

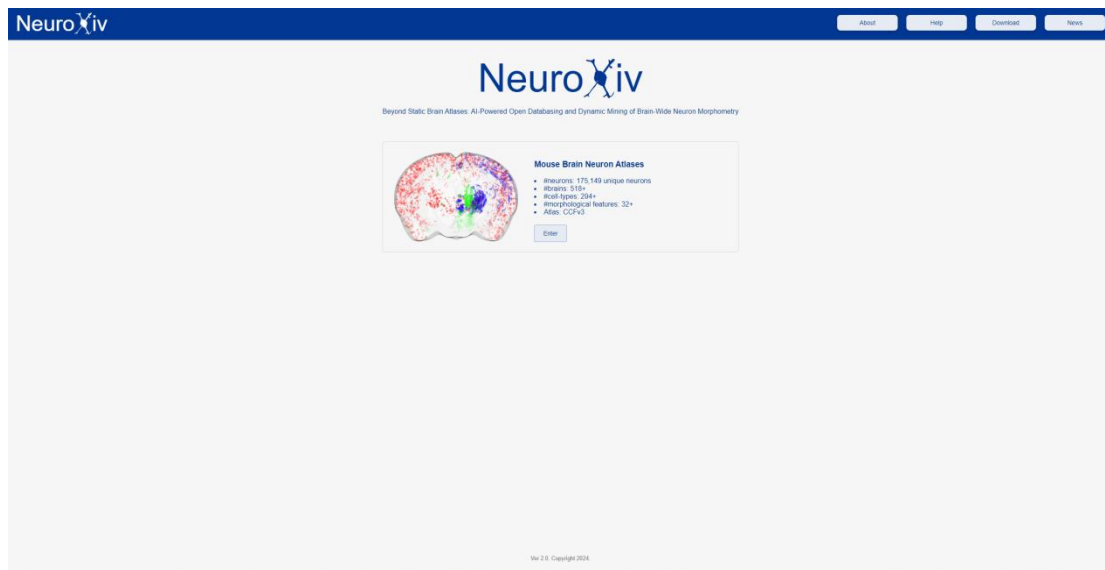
# **NeuroXiv User Manual**

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# Overview of NeuroXiv

NeuroXiv ([neuroxiv.org](https://neuroxiv.org)) is a cloud-based web platform designed for the dynamic mining of brain-wide neuron morphometry. It offers two key contributions: providing access to the largest and most comprehensive atlas-oriented neuron morphology resource, and enabling real-time, versatile analysis and mining of neuron data through its AI-Powered Open Mining (AIPOM) engine without requiring data downloads. The platform continuously aggregates data from diverse sources, standardizes it into the widely used SWC format, and maps it onto CCFv3 brain atlas to enhance data reusability. The analysis engine leverages advanced techniques, including rapidly evolving large language models (LLMs), databasing methods, and visualization tools, thereby facilitating the knowledge development process with both flexibility and efficiency (**Fig. 1**).



**Figure 1 | Introduction page of NeuroXiv.**

## Panel introduction

Our website interface is organized into three main sections: **Header Function Area (A)**, **Neuron Browser (B)**, and **Neuron Exploration Area (C)**. The Header Function Area is responsible for the primary task of data filtering, such as selecting a particular class of neurons. After filtering, the Neuron Browser automatically updates with a list of neurons that meet the specified criteria. The Neuron Exploration Area handles the interactive display and analysis of neuron data (**Fig. 2**).

The Neuron Exploration Area is primarily composed of three panels: *Neurons viewer*, *Neurons Analysis*, and *Single Neuron Info*. The Neurons Viewer serves as the main space for the interactive visualization of neurons, their substructures, and the brain atlas in a 3D environment. The Neurons Analysis panel provides visualizations of the quantitative analysis results related to neuronal morphology data. The Single Neuron Info panel is designed for interactively viewing detailed information about individual neurons.

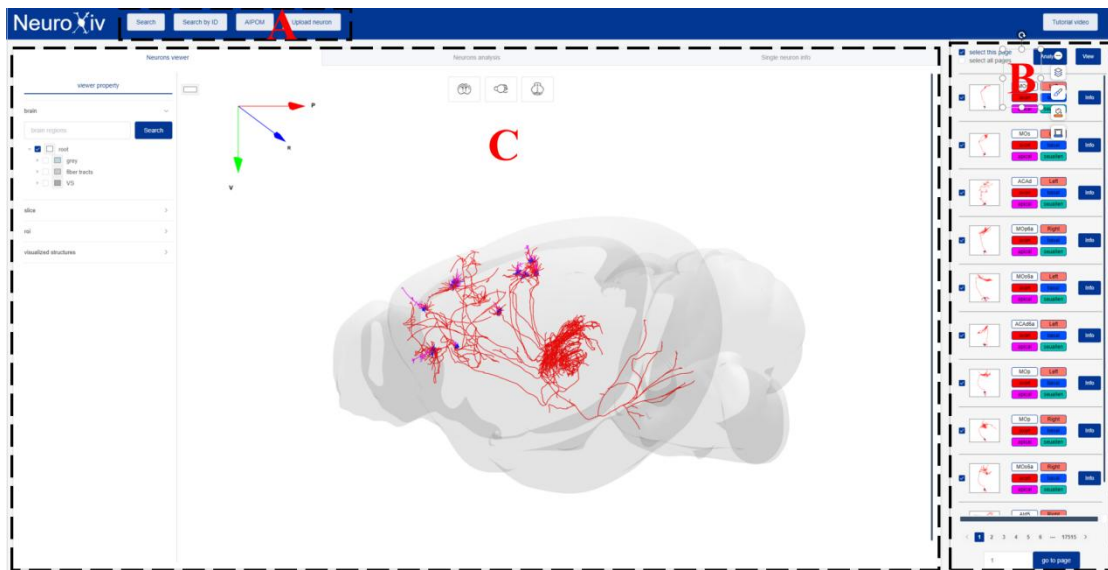


Figure 2 | Layout of NeuroXiv interface.

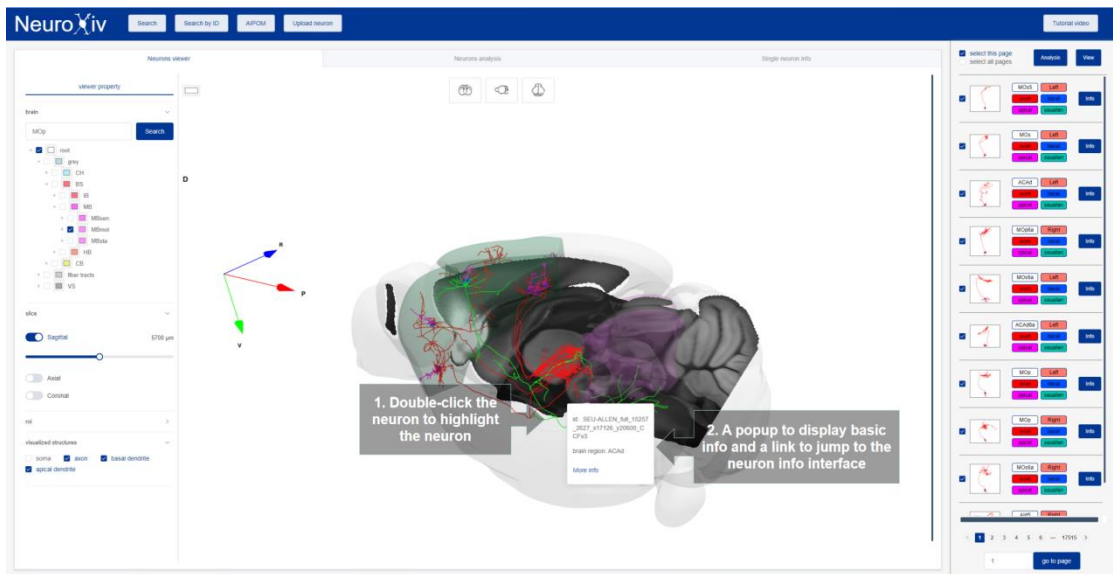
## Neuron Viewer

The Neuron Viewer panel (**Fig. 3**) is the core interface for exploring neuron reconstructions in 3D. Users can interact with the data in various ways:

- **3D Visualization:** Select neurons from the neuron browser to view their 3D reconstructions. This interactive visualization allows users to examine the detailed structure of neurons, including their dendrites and axons.
- **Brain Regions:** Use the search function to locate specific brain regions. Each region can be color-coded using the color button, helping users to differentiate between regions easily during analysis.
- **Brain Slices:** Users can choose to display brain slices, providing a cross-sectional view that helps in understanding the spatial context of neurons within the brain.
- **Neuron Structures:** The panel allows visualization of various neuron structures such as basal dendrites, apical dendrites, and axons. These can be toggled on or off to focus on specific aspects of the neuron.
- **Interactivity:** The viewer is fully interactive, allowing users to rotate, scale, and pan the 3D objects. Visibility of individual neurons can be controlled using checkboxes, enabling focused study of selected neurons (**Fig. 4**).



**Figure 3 | User can explore neurons in 3D in the Neuron Viewer panel**



**Figure 4 | Users can double-click on a single neuron from 3D viewer to view its info**

# Neuron Analysis

The Neuron Analysis panel (Fig. 5-6) provides tools for a more detailed examination of the neurons in the database. Users can view basic information, morphological features, anatomical and projection details, and distribution graphs for neurons. This panel serves as a powerful tool for researchers looking to analyze neuron data systematically.

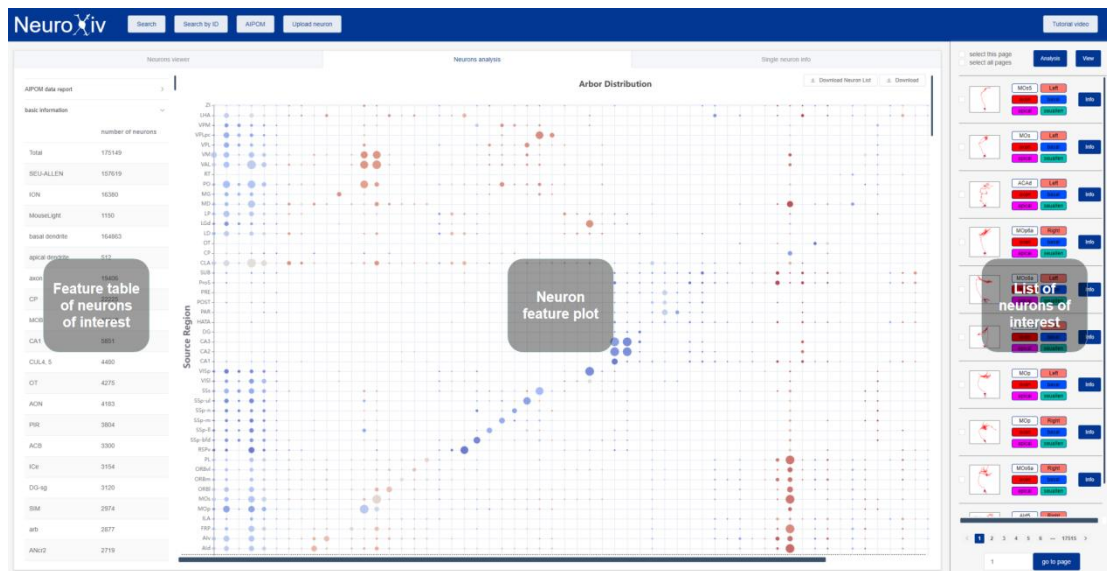


Figure 5 | User can view basic information, morphological features, anatomical and projection details, and distribution graphs for neurons in the Neuron Analysis panel



Figure 6 | Users can select neurons of interest from the right list to analysis.

## Single neuron info

In the Single neuron info panel (Fig. 7-10), basic information for each neuron is shown on the right side. Users can view detailed information and 3D visualization of each neuron by clicking 'info' button in the list. Users can control the 3D display of brain regions, neuron reconstructions, and brain slices using the left column interface. The central area allows users to freely rotate, scale, and pan objects—rotating with the left mouse button, translating with the right mouse button, and zooming with the mouse wheel. Additionally, in the lower right and left corners, users can independently rotate, scale, and pan the basal and apical dendrites of a neuron, respectively.

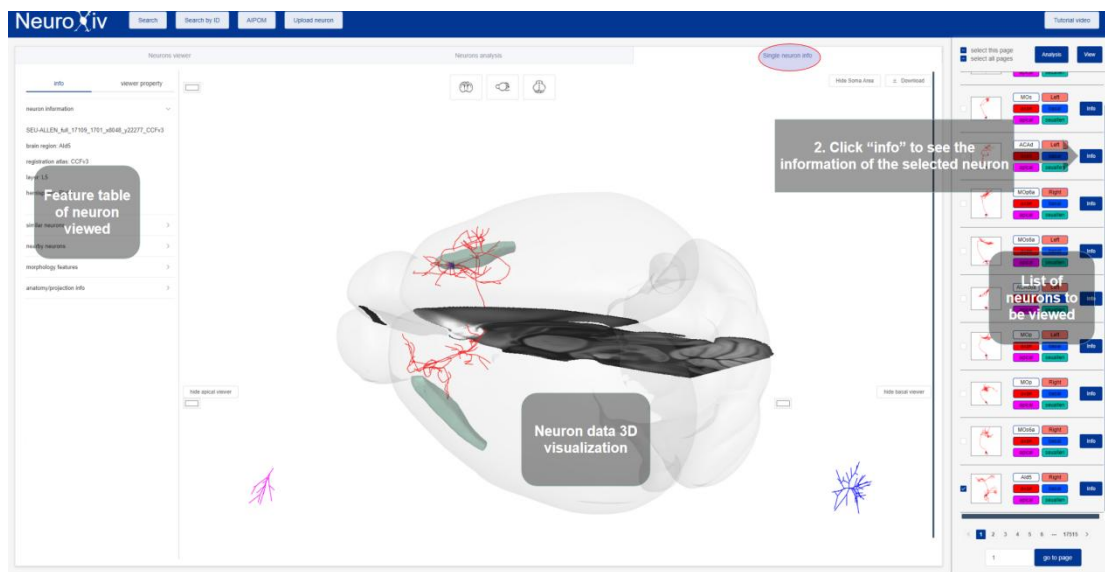


Figure 7 | User can view information and 3D visualization of a single neuron in the Single neuron info panel.

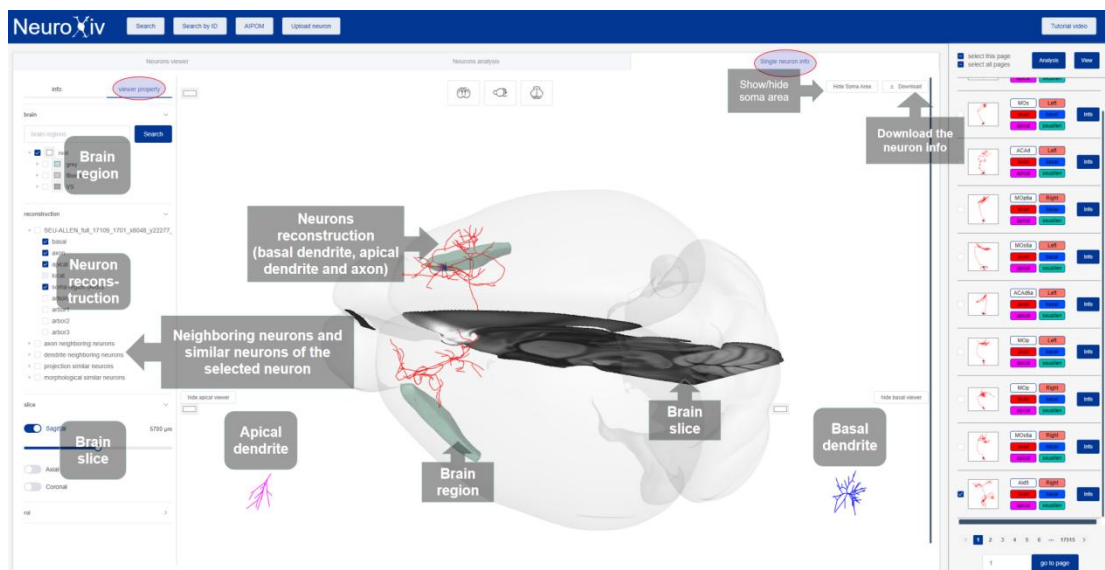
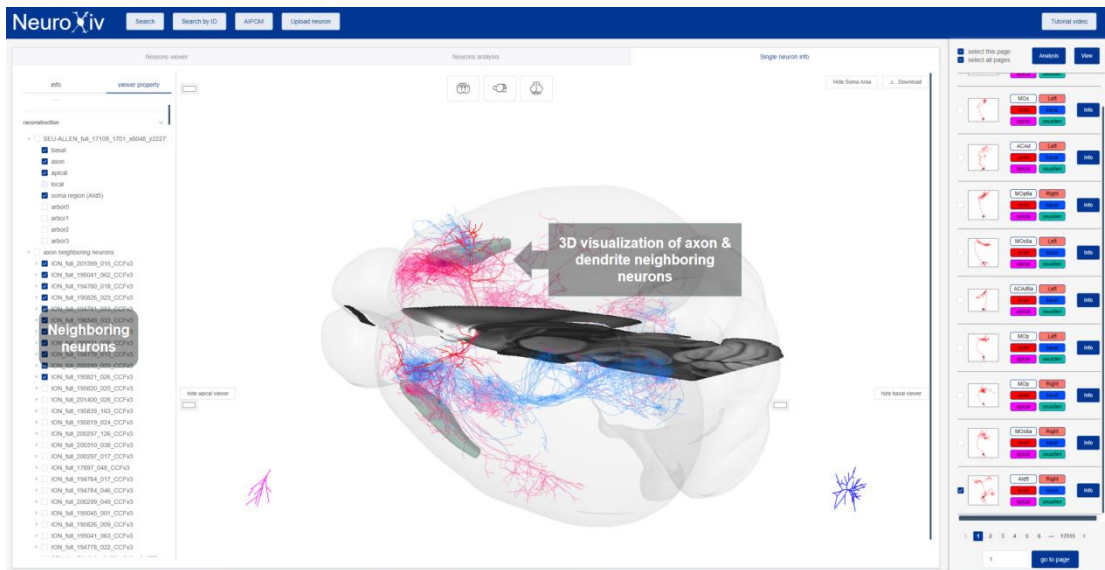
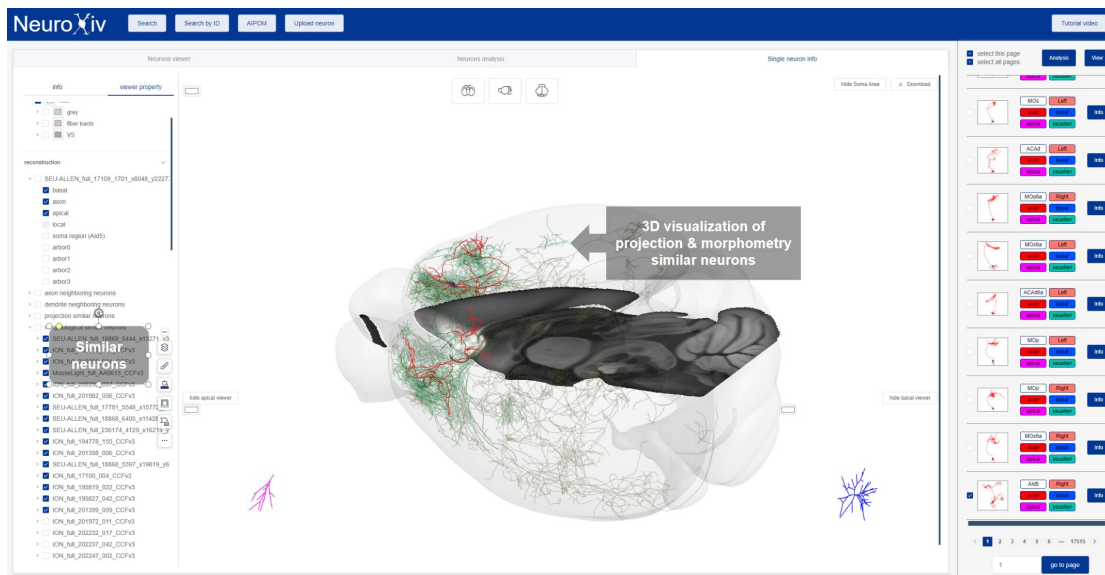


Figure 8 | Users can view neurons' reconstructions, neighboring neurons, and similar neurons of the selected neuron





**Figure 9 | Users can view 3D visualization of axon & dendrite neighboring neurons**



**Figure 10 | Users can view 3D visualization of morphological & projection neurons**

# Search function

## Search by different criteria

Click 'Search' button on the top to open search panel (Fig. 11). Users can search for neurons that meet the criteria they set, such as data source, soma region and so on. For categorical criteria such as brain region, users must choose from a predefined list of options. After selecting the desired options, they can add them to the query list (Fig. 12). Finally, users have the ability to save and load their own search criteria for future use (Fig. 13-14).

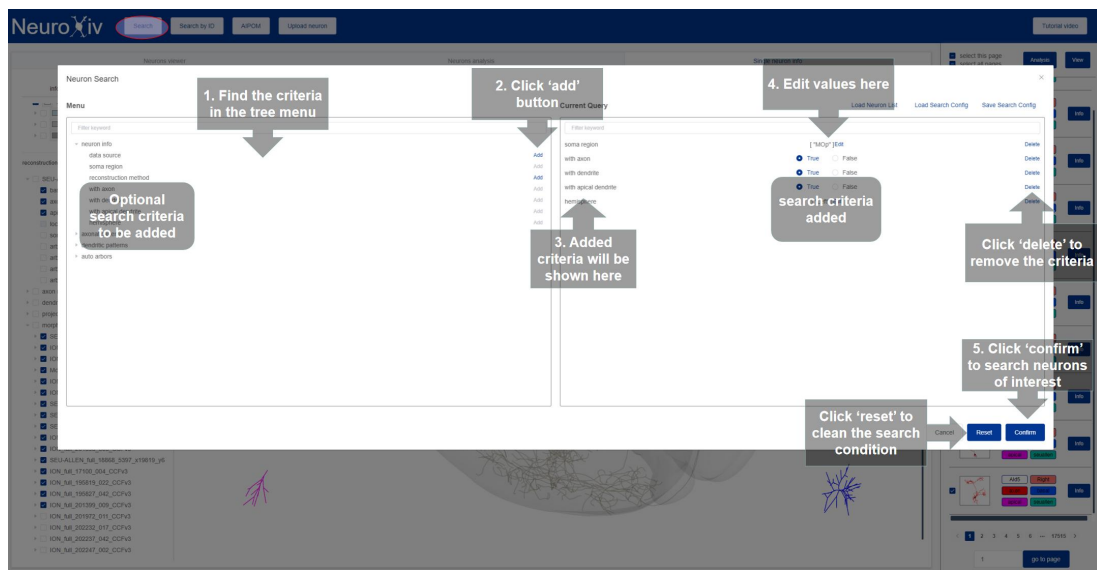


Figure 11 | User can search neurons by different criteria

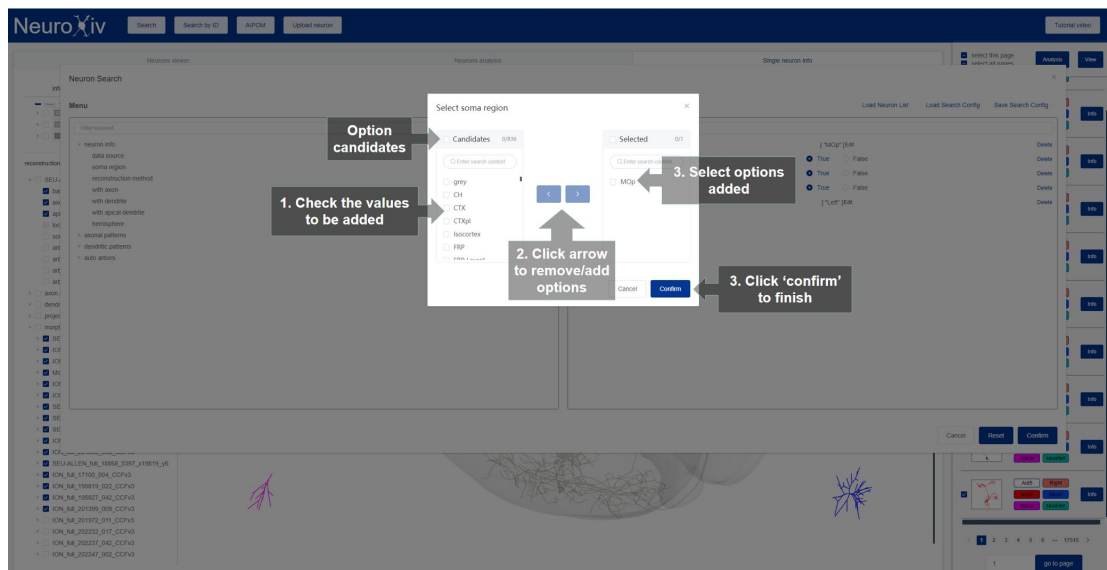


Figure 12 | Users need to select conditions from a given list of options.

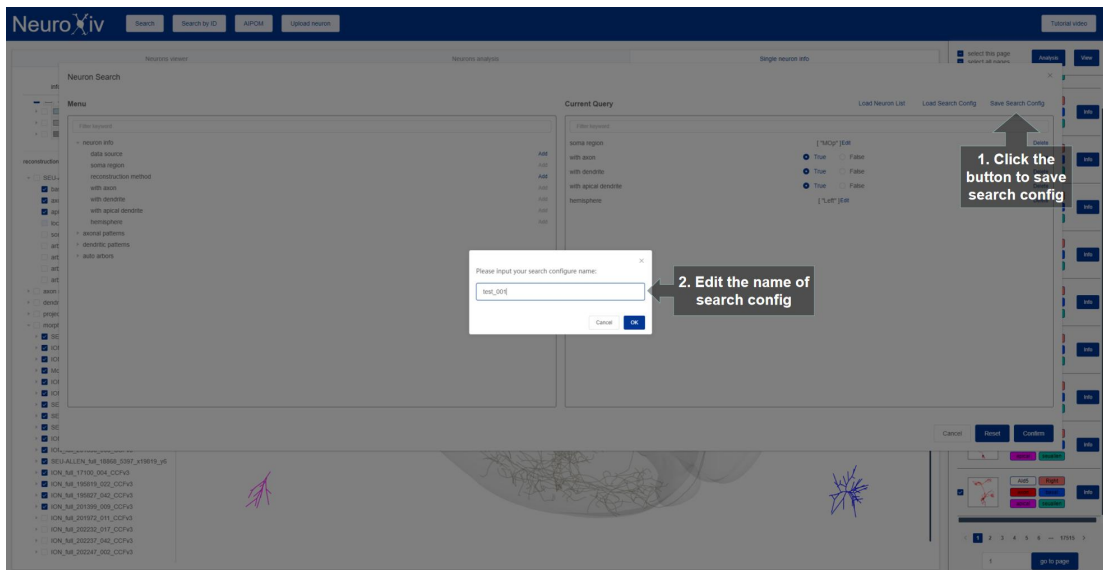


Figure 13 | users can save their own search criteria.

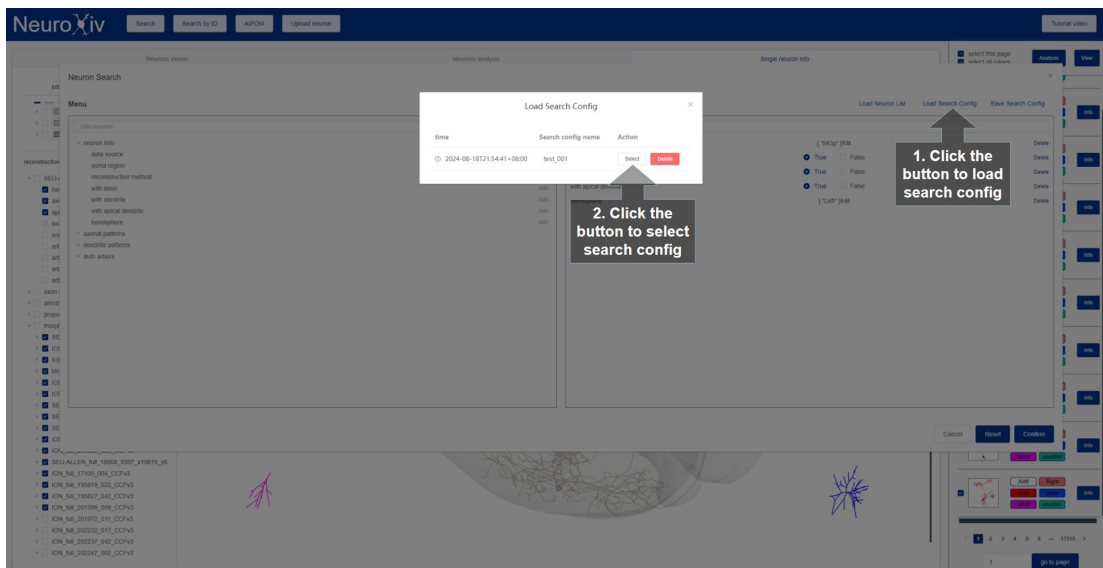


Figure 14 | users can load their own search criteria.

## Search by id

Click 'Search by id' button on the top to open search panel (Fig. 15-16). Users can search for a neuron based on the neuron id and jump to Single neuron info bar.

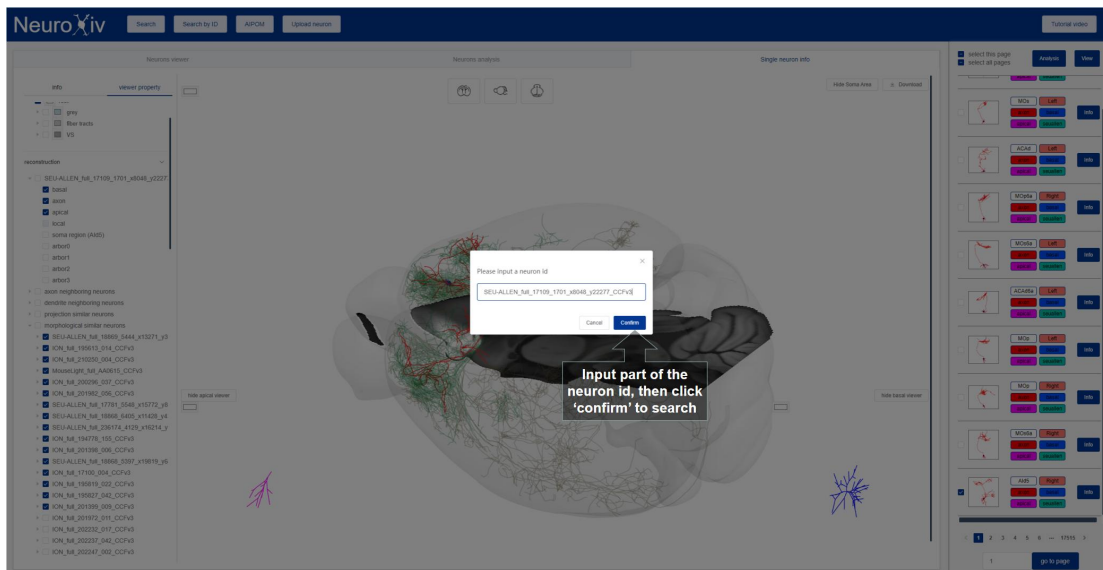


Figure 15 | Users can search neurons by neuron id

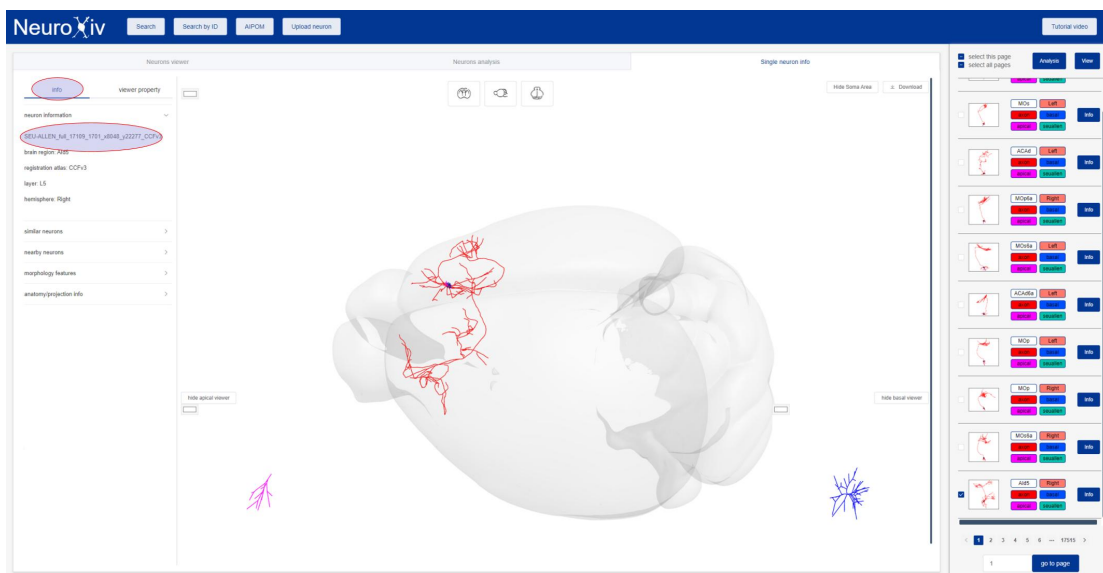
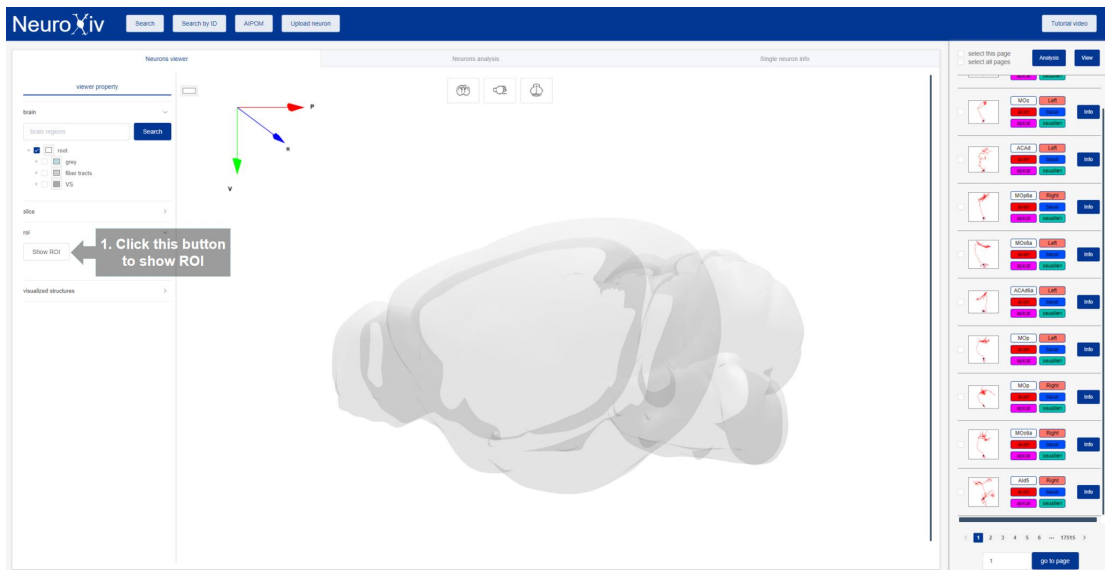


Figure 16 | After search, NeuroXiv will jump to Single neuron info bar

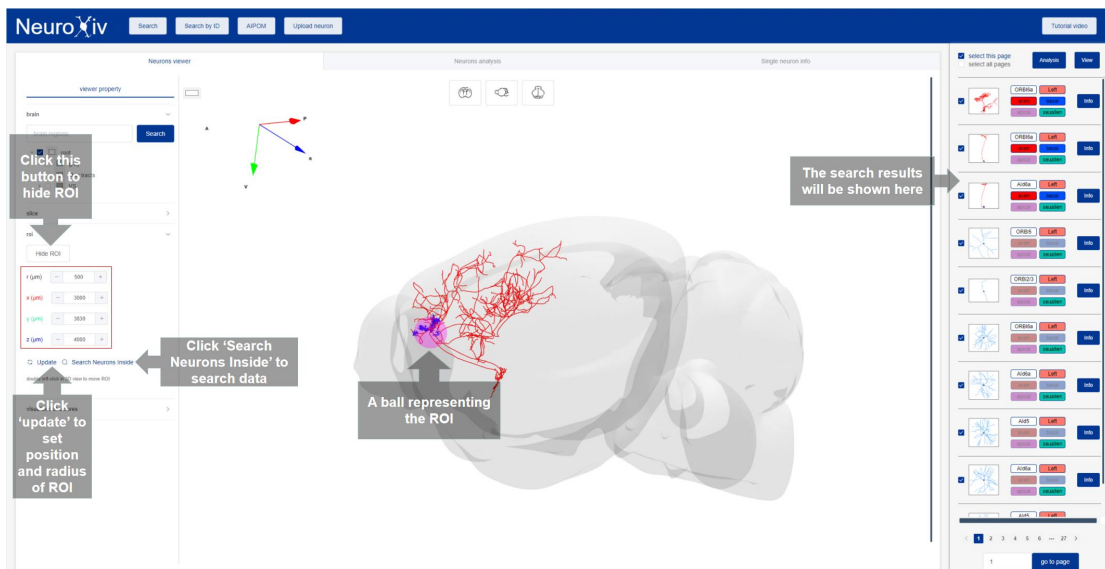
## Search by ROI

Click 'show ROI' button of 'roi' section in the Neurons viewer bar or Single neuron info bar to search for neurons based on ROI (Fig. 17-18). Users can double-click on the 3D viewer area or set position and radius to move the ROI ball.

Then, Users can click '*Search Neurons Insides*' to initiate a search, and the results will be displayed in the right column.



**Figure 17 | Users can create a ROI ball to search neurons inside**

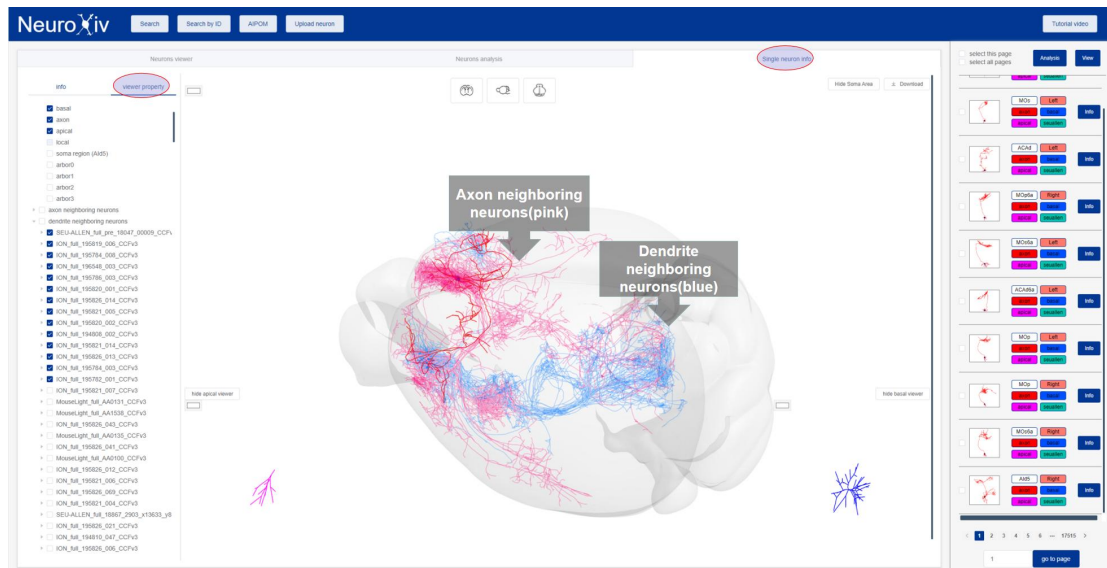


**Figure 18 | Users can interact with ROI and then search neurons inside**

# Advanced exploration

## Arbor-level connection

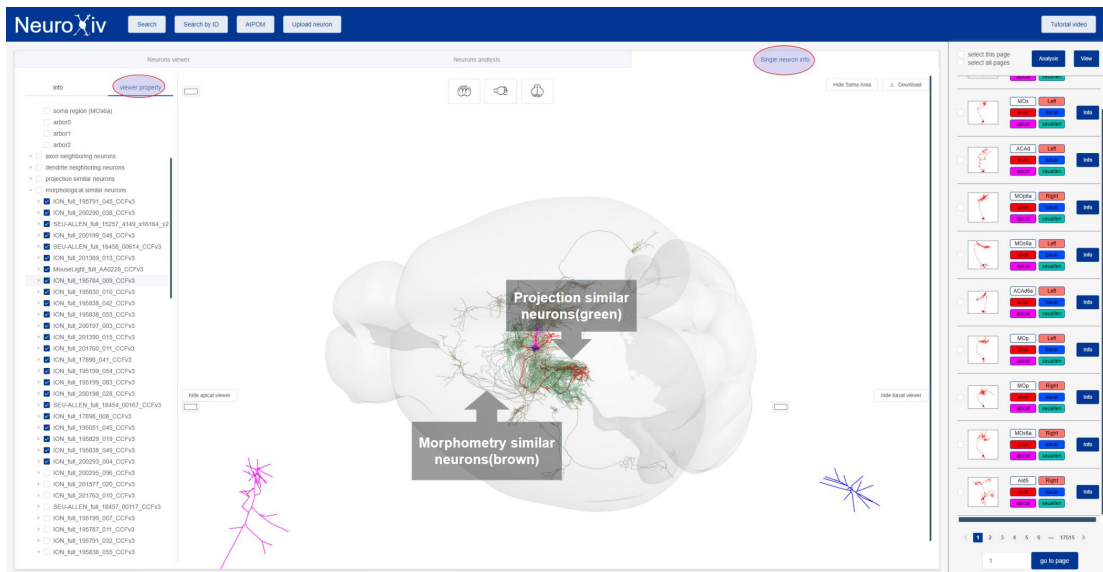
In single neuron info bar, users can observe the 3D visualization of the neighboring neurons of the viewed neuron (**Fig. 19**). Axon neighboring neurons are displayed in pink, and dendrite neighboring neurons are in blue.



**Figure 19 | Axon neighboring neurons are displayed in pink, and dendrite neighboring neurons are in blue**

## Morphology/projection similar neurons

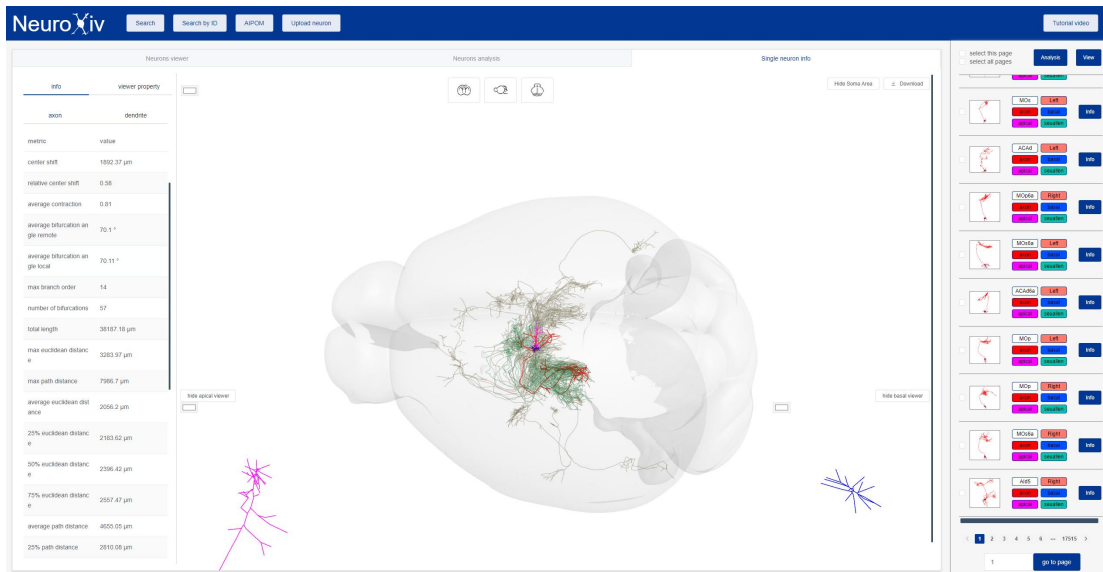
In single neuron info bar, users can observe the 3D visualization of the Morphology/projection similar neurons of the viewed neuron (**Fig. 20**). Projection similar neurons are displayed in green, and morphological similar neurons are in brown.



**Figure 20 | Projection similar neurons are displayed in green, and morphological similar neurons are in brown.**

## Morphological feature value and projection info

In Single neuron info bar, users can view morphological features of the axon and the dendrite (Fig. 21), as well as projection info of the axon, the dendrite and the arbor (Fig. 22).



**Figure 21 | users can view morphological features in Single neuron info bar**



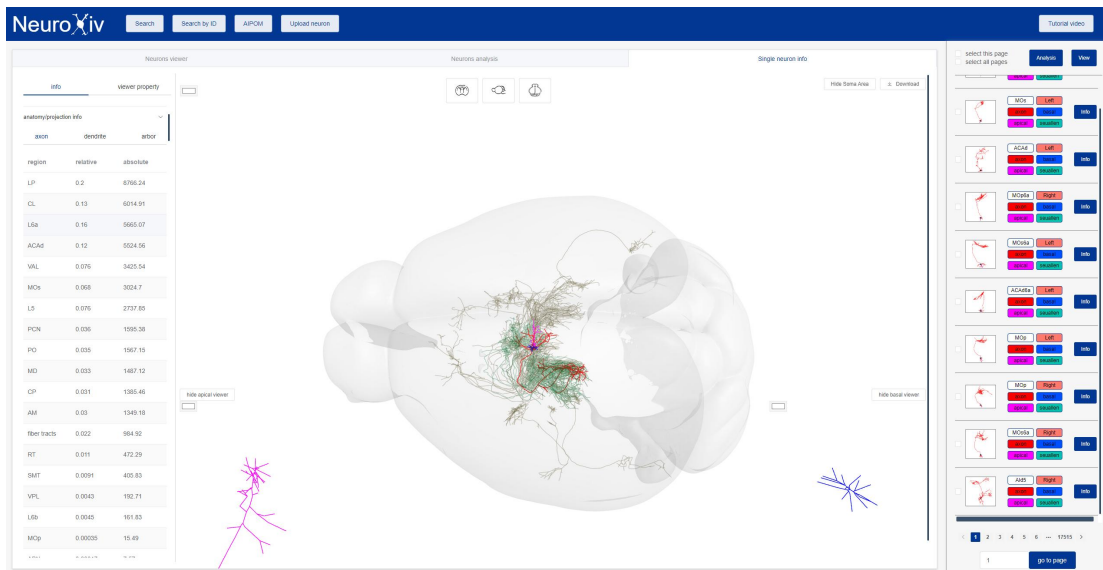


Figure 22 | users can view projection info in Single neuron info bar

## Group of neurons

### Feature distribution

In the Neuron analysis bar, users can view the morphological feature values for a group of neurons from the left column (Fig. 23). Feature distribution graphs is displayed in the middle column.



Figure 23 | Users can view the morphological feature values and feature distribution graphs in the Neuron analysis bar

### Projection matrix

In the Neuron analysis bar, users can observe the morphology level projection info for a group of neurons. Users can view the arbor length and distal arbor ratio by hovering the mouse over each circle.





**Figure 24 | Users can observe the morphology level projection info, the arbor length and distal arbor ratio in the Neuron analysis bar,**

## AIPOM

### AIPOM data report

The AIPOM system, powered by a Large Language Model (LLM) and utilizing a Mixture of Experts (MoE) structure, automatically generates comprehensive data reports. These reports provide users with a quick and insightful overview of the current dataset (Fig. 25).



**Figure 25 | The AIPOM system can generate data report about the current dataset automatically**

## AIPOM data search

Users can engage in a conversation with the AIPOM system through a chat interface to perform data retrieval using natural language queries (Fig. 26). The process involves entering a query in natural language into the input field, sending it to AIPOM, which then interprets the query, retrieves the relevant data, and synchronously updates the current dataset.

The screenshot displays the NeuroXiv AIPOM interface. On the left, there is a 'Neurons viewer' panel with an 'AIPOM data report' and a table of 'Source Region' counts. The main area is a chat window titled 'AIPOM' where a user has entered the query 'search MCPy neurons from SEU-ALLEN'. The chat shows a response from AIPOM: 'I have found 2043 neurons'. A callout box points to the chat input field with the text 'Enter query in natural language here'. Another callout points to the chat message with 'Results returned by AIPOM'. A third callout points to the chat input field with 'Send the query to AIPOM'. A fourth callout points to the chat message with 'AIPOM updates the dataset synchronously'. The interface also includes a search bar at the top, a 'Neuron List' on the right, and a 'get by page' button at the bottom right.

Source Region	number of neurons
SEU-ALLEN	2043
total	2043
basal dendrite	2043
apical dendrite	58
axon	72
MCPy	807
MCPyD3	579
MCPyA	406
MCPy1	101
MCPyB	90

**Figure 26 | Users can engage in a conversation with the AIPOM system through a chat interface to perform data retrieval using natural language queries**

# Data download

## Download the list of neurons and related information

This interface allows users to download neuron data efficiently. By clicking the first button, users can download a list of neurons, while the second button enables the download of all detailed information corresponding to the neurons in the list.

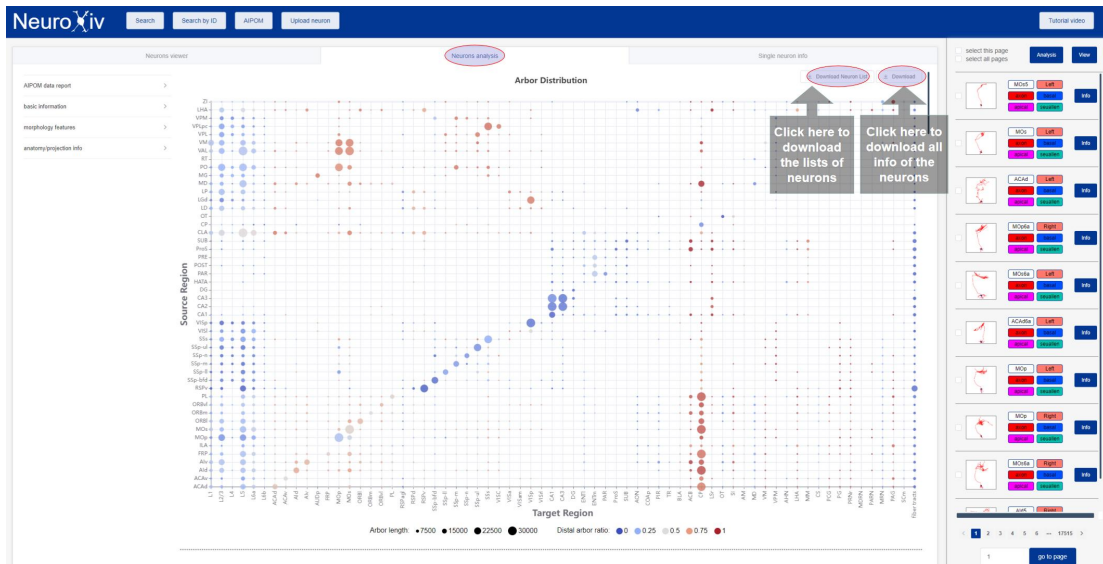
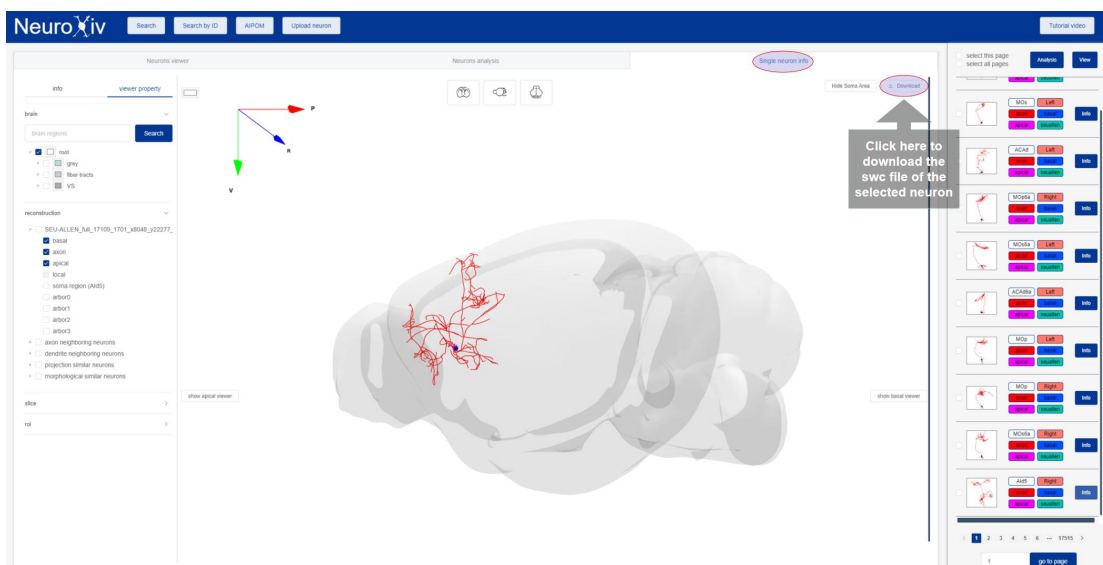


Figure 27 | Users can download neuron data in the Neuron Analysis panel

## Download the SWC file of the selected neuron

This interface allows users to visualize a selected neuron's 3D reconstruction within a brain model (Fig. 28). The key feature is the ability to download the SWC file of the selected neuron by clicking the designated download button. The SWC file contains detailed information about the neuron's structure, which can be used for further analysis or visualization in other tools.



**Figure 28 | Users can download the SWC file of the selected neuron**

## **Download standardized datasets**

We have set up an AWS server (<https://download.neuroxiv.org>) to facilitate easy access to standardized datasets.