

User Manual

python RECording aid

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1 Introduction

Imaging guided access to the brain has become a routine procedure for various research and clinical applications, including drug administration, neurophysiological recording, and sampling tissue. python REcording aid (pyRECaId) is an open-source tool designed to automate accessing the area of interest in the brain.

The software supports both Dicom and Nifti image format as input and provides processing procedures including re-slicing, flipping, adding chamber, and co-registration in an automated manner.

2 Installation

First, download or clone the directory to the desired location on your local system (extract the .zip file in case of downloading). Then redirect to this folder on your system to find the following files and folders:

Main directory → here you will see the program scripts, including the main method [...]. Files → here you will see the manual.pdf containing the user guide and the yml file for the conda environment.

Prior to the installation, you should have a distribution of Python3 interpreters installed on your system (we recommend the anaconda distribution). Instructions on how to run the software on Windows and Linux machines are described below. If you do not want to install the packages manually, jump to the yml installation part after installing anaconda.

2.1 Installing anaconda

Download the anaconda from [here](#) for your operating system. Then install the application and follow the procedure below to install software requirements.

2.2 For Windows users:

After installation of Python3, open the command prompt or the anaconda prompt (depending on your Python3 distribution and path settings) and type the following commands at the prompt (case sensitive):

```
$ pip install scipy dicom PyQt5 matplotlib OpenCV-Python scikit-image  
transforms3d dill nibabel torch torchvision torchaudio
```

If you have python2 in your environment, then you should type pip3 instead of pip in the above command since, in that case, pip defaults to Python2. It takes some time, so be patient and wait for the transactions to finish, and then enter:

```
$ conda install -c clinicalgraphics gdc
```

In case you do not want to install anaconda, you can download the GDCM library [here](#).

2.3 For Linux users:

Linux machines contain a system Python3. It is highly recommended that you don't install the program using the system Python3. You are better to install a virtual environment by venv or conda (in case you have anaconda or miniconda) and then follow the instructions below. Open a terminal with your desired python3 environment activated and type in the following line:

```
$ pip install scipy==1.2.0 dicom PyQt5 matplotlib OpenCV-Python scikit-image  
transforms3d dill nibabel torch==1.10.2+cpu torchvision==0.11.3+cpu  
torchaudio==0.10.2+cpu -f  
https://download.pytorch.org/whl/cpu/torch_stable.html
```

If you have python2 in your environment, then you should type pip3 instead of pip in the above command since, in that case, pip defaults to Python2. It takes some time, so be patient and wait for the transactions to finish, and then enter:

```
$ conda install -c clinicalgraphics gdc
```

In case you do not want to install anaconda, you can download the GDCM library [here](#).

2.4 yml file installation:

Installing from the yml file is the easiest way to execute the software. After installing the anaconda, open a terminal (Linux/Mac) or anaconda command prompt (Windows) and create a new environment by running:

```
$ conda env create -f environment.yml
```

By running this command, a new environment will be created under the name "pyRECaId". By executing the command below, you can see the existing environments in your device.

```
$ conda env list
```

If the installation process runs successfully, you should see the "pyRECaId" environment under the exported list. After installing successfully, you have to activate the environment by running:

```
$ conda activate pyRECaId
```

After activating the environment, go to the cloned code directory on your system and run:

```
$ python3 Main.py
```

After that, the software starts and is ready to be used.

3 Main Menu

This menu contains tools to show the 3d images, re-slice it, add chamber, and flip it if required. In the following subsections we express each part by detail:

3.1 Loading Image Folder

Using the **Load Folder** button, the series directory is selected. If there exist image series inside the selected directory, the list of existing series will be shown as shown in the figure 1.

3.2 Load Series

After loading all images inside the directory, you need to select the desired series and then press the **Load Series** button. Then the loaded series is shown in the main form as figure 2. As it is observable, images contain the slice distances in millimeters. Three slices, including Horizontal, Sagittal, and Coronal, are shown. The brain could be covered by moving the mouse scroll on each slice.

3.3 Enabling Extra Options

To enable re-slice, add chamber, and flip, the tools menu should be opened from the upper bar of the frame. Then, by pressing each option, the related window will be shown on the sidebar of the main form (figure 3)

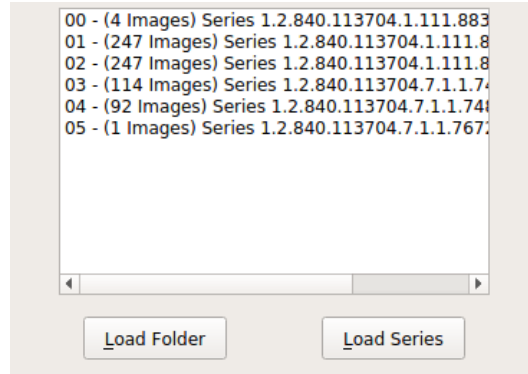


Figure 1: Series List

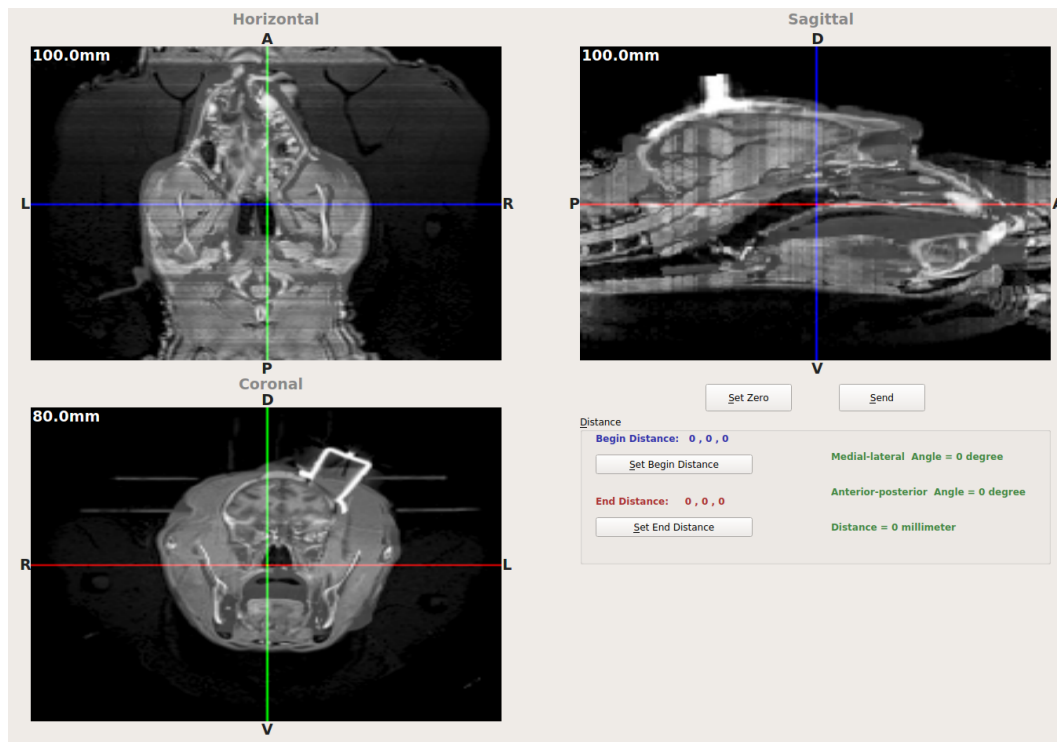


Figure 2: Loaded Series

3.4 Re-slice

This tool is used to re-slice the brain by specifying angles alongside each axis. All angles range from -180 to 180 degrees. To re-slice the brain in desired directions, related angles should be determined first, then by pressing the **Re-slice** button, a new form with re-sliced series is shown as figure 4.

3.5 Add Electrode(Chamber)

Adding an electrode to the brain is one of the options that is provided in both re-sliced and the main menu. As shown in figure 5, an electrode is added in the re-slice form by setting the required parameters. These parameters could be defined in the **Electrode Size (Chamber Size)** window (figure 6).

Reslice option

X: 0 Y: 0 Z: 0

Reslice Open Last Reslice

Flip

Flip_H Flip_S Flip_C

Chamber Size

depth: 0 ML: 0 AP: 0

Angle: 0 Angle: 0 Angle: 0

Add Chamber Clear Chamber

Figure 3: Extra Options

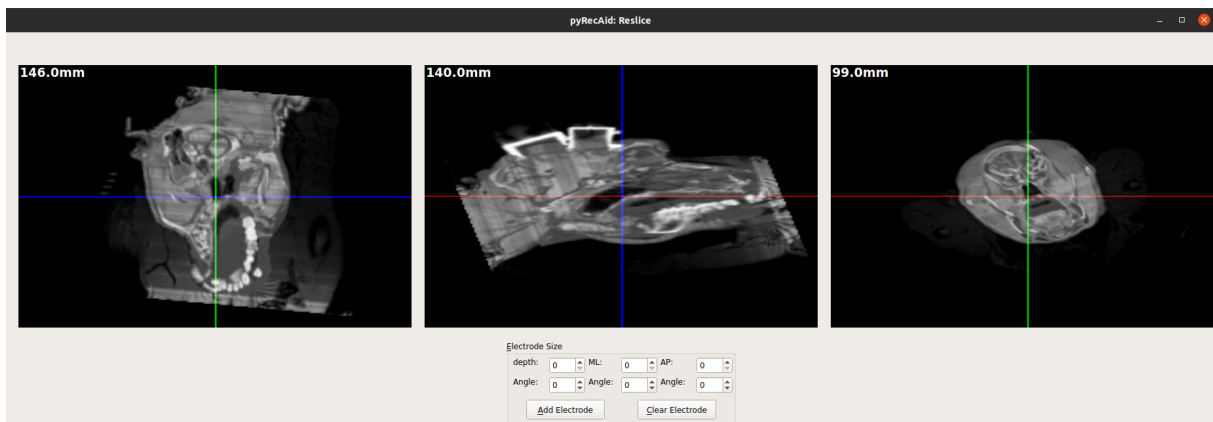


Figure 4: Re-slice form

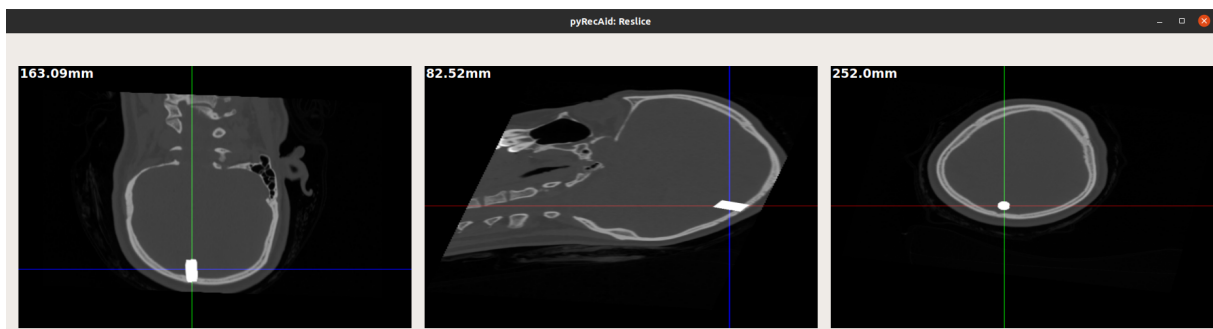


Figure 5: Adding Electrode

The image shows a dialog box titled "Electrode Size". It contains six spinners arranged in two rows. The first row has "depth:" with a value of 10, "ML:" with a value of 10, and "AP:" with a value of 40. The second row has "Angle:" with a value of 5, "Angle:" with a value of 25, and "Angle:" with a value of 5. At the bottom, there are two buttons: "Add Electrode" and "Clear Electrode".

Figure 6: Electrode Size

3.6 Flip Menu

This menu is convenient when the slices are not shown in the right Direction. If the directions of the head in series are not as desired, then by flipping them, they could be put in the right directions. As a case in point, the Sagittal view is flipped, as shown in figure 7.

3.7 Saving and Loading series

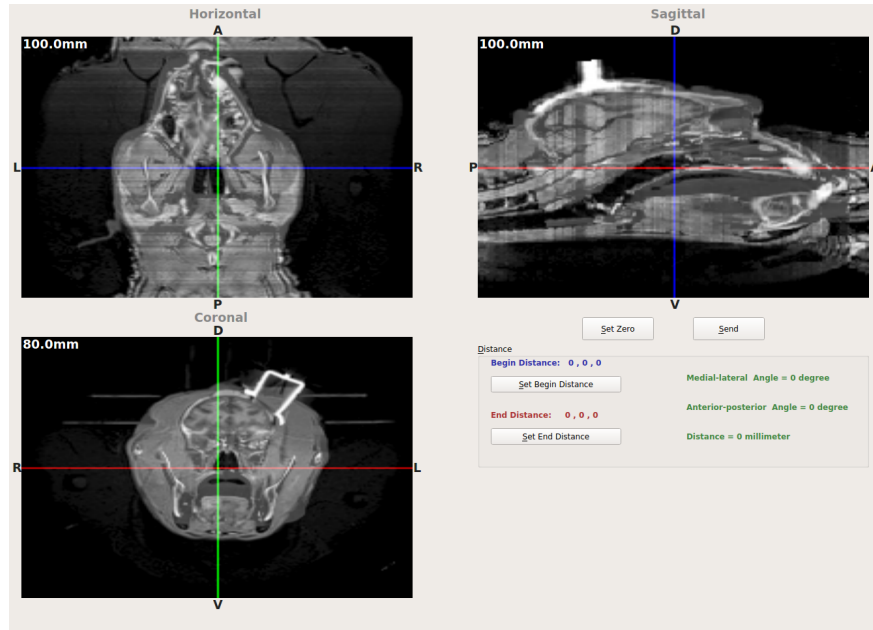
When an image series is loaded and manipulated, it may be needed to be saved for future experiments. As a case in point, you may want to use it in the co-registration menu for after-surgery assessments. In this case, the series could be saved by using the **save** button under the **File** menu. It is also available by pressing **Ctrl+s**. It is worth mentioning that the last re-slice will be saved too, and the software will automatically detect the last re-slice if it exists. The saved format is under dcmf format, which is easily readable and writable in python.

To load a previously saved image series, the user should select the **open** option under the **File** menu or simply press **Ctrl+o** to open the desired dcmf file. After loading it, it will be shown in the main form, and if a re-slice is saved, then the last re-slice button will be enabled in the re-slice option.

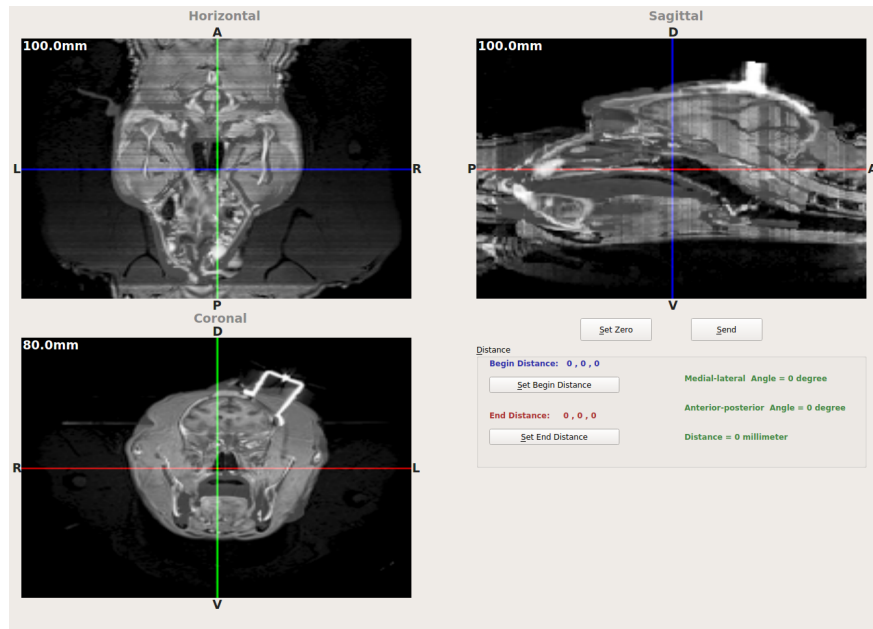
4 Co-registration Menu

This menu is accessible from both main form by pressing the **Co-registration** button or opening from the tools bar. The co-registration form is shown in figure 13. As it is observable, there are three rows for three series. The first and second series are the two series we intend to register. Consequently, the third row is for the resulting series, which is the combination of both the first and second series. Loading the series is quite similar to the main form. After loading both series, some options are available for users. There are two types of co-registration available in this form: manual and automatic. Each option could be activated from the **tools** menu.

- **Manual co-registration:** This type of series co-registration is done by applying shift and rotation on both series. The user could use both options provided in the related window to reach an accurate result. Rotation is available on three different axes, and the shift is also provided in six directions. The **rotation preview** button is used to show the rotated images, but the rotation will not be applied to other slices until the **rotation** button is pressed. If the rotation is not as desired in the preview, the user could move the mouse scroll on one of the images to eliminate the results as it is not finalized. Shift and rotate window is designed for this purpose, as shown in figure 14.
- **Affine co-registration:** This co-registration is done by utilizing 3D affine transformation. To achieve a proper result, the user has to determine four match points on both series and then press the co-registration button to see the result. It is significant to choose these points precisely with at least one point on a different slice from others (not all of four points on the same plane). The point selection window is designed for this purpose, as shown in figure 15. The points could be selected by setting the coordinates on both images by mouse scroll and pressing the **Select Point** button. A checkmark will appear in each box related to the point by selecting each point. If the user wants to clear points, it could be done by pressing the **Clear Points** button. If a single point is to be cleared, the user should clear the checkmark of the corresponding point.



(a)



(b)

Figure 7: Flipped images

4.1 Flip and Swap options

If the series is not in the same directions and they do not match, then the user could change it to the right order by using **Flip** or **Swap** buttons. Before using these tools, the related series should be chosen, and then the transformation could be applied (figure 16). These options could be enabled or disabled from the tools bar. Two series should be in the same direction to reach a suitable co-registration.

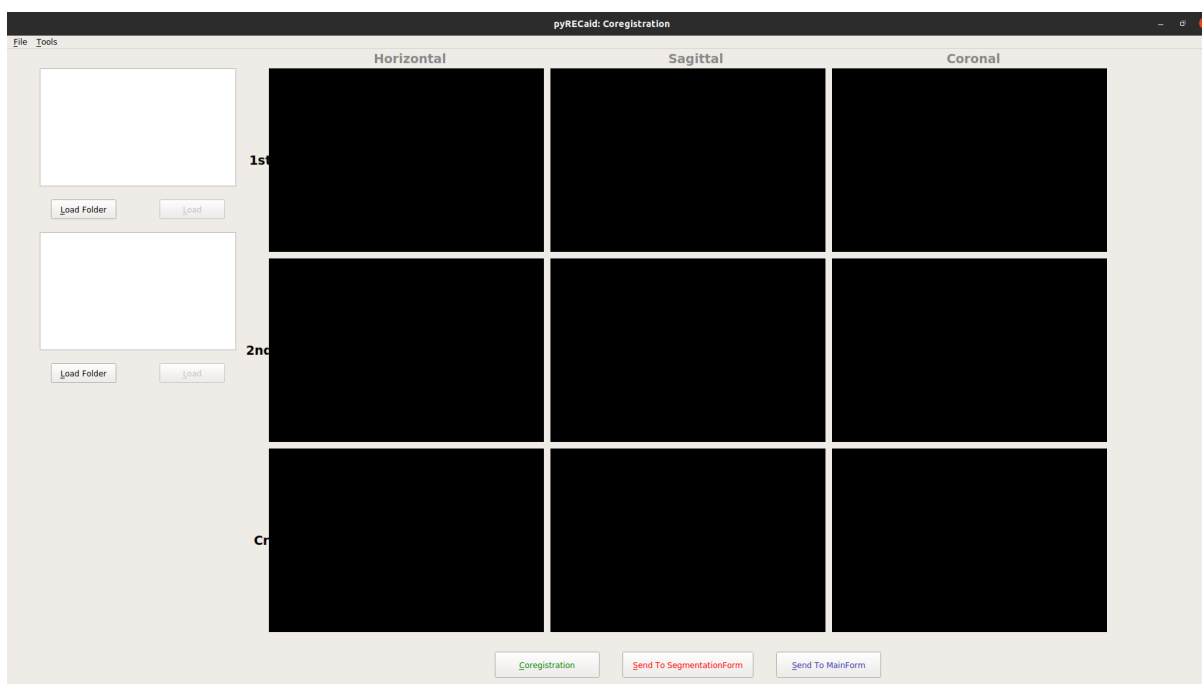


Figure 8: Co-registration Menu

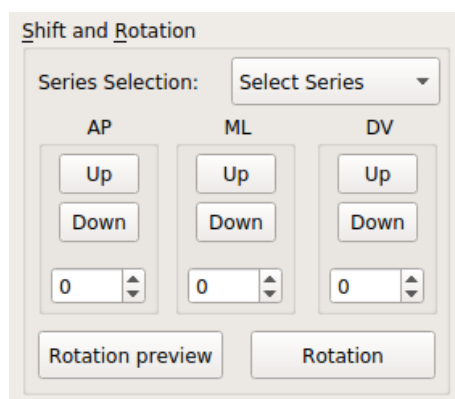


Figure 9: Shift and Rotation

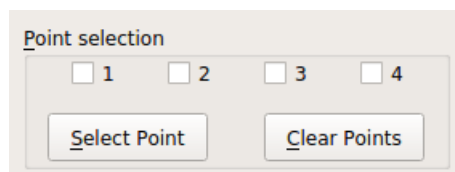


Figure 10: Point Selection

4.2 Crop

In the manual co-registration, the series may have noise or undesired parts that are good to remove. Hence, the **crop** option under the **tools** menu could be used in such cases. Cropping could be done from six different

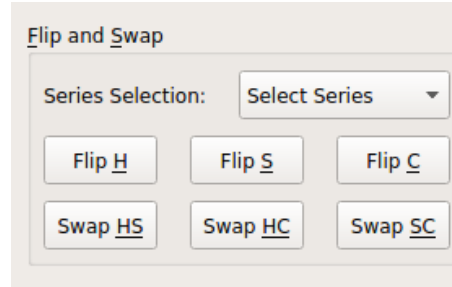


Figure 11: Flip and Swap window

directions and the maximum cropping pixels each time is 50 pixels per direction. **Crop preview** is used to see the cropped image series, and if it is as desired, it could be finalized by pressing the **crop** button or discarded by scrolling on the series. This menu is shown in figure 17.

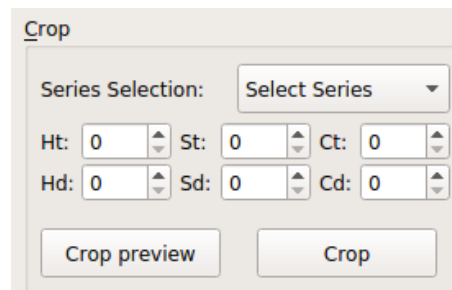


Figure 12: Crop window

4.3 Send to Main Form

After applying co-registration on series, the result could be sent to the main form by pressing **Send To Main Form** button. The series is available for re-slicing or adding a chamber in the main form.

4.4 Send to Segmentation Form

After applying co-registration on series, the result could be sent to the segmentation form by pressing **Send To Segmentation Form** button. The series is available for colorized segmentation with respect to a desired atlas in the segmentation form.

5 Segmentation Menu

This menu is accessible from both main form by pressing the **Co-registration** button or opening from the tools bar. The segmentation form is shown in figure 13. As it is observable, there are three rows for three series. The first row is the one that atlas series should be loaded in. In the second row we can upload our desired series or it could be transferred from the co-registration menu. Consequently, the third row is for the resulting series, which is the colorized segmentation result with respect to the atlas template. Loading the series is quite similar to the co-registration form. After loading both series, some options are available for users. There are two types of co-registration available in this form: manual and automatic. Each option could be activated from the **tools** menu. To segment the intended series with respect to the desired atlas, the user has to first co-register the template from atlas and the uploaded series. The procedure is similar to the co-registration menu.

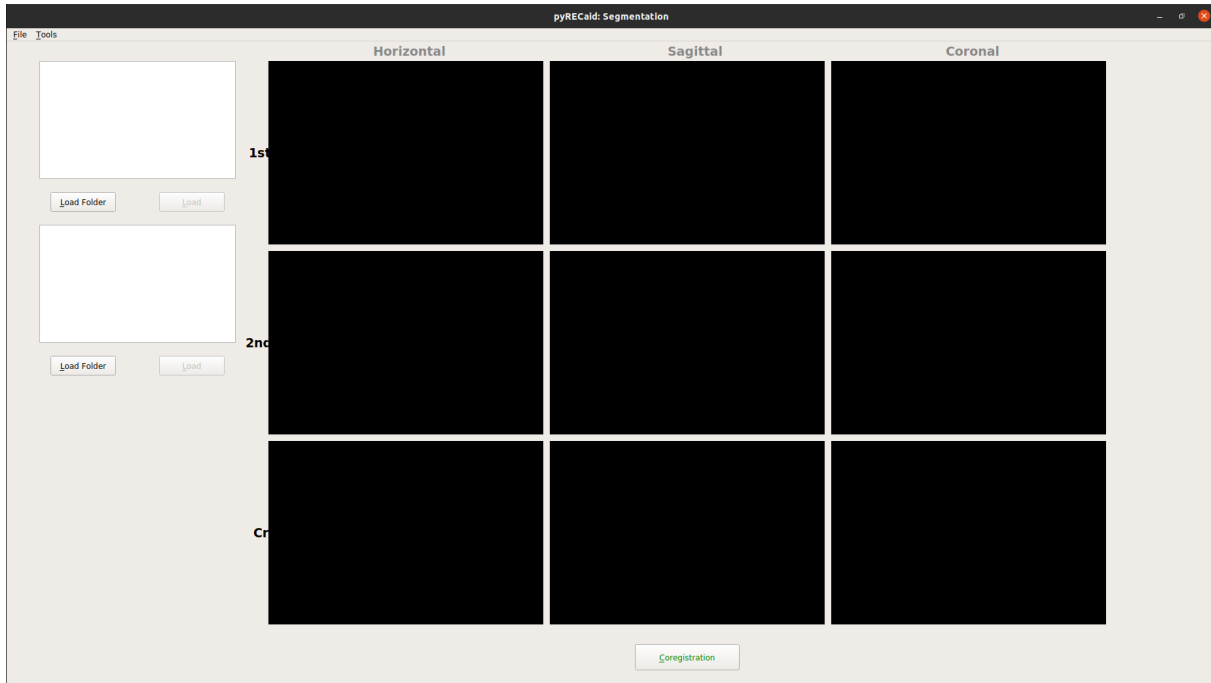


Figure 13: Segmentation Menu

- **Manual co-registration:** This type of series co-registration is done by applying shift and rotation on both series. The user could use both options provided in the related window to reach an accurate result. Rotation is available on three different axes, and the shift is also provided in six directions. The **rotation preview** button is used to show the rotated images, but the rotation will not be applied to other slices until the **rotation** button is pressed. If the rotation is not as desired in the preview, the user could move the mouse scroll on one of the images to eliminate the results as it is not finalized. Shift and rotate window is designed for this purpose, as shown in figure 14.
- **Affine co-registration:** This co-registration is done by utilizing 3D affine transformation. To achieve a proper result, the user has to determine four match points on both series and then press the co-registration button to see the result. It is significant to choose these points precisely with at least one point on a different slice from others (not all of four points on the same plane). The point selection window is designed for this purpose, as shown in figure 15. The points could be selected by setting the coordinates on both images by mouse scroll and pressing the **Select Point** button. A checkmark will appear in each box related to the point by selecting each point. If the user wants to clear points, it could be done by pressing the **Clear Points** button. If a single point is to be cleared, the user should clear the checkmark of the corresponding point.

After co-registering the series, the result series will be a colored series, which shows the segmented parts of brain with respect to the uploaded atlas. It is crucial to load the atlas template in the first row as it is the source of the colorization.

5.1 Flip and Swap options

If the series is not in the same directions and they do not match, then the user could change it to the right order by using **Flip** or **Swap** buttons. Before using these tools, the related series should be chosen, and then the transformation could be applied (figure 16). These options could be enabled or disabled from the tools bar. Two series should be in the same direction to reach a suitable co-registration.

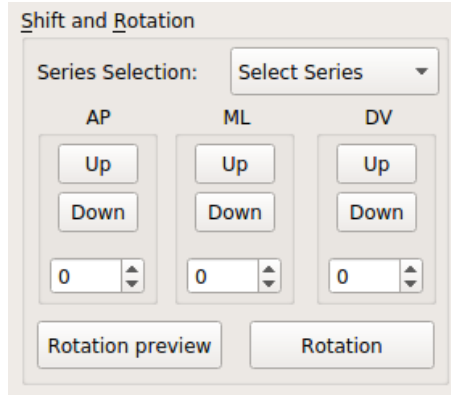


Figure 14: Shift and Rotation

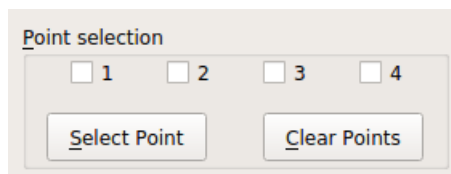


Figure 15: Point Selection

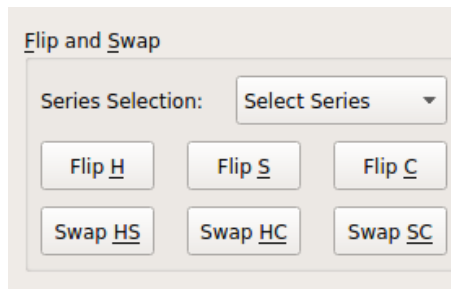


Figure 16: Flip and Swap window

5.2 Crop

In the manual co-registration, the series may have noise or undesired parts that are good to remove. Hence, the **crop** option under the **tools** menu could be used in such cases. Cropping could be done from six different directions and the maximum cropping pixels each time is 50 pixels per direction. **Crop preview** is used to see the cropped image series, and if it is as desired, it could be finalized by pressing the **crop** button or discarded by scrolling on the series. This menu is shown in figure 17.

6 Some usable notes

- Each slice could be maximized by double-clicking on it.
- The manual co-registration window and the affine co-registration window could not be shown at the same time, but it is possible to first apply for the manual registration and then do affine registration on the manipulated series.

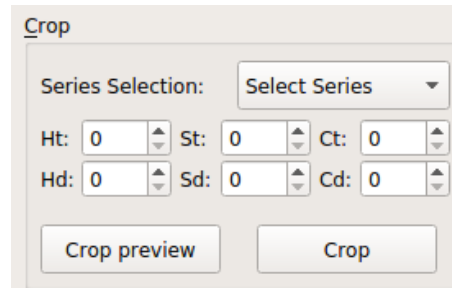


Figure 17: Crop window

- Crop and swap/flip menus are not usable at the same time in the co-registration menu, but they could be enabled and disabled from the tools menu. By enabling one of them, the other one will be automatically disabled.