NeuronizeV2

NeuronizeV2 is a tool focused on improving interoperability between two commonly used applications in the field of neuroscience, Imaris and Neurolucida®. Both tools use proprietary formats to store the information, which causes the information extracted using one tool cannot be used in the other. To solve this problem, NeuronizeV2 offers the possibility of generating tracing files for Neurolucida® from the Imaris Filament Tracer files.

On the other hand, the meshes exported by Imaris can contain morphological errors (holes, faces that intersect, etc.). These errors are propagated to the metrics computed on these meshes which implies a certain error. NeuronizeV2 can repair these meshes and then compute more accurate metrics. In addition, the tool can export the meshes (the original and the repaired one) to widely used standard formats, which allows that these meshes can be easily used in other tools or shared.

Apart from the functions related to interoperability, the tool is also capable of generating a three-dimensional representation of the neuron. The tool can use the spine information included in the new version of the Neurolucida® tracing files to place the dendritic spines in their actual positions and orientations. Likewise, the tool can take advantage of the information contained in the Imaris Filament Tracer files for, in addition to placing the spines in their real positions, using the real geometry present in the input file.

Additionally, Neurolucida® files can also include detailed information about the soma (defined as a set of 2D contours). This information can also be used by the tool to generate a highly accurate soma mesh.

Finally, to improve data sharing among neuroscientists, the tool incorporates a small database. This database stores all the information related to the generated neuron, and the repaired spines, in standard formats. Additionally, the tool can export the neuron metrics to a CSV file to be easily processed.

The way to interact with the tool to achieve all these functions is detailed below.

Generation of a three-dimensional representation from morphological information.

To generate three-dimensional representations form the morphological information of the tracing files the tool offers two ways: to generate the three-dimensional representation from a single file or generate representations of several neurons all at once.

First, the process of generating a three-dimensional representation of a single file is detailed, for which the “One Neuron” button must be selected.

1. The first step is to select the input files to generate the neuron. There are two options: to select tracing files (SWC or ASC) with the “tracing file” button, or to load a neuron from Imaris Filament Tracer (VRML) files. To do this, the “VRML Files” button must be selected; then, the file or files containing the basal dendrites are selected and, if necessary, the file containing the apical dendrite is selected. Finally, if the user wants to keep the tracing file generated by the tool, he/she clicks on the “Save Tracing” button and inserts the name for the output file. Note that, the name that will be given to the neuron by the application will be the name of the input file if it is a tracing file or the

name of the folder where the basal dendrites and axon are found in the case of Imaris Filament Tracer VRML input files.

2. Next, the user goes to the “Soma Builder” tab. If the input file contains soma information, it will be displayed. If this information is incorrect or does not seem realistic, the user can ignore it by clicking on the “Use Spherical Soma” button to use an initial spherical soma. Once the initial soma has been decided, clicking on the “Build Soma” button starts the deformation process. If the user is satisfied with the result, he/she will click on the “Go to Neurite Generation” button to proceed to the next step. If the result is not satisfactory, the user can click on the “Rebuild (advanced options)” button to change the parameters of the deformation process. Finally, if the user wants to export the deformed soma model, he/she will click on the “Export Soma” button.
3. The next step is done from the “Neurites Builder” tab, clicking on the “Build Neurites” button to generate the neurites. Once built, the geometry can be smoothed using the “Smooth” button. Finally, click on the “Go to Spine Generation” button to go to the next step.
4. At this point, the user must decide whether to export the neuron in the current state (without spines) by clicking on the “Export without spines” button or if he/she wants to add the spines by clicking on the “Build Spines” button.
5. If the user has decided to add the spines, he/she need to choose between the different options available. Note that, by default, the application selects the most accurate spines that it can place depending on the input file. Once the spine addition process is over (it may take some time), the neuron mesh can be exported as well as a mesh containing all the generated spines.

If the user wants to generate more than one three-dimensional representation, he/She can click on the “Set of Neurons” button, and then select the input directory and the output directory. Note that the input directories have particular requirements (see manual). Finally, there are two configuration options: one allows choosing how many times the smoothing process is applied on a neuron and the other establishes a base name for the folders generated by the tool. The process of automatic generation of tracings from geometry files is immersed within the neuron generation steps. To generate several tracings automatically in an unsupervised way from Imaris Filament Tracer files, several neurons will be generated at once and the files of the generated tracings will be found within the output folder of each corresponding neuron.

Mesh Repair

To repair the meshes it is necessary to have Python3 installed ((https://www.python.org/ftp/python/3.7.4/python-3.7.4-amd64.exe). If Python3 is installed in the system, the “Repair Mesh” tab will be active.

As in the previous case, the user can process a single file (VRML o IMX) with the “File” button, or process at once a set of files in a folder by clicking on the “Folder” button. In both cases, he/she needs to select the input and the output (be them a file or a folder). Finally, by clicking on “Advanced Options”, a series of advanced options are shown (by default, these options are configured to repair dendritic spines). When the user places the mouse over the name of these options, a dialog will appear indicating its functionality.

Mesh Comparison

The tool also allows comparing different meshes and observing the differences between them. This tool is very useful for comparing the original and repaired meshes.

To compare two meshes, first, the files must be loaded (the application supports OBJ, OFF, PLY and STL formats) by clicking on the “Select File” buttons. Once the two files are selected, the two meshes will be loaded. The color of the different parts of the meshes will indicate the distance between the meshes (warm colors imply a greater distance). The application also shows a correspondence between colors and distance, and a series of metrics (such max distance, min distance and mean distance) related to this distance.

On the other hand, the application also allows interacting with the views that are coordinated in such a way that the camera movements done in one of them are replicated in the other.

Exportation of the generated neurons

The application has a small local database that stores all the neurons processed with the application and all the spines.

To export the information contained in this database, the user clicks on the “File -> Export Neuron Info” menu, Next, a dialog will open that allows selecting the neurons to be exported. Once those neurons are selected, the user clicks on the “OK” button and selects the directory where the information will be exported. This exported information consists of one folder for each neuron that contains two CSV files, one with the soma information and the other with all its spines information.