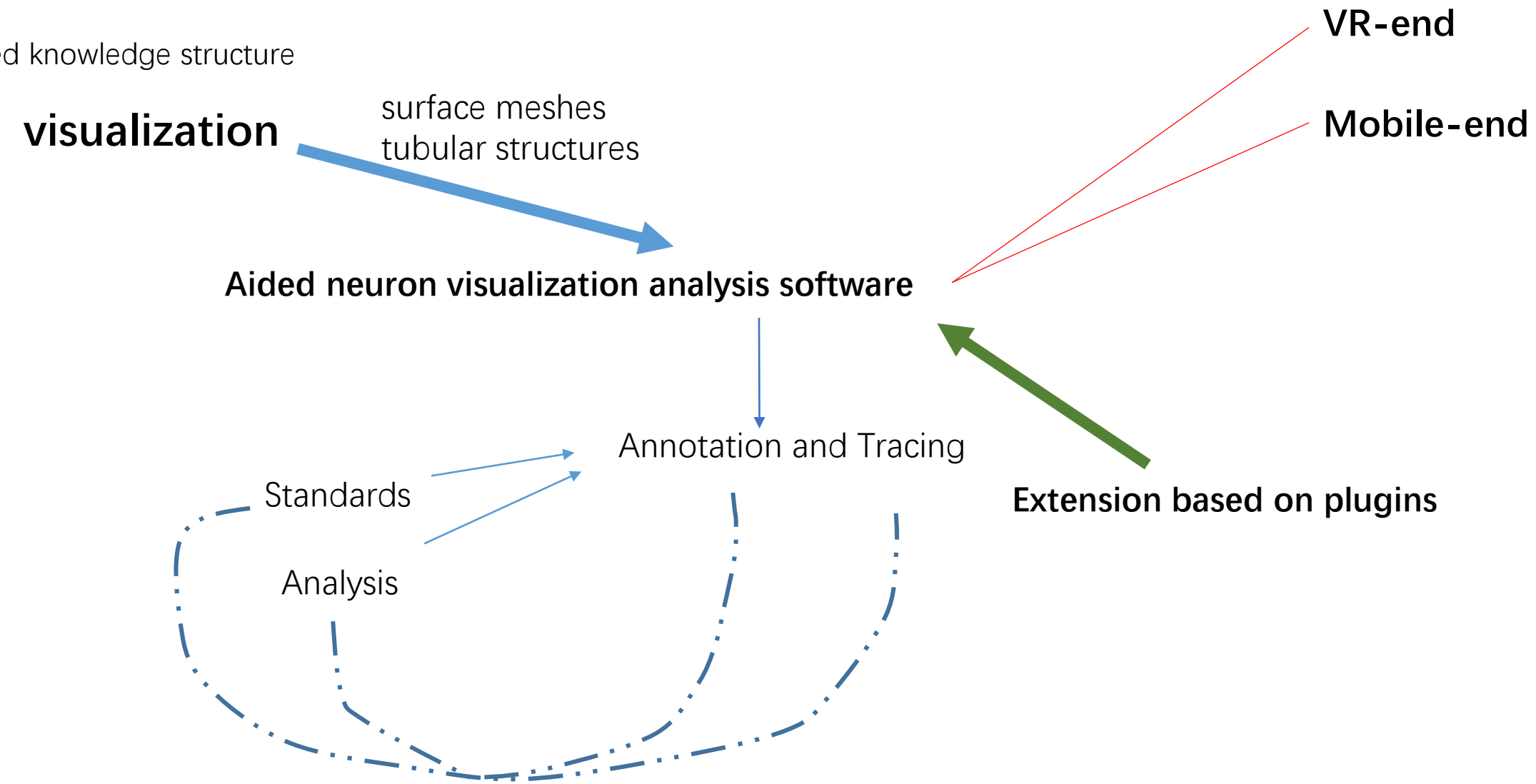
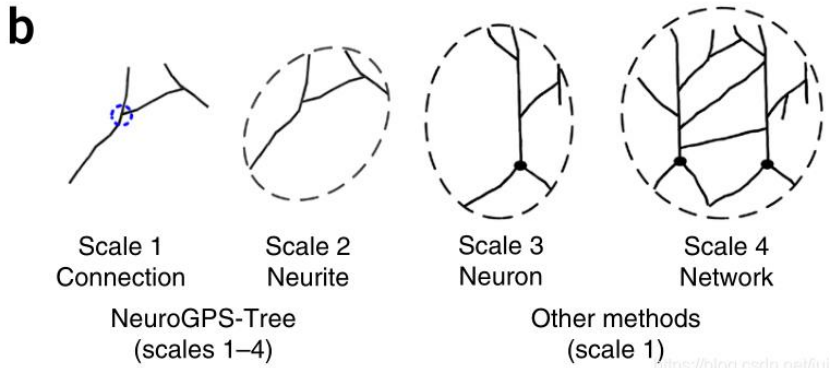
TeraFly
Plugin
Vaa3D related knowledge structure



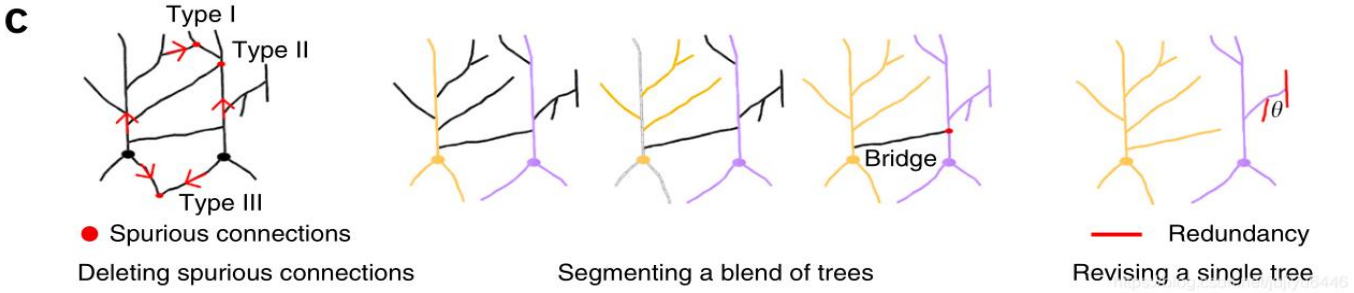
Vaa3D neuron tracing algorithms extension

neuroGPS-Tree tracing



Quan T, Zhou H, Li J, et al. NeuroGPS-Tree: automatic reconstruction of large-scale neuronal populations with dense neurites[J]. Nature methods, 2016, 13(1): 51.

NeuroGPS-Tree uses signal information at different scales to identify spurious links.



In this paper, there is less space for tracking individual neurons. This part of the main content in the previous work.

Quan T, Zheng T, Yang Z, et al. NeuroGPS: automated localization of neurons for brain circuits using L1 minimization model[J]. Scientific reports, 2013, 3: 1414.

Vaa3D neuron tracing algorithms extension

MOST_neuron tracing

Ming X, Li A, Wu J, Yan C, Ding W, et al. (2013) Rapid Reconstruction of 3D Neuronal Morphology from Light Microscopy Images with Augmented Rayburst Sampling.PLoS ONE 8(12): e84557. doi:10.1371/journal.pone.0084557

Main Contents:
Single threshold binarization generates a seed point in each connected domain.
Step tracking. Use local foreground information.
At each step, mark the sphere within the surrounding radius as tracked.
Extract forward direction within the hemispherical radius<d<Radius +2 inside foreground. Clustering, the center of the cluster as the location of the next point. The reason why it's hemispherical is because you want to screen out the direction back.
Get the next direction. The length of each step is approximately equal to the radius.
Algorithm characteristics
Using local information, no need to generate other information, the operation speed is very fast.
Step by step tracking, judging each step.
Algorithm shortcoming
Can't cross the gap.
It looks like the shape fits, but there might actually be a -1 point in every connected domain. Which means it's not connected.

Vaa3D neuron tracing algorithms extension

TReMAP

Zhou Z, Liu X, Long B, et al. TReMAP: automatic 3D neuron reconstruction based on tracing, reverse mapping and assembling of 2D projections[J]. Neuroinformatics, 2016, 14(1): 41-50.

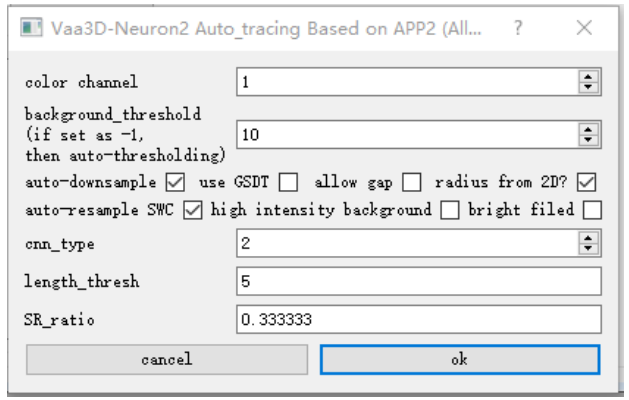
TReMAP :Tracing, Reverse Mapping and Assembling of 2D Projections.

The main features
Virtual Finger suits Super large image at 10GB level with fast speed and less memory consumption

The main process
1.MIP is converted into two-dimensional images, and the APP generates corresponding tracking results
2. Divide the tracking results into different segments from branch points
3. Each segment has an bounding box, and the corresponding 3D region is extracted. This is the main way to reduce memory requirements.
4. CDA2 Virtual Finger. The Curve - Drawing Algorithm 2
5.MST minimal spanning tree
6. Base the XY plane and supplement other planes XZ and YZ.

Vaa3D neuron tracing algorithms extension

APP2



Xiao, H. and Peng, H. (2013) APP2: automatic tracing of 3D neuron morphology based on hierarchical pruning of a gray-weighted image distance-tree,Bioinformatics, 29, 1448-1454. (http://home.penglab.com/papersall/docpdf/2013_BIOINFO_app2.pdf)

APP1:
Peng, H., Long, F. and Myers, G. (2011) Automatic 3D neuron tracing using all-path pruning, Bioinformatics, 27, i239-i247.

GWDT: gray-weighted image distance transform

Initial neuron reconstruction

Hierarchical pruning

The automatic tracking algorithm APP2 performs well in low-density neuron images

Main workflow GD-based

1. Enter the SOMA point, or find SOMA by the maximum value of fastmarching_dt. dt is the distance transform. The shortest distance from the foreground point to the background point is calculated.
2. Enter SOMA points into the fastmarching_tree, and the logic of the NeuronTree is to get the parent of each point, which is equal to the source point of the fashMarching.
3. Prune over the results obtained above. So it's called all path pruning. All Path means that each foreground point is contained within the path.
4. pruning.
5. swc2topo_segs
6. pruned by length_thresh、dark nodes pruning、dark segment pruning、hierarchy coverage order pruning、leaf nodes pruning 、joint leaf node pruning、smooth curve
7. topo_segs2swc

Feature

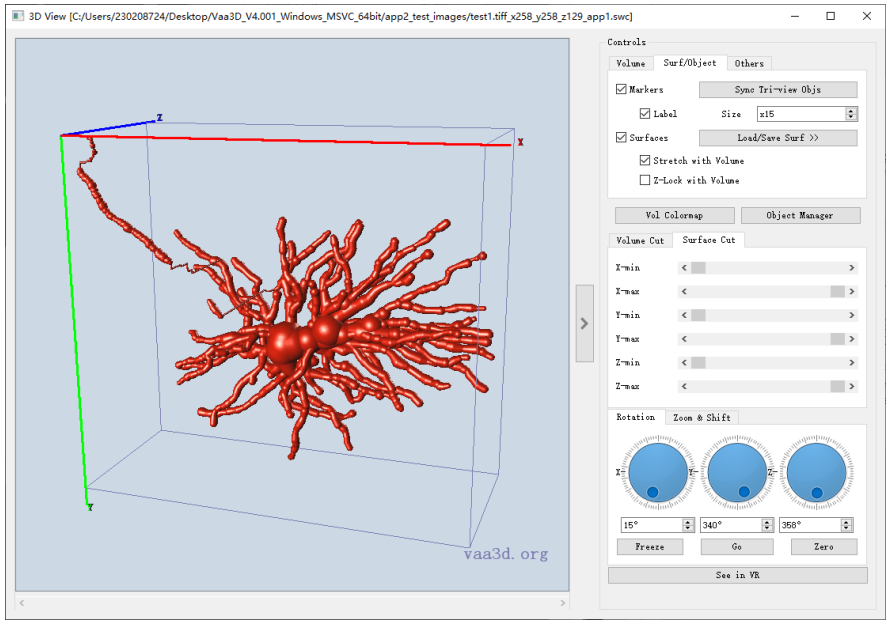
APP algorithms generally reduce the sampling, which is also one of the reasons for faster speed.

Vaa3D neuron tracing algorithms extension

swc

n	当前点编号
type	类型、颜色
x	x坐标
y	y坐标
z	z坐标
radius	半径
parent	父节点，parent不能等于n

0	白色
1	黑色
2	红色
3	蓝色
6	黄色
7	绿色
20-275	用于matlab热力图



neuron_utilities:
1.swc_to_maskimage_cylinder_unit
2.swc_to_maskimage_sphere_unit