NeuroExplorer Manual

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1. Getting Started

Installation

Before you can use NeuroExplorer, you must install NeuroExplorer program files, Sentinel system drivers and install the Sentinel hardware key.

Running NeuroExplorer Setup

Before you begin installing NeuroExplorer and its components, please exit all currently running applications. Please follow the following steps to install NeuroExplorer:

- Insert NeuroExplorer Setup USB flash drive into your computer USB port
- Navigate to NeuroExplorer4Setup.exe file on the flash drive and double-click on the file. NeuroExplorer Version 4 setup screen appears
- Follow the prompts of the setup dialogs and complete the installation
- At the end of the installation process, Sentinel System Driver Setup will start automatically
- Follow Sentinel Driver Setup prompts and complete the installation of Sentinel Drivers
- Reboot your computer

NeuroExplorer Setup will create the following directory structure:

- The main NeuroExplorer directory: C:\Program Files\Nex Technologies\NeuroExplorer
- SentinelDrivers subdirectory: C:\Program Files\Nex Technologies\NeuroExplorer\SentinelDrivers. If you need to reinstall Sentinel Drivers, you can run SentinelSetup.7.5.8.exe program in this directory.
- Additional NeuroExplorer files are copied to Windows Application Data directory (*C:\Documents and Settings\All Users\Application Data\Nex Technologies\NeuroExplorer* under Windows XP, or *C:\Application Data\Nex Technologies\NeuroExplorer* under Vista or Windows 7). This directory also contains Scripts and Templates folders where NeuroExplorer scripts and analysis templates are stored.

Installing Hardware Key

Before you can use NeuroExplorer, you need to install provided Sentinel Hardware Key on your computer.

To install the USB key:

- Make sure to run the NeuroExplorer setup and reboot the computer after installing NeuroExplorer
- Attach the key to the available USB port
- If the New Hardware Found wizard is shown, accept the defaults in the wizard

1.1. Getting Started with NeuroExplorer

This section, *Getting Started with NeuroExplorer*, describes the basics of using NeuroExplorer:

- Working with Sentinel keys
- NeuroExplorer Screen Elements
- Opening Files and Importing Data
- Importing Data from Text Files
- Importing Data from the Spreadsheets
- Analyzing Data
- Selecting Variables for Analysis
- Adjusting Analysis Properties
- Analysis Templates
- Numerical Results
- Post-processing
- Working with Matlab
- Working with Excel
- Saving Graphics

Additional information is available in the following sections:

- Working with Graphics
- NeuroExplorer Analysis Reference
- Programming with NexScript

NeuroExplorer Technical Support

NeuroExplorer users can get help via e-mail: support@neuroexplorer.com. Please visit NeuroExplorer Web site http://www.neuroexplorer.com for program updates and latest information about NeuroExplorer.

NeuroExplorer Updates

To get the latest version of NeuroExplorer, download the file http://www.neuroexplorer.com/downloads/NeuroExplorer4Setup.exe.

This file is a standard NeuroExplorer setup executable that is included in the NeuroExplorer CD. This setup file will execute the complete install – it will create folders, menu items in Start\Programs and create a desktop icon for NeuroExplorer.

1.2. Working with Sentinel Keys

General

NeuroExplorer requires a Sentinel key to operate. Sentinel drivers need to be installed so that NeuroExplorer can communicate with the Sentinel keys. These drivers are installed when you run NeuroExplorer setup (NeuroExplorer4Setup.exe).

Error Messages and Troubleshooting

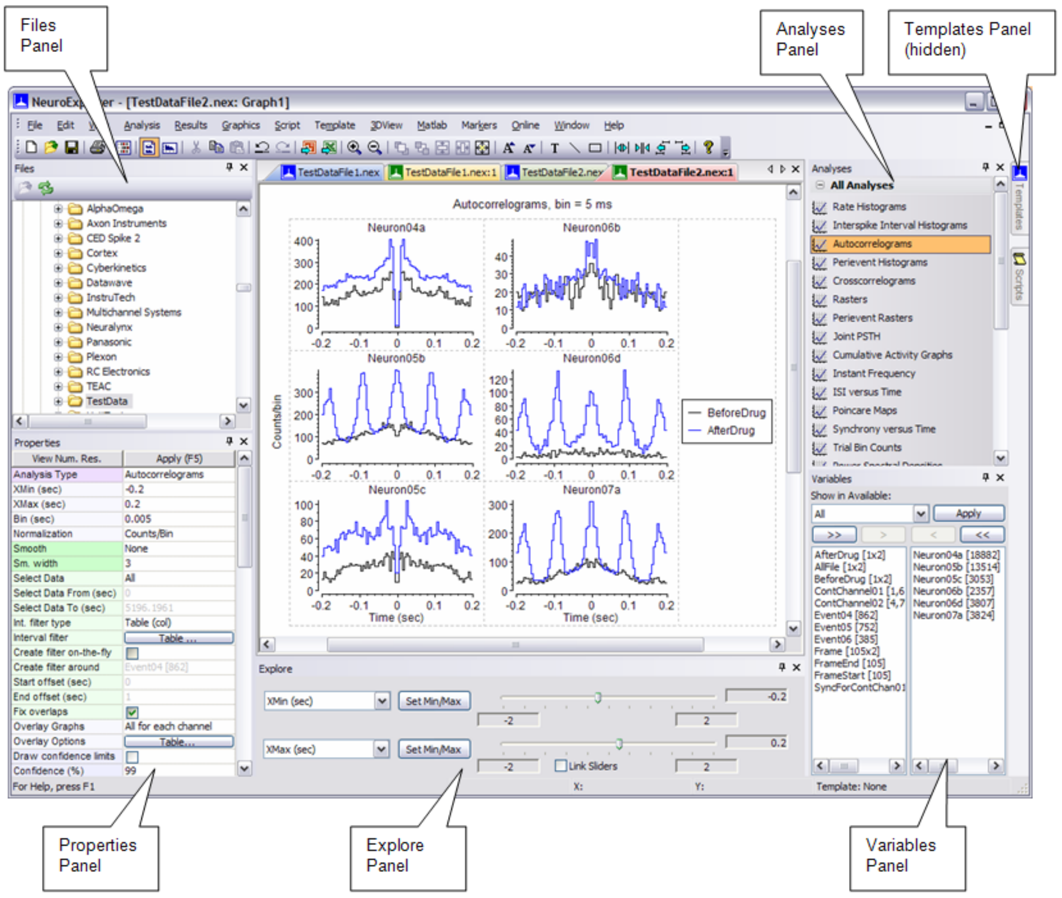
Error Message	Description and Probable Cause	Troubleshooting
Unable to initialize Sentinel library	Sentinel drivers are not installed or driver version is not supported.	Make sure that Sentinel drivers version 7.5.8 or later are installed: - Open Control Panel | Add or Remove Programs and verify that Sentinel System Driver Installer 7.5.8 is listed in Currently Installed Programs. - If an older version (prior to 7.5.8) of Sentinel Driver installer is listed, remove this version and reboot the computer. - To install the 7.5.8 drivers, run the driver installer: C:\Program Files\Nex Technologies\NeuroExplorer\SentinelDrivers\SentinelSetup.7.5.8.exe - Reboot the computer after installing the drivers.
Unable to find Sentinel key	NeuroExplorer Sentinel key is not attached to the computer or there is a problem communicating with the key.	1) Verify that you are using a NeuroExplorer key. The code *SRB10491* should be printed on the key. The newer keys also have *Neuroexplorer* printed on them. 2) Make sure that Sentinel drivers version 7.5.8 or later are installed. - Open Control Panel | Add or Remove Programs and verify that Sentinel System Driver Installer 7.5.8 is listed in Currently Installed Programs. - If an older version (prior to 7.5.8) of Sentinel Driver installer is listed, remove this version and reboot the computer. - To install the 7.5.8 drivers, run the driver installer: C:\Program Files\Nex Technologies\NeuroExplorer\SentinelD

		rivers\SentinelSetup.7.5.8.exe - Reboot the computer after installing the drivers. 3) If the problem persists, you may need to use the Cleanup utility. - Uninstall NeuroExplorer and all the Sentinel software items listed in Control Panel | Add or Remove Programs - Download Sentinel cleanup utility (SSD Cleanup) from this page: http://www.safenet-inc.com/support-downloads/sentinel-drivers/ - Unzip and run the utility. Make sure you let the utility to finish running. It may take several minutes. - Reboot the computer - Run NeuroExplorer4Setup.exe. Make sure not to cancel Sentinel Driver Setup. Accept defaults in Sentinel Driver Setup. - Reboot the computer Please contact NeuroExplorer technical support (mailto:support@neuroexplorer.com) if you still have problems with the Sentinel key.
Unable to read Sentinel key data	Malfunctioning or damaged Sentinel key.	Please contact NeuroExplorer technical support (mailto:support@neuroexplorer.com)
Sentinel key does not have version 4 license	You are using NeuroExplorer version 3 Sentinel key.	If you purchased NeuroExplorer version 4, please contact NeuroExplorer technical support (mailto:support@neuroexplorer.com) If you would like to upgrade to NeuroExplorer version 4, please contact NeuroExplorer support (support@neuroexplorer.com) or one of the NeuroExplorer resellers listed in the Purchase page of the NeuroExplorer web site: http://www.neuroexplorer.com/purchase.htm

1.3. NeuroExplorer Screen Elements

NeuroExplorer user interface consists of the main window surrounded by several panels. These panels allow you to select files, select analyses and specify analysis properties. The figure below shows the default layout of NeuroExplorer window. Files, Properties, Analyses, Variables and Explore panels are visible and Templates and Scripts panels are hidden. To view a hidden panel, click at the panel tab or use View menu command.

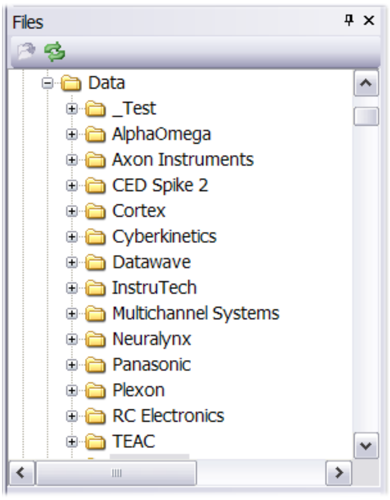
You can reposition panels by dragging them with your mouse and you can save and restore window layouts using Window menu commands.



View Num. Res.	Apply (F5)
Analysis Type	Autocorrelograms
XMin (sec)	-0.2
XMax (sec)	0.2
Bin (sec)	0.005
Normalization	Counts/Bin
Smooth	None
Sm. width	3
Select Data	All
Select Data From (sec)	0
Select Data To (sec)	5196.1961
Int. filter type	Table (col)
Interval filter	Table ...
Create filter on-the-fly	☐
Create filter around	Event04 [862]
Start offset (sec)	0
End offset (sec)	1
Fix overlaps	✓
Overlay Graphs	All for each channel
Overlay Options	Table...
Draw confidence limits	☐
Confidence (%)	99

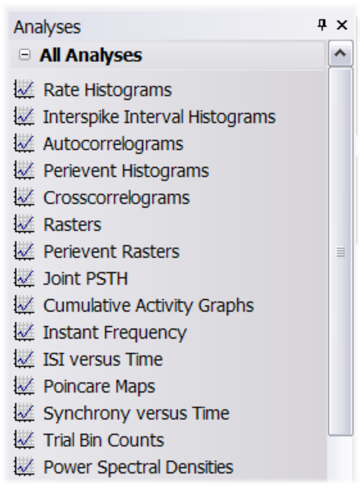
For Help, press F1

Files Panel



This view allows you to quickly browse through your data files. When you select (single-click) one of the data files, NeuroExplorer displays the file header information in the Properties panel. To open the data file, simply double-click the file name.

Analyses Panel



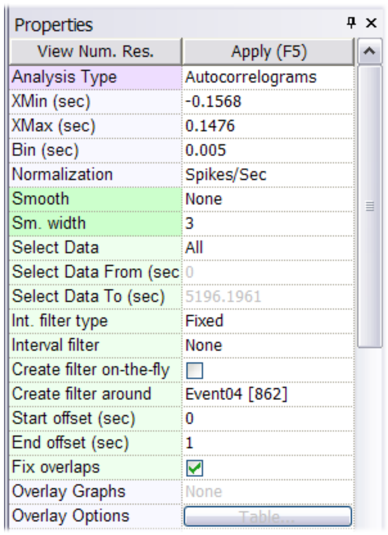
Analyses

All Analyses

- Rate Histograms
- Interspike Interval Histograms
- Autocorrelograms
- Perievent Histograms
- Crosscorrelograms
- Rasters
- Perievent Rasters
- Joint PSTH
- Cumulative Activity Graphs
- Instant Frequency
- ISI versus Time
- Poincare Maps
- Synchrony versus Time
- Trial Bin Counts
- Power Spectral Densities

This view allows you to quickly select one of the analyses available in NeuroExplorer. To apply analysis to the active data file, click at the analysis name.

Properties Panel



Properties

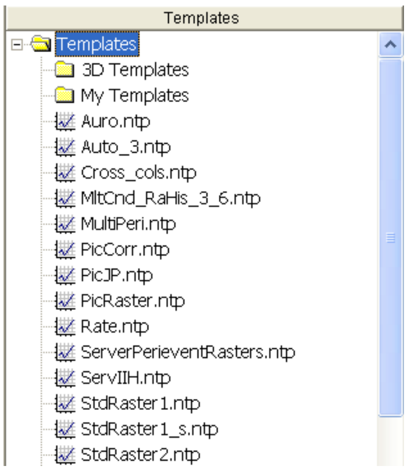
View Num. Res.	Apply (F5)
Analysis Type	Autocorrelograms
XMin (sec)	-0.1568
XMax (sec)	0.1476
Bin (sec)	0.005
Normalization	Spikes/Sec
Smooth	None
Sm. width	3
Select Data	All
Select Data From (sec	0
Select Data To (sec)	5196.1961
Int. filter type	Fixed
Interval filter	None
Create filter on-the-fly	☐
Create filter around	Event04 [862]
Start offset (sec)	0
End offset (sec)	1
Fix overlaps	✓
Overlay Graphs	None
Overlay Options	Table...

The left column of the Properties Panel lists the names of adjustable parameters for the selected object. The right column contains various controls that can be used to change the parameter values. To apply the changes, press the Apply button or hit the F5 key.

Templates Panel

The Templates View can be used to quickly execute an Analysis Template. Double-click the template name and the corresponding template will be immediately executed.

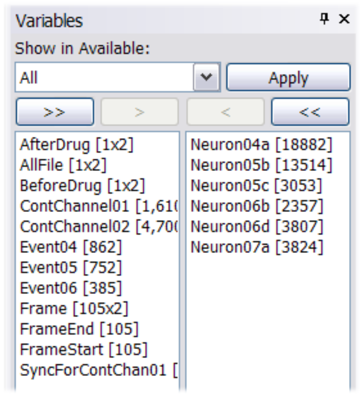
You can create subfolders in your template directory and then NeuroExplorer will allow you to navigate through the templates tree within the Templates View.



Templates
- 3D Templates
- My Templates
- Auro.ntp
- Auto_3.ntp
- Cross_cols.ntp
- MltCnd_RaHis_3_6.ntp
- MultiPeri.ntp
- PicCorr.ntp
- PicJP.ntp
- PicRaster.ntp
- Rate.ntp
- ServerPerieventRasters.ntp
- ServIIH.ntp
- StdRaster1.ntp
- StdRaster1_s.ntp
- StdRaster2.ntp

Variables Panel

You can analyze all the variables in your data file, a subset of the variables, or may be just one variable. Variables Panel allows you to quickly select and deselect the variables used for analysis:

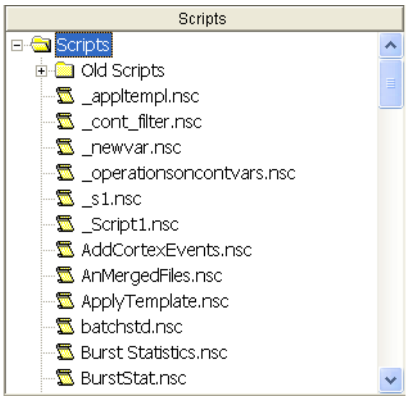


AfterDrug [1x2]	Neuron04a [18882]
AllFile [1x2]	Neuron05b [13514]
BeforeDrug [1x2]	Neuron05c [3053]
ContChannel01 [1,61	Neuron06b [2357]
ContChannel02 [4,70	Neuron06d [3807]
Event04 [862]	Neuron07a [3824]
Event05 [752]	
Event06 [385]	
Frame [105x2]	
FrameEnd [105]	
FrameStart [105]	
SyncForContChan01 [	

The left column shows the variables that are not currently selected; the right column shows the selected variables. To move variables from column to column, first select them, then press ">" (Select) or "<" (Deselect) buttons.

Scripts Panel

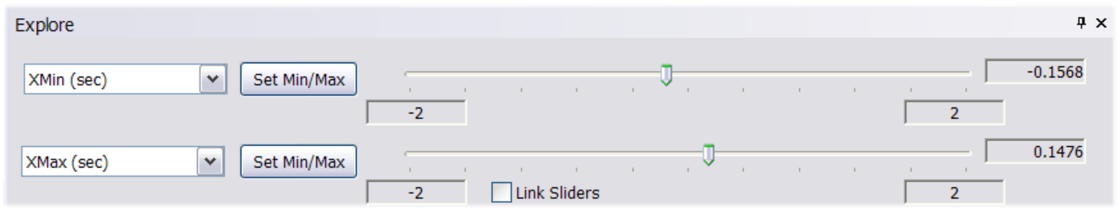
This panel can be used to select a script to be executed. Double-click the script name to run the selected script.



Scripts
- Old Scripts
- _appltempl.nsc
- _cont_filter.nsc
- _newvar.nsc
- _operationsoncontvars.nsc
- _s1.nsc
- _Script1.nsc
- AddCortexEvents.nsc
- AnMergedFiles.nsc
- ApplyTemplate.nsc
- batchstd.nsc
- Burst Statistics.nsc
- BurstStat.nsc

You can create subfolders in your script directory and then NeuroExplorer will allow you to navigate through the scripts tree within the Scripts View.

Explore Panel



Explore panel allows you to quickly explore analysis parameter ranges. Select a parameter you want to explore from a list and drag a slider. NeuroExplorer will keep recalculating analysis with the new parameter values while you drag the slider, thus creating an “analysis animation”.

One of the best uses for this panel is to explore analysis properties over a sliding window within your file:

- Specify Use Time Range using Analysis | Edit menu command, then Data Selection tab
- Select ‘Select Data From’ and ‘Select Data To’ parameters in the list boxes of the Explore panel
- Click on Link Sliders check box

Now, when you drag one of the sliders, the other one will follow allowing you to visualize analysis results over a sliding window in time.

1.4. Opening Files and Importing Data

NeuroExplorer can read native data files created by popular data acquisition systems (Alpha Omega, CED Spike-2, Cortex, Blackrock Microsystems, DataWave, Multi Channel Systems, Neuralynx, Plexon, RC Electronics. See Importing Files Created By Data Acquisition Systems for more information).

NeuroExplorer can also import data from text files (see Importing Data from Text Files).

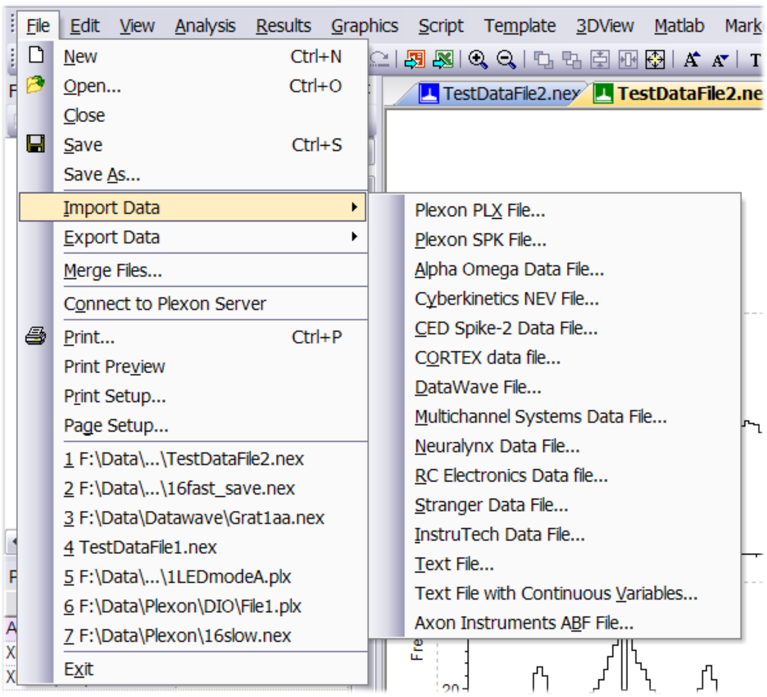
You can import the data from spreadsheets using the clipboard (see Importing Data from Spreadsheets).

NeuroExplorer has its own data format and by default saves the data in the binary file with the extension*.nex*.

To open a NeuroExplorer data file,

- press **File Open** toolbar button , or
- select **File | Open...** menu command.

To import data in any of the supported file formats, select the corresponding **File | Import** command:



You can also paste data directly into Data View. See Importing Data from the Text Files and Importing Data from Spreadsheets for more information.

1.5. Importing Files Created by Data Acquisition Systems

NeuroExplorer can read native data files created by popular data acquisition systems (Alpha Omega, CED Spike-2, Cortex, DataWave, Blackrock Microsystems, Multi Channel Systems, Neuralynx, Plexon, RC Electronics).

Since NeuroExplorer does not provide spike sorting capabilities yet, it is assumed that you have already sorted (clustered) the waveforms.

Alpha Omega Files

NeuroExplorer can import Alpha Omega MAP, ISI, NDA, MAT and LSM files. All the spike trains, DIO events and continuous variables are imported. The waveforms can be imported as an option (see **File Import Options** below).

Blackrock Microsystems Files

NeuroExplorer can import Blackrock Microsystems NEV files. All the spike trains and DIO events Analog channels can be imported as an option. The waveforms are imported when using Neuroshare DLL to import NEV files.

DataWave Files

NeuroExplorer can import both Discovery and Workbench files. In general, all the sorted spike trains, DIO events and trial descriptors are imported. The waveforms are not imported. Analog channels can be imported as an option (see **Options** below).

The following UFF types are imported from the Discovery files:

S, **E** and **U** UFF types are imported as spike trains

B UFF type records are imported as events

T UFF type records are imported as markers

P (position) UFF type records are imported as 4 continuous variables.

The following record types are imported from the Workbench files:

Analysis records (with appropriate subtypes) are imported as spike trains

Event records are imported as events

Trial records are imported as markers

CED Spike-2 Files

NeuroExplorer can import Spike-2 *.smr files. All the sorted spike trains, events and markers are imported. The waveforms are not imported. Analog (Adc) channels can be imported as an option (see **File Import Options** below).

Plexon Files

NeuroExplorer can read *.plx and *.ddt Plexon files. All the sorted spike trains and external events are imported. The waveforms are not imported. Analog (slow) channels can be imported as an option (see **File Import Options** below).

RC Electronics Files

NeuroExplorer can import both 12-bit RC Electronics files and 16-bit DATAMAX files. Since the current version of NeuroExplorer stores all the data in RAM, NeuroExplorer can import only relatively small (about the size of RAM on your PC) RC Electronics files.

Multi Channel Systems Files

NeuroExplorer can import standard MCS data files. All the sorted spike trains and external events are imported. The waveforms are not imported. Analog channels can be imported as an option (see **File Import Options** below).

Neuralynx Files

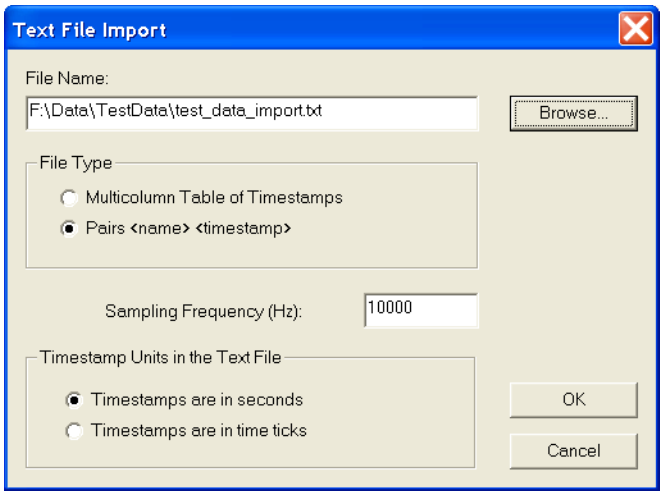
NeuroExplorer can import Neuralynx data files (tt*.dat, se*.dat, etc.) as well as the files created by **MClust** spike sorter (*.t files). All the sorted spike trains are imported. External events are imported as markers. Analog channels and waveforms can be imported as an option (see **File Import Options** below).

File Import Options

The file import options can be set in the **Data Import** dialog (use **View | Data Import Options** menu command to invoke the dialog).

1.6. Importing Data from Text Files

You can specify text import options in the Text Import dialog:



Text File Import

File Name: F:\Data\TestData\test_data_import.txt

File Type
- Multicolumn Table of Timestamps
- [✓ Pairs <name> <timestamp>]

Sampling Frequency (Hz): 10000

Timestamp Units in the Text File
- [✓ Timestamps are in seconds]
- Timestamps are in time ticks

Sampling Frequency - this parameter defines the internal representation of the timestamps that NeuroExplorer will use for this file. Internally, the timestamps are stored as integers representing the number of time ticks from the start of the experiment. The time tick is equal to

```
1./ Sampling_Frequency
```

Timestamp Units - this parameter defines how the numbers representing the timestamps are treated by NeuroExplorer. If the timestamps are in time ticks, they are stored internally exactly as they are in the text file. If the timestamps are in seconds, NeuroExplorer converts them to time ticks:

```
Internal_Timestamp = Timestamp_In_Seconds * Sampling_Frequency
```

NeuroExplorer can import timestamped data stored in the following text formats:

1. Multicolumn table of timestamps

In this format, each column in the text file contains the timestamps of a neuron. The first element in each column is **a neuron name**, that is the first line of the file contains names of all the variables.

Each **name** should be less than 64 characters long and should contain only letters, digits or the underscore sign. The first character of the name should be a letter. The **timestamps** are numbers representing the neuron firing time (or event time) in seconds or in time ticks. NeuroExplorer assumes that the columns are separated by **tabs**.

Here is an example of a text file with the timestamps represented in seconds:

```
Neuron01    Neuron02
0.01        0.001
0.3         0.05
0.5         0.1
           0.4
           0.6
```

NeuroExplorer can also export data in this format (use **File | Save Data | As a Text File** menu command).

2. Pairs <name> <timestamp>

The text file in this format should contain the pairs of the type

<name><timestamp>

where

<name> is a character string that is less that 64 characters long and contains only letters, digits and the underscore sign. The first character of the name should be a letter. If the number is used for the name, NeuroExplorer will add "event" at the beginning of the name.

<timestamp> is a number representing the neuron firing time (or event time) in seconds or in time ticks.

Here is an example of a text file with the timestamps represented in seconds:

```
Neuron01    0.01
Neuron01    0.3
Neuron02    0.001
Neuron02    0.05
Neuron01    0.5
Neuron02    0.1
Neuron02    0.4
```

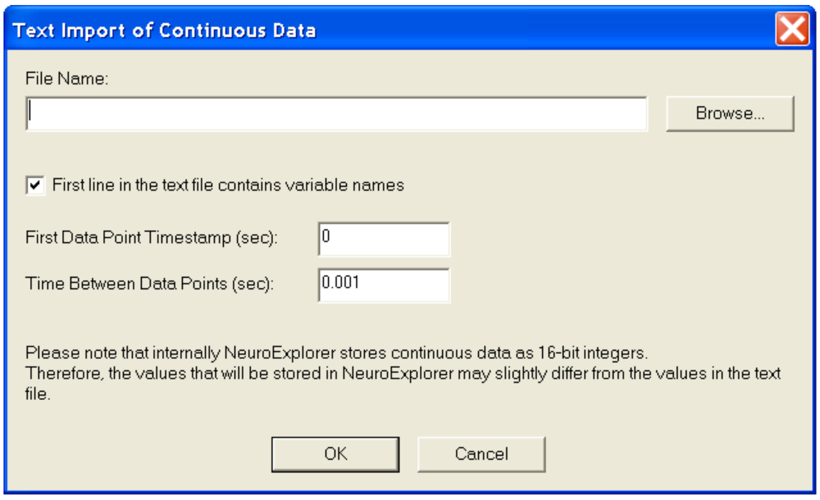
3. Multicolumn text files with continuous data

NeuroExplorer can also import **continuous data** from a multicolumn text file where each column corresponds to a continuous variable:

```
ContChannel1    ContChannel2
114.74609       -63.47656
56.15234        -358.88672
-187.98828      -63.47656
-48.82813       388.18359
-26.85547       285.64453
```

The columns may be separated by any number of spaces, tabs or commas.

When you import **continuous data** from text files, the following dialog is shown:



[✓] First line in the text file contains variable names

First Data Point Timestamp (sec): 0

Time Between Data Points (sec): 0.001

Please note that internally NeuroExplorer stores continuous data as 16-bit integers. Therefore, the values that will be stored in NeuroExplorer may slightly differ from the values in the text file.

First line contains variable names – if this option is selected, the fields of the first line of the text file are used as variable names. The second line in the file is the first row of data.

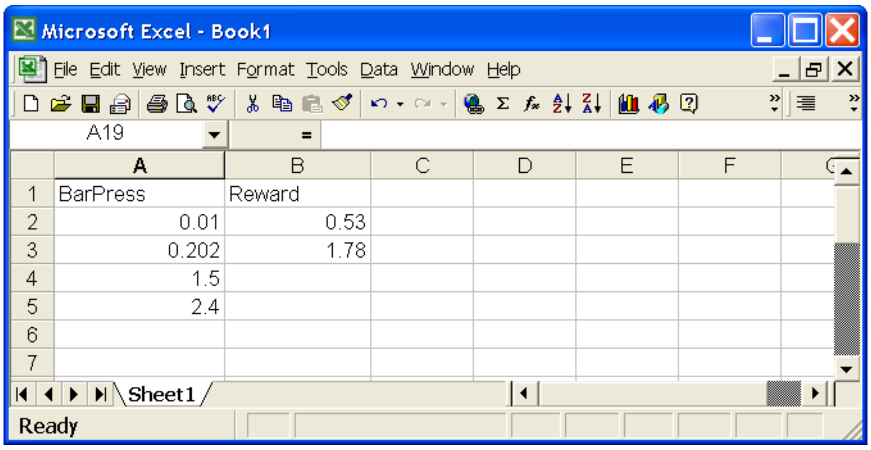
First Data Point Timestamp specifies the timestamp of the first data point in each continuous variable.

Time Between Data Points specifies the time step used in calculation of the timestamp for each row of data. For data row N (N = 1, 2, …) in the text file, the timestamp is calculated using the following formula:

```
DataRowTimestamp = FirstDataPoint + (N-1)*TimeBetweenDataPoints
```

1.7. Importing Data from Spreadsheets

Timestamped data can be pasted directly into the NeuroExplorer data table. To paste the following two timestamped variables (BarPress and Reward) from a spreadsheet to NeuroExplorer:



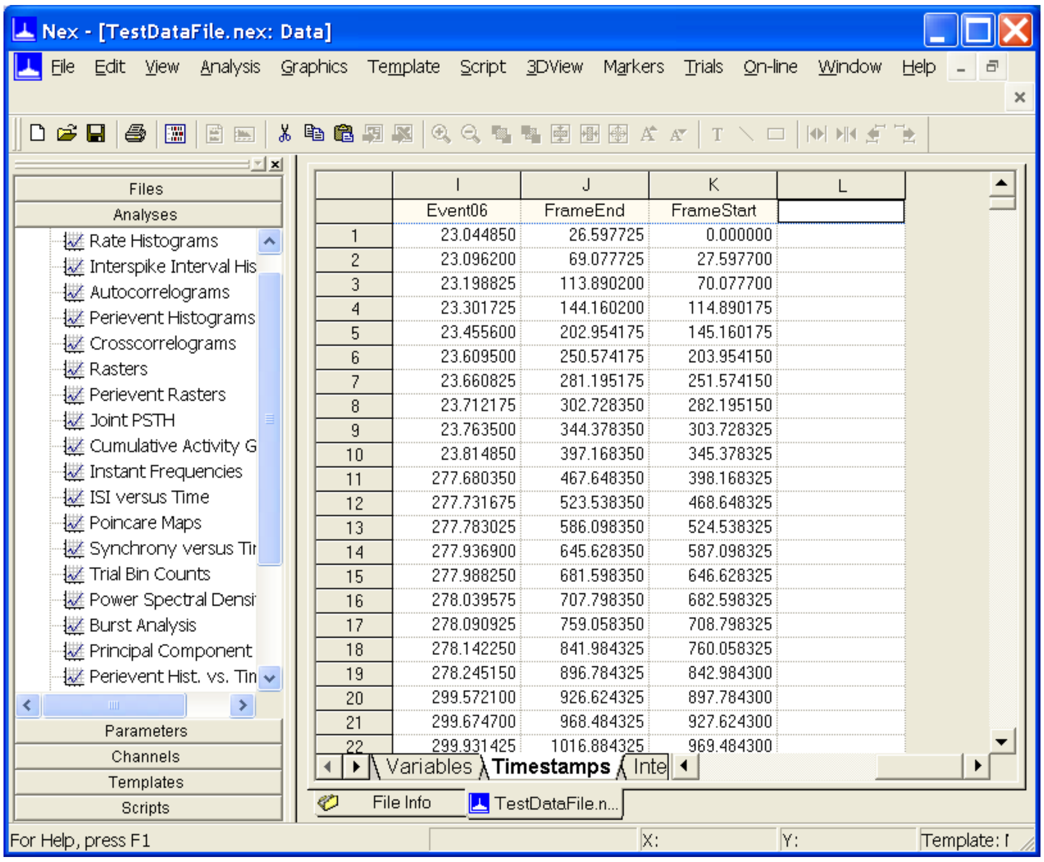
	A	B	C	D	E	F
1	BarPress	Reward				
2	0.01	0.53				
3	0.202	1.78				
4	1.5					
5	2.4					
6						
7						

In Excel:

- Using the mouse, select the cell range with both variables (A1 to B5)
- Select **Edit | Copy** menu command

In NeuroExplorer:

- Select Data view of the file in NeuroExplorer
- Select the Timestamps tab of the Data view
- Scroll the timestamps window to the right and select the topmost cell of the empty column:



	I	J	K	L
	Event06	FrameEnd	FrameStart	
1	23.044850	26.597725	0.000000	
2	23.096200	69.077725	27.597700	
3	23.198825	113.890200	70.077700	
4	23.301725	144.160200	114.890175	
5	23.455600	202.954175	145.160175	
6	23.609500	250.574175	203.954150	
7	23.660825	281.195175	251.574150	
8	23.712175	302.728350	282.195150	
9	23.763500	344.378350	303.728325	
10	23.814850	397.168350	345.378325	
11	277.680350	467.648350	398.168325	
12	277.731675	523.538350	468.648325	
13	277.783025	586.098350	524.538325	
14	277.936900	645.628350	587.098325	
15	277.988250	681.598350	646.628325	
16	278.039575	707.798350	682.598325	
17	278.090925	759.058350	708.798325	
18	278.142250	841.984325	760.058325	
19	278.245150	896.784325	842.984300	
20	299.572100	926.624325	897.784300	
21	299.674700	968.484325	927.624300	
22	299.931425	1016.884325	969.484300	

Select **Edit | Paste** menu command. NeuroExplorer will create two new Event variables and add them to the file. You need to save the file (use **File | Save** or **File | SaveAs** menu command) to make this change permanent.

1.8. Importing Data from Matlab

You can create spike trains (1xN or Nx1 matrices with timestamps in seconds) or continuous variables in Matlab and transfer them to NeuroExplorer on the fly. Here is how to do this:

- Select **File | New** menu command.
- Select **Matlab | Get Data From Matlab... | Open Matlab As Engine** menu command. NeuroExplorer will open Matlab as engine.
- In opened Matlab, run your Matlab scripts and create (or load from file) spike train variables or continuous variables.
- To import timestamp variables, in NeuroExplorer, select **Matlab | Get Data From Matlab... | Get Timestamp Variables...** menu command. NeuroExplorer will open a dialog with the list of available Matlab variables.
- In the dialog, select the variables you want to transfer to NeuroExplorer and press OK.
- To import continuous variables, in NeuroExplorer, select **Matlab | Get Data From Matlab... | Get Continuous Variables...** menu command. NeuroExplorer will open a dialog with the list of available Matlab variables.
- In the dialog, select one of the variables you want to transfer to NeuroExplorer and press OK. NeuroExplorer will open a dialog where you will specify the variable options.

1.9. Reading and Writing NeuroExplorer Data Files

NeuroExplorer Data file has the following structure:

file header

variable header 1

variable header 2

...

data for variable i

data for variable j

...

Each variable header contains the size of the array that stores the variable data as well as the location of this array in the file.

The pseudo-code for reading NeuroExplorer data file looks like this:

```
open file in binary mode

read file header

for each variable
  read variable header
end for

for each variable header
  seek to the file offset specified in the variable header
  read variable data
end for
```

The C++ source code of the program that reads and writes NeuroExplorer data files is available at NeuroExplorer web site:

http://www.neuroexplorer.com/downloads/HowToReadAndWriteNexFiles.zip

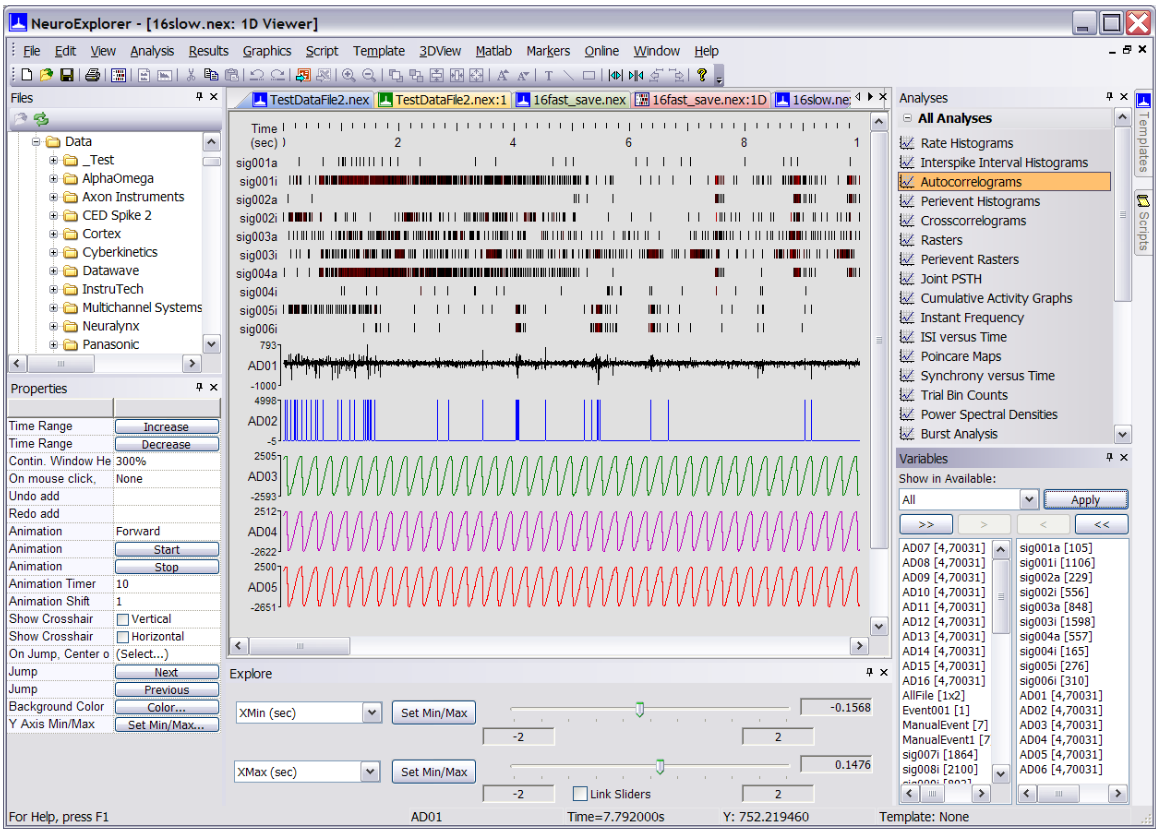
There are also Matlab scripts to read and write NeuroExplorer data files:

http://www.neuroexplorer.com/downloads/HowToReadAndWriteNexFilesInMatlab.zip

1.10. 1D Data Viewer

NeuroExplorer provides a window that displays graphically all the selected variables. To open this window, use **View | 1D Data Viewer Window** menu command.

You can also use 1D view to manually add events to the data file. Simply press the left mouse button when the pointer is in the 1D view and NeuroExplorer will add a new timestamp to the variable **ManualEvent**. You can also specify to what Event variable NeuroExplorer will add timestamps when you click in 1D view (use *On mouse click* parameter in the Properties Panel).



Properties

Time Range	Increase
Time Range	Decrease
Contin. Window He	300%
On mouse click,	None
Undo add	
Redo add	
Animation	Forward
Animation	Start
Animation	Stop
Animation Timer	10
Animation Shift	1
Show Crosshair	☐ Vertical
Show Crosshair	☐ Horizontal
On Jump, Center o	(Select...)
Jump	Next
Jump	Previous
Background Color	Color...
Y Axis Min/Max	Set Min/Max...

Explore

XMin (sec)	Set Min/Max	-0.1568	-2 … 2
XMax (sec)	Set Min/Max	0.1476	-2 … 2

☐ Link Sliders

Variables — Show in Available: All

AD07 [4,70031]	sig001a [105]
AD08 [4,70031]	sig001i [1106]
AD09 [4,70031]	sig002a [229]
AD10 [4,70031]	sig002i [556]
AD11 [4,70031]	sig003a [848]
AD12 [4,70031]	sig003i [1598]
AD13 [4,70031]	sig004a [557]
AD14 [4,70031]	sig004i [165]
AD15 [4,70031]	sig005i [276]
AD16 [4,70031]	sig006i [310]
AllFile [1x2]	AD01 [4,70031]
Event001 [1]	AD02 [4,70031]
ManualEvent [7]	AD03 [4,70031]
ManualEvent1 [7	AD04 [4,70031]
sig007i [1864]	AD05 [4,70031]
sig008i [2100]	AD06 [4,70031]

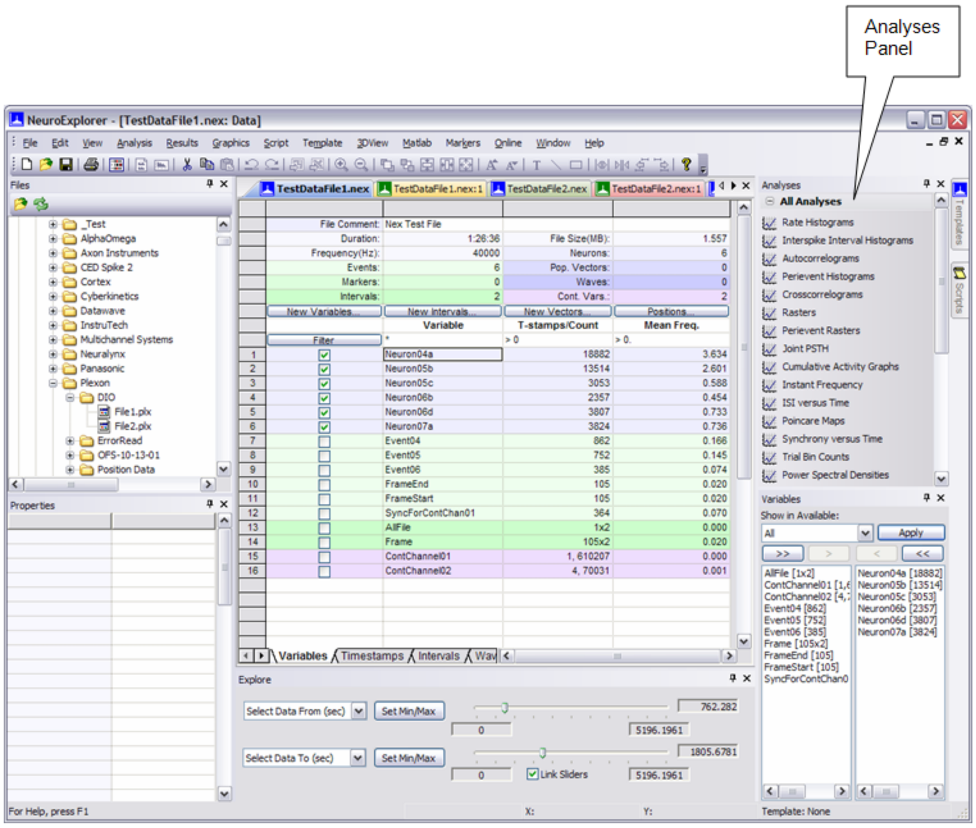
For Help, press F1 AD01 Time=7.792000s Y: 752.219460 Template: None

Mouse wheel can be used to quickly navigate in 1D View:

- Click in 1D View so set 1D View as an active window in NeuroExplorer
- Press Shift and rotate mouse wheel to shift 1D View horizontally
- Press Ctrl and rotate mouse wheel to increase time range (zoom out) and decrease time range (zoom in)

1.11. Analyzing Data

NeuroExplorer provides a variety of spike train analysis methods. Each method has a number of parameters and options. You can apply any available analysis by clicking at the corresponding analysis in the Analyses Panel (you can also use **Analysis | Select Analysis** menu commands):



File Comment:	Nex Test File		
Duration:	1:26:36	File Size(MB):	1.557
Frequency(Hz):	40000	Neurons:	6
Events:	6	Pop. Vectors:	0
Markers:	0	Waves:	0
Intervals:	2	Cont. Vars.:	2
New Variables...	New Intervals...	New Vectors...	Positions...

		Variable	T-stamps/Count	Mean Freq.
	Filter	*	> 0	> 0.
1	✓	Neuron04a	18882	3.634
2	✓	Neuron05b	13514	2.601
3	✓	Neuron05c	3053	0.588
4	✓	Neuron06b	2357	0.454
5	✓	Neuron06d	3807	0.733
6	✓	Neuron07a	3824	0.736
7	☐	Event04	862	0.166
8	☐	Event05	752	0.145
9	☐	Event06	385	0.074
10	☐	FrameEnd	105	0.020
11	☐	FrameStart	105	0.020
12	☐	SyncForContChan01	364	0.070
13	☐	AllFile	1x2	0.000
14	☐	Frame	105x2	0.020
15	☐	ContChannel01	1, 610207	0.000
16	☐	ContChannel02	4, 70031	0.001

AllFile [1x2]	Neuron04a [18882]
ContChannel01 [1,6	Neuron05b [13514]
ContChannel02 [4,7	Neuron05c [3053]
Event04 [862]	Neuron06b [2357]
Event05 [752]	Neuron06d [3807]
Event06 [385]	Neuron07a [3824]
Frame [105x2]	
FrameEnd [105]	
FrameStart [105]	
SyncForContChan0	

Select Data From (sec): 0 — 762.282 — 5196.1961
Select Data To (sec): 0 — 1805.6781 — 5196.1961

After you click at one of the analysis items, NeuroExplorer will open a dialog that will allow you to edit the analysis parameters. When you click OK in this dialog, NeuroExplorer will apply the specified analysis to all the selected variables.

Any combination of analysis parameters and options (together with all the graphics options) can be saved as a template. To save the current configuration as a template, right-click in the Graph Window and select **Save As New Template** menu command. The template names are shown in the Templates view of the control panel.

When you open a new data file, you can simply double-click on the template name to apply the specific analysis with the selected parameter values.

1.12. Selecting Variables for Analysis

NeuroExplorer can analyze at once any group of variables in the file.

To select the variables to be analyzed, use one of the following methods:

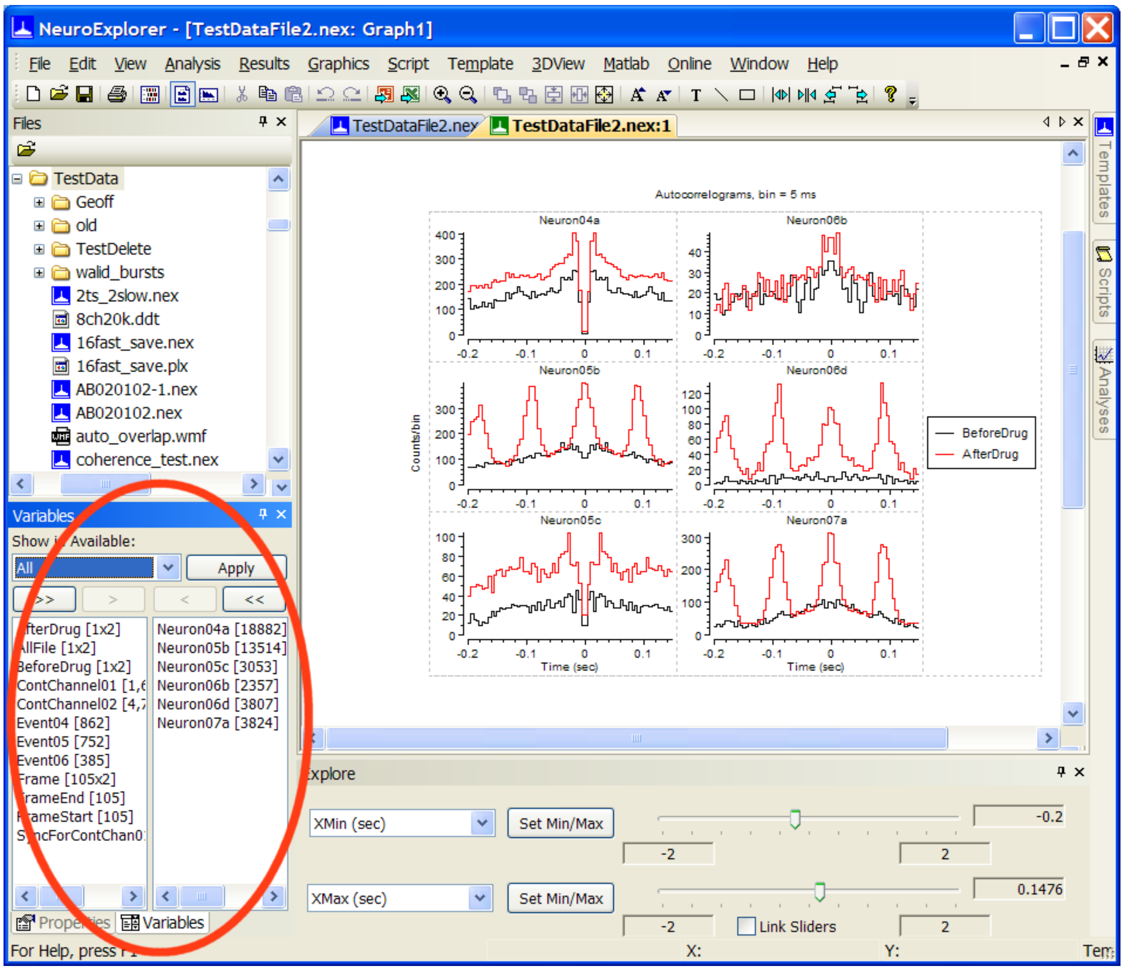
- Select the variables using the Variable Panel (see How to select variables using Variables Panel)
- Select the variables using **Analysis | Select Variables** menu command. This command will invoke the Variable Selection dialog similar to Variables Panel.
- Select the variables directly in the Variables Window by using the check boxes located next to the variable names. **Please note that variable selection in Variables Window is applied only when a new Graph Window or 1D View is created. To change the list of selected variables in existing Graph Window, use Variables Panel or Analysis | Select Variables menu command.** See How to Select Variables for Existing Analysis Window for details.

1.13. How to Select Variables for Existing Window

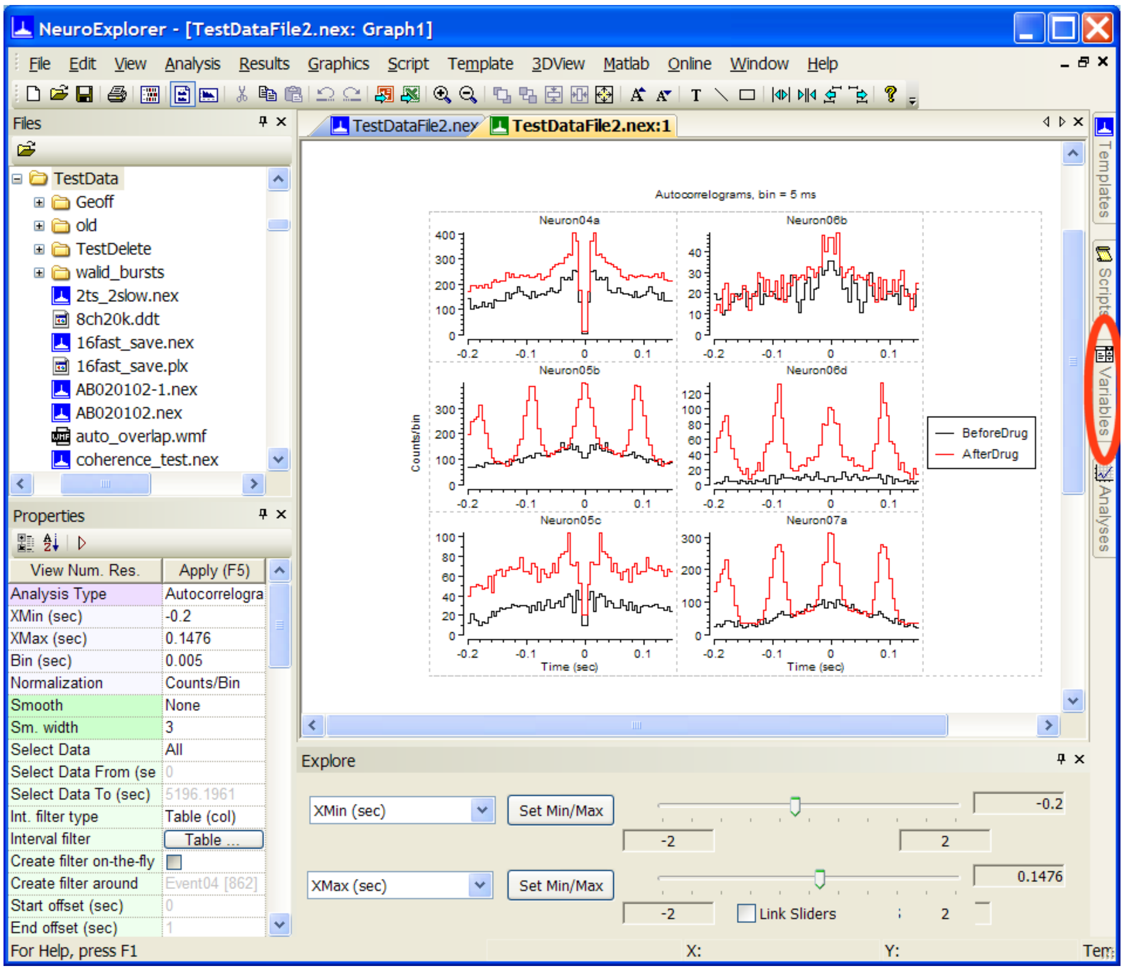
Variables selected in the Variables spreadsheet of data window are used to populate variables lists of **new** analysis windows.

If you would like to change the list of variables for **existing** analysis window, please follow these steps:

- Click anywhere in analysis window to activate it
- If Variables panel is visible, make changes in selected variables list (how?) and press Apply button:



- If Variables panel is hidden, click at panel tab to open it:



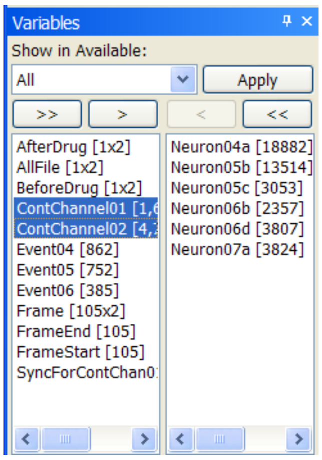
Analysis Type	Autocorrelogra
XMin (sec)	-0.2
XMax (sec)	0.1476
Bin (sec)	0.005
Normalization	Counts/Bin
Smooth	None
Sm. width	3
Select Data	All
Select Data From (se	0
Select Data To (sec)	5196.1961
Int. filter type	Table (col)
Interval filter	Table ...
Create filter on-the-fly	☐
Create filter around	Event04 [862]
Start offset (sec)	0
End offset (sec)	1

XMin (sec)	-2	2	-0.2
XMax (sec)	-2	2	0.1476

- Make changes in selected variables list (how to make changes?) and press Apply button
- If Variables panel or its tab is not visible, use View | Variables Panel menu command

1.14. How to Select Variables in Variables Panel

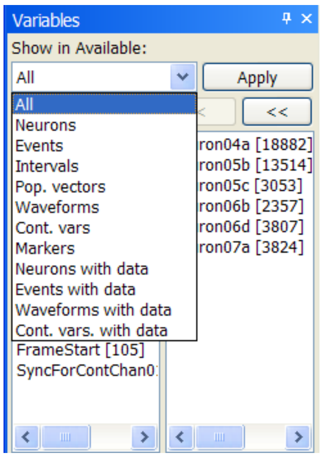
Select variables for analysis by moving them from the left (available) to the right (selected) list box. In the figure below, 6 variables (Neuron04a, Neuron05b, ..., Neuron07a) are selected for analysis:



To move variables from one listbox to another:

- Select variables using the mouse (in the figure above two variables in Available listbox are selected -- ContChannel01 and ContChannel02)
- Press one of four buttons just above the listboxes

The drop-down box above the buttons can be used to specify what kind of variables are shown in the available window:

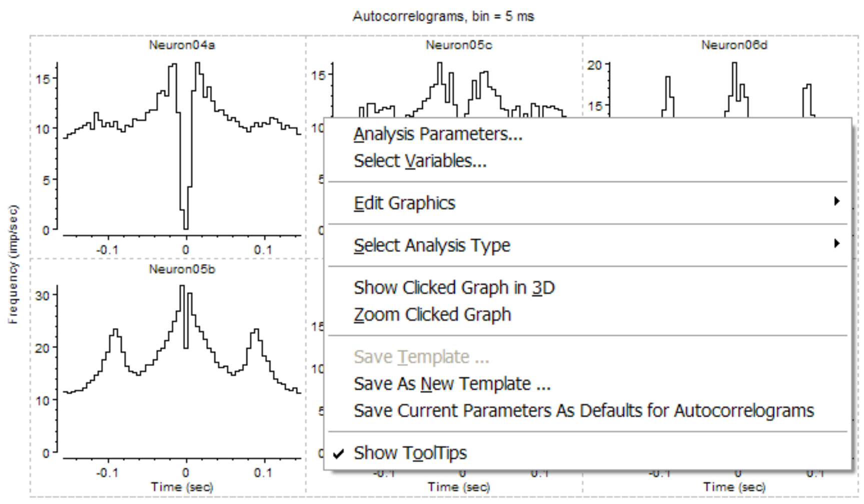


1.15. Adjusting Analysis Properties

There are several methods to adjust the analysis parameters:

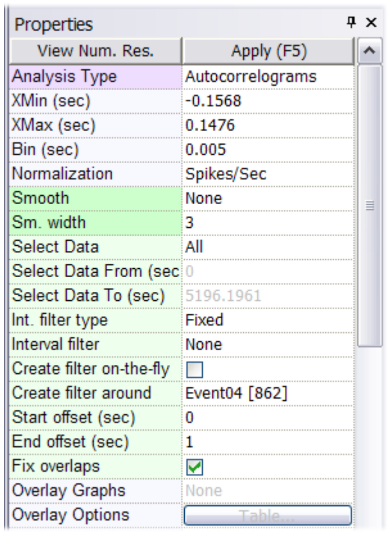
- Use **Analysis | Edit Parameters** menu command to invoke the Analysis Parameters dialog
- Right-click in the Graph Window and choose **Analysis Parameters** item in the floating menu

The floating menu is the fastest way to adjust any analysis or graphics parameters. Double-click (or right-click) anywhere in the Graph Window to invoke this menu:



This menu allows you to go directly to analysis properties, graph properties, axes properties, etc. You can also use it to save the current template and save the current analysis configuration as a new template.

- Single-click in the graph area of the Graph Window and adjust parameters in the Properties Panel:



Properties

View Num. Res.	Apply (F5)
Analysis Type	Autocorrelograms
XMin (sec)	-0.1568
XMax (sec)	0.1476
Bin (sec)	0.005
Normalization	Spikes/Sec
Smooth	None
Sm. width	3
Select Data	All
Select Data From (sec	0
Select Data To (sec)	5196.1961
Int. filter type	Fixed
Interval filter	None
Create filter on-the-fly	☐
Create filter around	Event04 [862]
Start offset (sec)	0
End offset (sec)	1
Fix overlaps	✓
Overlay Graphs	None
Overlay Options	Table...

1.16. Analysis Templates

In any analysis in NeuroExplorer, you can adjust a large number of parameters:

- Analysis type (Rate Histograms, IIH, etc)
- Analysis parameters (Bin, XMin, XMax, etc.)
- Graph parameters (graph type, graph color, grid lines, etc)
- Parameters of X and Y axes (labels, numerics, lines, colors, etc.)
- Graph and page labels and other elements

NeuroExplorer allows you to save all these parameters so that when you open another data file, you can easily reproduce exactly the same analysis with the same axes, labels and so on.

The set of all the analysis parameters is called **the Template**.

To save the current analysis as a template:

- Select the menu command **Template | Save As New Template**, or
- Right-click in the graph and choose the **Save As New Template** command in the floating menu.

After you saved the template, the name of the template appears in the Templates Window (see NeuroExplorer Screen Elements). You can apply the template to the currently opened file by double-clicking the template name in the Templates Window.

NeuroExplorer stores template files in Windows Application Data directory:

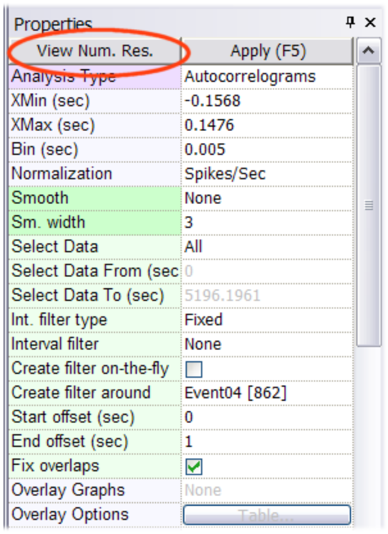
C:\Documents and Settings\All Users\Application Data\Nex Technologies\NeuroExplorer\Templates under Windows XP, or

C:\Application Data\Nex Technologies\NeuroExplorer\Templates under Vista or Windows 7.

1.17. Numerical Results

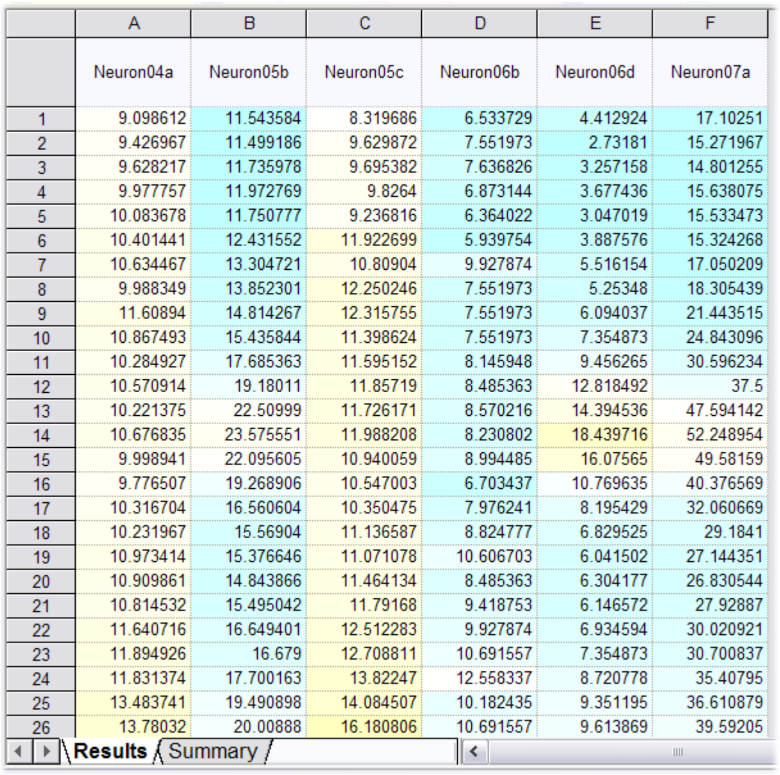
To view the analysis numerical results, select **View | Numerical Results** menu command.

You can also press the "View. Num. Res." button in the upper-left corner of the Properties Panel:



Analysis Type	Autocorrelograms
XMin (sec)	-0.1568
XMax (sec)	0.1476
Bin (sec)	0.005
Normalization	Spikes/Sec
Smooth	None
Sm. width	3
Select Data	All
Select Data From (sec	0
Select Data To (sec)	5196.1961
Int. filter type	Fixed
Interval filter	None
Create filter on-the-fly	☐
Create filter around	Event04 [862]
Start offset (sec)	0
End offset (sec)	1
Fix overlaps	✓
Overlay Graphs	None
Overlay Options	Table...

NeuroExplorer will open Numerical Results Window:

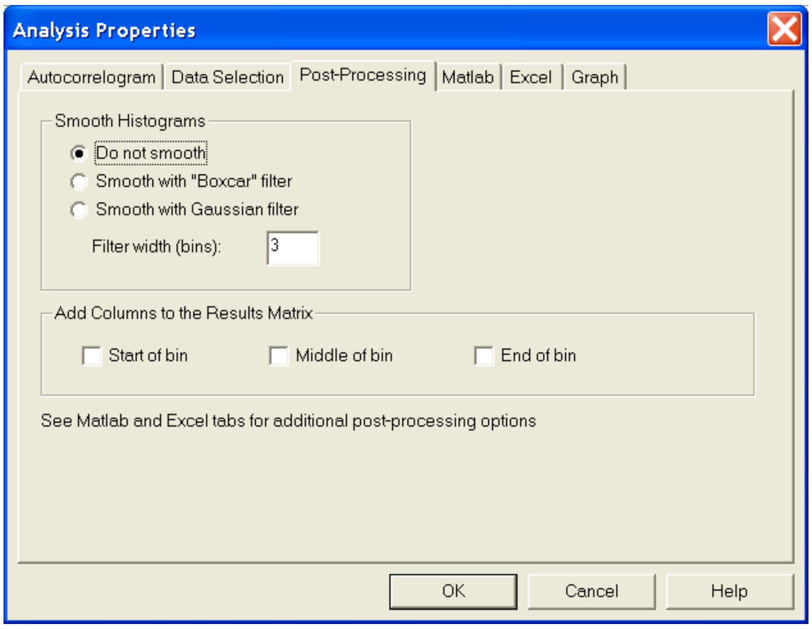


	A	B	C	D	E	F
	Neuron04a	Neuron05b	Neuron05c	Neuron06b	Neuron06d	Neuron07a
1	9.098612	11.543584	8.319686	6.533729	4.412924	17.10251
2	9.426967	11.499186	9.629872	7.551973	2.73181	15.271967
3	9.628217	11.735978	9.695382	7.636826	3.257158	14.801255
4	9.977757	11.972769	9.8264	6.873144	3.677436	15.638075
5	10.083678	11.750777	9.236816	6.364022	3.047019	15.533473
6	10.401441	12.431552	11.922699	5.939754	3.887576	15.324268
7	10.634467	13.304721	10.80904	9.927874	5.516154	17.050209
8	9.988349	13.852301	12.250246	7.551973	5.25348	18.305439
9	11.60894	14.814267	12.315755	7.551973	6.094037	21.443515
10	10.867493	15.435844	11.398624	7.551973	7.354873	24.843096
11	10.284927	17.685363	11.595152	8.145948	9.456265	30.596234
12	10.570914	19.18011	11.85719	8.485363	12.818492	37.5
13	10.221375	22.50999	11.726171	8.570216	14.394536	47.594142
14	10.676835	23.575551	11.988208	8.230802	18.439716	52.248954
15	9.998941	22.095605	10.940059	8.994485	16.07565	49.58159
16	9.776507	19.268906	10.547003	6.703437	10.769635	40.376569
17	10.316704	16.560604	10.350475	7.976241	8.195429	32.060669
18	10.231967	15.56904	11.136587	8.824777	6.829525	29.1841
19	10.973414	15.376646	11.071078	10.606703	6.041502	27.144351
20	10.909861	14.843866	11.464134	8.485363	6.304177	26.830544
21	10.814532	15.495042	11.79168	9.418753	6.146572	27.92887
22	11.640716	16.649401	12.512283	9.927874	6.934594	30.020921
23	11.894926	16.679	12.708811	10.691557	7.354873	30.700837
24	11.831374	17.700163	13.82247	12.558337	8.720778	35.40795
25	13.483741	19.490898	14.084507	10.182435	9.351195	36.610879
26	13.78032	20.00888	16.180806	10.691557	9.613869	39.59205

Note that the window has two Excel-style sheets -- the Results sheet and the Summary sheet. The Results sheet usually contains the bin counts or other histogram values. The Summary sheet contains summary statistics of the analyses such as the mean firing rate, the number of spikes used in the analysis, etc.

1.18. Post-processing

For the histogram-style analyses, NeuroExplorer has an optional **Post-Processing** analysis step. You can select post-processing options using Post-processing tab in the Analysis Parameters dialog (double-click in Graph window and select **Analysis Parameters** menu item):


Analysis Properties

Autocorrelogram | Data Selection | Post-Processing | Matlab | Excel | Graph

Smooth Histograms
- [✓ Do not smooth]
- Smooth with "Boxcar" filter
- Smooth with Gaussian filter

Filter width (bins): 3

Add Columns to the Results Matrix
- ☐ Start of bin
- ☐ Middle of bin
- ☐ End of bin

See Matlab and Excel tabs for additional post-processing options

You can smooth the resulting histogram with Gaussian or Boxcar filters. You can also add bin information to the matrix of results. See Post-processing Options for details.

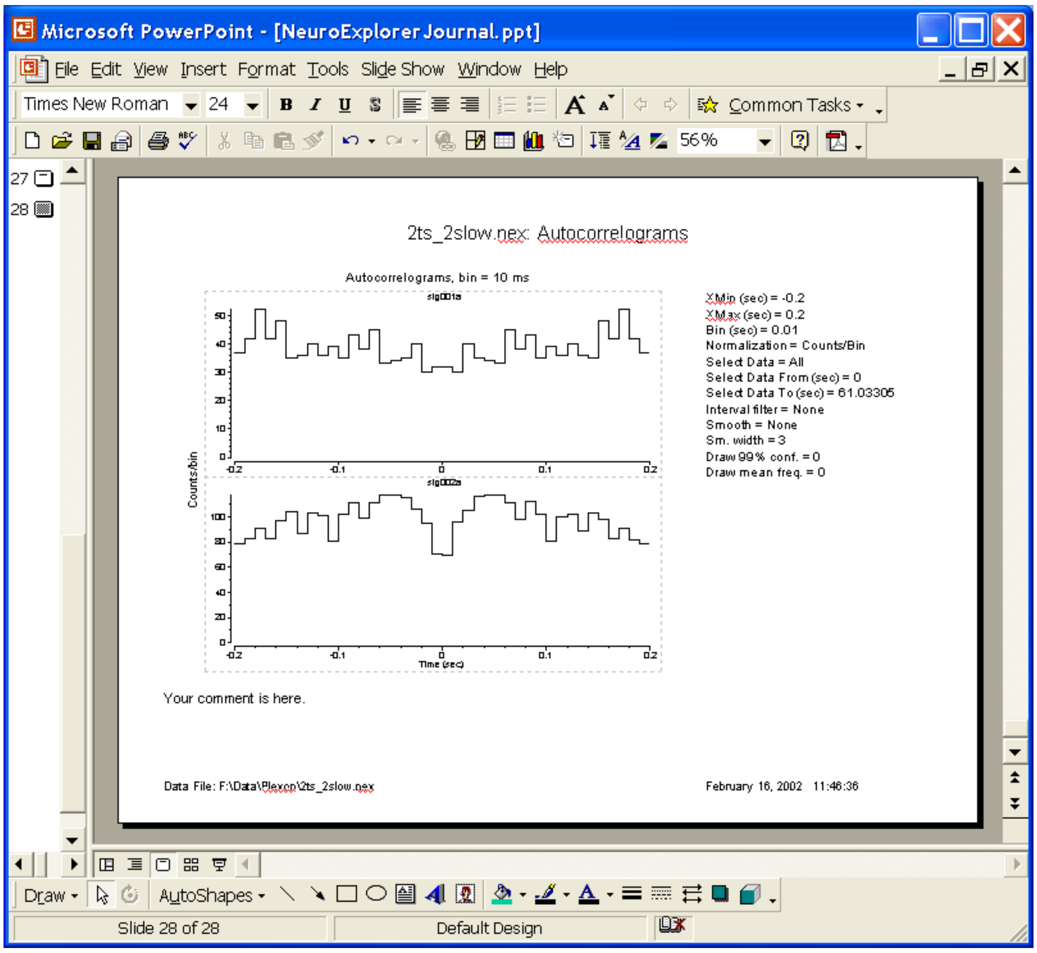
See Saving Results as Power Point Slides, Working with Matlab and Working with Excel for more information on NeuroExplorer post-processing options.

1.19. Saving Results as Power Point Slides

NeuroExplorer version 3 provides a powerful new option that allows you to save graphics, analysis parameters and your annotations as slides in a Power Point Presentation.

To save your results to Power Point, press a toolbar button , or select **Graphics | Export Graphics | Export to Power Point** menu command. NeuroExplorer will start Power Point if Power Point is not running, and will add a new slide to the specified presentation file. The slide will contain:

- Copy of the graphics
- Analysis parameters
- Your comment
- Data file name
- Current date and time


Microsoft PowerPoint - [NeuroExplorerJournal.ppt]
File Edit View Insert Format Tools Slide Show Window Help
Times New Roman 24
Common Tasks
56%
Draw AutoShapes
Slide 28 of 28
Default Design

2ts_2slow.nex: Autocorrelograms

Autocorrelograms, bin = 10 ms

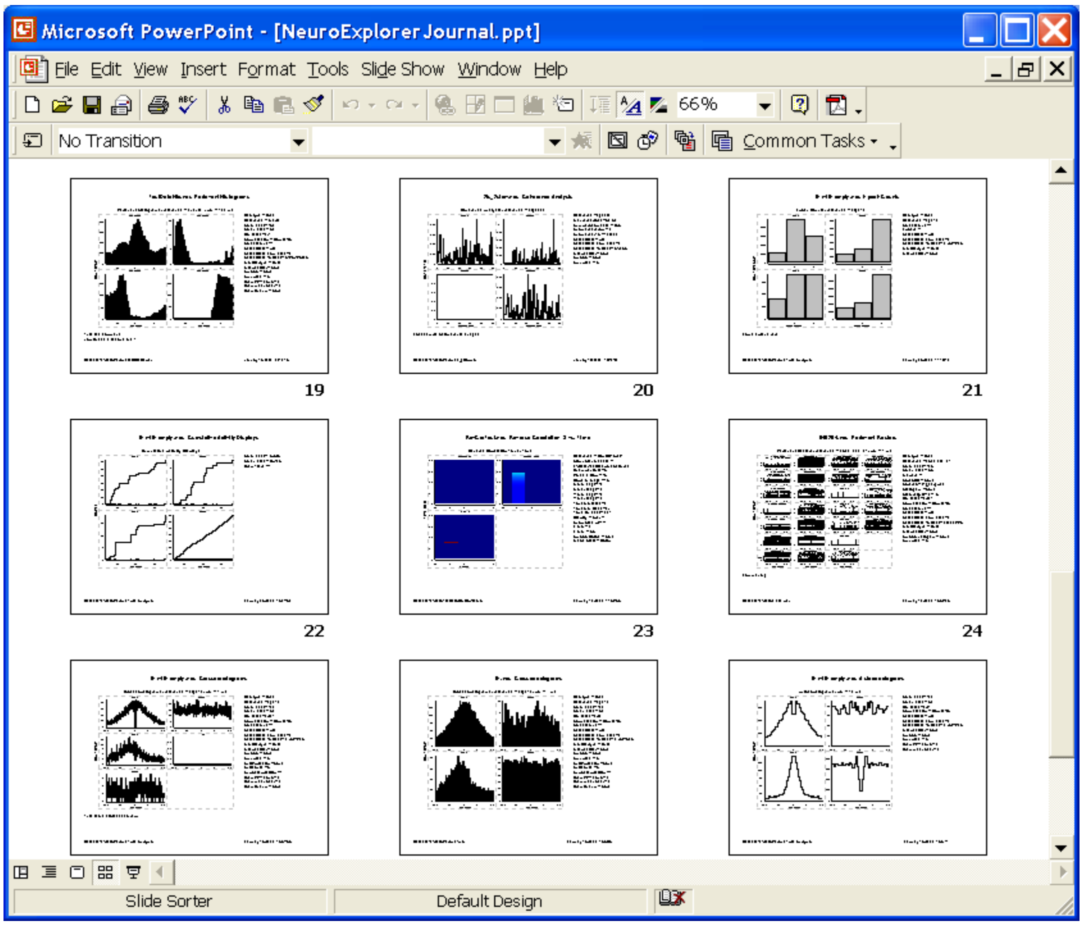
XMin (sec) = -0.2
XMax (sec) = 0.2
Bin (sec) = 0.01
Normalization = Counts/Bin
Select Data = All
Select Data From (sec) = 0
Select Data To (sec) = 61.03305
Interval filter = None
Smooth = None
Sm. width = 3
Draw 99% conf. = 0
Draw mean freq. = 0

Your comment is here.

Data File: F:\Data\Plexon\2ts_2slow.nex

February 16, 2002 11:46:36

Power point presentation then becomes your lab notebook where you can save your NeuroExplorer analysis results:


Microsoft PowerPoint - [NeuroExplorerJournal.ppt]
File Edit View Insert Format Tools Slide Show Window Help
66%
No Transition
Common Tasks
19
20
21
22
23
24
Slide Sorter
Default Design

1.20. Working with Matlab

NeuroExplorer can interact with Matlab via COM interface using Matlab as a powerful post-processing engine. Matlab can also control NeuroExplorer and exchange data with NeuroExplorer via NeuroExplorer COM interfaces. See COM/ActiveX Interfaces for details.

Immediately after calculating the histograms, NeuroExplorer can send the resulting matrix of histograms to Matlab and then ask Matlab to execute any series of Matlab commands.

Use the Matlab tab in the Analysis parameters dialog to specify the matrix name and the Matlab command string.

NeuroExplorer can also send its data variables to Matlab. To transfer the variables to Matlab, use **Matlab | Send Selected Variables to Matlab** menu command.

In general, a continuous variable may contain several fragments of data. Each fragment may be of a different length. NeuroExplorer does not store the timestamps for all the A/D values since they would use too much space. Instead, for each fragment, it stores the timestamp of the first A/D value in the fragment and the index of the first data point in the fragment. Therefore, for a continuous variable (named ContVar1), the following 3 vectors will be created in Matlab:

- **ContVar1** - vector (or matrix with 2 columns) of all A/D values in milliVolts. If "Optimize transfer for small amounts of data" is selected in View | Options | Matlab, Contvar1 is a matrix with 2 columns: the first column contains A/D values in millivolts, the second column contains timestamps in seconds.
- **ContVar1_ts** - vector of fragment timestamps in seconds. Each timestamp is for the first A/D value of the fragment.
- **ContVar1_ind** - array of indexes. Each index is the position of the first data point of the fragment in the A/D array. If ContVar1_ind (2) = 201, it means that the second fragment is ContVar1 [201], ContVar1 [202], etc.
- **ContVar1_ts_step** - digitizing step in seconds.

You can generate all the timestamps for continuous variable using this Matlab script:

```
 function [ ts ] = MakeTs( fragmentInd, fragmentTs, numValues, step )
% MakeTs: makes timestamps for continuous variable based on the fragment
%         information
% INPUT: fragmentInd - vector of fragment indexes
%        fragmentTs - vector of fragment timestamps
%        numValues - total number of values in all fragments
%        step - digitizing step of continuous variable
%
% Example: NeuroExplorer sent continuous variable FP01 via file transfer
%          The following values were sent:
%          FP01 - vector of continuous values
%          FP01_ind - fragment indexes
%          FP01_ts - fragment timestamps
%          FP01_ts_step - digitizing step
%
%          to generate all timestamps for FP01, use:
%
%          ts = MakeTs(FP01_ind, FP01_ts, size(FP01,1), FP01_ts_step);
%
   ts = [];
   numFr = size(fragmentTs);
   % add fake index for the last fragment
   fragmetInd = [fragmentInd; numValues+1];
   for i=1:numFr
       valuesInFragment = fragmetInd(i+1)-fragmentInd(i);
```

```
        ts = [ts; (fragmentTs(i) + (0:(valuesInFragment-1))*step)'];
    end
end
```

You can also import timestamped and continuous variables directly from Matlab. See Importing Data From Matlab for details.

See Also

Importing Data From Matlab

COM/ActiveX Interfaces

1.21. Working with Excel

The easiest way to transfer data and numerical results from NeuroExplorer to Excel is by using the clipboard:

- select a range of cells in NeuroExplorer and choose **Edit| Copy**
- switch to Excel and use the Paste command (select a cell and choose **Edit | Paste**).

NeuroExplorer can also send numerical results directly to Excel. There two ways to send the results to Excel:

- Use Send to Excel button on the toolbar or menu command **File | Save Numerical Results | Send Results to Excel**
- Use Excel tab in the Analysis Parameters dialog to specify what to transfer to Excel and the location of the top-left cell for the data from NeuroExplorer.

1.22. Saving Graphics

NeuroExplorer can save the contents of the Graph window in a file using the Windows Metafile format. The file can then be opened in any program that can use the*.wmf* format files (a word processor, graphics editor, etc.).

To save the graphics in a metafile, use **File | Save Graphics** menu command.

You can also copy the graphics to the clipboard and then paste in another application. To copy the graphics, single-click in the graph area and then select **Edit | Copy** menu command.

See also Saving Results as Power Point Slides.

2. Analysis Reference

This section, *NeuroExplorer Analysis Reference*, describes general pre-processing and post-processing analysis options, analysis parameters and computational algorithms used in analyses.

- Data Types
- Data Selection Options
- Post-Processing Options
- Matlab Options
- Excel Options
- Confidence Limits for Perievent Histograms
- Rate Histograms
- Interspike Interval Histograms
- Autocorrelograms
- Perievent Histograms
- Crosscorrelograms
- Rasters
- Perievent Rasters
- Joint PSTH
- Cumulative Activity Graphs
- Instant Frequency Graphs
- Interspike Intervals vs Time
- Poincare Maps
- Spike Distance vs Time
- Trial Bin Counts
- Power Spectral Densities
- Burst Analysis
- Principal Component Analysis
- Perievent Histograms vs. Time
- Correlations with Continuous Variables
- Regularity Analysis
- Place Cell Analysis
- Reverse Correlation
- Epoch Counts
- Coherence Analysis

2.1. Data Types

NeuroExplorer supports several data types -- spike trains, behavioral events, time intervals, continuously recorded data and other data types. The topics in this section describe the data types used in NeuroExplorer, list the properties of data types, and show how to view and modify various data types in NeuroExplorer.

2.1.1. Spike Trains

In NeuroExplorer, the most commonly used data type is a spike train. A spike train in NeuroExplorer does not contain the spike waveforms, it represents only the spike timestamps (the times when the spikes occurred). A special Waveform data type is used to store the spike waveform values.

Events are very similar to spike trains. The only difference between spike trains and events is that spike trains may contain additional information about recording sites, electrode numbers, etc. (for example, spike trains contain positions of neurons used in the 3D activity "movie").

Internally, the timestamps are stored as 32-bit signed integers. These integers are usually the timestamps recorded by the data acquisition system and they represent time in the so-called time ticks. For example, the typical time tick for the Plexon system is 25 microseconds, so an event recorded at 1 sec will have the timestamp equal to 40000.

Limitations

The maximum number of timestamps (in each spike train) in NeuroExplorer is 2,147,483,647. In reality, the limiting factor is the amount of virtual memory on your machine, since the timestamps of all the variables of a data file should fit into memory. NeuroExplorer requires that in each spike train all the timestamps are in ascending order, that is

timestamp[i+1] > timestamp[i] for all i.

NeuroExplorer also requires that

timestamp[i] >= 0 and timestamp[i] < 2,147,483,647 for all i.

The upper timestamp limit defines the maximum experiment length that can be safely analyzed in NeuroExplorer. Thus, for the standard Plexon setup, the maximum duration of the experiment is 2147483647/40000 seconds, or 14 hours and 54 minutes.

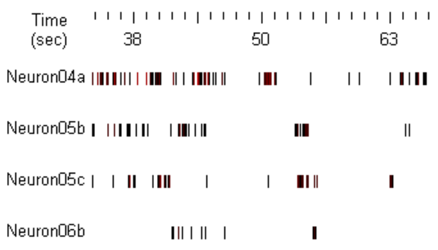
Timestamped Variables in NexScript

You can get access to any timestamp in the current file. For example, to assign the value 0.5 (sec) to the third timestamp of the variable SPK01a, you can use this script:

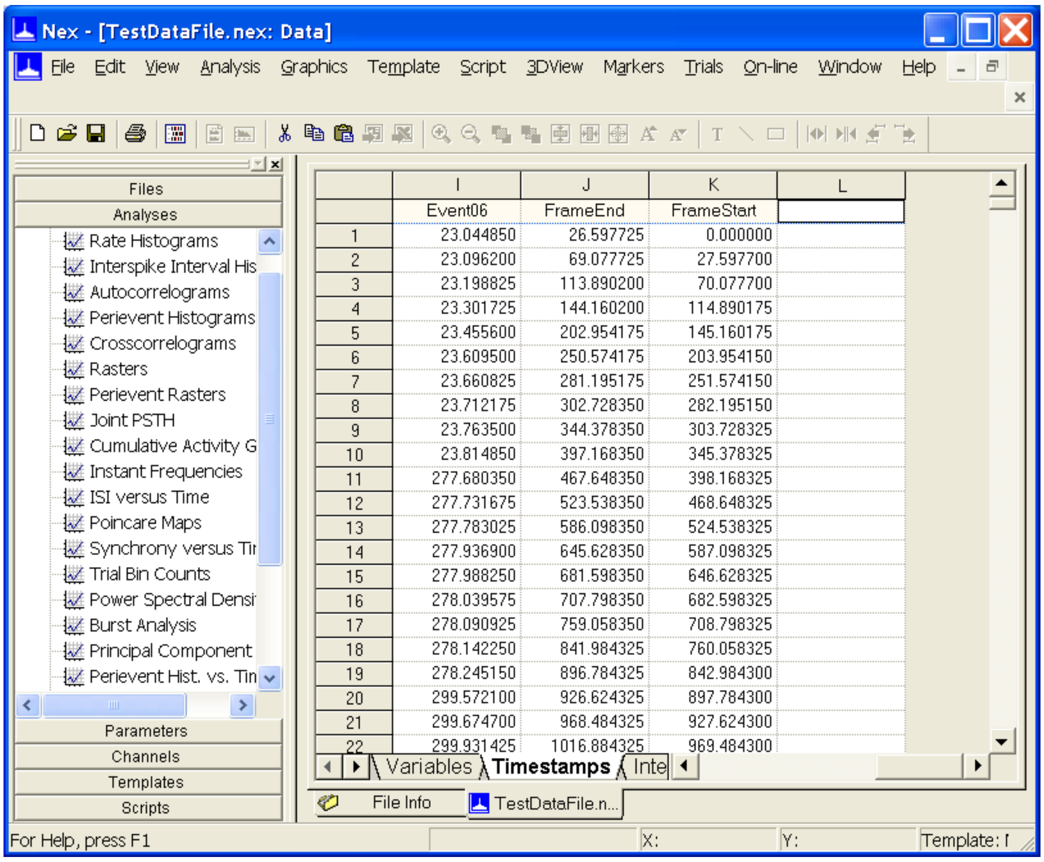
```
doc = GetActiveDocument()
doc.SPK01a[3] = 0.5
```

Viewers

You can view the timestamps of the selected variables in graphical display (**View | 1D Data Viewer** menu command):



Numerical values of the timestamps (in seconds) are shown in the **Timestamps** sheet of the Data view:



	I	J	K	L
	Event06	FrameEnd	FrameStart	
1	23.044850	26.597725	0.000000	
2	23.096200	69.077725	27.597700	
3	23.198825	113.890200	70.077700	
4	23.301725	144.160200	114.890175	
5	23.455600	202.954175	145.160175	
6	23.609500	250.574175	203.954150	
7	23.660825	281.195175	251.574150	
8	23.712175	302.728350	282.195150	
9	23.763500	344.378350	303.728325	
10	23.814850	397.168350	345.378325	
11	277.680350	467.648350	398.168325	
12	277.731675	523.538350	468.648325	
13	277.783025	586.098350	524.538325	
14	277.936900	645.628350	587.098325	
15	277.988250	681.598350	646.628325	
16	278.039575	707.798350	682.598325	
17	278.090925	759.058350	708.798325	
18	278.142250	841.984325	760.058325	
19	278.245150	896.784325	842.984300	
20	299.572100	926.624325	897.784300	
21	299.674700	968.484325	927.624300	
22	299.931425	1016.884325	969.484300	

2.1.2. Events

Event data type in NeuroExplorer is used to represent the series of timestamps recorded from external devices (for example, stimulation times recorded as pulses produced by the stimulus generator). Event data type stores only the times when the external events occurred. A special Marker data type is used to store the timestamps together with other stimulus or trial information.

Events are very similar to spike trains. The only difference between spike trains and events is that spike trains may contain additional information about recording sites, electrode numbers, etc.

Internally, event timestamps are represented exactly as Spike Train timestamps. See Spike Trains for more information about the timestamps in NeuroExplorer.

Creating Event Variables

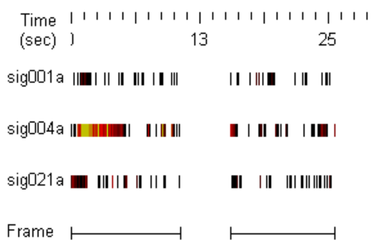
You can add events to the data file using **Copy | Paste** command in the Timestamps view (see Importing Data from Spreadsheets for details).

You can also create additional events based on the events in the data file. Use **Edit | Operations on Data Variables** menu command and then select one of the operations in the Operations dialog.

2.1.3. Intervals

Intervals are usually used in NeuroExplorer to select the data from a specified time periods (see Data Selection Options for details).

Each interval variable can contain multiple time intervals. For example, the Frame variable in the following figure has two intervals:



Creating Interval Variables

You can create intervals in NeuroExplorer using **Edit | Add Interval Variable** menu command.

You can also create intervals based on existing Event or Interval variables. Use **Edit | Operations on Data Variables** menu command and then select one of the following operations:

MakeIntervals

MakeIntFromStart

MakeIntFromEnd

IntOpposite

IntAnd

IntOr

IntSize

IntFind

Burst analysis creates interval variables (one for each neuron) that contain all the detected bursts as time intervals.

Interval Variables in NexScript

IntVar[i,1] gives you the access to the start of the i-th interval,

IntVar[i,2] gives you the access to the end of the i-th interval.

For example, the following script creates a new interval variable that has two intervals: from 0 to 100 seconds and from 200 to 300 seconds:

```
doc = GetActiveDocument()
doc.MyInterval = NewIntEvent(doc)
AddInterval(doc.MyInterval, 0., 100.)
AddInterval(doc.MyInterval, 200., 300.)
```

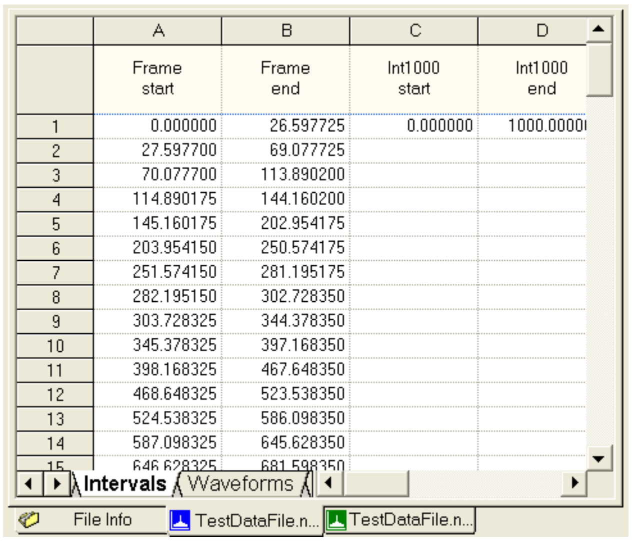
Limitations

Internally, NeuroExplorer stores the beginning and the end of each interval as a timestamp (see Spike Trains for more information about timestamps in NeuroExplorer).

Viewers

You can view the intervals of the selected variables in graphical display (**View | 1D Data Viewer** menu command, see figure above).

The intervals (in seconds) are shown in the **Intervals** sheet of the Data view:



	A	B	C	D
	Frame start	Frame end	Int1000 start	Int1000 end
1	0.000000	26.597725	0.000000	1000.0000
2	27.597700	69.077725		
3	70.077700	113.890200		
4	114.890175	144.160200		
5	145.160175	202.954175		
6	203.954150	250.574175		
7	251.574150	281.195175		
8	282.195150	302.728350		
9	303.728325	344.378350		
10	345.378325	397.168350		
11	398.168325	467.648350		
12	468.648325	523.538350		
13	524.538325	586.098350		
14	587.098325	645.628350		
15	646.628325	681.598350		

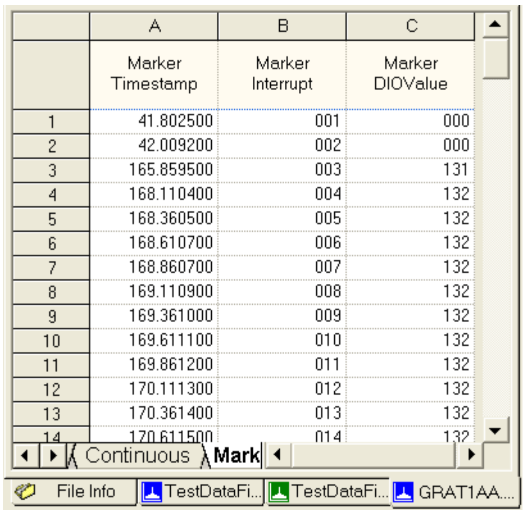
2.1.4. Markers

Marker data type in NeuroExplorer is used to represent the series of timestamps recorded from external devices (for example, stimulation times recorded as pulses produced by the stimulus generator) together with other stimulus or trial information. Event data type stores only the times when the external events occurred.

NeuroExplorer creates Marker variables when it imports strobed events from Plexon data files, when it imports Trial Descriptor Records from the Datawave files and when DIO events with flags are loaded from Alpha Omega files.

Viewers

You can view both the marker timestamps and additional marker information in the Markers tab of the Data window:

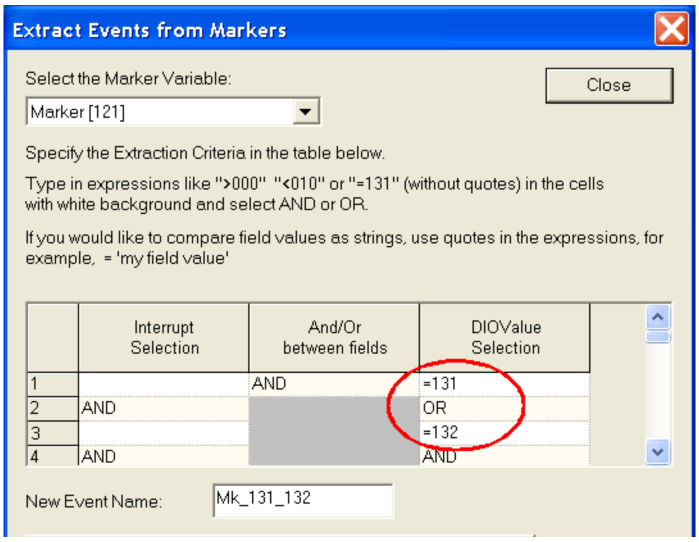


	A	B	C
	Marker Timestamp	Marker Interrupt	Marker DIOValue
1	41.802500	001	000
2	42.009200	002	000
3	165.859500	003	131
4	168.110400	004	132
5	168.360500	005	132
6	168.610700	006	132
7	168.860700	007	132
8	169.110900	008	132
9	169.361000	009	132
10	169.611100	010	132
11	169.861200	011	132
12	170.111300	012	132
13	170.361400	013	132
14	170.611500	014	132

Extracting Events

Usually you will need to extract events with specific trial information from the marker variables. To do this, use **Marker | Split...** and **Marker | Extract...** menu commands.

For example, you may want to extract from the marker variable shown in the figure above only the markers with DIOValue 131 or 132. **Marker | Extract...** menu command will open the Extract dialog box in which you can specify multiple criteria for extracting events from the marker variable:


Extract Events from Markers

Select the Marker Variable: Marker [121]

Specify the Extraction Criteria in the table below.

Type in expressions like ">000" "<010" or "=131" (without quotes) in the cells with white background and select AND or OR.

If you would like to compare field values as strings, use quotes in the expressions, for example, = 'my field value'

	Interrupt Selection	And/Or between fields	DIOValue Selection
1		AND	=131
2	AND		OR
3			=132
4	AND		AND

New Event Name: Mk_131_132

2.1.5. Population Vectors

Population vectors in NeuroExplorer can be used to display the linear combinations of histograms in some of the analyses. For example, you can calculate perievent histograms for each individual neuron recorded in a data file. If you want to calculate the response of the whole population of neurons (that is, create an average PST histogram) you need to use a population vector.

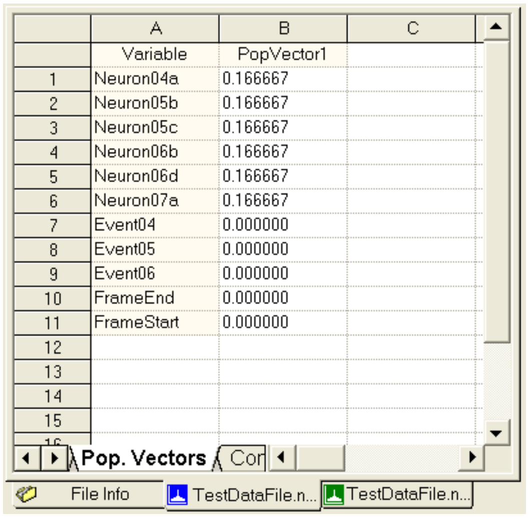
Population vector assigns a weight to each spike train or event variable in the file. You can then use population vectors in the following analyses:

- Rate Histograms
- Perievent Histograms
- Trial Counts

If you select the population vector for analysis and then run one of the three analyses listed above, the histogram corresponding to the population vector will be calculated as:

```
histogram_of_neuron_1 * weight_1 + histogram_of_neuron_2 * weight_2...
```

where the weights are defined in the population vector. For example, to calculate an average histogram for 6 neurons, the following population vector should be used:



	A	B	C
	Variable	PopVector1	
1	Neuron04a	0.166667	
2	Neuron05b	0.166667	
3	Neuron05c	0.166667	
4	Neuron06b	0.166667	
5	Neuron06d	0.166667	
6	Neuron07a	0.166667	
7	Event04	0.000000	
8	Event05	0.000000	
9	Event06	0.000000	
10	FrameEnd	0.000000	
11	FrameStart	0.000000	
12			
13			
14			
15			

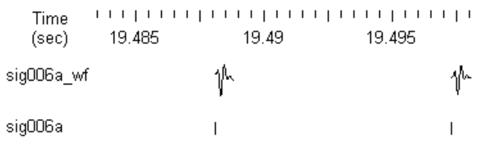
Creating Population Vectors

You can create new population vectors in NeuroExplorer using **Edit | Add Population Vector** menu command.

Principal Component Analysis creates a set of population vectors based on correlations between activities of individual neurons.

2.1.6. Waveforms

The waveform data type is used in NeuroExplorer to store the spike waveform values together with the spike timestamps. The following figure shows the waveform variable sig006a_wf together with the corresponding spike train sig006a:



The waveform data may not be imported by default from the data files created by the data acquisition systems. Use **View | Data Import Options** menu command to specify which data types NeuroExplorer will import from the data files.

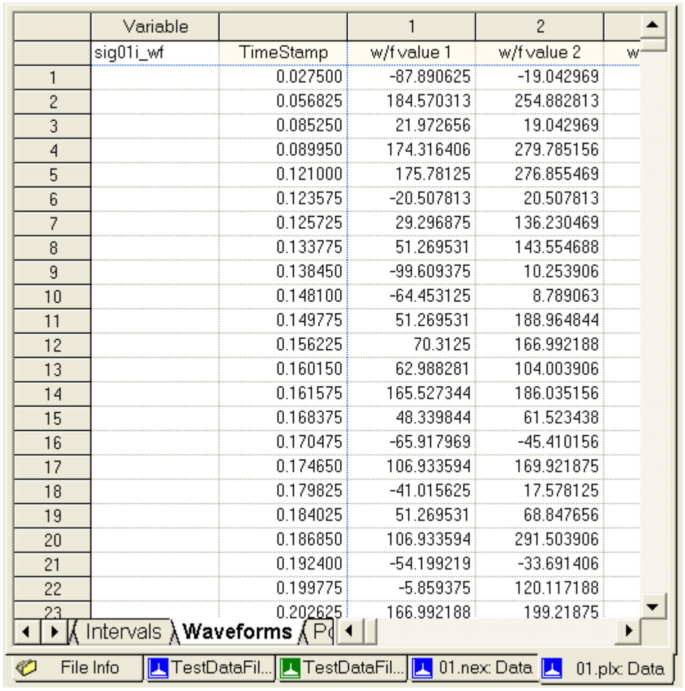
The waveform variables can be used in the following analyses:

- Rate Histograms
- Rasters
- Perievent Histograms (instead of PST, NeuroExplorer calculates spike-triggered average for a waveform variable)

Viewers

You can view the waveforms of the selected variables in the graphical display (**View | 1D Data Viewer** menu command, see figure above).

Numerical values of the waveforms and their timestamps are shown in the **Waveforms** sheet of the Data view.



	Variable		1	2	
	sig01i_wf	TimeStamp	w/f value 1	w/f value 2	w
1		0.027500	-87.890625	-19.042969	
2		0.056825	184.570313	254.882813	
3		0.085250	21.972656	19.042969	
4		0.089950	174.316406	279.785156	
5		0.121000	175.78125	276.855469	
6		0.123575	-20.507813	20.507813	
7		0.125725	29.296875	136.230469	
8		0.133775	51.269531	143.554688	
9		0.138450	-99.609375	10.253906	
10		0.148100	-64.453125	8.789063	
11		0.149775	51.269531	188.964844	
12		0.156225	70.3125	166.992188	
13		0.160150	62.988281	104.003906	
14		0.161575	165.527344	186.035156	
15		0.168375	48.339844	61.523438	
16		0.170475	-65.917969	-45.410156	
17		0.174650	106.933594	169.921875	
18		0.179825	-41.015625	17.578125	
19		0.184025	51.269531	68.847656	
20		0.186850	106.933594	291.503906	
21		0.192400	-54.199219	-33.691406	
22		0.199775	-5.859375	120.117188	
23		0.202625	166.992188	199.21875	

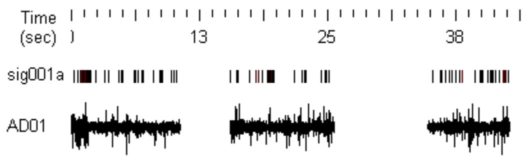
To select a different waveform variable, click in the cell located in the row 1 of the Variable column (the cell shows sig001i_wf in the figure above).

Waveform values are shown in columns labeled 1, 2, etc.

2.1.7. Continuously Recorded Data

The continuous data type is used in NeuroExplorer to store the data that has been continuously recorded (digitized).

The following figure shows continuous variable AD01 together with the spike train sig001a:



Continuous data may not be imported by default from the data files created by the data acquisition systems. Use **View | Data Import Options** menu command to specify which data types NeuroExplorer will import from the data files.

Continuous variables can be used in the following analyses:

- Rate Histograms
- Rasters
- Perievent Histograms (instead of PST, NeuroExplorer calculates the spike-triggered average for a continuous variable)
- Perievent Rasters (NeuroExplorer shows the values of continuous variable using color)
- Spectral Densities
- Correlations with Continuous Variable
- Coherence Analysis
- Spectrograms
- Perievent Spectrograms

Limitations

Internally, each data point of the continuous variable is stored as a 2-byte integer. The maximum number of values (in each continuous variable) in NeuroExplorer is 2,147,483,647. In reality, the limiting factor is the amount of virtual memory in your computer since all the values should fit into virtual memory.

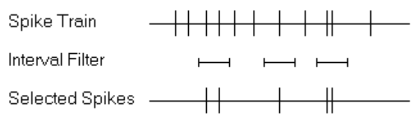
Viewers

You can view continuous variables in the graphical display (**View | 1D Data Viewer** menu command, see figure above).

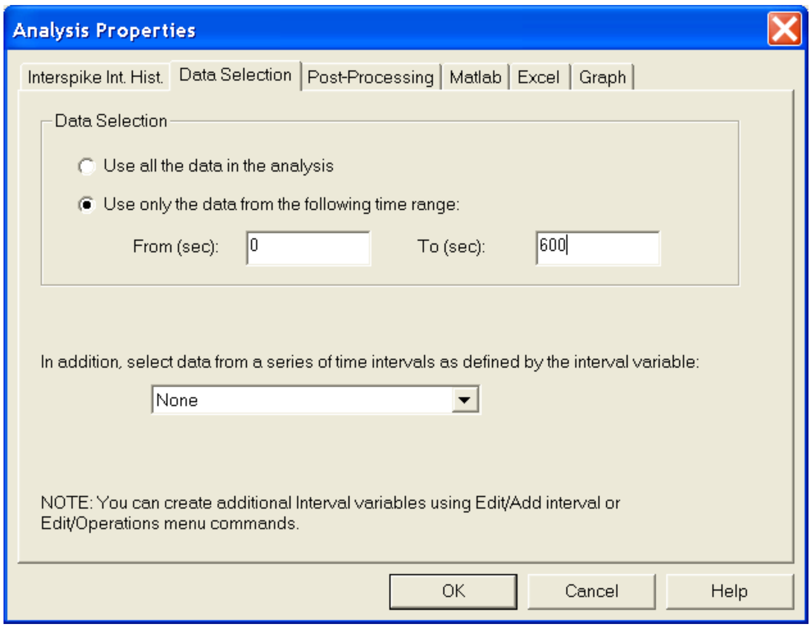
Numerical values of the continuous variables are shown in the **Continuous** sheet of the Data view.

2.2. Data Selection Options

Before performing the analysis, NeuroExplorer can select the timestamped events that are inside the specified time intervals:



For example, you may want to analyze only the first 10 minutes of the recording session. To do this, choose the Data Selection tab in the Analysis Parameters dialog, click **Use only the data from the following time range** and specify **From** and **To** parameters in seconds:



Data Selection

Use all the data in the analysis [✓ Use only the data from the following time range:]

From (sec): 0   To (sec): 600

In addition, select data from a series of time intervals as defined by the interval variable:

None

NOTE: You can create additional Interval variables using Edit/Add interval or Edit/Operations menu commands.

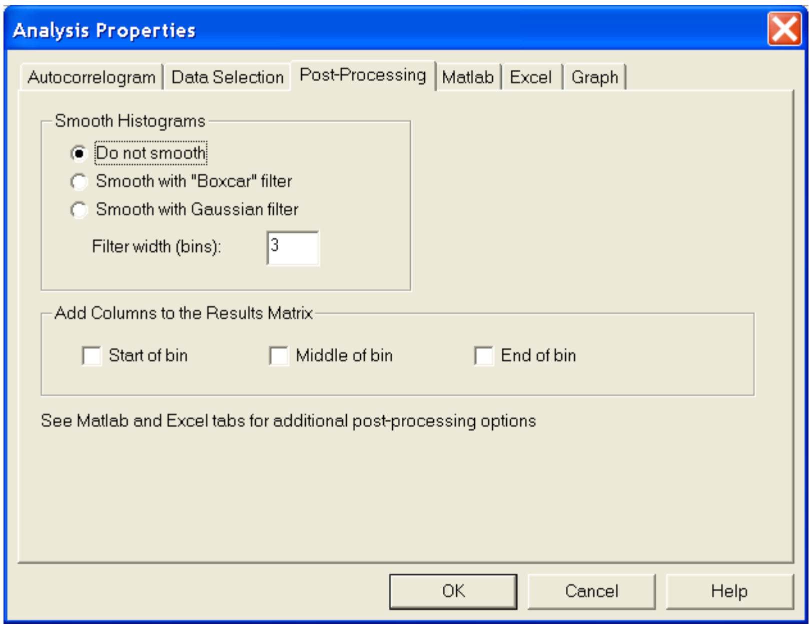
You can also choose an interval variable (at the bottom of the Data Selection page) as an additional data filter. NeuroExplorer then will select data from one or more time intervals as specified by the interval variable.

Some analyses (Perievent Histograms, Perievent Rasters and Crosscorrelograms) allow you to specify several interval filters, so that a different filter will be used for a column or for a row of graphs.

2.3. Post-Processing Options

For the histogram-style analyses, NeuroExplorer has an optional **Post-processing** analysis step. You can select post-processing options using Post-processing tab in the Analysis Parameters dialog.

(double-click in the Graph window and select **Analysis Parameters** menu item):



Smooth Histograms
[✓ Do not smooth]
Smooth with "Boxcar" filter
Smooth with Gaussian filter
Filter width (bins): 3

Add Columns to the Results Matrix
☐ Start of bin ☐ Middle of bin ☐ End of bin

See Matlab and Excel tabs for additional post-processing options

You can smooth the resulting histogram with Gaussian or Boxcar filters.

The boxcar filter is a filter with equal coefficients. If f[i] is i-th filter coefficient and w is the filter width, then

```
f[i] = 1/w for all i
```

Thus for the filter of width 3, the boxcar filter is

```
f[-1] = 0.33333, f[0] = 0.33333, f[1] = 0.33333.
```

and the smoothed histogram sh[i] is calculated as

```
sh[i] = f[-1]*h[i-1] + f[0]*h[i] + f[1]*h[i+1]
```

where h[i] is the original histogram.

The Gaussian filter is calculated using the following formula:

```
f[i] = exp(-i*i/sigma)/norm, i from -2*d to 2*d
```

where

```
d = ( (int)w + 1 )/2
sigma = -w * w * 0.25 / log(0.5)
norm = sum of exp( -i * i / sigma), i from -2*d to 2*d
```

The parameters of the filter are such that the width of the Gaussian curve at half the height equals to the specified filter width. Please note that for the Gaussian filter, width of the filter (w) can be a non-integer. For example, w can be 3.5.

See Matlab Options and Excel Options for more information on NeuroExplorer post-processing capabilities.

2.4. Matlab Options

NeuroExplorer can interact with Matlab via COM interface using Matlab as a powerful post-processing engine. Immediately after calculating histograms, NeuroExplorer can send the resulting matrix of histograms to Matlab and then ask Matlab to execute any series of Matlab commands.

Use the Matlab tab in the Analysis parameters dialog to specify the matrix name and the Matlab command string.

2.5. Excel Options

NeuroExplorer can send numerical results directly to Excel. There are two ways to send the results to Excel:

- Use Send to Excel button on the toolbar or menu command **File | Save Numerical Results | Send Results to Excel**
- Use Excel tab in the Analysis Parameters dialog to specify what to transfer to Excel and the location of the top-left cell for the data from NeuroExplorer.

2.6. Confidence Limits for Perievent Histograms

If the total time interval (experimental session) is T (seconds) and we have N spikes in the interval, then the neuron frequency is:

F = N/T

Several options how to calculate neuron frequency F are available. See **Options** below.

Then if the spike train is a Poisson train, the probability of the neuron to fire in the small bin of the size b (seconds) is

P = F*b

The expected bin count for the perievent histogram is then:

C = P*NRef, where NRef is the number of the reference events.

The value C is used for drawing the Mean Frequency in the Perievent Histograms and Cross- and Autocorrelograms.

The confidence limits for C are calculated using the assumption that C has a Poisson distribution. Assume that a random variable S has a Poisson distribution with parameter C. Then the 99% confidence limits are calculated as follows:

Low Conf. = x such that Prob(S < x) = 0.005

High Conf. = y such that Prob(S > y) = 0.005

If C < 30, NeuroExplorer uses the actual Poisson distribution

Prob(S = K) = exp(-C) * (C^K) / K!, where C^K is C to the power of K,

to calculate the confidence limits.

If C>= 30., the Gaussian approximation is used. For example, for 99% confidence limits:

Low Conf. = C - 2.58*sqrt(C);

High Conf.= C + 2.58*sqrt(C);

Reference

Abeles M. Quantification, smoothing, and confidence limits for single-units histograms. Journal of Neuroscience Methods. 5(4):317-25, 1982

Options

The following options to calculate neuron frequency F are available:

- Use all file data. Here T is the total length of experimental session, N is the total number of spikes for a given neuron.
- Use selected time range and interval filter. T is the length of all the time intervals used in analysis, N is the number of spikes within these intervals.
- Use time intervals corresponding to prereference bins. This option only works for a stimulation-type data. For example, if you stimulate every second and calculate PSTH with XMin=-0.2, XMax=0.2, NeuroExplorer can easily distinguish the spikes before and after the stimulus. However, if you stimulate every 200 ms, the spikes before the second stimulus are also the spikes after the first stimulus, so you cannot distinguish the spikes that should be used to calculate the mean firing rate. The algorithm: for each reference event timestamp r, a time interval (r+XMin, r) is created (where XMin is PSTH or crosscorrelogram time axis minimum parameter; XMin should be negative). T is the length of all (r+XMin, r) intervals that do not overlap, N is the number of spikes in these intervals. If more than 5% of intervals overlap, F is set to zero.

2.7. Cumulative Sum Graphs

Here is the algorithm that is used to draw optional cumulative sum graphs above the histograms.

Suppose we have a histogram with bin counts bc[i], i=1,...,N. Cumulative Sum Graph displays the following values cs[i]:

for bin 1: cs[1] = bc[1] - A

for bin 2: cs[2] = bc[1]+bc[2] - A*2

for bin 3: cs[3] = bc[1]+bc[2]+bc[3] - A*3, etc.

The value of A depends on the selected Cumulative Sum option:

A equals to average of all bc[i] if you select "Use all histogram" option

A equals to average of all bc[i] for bins that are before zero on time scale if you select "Use preref as base" option.

If you use "Use all histogram" option, the value of the cumulative sum for the last bin is always zero: sc[N] = bc[1]+bc[2]+...bc[N] - A*N, where A = (bc[1]+bc[2]+...bc[N])/N.

NeuroExplorer displays 99% confidence limits for Cumulative Sum Graphs. Confidence limits for "Use preref as base" option are proportional to square root of bin number.

Calculations of confidence limits for "Use all histogram" option are not trivial. These calculations are based on the formulas developed by the author of NeuroExplorer, Alexander Kirillov.

2.8. Rate Histograms

Rate histogram displays firing rate versus time.

Parameters

Parameter	Description
XMin/XMax type	An option on how XMin and XMax values are specified.
XMin	Time axis minimum in seconds.
XMax	Time axis maximum in seconds
Bin	Histogram bin size in seconds.
Normalization	Histogram units (Counts/Bin, Probability or Spikes/Second). See *Algorithm* below.
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Smooth histogram	An option to smooth the histogram after the calculation. See Post-Processing Options for details.
Smooth Filter Width	The width of the smooth filter. See Post-Processing Options for details.
Add to Results / Bin left	An option to add an additional vector (containing a left edge of each bin) to the matrix of numerical results.
Add to Results / Bin middle	An option to add an additional vector (containing a middle point of each bin) to the matrix of numerical results.
Add to Results / Bin right	An option to add an additional vector (containing a right edge of each bin) to the matrix of numerical results.
Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.
Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.
Sheet Name	The name of the worksheet in Excel where to copy the numerical results.
TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description

Variable	Variable name.
YMin	Histogram minimum.
YMax	Histogram maximum.
Spikes	The number of spikes used in calculation.
Filter Length	The length of all the intervals of the interval filter (if a filter was used) or the length or the recording session (in seconds).
Mean Freq.	Mean firing rate (Spikes/Filter_Length).
Mean Hist.	The mean of the histogram bin values.
St. Dev. Hist.	The standard deviation of the histogram bin values.
St. Err. Mean. Hist.	The standard error of mean of the histogram bin values.

Algorithm

The time axis is divided into bins. The first bin is **[XMin, XMin+Bin)**. The second bin is **[XMin+Bin, Xmin+Bin*2)**, etc. The left end is included in each bin, the right end is excluded from the bin.

For each bin, the number of events in this bin is calculated.

For example, for the first bin

```
bin_count = number of timestamps (ts) such that ts >= XMin and ts < XMin + Bin
```

If **Normalization** is Counts/Bin, no further calculations are performed.

If **Normalization** is Spikes/Sec, bin counts are divided by **Bin**.

2.9. Interspike Interval Histograms

Interspike interval histogram shows the conditional probability of a *first* spike at time *t0+t* after a spike at time *t0*.

Parameters

Parameter	Description
Min Interval	Minimum interspike interval in seconds.
Max Interval	Maximum interspike interval in seconds.
Bin	Bin size in seconds.
Normalization	Histogram units (Counts/Bin, Probability or Spikes/Second). See *Algorithm* below.
Log Bins and X Axis	An option to use Log10 interval scale (see *Algorithm* below for details).
Bins per decade	A bin size option if Log option is selected (see *Algorithm* below for details).
Y Axis Limit (%)	An option to "zoom in" small histogram values. This parameter specifies the maximum of Y axis. If it is 100%, the Y axis maximum equals to the maximum bin value. If it is, for example, 10%, Y axis maximum is set to 10% of the bin max and the small bin values have better visibility.
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Int. filter type	Specifies if the analysis will use a single or multiple interval filters.
Interval filter	Specifies the interval filter(s) that will be used to preselect data before analysis. See also Data Selection Options.
Create filter on-the-fly	Specifies if a temporary interval filter needs to be created (and used to preselect data).
Create filter around	Specifies an event that will be used to create a temporary filter.
Start offset	Offset (in seconds, relative to the event specified in *Create filter around* parameter) for the start of interval for the temporary filter.
End offset	Offset (in seconds, relative to the event specified in *Create filter around* parameter) for the end of interval for the temporary filter.
Fix overlaps	An option to automatically merge the overlapping intervals in the temporary filter.
Overlay Graphs	An option to draw several histograms in each graph. This option requires that *Int. filter type* specifies that multiple interval filters will be used (either *Table (row)* or *Table (col)*).
Smooth	Option to smooth the histogram after the calculation. See Post-Processing Options for details.
Smooth Filter Width	The width of the smooth filter. See Post-Processing Options for details.
Add to Results / Bin left	An option to add an additional vector (containing a left edge of each bin) to the matrix of numerical results.

Add to Results / Bin middle	An option to add an additional vector (containing a middle point of each bin) to the matrix of numerical results.
Add to Results / Bin right	An option to add an additional vector (containing a right edge of each bin) to the matrix of numerical results.
Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.
Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.
Sheet Name	The name of the worksheet in Excel where to copy the numerical results.
TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
YMin	Histogram minimum.
YMax	Histogram maximum.
Spikes	The number of spikes used in calculation.
Filter Length	The length of all the intervals of the interval filter (if a filter was used) or the length or the recording session (in seconds).
Mean Freq.	Mean firing rate (Spikes/Filter_Length).
Mean Hist.	The mean of the histogram bin values.
St. Dev. Hist.	The standard deviation of the histogram bin values.
St. Err. Mean. Hist.	The standard error of mean of the histogram bin values.
Mean ISI	The mean of the interspike intervals.
St. Dev. ISI	The standard deviation of the interspike intervals.
Coeff. Var. ISI	Coefficient of variation of the interspike intervals.
Median ISI	Median of the interspike intervals.
Mode ISI	Mode of the interspike intervals.

Algorithm

If Use Log Bins and X Axis option is not selected:

The time axis is divided into bins. The first bin is **[IntMin, IntMin+Bin)**. The second bin is **[IntMin+Bin, Intmin+Bin*2)**, etc. The left end is included in each bin, the right end is excluded from the bin. For each bin, the number of interspike intervals within this bin is calculated.

For example, for the first bin

```
bin_count = number of interspike intervals (isi)
such that isi >= IntMin and isi < IntMin + Bin
```

If **Normalization** is **Counts/Bin**, no further calculations are performed.

If **Normalization** is **Probability**, bin counts are divided by the number of interspike intervals in the spike train.

If **Normalization** is **Spikes/Sec**, bin counts are divided by **NumInt*Bin**, where NumInt is the number of interspike intervals in the spike train.

If Use Log Bins and X Axis option is selected:

The i-th bin (i=1,2,...) is **[IntMin * 10 ^ ((i -1)/D), IntMin * 10 ^ (i/D))**, where **D** is the **Number of Bins Per Decade.** For each bin, the number of interspike intervals within this bin is calculated. For discussion on using logarithm of interspike intervals, see:

Alan D. Dorval, Probability distributions of the logarithm of inter-spike intervals yield accurate entropy estimates from small datasets. Journal of Neuroscience Methods 173 (2008) 129–139

2.10. Autocorrelograms

Autocorrelogram shows the conditional probability of a spike at time *t0+t* on the condition that there is a spike at time *t0*.

Parameters

Parameter	Description
XMin	Time axis minimum in seconds.
XMax	Time axis maximum in seconds.
Bin	Bin size in seconds.
Normalization	Histogram units (Counts/Bin, Probability or Spikes/Second). See *Algorithm* below.
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Int. filter type	Specifies if the analysis will use a single or multiple interval filters.
Interval filter	Specifies the interval filter(s) that will be used to preselect data before analysis. See also Data Selection Options.
Create filter on-the-fly	Specifies if a temporary interval filter needs to be created (and used to preselect data).
Create filter around	Specifies an event that will be used to create a temporary filter.
Start offset	Offset (in seconds, relative to the event specified in *Create filter around* parameter) for the start of interval for the temporary filter.
End offset	Offset (in seconds, relative to the event specified in *Create filter around* parameter) for the end of interval for the temporary filter.
Fix overlaps	An option to automatically merge the overlapping intervals in the temporary filter.
Overlay Graphs	An option to draw several histograms in each graph. This option requires that *Int. filter type* specifies that multiple interval filters will be used (either *Table (row)* or *Table (col))*.
Smooth	Option to smooth the histogram after the calculation. See Post-Processing Options for details.
Smooth Filter Width	The width of the smooth filter. See Post-Processing Options for details.
Draw confidence limits	An option to draw the confidence limits.
Confidence (%)	Confidence level (percent). See Confidence Limits for details.
Conf. mean calculation	An option that specifies how the mean firing rate (that is used in the derivation of the confidence limits) is calculated. There are 2 options: *Use data selection and Use all file.* See Confidence Limits for details.
Conf. display	An option to draw confidence limits either as horizontal lines or as a

	colored background.
Conf. line style	Line style for drawing confidence limits (used when Conf. display is *Lines*).
Conf. background color	Background color for drawing confidence limits (used when Conf. display is *Colored Background*).
Draw mean freq.	An option to draw a horizontal line representing the expected histogram value for a Poisson spike train. See Confidence Limits for details.
Mean line style	Line style for drawing mean frequency.
Add to Results / Bin left	An option to add an additional vector (containing a left edge of each bin) to the matrix of numerical results.
Add to Results / Bin middle	An option to add an additional vector (containing a middle point of each bin) to the matrix of numerical results.
Add to Results / Bin right	An option to add an additional vector (containing a right edge of each bin) to the matrix of numerical results.
Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.
Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.
Sheet Name	The name of the worksheet in Excel where to copy the numerical results.
TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
YMin	Histogram minimum.
YMax	Histogram maximum.
Spikes	The number of spikes used in calculation.
Filter Length	The length of all the intervals of the interval filter (if a filter was used) or the length or the recording session (in seconds).
Mean Freq.	Mean firing rate (Spikes/Filter_Length).
Mean Hist.	The mean of the histogram bin values.
St. Dev. Hist.	The standard deviation of the histogram bin values.
Conf. Low	Lower confidence level.
Conf. High	Upper confidence level.
Mean	Expected mean value of the histogram.

Norm. Factor	Normalization factor. Bin counts are divided by this value. See Normalization in *Algorithm* below.
First Min. Time	Position of the histogram minimum (in seconds). If there are multiple bins in the histogram where the bin value equals to the histogram minimum, this value represents the position of the first such bin.
First Max. Time	Position of the histogram maximum (in seconds). If there are multiple bins in the histogram where the bin value equals to the histogram maximum, this value represents the position of the first such bin.

Algorithm

In general, the Autocorrelogram shows the conditional probability of a spike in the spike train at time t on the condition that there is a spike at time zero.

The time axis is divided into bins. The first bin is **[XMin, XMin+Bin)**. The second bin is **[XMin+Bin, Xmin+Bin*2)**, etc. The left end is included in each bin, the right end is excluded from the bin.

Let ts[i] be the spike train (each ts is the timestamp).

For each timestamp ts[k]:

calculate the distances from this spike to all other spikes in the spike train:

```
d[i] = ts[i] - ts[k]
```

for each i except i equal to k:

if d[i] is inside the first bin, increment the bin counter for the first bin:

```
if d[i] >= XMin and d[i] < XMin + Bin
then bincount[1] = bincount[1] +1
```

if d[i] is inside the second bin, increment the bin counter for the second bin:

```
if d[i] >= XMin+Bin and d[i] < XMin + Bin*2
then bincount[2] = bincount[2] +1
```

and so on... .

If **Normalization** is **Counts/Bin**, no further calculations are performed.

If **Normalization** is **Probability**, bin counts are divided by the number of spikes in the spike train.

Note that the Probability normalization makes sense only for small values of Bin. For Probability normalization to be valid (so that the values of probability are between 0 and 1), there should be no more than one spike in each bin. For example, if the Bin value is large and for each ts[k] above there are many d[i] values such that d[i] >= XMin and d[i] < XMin + Bin, the bin count for the first bin can exceed the number of spikes in the spike train. Then, the probability value (bincount[1]/number_of_spikes) could be larger than 1.

If **Normalization** is **Spikes/Sec**, bin counts are divided by **NumSpikes*Bin**, where NumSpikes is the number of spikes in the spike train.

2.11. Perievent Histograms

Perievent Histogram shows the conditional probability of a spike at time *t0+t* on the condition that there is a reference event at time *t0*.

Parameters

Parameter	Description
Reference Type	Specifies if the analysis will use a single or multiple reference events.
Reference	Specifies a reference neuron or event (or a group of reference neurons or events).
XMin	Histogram time axis minimum in seconds.
XMax	Histogram time axis maximum in seconds
Bin	Bin size in seconds.
Normalization	Histogram units (Counts/Bin, Probability, Spikes/Second or Z-score). See *Algorithm* below.
No Selfcount	An option not to count reference events if the target event is the same as the reference event (prevents a histogram to have a huge peak at zero when calculating PSTH versus itself).
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Int. filter type	Specifies if the analysis will use a single or multiple interval filters.
Interval filter	Specifies the interval filter(s) that will be used to preselect data before analysis. See also Data Selection Options.
Create filter on-the-fly	Specifies if a temporary interval filter needs to be created (and used to preselect data).
Create filter around	Specifies an event that will be used to create a temporary filter.
Start offset	Offset (in seconds, relative to the event specified in *Create filter around* parameter) for the start of interval for the temporary filter.
End offset	Offset (in seconds, relative to the event specified in *Create filter around* parameter) for the end of interval for the temporary filter.
Fix overlaps	An option to automatically merge the overlapping intervals in the temporary filter.
Overlay Graphs	An option to draw several histograms in each graph. This option requires that *Int. filter type* specifies that multiple interval filters will be used (either *Table (row)* or *Table (col)*).
Overlay Options	Specifies line colors and line styles for overlaid graphs.
Smooth	Option to smooth the histogram after the calculation. See Post-Processing Options for details.
Smooth Filter Width	The width of the smooth filter. See Post-Processing Options for details.

Draw confidence limits	An option to draw the confidence limits.
Confidence (%)	Confidence level (percent). See Confidence Limits for details.
Conf. mean calculation	An option that specifies how the mean firing rate (that is used in the derivation of the confidence limits) is calculated. There are 3 options: *Use data selection*, *Use all file* and *Use pre-ref data*. See Confidence Limits for details. Note that *Use pre-ref data* option can only be used for a stimulation type data, i.e. when the distance between any two consecutive reference events is larger than *XMax-XMin*. See Confidence Limits for details.
Conf. display	An option to draw confidence limits either as horizontal lines or as a colored background.
Conf. line style	Line style for drawing confidence limits (used when Conf. display is *Lines*).
Conf. background color	Background color for drawing confidence limits (used when Conf. display is *Colored Background*).
Draw mean freq.	An option to draw a horizontal line representing the expected histogram value for a Poisson spike train. See Confidence Limits for details.
Mean line style	Line style for drawing mean frequency.
Draw Cusum	An option to draw a cumulative sum graph above the histogram. See Cumulative Sum Graphs for details.
Add to Results / Bin left	An option to add an additional vector (containing a left edge of each bin) to the matrix of numerical results.
Add to Results / Bin middle	An option to add an additional vector (containing a middle point of each bin) to the matrix of numerical results.
Add to Results / Bin right	An option to add an additional vector (containing a right edge of each bin) to the matrix of numerical results.
Background	An option on how to calculate the histogram background for the peak and through analysis. See *Peak and Trough Statistics* below.
Peak width	Peak width (the number of bins in peak) in the peak and through analysis. See *Peak and Trough Statistics* below.
Left shoulder	Specifies the left shoulder value (in seconds) in the peak and through analysis. See *Peak and Trough Statistics* below.
Right shoulder	Specifies the right shoulder value (in seconds) in the peak and through analysis. See *Peak and Trough Statistics* below.
Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.
Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.
Sheet Name	The name of the worksheet in Excel where to copy the numerical results.
TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
Reference	Reference variable name.
NumRefEvents	The number of reference events used in calculation.
YMin	Histogram minimum.
YMax	Histogram maximum.
Spikes	The number of spikes used in calculation.
Filter Length	The length of all the intervals of the interval filter (if a filter was used) or the length or the recording session (in seconds).
Mean Freq.	Mean firing rate (Spikes/Filter_Length).
Mean Hist.	The mean of the histogram bin values.
St. Dev. Hist.	The standard deviation of the histogram bin values.
St. Err. Mean. Hist.	The standard error of mean of the histogram bin values.
Conf. Low	Lower confidence level.
Conf. High	Upper confidence level.
Mean	Expected mean value of the histogram. If Z-score normalization is specified, this value is zero and the expected mean value of the histogram with Counts/Bin normalization is shown in Z-score Mean.
Norm. Factor	Normalization factor. Bin counts are divided by this value. See Normalization in *Algorithm* below.
Z-score mean	Expected mean value of the histogram before Z-score normalization (in other words, confidence mean). See Confidence Limits for details .
Mean Before Ref.	Mean of the histogram before the reference event (i.e. for all the bins before zero on time axis).
Bins Before Ref.	The number of bins before the bin that contains zero on time axis.
Zero Bin	The index of the bin that contains zero on time axis.
Background Mean	The mean of the histogram background for the peak and trough analysis. See *Peak and Through Statistics* below.
Background Stdev	The standard deviation of the histogram background for the peak and trough analysis. See *Peak and Trough Statistics* below.
Peak Z-score	Peak Z-score. See *Peak and Trough Statistics* below.
Peak/Mean	Histogram peak value divided by the background mean value.
Peak Position	Peak position (in seconds).
Peak Half Height	The Y value of the half height of the peak, i.e. histogram_background_mean + (peak-mean)/2.
Peak Width at Half Height	Peak width at the peak half height level (in seconds).

Trough Z-score	Trough Z-score. See *Peak and Trough Statistics* below.
Trough/Mean	Histogram trough value divided by the background mean value.
Trough Position	Trough position (in seconds).
Trough Half Height	The Y value of the half height of the trough, i.e. histogram_background_mean + (trough-mean)/2.
Trough Width at Half Height	Trough width at the trough half height level (in seconds).

Algorithm

In general, the Perievent Histogram shows the conditional probability of a spike in the spike train at time t0+t on the condition that there is a reference event (or reference spike) at time t0.

The time axis is divided into bins. The first bin is **[XMin, XMin+Bin)**. The second bin is **[XMin+Bin, XMin+Bin*2)**, etc. The left end is included in each bin, the right end is excluded from the bin.

Let ref[i] be the array of timestamps of the reference event,

ts[i] be the spike train (each ts is the timestamp)

For each timestamp ref[k]:

1) calculate the distances from this event (or spike) to all the spikes in the spike train:

```
d[i] = ts[i] - ref[k]
```

2) for each i:

if d[i] is inside the first bin, increment the bin counter for the first bin:

```
if d[i] >= XMin and d[i] < XMin + Bin
then bincount[1] = bincount[1] +1
```

if d[i] is inside the second bin, increment the bin counter for the second bin:

```
if d[i] >= XMin+Bin and d[i] < XMin + Bin*2
then bincount[2] = bincount[2] +1
```

and so on... .

If **Normalization** is **Counts/Bin**, no further calculations are performed.

If **Normalization** is **Probability**, bin counts are divided by the number of reference events.

Note that the Probability normalization makes sense only for small values of Bin. For Probability normalization to be valid (so that the values of probability are between 0 and 1), there should be no more than one spike in each bin. For example, if the Bin value is large and for each ref[k] above there are many d[i] values such that d[i] >= XMin and d[i] < XMin + Bin, the bin count for the first bin can exceed the number of reference events. Then, the probability value (bincount[1]/number_of_reference_events) could be larger than 1.

If **Normalization** is **Spikes/Sec**, bin counts are divided by **NumRefEvents*Bin**, where NumRefEvents is the number of reference events.

If **Normalization** is **Z-score**, bin_value = (bin_count - Confidence_mean)/sqrt(Confidence_mean), where Confidence_mean is the expected mean bin count calculated according to **Conf. mean calculation** parameter. Please note that bin counts are assumed to have Poisson distribution (therefore, standard deviation is equal to square root of expected mean) and Z-score can be considered to have Normal distribution only for large values (more than 10) of the Confidence_mean.

Peak and Trough Statistics

NeuroExplorer calculates the histogram peak statistics the following way:

- Maximum of the histogram is found
- If the histogram contains several maxima with the same value, peak statistics are not calculated
- Otherwise, the center of the bin, where the histogram reaches maximum, is shown as **Peak Position** in the Summary of Numerical results
- The mean **M** and standard deviation **S** of the bin values of the histogram background are calculated: If Background parameter is set as Bins outside peak/trough, bins outside peak and trough (i.e., bins that are more than PeakWidth/2 away from the bin with the histogram maximum and the bin with the histogram minimum) are used to calculate M and S If Background parameter is set as Shoulders, bins that are to the left of Left Shoulder or to the right of Right Shoulder parameters are used to calculate M and S
- The value **M** (mean of the background bin values) is shown as **Background Mean** in the Summary of Numerical results
- The value **S** (standard deviation of the background bin values) is shown as **Background Stdev** in the Summary of Numerical results
- The value **(HistogramMaximum – M)/S** is shown as **Peak Z-score**
- The value **(HistogramMaximum + M)/2** is shown as **Peak Half Height**
- Histogram intersects a horizontal line drawn at Peak Half Height at time points TLeft and TRight. (TRight - TLeft) is shown as **Peak Width**

Histogram trough statistics are calculated in a similar way. The only difference is that histogram minimum instead of histogram maximum is analyzed.

2.12. Crosscorrelograms

Crosscorrelogram shows the conditional probability of a spike at time *t0+t* on the condition that there is a reference event at time *t0*.

Compared to PSTH (that calculates the same probabilities), crosscorrelogram allows to use shift-predictors.

Parameters

Parameter	Description
Reference Type	Specifies if the analysis will use a single or multiple reference events.
Reference	Specifies a reference neuron or event (or a group of reference neurons or events).
XMin	Histogram time axis minimum in seconds.
XMax	Histogram time axis maximum in seconds
Bin	Bin size in seconds.
Normalization	Histogram units (Counts/Bin, Probability, Spikes/Second or Z-score). See *Algorithm* below.
No Selfcount	An option not to count reference events if the target event is the same as the reference event (prevents a histogram to have a huge peak at zero when calculating crosscorrelogram versus itself).
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Int. filter type	Specifies if the analysis will use a single or multiple interval filters.
Interval filter	Specifies the interval filter(s) that will be used to preselect data before analysis. See also Data Selection Options.
Count bins in filter	An option to normalize each bin individually if the interval filter is used. See *Algorithm* section below for detailed discussion.
Create filter on-the-fly	Specifies if a temporary interval filter needs to be created (and used to preselect data).
Create filter around	Specifies an event that will be used to create a temporary filter.
Start offset	Offset (in seconds, relative to the event specified in *Create filter around* parameter) for the start of interval for the temporary filter.
End offset	Offset (in seconds, relative to the event specified in *Create filter around* parameter) for the end of interval for the temporary filter.
Fix overlaps	An option to automatically merge the overlapping intervals in the temporary filter.
Overlay Graphs	An option to draw several histograms in each graph. This option requires that *Int. filter type* specifies that multiple interval filters will be used (either *Table (row)* or *Table (col)*).
Overlay Options	Specifies line colors and line styles for overlaid graphs.

Smooth	Option to smooth the histogram after the calculation. See Post-Processing Options for details.
Smooth Filter Width	The width of the smooth filter. See Post-Processing Options for details.
Shift-predictor	An option to use shift-predictor. Shift-predictor requires that an interval filter is used in the analysis. See Using Shift-Predictor for details.
Shift times	How many times to calculate shift predictor. See Using Shift-Predictor for details.
Subtract predictor	An option to subtract shift-predictor from crosscorrelogram. See Using Shift-Predictor for details.
Predictor line style	Specifies the line used to draw shift-predictor (if subtract predictor is not selected).
Draw confidence limits	An option to draw the confidence limits.
Confidence (%)	Confidence level (percent). See Confidence Limits for details.
Conf. mean calculation	An option that specifies how the mean firing rate (that is used in the derivation of the confidence limits) is calculated. There are 3 options: *Use data selection*, *Use all file* and *Use pre-ref data*. See Confidence Limits for details. Note that *Use pre-ref data* option can only be used for a stimulation type data, i.e. when the distance between any two consecutive reference events is larger than *XMax-XMin*. See Confidence Limits for details.
Conf. display	An option to draw confidence limits either as horizontal lines or as a colored background.
Conf. line style	Line style for drawing confidence limits (used when Conf. display is *Lines*).
Conf. background color	Background color for drawing confidence limits (used when Conf. display is *Colored Background*).
Draw mean freq.	An option to draw a horizontal line representing the expected histogram value for a Poisson spike train. See Confidence Limits for details.
Mean line style	Line style for drawing mean frequency.
Draw Cusum	An option to draw a cumulative sum graph above the histogram. See Cumulative Sum Graphs for details.
Add to Results / Bin left	An option to add an additional vector (containing a left edge of each bin) to the matrix of numerical results.
Add to Results / Bin middle	An option to add an additional vector (containing a middle point of each bin) to the matrix of numerical results.
Add to Results / Bin right	An option to add an additional vector (containing a right edge of each bin) to the matrix of numerical results.
Background	An option on how to calculate the histogram background for the peak and through analysis. See *Peak and Trough Statistics* below.
Peak width	Peak width (the number of bins in peak) in the peak and through analysis. See *Peak and Trough Statistics* below.
Left shoulder	Specifies the left shoulder value (in seconds) in the peak and through analysis. See *Peak and Trough Statistics* below.
Right shoulder	Specifies the right shoulder value (in seconds) in the peak and through analysis. See *Peak and Trough Statistics* below.

Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.
Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.
Sheet Name	The name of the worksheet in Excel where to copy the numerical results.
TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
Reference	Reference variable name.
NumRefEvents	The number of reference events used in calculation.
YMin	Histogram minimum.
YMax	Histogram maximum.
Spikes	The number of spikes used in calculation.
Filter Length	The length of all the intervals of the interval filter (if a filter was used) or the length or the recording session (in seconds).
Mean Freq.	Mean firing rate (Spikes/Filter_Length).
Mean Hist.	The mean of the histogram bin values.
St. Dev. Hist.	The standard deviation of the histogram bin values.
St. Err. Mean. Hist.	The standard error of mean of the histogram bin values.
Conf. Low	Lower confidence level.
Conf. High	Upper confidence level.
Mean	Expected mean value of the histogram. If Z-score normalization is specified, this value is zero and the expected mean value of the histogram with Counts/Bin normalization is shown in Z-score Mean.
Norm. Factor	Normalization factor. Bin counts are divided by this value. See Normalization in *Algorithm* below.
Z-score mean	Expected mean value of the histogram before Z-score normalization (in other words, confidence mean). See Confidence Limits for details .
Mean Before Ref.	Mean of the histogram before the reference event (i.e. for all the bins before zero on time axis).
Bins Before Ref.	The number of bins before the bin that contains zero on time axis.
Zero Bin	The index of the bin that contains zero on time axis.

Background Mean	The mean of the histogram background for the peak and trough analysis. See *Peak and Through Statistics* below.
Background Stdev	The standard deviation of the histogram background for the peak and trough analysis. See *Peak and Trough Statistics* below.
Peak Z-score	Peak Z-score. See *Peak and Trough Statistics* below.
Peak/Mean	Histogram peak value divided by the background mean value.
Peak Position	Peak position (in seconds).
Peak Half Height	The Y value of the half height of the peak, i.e. histogram_background_mean + (peak-mean)/2.
Peak Width at Half Height	Peak width at the peak half height level (in seconds).
Trough Z-score	Trough Z-score. See *Peak and Trough Statistics* below.
Trough/Mean	Histogram trough value divided by the background mean value.
Trough Position	Trough position (in seconds).
Trough Half Height	The Y value of the half height of the trough, i.e. histogram_background_mean + (trough-mean)/2.
Trough Width at Half Height	Trough width at the trough half height level (in seconds).

Algorithm

Crosscorrelogram shows the conditional probability of a spike at time *t0+t* on the condition that there is a reference event at time *t0*.

The time axis is divided into bins. The first bin is **[XMin, XMin+Bin)**. The second bin is **[XMin+Bin, XMin+Bin*2)**, etc. The left end is included in each bin, the right end is excluded from the bin.

Let ref[i] be the array of timestamps of the reference event,

ts[i] be the spike train (each ts is the timestamp).

For each timestamp ref[k]:

1) calculate the distances from this event (or spike) to all the spikes in the spike train:

```
d[i] = ts[i] - ref[k]
```

2) for each i:

if d[i] is inside the first bin, increment the bin counter for the first bin:

```
if d[i] >= XMin and d[i] < XMin + Bin
then bincount[1] = bincount[1] +1
```

if d[i] is inside the second bin, increment the bin counter for the second bin:

```
if d[i] >= XMin+Bin and d[i] < XMin + Bin*2
then bincount[2] = bincount[2] +1
```

and so on... .

If **Normalization** is **Counts/Bin**, no further calculations are performed.

If **Normalization** is **Probability**, bin counts are divided by the number of reference events.

Note that the Probability normalization makes sense only for small values of Bin. For Probability normalization to be valid (so that the values of probability are between 0 and 1), there should be no more than one spike in each bin. For example, if the Bin value is large and for each ref[k] above there are many d[i] values such that d[i] >= XMin and d[i] < XMin + Bin, the bin count for the first bin can exceed the number of reference events. Then, the probability value (bincount[1]/number_of_reference_events) could be larger than 1.

If **Normalization** is **Spikes/Sec**, bin counts are divided by **NumRefEvents*Bin**, where NumRefEvents is the number of reference events.

If **Normalization** is **Z-score**, bin_value = (bin_count - Confidence_mean)/sqrt(Confidence_mean), where Confidence_mean is the expected mean bin count calculated according to **Conf. mean calculation** parameter. Please note that bin counts are assumed to have Poisson distribution (therefore, standard deviation is equal to square root of expected mean) and Z-score can be considered to have Normal distribution only for large values (more than 10) of the Confidence_mean.

If the option **Count Bins In Filter** is selected, for normalization Spikes/Second, NeuroExplorer will divide bin count by **NumTimesBinWasInFilter*Bin** instead of **NumRefEvents*Bin.** The problem is that when the interval filter is used, bins close to XMin and to XMax may often (when a reference event is close to the beginning or to the end of the interval in the interval filter) be positioned outside the filter and therefore will not be used for many reference events. Hence, the bins close to 0.0 will be used in analysis more often than the bins close to XMin and XMax. If the option **Count Bins In Filter** is selected, NeuroExplorer will count the number of times each bin was used in the calculation and use this count, **NumTimesBinWasInFilter,** (instead of the number of reference events) to normalize the histogram.

Peak and Trough Statistics

NeuroExplorer calculates histogram peak statistics the following way:

- Maximum of the histogram is found
- If the histogram contains several maxima with the same value, peak statistics are not calculated
- Otherwise, the center of the bin, where the histogram reaches maximum, is shown as **Peak Position** in the Summary of Numerical results
- The mean **M** and standard deviation **S** of the bin values of the histogram background are calculated: If Background parameter is set as Bins outside peak/trough, bins outside peak and trough (i.e., bins that are more than PeakWidth/2 away from the bin with the histogram maximum and the bin with the histogram minimum) are used to calculate M and S If Background parameter is set as Shoulders, bins that are to the left of Left Shoulder or to the right of Right Shoulder parameters are used to calculate M and S
- The value **M** (mean of the background bin values) is shown as **Background Mean** in the Summary of Numerical results
- The value **S** (standard deviation of the background bin values) is shown as **Background Stdev** in the Summary of Numerical results
- The value **(HistogramMaximum – M)/S** is shown as **Peak Z-score**
- The value **(HistogramMaximum + M)/2** is shown as **Peak Half Height**
- Histogram intersects a horizontal line drawn at Peak Half Height at time points TLeft and TRight. (TRight - TLeft) is shown as **Peak Width**

Histogram trough statistics are calculated in a similar way. The only difference is that histogram minimum instead of histogram maximum is analyzed.

2.13. Shift-Predictor for Crosscorrelograms

Shift-predictor is defined for a series of trials - you take the spikes of one neuron in trial 1 and correlate them with the spikes of another neuron in trial 2, etc.

These "trials" are represented in NeuroExplorer as time intervals, i.e. pairs of numbers:

start of interval 1, end of interval 1

start of interval 2, end of interval 2, etc.

To use the shift-predictor, you need to create those "trials" first.

You need an external event that is fired at the beginning of each trial. Suppose *Event03* is the event that happens at the beginning of each trial and each trial lasts 20 seconds.

To create the trial intervals:

- click on the *New Events!* button (or select **Edit | Operations on Variables** menu command)
- in the operations list, select *MakeIntervals*
- in the First Operand, select the external event *Event03*
- set *Shift Min* to 0. and *Shift Max* to 20.0
- in the *New Var Name*, type: *Trials*
- press *Run the Operation* button
- close the dialog.

Now, click on the Crosscorrelogram button, select Shift-predictor page and select *Trials* as an interval filter and specify other shift-predictor parameters.

Shift-Predictor Algorithm

Suppose we have n trial intervals:

[t1a, t1b], [t2a, t2b], ..., [tna, tnb]

and we have 2 spike trains:

reference spike train with N timestamps **r1, r2, ... , rN**;

and target spike train with M timestamps **s1, s2, ... , sM**.

Shift-predictor for shift = 1 is calculated like this:

Step 1: find all the timestamps **ri** that are inside the first trial interval **[t1a, t1b]**

Step 2: find all the timestamps **sj** that are inside the second trial interval **[t2a, t2b]**

Step 3: shift all the timestamps **ri** so that thay align with the second trial:

calculate new timestamps **pi = ri + (t2a-t1a)**

Step 4: calculate a crosscorrelogram between **pi** and **sj**

Repeat Steps 1 through 4 with interval **[t2a, t2b]** in Step 1 and interval **[t3a, t3b]** in Step 2.

...

Repeat Steps 1 through 4 with interval **[tna, tnb]** in Step 1 and interval **[t1a, t1b]** in Step 2. Note that we wrap around the trials: the last trial is correlated with the first one.

Then, calculate shift-predictors for shift = 2:

Repeat Steps 1 through 4 with interval **[t1a, t1b]** in Step 1 and interval **[t3a, t3b]** in Step 2. That is, shift trials by 2.

...

And, finally, calculate shift-predictors for shift = Number_of_shifts specified in the shift-predictor options.

More on Time Intervals

These time intervals can be used in other analyses in NeuroExplorer to analyze spikes only from those intervals.

For example, you may have a pre-drug period in the experiment (say, from 0 to 600 seconds) and want to analyze the spikes from this pre-drug time period.

To do this, you create a new "interval variable" (let's call it "PreDrug") that contains only one interval (0., 600.) (press "New Intervals!" button to create a new interval variable).

Then you can calculate, for example, the autocorrelograms for the spikes in the pre-drug period by specifying PreDrug as an "interval filter" in the Data Selection page of the Autocorrelogram parameters dialog.

2.14. Rasters

The raster display shows the spikes as vertical lines (tick) positioned according to the spikes timestamps. This analysis does not generate numerical results since the raster lines (ticks) are drawn directly from the data. Some generic analysis statistics are available in the Summary of Numerical Results (see below).

Parameters

Parameter	Description
XMin	Time axis minimum in seconds.
XMax	Time axis maximum in seconds
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Interval filter	Specifies the interval filter(s) that will be used to preselect data before analysis. See also Data Selection Options.
Vert. size	The size of a raster tick (in percent of the graph height).

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
YMin	Y axis minimum (added for compatibility with other analyses, always 0).
YMax	Y axis maximum (added for compatibility with other analyses, always 1).
Spikes	The number of spikes used in calculation.
Filter Length	The length of all the intervals of the interval filter (if a filter was used) or the length or the recording session (in seconds).
Mean Freq.	Mean firing rate (Spikes/Filter_Length).

Algorithm

The raster display shows the spikes as vertical lines positioned according to the spikes timestamps.

2.15. Perievent Rasters

This analysis shows the timestamps of the selected variable relative to the timestamps of the reference variable.

Parameters

Parameter	Description
Reference Type	Specifies if the analysis will use a single or multiple reference events.
Reference	Specifies a reference neuron or event (or a group of reference neurons or events).
XMin	Time axis minimum in seconds.
XMax	Time axis maximum in seconds
Markers	An option to display additional events (as markers - triangles, squares, etc.) in the perievent raster.
Background Intervals	An option to draw intervals in the raster background.
Trial Order	This option allows you to specify how the raster lines are drawn. The raster lines (corresponding to reference events) can be drawn in the order of reference events (with the first event on top, the last at the bottom of the perievent raster), or in the reverse order (the first event at the bottom of the raster display, the last event at the top). This option is ignored if *Sort trials* parameter is not None.
Sort trials	An option to sort raster lines. By default, the raster lines (corresponding to reference events) are drawn in the order specified by the Trial Order parameter. This option allows you to display reference events in a different order. For example, in behavioral experiments, you can sort the trials according to the latency of the response.
Sort event	Specifies how to identify the timestamps (in Sort ref. variable) that will be used in sorting.
Sort ref.	Specifies event variable that will be used to sort trials.
Histogram	An option to draw a histogram.
Bin	Histogram bin size in seconds.
Normalization	Histogram units (Counts/Bin, Probability or Spikes/Second). See *Algorithm* below.
No Selfcount	An option not to count reference events if the target event is the same as the reference event (prevents a histogram to have a huge peak at zero when calculating PSTH versus itself).
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Int. filter type	Specifies if the analysis will use a single or multiple interval filters.
Interval filter	Specifies the interval filter(s) that will be used to preselect data before analysis. See also Data Selection Options.

Create filter on-the-fly	Specifies if a temporary interval filter needs to be created (and used to preselect data).
Create filter around	Specifies an event that will be used to create a temporary filter.
Start offset	Offset (in seconds, relative to the event specified in *Create filter around* parameter) for the start of interval for the temporary filter.
End offset	Offset (in seconds, relative to the event specified in *Create filter around* parameter) for the end of interval for the temporary filter.
Fix overlaps	An option to automatically merge the overlapping intervals in the temporary filter.
Smooth histogram	An option to smooth the histogram after the calculation. See Post-Processing Options for details.
Smooth Filter Width	The width of the smooth filter. See Post-Processing Options for details.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
Reference	Reference variable name.
NumRefEvents	The number of reference events used in calculation.
YMin	Histogram minimum.
YMax	Histogram maximum.
Spikes	The number of spikes used in calculation.
Filter Length	The length of all the intervals of the interval filter (if a filter was used) or the length or the recording session (in seconds).
Mean Freq.	Mean firing rate (Spikes/Filter_Length).
Mean Hist.	The mean of the histogram bin values.
St. Dev. Hist.	The standard deviation of the histogram bin values.
St. Err. Mean. Hist.	The standard error of mean of the histogram bin values.

Algorithm

For the perievent histogram calculation, see Perievent Histograms.

Let ref[i] be the array of timestamps of the reference event,

sortref[i] be the array of timestamps of the sort event.

If **Sort Trials** is selected, the following algorithm is used:

1) for each timestamp ref[k], NeuroExplorer finds the smallest sortref[i], such that

sortref[i] > ref[k]

2) the distance between two events is calculated:

dist[k] = sortref[i] - ref[k]

3) the trials ref[k] are sorted array sorted in ascending or descending order of dist[k].

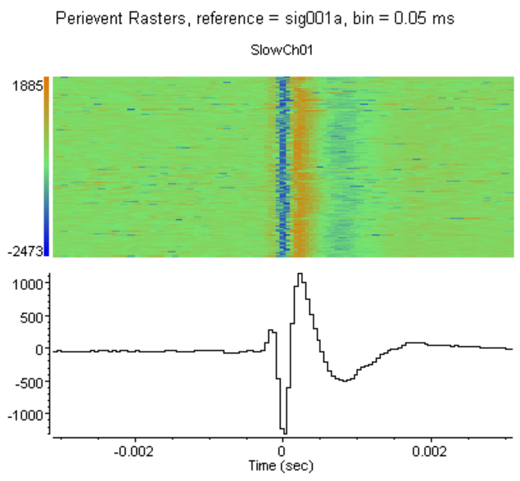
Continuous variables can also be used in this analysis.

For each ref[k], NeuroExplorer calculates a series of bins. The first bin is:

[ref[k]+XMin, ref[k]+XMin+Bin]

the second bin is [ref[k]+XMin+Bin, ref[k]+XMin+Bin+Bin], etc.

Then, the **average value** of a continuous variable is calculated within each of the bins and this average value is displayed using the color scale. If bin does not contain any timestamps of the continuous variable, the previous value of the continuous variable is used.



2.16. Joint PSTH

Joint PSTH matrix shows the correlations of the two neurons around the reference events.

Parameters

Parameter	Description
XMin	Time axis minimum in seconds.
XMax	Time axis maximum in seconds
Bin	Bin size in seconds.
Reference	Specifies a reference neuron or event.
Bottom Neuron	The neuron of event shown along the horizontal axis (the vertical axis shows a neuron selected for analysis).
Diag	The width (in seconds) of the area in the scatter matrix around its main diagonal used to calculate the main diagonal histogram.
Normalization	Scatter matrix normalization.
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Int. filter type	Specifies if the analysis will use a single or multiple interval filters.
Interval filter	Specifies the interval filter(s) that will be used to preselect data before analysis. See also Data Selection Options.
Create filter on-the-fly	Specifies if a temporary interval filter needs to be created (and used to preselect data).
Create filter around	Specifies an event that will be used to create a temporary filter.
Start offset	Offset (in seconds, relative to the event specified in *Create filter around* parameter) for the start of interval for the temporary filter.
End offset	Offset (in seconds, relative to the event specified in *Create filter around* parameter) for the end of interval for the temporary filter.
Fix overlaps	An option to automatically merge the overlapping intervals in the temporary filter.
Smooth	Option to smooth the histograms (not the scatter matrix) after the calculation. See Post-Processing Options for details.
Smooth Filter Width	The width of the smooth filter. See Post-Processing Options for details.
Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.
Send to Excel	An option to send numerical results or summary of numerical results to

	Excel. See also Excel Options.
Sheet Name	The name of the worksheet in Excel where to copy the numerical results.
TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.
Matrix Scale	An option on how to draw the scatter matrix (color or black and white).
Font size (% matrix)	Font size in percent of scatter matrix height.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
YMin	Y axis minimum (added for compatibility with other analyses, always 0).
YMax	Y axis maximum (added for compatibility with other analyses, always 1).
Spikes	The number of spikes of the neuron shown on the vertical axis used in calculation.
Filter Length	The length of all the intervals of the interval filter (if a filter was used) or the length or the recording session (in seconds).
Mean Freq.	Mean firing rate (Spikes/Filter_Length).
Hist. norm.	Normalization factor. Histogram bin counts are divided by this value.
Color scale minimum	Scatter matrix color scale minimum.
Color scale maximum	Scatter matrix color scale maximum.

Algorithm

The main Joint PSTH matrix shows the correlations of the bin counts of two neurons around the reference events. Histograms to the left of and below the matrix are standard perievent histograms for two specified neurons. The first histogram to the right of the matrix shows the correlations of near-coincident spikes around the reference events. The far-right histogram shows correlations of firings of two neurons around reference events.

See the following paper for details on Joint PSTH analysis:

M. H. J. Aertsen, G. L. Gerstein, M. K. Habib and G. Palm. Dynamics of Neuronal Firing Correlation: Modulation of "Effective Connectivity" J. Neurophysiol., Vol. 61, pp. 900-917, 1989.

2.17. Cumulative Activity Graphs

The cumulative activity display shows a stepwise function which makes a jump at the moment of spike and stays constant between the spikes.

This analysis does not generate numerical results since the stepwise function is drawn directly from the data. Some generic analysis statistics are available in the Summary of Numerical Results (see below).

Parameters

Parameter	Description
XMin	Time axis minimum in seconds.
XMax	Time axis maximum in seconds

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
YMin	Y axis minimum.
YMax	Y axis maximum.
Spikes	The number of spikes used in calculation.
Mean Freq.	Mean firing rate.

Algorithm

The cumulative activity display shows the stepwise function, which makes a jump at the moment of spike and stays constant between the spikes.

2.18. Instant Frequency

The instant frequency display shows the instantaneous frequency of the spike train (at the end of each interspike interval, the inverted interspike interval is drawn as a vertical line).

This analysis does not generate numerical results since the graph is drawn directly from the data. Some generic analysis statistics are available in the Summary of Numerical Results (see below).

Parameters

Parameter	Description
XMin	Time axis minimum in seconds.
XMax	Time axis maximum in seconds
Graph Style	An option to draw vertical lines or points.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
YMin	Y axis minimum.
YMax	Y axis maximum.
Spikes	The number of spikes used in calculation.
Mean Freq.	Mean firing rate.

Algorithm

The instant frequency display shows the instantaneous frequency of the spike train.

For each spike that occurred at time t[i] it draws the vertical line

from point (t[i], 0.) to point (t[i], 1/(t[i] - t[i-1])),

where t[i-1] is the time of the preceding spike.

In other words, at the end of each interspike interval, the inverted interspike interval is drawn as a vertical line.

2.19. Interspike Intervals vs. Time

The intervals vs. time graph displays interspike intervals against time (at the end of each interspike interval, the point is drawn with the Y coordinate equal to the interspike interval).

This analysis does not generate numerical results since the graph is drawn directly from the data. Some generic analysis statistics are available in the Summary of Numerical Results (see below).

Parameters

Parameter	Description
XMin	Time axis minimum in seconds.
XMax	Time axis maximum in seconds

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
YMin	Y axis minimum.
YMax	Y axis maximum.
Spikes	The number of spikes used in calculation.
Mean Freq.	Mean firing rate.

Algorithm

The intervals vs. time graph displays interspike intervals against time.

For each spike that occurred at time t[i] it draws the point with the coordinates

```
(t[i], t[i] - t[i-1]),
```

where t[i-1] is the time of the preceding spike.

In other words, at the end of each interspike interval, the point is drawn with the Y coordinate equal to the interspike interval.

2.20. Poincare Maps

For each spike, a point is displayed where the X coordinate of the point is the current interspike interval and Y coordinate of the point is the preceding interspike interval.

This analysis does not generate numerical results since the graph is drawn directly from the data. Some generic analysis statistics are available in the Summary of Numerical Results (see below).

Parameters

Parameter	Description
Min Interval	Time axis minimum in seconds.
Max Interval	Time axis maximum in seconds
Log Axis Scale	An option to use Log10 axis scales.
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Int. filter type	Specifies if the analysis will use a single or multiple interval filters.
Interval filter	Specifies the interval filter(s) that will be used to preselect data before analysis. See also Data Selection Options.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
YMin	Y axis minimum.
YMax	Y axis maximum.
Spikes	The number of spikes used in calculation.
Mean Freq.	Mean firing rate.

Algorithm

For each spike that occurred at time t[i], Poincare plot shows the point with the coordinates

```
(t[i] - t[i-1], t[i-1] - t[i-2]).
```

That is, the X coordinate of the point is the current interspike interval and Y coordinate of the point is the preceding interspike interval.

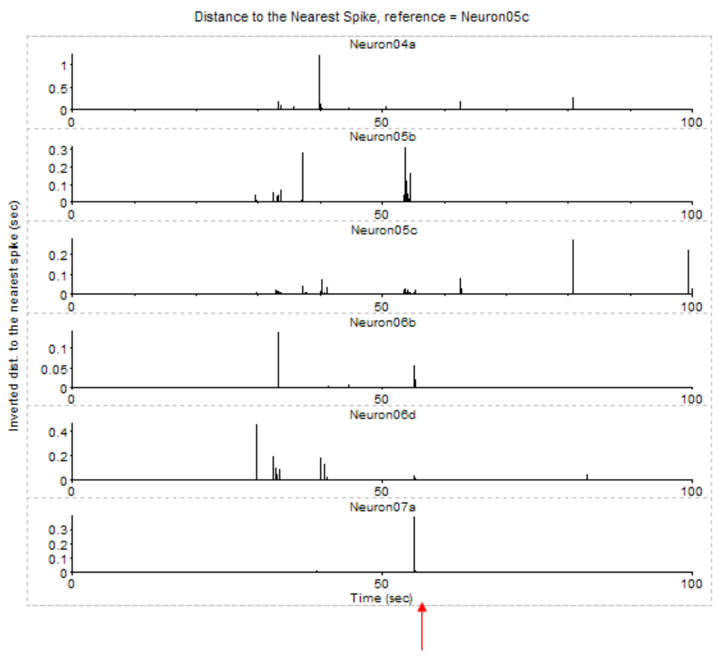
2.21. Synchrony vs. Time

For each spike, this graph shows the distance from this spike to the closest spike (timestamp) in the reference event.

This analysis does not generate numerical results since the graph is drawn directly from the data. Some generic analysis statistics are available in the Summary of Numerical Results (see below).

This analysis is useful in identifying the moments in time when several neurons are in sync with the reference neuron. To do this, you need to select Inverted Distance. Then, high values will indicate spikes that are close to each other. Also, it is useful to specify that the graphs are shown in 1 column (in Num. Columns in Properties panel).

The red arrow in the picture below shows a moment in time where several neurons have almost-synchronous spikes with the reference.



Parameters

Parameter	Description
XMin	Time axis minimum in seconds.
XMax	Time axis maximum in seconds
Reference	Reference event.
Distance	An option to draw linear or inverted distance.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.

YMin	Y axis minimum.
YMax	Y axis maximum.
Spikes	The number of spikes used in calculation.
Mean Freq.	Mean firing rate.

Algorithm

For each spike that occurred at time t[i], this graph shows the distance from this spike to the closest spike (timestamp) in the reference event:

dist = min(abs(t[i] - ref[j])),

where ref[j] is a timestamp of the reference event

If **Distance** is **Linear**, the vertical line is drawn

from point (t[i], 0.) to point (t[i], dist).

If **Distance** is **Inverted**, the vertical line is drawn

from point (t[i], 0.) to point (t[i], 1/dist).

2.22. Trial Bin Counts

Trial bin counts analysis computationally is essentially the same as the perievent histogram. The difference is that the bin counts are saved for each reference event. When used with continuous data, for each bin and reference vent, the average of the continuous values within the bin is calculated.

Parameters

Parameter	Description
Reference	Specifies a reference neuron or event.
XMin	Histogram time axis minimum in seconds.
XMax	Histogram time axis maximum in seconds
Bin	Bin size in seconds.
Normalization	Histogram units (Counts/Bin, Probability or Spikes/Second). See *Algorithm* below.
No Selfcount	An option not to count reference events if the target event is the same as the reference event (prevents a histogram to have a huge peak at zero when calculating PSTH versus itself).
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Interval filter	Specifies the interval filter(s) that will be used to preselect data before analysis. See also Data Selection Options.
Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.
Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.
Sheet Name	The name of the worksheet in Excel where to copy the numerical results.
TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.

Color Scale Min	Color scale minimum.
Color Scale Max	Color scale maximum.
Reference	Reverence event.
NumRefEvents	Number of reference events.
Bin001Mean	Mean of all the values for Bin 1.
Bin001SdDev	Standard deviation of all the values for Bin 1.

Algorithm

Trial bin counts analysis computationally is essentially the same as the perievent histogram. The difference is that the bin counts are saved for each reference event. When used with continuous data, for each bin and reference vent, the average of the continuous values within the bin is calculated.

The time axis is divided into bins. The first bin is **[XMin, XMin+Bin)**. The second bin is **[XMin+Bin, Xmin+Bin*2)**, etc. The left end is included in each bin, the right end is excluded from the bin.

Let ref[i] be the array of timestamps of the reference event,

ts[i] be the spike train (each ts is the timestamp)

For each timestamp ref[k]:

Set all bin counts to zero:

bincount[i] = 0 for all i

Calculate the distances from this event (or spike) to all the spikes in the spike train:

```
d[i] = ts[i] - ref[k]
```

for each i:

if d[i] is inside the first bin, increment the bin counter for the first bin:

```
if d[i] >= XMin and d[i] < XMin + Bin
then bincount[1] = bincount[1] +1
```

if d[i] is inside the second bin, increment the bin counter for the second bin:

```
if d[i] >= XMin+Bin and d[i] < XMin + Bin*2
then bincount[2] = bincount[2] +1
```

and so on... .

If **Normalization** is **Counts/Bin**, no further calculations are performed.

If **Normalization** is **Spikes/Sec**, bin counts are divided by **Bin.**

2.23. Power Spectral Densities

This analysis captures the frequency content of continuous variables or neuronal rate histograms.

Parameters

Parameter	Description
Max Frequency	Maximum frequency of the spectrum in Hz
Number of values	Number of values in the spectrum.
Show Frequency From	Minimum frequency to be shown in the spectrum graph.
Show Frequency To	Maximum frequency to be shown in the spectrum graph.
Normalization	Spectrum normalization. See *Algorithm* below.
Log Frequency Scale	An option show Log10 frequency scale.
Smooth	Option to smooth the spectrum after the calculation. See Post-Processing Options for details.
Smooth Filter Width	The width of the smooth filter. See Post-Processing Options for details.
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Int. filter type	Specifies if the analysis will use a single or multiple interval filters.
Interval filter	Specifies the interval filter(s) that will be used to preselect data before analysis. See also Data Selection Options.
Create filter on-the-fly	Specifies if a temporary interval filter needs to be created (and used to preselect data).
Create filter around	Specifies an event that will be used to create a temporary filter.
Start offset	Offset (in seconds, relative to the event specified in *Create filter around* parameter) for the start of interval for the temporary filter.
End offset	Offset (in seconds, relative to the event specified in *Create filter around* parameter) for the end of interval for the temporary filter.
Fix overlaps	An option to automatically merge the overlapping intervals in the temporary filter.
Overlay Graphs	An option to draw several histograms in each graph. This option requires that *Int. filter type* specifies that multiple interval filters will be used (either *Table (row)* or *Table (col)*).
Overlay Options	Specifies line colors and line styles for overlaid graphs.
Add to Results / Bin left	An option to add an additional vector (containing a left edge of each bin) to the matrix of numerical results.
Add to Results / Bin middle	An option to add an additional vector (containing a middle point of each bin) to the matrix of numerical results.
Add to Results / Bin	An option to add an additional vector (containing a right edge of each bin)

right	to the matrix of numerical results.
Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.
Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.
Sheet Name	The name of the worksheet in Excel where to copy the numerical results.
TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
YMin	Spectrum minimum.
YMax	Spectrum maximum.
Spikes	The number of spikes used in spectrum calculation.
Filter Length	The length of all the intervals of the interval filter (if a filter was used) or the length or the recording session (in seconds).
Mean Freq.	Mean firing rate (Spikes/Filter_Length).
First Minimum Frequency Position	The position of the minimum of the displayed spectrum (in Hz). If there are multiple bins in the spectrum where the spectrum value equals to the spectrum minimum, this value represents the frequency of the first such bin.
First Maximum Frequency Position	The position of the maximum of the displayed spectrum (in Hz). If there are multiple bins in the spectrum where the spectrum value equals to the spectrum maximum, this value represents the frequency of the first such bin.

Algorithm

Spectral Densities for Spike Trains and Events

NeuroExplorer uses rate histograms to estimate the power spectra of the spike trains. The parameters of rate histograms are calculated using the following formulas:

Bin = 1./(2.* **Maximum_Frequency**)

Number_of_Bins = 2* **Number_of_Frequency_Values**

The time axis is divided into intervals of length Bin*NumberOfBins. Then the power spectrum for each interval is calculated. The final raw power spectrum is the average of all the spectra for the separate intervals.

For each interval:

- The rate histogram is calculated.
- The histogram is detrended (its linear regression is subtracted)
- The Hann window w[i] = (1 - cos(2*PI*i/(Number_Of_Bins-1)))/2

is applied to the histogram.

- FFT of the result is calculated.
- Raw power spectrum is formed from the FFT.

Spectral Densities for Continuous Variables

If **Maximum_Frequency** = M and **Number_of_Frequency_Values** = N, we need to calculate the spectrum for frequency values 0, M/N, 2*M/N, ..., M.

For a continuous variable with digitizing frequency F, a standard power spectrum with K values in the FFT transform would produce the spectrum values for frequencies 0, F/K, 2*F/K, ..., F/2.

If a continuous variable digitizing frequency F equals to **Maximum_Frequency*2**, we can set K = **Number_of_Frequency_Values*2** and calculate the standard power spectrum to get the spectrum values for the desired frequencies. That is, in the algorithm described above, instead of rate histogram we simply use continuous variable values in milliVolts.

If a continuous variable digitizing frequency is not equal to **Maximum_Frequency*2**, we cannot directly calculate the spectrum for the specified frequencies. Instead, we find a value K such that the frequency step for continuous variable spectrum is less than the specified step (i.e. F/K < M/N, so that we should get a more detailed spectrum than specified) and calculate the spectrum for this value of K. Then, we resample the resulting spectrum to get the spectrum values for the specified frequencies.

Normalization

If **Normalization** is Raw PSD, the power spectrum is normalized so that the sum of all the spectrum values equals to the mean squared value of the rate histogram.

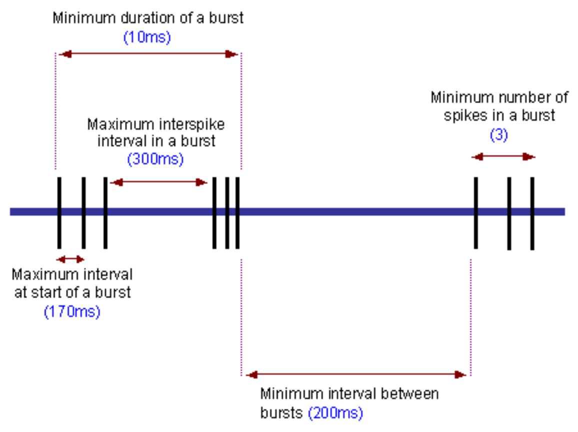
If **Normalization** is % of Total PSD, the power spectrum is normalized so that the sum of all the spectrum values equals 100.

If **Normalization** is Log of PSD, the power spectrum is calculated using the formula:

```
power_spectrum[i] = 10.*log10(raw_spectrum[i])
```

2.24. Burst Analysis

This analysis identifies bursts in spike trains. For each spike train (neuron variable), a new interval variable is created that contains the time intervals corresponding to bursts.



Parameters

Parameter	Description
Algorithm	Selection of MaxInterval or Surprise algorithms.
Max Interval	Maximum interspike interval to start the burst (in seconds, MaxInterval method).
Max End Interval	Maximum interspike interval to end the burst (in seconds, MaxInterval method).
Min Interburst Interval	Minimum interval between bursts (in seconds, MaxInterval method).
Min Burst Duration	Minimum burst duration (in seconds, MaxInterval method)
Min Number of Spikes	Minimum number of spikes in the burst (MaxInterval method).
Min Surprise	Minimum surprise of the burst (Surprise method).
Rate Histogram Bin	The value of the bin for the burst rate histogram (in seconds).
Rate Histogram Units	Histogram units (Counts/Bin, Probability or Spikes/Second). See Rate Histograms for details.
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Interval filter	Specifies the interval filter(s) that will be used to preselect data before analysis. See also Data Selection Options.
Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.
Sheet Name	The name of the worksheet in Excel where to copy the numerical results.
TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
YMin	Burst rate histogram minimum.
YMax	Burst rate histogram maximum.
Spikes	The number of spikes used in spectrum calculation.
Filter Length	The length of all the intervals of the interval filter (if a filter was used) or the length or the recording session (in seconds).
Mean Frequency	Mean firing rate (Spikes/Filter_Length).
Num Bursts	Number of bursts.
Bursts Per Second	Burst rate in bursts per second.
Bursts Per Minute	Burst rate in bursts per minute.
% of Spikes in Bursts	Percent of spikes in bursts.
Mean Burst Duration	Mean duration of burst (in seconds).
St. Dev. of Burst Duration	Standard deviation of burst duration.
Mean Spikes in Burst	Average number of spikes in burst.
St. Dev. of Spikes in Burst	Standard deviation of the number of spikes in burst.
Mean ISI Burst	Mean interspike interval in burst.
St. Dev of ISI in Burst	Standard deviation of interspike intervals in burst.
Mean Freq. in Burst	Mean firing rate (1/interspike_interval) in burst.
St. Dev. of Freq. in Burst	Standard deviation of (1/interspike_interval) in burst.
Mean Peak Frequency in Burst	Mean of (1/min_interspike_interval), where min_interspike_interval is the minimum interspike interval in a burst.
St. Dev. Peak Frequency in Burst	Standard deviation of (1/min_interspike_interval), where min_interspike_interval is the minimum interspike interval in a burst.
Mean Interburst Interval	Average length (in seconds) of interburst interval. Interburst interval is the interval from the end of the previous burst to the start of the current burst.
St. Dev. of Interburst Interval	Standard deviation of the interburst intervals.
Mean Burst Surprise	Average burst surprise.
St. Dev. Burst Surprise	Standard deviation of burst surprise.

Algorithm

For each spike train, NeuroExplorer creates a new Interval variable and stores all the burst intervals in this variable.

MaxInterval method

Find all the bursts using the following algorithm:

- Scan the spike train until an interspike interval is found that is less than or equal to **Max. Interval** .
- While the interspike intervals are less than **Max. End Interval,** they are included in the burst.
- If the interspike interval is more than **Max. End Interval**, the burst ends.
- Merge all the bursts that are less than **Min. Interval Between Bursts** apart.
- Remove the bursts that have duration less than **Min. Duration of Burst** or have fewer spikes than **Min. Number of Spikes**.

Surprise method

1) First the mean firing rate (**Freq**) and mean interspike interval (**MeanISI**) of the neuron are calculated.

Freq = NumberOfSpikes / (FileEndTime – FileStartTime)

MeanISI = 1 / Freq

2) NeuroExplorer scans the spike train until it finds two sequential ISI's so that each of those ISIs is less than **MeanISI/2**. The surprise of the resulting 3-spike sequence is calculated:

If we assume that a random variable **P** has a Poisson distribution with parameter **Freq** and we also assume that the burst has **N** spikes and the distance from the first to the last spike of the burst is **T**, then the surprise of the burst is:

S = - log10 (Probability that **P** has at least **N** points in a time interval of length **T**)

3) NeuroExplorer adds the spikes to the end of the burst until the first ISI that is more than **MeanISI** and calculates surprise for each of the bursts (with 3 initial spikes, 4 spikes, 5 spikes, etc.) The burst with maximum surprise **Smax** is then selected.

4) NeuroExplorer removes the spikes from the beginning of the burst and calculates the surprise for each of the reduced bursts. The burst with maximum surprise **Smax** is then selected.

5) If **Smax** is more than **MinSurprise** and the number of spikes in the burst is more than 3, NeuroExplorer adds the burst to the result.

Reference

Legendy C.R. and Salcman M. (1985): Bursts and recurrences of bursts in the spike trains of spontaneously active striate cortex neurons. *J. Neurophysiology*, 53(4):926-39.

2.25. Principal Component Analysis

This analysis calculates eigenvalues and eigenvectors (principal components) of the matrix of correlations of rate histograms. The analysis creates population vectors corresponding to the principal components.

Parameters

Parameter	Description
Bin	Bin size in seconds.
Vectors Prefix	A string specifying how the population vector names will be generated. For example, if prefix is **pca1**, the vector names will be **pca1_01**, **pca1_02**, etc.
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Interval filter	Specifies the interval filter that will be used to preselect data before analysis. See also Data Selection Options.
Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.
Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.
Sheet Name	The name of the worksheet in Excel where to copy the numerical results.
TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name and PCA statistics name.
pca1_N	The weight of the variable in the N-th eigenvector. The rows at the bottom of the table also show Eigenvalue of this eigenvector, % of variance it explains, and the cumulative percent of the variance explained by this and preceding eigenvectors.
Corr with VAR	Correlation with the specified variable.

Numerical Results

The **Results** sheet shows for each neuron the weights this neuron has in all the eigenvectors.

Algorithm

Step 1.

Rate histograms are calculated for each of the selected neurons.

The time axis is divided into bins. The first bin is **[0, Bin)**. The second bin is **[Bin, Bin*2)**, etc. The left end is included in each bin, the right end is excluded from the bin. For each bin, the number of events (spikes) in this bin is calculated.

For example, for the first bin

```
bin_count = number of timestamps (ts) such that ts >= 0 and ts < Bin
```

Bin counts are calculated in such a way for all the selected variables resulting in a matrix

bin_count[i, j],

where i is the neuron number, j is the bin number.

Step 2.

The matrix of correlations between neurons c[t, s] is calculated:

c[t, s] = correlation between vectors bin_count[t, *] and bin_count[s, *], s, t = 1, ..., number of selected neurons.

Step 3

The eigenvalues and eigenvectors are calculated for the matrix c[t, s]. The eigenvectors (principal components) are sorted according to their eigenvalues. The first principal component has the largest eigenvalue.

Each principal component becomes a new population vector in the data file.

2.26. PSTH Versus Time

This analysis shows the dynamics of the perievent histogram over time. It calculates multiple PST histograms using a "sliding window" in time. Each histogram is shown as a vertical stripe with colors representing the bin counts. Horizontal axis represents the position of the sliding window in time.

Parameters

Parameter	Description
Reference	Specifies a reference neuron or event.
XMinPSTH	Histogram time minimum in seconds.
XMaxPSTH	Histogram time maximum in seconds
BinPSTH	Histogram bin size in seconds.
Start	Start of the first sliding window in seconds.
Duration	Duration of the sliding window in seconds.
Shift	How much sliding window is shifted each time.
Number of shifts	The number of sliding windows to be used.
Normalization	Histogram units (Counts/Bin, Probability or Spikes/Second). See *Algorithm* below.
No Selfcount	An option not to count reference events if the target event is the same as the reference event (prevents a histogram to have a huge peak at zero when calculating PSTH versus itself).
Sliding window axis direction	Direction of the sliding window axis (horizontal or vertical).
Sliding window axis alignment	Allows to specify what values are shown in the sliding window axis. There are two options: Start of Window and Center of Window. Suppose your data has the strongest correlation at 50 seconds. This means that the window that has 50 seconds as its center will show the highest PST values. If the window width is 20 seconds, it will be the window [40,60]. If you are using 'Start of window' option, you will see the peak at 40 instead of 50 seconds. However, with 'Center of window' option, the peak will be at 50 seconds.
Smooth	Option to smooth the histogram after the calculation. See Post-Processing Options for details.
Smooth Filter Width	The width of the smooth filter. See Post-Processing Options for details.
Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.
Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.
Sheet Name	The name of the worksheet in Excel where to copy the numerical results.

TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
Reference	Reference variable name.
YMin	PSTH minimum.
YMax	PSTH maximum.
Color Scale Min	PSTH minimum.
Color Scale Max	PSTH maximum.
Spikes	The number of spikes in the variable.

Algorithm

NeuroExplorer calculates multiple PST histograms (see Perievent Histogram for more information on how each PSTH is calculated). Each histogram is calculated for a different interval (window) in time:

[window_start[i], window_end[i]], i = 1,..., **Number of Shifts**.

That is, for each histogram only the timestamps that are within the window are used.

The following rules are used to calculate the windows:

window_start[1] = **Start**

window_end[1] = **Start** + **Duration**

window_start[2] = **Start + Shift**

window_end[2] = **Start + Shift + Duration**

...

2.27. Correlations with Continuous Variable

This analysis calculates crosscorrelations between a continuously recorded variable and a neuronal firing rate, or crosscorrelations between a continuously recorded variable and another continuous variable.

Parameters

Parameter	Description
Reference	Specifies a reference continuous variable.
XMin	Time axis minimum in seconds.
XMax	Time axis maximum in seconds.
Bin Type	An option to specify how the bin value is determined. If this option is *Auto*, NeuroExplorer will use the bin equal to the A/D sampling interval of the reference variable.
Bin	Bin size in seconds. Used if *Bin Type* is set to *User defined*.
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Interval filter	Specifies the interval filter(s) that will be used to preselect data before analysis. See also Data Selection Options.
Smooth	Option to smooth the histogram after the calculation. See Post-Processing Options for details.
Smooth Filter Width	The width of the smooth filter. See Post-Processing Options for details.
Add to Results / Bin left	An option to add an additional vector (containing a left edge of each bin) to the matrix of numerical results.
Add to Results / Bin middle	An option to add an additional vector (containing a middle point of each bin) to the matrix of numerical results.
Add to Results / Bin right	An option to add an additional vector (containing a right edge of each bin) to the matrix of numerical results.
Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.
Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.
Sheet Name	The name of the worksheet in Excel where to copy the numerical results.
TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
Reference	Reference variable name.
YMin	Y axis minimum.
YMax	Y axis maximum.
Mean Hist.	Mean of all the correlation values for this variable.
St. Dev. Hist	Standard deviation of all the correlation values for this variable.
St. Eff. Mean Hist	Standard error of mean of all the correlation values for this variable.

Algorithm

This analysis calculates standard correlograms for two (continuously recorded) vectors. For spike trains and events, NeuroExplorer first calculates the rate histograms with the specified bin size, and then calculates the correlations between the reference variable and the rate histogram.

If x[i], i=1,...N is the reference variable and y[i], i=1,...,N is another continuous variable or spike train rate histogram, then

c[t] = Pearson correlation between vectors

{ x[1], x[2], …, x[N-t] }

and

{ y[t+1], y[t+2], …, y[N] }

2.28. Regularity Analysis

This analysis estimates the regularity of neuronal firing after the stimulation.

Parameters

Parameter	Description
Reference	Specifies a reference event or spike train.
XMin	Time axis minimum in seconds.
XMax	Time axis maximum in seconds.
Bin	Bin size in seconds. Used if *Bin Type* is set to *User defined*.
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Interval filter	Specifies the interval filter that will be used to preselect data before analysis. See also Data Selection Options.
ISI Graph	This parameter determines how the mean ISI values is displayed in the graph.
SD Graph	This parameter determines how the standard deviation of ISI is displayed in the graph.
CV Graph	This parameter determines how the CV (coefficient of variation) values are displayed in the graph.
CV Graph Max	This parameter determines the scale for the CV values in the graph. CV values are scaled from **zero** (bottom of the graph) to **CV Graph Max** (top of the graph).
Add to Results / Bin left	An option to add an additional vector (containing a left edge of each bin) to the matrix of numerical results.
Add to Results / Bin middle	An option to add an additional vector (containing a middle point of each bin) to the matrix of numerical results.
Add to Results / Bin right	An option to add an additional vector (containing a right edge of each bin) to the matrix of numerical results.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
NumRefEvents	Number of reference events.
YMin	Histogram minimum.
YMax	Histogram maximum.
Spikes	The number of spikes used in calculation.

Filter Length	The length of all the intervals of the interval filter (if a filter was used) or the length or the recording session (in seconds).
Mean Freq.	Mean firing rate (Spikes/Filter_Length).
Mean Hist.	The mean of the histogram bin values (ISI values).
St. Dev. Hist.	The standard deviation of the histogram bin values.
St. Dev. ISI	The mean value of the SD ISI graph.
CV	The mean value of the CV ISI graph.

Algorithm

This analysis estimates the regularity of neuronal firing after the stimulation. The time axis is divided into bins with the first bin starting at the stimulus sync pulse. Interspike intervals are computed and interval values are placed in time bins according to the latency of the first spike in the interval (if the end of the ISI is more than XMax, the interval is not used in the analysis). Then the mean and standard deviation in each bin are calculated. CV is equal to standard deviation for the bin divided by the mean ISI for the bin.

Let ref[i] be the array of timestamps of the reference event,

ts[i] be the spike train (each ts is the timestamp)

For each timestamp ref[k]:

1a) calculate the distances from this event (or spike) to all the spikes in the spike train:

```
d[i] = ts[i] - ref[k]
```

1b) calculate the interspike interval

```
isi[i] = ts[i+1] - ts[i]
```

1c) for each i:

if d[i] is inside the first bin (d[i] >= XMin and d[i] < XMin + Bin)

and d[i] + isi[i] < XMax,

add isi[i] to the series of intervals for the first bin

if d[i] is inside the second bin (d[i] >= XMin+Bin and d[i] < XMin + Bin*2)

and d[i] + isi[i] < XMax, add isi[i] to the series of intervals for the second bin

and so on... .

2) for each bin, calculate mean and standard deviation of the series of interspike intervals for this bin.

Reference

E.D. Young, J.-M. Robert and W.P. Shofner. Regularity and latency of units in ventral cochlear nucleus: implications for unit classification and generation of response properties. J. Neurophysiology, Vol. 60, 1988, 1-29.

2.29. Place Cell Analysis

This analysis estimates the frequency of neuronal firing as a function of position of an animal. The animal position should be described by two continuously recorded variables.

Parameters

Parameter	Description
X Position	Continuous variable that describes X position of the animal.
Y Position	Continuous variable that describes Y position of the animal.
Fix Positions	This option specifies whether NeuroExplorer needs to fix problems that often occur in recording of position variables. For example, when LED is obscured by the wires, both position variables suddenly jump to 0 and then jump back to the previous position.
Fix Threshold	*Fix Positions* parameter. See *Algorithm* section below for details.
Fix Bad X	*Fix Positions* parameter. The 'bad' value of X variable. See *Algorithm* section below for details.
Fix Bad Y	*Fix Positions* parameter. The 'bad' value of Y variable. See *Algorithm* section below for details.
X Min	X axis minimum in X Position units.
X Max	X axis maximum in X Position units.
Y Min	Y axis minimum in Y Position units.
Y Max	Y axis maximum in Y Position units.
Number of Bins (X)	Number of bins along X axis.
Number of Bins (Y)	Number of bins along Y axis.
Display	This parameter determines what kind of Place Cell Analysis display is shown (Path, Firing Positions, Time Spent (in each cell), Number of Visits (to each cell), Spike Counts (for each cell), Firing Rates (for each cell), Firing Fields).
Min. Time Spent	Minimum time spent. This parameter is used only with Firing Rates display. If the animal spent less time in the cell than **Min Time Spent**, the firing rate for the cell is set to zero.
Min Visits	Minimum number of visits. This parameter is used only with Firing Rates display. If the animal visited the cell less than **Min Visits** number of times, the firing rate for the cell is set to zero.
Firing Rate Bin	Bin size (in seconds) to calculate firing rates.
Min Std. Dev. in Field	Minimum standard deviation in the field. See *Algorithm* section below for details.
Min. Pixels in Field	Minimum number of pixels in the field. See *Algorithm* section below for details.
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.

Select Data To	End of the time range in seconds.
Int. filter type	Specifies if the analysis will use a single or multiple interval filters.
Interval filter	Specifies the interval filter(s) that will be used to preselect data before analysis. See also Data Selection Options.
Create filter on-the-fly	Specifies if a temporary interval filter needs to be created (and used to preselect data).
Create filter around	Specifies an event that will be used to create a temporary filter.
Start offset	Offset (in seconds, relative to the event specified in *Create filter around* parameter) for the start of interval for the temporary filter.
End offset	Offset (in seconds, relative to the event specified in *Create filter around* parameter) for the end of interval for the temporary filter.
Fix overlaps	An option to automatically merge the overlapping intervals in the temporary filter.
Smooth Matrix	An option to smooth the matrix after the calculation. See Post-Processing Options for details.
Smooth Radius	The radius of the smoothing filter (in cells) See Post-Processing Options for details.
Smooth Colors	An option to smooth colors (blend colors across cells to make smooth color transitions). This option may require considerable computation time.
Bins with Num Visits Less than Min	An option on how to display cells where the number of visits is less than the specified minimum (*Min Visits* parameter).
Bins with Time Spent Less than Min	An option on how to display cells where the time spent is less than the specified minimum (*Min. Time Spent* parameter).
Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.
Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.
Sheet Name	The name of the worksheet in Excel where to copy the numerical results.
TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
Spikes	The number of spikes used in calculation.
Filter Length	The length of all the intervals of the interval filter (if a filter was used) or the length or the recording session (in seconds).

Position ISI mode	Average interval between two consecutive position data points (in seconds).
Mean Firing Rate	Mean firing rate (mean of all the firing rates for all the cells).
St. Dev. Firing Rate	Standard deviation of the firing rate (st. dev. of all the firing rates for all the cells).
Firing Fields	The number of firing fields.
Field N Num Cells	The number of cells in the firing field N.
Field N Centroid X	X coordinate of the field N centroid.
Field N Centroid Y	Y coordinate of the field N centroid.
Field N Peak Rate	Maximum firing rate among the cells inside the firing field N.
Field N Spikes	Number of spikes in field N.
Field N Time Spent	Total time spend in the field N.
Field N Rate	Average firing rate in field N (*Field N Spikes* divided by *Field N Time Spent*).
Field N Coherence	Coherence measures the local smoothness of the firing rate distribution in the field. It is the Pearson correlation of the firing rate in each cell (pixel) with the firing rate averaged over the pixel and its 8 nearest neighbors.

Algorithm

If **Fix Positions** is set to **Use 4 Neighbors**, NeuroExplorer will analyze X and Y position variables and do the following:

for each point **x[t]**, calculate the average of its 4 neighbors:

aver = (x[t-2]+x[t-1]+x[t+1]+x[t+2])/4

if **abs(x[t] - aver) > FixThreshold**, then assign x[t] the average of its neighbors:

x[t] = aver

If **Fix Positions** is set to **Ignore Bad**, NeuroExplorer will ignore position points that have coordinates that are within 0.001 of the specified 'bad' X and X values.

If **Fix Positions** is set to **Interpolate**, NeuroExplorer, for position points that have coordinates that are within 0.001 of the specified 'bad' X and X values, the X and Y values are interpolated using the closest previous valid position and the closest next valid position.

The following steps are then performed:

The position space is divided into cells with width (**XMax** - **XMin**)/ **Number of Bins (X)** and height (**YMax** - **YMin**)/ **Number of Bins (Y).**

For each cell, the number of visits to this cell and the time spent in the cell are calculated.

For each of the neuron firing times, the position of the animal is calculated using linear interpolation of animal positions before and after the spike.

For each cell, the number of times the neuron fired in this cell is calculated.

With **Firing Rates** display, if the animal spent less time in the cell than **Min Time Spent** or visited the cell less than **Min Visits** number of times, the firing rate for the cell is set to zero. Otherwise the number of times the neuron fired in this cell is divided by the time the animal spent in the cell producing the firing rate for the cell.

Firing Field a set of at least *Min. Pixels in Field* contiguous cells where each cell in the field shared at least one side with another cell in the field and each cell had a firing rate greater than (Session_mean + *Min Std. Dev. in Field* * Session_st_dev), where Session_mean is the firing rate of the complete recording session, Session_st_dev is the standard deviation of the mean firing rate. Session_mean and Session_st_dev are calculated the following way: the recording session is divided into time bins of size **Firing Rate Bin**. For each bin i, neuron firing rate R[i] is calculated. Session_mean is the mean of array R[i], Session_st_dev is the standard deviation of array R[i].

Centroid of field location is the arithmetic mean center of a firing field's spatial firing rate distribution determined after the coordinates of each cell in the field was multiplied by the firing rate in the cell.

Coherence measures the local smoothness of the firing rate distribution in the field. It is the Pearson correlation of the firing rate in each cell with the firing rate averaged over the cell and its 8 nearest neighbors.

Reference

A. Fentona, Gyorgy Csizmadiab, and Robert U. Muller. Conjoint Control of Hippocampal Place Cell Firing by Two Visual Stimuli I. The Effects of Moving the Stimuli on Firing Field Positions. *The Journal of General Physiology*, Volume 116, Number 2, August 1, 2000 191-210.

2.30. Reverse Correlation

This analysis is used for estimation of receptive fields in vision research. The analysis calculates the average visual stimulus that preceded the spike.

Parameters

Parameter	Description
Reference	the variable that contains timestamps of the stimuli.
Stim. Sequence File	The path of the text file that contains the sequence of images used for stimulation. See Algorithm below for file format description.
Char. per pixel	The number of characters per pixel in image file.
Pixels in Row	The number of pixels in a row for each stimulus image.
Rows in Image	The number of rows of pixels in each stimulus image.
Cache Stim. Data	An option to cache stimulus image data. If this option is selected, the image data is loaded once and stored in memory (until a different stimulus sequence file is specified). To clear cache, run this analysis once with this option disabled.
XMin (deg)	Minimum of the X axis of the average stimulus display (in degrees).
XMax (deg)	Maximum of the X axis of the average stimulus display (in degrees).
YMin (deg)	Minimum of the Y axis of the average stimulus display (in degrees).
YMax (deg)	Maximum of the Y axis of the average stimulus display (in degrees).
Time Min (sec)	Time minimum in seconds.
Time Max (sec)	Time maximum. For example, if Time Min = -0.4 and Time Max = 0, NeuroExplorer will analyze all the stimuli that were presented up to 400 msec before each spike.
Time Bin (sec)	Time bin.
Display	This option specifies what view of the average stimulus will be displayed. See *Algorithm* below.
Show Slice At	This option specifies the slice that will be shown. The units and valid range depend on the Display option See *Algorithm* below.
Z Min	Color scale minimum.
Z Max	Color scale maximum.
Smooth Colors	An option to smooth colors of the average stimulus matrix.
Matrix Scale	An option on what color scale to use when drawing the matrix.
Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.
Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.

Sheet Name	The name of the worksheet in Excel where to copy the numerical results.
TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.
Save 3D Matrix	An option to save 3D matrix of numerical results in a .csv file. 3D matrix (in X vs. Y display case) is saved starting from the first slice (at Time Min), then the second slice, etc. Within the slice, the first row corresponds to Y Min, the first column corresponds to X Min.
Save File	The name of the file that will contain 3D matrix data.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
YMin	Y axis minimum.
YMax	Y axis maximum.
RefCount	Number of reference events (and images used).
Color Scale Min	Minimum of color scale.
Color Scale Max	Maximum of color scale.
Spikes	The number of spikes used in calculation.

Algorithm

Stimulus File Format. NeuroExplorer assumes that the sequence of images used for stimulation is saved in a text file. The file has the following format:

- each line of the file represents a row of pixels in the stimulus image
- each pixel is represented by an integer
- each pixel has the same number of characters used for its description
- images are saved in the file in the order they were presented
- images can be (optionally) separated by blank lines

Here is an example of an image file with 2 images (16 pixels per row, 12 rows per image):

```
0   1   1   1   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0

0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   1   1   1   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
```

```
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```

The computational algorithm works the following way. For each spike of a selected neuron, NeuroExplorer identifies the images that precede the spike and are within the specified time interval (between Tmin and Tmax; for example, if Tmin = -0.4 and Tmax = 0, NeuroExplorer will analyze all the stimuli that were presented up to 400 msec before each spike).

Then, NeuroExplorer calculates the average of the presented stimuli over all the spikes. The result is a 3-dimensional matrix (with X, Y, and Time dimensions, time axis is divided into bins of the specified size).

Display option identifies what 2-dimensional view of this matrix is presented:

X vs. Y display shows an average stimulus image for the specified time slice

X vs. Time display shows average X pixels of the stimuli for the specified Y value

Y vs. Time display shows average Y pixels of the stimuli for the specified X value

Reference

Izumi Ohzawa, Gregory C. DeAngelis, and Ralph D. Freeman (1996). Encoding of binocular disparity by simple cells in the cat's visual cortex. J. Neurophysiol. 75: 1779-1805.

2.31. Epoch Counts

This analysis is very similar to Perievent Histograms. The only distinction is that, instead of calculating bin counts for consecutive bins of the same size, Epoch Counts analysis can calculate bin counts for bins (epochs) of any size. Epochs can be of different lengths and can overlap.

Parameters

Parameter	Description
Reference Type	Specifies if the analysis will use a single or multiple reference events.
Reference	Specifies a reference neuron or event (or a group of reference neurons or events).
Epochs	A table of epochs in seconds.
No Selfcount	An option not to count reference events if the target event is the same as the reference event (prevents a histogram to have a huge peak at zero when calculating PSTH versus itself).
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Int. filter type	Specifies if the analysis will use a single or multiple interval filters.
Interval filter	Specifies the interval filter(s) that will be used to preselect data before analysis. See also Data Selection Options.
Add to Results / Bin left	An option to add an additional vector (containing a left edge of each epoch) to the matrix of numerical results.
Add to Results / Bin right	An option to add an additional vector (containing a right edge of each epoch) to the matrix of numerical results.
Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.
Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.
Sheet Name	The name of the worksheet in Excel where to copy the numerical results.
TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description

Variable	Variable name.
Reference	The name of the reference event.
NumRefEvents	The number of reference events.
YMin	Minimum epoch count for this variable.
YMax	Maximum epoch count for this variable.
Filter Length	The length of the interval filter.

Algorithm

Let ref[i] be the array of timestamps of the reference event, ts[i] be the spike train (each ts is the timestamp) and epochs are specified as EpochStart[j], EpochEnd[j].

For each timestamp ref[k]:

1) calculate the distances from this event (or spike) to all the spikes in the spike train:

```
d[i] = ts[i] - ref[k]
```

2) for each i:

if d[i] is inside the first epoch, increment the counter for the first epoch:

```
if d[i] >= EpochStart[1] and d[i] < EpochEnd[1]
then epochcount[1] = epochcount[1] +1
```

if d[i] is inside the second epoch, increment the counter for the second epoch:

```
if d[i] >= EpochStart[2] and d[i] < EpochEnd[2]
then epochcount[2] = epochcount[2] +1
```

and so on... .

2.32. Coherence Analysis

Coherence is a measure of the degree of relationship, as a function of frequency, between two time series.

Parameters

Parameter	Description
Reference	Specifies a reference variable.
Max. Freq.	Frequency maximum (Hz).
Number of Fr. Values	Number of frequency values.
Window Overlap	Percent of window overlaps when calculating FFTs.
Show Freq. From	An option to show a subset of frequencies. Specifies minimum frequency to be displayed.
Show Freq. To	An option to show a subset of frequencies. Specifies maximum frequency to be displayed.
Calculate	Specifies whether coherence values or coherence phases are calculated.
Confidence Level (%)	Confidence level (percent) for the coherence values. See Confidence Level Calculation below for details.
Draw confidence level	An option to draw the confidence level. Confidence level is not drawn if coherence phases are specified in Calculate parameter.
Conf. line style	Line style for drawing confidence level.
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Interval filter	Specifies the interval filter that will be used to preselect data before analysis. See also Data Selection Options.
Add to Results / Bin left	An option to add an additional vector (containing a left edge of each frequency bin) to the matrix of numerical results.
Add to Results / Bin middle	An option to add an additional vector (containing a center of each frequency bin) to the matrix of numerical results.
Add to Results / Bin right	An option to add an additional vector (containing a right edge of each frequency bin) to the matrix of numerical results.
Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.
Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.
Sheet Name	The name of the worksheet in Excel where to copy the numerical results.

TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
Y Min	Y axis minimum.
Y Max	Y axis maximum.
Spikes	The number of spikes used (for neurons or events).
Rate Hist Bin	Bin size of the rate histograms used for the calculations (for neurons or events).
Filter Length	The length of the interval filter.
Mean Freq.	Mean firing rate (for neurons or events).
Confidence Level	Confidence level for the coherence values.

Algorithm

NeuroExplorer uses rate histograms to estimate the power spectra of the spike trains. The parameters of rate histograms are calculated using the following formulas:

Bin = 1./(2.* **Maximum_Frequency**)

Number_of_Bins = 2* **Number_of_Frequency_Values**

For two variables X (reference) and Y (target) the following entities are calculated. The time intervals of length Bin*NumberOfBins with specified overlaps are defined. For each interval, rate histograms are calculated and detrended, Hanning window is applied and FFTs are calculated. Then, individual and cross-densities are calculated:

Pxx = FFT(X)*Conj(FFT(X)),

Pyy = FFT(Y)*Conj(FFT(Y))

Pxy = FFT(X)*Conj(FFT(Y)).

Here Conj(z) is a complex conjugate of z. Pxx, Pyy and Pxy values are averaged across all intervals and coherence values are calculated as

Mean(Pxy)*Mean(Pxy) / (Mean(Pxx)*Mean(Pyy)).

Coherence phase values are calculated as phase of Mean(Pxy).

For continuous variables, if both the reference and the target variables have the same digitizing frequency, the FFTs of variable values (after detrending and applying Hanning tapering) are calculated and then resampled to the specified frequency steps. If the reference is a timestamped variable or two continuous variables have different digitizing rates, the values of continuous variables are averaged within the specified bins and then FFTs of these averages are calculated.

Calculation of the Confidence Level

Confidence levels are calculated as described in Kattla and Lowery (2010). The confidence level Z is calculated as

Z = 1 - pow(alpha, 1/(w*L - 1))

where

pow(x,y) returns x to the power of y,

alpha = 1 - Confidence_Level*0.01,

L is the number of overlapped windows

w is the correction due to the Hanning window tapering (see eq. (5) and (6) in Kattla and Lowery (2010)).

Reference

Kattla S, Lowery MM. Fatigue related changes in electromyographic coherence between synergistic hand muscles. Exp Brain Res. 2010 Apr;202(1):89-99. Epub 2009 Dec 12. .

2.33. Spectrogram Analysis

This analysis captures the frequency content of continuous variables or neuronal rate histograms.

Parameters

Parameter	Description
Max. Freq.	Maximum frequency for the spectrograms. If at least one continuous variable is selected, the value of the Maximum Frequency parameter is set as 0.5*Digitizing frequency of the first selected continuous variable. All continuous variables selected for this analysis should have the same digitizing rate.
Number of Fr. Values	Number of frequency values.
Normalization	Spectrum units (Raw PSD (Power Spectral Density), Log of PSD).
Start	Start of the first window.
Shift	How much sliding window is shifted each time.
Number of Shifts	total number of sliding windows.
Show Freq. From	An option to show a subset of frequencies. Specifies minimum frequency to be displayed.
Show Freq. To	An option to show a subset of frequencies. Specifies maximum frequency to be displayed.
X Axis	Allows to specify what values are shown in the sliding window X axis. There are two options: Start of Window and Center of Window. Suppose your data has the strongest spectral value at 50 seconds. This means that the window that has 50 seconds as its center will show the highest spectrum values. If the window width is 20 seconds, it will be the window [40,60]. If you are using 'Start of window' option, you will see the peak at 40 instead of 50 seconds. However, with 'Center of window' option, the peak will be at 50 seconds.
Smooth	Option to smooth the spectrum after the calculation. See Post-Processing Options for details.
Smooth Filter Width	The width of the smooth filter. See Post-Processing Options for details.
Add to Results / Bin left	An option to add an additional vector (containing a left edge of each frequency bin) to the matrix of numerical results.
Add to Results / Bin middle	An option to add an additional vector (containing a center of each frequency bin) to the matrix of numerical results.
Add to Results / Bin right	An option to add an additional vector (containing a right edge of each frequency bin) to the matrix of numerical results.
Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.
Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.

Sheet Name	The name of the worksheet in Excel where to copy the numerical results.
TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
Y Min	Y axis minimum.
Y Max	Y axis maximum.
Color Scale Min	Color scale minimum.
Color Scale Max	Color scale maximum.
Max Frequency Used	Maximum frequency of the FFTs used.
Rate Histogram Bin	Rate histogram bin size in seconds (if used).
Window width	FFT window width (seconds).
Actual shift	Actual window shift used in analysis.

Algorithm

The power spectrum is calculated for the specified number (**Number of Shifts**) of windows. For each window:

Normalization

If **Normalization** is Raw PSD, the power spectrum is normalized so that the sum of all the spectrum values equals to the mean squared value of the Signal.

If **Normalization** is Log of PSD, the power spectrum is calculated using the formula:

```
power_spectrum[i] = 10.*log10(raw_spectrum[i])
```

2.34. Perievent Spectrograms

This analysis captures the frequency content of continuous variables or neuronal rate histograms in the time windows around reference events.

Parameters

Parameter	Description
Reference	Reference event.
Max. Freq.	Maximum frequency for the spectrograms. If at least one continuous variable is selected, the value of the Maximum Frequency parameter is set as 0.5*Digitizing frequency of the first selected continuous variable. All continuous variables selected for this analysis should have the same digitizing rate.
Number of Fr. Values	Number of frequency values.
Normalization	Spectrum units (Raw PSD (Power Spectral Density), Log of PSD).
Start	Start of the first window (relative to the reference event).
Shift	How much sliding window is shifted each time.
Number of Shifts	total number of sliding windows.
Show Freq. From	An option to show a subset of frequencies. Specifies minimum frequency to be displayed.
Show Freq. To	An option to show a subset of frequencies. Specifies maximum frequency to be displayed.
X Axis	Allows to specify what values are shown in the sliding window X axis. There are two options: Start of Window and Center of Window. Suppose your data has the strongest spectral value at 50 seconds. This means that the window that has 50 seconds as its center will show the highest spectrum values. If the window width is 20 seconds, it will be the window [40,60]. If you are using 'Start of window' option, you will see the peak at 40 instead of 50 seconds. However, with 'Center of window' option, the peak will be at 50 seconds.
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Interval filter	Specifies the interval filter that will be used to preselect data before analysis. See also Data Selection Options.
Smooth	Option to smooth the spectrum after the calculation. See Post-Processing Options for details.
Smooth Filter Width	The width of the smooth filter. See Post-Processing Options for details.
Add to Results / Bin left	An option to add an additional vector (containing a left edge of each frequency bin) to the matrix of numerical results.
Add to Results / Bin middle	An option to add an additional vector (containing a center of each frequency bin) to the matrix of numerical results.

Add to Results / Bin right	An option to add an additional vector (containing a right edge of each frequency bin) to the matrix of numerical results.
Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.
Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.
Sheet Name	The name of the worksheet in Excel where to copy the numerical results.
TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
Y Min	Y axis minimum.
Y Max	Y axis maximum.
Color Scale Min	Color scale minimum.
Color Scale Max	Color scale maximum.
Max Frequency Used	Maximum frequency of the FFTs used.
Rate Histogram Bin	Rate histogram bin size in seconds (if used).
Number of Ref. Events	Number of reference events.
Window width	FFT window width (seconds).
Actual shift	Actual window shift used in analysis.
Number of Bins In Shift	Number of rate histogram bins in shift (if rate histograms were used).

Algorithm

For each selected variable, this analysis calculates multiple spectrograms that start at the specified time after each occurrence of the Reference event. These spectrograms are then averaged over all the reference events. Spectrogram calculation algorithm is described in Spectrogram Analysis.

2.35. Joint ISI Distribution

For each spike, a point is calculated where the X coordinate of the point is the current interspike interval and Y coordinate of the point is the preceding interspike interval. The density of these points is shown in the graph.

Parameters

Parameter	Description
Min Interval	Time axis minimum in seconds.
Max Interval	Time axis maximum in seconds
Bin	Bin size in seconds.
Log Axis Scale	An option to use Log10 axis scales.
Matrix Scale	Matrix color scale.
Smooth Matrix	An option to smooth matrix after calculation.
Smooth Radius	Radius of the smooth filter (in bins).
Smooth Colors	An option to smooth colors using bicubic splines.
Log Color Scale	An option to use Log10 color scale.
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Interval filter	Specifies the interval filter that will be used to preselect data before analysis. See also Data Selection Options.
Add to Results / Bin left	An option to add an additional vector (containing a left edge of each bin) to the matrix of numerical results.
Add to Results / Bin middle	An option to add an additional vector (containing a middle point of each bin) to the matrix of numerical results.
Add to Results / Bin right	An option to add an additional vector (containing a right edge of each bin) to the matrix of numerical results.
Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.
Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.
Sheet Name	The name of the worksheet in Excel where to copy the numerical results.
TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
YMin	Y axis minimum.
YMax	Y axis maximum.
Color Scale Min	Color scale minimum.
Color Scale Max	Color scale maximum.

Algorithm

If Use Log Bins and Axes option is not selected:

Matrix of binCounts[x,y] is created. Each element of the matrix is initialized as zero.

For each spike that occurred at time t[i], the following values are calculated:

```
Interval_I = t[i] - t[i-1]
binX = (Interval_I – MinInterval)/Bin

Interval_I_Plus_1 = t[i+1] - t[i]
binY = (Interval_I_Plus_1 – MinInterval)/Bin
```

Then, the corresponding bin count is incremented:

```
binCounts[binX, binY] = binCounts[binX, binY] + 1
```

The graph shows binCounts matrix values using color scale.

If Use Log Bins and Axes option is selected:

The i-th bin (i=1,2,...) on each axis is **[IntMin * 10 ^ ((i -1)/D), IntMin * 10 ^ (i/D))**, where **D** is **Number of Bins Per Decade.** binX and binY are calculated accordingly:

```
binX = ( log10(Interval_I) – log10(MinInterval) )* NumBinsPerDecade
```

Reference

For discussion on using logarithm of interspike intervals, see:

Alan D. Dorval, Probability distributions of the logarithm of inter-spike intervals yield accurate entropy estimates from small datasets. Journal of Neuroscience Methods 173 (2008) 129–139

2.36. Autocorrelograms Versus Time

This analysis shows the dynamics of the autocorrelograms over time. It calculates multiple autocorrelograms using a "sliding window" in time. Each autocorrelogram is shown as a vertical stripe with colors representing the bin counts. Horizontal axis represents the position of the sliding window in time.

Parameters

Parameter	Description
XMin AutoCorr	Autocorrelogram time axis minimum in seconds.
XMax AutoCorr	Autocorrelogram time axis maximum in seconds.
Bin AutoCorr	Autocorrelogram bin size in seconds.
Normalization	Histogram units (Counts/Bin, Probability or Spikes/Second). See *Algorithm* below.
Start	Start of the first sliding window in seconds.
Duration	Duration of the sliding window in seconds.
Shift	How much sliding window is shifted each time.
Number of shifts	The number of sliding windows to be used.
Matrix Scale	Specifies color scale for drawing matrix.
X Axis (Sliding window axis alignment)	Allows to specify what values are shown in the sliding window axis. There are two options: Start of Window and Center of Window. Suppose your data has the strongest correlation at 50 seconds. This means that the window that has 50 seconds as its center will show the highest autocorrelation values. If the window width is 20 seconds, it will be the window [40,60]. If you are using 'Start of window' option, you will see the peak at 40 instead of 50 seconds. However, with 'Center of window' option, the peak will be at 50 seconds.
Smooth	Option to smooth the histogram after the calculation. See Post-Processing Options for details.
Smooth Filter Width	The width of the smooth filter. See Post-Processing Options for details.
Select Data	If Select Data is *From Time Range*, only the data from the specified (by *Select Data From* and *Select Data To* parameters) time range will be used in analysis. See also Data Selection Options.
Select Data From	Start of the time range in seconds.
Select Data To	End of the time range in seconds.
Interval filter	Specifies the interval filter that will be used to preselect data before analysis. See also Data Selection Options.
Send to Matlab	An option to send the matrix of numerical results to Matlab. See also Matlab Options.
Matrix Name	Specifies the name of the results matrix in Matlab workspace.
Matlab command	Specifies a Matlab command that is executed after the numerical results are sent to Matlab.

Send to Excel	An option to send numerical results or summary of numerical results to Excel. See also Excel Options.
Sheet Name	The name of the worksheet in Excel where to copy the numerical results.
TopLeft	Specifies the Excel cell where the results are copied. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.

Summary of Numerical Results

The following information is available in the Summary of Numerical Results

Column	Description
Variable	Variable name.
YMin	Y axis minimum.
YMax	Y axis maximum.
Color Scale Min	Color scale minimum.
Color Scale Max	Color scale maximum.
Spikes	Number of spikes used.

Algorithm

NeuroExplorer calculates here multiple autocorrelograms (see Autocorrelograms for more information on how each autocorrelogram is calculated). Each autocorrelogram is calculated for a different interval (window) in time:

[window_start[i], window_end[i]], i = 1,..., **Number of Shifts**.

That is, for each autocorrelogram only the timestamps that are within the window are used.

The following rules are used to calculate the windows:

window_start[1] = **Start**

window_end[1] = **Start** + **Duration**

window_start[2] = **Start + Shift**

window_end[2] = **Start + Shift + Duration**

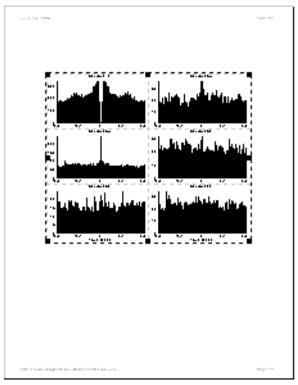
...

3. Working with Graphics

Graphical analysis results in NeuroExplorer can be adjusted by the user to include custom labels, lines and arrows. The topics in this section describe the graphics elements, list the attributes that you can use with them, and show how to customize NeuroExplorer graphics output.

3.1. NeuroExplorer Graphics

NeuroExplorer Graph Window shows the graphs as they will be printed on a page. If you press Zoom Out button several times, you'll see the whole page with the graphs, header and footer:

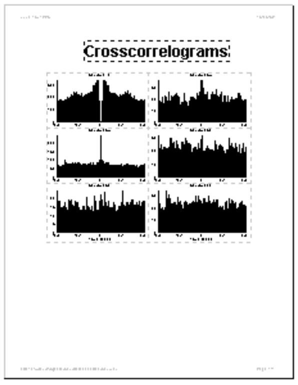


NeuroExplorer Graph Window shows one or more graphics objects. The page above has only one object - a block of graphs. You can add more objects by using **Insert** menu commands.

For example, to add a label to the NeuroExplorer Graph Window:

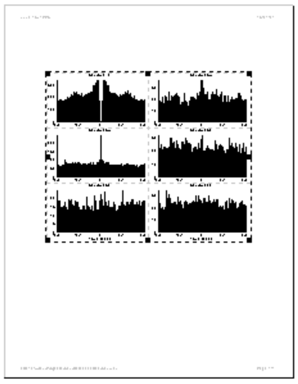
- select **Insert | Text** menu command
- click in the Graph window where you want the new label to be placed
- edit the label properties in the Text Dialog

Here is the page shown above with an additional Text object ("Crosscorrelograms" label):



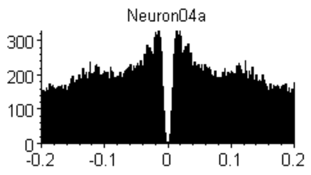
3.2. Graphics Modes

The standard display of the NeuroExplorer Graph Window shows the graphics in the Page Mode:



In this mode, you can add, delete and edit **page** graphics objects, i.e. the graphics elements that you want to have on the page.

Each **graph** in the page, however, has its own set of graphics objects. Thus, the default graph usually contains the text label that displays the variable name (Neuron04a in this picture):

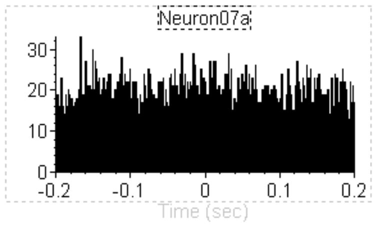


To edit the properties of the graphical objects (like the label "Neuron04a" above) that belong to the **graph**, you need to switch the Graph Window to the **Graph Mode**.

Use **Graphics | Edit Graphics | Graph Layout Mode** and **Graphics | Edit Graphics | Page Layout Mode** menu commands to switch the graphics mode in NeuroExplorer. You can also use the following toolbar buttons to switch the graphics modes:

The left button will switch the Graph Window to the Page Mode, the right button will switch it to the Graph Mode.

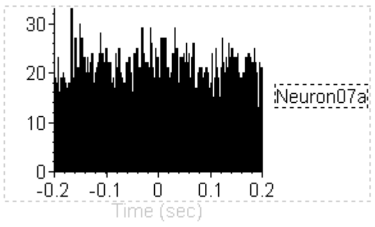
Here is the typical picture in Graph Mode:



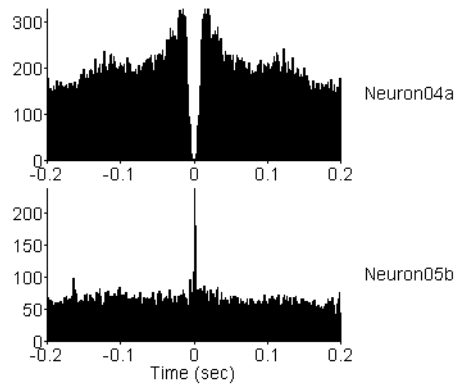
Only one graph is visible in this mode. While in the Graph Mode, you can select, drag, resize and edit the graphical objects that will appear in every graph.

For example, to move the variable name label to a different position relative to the graph:

- Switch to the Graph Mode as described above
- Click on the text label to select it
- Drag the label to a different position:



- Switch back to the Page Mode:



Note that the labels of **all** graphs are now in new positions.

3.3. Positioning the Graphics Objects

Every graphical object in NeuroExplorer has its parent. Thus, the Block of Graphs is a parent of all the page graphics objects. The Graph is a parent of all the objects inside the graph (X and Y axes, variable label, etc.).

A position of any graphics object is always specified relative to its parent. When you move or resize the owner, other objects will move together with their parent.

There are several types of coordinates units that you can use to position the objects.

For X coordinates, NeuroExplorer has the following options:

Graph Width. With these coordinate units, 0.0 corresponds to the left edge of the owner, 1.0 corresponds to the right edge of the parent.

Inches From Left. Here 0.0 corresponds to the left edge of the parent. If you want on object to be 0.3 inches to the left of the parent, specify X as -0.3.

Inches From Right. Here 0.0 corresponds to the right edge of the parent. If you want on object to be 0.3 inches to the right of the parent, specify X as 0.3.

Graph Data. With these coordinate units, X coordinate corresponds to the graph X axis.

For Y coordinates, NeuroExplorer has the following options:

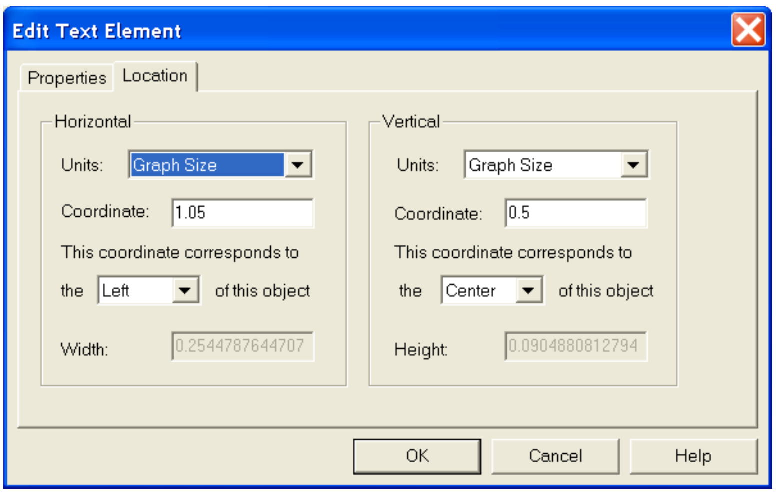
Graph Height. With these coordinate units, 0.0 corresponds to the bottom edge of the parent, 1.0 corresponds to the top edge of the parent.

Inches From Bottom. Here 0.0 corresponds to the bottom edge of the parent. If you want on object to be 0.3 inches below of the parent, specify Y as -0.3.

Inches From Top. Here 0.0 corresponds to the top edge of the parent. If you want on object to be 0.3 inches above the parent, specify Y as 0.3.

Graph Data. With these coordinate units, Y coordinate corresponds to the graph Y axis.

Use Location tab in the graphics object Edit dialog to specify the object's position:


Edit Text Element

Properties | Location

Horizontal

Units: Graph Size

Coordinate: 1.05

This coordinate corresponds to the Left of this object

Width: 0.2544787644707

Vertical

Units: Graph Size

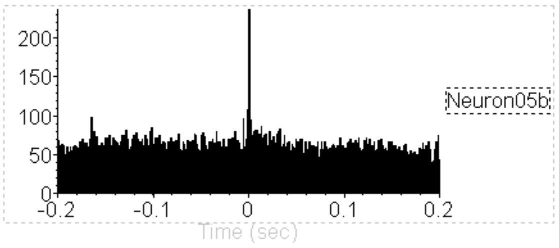
Coordinate: 0.5

This coordinate corresponds to the Center of this object

Height: 0.0904880812794

OK | Cancel | Help

Coordinates and alignment options shown in this dialog are for the text label in the following graph:



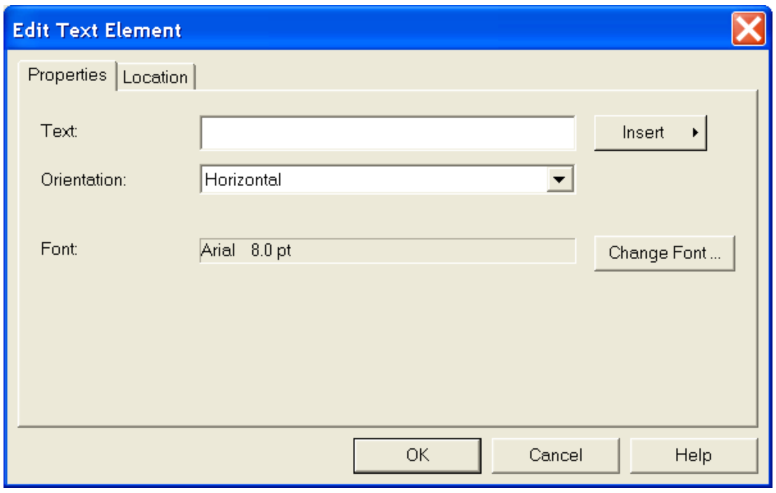
This text object is located to the right of the graph, so the X coordinate is 1.05 with the Graph Size units and horizontal alignment Left.

The object is centered vertically relative to the graph, so its Y coordinate is 0.5 with the Graph Size units and vertical alignment Center.

3.4. Text Labels

To add a label in the NeuroExplorer Graph Window:

- Select **Insert | Text** menu command
- Move the mouse pointer to the Graph Window. Note that the cursor changes to the picture of a hand
- Click in the Graph window where you want the new label to be placed
- Edit the label properties in the displayed Text Dialog


Edit Text Element

Properties | Location

Text:

Orientation: Horizontal

Font: Arial 8.0 pt

Insert | Change Font ...

OK | Cancel | Help

To specify the font, press **Change Font** button.

To specify the exact position of the text object, use the **Location** page of the dialog. See Positioning the Graphics Objects for details.

To specify the text of the label, type the text of the label in the **Text** field.

In many cases there is a need to specify a text that depends on the opened data file, the variable in the graph, etc. NeuroExplorer uses **Template Strings** to accomplish this task.

Template String is a string enclosed in brackets (for example, <*VarName*>). During the drawing process, NeuroExplorer tries to find the actual string for each of the template strings. If the actual string is found, the template string is replaced by the actual string. For example, if the variable used in the graph is Neuron04a, the <*VarName*> string in the text object is replaced by *Neuron04a*.

Insert button in the Text Edit Dialog opens a menu that allows you to insert various Template Strings into the text object. You can also manually type in the template strings into the text field of the dialog.

Here is the list of available template strings:

<VarName> - replaced by the name of the variable used in a graph. Works in the graph labels only.

<ColVarName> - replaced by the name of the variable used for a column of graphs. Works in the page labels only when the analysis has a reference variable and the reference type is Table.

<RowVarName> - replaced by the name of the variable used for a row of graphs. Works in the page labels only when the analysis has a reference variable and the reference type is Table.

<Bin> - replaced by the bin value in seconds.

<BinMS> - replaced by the bin value in milliseconds.

<RefName> - replaced by the name of the reference variable. Works only when the analysis has a reference variable.

<NumRef> - replaced by the number of reference events. Works only when the analysis has a reference variable.

<FileName> - replaced with the name of the data file.

<FilePath> - replaced with the full path of the data file.

<Date> - replaced with current date.

<Time> - replaced with current time.

<Smooth> - replaced with one of the three strings "None", "Boxcar" or "Gaussian", depending of the current smooth selection. Works with histogram-type analyses only.

<SmoothWidth> - replaced with the smooth filter width. Works with histogram-type analyses only.

<IntFilter> - replaced with the name of the Interval Filter.

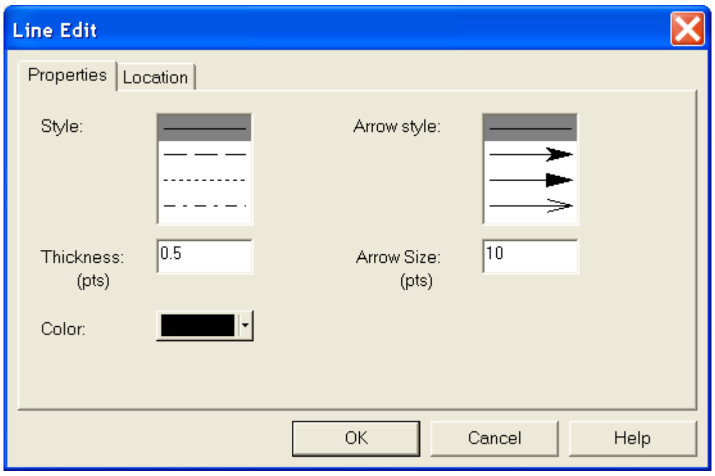
<FirstInt> - replaced with the first interval of the Interval Filter (if Interval Filter is specified), or the interval from 0 to the end of experiment (if the filter is not specified).

3.5. Lines

To add a line in the NeuroExplorer Graph Window:

- Select **Insert | Line** menu command
- Move the mouse pointer to the Graph Window. Note that the cursor changes to the picture of a hand
- Click in the Graph window where you want the new line to start and keep the left mouse button down
- Drag the mouse pointer to the place where you want the new line to end
- Release mouse button

To edit the properties of the line, double-click at the line. The following dialog will be displayed:



Thickness: (pts) 0.5

Arrow Size: (pts) 10

Color:

Line thickness and the size of the arrow are specified in points (1/72th of the inch).

To specify the exact position of the line, use the **Location** page of the dialog. See Positioning the Graphics Objects for details.

3.6. Rectangles

To add a rectangle in the NeuroExplorer Graph Window:

- Select **Insert | Rectangle** menu command
- Move mouse pointer to the Graph Window. Note that the cursor changes to the picture of a hand
- Click in the Graph window where you want to position the top-left corner of the new rectangle and keep the left mouse button down
- Drag the mouse pointer to the place where you want to position the bottom-right corner of the new rectangle
- Release mouse button

To edit the properties of the rectangle, double-click anywhere in the rectangle and specify rectangle parameters in Rectangle Properties dialog.

To specify the exact position of the rectangle, use the **Location** page of the dialog. See Positioning the Graphics Objects for details.

4. Working with 3D Graphics

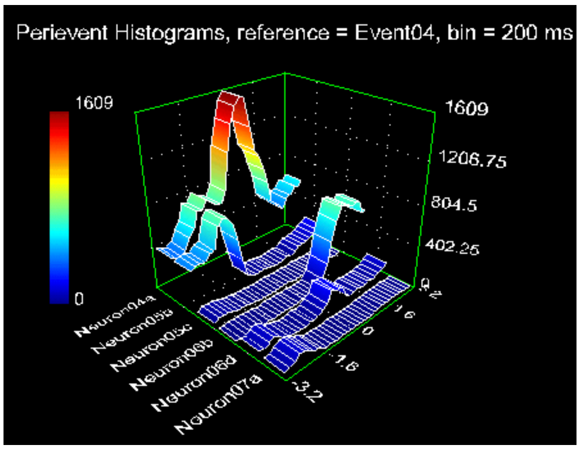
NeuroExplorer 3D Graphics Module adds high quality 3D graphics to NeuroExplorer. It was always possible before to export the analysis results from NeuroExplorer to Matlab and then create the 3D graphs in Matlab. However, it would require a considerable amount of time and effort to create the properly labeled 3D graph in Matlab. With the NeuroExplorer 3D Module installed, a single click of a button will display in NeuroExplorer a highly customizable and properly labeled 3D graph.

You can easily change dozens of graph parameters and options using the Properties Window or dialogs. You can even rotate the graph with the mouse in all 3 dimensions.

As with the NeuroExplorer Analysis Templates, any set or 3D graph parameters can be saved as a template. For example, you may save one set of color preferences for slide presentations and another set of colors for printed materials.

NeuroExplorer 3D Module also enables you to display a "movie" of the concurrent activity of a neuronal network. You can specify a position of each recorded neuron in a plane and then display the animation of the activity of the neurons over time.

Here is an example of a 3D graph in NeuroExplorer. Multiple perievent histograms are shown side-by-side in 3 dimensions:

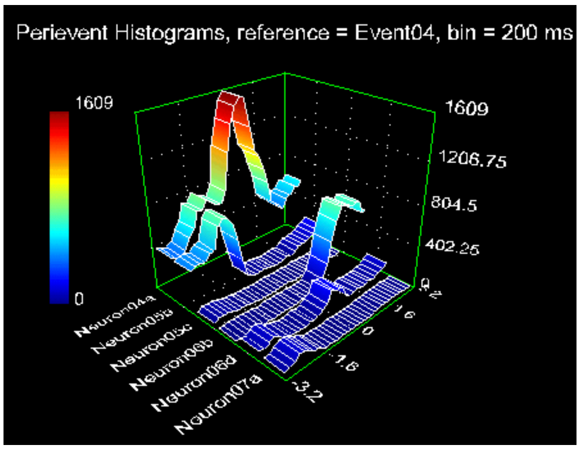


4.1. Viewing Multiple Histograms in 3D

To view a set of histograms in 3 dimensions:

- Calculate the histograms by applying any of the histogram analyses (Rate Histograms, Interspike Interval Histograms, Auto- and Cross-correlograms, Perievent Histograms, etc.)
- Select **3D | View Histograms in 3D** menu command.

NeuroExplorer will open the 3D Viewer window and all the histograms in the NeuroExplorer graphics view will be shown in a 3D graph:

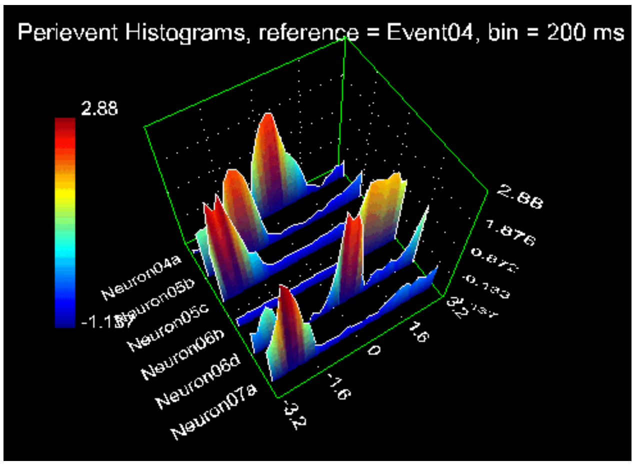


Note that all the histograms are shown in the same scale. However, neurons often have very different firing rates so that the histograms for the slow firing neurons may be displayed as having almost zero values.

If you would like to view the variations of the histograms around their respective means, you can use a separate menu command, **3D | View Histogram Variations in 3D**. This option will allow you to view the z-scores of histograms instead of the raw histogram values. z-score is calculated as:

z = (histogram_value - histogram_mean)/histogram_standard_deviation

Here is the same set of histograms as above shown using **3D | View Histogram Variations in 3D** menu command (the graph type is also changed from 'Stripes' to 'Walls'):



For more information on 3D Viewer options and parameters, see 3D Graphics Parameters.

4.2. 3D Graphics Parameters

3D Template - allows you to choose the 3D Template. When you start using 3D Module, only one 3D Template, **Default** is available. You can add templates by saving any set of 3D graphics parameters as a new template (to do this, use **3DView | Save As New 3D Template** menu command).

Graph Type - allows you to choose the graph type.

Draw Lines - an option to draw mesh or contour lines.

Z Color Scale - an option to use color scale in the graph.

Light - an option to use lighting effects in the graph.

Smooth - an option to smooth the graph using a 2D Gaussian filter.

Smooth Radius - smooth filter radius in mesh points.

Z Min, Z Max - overwritable minimum and maximum of the Z Axis.

Distance From Camera - this parameter determines the size of the graph in the window. The distance should be between 1 and 10.

Draw Labels - an option to draw axes labels.

Title - 3D graph title.

Title Font Size, Label Font Size - font sizes relative to the 3D graph "cube" size.

Light X, Y, Z - position of the light source.

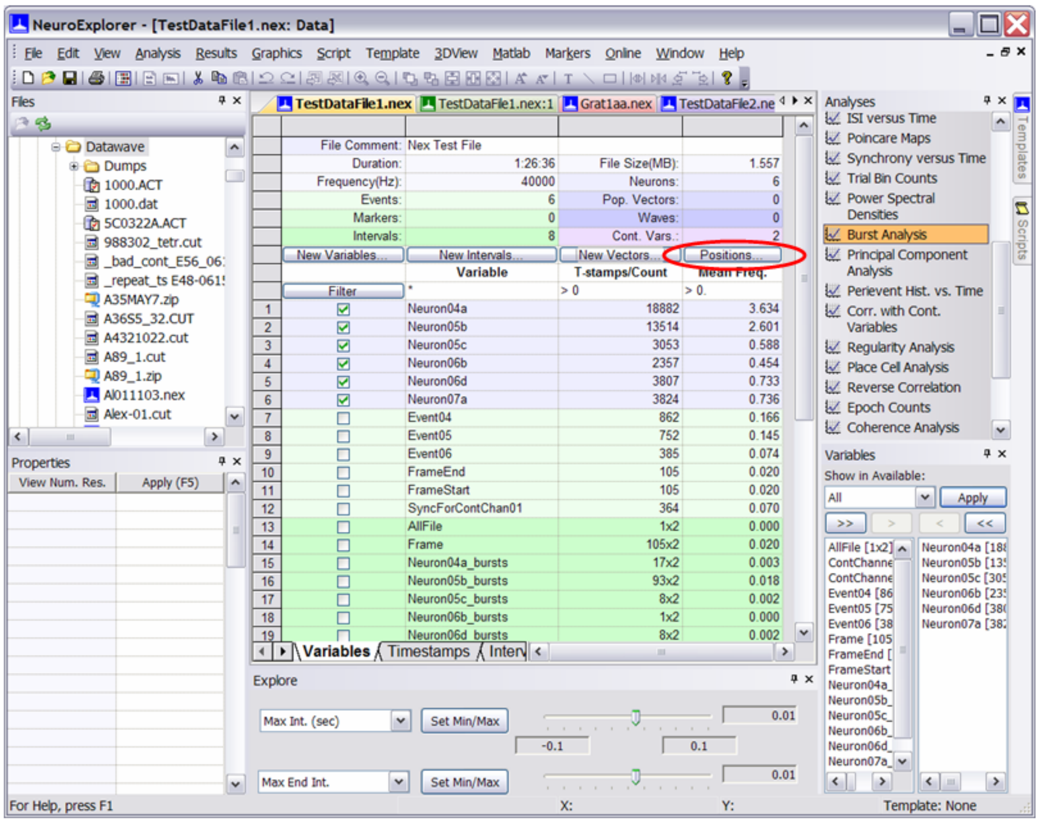
4.3. Viewing the Neuronal Activity "Movie"

To view a 'movie' of neuronal activity:

- Open the data file.

Next, you need to specify the positions of neurons. Neuron positions are saved in a NeuroExplorer data file, so you only need to do this once.

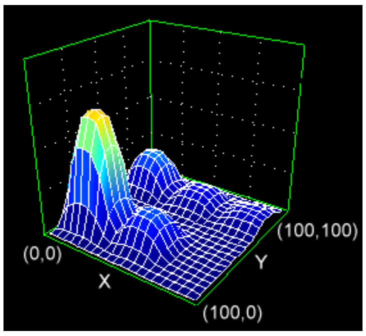
- Press **Positions** button in the Variables sheet of the Data View:



File Comment:	Nex Test File		
Duration:	1:26:36	File Size(MB):	1.557
Frequency(Hz):	40000	Neurons:	6
Events:	6	Pop. Vectors:	0
Markers:	0	Waves:	0
Intervals:	8	Cont. Vars.:	2

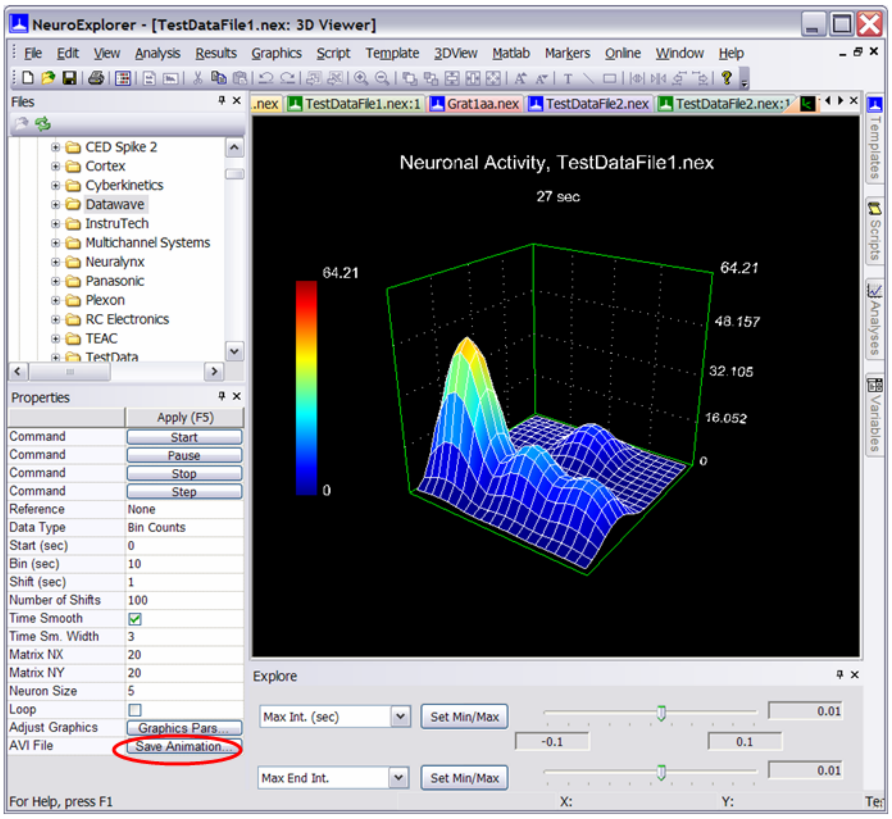
	Filter	Variable	T-stamps/Count	Mean Freq.
		*	> 0	> 0.
1	✓	Neuron04a	18882	3.634
2	✓	Neuron05b	13514	2.601
3	✓	Neuron05c	3053	0.588
4	✓	Neuron06b	2357	0.454
5	✓	Neuron06d	3807	0.733
6	✓	Neuron07a	3824	0.736
7	☐	Event04	862	0.166
8	☐	Event05	752	0.145
9	☐	Event06	385	0.074
10	☐	FrameEnd	105	0.020
11	☐	FrameStart	105	0.020
12	☐	SyncForContChan01	364	0.070
13	☐	AllFile	1x2	0.000
14	☐	Frame	105x2	0.020
15	☐	Neuron04a_bursts	17x2	0.003
16	☐	Neuron05b_bursts	93x2	0.018
17	☐	Neuron05c_bursts	8x2	0.002
18	☐	Neuron06b_bursts	1x2	0.000
19	☐	Neuron06d_bursts	8x2	0.002

- Specify the positions of neurons in the Positions Dialog Box. NeuroExplorer assumes that all the neurons are located on a plane with X and Y coordinates ranging from 0 to 100:



- Select **3D | Activity Animation** menu command.
- Use the buttons in the Properties Panel to start and stop the animation.

You can save animation to an AVI file. To do this, press "Save Animation" button in the control panel:



Properties

	Apply (F5)
Command	Start
Command	Pause
Command	Stop
Command	Step
Reference	None
Data Type	Bin Counts
Start (sec)	0
Bin (sec)	10
Shift (sec)	1
Number of Shifts	100
Time Smooth	✓
Time Sm. Width	3
Matrix NX	20
Matrix NY	20
Neuron Size	5
Loop	☐
Adjust Graphics	Graphics Pars...
AVI File	Save Animation...

Max Int. (sec) Set Min/Max 0.01 -0.1 0.1

Max End Int. Set Min/Max 0.01

You may want to change the 3D graph properties to get the smooth surface shown above. To change the graph properties, right-click in the 3D Viewer window and select **Graphics Parameters** menu command. Select Surface plot type and enable Gaussian Smoothing.

For more information on 3D Viewer options and parameters, see 3D Graphics Parameters.

For more information on Activity Animation options and parameters, see Activity Animation Parameters.

4.4. Activity Animation Parameters

Animation Template - allows you to choose the Animation Template. When you start using 3D Module, only one Animation Template, **Default** is available. You can add templates by saving any set of Animation parameters as a new template (to do this, use **3DView | Save As New Animation Template** menu command).

Reference - if this parameter is **None**, NeuroExplorer shows the rate histograms-based animation (that is, neuronal activity in real time). If this parameter is not None, NeuroExplorer calculates the perievent histograms for the specified reference and shows neural network activity around the specified event.

NeuroExplorer uses a sliding window to calculate the firing rates of the neurons. The window has the width equal to the **Bin**. The first window begins at **Start** time. The second window begins at **Start+Shift** and ends at **Start+Shift+Bin**, etc. For each of the windows, the number of spikes that each neuron has inside this window is calculated. Then for each neuron the point (X_position, Y_position, Spike_Count) is shown in a 3D graph.

Start - beginning of the first sliding window.

Bin - width of the sliding window.

Shift - sliding window shift.

Number of shifts - number of windows (frames).

Time Smooth - allows you to enable or disable time smoothing of the spike counts.

Time Smooth Width - sigma of the Gaussian filter used for smoothing over time. See Post-Processing Options for more information about smoothing the histograms.

Matrix NX - the number of points in the mesh in X direction.

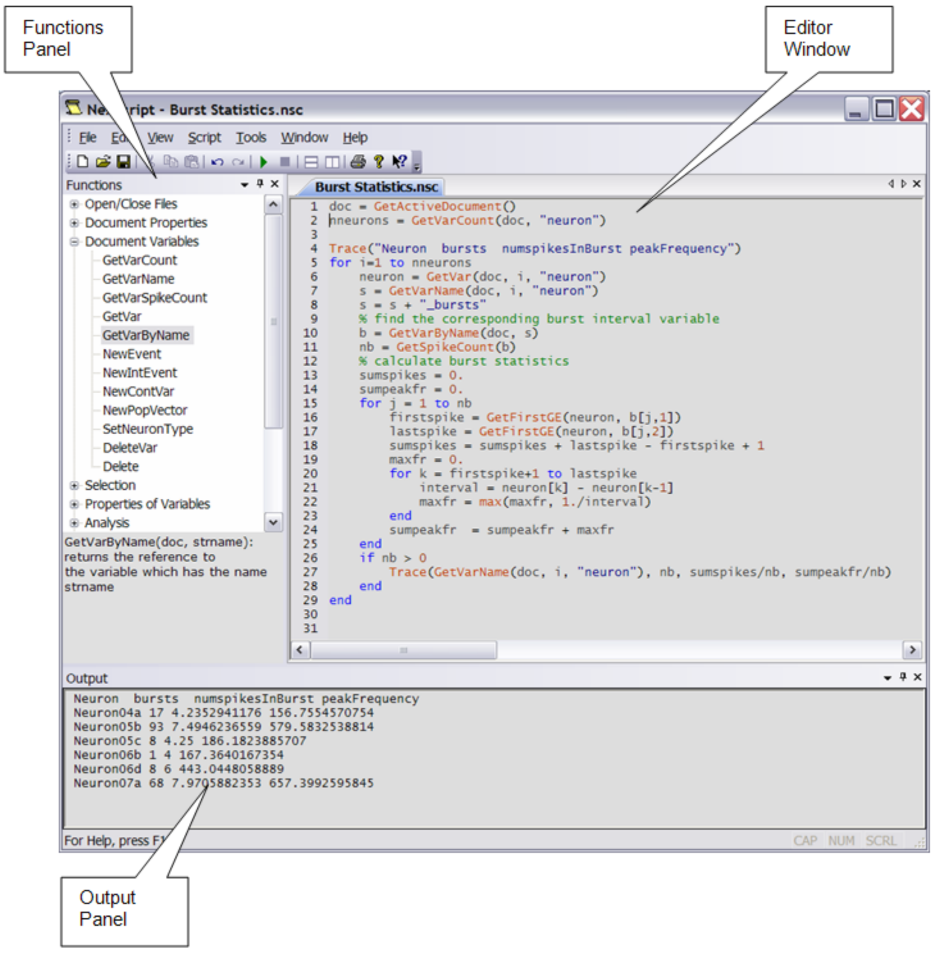
Matrix NY - the number of points in the mesh in Y direction.

Neuron Size - the size of the square (in mesh points) that represents a single neuron.

Loop - an option to show the animation in a "loop" mode (after all the frames are shown, animation goes back to the first frame and starts again).

5. Programming with NexScript

NeuroExplorer has a powerful scripting language (NexScript) resembling the Matlab language. To create a script, select the **Script | New Script** menu command. To open existing script, double-click at the script name in the Scripts View. NeuroExplorer will open NexScript editor:



```
GetVarByName(doc, strname):
returns the reference to
the variable which has the name
strname
```

```
doc = GetActiveDocument()
nneurons = GetVarCount(doc, "neuron")

Trace("Neuron  bursts  numspikesInBurst peakFrequency")
for i=1 to nneurons
    neuron = GetVar(doc, i, "neuron")
    s = GetVarName(doc, i, "neuron")
    s = s + "_bursts"
    % find the corresponding burst interval variable
    b = GetVarByName(doc, s)
    nb = GetSpikeCount(b)
    % calculate burst statistics
    sumspikes = 0.
    sumpeakfr = 0.
    for j = 1 to nb
        firstspike = GetFirstGE(neuron, b[j,1])
        lastspike = GetFirstGE(neuron, b[j,2])
        sumspikes = sumspikes + lastspike - firstspike + 1
        maxfr = 0.
        for k = firstspike+1 to lastspike
            interval = neuron[k] - neuron[k-1]
            maxfr = max(maxfr, 1./interval)
        end
        sumpeakfr  = sumpeakfr + maxfr
    end
    if nb > 0
        Trace(GetVarName(doc, i, "neuron"), nb, sumspikes/nb, sumpeakfr/nb)
    end
end


```

```
Neuron  bursts  numspikesInBurst peakFrequency
Neuron04a 17 4.2352941176 156.7554570754
Neuron05b 93 7.4946236559 579.5832538814
Neuron05c 8 4.25 186.1823885707
Neuron06b 1 4 167.3640167354
Neuron06d 8 6 443.0448058889
Neuron07a 68 7.9705882353 657.3992595845
```

NexScript editor has two docked panels: Functions Panel and Output Panel. In the Functions Panel, you cal click at the function name to display function description. You can also double-click at the function name to insert the function into the script. The Output Panel displays compiler messages and debug output (generated using Trace function).

Scripts

Each script is a text file that has an extension .nsc. Scripts are usually saved in Windows Application Data directory:

C:\Documents and Settings\All Users\Application Data\Nex Technologies\NeuroExplorer\Scripts (when running under Windows XP), or

C:\Program Data\Nex Technologies\NeuroExplorer\Scripts (when running under Vista or Windows 7).

Note that you can create subfolders in the scripts folder. The scripts tree shown in the Scripts View is a copy of the scripts directory specified above. You can create subfolders in your scripts directory and then NeuroExplorer will allow you to navigate through the scripts directory tree within the Scripts View.

Lines and Comments

Each line of the script may contain only one statement, for example:

```
x = 0
```

If the statement is very long, you can use the line continuation symbol (backslash \) to indicate that the next line contains the continuation of the current line. For example, instead of:

```
Dialog(doc, "D:\Plexon\data\mydata\*.plx", "Filter", "string")
```

you can write:

```
Dialog(doc, "D:\Plexon\data\mydata\*.plx",\
"Filter"", "string")
```

The percent symbol (%) marks the beginning of a comment, for example:

```
% this is a comment line
x = 0 % this is also a comment
```

Variables and Expressions

NexScript supports numeric variables and standard expressions:

```
xmean = (xmax - xmin)/2.
```

strings:

```
name = "SPK" + "01"
```

You can also query and modify file variables (spike trains, intervals, continuous variables, etc.).

See Variables and Expressions to learn more about the basics of NexScript.

Flow Control

for loops, **while** loops and **if … else** constructs can be used for flow control:

```
imax = 0
doc = GetActiveDocument()
for i = 2 to n
   interval = doc.SPK01a[i] - doc.SPK01a[i-1]
   if interval > imax
       imax = interval
   end
end
```

See Flow Control for more information.

Functions

NexScript offers more than 140 functions that allow you to edit data, open and close files, perform analyses, save the results and send results to Matlab of Excel. See Functions for more information.

5.1. Script Variables

Variable Names

The variable name in NexScript should begin with a letter and contain only letters, digits and the underscore sign.

The following names are valid:

```
Neuron01      Bar_press    Nr_1a       SPK02b
```

These variable names cannot be used in NexScript:

```
 2Neuron   Bar-press
```

The variables from the opened data file can be accessed using the prefix specifying the document. For example, the spike train SPK01a from the active document can be addressed as:

```
doc.SPK01a
```

where doc is a reference to the document. You can get this reference by calling *GetActiveDocument* or calling *OpenDocument*.

An alternative way to access file variable is by getting a reference to the variable:

```
SPK01a = GetVarByName(doc, "SPK01a")
```

See Also File Variables

Variable Types

NexScript supports numeric variables:

```
xmean = (xmax - xmin)/2.
```

and strings:

```
name = "SPK" + "01"
```

A variable can also be a reference to the existing variable in the file:

```
neuron1 = GetVar(doc, 1, "neuron")
```

or a reference to the opened document:

```
doc = GetActiveDocument()
```

A variable type can be changed if the right-hand side of the assignment has a different type. For example:

```
x = 0.005 % x now is a numeric variable
x = "SPK" % after this statement, x is a string
```

Global Variables

A variable can be declared global so that it can be accessed from several scripts:

```
Global name
```

Global statements should be placed at the beginning of the script.

See Also File Variables

5.2. File Variables

The variables from the opened data file can be accessed using the prefix specifying the document. For example, the spike train SPK01a from the active document can be addressed as:

```
doc.SPK01a
```

where doc is a reference to the document. You can get this reference by calling *GetActiveDocument* or calling *OpenDocument*.

An alternative way to access a file variable is by getting a reference to the variable:

```
spikeTrain = GetVarByName(doc, "SPK01a")
```

Yet another way to access a file variable is by getting a reference to the variable via doc["VarName"] notation:

```
spikeTrainA = doc["SPK01a"]
name = "SPK01b"
spikeTrainB = doc[name]
```

Access to the Data in File Variables

Timestamped Variables

You can access the timestamp value by specifying the timestamp index (1-based, i.e. the first timestamp has index 1) in square brackets:

```
doc = GetActiveDocument()
% first option: use doc.VarName notation
timestamp = doc.SPK01a[3]
% second option: get variable by name and then use the variable directly
spikeTrain = GetVarByName(doc, "SPK01a")
timestamp = spikeTrain[3]
% third option: get variable using doc["VarName"] notation and then use the
variable directly
spikeTrain1 = doc["SPK01a"]
timestamp = spikeTrain1[3]
```

You can assign a new value for any timestamp in the current file. For example, to assign the value 0.5 (sec) to the third timestamp of the variable SPK01a, you can use this script:

```
doc = GetActiveDocument()
doc.SPK01a[3] = 0.5
```

You can also add timestamps to a variable using NexScript functions. See Properties of Variables and Adding Data to Variables for details.

Interval Variables

IntVar[i,1] gives you read/write access to the start of the i-th interval, IntVar[i,2] gives you read/write access to the end of the i-th interval.

For example, to assign the value 27.5 seconds to the end of the first interval of interval variable Frame, you would use this script:

```
doc = GetActiveDocument()
doc.Frame[1,2] = 27.5
```

You can also add intervals to an interval variable using NexScript functions. See Properties of Variables and Adding Data to Variables for details.

Continuous Variables

ContVar[i,1] gives you read-only access to the timestamp of the i-th data point.

ContVar[i,2] gives you read-write access to the value of the i-th data point.

For example, the following script prints the timestamp and the value of the fifth data point in variable ContChannel01:

```
Trace("ts = ", doc.ContChannel01[5,1], "value =" ,doc.ContChannel01[5,2])
```

The following script line assigns the value of 100 to the fifth data point:

```
doc.ContChannel01[5,2] = 100.
```

You can add new data points to a continuous variable using NexScript functions. See Properties of Variables and Adding Data to Variables for details.

Marker Variables

MarkerVar[i,1] gives you read-only access to the timestamp of the i-th marker.

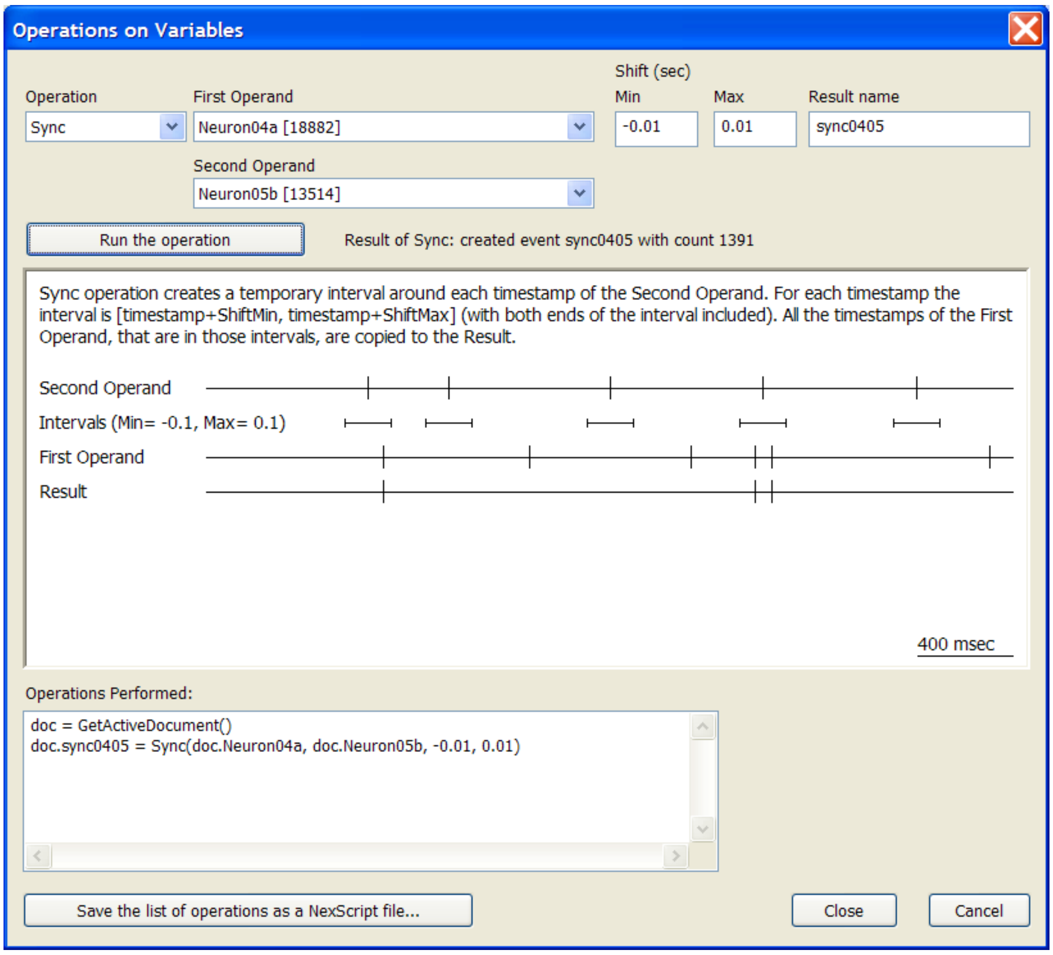
MarkerVar[i,2] gives you read-only access to the value of the first field of the i-th marker. Note that marker field values are stored as strings, so you will need to use StrToNum() function to convert these values to numbers.

For example, the following script prints the timestamp and the first field value of the fifth marker in variable Strobed:

```
Trace("ts = ", doc.Strobed[5,1], "marker value =" ,doc.Strobed[5,2])
```

Operations on Variables

Many operations on data variables are available via Edit | Operations on Data Variables menu command. This menu command opens Operations dialog:



Operation: Sync
First Operand: Neuron04a [18882]
Min: -0.01
Max: 0.01
Result name: sync0405
Second Operand: Neuron05b [13514]

Result of Sync: created event sync0405 with count 1391

Sync operation creates a temporary interval around each timestamp of the Second Operand. For each timestamp the interval is [timestamp+ShiftMin, timestamp+ShiftMax] (with both ends of the interval included). All the timestamps of the First Operand, that are in those intervals, are copied to the Result.

```
doc = GetActiveDocument()
doc.sync0405 = Sync(doc.Neuron04a, doc.Neuron05b, -0.01, 0.01)
```

The operation is specified in the top left corner of the dialog. When you select an operation, an operation description is shown in the central panel of the dialog. When you press Run the Operation button, the specified operation is performed and a script line is added to the 'Operations Performed' window at the bottom of the dialog. You can save the list of operations in a NexScript file if you press the "Save.." button.

See Also Properties of Variables and Adding Data to Variables

See Also Document Variables and Adding New Variables

See Also Operations on Document Variables

5.3. Expressions

Standard algebraic expressions are supported:

```
xmean = (xmax - xmin)/2.
```

Addition operation can also be applied to the strings:

```
name = "SPK" + "01"
```

Logical expressions may be used in **if** and **while** statements:

```
x = 2

if x >= 2
   Trace("x is greater or equal to 2")
End

if x > 2
   Trace("x > 2")
End

if x <= 2
   Trace("x <= 2")
end

if x == 2
  Trace("x equals 2")
end

if x <> 1
  Trace("x is not equal to 1")
end
```

Logical expressions may be combined using logical **AND** (&) or logical **OR** (|) operators:

```
if (x >= 2) & (y <4)
   Trace("x <=2 and y <4")
end

if (x >= 2) | (y <4)
   Trace("x <=2 or y <4")
end
```

5.4. Flow Control

Loops

NexScript supports two types of loops: **for** loops and **while** loops.

for loop has the following syntax:

```
for variable = expression to expression
  statements ...
end
```

Example:

```
for i = 1 to 10
   SelectVar(doc, i, "neuron")
end
```

while loop has the following syntax:

```
while logical_expression
  statements ...
end
```

Example:

```
i = 1
while i < 10
   SelectVar(doc, i, "neuron")
   i = i + 1
end
```

break

break statement causes an immediate exit from the loop.

The following loop

```
for i = 1 to 10
  Trace(i)
  if i == 5
     break
  end
end
```

will produce output: 1 2 3 4 5

continue

continue statement returns to the loop's beginning skipping the statements that follow it.

The following loop

```
for i = 1 to 5
  if i == 3
     continue
  end
  Trace(i)
end
```

will produce output: 1 2 4 5

return

return statement causes an immediate exit from the script.

Conditional operators

Operator **if** has the following syntax:

```
if logical_expression statements ...  end
```

or

```
if logical_expression statements ... else statements ...
   end
```

Example

```
% select a variable if it has at lest one spike
% otherwise, deselect the variable

if GetVarCount(doc, i, "neuron") > 0
   SelectVar(doc, i, "neuron")
else
   DeselectVar(doc, i, "neuron")
end
```

5.5. Functions

The following function categories are available in NexScript

Category	Description
File Read and Write Functions	Functions to read data and text files, save data and results.
Document Properties	Functions to access general document properties such as file name and comment.
Document Variables and Adding New Variables	Functions to get the number of spike trains, etc. in the document; to get variable by name; to add new variables to the document.
Selecting Document Variables	Functions to select variables for analysis.
Properties of Variables and Adding Data to Variables	Functions to get the number of timestamps and data points and add timestamps and data points.
Analysis Functions	Functions to run analysis templates, modify templates, print results.
Numerical Results Functions	Functions to query and save numerical results.
Operations on Document Variables	Functions to modify existing variables (for example, frequency filter) and to run calculations based on the variables (for example, find synchronous spikes).
Matlab Functions	Functions to send data and results to Matlab and to read data from Matlab.
Excel Functions	Functions to send data and results to Excel.
Power Point Functions	Functions to send graphical results to Power Point.
Running Script Functions	Functions to run another script or to pause script.
Math Functions	Various math functions (random numbers, bitwise operations, square root, etc.).
String Functions	Functions related to stings (search in string, substrings, convert numbers to strings, etc.).
Debug Functions	Functions that are helpful in debugging (for example, print script variables).

See Also

Introduction to NexScript Programming

5.5.1. File Read and Write Functions

The following file read and write functions are available in NexScript

Function	Description
GetFileCount	Returns the number of files that match the specified file filter.
GetFileName	Returns the file name for the specified index after GetFileCount() was called.
OpenFile	Opens text file using the specified mode, returns file ID.
CloseFile	Closes the file.
ReadLine	Reads a line from the specified text file.
WriteLine	Writes a line of text to the specified file.
OpenDocument	Opens a data file with the specified path.
NewDocument	Opens a new document (data file) with the specified timestamp frequency.
CloseDocument	Closes the specified document.
SaveDocument	Saves the specified document.
SaveDocumentAs	Saves the specified document in a file with the specified file path.
SaveNumResults	Saves the numerical results to a text file with the specified name.
SaveNumSummary	Saves the summary of numerical results to a text file with the specified name.
SaveAsTextFile	Saves the document in the text file with the specified file name.
MergeFiles	Merges the specified files, returns the reference to the merged file.
ReadBinary	Reads binary value of a specified type.
FileSeek	Repositions file pointer by the specified offset.
SelectFile	Returns the path of the file selected in File Open dialog.

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.1.1. GetFileCount Function

GetFileCount Function

Returns the number of files that match the file filter.

Syntax

double GetFileCount(string fileFilter)

Parameters

Parameter	Type	Description
fileFilter	string	File filter specification. Can contain wildcards (*). For example, to get all .nex files in folder C:\data\, use filter "C:\data\*.nex".

Returns

Returns the number of files that match file filter.

Comments

None

Usage

NexScript

```
% repeat analysis for all .nex files in the folder
filefilter = "C:\Data\*.nex"
n = GetFileCount(filefilter)
for i=1 to n
   name = GetFileName(i)
   doc = OpenDocument(name)
   if doc > 0
       % run the analysis, print results and close the file
       ApplyTemplate(doc, "Interspike Interval Histograms")
       PrintGraphics(doc)
       CloseDocument(doc)
   end
end
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.1.2. GetFileName Function

GetFileName Function

Returns the file name for the specified index after GetFileCount() was called.

Syntax

GetFileName(double index)

Parameters

Parameter	Type	Description
index	double	Index of the file in the file list created by the last call to GetFileCount.

Returns

Returns the file name (the full path of the file) for the specified index after GetFileCount() was called.

Comments

None

Usage

NexScript

```
% repeat analysis for all .nex files in the folder
filefilter = "C:\Data\*.nex"
n = GetFileCount(filefilter)
for i=1 to n
   name = GetFileName(i)
   doc = OpenDocument(name)
   if doc > 0
       % run the analysis, print results and close the file
       ApplyTemplate(doc, "Interspike Interval Histograms")
       PrintGraphics(doc)
       CloseDocument(doc)
   end
end
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.1.3. OpenFile Function

OpenFile Function

Opens text file using the specified mode, returns file ID.

Syntax

double OpenFile(string filePath, string mode)

Parameters

Parameter	Type	Description
filePath	string	Full path of the file.
mode	string	File open mode. Can be either "r", "rt" (read), "w" or "wt" (write) or "a" or "at" (append).

Returns

Returns file ID.

Comments

None

Usage

NexScript

```
% open a file in read mode
file = OpenFile("C:\Data\parameters.txt", "r")
% read all the lines in the file and print them
if file > 0
   line = "" % make line a string variable
   while ReadLine(file, line) > 0
       Trace(line)
   end
   CloseFile(file)
end
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.1.4. CloseFile Function

CloseFile Function

Closes the specified file.

Syntax

CloseFile(fileID)

Parameters

Parameter	Type	Description
fileID	double	File ID received from OpenFile function.

Returns

None

Comments

None

Usage

NexScript

```
% open a file in read mode
file = OpenFile("C:\Data\parameters.txt", "r")
% read all the lines in the file and print them
if file > 0
   line = " " % make line a string variable
   while ReadLine(file, line) > 0
       Trace(line)
   end
   CloseFile(file)
end
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.1.5. ReadLine Function

ReadLine Function

Reads a line from the text file.

Syntax

double ReadLine(fileID, string lineString)

Parameters

Parameter	Type	Description
fileID	double	File ID received from OpenFile function.
lineString	string	String that receives the text from the file.

Returns

Returns 1 if more text to read is available in the file, otherwise, returns 0.

Comments

None

Usage

NexScript

```
% open a file in read mode
file = OpenFile("C:\Data\parameters.txt", "r")
% read all the lines in the file and print them
if file > 0
   line = " " % make line a string variable
   while ReadLine(file, line) > 0
       Trace(line)
   end
   CloseFile(file)
end
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.1.6. WriteLine Function

WriteLine Function

Writes a line of text to a text file.

Syntax

WriteLine(fileID, lineString)

Parameters

Parameter	Type	Description
fileID	double	File ID received from OpenFile function.
lineString	string	The string to be written to the file.

Returns

None

Comments

None

Usage

NexScript

```
% open a file in write mode
fileID = OpenFile("C:\results.txt", "w")
WriteLine(fileID, "first line")
CloseFile(fileID)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.1.7. OpenDocument Function

OpenDocument Function

Opens a data file with the specified path. Returns a reference to the opened document.

Syntax

documentReference OpenDocument(string filePath)

Parameters

Parameter	Type	Description
filePath	string	Full path of the file.

Returns

Returns a reference to the opened document. The function returns zero (invalid document reference) if OpenDocument operation failed.

Comments

None

Usage

NexScript

This function can be used to open all supported data file formats. For example:

```
doc = OpenDocument("C:\Data\file1.plx")
doc = OpenDocument("C:\Data\file1.map")
doc = OpenDocument("C:\Data\file1.mcd")
doc = OpenDocument("C:\Data\file1.txt")
```

Before opening a text file, specify text file options using **View/Options** menu command.

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.1.8. NewDocument Function

NewDocument Function

Creates a new document (data file) with the specified timestamp frequency.

Syntax

documentReference NewDocument(frequency)

Parameters

Parameter	Type	Description
frequency	double	Timestamp frequency.

Returns

Returns the reference to the new document.

Comments

None

Usage

NexScript

```
doc = NewDocument(25000.)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.1.9. CloseDocument Function

CloseDocument Function

Closes the specified document.

Syntax

CloseDocument(doc)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.

Returns

None

Comments

None

Usage

NexScript

```
% this script prints the number of variables in the file
doc = GetActiveDocument()
Trace("document contains", GetVarCount(doc, "all"), "variables")
CloseDocument(doc)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.1.10. SaveDocument Function

SaveDocument Function

Saves the specified document.

Syntax

SaveDocument(doc)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.

Returns

None

Comments

Document is saved as a .nex file.

Usage

NexScript

```
doc = GetActiveDocument()
SaveDocument(doc)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.1.11. SaveDocumentAs Function

SaveDocumentAs Function

Saves the specified document (in .nex format) in a file with the specified file path.

Syntax

SaveDocumentAs(doc, filePath)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
filePath	string	File path.

Returns

None

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
SaveDocumentAs(doc, "C:\Data\file1.nex")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.1.12. SaveNumResults Function

SaveNumResults Function

Saves the numerical results to a text file with the specified name.

Syntax

SaveNumResults(doc, fileName)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
fileName	string	File path for saved results.

Returns

None

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
SaveNumResults(doc, "C:\Data\res1.txt")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.1.13. SaveNumSummary Function

SaveNumSummary Function

Saves the summary of numerical results to a text file with the specified name.

Syntax

SaveNumSummary(doc, filename)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
filename	string	File path for saved results.

Returns

None

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
SaveNumSummary(doc, "C:\Data\res1summary.txt")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.1.14. SaveAsTextFile Function

SaveAsTextFile Function

Saves the document in the text file with the specified file name.

Syntax

SaveAsTextFile(doc, filePath)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
filePath	string	Text file path.

Returns

None

Comments

This function uses options that were specified the last time the menu command **File | Export Data | As Text File** was executed.

Usage

NexScript

```
doc = GetActiveDocument()
SaveAsTextFile(doc, fileNename)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.1.15. MergeFiles Function

MergeFiles Function

Opens and merges the specified files, returns the reference to the merged file.

Syntax

documentReference MergeFiles(name_list, gap)

Parameters

Parameter	Type	Description
name_list	string	The list of files to be merged. File names should be separated by commas.
gap	number	Gap between the files (in seconds). See comments below.

Returns

Returns the reference to the merged files.

Comments

In merge process, the data (for the same variable) from the second file is appended to the data from the first file. Before appending, the timestamps of the variable in the second file are shifted by the value equal to duration_of_the_first_file + gap. Since the function uses commas as separators between file names, it is assumed that each file name does not contain commas.

Usage

NexScript

```
dataDir = "C:\Data\"
file1 = dataDir + "file1.plx"
file2 = dataDir + "file2.plx"
file3 = dataDir + "file3.plx"
mergeList = file1 + "," + file2 + "," + file3
doc = MergeFiles(mergeList, 1.)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.1.16. ReadBinary Function

ReadBinary Function

Reads a binary value of a specified type from a file.

Syntax

double ReadBinary(fileID, valueType)

Parameters

Parameter	Type	Description
fileID	double	File ID received from OpenFile function.
valueType	string	Binary type. Should be "char", "uchar", "short", "ushort", "int", "uint", "int64", "uint64", "float" or "double".

Returns

The value read from the file.

Comments

None

Usage

NexScript

```
% open binary file in read mode
file = OpenFile("C:\Data\binaryfile.dat", "r")
% read short (2-byte signed) value
shortValue = ReadBinary(file, "short")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.1.17. FileSeek Function

FileSeek Function

Repositions file pointer by the specified offset.

Syntax

double FileSeek(fileID, offset, type)

Parameters

Parameter	Type	Description
fileID	double	File ID received from OpenFile function.
offset	double	Number of bytes to move the file pointer.
type	string	Pointer movement mode. Should be "begin", "current" or "end".

Returns

The new byte offset from the beginning of the file.

Comments

FileSeek(file,0,"end") returns file size in bytes. FileSeek(file,0,"current") returns current file position.

Usage

NexScript

```
% open binary file in read mode
file = OpenFile("C:\Data\binaryfile.dat", "r")
% get file length
fileLength = FileSeek(file, 0, "end")
% move pointer 4 bytes from the beginning of the file
newPosition = FileSeek(file, 4, "begin")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.1.18. SelectFile Function

SelectFile Function

Opens File Open dialog and returns the path of the file selected in the dialog.

Syntax

string SelectFile()

Returns

Returns the path of the file selected in File Open dialog.

Comments

None

Usage

NexScript

```
path = SelectFile()
% path can be empty if the user pressed Cancel in file dialog
if StrLength(path) > 0
 % open file for reading
 file = OpenFile(path, "r")
 line = ""
 % read the first line of the file
 ReadLine(file, line)
 Trace(line)
 CloseFile(file)
end
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.2. Document Properties Functions

The following document properties functions are available in NexScript

Function	Description
GetDocPath	Returns the full path of the data file.
GetDocTitle	Returns the data file name.
GetTimestampFrequency	Returns the frequency used in the specified file to store the timestamps.
GetDocEndTime	Returns the maximum timestamp value (in seconds) for all the document variables.
SetDocEndTime	Sets the length of experimental session (in seconds) for the document.
GetDocComment	Returns the document comment string.

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.2.1. GetDocPath Function

GetDocPath Function

Returns the full path of the data file.

Syntax

string GetDocPath(doc)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.

Returns

Returns the full path of the data file.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
path = GetDocPath(doc)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.2.2. GetDocTitle Function

GetDocTitle Function

Returns the data file name.

Syntax

string GetDocTitle(doc)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.

Returns

Returns the data file name. For example, if the document has the path "C:\Data\data1.nex", this function will return "data1.nex"

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
fileName = GetDocTitle(doc)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.2.3. GetTimestampFrequency Function

GetTimestampFrequency Function

Returns the frequency used in the internal representation of the timestamps.

Syntax

double GetTimestampFrequency(doc)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.

Returns

Returns the frequency used in the specified file to store the timestamps.

Comments

Internally, the timestamps are stored as integers representing the number of time ticks from the start of the experiment. The time tick is equal to 1./Timestamp_Frequency.

Usage

NexScript

```
doc = GetActiveDocument()
tsFreq = GetTimestampFrequency(doc)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.2.4. GetDocEndTime Function

GetDocEndTime Function

Returns the maximum timestamp value (in seconds) for all the document variables.

Syntax

double GetDocEndTime(doc)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.

Returns

Returns the maximum timestamp value (in seconds) for all the document variables.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
endTime = GetDocEndTime(doc)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.2.5. SetDocEndTime Function

SetDocEndTime Function

Sets the length of experimental session for the document.

Syntax

SetDocEndTime(doc, endtime)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
endtime	double	Document end time in seconds.

Returns

None

Comments

NeuroExplorer determines document end time when the document is loaded. Then, the duration of experimental session (endTime - startTime) may be used in the calculations of the confidence limits. If your script modifies or adds the variables, you may need to set the document end time directly to maintain correctness of the confidence calculations.

Usage

NexScript

```
doc = GetActiveDocument()
SetDocEndTime(doc, 1200.3)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.2.6. GetDocComment Function

GetDocComment Function

Returns the document comment string.

Syntax

string GetDocComment(doc)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.

Returns

Returns the document comment string.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
comment = GetDocComment(doc)
Trace(comment)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.3. Document Variables Functions

The following document variables functions are available in NexScript

Function	Description
GetVarCount	Returns the number of variables of the specified type in the file.
GetVarName	Returns a string -- the name of the variable of the specified type in the file.
GetVarSpikeCount	Returns the number of timestamps in the variable.
GetVar	Returns the reference to the specified variable.
DeleteVar	Deletes the specified variable from the file.
Delete	Deletes the specified variable from the file.
GetVarByName	Returns the reference to the variable which has the specified name.
NewEvent	Creates a new timestamped variable.
NewIntEvent	Creates a new interval variable.
NewPopVector	Creates a new population vector.
GetContNumDataPoints	Returns the number of data points in the continuous variable.
NewContVar	Creates a new continuous variable.
CopySelectedVarsToAnotherFile	Copies selected variables from one file to another.

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.3.1. GetVarCount Function

GetVarCount Function

Returns the number of variables of the specified type in the file.

Syntax

double GetVarCount(doc, varType)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
varType	string	Variable type. Should be "neuron", "neuronorevent" , "event", "interval" "wave", "popvector", "continuous", "marker" or "all".

Returns

Returns the number of variables of the specified type in the file.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
% get the number of continuous variables
numContVars = GetVarCount(doc, "continuous")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.3.2. GetVarName Function

GetVarName Function

Returns the name of the specified variable.

Syntax

string GetVarName(doc, number, varType)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
number	double	1-based variable number within the group specified by varType.
varType	variableReference	Variable type. Should be "neuron", "neuronorevent" , "event", "interval" "wave", "popvector", "continuous", "marker" or "all".

Returns

Returns the name of the specified variable.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
% get the name of the first event variable
name = GetVarName(doc, 1, "event")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.3.3. GetVarSpikeCount Function

GetVarSpikeCount Function

Returns the number of timestamps in the specified variable.

Syntax

double GetVarSpikeCount(doc, number, varType)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document
number	double	1-based variable number within the group specified by varType.
varType	string	Variable type. Should be "neuron", "neuronorevent" , "event", "interval" "wave", "popvector", "continuous", "marker" or "all".

Returns

Returns the number of timestamps in the variable.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
numSpikes = GetVarSpikeCount(doc, 3, "neuron")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.3.4. GetVar Function

GetVar Function

Returns the reference to the specified variable.

Syntax

variableReference GetVar(doc, number, varType)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document
number	double	1-based variable number within the group specified by varType.
varType	string	Variable type. Should be "neuron", "neuronorevent" , "event", "interval" "wave", "popvector", "continuous", "marker" or "all".

Returns

Returns the reference to the specified variable.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
% get the second event variable
event = GetVar(doc, 2, "event")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.3.5. DeleteVar Function

DeleteVar Function

Deletes the specified variable from the file.

Syntax

DeleteVar(doc, number, varType)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
number	double	1-based variable number within the group specified by varType.
varType	string	Variable type. Should be "neuron", "neuronorevent" , "event", "interval" "wave", "popvector", "continuous", "marker" or "all".

Returns

None

Comments

All the analysis windows are closed before executing this function. Please note that this function produces an immediate result - after the execution of this function, the number of variables of the specified type is reduced by 1. Thererefore, you cannot use a simple **for** loop to delete all the variables of a certain type. You can use **while** loop as shown in the example script below.

Usage

NexScript

```
doc = GetActiveDocument()
% delete the first continuous variable
DeleteVar(doc, 1, "continuous")

% delete all waveform variables
% note that we always delete the first variable
while GetVarCount(doc, "wave") > 0
  DeleteVar(doc, 1, "wave")
end
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.3.6. Delete Function

Delete Function

Deletes the specified variable from the file.

Syntax

Delete(doc, var)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
var	variableReference	Reference to the variable.

Returns

None

Comments

All the analysis windows are closed before executing this function.

Usage

NexScript

```
doc = GetActiveDocument()
var = GetVarByName(doc, "Event04")
Delete(doc, var)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.3.7. GetVarByName Function

GetVarByName Function

Returns the reference to the variable which has the specified name.

Syntax

variableReference GetVarByName(doc, name)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
name	string	Variable name.

Returns

Returns the reference to the variable which has the specified name.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
% get the variable with the name TrialStart
start = GetVarByName(doc, "TrialStart")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.3.8. NewEvent Function

NewEvent Function

Creates a new timestamped variable.

Syntax

variableReference NewEvent(doc, count)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
count	double	Initial number of the timestamps in the document.

Returns

Returns a reference to the new variable.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
temp = NewEvent(doc, 10) % creates a script-only variable
doc.NewVar = NewEvent(doc, 0) % creates a new variable in the file
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.3.9. NewIntEvent Function

NewIntEvent Function

Creates a new interval variable.

Syntax

variableReference NewIntEvent(doc, count)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
count	double	Initial number of intervals in the variable. This parameter is optional.

Returns

Returns a reference to the new variable.

Comments

If initial number of intervals is positive, intervals are initialized with values [0, 0.5], [1, 1.5], etc.

Usage

NexScript

The following script creates a new interval variable that has two intervals: from 0 to 100 seconds and from 200 to 300 seconds:

```
doc = GetActiveDocument()
doc.MyInterval = NewIntEvent(doc)
AddInterval(doc.MyInterval, 0., 100.)
AddInterval(doc.MyInterval, 200., 300.)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.3.10. NewPopVector Function

NewPopVector Function

Creates a new population vector.

Syntax

variableReference NewPopVector(doc, type)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
type	double	if **type** = 0, all weights of the new vector are equal to zero.

Returns

Returns a reference to the new vector.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
doc.neuronAverage = NewPopVector(doc, 1)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.3.11. GetContNumDataPoints Function

GetContNumDataPoints Function

Returns the number of data points in the continuous variable.

Syntax

double GetContNumDataPoints(var)

Parameters

Parameter	Type	Description
var	variableReference	Reference to a continuous variable.

Returns

Returns the number of data points in the continuous variable.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
var = GetVarByName(doc, "AD_01")
numPoints = GetContNumDataPoints(var)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.3.12. NewContVar Function

NewContVar Function

Creates a new continuous variable.

Syntax

variableReference NewContVar(doc, frequency, mVmin, mVmax)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
frequency	double	Specifies the sampling frequency of the new variable (in Hz).
mVmin	double	Minimum of the values of the new variable (in milliVolts).
mVmax	double	Maximum of the values of the new variable (in milliVolts).

Returns

Returns a reference to the new variable.

Comments

NeuroExplorer stores the values of continuous variables as scaled 2-byte integers. Specifying minimum and maximum of the variable values helps to determine the correct scaling factor for the new variable.

Usage

NexScript

```
doc = GetActiveDocument()
freq = 1000.
% create new variable in the file
doc.Temp1 = NewContVar(doc, 1000., -500.,500.)
% add the values to the new variable
for i = 1 to 10000
   % timestamp
   ts = i/freq
   % value
   value = 500.*sin(ts)
   AddContValue(doc.Temp1, ts, value)
end
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.3.13. CopySelectedVarsToAnotherFile Function

CopySelectedVarsToAnotherFile Function

Copies selected variables from one file to another.

Syntax

CopySelectedVarsToAnotherFile(fromDoc, toDoc)

Parameters

Parameter	Type	Description
fromDoc	documentReference	Reference to the document. The variables are copied **from** this document.
toDoc	documentReference	Reference to the document. The variables are copied **to** this document.

Returns

None

Comments

None

Usage

NexScript

```
fromDoc = OpenDocument("C:\Data\File1.nex")
toDoc = OpenDocument("C:\Data\File2.nex")
% copy all events from fromDoc to toDoc
% first, select all events
SelectAllEvents(fromDoc)
% call CopySelectedVarsToAnotherFile
CopySelectedVarsToAnotherFile(fromDoc, toDoc)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.4. Variable Selection Functions

The following selection functions are available in NexScript:

Function	Description
IsSelected	Returns selection status of the specified variable.
Select	Selects the specified variable (with variable type and index) for analysis.
Deselect	Deselects the specified variable (with variable type and index).
SelectVar	Selects the specified variable for analysis.
DeselectVar	Deselects the specified variable.
SelectAll	Selects all variables for analysis.
DeselectAll	Deselects all variables.
SelectAllNeurons	Selects all the neuron type variables for analysis.
SelectAllEvents	Selects all the event type variables for analysis.
EnableRecalcOnSelChange	Enables recalculation of analyses when the list of selected variables changes.
DisableRecalcOnSelChange	Disables recalculation of analyses when the list of selected variables changes.

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.4.1. IsSelected Function

IsSelected Function

Returns 1 if the variable var is selected, 0 otherwise.

Syntax

double IsSelected(var)

Parameters

Parameter	Type	Description
var	variableReference	Reference to the variable.

Returns

Returns 1 if the variable var is selected, 0 otherwise.

Comments

Only selected variables used in analysis.

Usage

NexScript

```
doc = GetActiveDocument()
isSel = IsSelected(doc.Neuron1)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.4.2. Select Function

Select Function

Selects the specified variable for analysis.

Syntax

Select(doc, var)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
var	variableReference	Reference to the variable.

Returns

None

Comments

Only selected variables used in analysis. Use select and deselect functions to specify what variables you want to analyze.

Usage

NexScript

```
doc = GetActiveDocument()
Select(doc, GetVarByName(doc, "Neuron1"))
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.4.3. Deselect Function

Deselect Function

Deselects the specified variable.

Syntax

Deselect(doc, var)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
var	variableReference	Reference to the variable.

Returns

None

Comments

Only selected variables used in analysis. Use select and deselect functions to specify what variables you want to analyze.

Usage

NexScript

```
doc = GetActiveDocument()
% deselect variable Neuro04a from analysis
Deselect(doc, GetVarByName(doc, "Neuro04a"))
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.4.4. SelectVar Function

SelectVar Function

Selects the specified variable for analysis.

Syntax

SelectVar(doc, number, varType)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
number	double	Variable number within the group specified by varType.
varType	string	Variable type. Should be "neuron", "neuronorevent" , "event", "interval" "wave", "popvector", "continuous", "marker" or "all".

Returns

None

Comments

Only selected variables used in analysis. Use select and deselect functions to specify what variables you want to analyze.

Usage

NexScript

```
doc = GetActiveDocument()
% select the second neuron for analysis
SelectVar(doc, 2, "neuron")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.4.5. DeselectVar Function

DeselectVar Function

Deselects the specified variable.

Syntax

DeselectVar(doc, number, varType)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
number	double	Variable number within the group specified by varType.
varType	string	Variable type. Should be "neuron", "neuronorevent" , "event", "interval" "wave", "popvector", "continuous", "marker" or "all".

Returns

None

Comments

Only selected variables used in analysis. Use select and deselect functions to specify what variables you want to analyze.

Usage

NexScript

```
doc = GetActiveDocument()
% deselect the second neuron
DeselectVar(doc, 2, "neuron")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.4.6. Select Function

Select Function

Selects the specified variable for analysis.

Syntax

Select(doc, var)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
var	variableReference	Reference to the variable.

Returns

None

Comments

Only selected variables used in analysis. Use select and deselect functions to specify what variables you want to analyze.

Usage

NexScript

```
doc = GetActiveDocument()
Select(doc, GetVarByName(doc, "Neuron1"))
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.4.7. Deselect Function

Deselect Function

Deselects the specified variable.

Syntax

Deselect(doc, var)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
var	variableReference	Reference to the variable.

Returns

None

Comments

Only selected variables used in analysis. Use select and deselect functions to specify what variables you want to analyze.

Usage

NexScript

```
doc = GetActiveDocument()
% deselect variable Neuro04a from analysis
Deselect(doc, GetVarByName(doc, "Neuro04a"))
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.4.8. SelectAll Function

SelectAll Function

Selects all the variables for analysis.

Syntax

SelectAll(doc)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.

Returns

None

Comments

Only selected variables used in analysis. Use select and deselect functions to specify what variables you want to analyze.

Usage

NexScript

```
doc = GetActiveDocument()
SelectAll(doc)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.4.9. DeselectAll Function

DeselectAll Function

Deselects all variables.

Syntax

DeselectAll(doc)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.

Returns

None

Comments

Only selected variables used in analysis. Use select and deselect functions to specify what variables you want to analyze.

Usage

NexScript

```
doc = GetActiveDocument()
DeselectAll(doc)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.4.10. SelectAllNeurons Function

SelectAllNeurons Function

Selects all neuron type variables for analysis.

Syntax

SelectAllNeurons(doc)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.

Returns

None

Comments

Only selected variables used in analysis. Use select and deselect functions to specify what variables you want to analyze.

Usage

NexScript

```
doc = GetActiveDocument()
SelectAllNeurons(doc)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.4.11. SelectAllEvents Function

SelectAllEvents Function

Selects all event type variables for analysis.

Syntax

SelectAllEvents(doc)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.

Returns

None

Comments

Only selected variables used in analysis. Use select and deselect functions to specify what variables you want to analyze.

Usage

NexScript

```
doc = GetActiveDocument()
SelectAllEvents(doc)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.4.12. EnableRecalcOnSelChange Function

EnableRecalcOnSelChange Function

Enables recalculation of analyses when the list of selected variables changes.

Syntax

EnableRecalcOnSelChange ()

Parameters

None

Returns

None

Comments

If there is an analysis window open in NeuroExplorer (for example, if an analysis window was open before script began or ApplyTemplate was called in the script) and a list of selected variables changes, NeuroExplorer can automatically recalculate the analysis results. This automatic recalculation was enabled by default in NeuroExplorer prior to version 4.095. In versions 4.095 and higher, automatic recalculation on selection change is disabled. This function allows you to enable automatic recalculation on selection change.

Usage

NexScript

```
EnableRecalcOnSelChange ()
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.4.13. DisableRecalcOnSelChange Function

DisableRecalcOnSelChange Function

Disables recalculation of analyses when the list of selected variables changes.

Syntax

DisableRecalcOnSelChange()

Parameters

None

Returns

None

Comments

If there is an analysis window open in NeuroExplorer (for example, if an analysis window was open before script began or ApplyTemplate was called in the script) and a list of selected variables changes, NeuroExplorer can automatically recalculate the analysis results. This automatic recalculation was enabled by default in NeuroExplorer prior to version 4.095. In versions 4.095 and higher, automatic recalculation on selection change is disabled. This function allows you to disable automatic recalculation on selection change if you are using version prior to 4.095.

Usage

NexScript

```
DisableRecalcOnSelChange()
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.5. Properties of Variables Functions

The following functions that can get or change properties of variables are available in NexScript

Function	Description
GetName	Returns the name of the variable.
GetSpikeCount	Returns the number of timestamps in the variable.
AddTimestamp	Adds a new timestamp to the specified variable.
SetNeuronType	Changes the type of the timestamp variable to either 'neuron' or 'event'.
AddContValue	Adds a new data point to the specified continuous variable.
AddInterval	Adds a new interval to the specified interval variable.

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.5.1. GetName Function

GetName Function

Returns the name of the variable.

Syntax

string GetName(var)

Parameters

Parameter	Type	Description
var	variableReference	Reference to the variable.

Returns

Returns the name of the variable.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
% get the first neuron variable
var = GetVar(doc, 1, "neuron")
% get the variable name
name = GetName(var)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.5.2. GetSpikeCount Function

GetSpikeCount Function

Returns the number of timestamps in the variable.

Syntax

double GetSpikeCount(var)

Parameters

Parameter	Type	Description
var	variableReference	Reference to the variable.

Returns

Returns the number of timestamps in the variable.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
count = GetSpikeCount(GetVarByName("Neuron04a"))
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.5.3. AddTimestamp Function

AddTimestamp Function

Adds a new timestamp to the specified event or neuron variable.

Syntax

AddTimestamp(var, timestamp)

Parameters

Parameter	Type	Description
var	variableReference	Reference to the event or neuron variable.
timestamp	double	New timestamp (in seconds).

Returns

None

Comments

The new timestamp should not be equal to one of the existing timestamps of the specified variable.

Usage

NexScript

```
doc = GetActiveDocument()
eventVar = GetVarByName(doc, "Event04")
% add timestamp at 1.5 seconds
AddTimestamp(eventVar, 1.5)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.5.4. SetNeuronType Function

SetNeuronType Function

Changes the type of the specified timestamped variable.

Syntax

SetNeuronType(doc, var, type)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
var	variableReference	Reference to the variable.
type	double	If type is positive, the variable type is set to 'neuron', if type is zero or negative, the variable type is set to 'event'.

Returns

None

Comments

Neuron and event types are almost identical. The main difference is that when a data file is opened by NeuroExplorer, all the neuron variables in this file are selected for analysis.

You may need to use this function when creating new neuron variables using NewEvent. NewEvent creates an event variable and the variable type can later be changed to 'neuron' using SetNeuronType.

Usage

NexScript

```
doc = GetActiveDocument()
doc.neuron1 = NewEvent(doc, 0)
SetNeuronType(doc, doc.neuron1, 1)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.5.5. AddContValue Function

AddContValue Function

Adds a new data point to the specified continuous variable

Syntax

AddContValue(var, timestamp, value)

Parameters

Parameter	Type	Description
var	variableReference	Reference to the continuous variable.
timestamp	double	Timestamps value in seconds.
value	double	Voltage value in millivolts.

Returns

None

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
contVar = GetVarByName(doc, "ContVar1")
% add voltage value of 25.7 mV at the time 100.3 seconds
AddContValue(contVar, 100.3, 25.7)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.5.6. AddInterval Function

AddInterval Function

Adds a new interval to the specified interval variable.

Syntax

AddInterval(var, interval_start, interval_end)

Parameters

Parameter	Type	Description
var	variableReference	Reference to the interval variable.
interval_start	double	Start of new interval (in seconds).
interval_end	double	End of new interval (in seconds).

Returns

None

Comments

The new interval should not overlap with any of the existing intervals of the specified interval variable.

Usage

NexScript

```
doc = GetActiveDocument()
intervalVar = GetVarByName(doc, "Trials")
% add interval [100s,120s]
AddInterval(intervalVar, 100, 120)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.6. Analysis Functions

The following analysis functions are available in NexScript

Function	Description
ApplyTemplate	Runs the analysis specified in the template.
ApplyTemplateToWindow	Runs the analysis specified in the template and shows the result in the specified Graph window.
EnableRecalcOnSelChange	Enables recalculation of analyses when the list of selected variables changes.
DisableRecalcOnSelChange	Disables recalculation of analyses when the list of selected variables changes.
PrintGraphics	Prints the contents of the first graphical window of the document.
Dialog	Shows a dialog allowing to set script parameters.
ModifyTemplate	Modifies one of the template parameters.
RecalculateAnalysisInWindow	Forces recalculation of analysis in the specified graphic window.
SendGraphicsToPowerPoint	Sends the contents of the first graphical window of the document to the specified Power Point presentation.
SaveGraphics	Saves the graphics to a WMF or PNG file.

See also Numerical Results functions.

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.6.1. ApplyTemplate Function

ApplyTemplate Function

Runs the analysis specified in the analysis template.

Syntax

ApplyTemplate(doc, templateName)

Parameters

Parameter	Type	Description
documentReference	doc	Reference to the document.
string	templateName	The name of the template.

Returns

None

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
% run PSTH analysis saved in the template Peri1
ApplyTemplate(doc, "Peri1")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.6.2. ApplyTemplateToWindow Function

ApplyTemplateToWindow Function

Runs the analysis specified in the template and shows the result in the specified Graph window.

Syntax

ApplyTemplateToWindow(doc, templatename, windownumber)

Parameters

Parameter	Type	Description
documentReference	doc	Reference to the document.
string	templatename	The name of the template.
double	windownumber	The number of the graph window of the document. Graph windows are named Graphs1, Graphs2, etc. Thus, if you need to specify window Graphs2, windownumber should be equal to 2. If the Graph window with the specified number does not exist, a new Graph window is created

Returns

None

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
% run PSTH analysis saved in the template Peri1 and show the results in Graph2
window
ApplyTemplate(doc, "Peri1", 2)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.6.3. PrintGraphics Function

PrintGraphics Function

Prints the contents of the first graphical window of the document.

Syntax

PrintGraphics(doc)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.

Returns

None

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
PrintGraphics(doc)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.6.4. Dialog Function

Dialog Function

Shows a dialog that can be used to specify the script parameters.

Syntax

double Dialog(doc, par1, name1, type1, par2, name2, type2, ...)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document. Could be zero if all the type values are "number" or "string".
par1	variable	A variable that will be assigned a value after Dialog exits. The variable should be created before the Dialog function is called
name1	string	Prompt that will be shown in the dialog.
type1	string	Parameter type. It should be one of: "number", "string", "neuron", "neuronorevent", "event", "interval", "wave", "continuous", "marker" or "all".

Returns

Dialog function returns 1 if user pressed OK button or 0, if user pressed Cancel button.

Comments

None

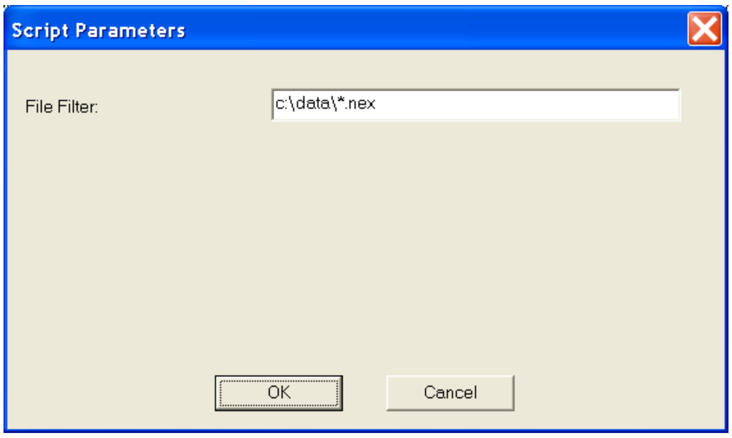
Usage

NexScript

```
% create a string variable
filefilter = "C:\Data\*.nex"

% show the dialog to the user
res = Dialog(0., filefilter , "File Filter:", "string")
```

The following dialog will be shown:



File Filter: c:\data\*.nex

Now a user can type the new value in the File Filter edit box. If the user presses OK button, the Dialog function returns 1, otherwise, it returns 0.

The following script will allow a user to choose one of the neurons in the active document and select this neuron for analysis:

```
doc = GetActiveDocument()
Neuron_Number = 1
% choose a neuron
res = Dialog(doc, Neuron_Number, "Select Neuron", "neuron")
% get the neuron variable and select it
Neuron_Var = GetVar(doc, Neuron_Number, "neuron")
Select(doc, Neuron_Var)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.6.5. ModifyTemplate Function

ModifyTemplate Function

Modifies one of the template parameters.

Syntax

ModifyTemplate(doc, templateName, paramName, newParValue)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
templateName	string	The name of the template.
paramName	string	The name of the parameter to be modified.
newParValue	string	The new value of the parameter (as a string).

Returns

None

Comments

None

Usage

NexScript

To set the new bin value in the *Rate Histograms* template, you need to write:

```
ModifyTemplate(doc, "Rate Histograms", "Bin (sec)", "5.0")
```

Note that parameter name should be specified exactly as it is shown in the left column of the *Properties Panel* (e.g. not "Bin", but "Bin (sec)" as in the example above). You can select the parameter name in the left column of Properties Panel and press Ctrl+C to copy the parameter name to the clipboard and then paste the name of the parameter into your script.

If you need to use a numeric value as newparvalue, you need to convert it to string using NumToStr function. For example, if you need to set Select Data From = doc.Start[1]:

```
ModifyTemplate(doc, "Peri", "Select Data From (sec)", NumToStr(doc.Start[1]))
```

ModifyTemplate can be used to specify multiple references in Perievent Histograms, Crosscorrelograms and Perievent Rasters by using "+":

```
doc = GetActiveDocument()
ModifyTemplate(doc, "Peri", "Ref. type", "Table (row)")
ModifyTemplate(doc, "Peri", "Reference", "Event04+Event05+Event06")
ApplyTemplate(doc, "Peri")
```

You can also use "+" to specify multiple interval filters in Perievent Histograms, Crosscorrelograms and Perievent Rasters.

ModifyTemplate can be used to specify graphics parameters. To change the Graph parameter, you need to add **Graph|** before the parameter name:

```
doc = GetActiveDocument()
ModifyTemplate(doc, "Peri", "Graph|Graph Style", "Histogram")
ModifyTemplate(doc, "Peri", "Graph|Line color", "1")
ModifyTemplate(doc, "Peri", "Graph|Fill under line", "0")
```

To change the Y Axis parameter, you need to add **YAxis|** before the parameter name:

```
ModifyTemplate(doc, "Peri", "YAxis|Max Type", "Fixed")
ModifyTemplate(doc, "Peri", "YAxis|Fixed Max", "50.")
```

To change the X Axis parameter, you need to add **XAxis|** before the parameter name.

```
doc = GetActiveDocument()
ModifyTemplate(doc, templateName, paramName, newParValue)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.6.6. RecalculateAnalysisInWindow Function

RecalculateAnalysisInWindow Function

Forces recalculation of analysis in the specified graphic window.

Syntax

RecalculateAnalysisInWindow(doc, graphWindowNumber)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
graphWindowNumber	double	Index of the Graph window.

Returns

None

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
RecalculateAnalysisInWindow(doc, 1)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.6.7. EnableRecalcOnSelChange Function

EnableRecalcOnSelChange Function

Enables recalculation of analyses when the list of selected variables changes.

Syntax

EnableRecalcOnSelChange ()

Parameters

None

Returns

None

Comments

If there is an analysis window open in NeuroExplorer (for example, if an analysis window was open before script began or ApplyTemplate was called in the script) and a list of selected variables changes, NeuroExplorer can automatically recalculate the analysis results. This automatic recalculation was enabled by default in NeuroExplorer prior to version 4.095. In versions 4.095 and higher, automatic recalculation on selection change is disabled. This function allows you to enable automatic recalculation on selection change.

Usage

NexScript

```
EnableRecalcOnSelChange ()
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.6.8. DisableRecalcOnSelChange Function

DisableRecalcOnSelChange Function

Disables recalculation of analyses when the list of selected variables changes.

Syntax

DisableRecalcOnSelChange()

Parameters

None

Returns

None

Comments

If there is an analysis window open in NeuroExplorer (for example, if an analysis window was open before script began or ApplyTemplate was called in the script) and a list of selected variables changes, NeuroExplorer can automatically recalculate the analysis results. This automatic recalculation was enabled by default in NeuroExplorer prior to version 4.095. In versions 4.095 and higher, automatic recalculation on selection change is disabled. This function allows you to disable automatic recalculation on selection change if you are using version prior to 4.095.

Usage

NexScript

```
DisableRecalcOnSelChange()
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.6.9. SendGraphicsToPowerPoint Function

SendGraphicsToPowerPoint Function

Sends the contents of the first graphical window of the document to the specified Power Point presentation.

Syntax

SendGraphicsToPowerPoint (doc, presentationPath, slideTitle, comment, addParameters, useBitmap)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
presentationPath	string	Path of the presentation file.
slideTitle	string	Slide title.
comment	string	Slide comment. Will be shown below graphics.
addParameters	double	If 1, add a text box with analysis parameter values.
useBitmap	double	If 1, transfer graphics as a bitmap, otherwise, transfer graphics as a metafile.

Returns

None

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
SendGraphicsToPowerPoint(doc, "C:\Data\NexResults.ppt", "Slide 1", "Sample slide",
1, 0)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.6.10. SaveGraphics Function

SaveGraphics Function

Saves the graphics of rthe first graphics window of the document to a WMF or PNG file.

Syntax

SaveGraphics(doc, filePath, asPng)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
filePath	string	Graphics file path
asPng	double	If this parameter value is zero, graphics is saved in Windows Metafile format. Otherwise, the graphics is saved in PNG format.

Returns

None

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
SaveGraphics(doc, "C:\Data\NexGraphics.wmf", 0)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.7. Numerical Results Functions

The following numerical results functions are available in NexScript

Function	Description
GetNumRes	Returns the value of the specified cell in the Numerical Results Window of the first graphical view of the document.
GetNumResNCols	Returns the number of columns of the Numerical Results Window of the first graphical view of the document.
GetNumResNRows	Returns the number of rows of the Numerical Results Window of the first graphical view of the document.
GetNumResColumnName	Returns the name of the specified column of the Numerical Results Window of the first graphical view of the document.
SendResultsToExcel	Sends numerical results (of the first graphics window of the document) to Excel.
GetNumResSummaryNCols	Returns the number of columns of the Numerical Results Summary Window of the first graphical view of the document.
GetNumResSummaryNRows	Returns the number of rows of the Numerical Results Summary Window of the first graphical view of the document.
GetNumResSummaryColumnName	Returns the name of the specified column of the Numerical Results Summary Window of the first graphical view of the document.
GetNumResSummaryData	Returns the value of the specified cell in the Numerical Results Summary Window of the first graphical view of the document.
SendResultsSummaryToExcel	Sends summary of numerical results (of the first graphics window of the document) to Excel.
SaveNumResults	Saves the numerical results to a text file with the specified name.
SaveNumSummary	Saves the summary of numerical results to a text file with the specified name.

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.7.1. GetNumRes Function

GetNumRes Function

Returns the value of the specified cell in the Numerical Results Window of the first graphical view of the document.

Syntax

double GetNumRes(doc, row, col)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
row	double	1-based row number.
col	double	1-based column number.

Returns

Returns the numeric value of the specified cell in the Numerical Results Window of the first graphical view of the document.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
ApplyTemplate(doc, "PSTH")
% get the value of the second bin of the first histogram
binCount = GetNumRes(doc, 2, 1)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.7.2. GetNumResNCols Function

GetNumResNCols Function

Returns the number of columns of the Numerical Results Window of the first graphical view of the document.

Syntax

double GetNumResNCols(doc)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.

Returns

Returns the number of columns of the Numerical Results Window of the first graphical view of the document.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
numCols = GetNumResNCols(doc)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.7.3. GetNumResNRows Function

GetNumResNRows Function

Returns the number of rows of the Numerical Results Window of the first graphical view of the document.

Syntax

double GetNumResNRows(doc)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.

Returns

Returns the number of rows of the Numerical Results Window of the first graphical view of the document.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
numRows = GetNumResNRows(doc)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.7.4. GetNumResColumnName Function

GetNumResColumnName Function

Returns the name of the specified column of the Numerical Results Window.

Syntax

string GetNumResColumnName(doc, col)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
col	number	1-based column number.

Returns

Returns the name of the column of the Numerical Results Window of the first graphical view of the document.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
% get the name of the second column of the Numerical Results Window
colName = GetNumResColumnName(doc, 2)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.7.5. SendResultsToExcel Function

SendResultsToExcel Function

Sends numerical results (of the first graphics window of the document) to Excel.

Syntax

SendResultsToExcel(doc, fileName, worksheetName, useFirstEmptyRow, cellName, includeHeader, includeFileName)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
fileName	string	Excel file path.
worksheetName	string	Excel worksheet name.
useFirstEmptyRow	double	If 1, NeuroExplorer will ignore cellName parameter and add the results to the first row where the cell in column A is empty. If 0, NeuroExplorer will copy the data starting with the cell specified in **cellName.**
cellName	string	Excel cell where to copy the results. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.
includeHeader	double	If 1, NeuroExplorer will paste column names.
includeFileName	double	If 1, NeuroExplorer will add a column with the data file name.

Returns

None

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
SendResultsToExcel(doc, "C:\Data\NexResults.xls", "Nex", 0, "A1", 1, 0)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.7.6. GetNumResSummaryNCols Function

GetNumResSummaryNCols Function

Returns the number of columns of the Numerical Results Summary Window of the first graphical view of the document.

Syntax

double GetNumResSummaryNCols(doc)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.

Returns

Returns the number of columns of the Numerical Results Summary Window of the first graphical view of the document.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
nCols = GetNumResSummaryNCols(doc)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.7.7. GetNumResSummaryNRows Function

GetNumResSummaryNRows Function

Returns the number of rows of the Numerical Results Summary Window of the first graphical view of the document.

Syntax

double GetNumResSummaryNRows(doc)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.

Returns

Returns the number of rows of the Numerical Results Summary Window of the first graphical view of the document.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
nRows = GetNumResSummaryNRows(doc)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.7.8. GetNumResSummaryColumnName Function

GetNumResSummaryColumnName Function

Returns the name of the specified column of the Numerical Results Summary Window of the first graphical view of the document.

Syntax

string GetNumResSummaryColumnName(doc, col)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
col	double	1-based column number.

Returns

Returns the name of the column of the Numerical Results Summary Window of the first graphical view of the document.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
% get the name of the third column in Numerical Results Summary
colName = GetNumResSummaryColumnName(doc, 3)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.7.9. GetNumResSummaryData Function

GetNumResSummaryData Function

Returns the string value of the specified cell in the Numerical Results Summary Window of the first graphical view of the document.

Syntax

string GetNumResSummaryData(doc, row, col)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document
row	double	1-based row number.
col	double	1-based column number.

Returns

Returns the string value of the specified cell in the Numerical Results Summary Window of the first graphical view of the document.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
% get the value of the cell in row 3, column 2
summaryCellString = GetNumResSummaryData(doc, 3, 2)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.7.10. SendResultsSummaryToExcel Function

SendResultsSummaryToExcel Function

Sends summary of numerical results (of the first graphics window of the document) to Excel.

Syntax

SendResultsSummaryToExcel(doc, fileName, worksheetName, useFirstEmptyRow, cellName, includeHeader, includeFileName)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
fileName	string	Excel file path.
worksheetName	string	Excel worksheet name.
useFirstEmptyRow	double	If 1, NeuroExplorer will ignore cellName parameter and add the results to the first row where the cell in column A is empty. If 0, NeuroExplorer will paste data starting with the cell specified in **cellName.**
cellName	string	Excel cell where to paste the results. Should be in the form CR where C is Excel column name, R is the row number. For example, A1 is the top-left cell in the worksheet.
includeHeader	double	If 1, will paste column names.
includeFileName	double	If 1, will add a column with the data file name.

Returns

None

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
SendResultsSummaryToExcel(doc, "C:\Data\res.xls", "FromNex", 0, "A1", 1, 0)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.7.11. SaveNumResults Function

SaveNumResults Function

Saves the numerical results to a text file with the specified name.

Syntax

SaveNumResults(doc, fileName)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
fileName	string	File path for saved results.

Returns

None

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
SaveNumResults(doc, "C:\Data\res1.txt")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.7.12. SaveNumSummary Function

SaveNumSummary Function

Saves the summary of numerical results to a text file with the specified name.

Syntax

SaveNumSummary(doc, filename)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
filename	string	File path for saved results.

Returns

None

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
SaveNumSummary(doc, "C:\Data\res1summary.txt")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8. Operations on Variables Functions

The following operations on variables functions are available in NexScript

Function	Description
Rename	Renames the specified variable.
Join	Creates the new event that contains both the timestamps of var1 and the timestamps of var2.
Sync	Creates the new event containing all the timestamps of var1 that are in the intervals [var2+from, var2+to].
NotSync	Creates the new event containing all the timestamps of var1 that are NOT in the intervals [var2+from, var2+to].
FirstAfter	Creates the new event containing the first timestamp of var1 in each of the intervals [var2+from, var2+to].
FirstNAfter	Creates the new event containing the first N timestamps of var1 after each of the var2 timestamps.
LastBefore	Creates the new event containing the last timestamp of var1 in each of the intervals [var2+from, var2+to].
IntervalFilter	Creates the new event containing all the timestamps of var that are in the intervals of the intervalVar.
SelectTrials	Creates the new event containing the specified timestamps of variable var. selectList can contain comma-separated indexes or ranges of timestamps for example: 1,3-5,10.
SelectRandom	Creates the new event containing randomly selected timestamps of variable var.
SelectEven	Creates the new event containing even (2nd, 4th, etc.) timestamps of variable var.
SelectOdd	Creates the new event containing odd (1st, 3rd, etc.) timestamps of variable var.
ISIFilter	Creates the new event containing timestamps of the variable var that have preceding interspike intervals larger than min ISI.
FirstInInterval	Creates the new event. For each interval of intervalVar, the first var timestamp in this interval is copied to the result.
LastInInterval	Creates the new event. For each interval of intervalVar, the last var timestamp in this interval is copied to the result.
StartOfInterval	Creates the new event. Copies the start of each interval of intervalVar the result.
EndOfInterval	Creates the new event. Copies the end of each interval of intervalVar the result.
MakeIntervals	Creates new interval variable with intervals [varTimestamp+shiftmin, varTimestamp+shiftMax].
MakeIntFromStart	Creates new interval variable. For each timestamp (tstart) of intStartVar, it looks for the first timestamp (tend) of the intEndVar after tstart. If tend is before the next timestamp of intStartVar, it adds the interval [tstart+shift1, tend+shift2] to the result.
MakeIntFromEnd	Creates new interval variable. For each timestamp of the

	intEndVar (tend), it looks for the last timestamp (tstart) of the intStartVar before tend. If tstart is after the previous timestamp of intEndVar, it adds the interval [tstart+shift1, tend+shift2] to the result.
IntOpposite	Creates a new interval variable that contains intervals 'complementary' to the intervals of intervalvar.
IntOr	Creates a new Interval Variable that contains unions of the intervals of intervalVar1 and intervalVar2.
IntAnd	Creates a new Interval Variable that contains intersections of the intervals of intervalVar1 and intervalVar2.
IntSize	Creates a new Interval Variable that contains all of the intervals of intervalVar that have the length which is more or equal to minInt and less than or equal to intMax.
IntFind	Creates a new Interval Variable. Each interval of intervalVar that contains one or more timestamps of eventVar is copied to the result.
MarkerExtract	Creates a new event variable based on an existing marker variable.
Shift	Returns a new variable with all the timestamps of variable var shifted in time by shiftBy seconds.
NthAfter	Returns the N-th timestamp in var1 after the timestamp in var2.
PositionSpeed	Calculates position speed from X and Y coordinate variables. Speed is calculated from positions at times (t-deltaT, t+deltaT).
FilterContinuousVariable	Applies the specified frequency filter to the specified continuous variable.
LinearCombinationOfContVars	Calculates a linear combination of two continuous variables.
DecimateContVar	Decimates a continuous variable.

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.1. Rename Function

Rename Function

Renames the specified variable.

Syntax

Rename(doc, var, newName)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
var	variableReference	Reference to the variable.
newName	string	The new name of the variable.

Returns

None

Comments

Use this function when you need to assign the variable name generated in the script.

Usage

NexScript

```
doc = GetActiveDocument()
doc.Temp = IntervalFilter(GetVarByName("Neuron04a"), GetVarByName("Trials"))
Rename(doc, doc.Temp, "Neuron04a_filtered")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.2. Join Function

Join Function

Creates the new event that contains the timestamps of the two specified variables.

Syntax

variableReference Join(var1, var2)

Parameters

Parameter	Type	Description
var1	variableReference	Reference to the variable.
var2	variableReference	Reference to the variable.

Returns

Reference to the new variable.

Comments

Creates the new event that contains both the timestamps of var1 and the timestamps of var2.

Usage

NexScript

```
doc = GetActiveDocument()
doc.Events4and5 = Join(doc.Event4, doc.Event5)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.3. Sync Function

Sync Function

Creates the new event containing all the timestamps of var1 that are in the intervals [var2+from, var2+to].

Syntax

variableReference Sync(var1, var2, from, to)

Parameters

Parameter	Type	Description
var1	variableReference	Reference to the variable.
var2	variableReference	Reference to the variable.
from	double	Offset minimum (seconds).
to	double	Offset maximum (seconds).

Returns

Reference to the new variable.

Comments

Creates the new event containing all the timestamps of var1 that are in the intervals [var2+from, var2+to]

Usage

NexScript

```
doc = GetActiveDocument()
doc.synced_1_and_2 = Sync(doc.Neuron1, doc.Neuron2, -0.01, 0.01)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.4. NotSync Function

NotSync Function

Creates the new event containing all the timestamps of var1 that are NOT in the intervals [var2+from, var2+to].

Syntax

variableReference NotSync(var1, var2, from, to)

Parameters

Parameter	Type	Description
var1	variableReference	Reference to the variable.
var2	variableReference	Reference to the variable.
from	double	Offset minimum (seconds).
to	double	Offset maximum (seconds).

Returns

Reference to the new variable.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
doc.notSync_4_and_5 = NotSync(doc.Neuron04, doc.Neuron05, -0.01, 0.01)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.5. FirstAfter Function

FirstAfter Function

Creates the new event containing the first timestamp of var1 in each of the intervals [var2+from, var2+to].

Syntax

variableReference FirstAfter(var1, var2, from, to)

Parameters

Parameter	Type	Description
var1	variableReference	Reference to the variable.
var2	variableReference	Reference to the variable.
from	double	Offset of interval start around var2 timestamps.
to	double	Offset of interval end around var2 timestamps.

Returns

Reference to the new variable.

Comments

Creates the new event containing the first timestamp of var1 in each of the intervals [var2+from, var2+to].

Usage

NexScript

```
doc = GetActiveDocument()
% find the first spike of Neuron1 after each stimulus (in the first second after
stimulus)
doc.FirstN1 = FirstAfter(GetVarByName(doc, "Neuron1"), GetVarByName(doc,
"Stimulus"), 0, 1)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.6. FirstNAfter Function

FirstNAfter Function

Creates the new event containing the first N timestamps of one variable after each of the timestamps of the second variable.

Syntax

variableReference FirstNAfter(var1, var2, count)

Parameters

Parameter	Type	Description
var1	variableReference	Reference to the variable.
var2	variableReference	Reference to the variable.
count	double	How many timestamps of var1 (that are after each timestamp of var2) to copy to the result.

Returns

The reference to the new variable.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
doc.first5SpikesAfterStimulus = FirstNAfter(GetVarByName(doc,"Neuron1"),
GetVarByName(doc,"Stimulus"), 5)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.7. LastBefore Function

LastBefore Function

Creates the new event containing the last timestamp of var1 in each of the intervals [var2+from, var2+to].

Syntax

variableReference LastBefore(var1, var2, from, to)

Parameters

Parameter	Type	Description
var1	variableReference	Reference to the variable.
var2	variableReference	Reference to the variable.
from	double	Interval start offset (seconds).
to	double	Interval end offset (seconds).

Returns

Reference to the new variable.

Comments

Creates the new event containing the last timestamp of var1 in each of the intervals [var2+from, var2+to].

Usage

NexScript

```
doc = GetActiveDocument()
doc.last = LastBefore(doc.Neuron1, doc.Event4, 0, 5)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.8. IntervalFilter Function

IntervalFilter Function

Creates the new event containing all the timestamps of the specified event or neuron variable that are in the intervals of the specified interval variable.

Syntax

variableReference IntervalFilter(var, intervalVar)

Parameters

Parameter	Type	Description
var	variableReference	Reference to the variable.
intervalVar	variableReference	Reference to the interval variable.

Returns

Reference to the new variable.

Comments

Creates the new event containing all the timestamps of var that are in the intervals of the intervalVar

Usage

NexScript

```
doc = GetActiveDocument()
doc.filtered = IntervalFilter(GetVarByName(doc, "Neuron1"), GetVarByName(doc,
"Trials"))
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.9. SelectTrials Function

SelectTrials Function

Creates the new event containing the specified timestamps of a variable.

Syntax

variableReference SelectTrials(var, selectList)

Parameters

Parameter	Type	Description
var	variableReference	Reference to the variable.
selectList	string	A list of comma-separated indexes or ranges of timestamps. for example: 1,3-5,10.

Returns

The reference to the new variable.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
doc.selectedEvents = SelectTrials(GetVarByName("Event04"), "1,5-10")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.10. SelectRandom Function

SelectRandom Function

Creates the new event containing randomly selected timestamps of the specified variable.

Syntax

variableReference SelectRandom(var, nSelect)

Parameters

Parameter	Type	Description
var	variableReference	Reference to the variable.
nSelect	double	Number of timestamps to select.

Returns

The reference to the new event containing randomly selected timestamps of the specified variable.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
doc.randomEvents04 = SelectRandom(GetVarByName(doc, "Event04"), 10)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.11. SelectEven Function

SelectEven Function

Creates the new event containing even (2nd, 4th, etc.) timestamps of the specified variable.

Syntax

variableReference SelectEven(var)

Parameters

Parameter	Type	Description
var	variableReference	Reference to the variable.

Returns

The reference to the new event containing even (2nd, 4th, etc.) timestamps of the specified variable.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
doc.evenEvents04 = SelectEven(GetVarByName(doc, "Event04"))
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.12. SelectOdd Function

SelectOdd Function

Creates the new event containing the odd (1st, 3rd, etc.) timestamps of the specified variable.

Syntax

variableReference SelectOdd(var)

Parameters

Parameter	Type	Description
var	variableReference	Reference to the variable.

Returns

The reference to the new event containing the odd (1st, 3rd, etc.) timestamps of the specified variable.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
doc.oddEvents04 = SelectOdd(GetVarByName(doc, "Event04"))
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.13. ISIFilter Function

ISIFilter Function

Creates the new event containing the timestamps of the specified variable that have preceding interspike intervals larger than the specified value.

Syntax

variableReference ISIFilter(var, minISI)

Parameters

Parameter	Type	Description
var	variableReference	Reference to the variable.
minISI	double	Minimum ISI (in seconds).

Returns

Reference to the new variable.

Comments

Creates the new event containing timestamps of the variable var that have preceding interspike intervals larger than minISI.

Usage

NexScript

```
doc = GetActiveDocument()
doc.RemovedSmallISI = ISIFilter(doc.Neuron1, 0.1)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.14. FirstInInterval Function

FirstInInterval Function

Creates the new event. For each interval of the specified interval variable, the first timestamp in this interval is copied to the result.

Syntax

variableReference FirstInInterval(var, intervalVar)

Parameters

Parameter	Type	Description
var	variableReference	Reference to the neuron or event variable.
intervalVar	variableReference	Reference to the interval variable.

Returns

The reference to the new variable.

Comments

Creates the new event. For each interval of intervalVar, the first var timestamp in this interval is copied to the result.

Usage

NexScript

```
doc = GetActiveDocument()
doc.firstInTrial = FirstInInterval(GetVarByName(doc,"Neuron1"),
GetVarByName(doc,"Trials"))
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.15. LastInInterval Function

LastInInterval Function

Creates the new event. For each interval of the specified interval variable, the last timestamp in this interval is copied to the result.

Syntax

variableReference LastInInterval(var, intervalVar)

Parameters

Parameter	Type	Description
var	variableReference	Reference to the variable.
intervalVar	variableReference	Reference to the interval variable.

Returns

Reference to the new variable.

Comments

Creates the new event. For each interval of intervalVar, the last var timestamp in this interval is copied to the result.

Usage

NexScript

```
doc = GetActiveDocument()
doc.LastSpikeInTrial = LastInInterval(doc.Neuron1, doc.Trials)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.16. StartOfInterval Function

StartOfInterval Function

Creates the new event. Copies the start of each interval of the specified interval variable to the result.

Syntax

variableReference StartOfInterval(intervalVar)

Parameters

Parameter	Type	Description
intervalVar	variableReference	Reference to the interval variable.

Returns

Reference to the new variable.

Comments

Creates the new event. Copies the start of each interval of intervalVar to the result.

Usage

NexScript

```
doc = GetActiveDocument()
doc.TrialStarts = StartOfInterval(doc.Trial)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.17. EndOfInterval Function

EndOfInterval Function

Creates the new event based on the specified interval variable. Copies the end of each interval of the interval variable to the result.

Syntax

variableReference EndOfInterval(intervalVar)

Parameters

Parameter	Type	Description
intervalVar	double	Reference to an interval variable.

Returns

Reference to the new variable.

Comments

Creates the new event based on the specified interval variable. Copies the end of each interval of the interval variable to the result.

Usage

NexScript

```
doc = GetActiveDocument()
doc.trialEnds = EndOfInterval(GetVarByName(doc, "Trials"))
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.18. MakeIntervals Function

MakeIntervals Function

Creates new interval variable with intervals [varTimestamp+shiftmin, varTimestamp+shiftMax].

Syntax

variableReference MakeIntervals(var, shiftMin, shiftMax)

Parameters

Parameter	Type	Description
var	variableReference	Reference to the variable.
shiftMin	double	Shift minimum in seconds.
shiftMax	double	Shift maximum in seconds.

Returns

Reference to the new variable.

Comments

Creates new interval variable with intervals [varTimestamp+shiftmin, varTimestamp+shiftMax].

Usage

NexScript

```
doc = GetActiveDocument()
doc.IntAroundEvent04 = MakeIntervals(doc.Event04, 0, 2)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.19. MakeIntFromStart Function

MakeIntFromStart Function

Creates new interval variable. For each timestamp *tstart* of intStartVar, it looks for the first timestamp *tend* of the intEndVar after *tstart*. If *tend* is before the next timestamp of intStartVar, it adds the interval [*tstart* +shift1, *tend* +shift2] to the result.

Syntax

variableReference MakeIntFromStart(intStartVar, intEndVar, shift1, shift2)

Parameters

Parameter	Type	Description
intStartVar	variableReference	Reference to the variable
intEndVar	variableReference	Reference to the variable
shift1	double	Shift minimum (seconds).
shift2	double	Shift maximum (seconds).

Returns

Reference to the new variable.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
doc.Int2 = MakeIntFromStart(doc.Event04, doc.Event05, -0.1, 0.1)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.20. MakeIntFromEnd Function

MakeIntFromEnd Function

Creates new interval variable. For each timestamp *tend* of the intEndVar, it looks for the last timestamp (*tstart*) of the intStartVar before *tend*. If *tstart* is after the previous timestamp of intEndVar, it adds the interval [*tstart* +shift1, *tend* +shift2] to the result.

Syntax

variableReference MakeIntFromEnd(intStartVar, intEndVar, shift1, shift2)

Parameters

Parameter	Type	Description
intStartVar	variableReference	Reference to the variable.
intEndVar	variableReference	Reference to the variable.
shift1	double	Shift minimum (seconds).
shift2	double	Shift maximum (seconds).

Returns

Reference to the new variable.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
doc.Int2 = MakeIntFromEnd(doc.Event04, doc.Event05, -0.1, 0.1)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.21. IntOpposite Function

IntOpposite Function

Creates a new interval variable that contains intervals 'complementary' to the intervals of the specified interval variable.

Syntax

variableReference IntOpposite(doc, intervalVariable)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document
intervalVariable	variableReference	Reference to the interval variable.

Returns

Reference to the new interval variable.

Comments

Creates a new interval variable that contains intervals 'complementary' to the intervals of intervalVariable.

Usage

NexScript

```
doc = GetActiveDocument()
doc.OusideTrials = IntOpposite(doc, doc.Trials)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.22. IntOr Function

IntOr Function

Creates a new Interval Variable that contains unions of the intervals of intervalVar1 and intervalVar2.

Syntax

variableReference IntOr(doc, intervalVar1, intervalVar2)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
intervalVar1	variableReference	Reference to the interval variable.
intervalVar2	variableReference	Reference to the interval variable.

Returns

Reference to the new interval variable.

Comments

Creates a new Interval Variable that contains unions of the intervals of intervalVar1 and intervalVar2

Usage

NexScript

```
doc = GetActiveDocument()
doc.Trials1and2 = IntOr(doc, doc.Trials1, doc.Trials2)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.23. IntAnd Function

IntAnd Function

Creates a new Interval Variable that contains intersections of the intervals of intervalVar1 and intervalVar2.

Syntax

IntAnd(intervalVar1, intervalVar2)

Parameters

Parameter	Type	Description
intervalVar1	variableReference	Reference to the interval variable.
intervalVar2	variableReference	Reference to the interval variable.

Returns

The reference to the new interval variable.

Comments

Creates a new Interval Variable that contains intersections of the intervals of intervalVar1 and intervalVar2

Usage

NexScript

```
doc.Int3 = IntAnd(doc.Interval1, doc.Interval2)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.24. IntSize Function

IntSize Function

Creates a new Interval Variable that contains the intervals with the specified length range.

Syntax

variableReference IntSize(intervalVar, minInt, maxInt)

Parameters

Parameter	Type	Description
intervalVar	variableReference	Reference to the interval variable.
minInt	double	Minimum interval length (in seconds).
maxInt	double	Maximum interval length (in seconds).

Returns

Reference to the new interval variable.

Comments

Creates a new Interval Variable that contains all of the intervals of intervalVar that have the length which is more or equal to minInt and less than or equal to intMax.

Usage

NexScript

```
doc = GetActiveDocument()
doc.TrialsLessThan10secDuration = IntSize(doc.Trials, 0, 10)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.25. IntFind Function

IntFind Function

Finds all intervals that contain at least one timestamp of the specified event or neuron variable.

Syntax

variableReference IntFind(intervalVar, eventVar)

Parameters

Parameter	Type	Description
intervalVar	variableReference	Reference to the interval variable.
eventVar	variableReference	Reference to the event or neuron variable.

Returns

None

Comments

Creates a new Interval Variable. Each interval of intervalVar that contains one or more timestamps of eventVar is copied to the result.

Usage

NexScript

```
doc = GetActiveDocument()
doc.Ints1 = IntFind(doc.Interval1, doc.Event4)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.26. MarkerExtract Function

MarkerExtract Function

Creates a new event variable based on existing marker variable.

Syntax

variableReference MarkerExtract(doc, MarkerVariableName, ExtractString)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document
MarkerVariableName	string	The name of the marker variable.
ExtractString	string	Extract string. See comments.

Returns

None

Comments

ExtractString contains a list of items separated by commas. Items AND or OR should be placed between the conditions for the sample field. Conditions for each marker field should end with the item EOF. The last item in **ExtractString** list should be END.

For example, assume that we have a marker variable *Strobed* with one field that contains integer values. To extract all the timestamps with the field value 3 you may use the following command:

```
doc.NewEvent = MarkerExtract(doc, "Strobed", "=3,EOF,END")
```

To extract all the timestamps with the field values 3, 4 and 5 you may use the command:

```
doc.NewEvent = MarkerExtract(doc, "Strobed", ">2,AND,<6,EOF,END")
```

To use string comparisons in timestamp extraction, add $ sign at the beginning of the string. For example, to extract timestamps with *Ev_Marker* field value *WL*, use:

```
doc.NewEvent1 = MarkerExtract(doc, "Ev_Marker", "=$WL,EOF,END")
```

Usage

NexScript

```
doc = GetActiveDocument()
doc.NewEvent = MarkerExtract(doc, "Strobed", "=3,EOF,END")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.27. Shift Function

Shift Function

Returns a new variable with all the timestamps of variable var shifted in time by shiftBy seconds.

Syntax

variableReference Shift(var, shiftBy)

Parameters

Parameter	Type	Description
var	variableReference	Reference to the variable.
shiftBy	double	Shift value (in seconds).

Returns

Reference to the new variable.

Comments

Returns a new variable with all the timestamps of variable var shifted in time by shiftBy seconds.

Usage

NexScript

```
doc = GetActiveDocument()
doc.Event04Shifted = Shift(doc.Event04, 10)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.28. NthAfter Function

NthAfter Function

Creates the new variable with the N-th timestamp in var1 after each timestamp in var2.

Syntax

variableReference NthAfter(var1, var2, N)

Parameters

Parameter	Type	Description
var1	variableReference	Reference to the variable
var2	variableReference	Reference to the variable
N	double	Spike number.

Returns

Reference to the new variable.

Comments

Creates the new variable with the N-th timestamp in var1 after each timestamp in var2.

Usage

NexScript

```
doc = GetActiveDocument()
doc.SecondSpike = NthAfter(doc.Neuron1, doc.Neuron2, 2)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.29. PositionSpeed Function

PositionSpeed Function

Calculates the position speed from X and Y coordinate variables and creates a new continuous variable.

Syntax

variableReference PositionSpeed(varX, varY, deltaT, smoothRadius)

Parameters

Parameter	Type	Description
varX	variableReference	Reference to the variable.
varY	variableReference	Reference to the variable.
deltaT	double	Time step for speed calculation.
smoothRadius	double	Smooth parameter. See Comments.

Returns

Reference to the new variable

Comments

PositionSpeed operation calculates the scalar speed of a pair of the position variables.

1. First, for each data point of Position variable PosX[T], where T is time, the raw scalar speed is calculated:

dX = PosX[T + DeltaT] - PosX[T]

dY = PosY[T + DeltaT] - PosY[T]

RawScalarSpeed[T] = sqrt(dX*dX + dY*dY) / DeltaT

If there is no data point at time T + DeltaT, a linear interpolation is used to calculate PosX[T + DeltaT] and PosY[T + DeltaT].

2. Second, RawScalarSpeed is smoothed with the Gaussian filter. The parameters of the filter are such that the width (in seconds) of the Gaussian curve at half the height is equal to the value of Smooth parameter. If Smooth = 0, Gaussian filter is not applied.

Usage

NexScript

```
doc = GetActiveDocument()
doc.speed = PositionSpeed(doc.LED1_X, doc.LED1_Y, 0.1, 0.5)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.30. FilterContinuousVariable Function

FilterContinuousVariable Function

Filters the specified continuous variable using the specified frequency filter.

Syntax

FilterContinuousVariable(doc, contVar, filteredVarName, filterType, filterOrder, freq1, freq2)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
contVar	variableReference	Reference to the variable.
filteredVarName	string	The name of the filtered variable.
filterType	string	The type of the filter. Should be "Lowpass", "Highpass", "Bandpass", "Bandstop" or "Notch".
filterOrder	double	The number specifying the filter order. Should be between 3 and 11 inclusive.
freq1	double	Filter frequency parameter (in Hz). See comments below.
freq2	double	Filter frequency parameter (in Hz). See comments below.

Returns

None

Comments

If the filter type is **Lowpass** or **Highpass**, **freq1** is a cutoff frequency and **freq2** is not used.

If the filter type is **Bandpass** or **Bandstop**, **freq1** is a minimum of the frequency range and **freq2** is a maximum of the frequency range.

If the filter type is **Notch**, **freq1** is the center of Notch filter and **freq2** is the width of the Notch filter.

Usage

NexScript

The following sample script applies Bandpass filter to the variable ContChannel01. The result of filtering will be saved in continuous variable Cont1BandFiltered. The filter order is 5 and the frequency band is from 1000 Hz to 2000 Hz:

```
doc = GetActiveDocument()
var = GetVarByName(doc, "ContChannel01")
FilterContinuousVariable(doc, var, "Cont1BandFiltered", "Bandpass", 5, 1000, 2000)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.31. LinearCombinationOfContVars Function

LinearCombinationOfContVars Function

Calculates a linear combination of two continuous variables.

Syntax

LinearCombinationOfContVars(doc, resultName, contVar1, coeff1, contVar2, coeff2)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
resultName	string	The name of the result.
contVar1	variableReference	Reference to the first continuous variable.
coeff1	double	Coefficient for the first continuous variable
contVar2	variableReference	Reference to the second continuous variable.
coeff2	double	Coefficient for the second continuous variable

Returns

None

Comments

This function calculates a linear combination of two continuous variables. The values of the resulting variable are:

```
contVar1_value*coeff1 + contVar2_value*coeff2
```

Usage

NexScript

```
doc = GetActiveDocument()
% calculate average of contVar1 and contVar2
LinearCombinationOfContVars(doc, "average", doc.contVar1, 0.5, doc.contVar2, 0.5)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.8.32. DecimateContVar Function

DecimateContVar Function

Decimates a continuous variable.

Syntax

DecimateContVar(doc, resultName, contVar, decimationFactor)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
resultName	string	The name of the decimated continuous variable.
contVar	variableReference	Reference to the variable.
decimationFactor	double	If decimationFactor = 2, every second data point of contVar is copied to the result, if decimationFactor = 3, every third, etc.

Returns

None

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
DecimateContVar(doc, "decimated", doc.contVar1, 10)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.9. Matlab Functions

The following matlab functions are available in NexScript

Function	Description
SendSelectedVarsToMatlab	Sends the selected variables to Matlab.
ExecuteMatlabCommand	Sends the string command to Matlab and executes the command in Matlab.
GetVarFromMatlab	Gets the specified timestamped variable (array of timestamps) from Matlab.
GetContVarFromMatlab	Imports the specified matrix containing continuous variable data from Matlab.
GetContVarWithTimestampsFromMatlab	Imports the specified matrix containing continuous variable data from Matlab.
GetIntervalVarFromMatlab	Imports the specified matrix containing intervals from Matlab.

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.9.1. SendSelectedVarsToMatlab Function

SendSelectedVarsToMatlab Function

Sends selected variables to Matlab.

Syntax

SendSelectedVarsToMatlab(doc)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.

Returns

None

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
SendSelectedVarsToMatlab(doc)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.9.2. ExecuteMatlabCommand Function

ExecuteMatlabCommand Function

Sends the string command to Matlab and executes the command in Matlab.

Syntax

ExecuteMatlabCommand(command)

Parameters

Parameter	Type	Description
command	string	Matlab command to be run.

Returns

None

Comments

Any valid Matlab command that you can type at Matlab prompt can be used. For example, you can call a Matlab script or a function.

Usage

NexScript

```
ExecuteMatlabCommand("x=randn(10,1);plot(x)")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.9.3. GetVarFromMatlab Function

GetVarFromMatlab Function

Gets the specified neuron or event variable from Matlab.

Syntax

GetVarFromMatlab(doc, varname, isneuron)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
varname	string	The name of the matrix in Matlab workspace. The matrix should be a double matrix with either one row or one column of data containing timestamps in seconds.
isneuron	double	If isneuron is 1, the imported variable is added to the list of Neurons. Otherwise, the variable is added to the list of events.

Returns

None

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
% get the 1-column matrix ev1 and add it to the list of events
GetVarFromMatlab(doc, "ev1", 0)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.9.4. GetContVarFromMatlab Function

GetContVarFromMatlab Function

Imports the specified matrix from Matlab. Each column of the matrix is imported as a continuous variable.

Syntax

GetContVarFromMatlab(doc, MatrixName, TimestampOfFirstValue, TimeStep)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
MatrixName	string	The name of a matrix in Matlab workspace.
TimestampOfFirstValue	double	The timestamp (in seconds) of the first value of each continuous variable.
TimeStep	double	Digitizing time step (in seconds) of the imported variables.

Returns

None

Comments

This function adds continuous variables to the specified document. The names of the variables include the MatrixName and the column number.

Usage

NexScript

```
doc = GetActiveDocument()
% import matrix contData from Matlab. first timestamp is 0, time step is 0.001s.
GetContVarFromMatlab(doc, "contData", 0, 0.001)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.9.5. GetContVarWithTimestampsFromMatlab Function

GetContVarWithTimestampsFromMatlab Function

Imports the specified 2-column matrix containing continuous variable data from Matlab.

Syntax

GetContVarWithTimestampsFromMatlab(doc, MatrixName, UseFirstDeltaAsDigRate)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document
MatrixName	string	The name of the Matrix in Matlab workspace. The first column of the matrix should contain the values of a continuous variable, the second column - the corresponding timestamps.
UseFirstDeltaAsDigRate	double (0 or 1)	If this parameter is positive, the difference between the second and the first timestamp is used as the variable digitizing rate.

Returns

None

Comments

This function adds a continuous variable to the specified document. The name of the new variable is the MatrixName.

Usage

NexScript

```
doc = GetActiveDocument()
GetContVarWithTimestampsFromMatlab(doc, MatrixName, UseFirstDeltaAsDigRate)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.9.6. GetIntervalVarFromMatlab Function

GetIntervalVarFromMatlab Function

Imports the specified matrix containing intervals from Matlab.

Syntax

GetIntervalVarFromMatlab(doc, MatrixName)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
MatrixName	string	The name of the 2-column matrix in Matlab workspace.

Returns

None

Comments

Imports the specified 2-column matrix from Matlab. The first column of the matrix should contain interval start times in seconds, the second column - interval end times in seconds.

Usage

NexScript

```
doc = GetActiveDocument()
GetIntervalVarFromMatlab(doc, "trials")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.10. Excel Functions

The following Excel functions are available in NexScript

Function	Description
SetExcelCell	Sets the text value of the specified cell in Excel.
CloseExcelFile	Closes the specified Excel file if the file is open.
SendResultsToExcel	Sends numerical results (of the first graphics window of the document) to Excel.
SendResultsSummaryToExcel	Sends summary of numerical results (of the first graphics window of the document) to Excel.

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.10.1. SetExcelCell Function

SetExcelCell Function

Sets the text value of the specified cell in Excel.

Syntax

SetExcelCell(worksheet, cell, text, excelFilePath)

Parameters

Parameter	Type	Description
worksheet	string	The name of the worksheet.
cell	string	Excel cell specification, Should be in the form CR where C is Excel column name, R is the row number. For example, "A1" is the top-left cell in the worksheet.
text	string	The text to be copied to the cell.
excelFilePath	string	Full path of the Excel file. This parameter is optional. See Usage below.

Returns

None

Comments

None

Usage

NexScript

```
% this call will open Excel, Excel will create
% a new workbook (Excel file) and paste the text to the specified cell
SetExcelCell("fromNex", "A1", "cell text")

% this call will set the cell in the specified Excel file
SetExcelCell("fromNex", "A1", "cell text", "C:\Data\Results.xls")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.10.2. CloseExcelFile Function

CloseExcelFile Function

Closes the specified Excel file if the file is open.

Syntax

CloseExcelFile(filePath)

Parameters

Parameter	Type	Description
filePath	string	Full path of the Excel file.

Returns

None

Comments

None

Usage

NexScript

```
excelFilePath = "C:\Data\NexResults.xls"
SendResultsToExcel(doc, excelFilePath, "Nex", 0, "A1", 1, 0)
CloseExcelFile(excelFilePath)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.11. Power Point Functions

The following power point functions are available in NexScript

Function	Description
SendGraphicsToPowerPoint	Sends analysis graphics to the specified Power Point file.
ClosePowerPointFile	Closes the specified Power Point file if the file is open.

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.11.1. SendGraphicsToPowerPoint Function

SendGraphicsToPowerPoint Function

Sends the contents of the first graphical window of the document to the specified Power Point presentation.

Syntax

SendGraphicsToPowerPoint (doc, presentationPath, slideTitle, comment, addParameters, useBitmap)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
presentationPath	string	Path of the presentation file.
slideTitle	string	Slide title.
comment	string	Slide comment. Will be shown below graphics.
addParameters	double	If 1, add a text box with analysis parameter values.
useBitmap	double	If 1, transfer graphics as a bitmap, otherwise, transfer graphics as a metafile.

Returns

None

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
SendGraphicsToPowerPoint(doc, "C:\Data\NexResults.ppt", "Slide 1", "Sample slide",
1, 0)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.11.2. ClosePowerPointFile Function

ClosePowerPointFile Function

Closes the specified Power Point file if the file is open.

Syntax

ClosePowerPointFile(filePath)

Parameters

Parameter	Type	Description
filePath	string	Full path of the Power Point file.

Returns

None

Comments

None

Usage

NexScript

```
pptFilePath = "C:\Data\NexResults.ppt"
SendGraphicsToPowerPoint(doc, pptFilePath, "Slide 1", "Sample slide", 1, 0)
ClosePowerPointFile(pptFilePath)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.12. Running Script Functions

The following running script functions are available in NexScript

Function	Description
RunScript	Runs the script with the specified file name.
Sleep	Pauses execution of the script.

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.12.1. RunScript Function

RunScript Function

Runs the script with the specified name.

Syntax

RunScript(scriptName)

Parameters

Parameter	Type	Description
scriptName	string	Script name.

Returns

None

Comments

None

Usage

NexScript

```
RunScript("MyOtherScript")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.12.2. Sleep Function

Sleep Function

Pauses execution of the script for nms milliseconds.

Syntax

Sleep(nms)

Parameters

Parameter	Type	Description
nms	double	The number of milliseconds to pause.

Returns

None

Comments

None

Usage

NexScript

```
% pause for 2 seconds
Sleep(2000)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13. Math Functions

The following math functions are available in NexScript

Function	Description
seed	Initializes random number generator.
expo	Generates a random value exponentially distributed with the specified mean.
floor	Returns the largest integer that is less than or equal to the specified number.
ceil	Returns the smallest integer that is greater than or equal to the specified number.
round	Rounds the specified number to the nearest integer.
abs	Returns the absolute value of the specified number.
sqrt	Returns square root of the specified number.
pow	Returns the specified number raised to the specified power.
exp	Returns exponential of the specified number.
min	Returns minimum of two numbers.
max	Returns maximum two number.
log	Returns logarithm of the specified number.
sin	Returns sine of the specified number.
cos	Returns cosine of the specified number.
tan	Returns tangent of the specified number.
acos	Returns arccosine of the specified number.
asin	Returns arcsine of the specified number.
atan	Returns arctangent of the specified number.
RoundToTS	Rounds the number to the nearest timestamp value.
GetFirstGE	Returns the index of the first timestamp in the specified variable that is greater or equal to the specified number.
GetFirstGT	Returns the index of the first timestamp in the specified variable that is greater than the specified number.
GetBinCount	Calculates the number of timestamps in neuron the specified time interval.
BitwiseAnd	Converts values to unsigned integers and performs bitwise AND operation.
BitwiseOr	Converts values to unsigned integers and performs bitwise OR operation.
GetBit	Converts the specified number to an unsigned integer and returns the value of the specified bit (1 to 32).

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.1. seed Function

seed Function

Initializes random number generator.

Syntax

seed(double iseed)

Parameters

Parameter	Type	Description
iseed	double	Numeric seed value. Should be a positive integer.

Returns

None

Comments

None

Usage

NexScript

```
seed(1717)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.2. expo Function

expo Function

Generates a random value exponentially distributed with the specified mean.

Syntax

double expo(double fmean)

Parameters

Parameter	Type	Description
fmean	double	Mean of the exponential distribution.

Returns

None

Comments

None

Usage

NexScript

```
y = expo(10)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.3. floor Function

floor Function

Returns the largest integer that is less than or equal to the specified number.

Syntax

double floor(double x)

Parameters

Parameter	Type	Description
x	double	Numeric value.

Returns

Returns the largest integer that is less than or equal to x.

Comments

None

Usage

NexScript

```
x = 1.7
y = floor(x)
% y now equals to 1
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.4. ceil Function

ceil Function

Returns the smallest integer that is greater than or equal to the specified number.

Syntax

double ceil(double x)

Parameters

Parameter	Type	Description
x	double	Numeric value.

Returns

Returns the smallest integer that is greater than or equal to x.

Comments

None

Usage

NexScript

```
x = ceil(1.01)
% x now equals to 2
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.5. round Function

round Function

Rounds the specified number to the nearest integer.

Syntax

round(double x)

Parameters

Parameter	Type	Description
x	double	Numeric value.

Returns

Returns the integer that is closest to x

Comments

None

Usage

NexScript

```
y = round(1.3)
% y now is 1
y = round(1.6)
% y now is 2
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.6. abs Function

abs Function

Returns absolute value of the specified number.

Syntax

double abs(double x)

Parameters

Parameter	Type	Description
x	double	Numeric value.

Returns

Returns absolute value of x.

Comments

None

Usage

NexScript

```
% this script tests abs function
x = -2
ax = abs(x)
% ax equals to 2
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.7. sqrt Function

sqrt Function

Returns the square root of the specified number.

Syntax

double sqrt(double x)

Parameters

Parameter	Type	Description
x	double	Numeric value (should be non-negative).

Returns

Returns the square root of x.

Comments

None

Usage

NexScript

```
y = sqrt(2)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.8. pow Function

pow Function

Returns x raised to the power of y.

Syntax

double pow(double x, double y)

Parameters

Parameter	Type	Description
x	double	Number to be raised to the specified power.
y	double	The power.

Returns

Returns x raised to the power of y.

Comments

None

Usage

NexScript

```
z = pow(2, 3)
% z now equals to 8
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.9. exp Function

exp Function

Returns exponential of x.

Syntax

double exp(double x)

Parameters

Parameter	Type	Description
x	double	Numeric value.

Returns

Returns exponential of x.

Comments

None

Usage

NexScript

```
y = exp(2.5)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.10. min Function

min Function

Returns the minimum of two numbers.

Syntax

double min(double x, double y)

Parameters

Parameter	Type	Description
x	double	Numeric value.
y	double	Numeric value.

Returns

Returns minimum of x and y.

Comments

None

Usage

NexScript

```
x = 4
y = 2
z = min(x, y)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.11. max Function

max Function

Returns maximum of two numbers.

Syntax

max(double x, double y)

Parameters

Parameter	Type	Description
x	double	Numeric value.
y	double	Numeric value.

Returns

Returns maximum of x and y.

Comments

None

Usage

NexScript

```
x = 7
y = max(x, 5)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.12. log Function

log Function

Returns logarithm of the specified number.

Syntax

log(double x)

Parameters

Parameter	Type	Description
x	double	Numeric value (the value should be positive).

Returns

Returns logarithm of x.

Comments

None

Usage

NexScript

```
y = log(2.5)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.13. sin Function

sin Function

Returns sine of the specified number.

Syntax

sin(double x)

Parameters

Parameter	Type	Description
x	double	Numeric value (sine parameter in radians).

Returns

Returns the sine of x.

Comments

None

Usage

NexScript

```
x = 10
y = sin(x)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.14. cos Function

cos Function

Returns cosine of the specified number.

Syntax

double cos(double x)

Parameters

Parameter	Type	Description
x	double	Numeric value (cosine parameter in radians).

Returns

Returns cosine of x.

Comments

None

Usage

NexScript

```
y = cos(0.5)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.15. tan Function

tan Function

Returns tangent of the specified number.

Syntax

tan(double x)

Parameters

Parameter	Type	Description
x	double	Numeric value (tangent parameter in radians).

Returns

Returns tangent of x.

Comments

None

Usage

NexScript

```
y = tan(1)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.16. acos Function

acos Function

Returns the arccosine (in radians) of the specified number.

Syntax

double acos(double x)

Parameters

Parameter	Type	Description
x	double	Numeric value (the value should be from -1 to +1).

Returns

Returns y such that x = cos(y).

Comments

None

Usage

NexScript

```
x = 0.5
y = acos(x)
% y is 1.047197551
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.17. asin Function

asin Function

Returns the arcsine of the specified number.

Syntax

double asin(double x)

Parameters

Parameter	Type	Description
double	x	Numeric value (the value should be from -1 to +1).

Returns

Returns y such that x = sin(y).

Comments

None

Usage

NexScript

```
x = 0.5
y = asin(x)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.18. atan Function

atan Function

Returns the arctangent of the specified number.

Syntax

double acos(double x)

Parameters

Parameter	Type	Description
double	x	Numeric value.

Returns

Returns y such that x = tan(y).

Comments

None

Usage

NexScript

```
x = 2
y = atan(x)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.19. RoundToTS Function

RoundToTS Function

Rounds the specified number to the nearest timestamp value.

Syntax

double RoundToTS(doc, time)

Parameters

Parameter	Type	Description
doc	documentReference	Reference to the document.
time	double	The time value (in seconds) to be rounded.

Returns

The document timestamp value (in seconds) nearest to the specified time.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
ts = RoundToTS(doc, 1.234)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.20. GetFirstGE Function

GetFirstGE Function

Returns the index of the first timestamp in the specified variable that is greater than or equal to the specified number.

Syntax

double GetFirstGE(var, number)

Parameters

Parameter	Type	Description
var	variableReference	Reference to the variable.
number	double	Time value in seconds.

Returns

Returns the index of the first timestamp in the specified variable that is greater than or equal to the specified number.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
neuron = GetVarByName(doc, "Neuron04a")
% get the index of the first spike at or after 5.7s
index = GetFirstGE(var, 5.7)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.21. GetFirstGT Function

GetFirstGT Function

Returns the index of the first timestamp in the specified variable that is greater than the specified number.

Syntax

double GetFirstGT(var, number)

Parameters

Parameter	Type	Description
var	variableReference	Reference to the variable.
number	double	Time value in seconds.

Returns

Returns the index of the first timestamp in the specified variable that is greater than the specified number.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
neuron = GetVarByName(doc, "Neuron04a")
% get the index of the first spike after 5.7s
index = GetFirstGT(var, 5.7)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.22. GetBinCount Function

GetBinCount Function

Calculates the number of timestamps in the specified time range.

Syntax

double GetBinCount(var, timeMin, timeMax)

Parameters

Parameter	Type	Description
var	variableReference	Reference to a variable. Should be a reference to a neuron, event, interval or continuous variable.
timeMin	double	Time range minimum (in seconds).
timeMax	double	Time range maximum (in seconds).

Returns

The number of timestamps of the specified variable in the specified time range.

Comments

None

Usage

NexScript

```
doc = GetActiveDocument()
neuron = GetVarByName("Neuron04a")
% calculate how many timestamps of Neuron04a are in the interval [5.3s, 10.2s]
count = GetBinCount(neuron, 5.3, 10.2)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.23. BitwiseAnd Function

BitwiseAnd Function

Returns the result of the bitwise AND operation.

Syntax

double BitwiseAnd(value1, value2)

Parameters

Parameter	Type	Description
value1	double	Numeric value.
value2	double	Numeric value.

Returns

Result of the bitwise AND operation.

Comments

value1 and value2 are converted to integers and then bitwise AND operation is applied to these integers.

Usage

NexScript

```
x = BitwiseAnd(7, 1)
% x now equals to 1
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.24. BitwiseOr Function

BitwiseOr Function

Returns the result of the bitwise OR operation.

Syntax

double BitwiseOr(value1, value2)

Parameters

Parameter	Type	Description
value1	double	Numeric value.
value2	double	Numeric value.

Returns

Result of the bitwise OR operation.

Comments

value1 and value2 are converted to integers and then the bitwise OR operation is applied to these integers.

Usage

NexScript

```
x = BitwiseOr(2, 1)
% x now equals to 3
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.13.25. GetBit Function

GetBit Function

Returns the value of the specified bit (1 to 32).

Syntax

double GetBit(number, bitNumber)

Parameters

Parameter	Type	Description
number	double	Numeric value.
bitNumber	double	1-based bin number. 1 is the least significant bit, 32 is the most significant bit.

Returns

Returns the value (0 or 1) of the specified bit.

Comments

The first parameter is converted to an unsigned 32-bit integer and then the bit value of this unsigned integer is returned.

Usage

NexScript

```
% get the second bit of 3
b2 = GetBit(3, 2)
% b2 is now equal to 1
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.14. String Functions

The following string functions are available in NexScript

Function	Description
Left	Extracts substring from the left part of the string, returns string.
Mid	Extracts substring from the middle of the string.
Right	Extracts substring from the right part of the string.
Find	Looks for a substring inside the specified string.
StrLength	Calculates the number of characters in the string, returns number.
NumToStr	Converts a number to string using optional format, returns string.
StrToNum	Converts string to number.
GetNumFields	Returns the number of fields in the string. The field is a substring that does not contain spaces, tabs or commas.
GetField	Returns the field with the specified field index.
CharToNum	Converts a one-character string to a number (a character's ASCII code).
NumToChar	Converts a number to a one-character string containing the character with the ASCII code equal to the number.

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.14.1. Left Function

Left Function

Returns a substring that starts at the beginning of the string.

Syntax

string Left(string, nchar)

Parameters

Parameter	Type	Description
string	string	String parameter.
nchar	number	Number of characters in the substring.

Returns

Returns a substring that starts at the beginning of the string.

Comments

None

Usage

NexScript

```
sub = Left("abcdefg", 3)
% sub now is "abc"
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.14.2. Mid Function

Mid Function

Returns the specified substring.

Syntax

string Mid(string, nstartchar, nchar)

Parameters

Parameter	Type	Description
string	string	String parameter.
nstartchar	double	1-based index of the start character.
nchar	double	Number of characters to select.

Returns

Returns the substring that starts at character nstartchar and contains nchar characters.

Comments

None

Usage

NexScript

```
sub = Mid("abcdefg", 2, 3)
% sub now is "cde"
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.14.3. Right Function

Right Function

Returns a substring that ends at the end of the string.

Syntax

string Right(string, nchar)

Parameters

Parameter	Type	Description
string	string	String parameter.
nchar	string	Number of characters in the substring.

Returns

Extracts right nchar characters from string, returns string.

Comments

None

Usage

NexScript

```
sub = Right("abcdefg", 3)
% sub now is "efg"
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.14.4. Find Function

Find Function

Looks for a substring inside a specified string.

Syntax

double Find(string1, string2)

Parameters

Parameter	Type	Description
string1	string	The string where we look for a substring.
string2	string	The substring that we are trying to find.

Returns

Looks for a string string2 inside the string string1, returns a number - the position of the first character of string2 in the string1. Returns zero is string2 is not found.

Comments

None

Usage

NexScript

```
% this script selects only the neurons that have "05" in their name
doc = GetActiveDocument()
DeselectAll(doc)
for i=1 to GetVarCount(doc, "neuron")
   name = GetVarName(doc, i, "neuron")
   if Find(name, "05")> 0
       SelectVar(doc, i, "neuron")
   end
end
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.14.5. StrLength Function

StrLength Function

Calculates the number of characters in the string.

Syntax

double StrLength(string)

Parameters

Parameter	Type	Description
string	string	The string parameter.

Returns

Returns the number of characters in the string.

Comments

None

Usage

NexScript

```
n = StrLength("abcd")
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.14.6. NumToStr Function

NumToStr Function

Converts number to string using optional format string.

Syntax

string NumToStr(number, formatString)

Parameters

Parameter	Type	Description
number	double	Number to be converted to string.
formatString	string	Optional format string (a standard C/C++ format specifier). See, for example, http://www.cplusplus.com/reference/clibrary/cstdio/printf/

Returns

Returns string representing the specified number.

Comments

None

Usage

NexScript

For example, to generate strings:

Event001, Event002, ..., Event016

use the following loop

```
for i=1 to 16
   str = "Event0" + NumToStr(i, "%02.0f")
end
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.14.7. StrToNum Function

StrToNum Function

Converts string to number.

Syntax

double StrToNum(stringRepresentingNumber)

Parameters

Parameter	Type	Description
stringRepresentingNumber	string	A string containing a valid representation of the number, for example, "1", "002", "123.456".

Returns

Returns the number corresponding to the specified string.

Comments

None

Usage

NexScript

```
x = StrToNum("003")
% x now equals to 3
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.14.8. GetNumFields Function

GetNumFields Function

Returns the number of fields in the string. The field is a substring that does not contain spaces, tabs or commas.

Syntax

GetNumFields(stringWithFields)

Parameters

Parameter	Type	Description
stringWithFields	string	The string containing fields. The field is a substring that does not contain spaces, tabs or commas.

Returns

Returns the number of fields in the string. The field is a substring that does not contain spaces, tabs or commas.

Comments

None

Usage

NexScript

```
numFields = GetNumFields("One two 3 4")
% numFields is now equal to 4
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.14.9. GetField Function

GetField Function

Returns the string field.

Syntax

string GetField(stringWithFields, fieldnumber)

Parameters

Parameter	Type	Description
stringWithFields	string	The string containing multiple data fields. The field is a substring that does not contain spaces, tabs or commas.
fieldnumber	double	The field number.

Returns

Returns the field with the specified number as a string. The field is a substring that does not contain spaces, tabs or commas. For example,

GetField("One two 3 4", 3) returns "3".

Comments

None

Usage

NexScript

```
secondField = GetField("Neuro04a Neuron05b", 2)
% secondField now equals to "Neuron05b"
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.14.10. CharToNum Function

CharToNum Function

Converts a one-character string to a number (a character's ASCII code).

Syntax

double CharToNum(oneCharString)

Parameters

Parameter	Type	Description
oneCharString	string	A string of length 1 (for example, "a", "5").

Returns

The string character's ASCII code.

Comments

None

Usage

NexScript

```
x = CharToNum("1")
% x now equals to 49
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.14.11. NumToChar Function

NumToChar Function

Converts a number to a one-character string containing a character with the ASCII code equal to the number.

Syntax

string NumToChar(number)

Parameters

Parameter	Type	Description
number	double	ASCII code of the character.

Returns

Returns a one-character string containing the character with the ASCII code equal to the specified number.

Comments

None

Usage

NexScript

```
oneAsString = NumToChar(49)
% oneAsString now equals to "1"
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.15. Debug Functions

The following debug functions are available in NexScript

Function	Description
Trace	Prints arguments to output window.
MsgBox	Displays a message box.

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.15.1. Trace Function

Trace Function

Prints arguments to the output window.

Syntax

Trace(arg1, arg2, ...)

Parameters

Parameter	Type	Description
arg1	any type	String, number or any other valid NexScript value.
arg2	any type	String, number or any other valid NexScript value.

Returns

None

Comments

Converts each parameter to string and the prints the result to the output window.

Usage

NexScript

```
x = 30
% print the value of x
Trace("x=", x)
```

See Also

Introduction to NexScript Programming

NexScript Function Categories

5.5.15.2. MsgBox Function

MsgBox Function

This function is equivalent to Trace function.

See Also

Introduction to NexScript Programming

NexScript Function Categories

6. COM/ActiveX Interfaces

NeuroExplorer exposes COM (Component Object Model) interfaces that allow other applications to launch and control NeuroExplorer.

For example, the following Matlab code starts NeuroExplorer, opens a data file and loads Neuron04a timestamps into the Matlab workspace:

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
neuron = doc.Variable('Neuron04a');
timestamps = neuron.Timestamps();
```

The table below lists the objects that NeuroExplorer exposes via COM methods and properties.

Interface	Description
Application	Neuroexplorer application interface. Provides methods and properties for the main application (for example, open document).
Document	Document interface. Provides methods and properties of the document (for example, lists variables in the document).
Variable	Variable interface. Provides methods and properties of a variable inside a document (for example, gets variable timestamps).

6.1. Application

Application Interface

External applications can open an instance of NeuroExplorer using its Program ID **"NeuroExplorer.Application"**.

For example, to open NeuroExplorer (or to connect to a running instance of NeuroExplorer) in Matlab , you can use the following command:

```
nex = actxserver('NeuroExplorer.Application');
```

The object returned by the actxserver command is an Application object. The properties and methods of this object are listed below.

Properties

Property	Description
ActiveDocument	Read-only access to the active document
DocumentCount	The number of open documents
Version	NeuroExplorer version
Visible	Controls visibility of the application

Methods

Method	Description
OpenDocument	Opens a specified document (data file)
Document	Returns one of the open documents
Sleep	Pauses the program
RunNexScript	Runs NexScript saved in a file
RunNexScriptCommands	Runs the specified NexScript text

See Also

COM/ActiveX Interfaces

6.1.1. ActiveDocument Property

Application.ActiveDocument Property

Read-only property that returns a Document object that represents the active document (the document corresponding to the active window of the application). Returns null if there are no open documents.

Syntax

Document ActiveDocument

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.ActiveDocument;
```

See Also

Application Interface

Document Interface

COM/ActiveX Interfaces

6.1.2. DocumentCount Property

Application.DocumentCount Property

Read-only property that returns the number of open documents (data files).

Syntax

int DocumentCount

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
numDocs = nex.DocumentCount;
```

See Also

Application Interface

COM/ActiveX Interfaces

6.1.3. Version Property

Application.Version Property

Read-only property that returns a string with the current version of NeuroExplorer.

Syntax

string Version

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
version = nex.Version;
```

See Also

Application Interface

COM/ActiveX Interfaces

6.1.4. Visible Property

Application.Visible Property

Boolean read/write property that controls the visibility of NeuroExplorer.

Syntax

Boolean Visible

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
isVisible = nex.Visible;
% make sure that NeuroExplorer is visible
nex.Visible = true;
```

See Also

Application Interface

COM/ActiveX Interfaces

6.1.5. OpenDocument Method

Application.OpenDocument Method

Opens the specified data file. Returns Document object if succeeded.

Syntax

Document OpenDocument (string documentPath)

Parameters

Parameter	Type	Description
documentPath	string	Full data file path

Returns

Returns Document object.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
```

See Also

Application Interface

Document Interface

COM/ActiveX Interfaces

6.1.6. Document Medhod

Application.Document Method

Returns Document object for the specified document index.

Syntax

Document Document(int documentIndex)

Parameters

Parameter	Type	Description
documentIndex	int	1-based document index

Returns

Returns Document object.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
% get the first open document
doc = nex.Document(1);
```

See Also

Application Interface

Document Interface

COM/ActiveX Interfaces

6.1.7. Sleep Method

Application.Sleep Method

Pauses the application.

Syntax

void Sleep (int millisecondsToSleep)

Parameters

Parameter	Type	Description
millisecondsToSleep	int	Number of milliseconds to sleep

Returns

None.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
% pause NeuroExplorer for 1 second
nex.Sleep(1000);
```

See Also

Application Interface

COM/ActiveX Interfaces

6.1.8. RunNexScript Method

Application.RunNexScript Method

Runs the specified NexScript. Returns true if succeeded.

Syntax

bool RunNexScript (string scriptPath)

Parameters

Parameter	Type	Description
scriptPath	string	Script path.

Returns

Returns true if script succeeded, otherwise, returns false.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
res = nex.RunNexScript('C:\Data\Scripts\TestScript.nsc');
```

See Also

Application Interface

Document Interface

COM/ActiveX Interfaces

6.1.9. RunNexScriptCommands Method

Application.RunNexScriptCommands Method

Runs the specified NexScript text. Returns true if succeeded.

Syntax

bool RunNexScriptCommands (string script)

Parameters

Parameter	Type	Description
script	string	Script text. Script lines should be separated by \n.

Returns

Returns true if script succeeded, otherwise, returns false.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
res = nex.RunNexScriptCommands('doc=GetActiveDocument()\ndoc.NewEvent =
Sync(doc.Neuron04a, doc.Neuron05b, -0.01, 0.01)')
res =
nex.RunNexScriptCommands('doc=GetActiveDocument()\nApplyTemplate(doc,"AutoCorrelog
rams")');
```

See Also

Application Interface

Document Interface

COM/ActiveX Interfaces

6.2. Document

Document Interface

NeuroExplorer Application object provides access to the open documents. For example, to open a document in NeuroExplorer in Matlab script, you can use:

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
```

Here OpenDocument method returns a Document object corresponding to the specified data file.

The properties and methods of the Document object are listed below.

Properties

Property	Description
Path	Document file path
FileName	Document file name
Comment	Document comment
TimestampFrequency	Document timestamp frequency
StartTime	Document data start time
EndTime	Document data end time
VariableCount	The number of variables in the document
NeuronCount	The number of neuron variables in the document
EventCount	The number of event variables in the document
IntervalCount	The number of interval variables in the document
MarkerCount	The number of marker variables in the document
WaveCount	The number of waveform variables in the document
ContinuousCount	The number of continuous variables in the document

Methods

Method	Description
Variable	Returns the specified variable
Neuron	Returns the specified neuron variable
Event	Returns the specified event variable
Marker	Returns the specified marker variable
Interval	Returns the specified interval variable
Wave	Returns the specified waveform variable
Continuous	Returns the specified continuous variable
DeselectAll	Deselects all the data variables in the document
SelectAllNeurons	Selects all the neuron variables in the document

SelectAllContinuous	Selects all the continuous variables in the document
ApplyTemplate	Runs the analysis specified in the analysis template
GetNumericalResults	Returns numerical results for the first graph view of the document
Close	Closes the document

See Also

COM/ActiveX Interfaces

6.2.1. Path Property

Document.Path Property

Read-only property that returns a string with the full path of the document.

Syntax

string Path

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
path = doc.Path;
```

See Also

Document Interface

COM/ActiveX Interfaces

6.2.2. FileName Property

Document.FileName Property

Read-only property that returns a string with the file name.

Syntax

string FileName

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
path = doc.Path;
fileName = doc.FileName;
% path is 'C:\Data\MyDataFile.nex'
% fileName is 'MyDataFile.nex'
```

See Also

Document Interface

COM/ActiveX Interfaces

6.2.3. Comment Property

Document.Comment Property

Read-only property that returns a string with the data file comment.

Syntax

string Comment

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
comment = doc.Comment;
```

See Also

Document Interface

COM/ActiveX Interfaces

6.2.4. TimestampFrequency Property

Document.TimestampFrequency Property

Read-only property that returns the timestamp frequency of the document in Hertz.

Syntax

double TimestampFrequency

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
tsFrequency = doc.TimestampFrequency;
```

See Also

Document Interface

COM/ActiveX Interfaces

6.2.5. StartTime Property

Document.StartTime Property

Read-write property that specifies the document data start time (minimum timestamp) in seconds.

Syntax

double StartTime

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
startTime = doc.StartTime;
```

See Also

Document Interface

COM/ActiveX Interfaces

6.2.6. EndTime Property

Document.EndTime Property

Read-write property that specifies the document data end time (maximum timestamp) in seconds.

Syntax

double EndTime

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
endTime = doc.EndTime;
```

See Also

Document Interface

COM/ActiveX Interfaces

6.2.7. VariableCount Property

Document.VariableCount Property

Read-only property that returns the number of variables in the document.

Syntax

int VariableCount

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
numVars = doc.VariableCount;
```

See Also

Document Interface

COM/ActiveX Interfaces

6.2.8. NeuronCount Property

Document.NeuronCount Property

Read-only property that returns the number of neurons in the document.

Syntax

int NeuronCount

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
numNeurons = doc.NeuronCount;
```

See Also

Document Interface

COM/ActiveX Interfaces

6.2.9. EventCount Property

Document.EventCount Property

Read-only property that returns the number of event variables in the document.

Syntax

int EventCount

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
numEventVars = doc.EventCount;
```

See Also

Document Interface

COM/ActiveX Interfaces

6.2.10. IntervalCount Property

Document.IntervalCount Property

Read-only property that returns the number of interval variables in the document.

Syntax

int IntervalCount

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
numIntervalVars = doc.IntervalCount;
```

See Also

Document Interface

COM/ActiveX Interfaces

6.2.11. MarkerCount Property

Document.MarkerCount Property

Read-only property that returns the number of marker variables in the document.

Syntax

int MarkerCount

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
numMarkerVars = doc.MarkerCount;
```

See Also

Document Interface

COM/ActiveX Interfaces

6.2.12. WaveCount Property

Document.WaveCount Property

Read-only property that returns the number of waveform variables in the document.

Syntax

int WaveCount

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
numWaveVars = doc.WaveCount;
```

See Also

Document Interface

COM/ActiveX Interfaces

6.2.13. ContinuousCount Property

Document.ContinuousCount Property

Read-only property that returns the number of continuous variables in the document.

Syntax

int ContinuousCount

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
numContinuousVars = doc.ContinuousCount;
```

See Also

Document Interface

COM/ActiveX Interfaces

6.2.14. Variable Method

Document.Variable Method

Returns Variable object for the specified variable index or name.

Syntax

Variable Variable(object variableIndexOrName)

Parameters

Parameter	Type	Description
variableIndexOrName	int or string	1-based variable index or a string with the variable name

Returns

Returns Variable object.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% get the first variable
var1 = doc.Variable(1);
% get the variable with the name Neuron04a
neuron = doc.Variable('Neuron04a');
```

See Also

Variable Interface

Application Interface

Document Interface

COM/ActiveX Interfaces

6.2.15. Neuron Method

Document.Neuron Method

Returns Variable object for the specified neuron variable index.

Syntax

Variable Neuron(int neuronIndex)

Parameters

Parameter	Type	Description
neuronIndex	int	1-based neuron variable index

Returns

Returns Variable object.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% get the first neuron variable
neuron1 = doc.Neuron(1);
% get the last neuron variable
neuronLast = doc.Neuron(doc.NeuronCount);
```

See Also

Variable Interface

Application Interface

Document Interface

COM/ActiveX Interfaces

6.2.16. Event Method

Document.Event Method

Returns Variable object for the specified event variable index.

Syntax

Variable Event(int eventIndex)

Parameters

Parameter	Type	Description
eventIndex	int	1-based event variable index

Returns

Returns Variable object.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% get the first event variable
Event1 = doc.Event(1);
% get the last event variable
EventLast = doc.Event(doc.EventCount);
```

See Also

Variable Interface

Application Interface

Document Interface

COM/ActiveX Interfaces

6.2.17. Interval Method

Document.Interval Method

Returns Variable object for the specified interval variable index.

Syntax

Variable Interval(int IntervalIndex)

Parameters

Parameter	Type	Description
IntervalIndex	int	1-based interval variable index

Returns

Returns Variable object.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% get the first interval variable
Interval1 = doc.Interval(1);
% get the last interval variable
IntervalLast = doc.Interval(doc.IntervalCount);
```

See Also

Variable Interface

Application Interface

Document Interface

COM/ActiveX Interfaces

6.2.18. Marker Method

Document.Marker Method

Returns Variable object for the specified marker variable index.

Syntax

Variable Marker(int markerIndex)

Parameters

Parameter	Type	Description
markerIndex	int	1-based marker variable index

Returns

Returns Variable object.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% get the first marker variable
Marker1 = doc.Marker(1);
% get the last marker variable
MarkerLast = doc.Marker(doc.MarkerCount);
```

See Also

Variable Interface

Application Interface

Document Interface

COM/ActiveX Interfaces

6.2.19. Wave Method

Document.Wave Method

Returns Variable object for the specified waveform variable index.

Syntax

Variable Wave(int waveIndex)

Parameters

Parameter	Type	Description
waveIndex	int	1-based waveform variable index

Returns

Returns Variable object.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% get the first waveform variable
Wave1 = doc.Wave(1);
% get the last waveform variable
WaveLast = doc.Wave(doc.WaveCount);
```

See Also

Variable Interface

Application Interface

Document Interface

COM/ActiveX Interfaces

6.2.20. Continuous Method

Document.Continuous Method

Returns Variable object for the specified continuous variable index.

Syntax

Variable Continuous(int continuousIndex)

Parameters

Parameter	Type	Description
continuousIndex	int	1-based continuous variable index

Returns

Returns Variable object.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% get the first continuous variable
Continuous1 = doc.Continuous(1);
% get the last continuous variable
ContinuousLast = doc.Continuous(doc.ContinuousCount);
```

See Also

Variable Interface

Application Interface

Document Interface

COM/ActiveX Interfaces

6.2.21. DeselectAll Method

Document.DeselectAll Method

Deselects all the data variables in the document.

Syntax

void DeselectAll()

Returns

None.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% deselect all variables
doc.DeselectAll();
% select one variable
doc.Variable('Neuron01').Select();
% run Interspike Interval Histogram analysis saved in 'ISI' template
doc.ApplyTemplate('ISI');
% get numerical results
results = doc.GetNumericalResults();
```

See Also

Variable Interface

Application Interface

Document Interface

COM/ActiveX Interfaces

6.2.22. SelectAllNeurons Method

Document.SelectAllNeurons Method

Selects all the neuron variables in the document. Selected variables are used in analysis when ApplyTemplate document method is called.

Syntax

void SelectAllNeurons()

Returns

None.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% deselect all variables
doc.DeselectAll();
% select all neurons
doc.SelectAllNeurons();
% run Interspike Interval Histogram analysis saved in 'ISI' template
doc.ApplyTemplate('ISI');
% get numerical results
results = doc.GetNumericalResults();
% close NeuroExplorer
nex.delete;
```

See Also

Variable Interface

Application Interface

Document Interface

COM/ActiveX Interfaces

6.2.23. SelectAllContinuous Method

Document.SelectAllContinuous Method

Selects all the continuous variables in the document.

Syntax

void SelectAllContinuous()

Returns

None.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% deselect all variables
doc.DeselectAll();
% select all continuous variables
doc.SelectAllContinuous();
% run Perievent Histogram analysis saved in 'PSTH' template
doc.ApplyTemplate('PSTH');
% get numerical results
results = doc.GetNumericalResults();
```

See Also

Variable Interface

Application Interface

Document Interface

COM/ActiveX Interfaces

6.2.24. ApplyTemplate Method

Document.ApplyTemplate Method

Runs the analysis specified in the analysis template.

Syntax

void ApplyTemplate(string templateName)

Parameters

Parameter	Type	Description
templateName	string	template name

Returns

None.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% deselect all variables
doc.DeselectAll();
% select all neurons
doc.SelectAllNeurons();
% run Interspike Interval Histogram analysis saved in 'ISI' template
doc.ApplyTemplate('ISI');
% get numerical results
results = doc.GetNumericalResults();
% close NeuroExplorer
nex.delete;
```

See Also

Variable Interface

Application Interface

Document Interface

COM/ActiveX Interfaces

6.2.25. GetNumericalResults Method

Document.GetNumericalResults Method

Returns 2-dimensional array of numerical results for the first graph view of the document.

Syntax

Array GetNumericalResults()

Returns

Returns 2-dimensional array of numerical results.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% apply AutoCorrelograms analysis template
nex.RunNexScriptCommands('doc=GetActiveDocument()\nApplyTemplate(doc,"AutoCorrelog
rams")');
% get numerical results
results = doc.GetNumericalResults();
```

See Also

Variable Interface

Application Interface

Document Interface

COM/ActiveX Interfaces

6.2.26. Close Method

Document.Close Method

Closes the document.

Syntax

void Close()

Parameters

None.

Returns

None.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% close the document
doc.Close();
```

See Also

Variable Interface

Application Interface

Document Interface

COM/ActiveX Interfaces

6.3. Variable

Variable Interface

NeuroExplorer Application object provides access to the open files and variables contained in the files. For example, to open a document in NeuroExplorer and get the first event variable in the document in Matlab, you can use:

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
event1 = doc.Event(1);
```

Here Event() method returns a Variable object corresponding to the first event variable in the file.

The properties and methods of the Variable object are listed below.

Properties

Property	Description
Name	Variable name
TimestampCount	Number of timestamps in the variable

Methods

Method	Description
Timestamps	Returns all the variable timestamps in an array
IntervalStarts	For interval variables, returns all the interval start values
IntervalEnds	For interval variables, returns all the interval end values
FragmentTimestamps	For continuous variables, returns fragment timestamps
FragmentCounts	For continuous variables, returns the number of data points in each fragment
ContinuousValues	For continuous variables, returns A/D values in milliVolts
MarkerValues	For marker variables, returns marker string values
WaveformValues	For waveform variables, returns waveform values
SamplingRate	For continuous and waveform variables, returns sampling rate in Hz
Select	Selects the variable for analysis
Deselect	Deselects the variable

See Also

Document Interface

COM/ActiveX Interfaces

6.3.1. Name Property

Variable.Name Property

Read-only property that returns a string with the variable name.

Syntax

string Name

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% get the first neuron variable
neuron1 = doc.Neuron(1);
neuron1Name = neuron1.Name;
```

See Also

Variable Interface

Document Interface

COM/ActiveX Interfaces

6.3.2. TimestampCount Property

Variable.TimestampCount Property

Read-only property that returns the number of timestamps in the variable. For interval variables, returns the number of intervals. For waveforms variable, returns the number of waveforms. For continuous variables, returns the total number of data points.

Syntax

int TimestampCount

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% get the first neuron variable
neuron1 = doc.Neuron(1);
numTimestamps = neuron1.TimestampCount;
```

See Also

Variable Interface

Document Interface

COM/ActiveX Interfaces

6.3.3. Timestamps Method

Variable.Timestamps Method

Returns all the timestamps of the variable in seconds. Timestamps are returned as an array (vector) of double values. For interval variables, returns the interval starts. For waveforms variable, returns the waveform timestamps. For continuous variables, returns the timestamps corresponding to all the variable data points.

Syntax

SAFEARRAY(double) Timestamps()

Parameters

None.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% get the first neuron variable
neuron1 = doc.Neuron(1);
% get all the timestamps
ts = neuron1.Timestamps();
% now ts is a vector of timestamps
%
% get the first continuous variable
cont1 = doc.Continuous(1);
% get all the timestamps for continuous variable
cont1_ts = cont1.Timestamps();
```

See Also

Variable Interface

Document Interface

COM/ActiveX Interfaces

6.3.4. IntervalStarts Method

Variable.IntervalStarts Method

For an interval variable, returns the interval start values in seconds. This method is valid only for interval variables.

Syntax

SAFEARRAY(double) IntervalStarts()

Parameters

None.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% get the first interval variable
int1= doc.Interval(1);
% get all the interval starts
int1Starts = int1.IntervalStarts();
```

See Also

Variable Interface

Document Interface

COM/ActiveX Interfaces

6.3.5. IntervalEnds Method

Variable.IntervalEnds Method

For an interval variable, returns the interval end values in seconds. This method is valid only for interval variables.

Syntax

SAFEARRAY(double) IntervalEnds()

Parameters

None.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% get the first interval variable
int1= doc.Interval(1);
% get all the interval ends
int1Ends = int1.IntervalEnds();
```

See Also

Variable Interface

Document Interface

COM/ActiveX Interfaces

6.3.6. FragmentTimestamps Method

Variable.FragmentTimestamps Method

For continuous variable, returns the fragment timestamp values in seconds. This method is valid only for continuous variables.

In general, a continuous variable may contain several fragments of data. Each fragment may be of a different length. NeuroExplorer does not store the timestamps for all the A/D values since they would use too much space. Instead, for each fragment, it stores the timestamp of the first A/D value in the fragment and the index of the first data point in the fragment. The timestamps of the first A/D value in each fragment are returned by this method.

Syntax

SAFEARRAY(double) FragmentTimestamps()

Parameters

None.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% get the first continuous variable
cont1= doc.Continuous(1);
% get all the fragment timestamps
cont1FragmentTs = cont1.FragmentTimestamps();
```

See Also

Variable Interface

Document Interface

COM/ActiveX Interfaces

6.3.7. FragmentCounts Method

Variable.FragmentCounts Method

For continuous variable, returns the number of data points in fragments. This method is valid only for continuous variables.

In general, a continuous variable may contain several fragments of data. Each fragment may be of a different length. NeuroExplorer does not store the timestamps for all the A/D values since they would use too much space. Instead, for each fragment, it stores the timestamp of the first A/D value in the fragment and the index of the first data point in the fragment. The number of data points in each fragment are returned by this method.

Syntax

SAFEARRAY(double) FragmentCounts()

Parameters

None.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% get the first continuous variable
cont1= doc.Continuous(1);
% get all the fragment counts
cont1FragmentCounts = cont1.FragmentCounts();
```

See Also

Variable Interface

Document Interface

COM/ActiveX Interfaces

6.3.8. ContinuousValues Method

Variable.ContinuousValues Method

For continuous variable, returns all the A/D values in milliVolts. This method is valid only for continuous variables.

Syntax

SAFEARRAY(double) ContinuousValues()

Parameters

None.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% get the first continuous variable
cont1= doc.Continuous(1);
% get all the values
cont1Values = cont1.ContinuousValues();
```

See Also

Variable Interface

Document Interface

COM/ActiveX Interfaces

6.3.9. MarkerValues Method

Variable.MarkerValues Method

For a marker variable, returns all the marker values as strings. The values are returned in a two-dimensional array. Each row of the array represents all the marker strings for one timestamp.

This method is valid only for marker variables.

Syntax

SAFEARRAY(string) MarkerValues()

Parameters

None.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% get the first markervariable
marker1 = doc.Marker(1);
% get all the marker values
marker1Values = marker1.MarkerValues();
```

See Also

Variable Interface

Document Interface

COM/ActiveX Interfaces

6.3.10. WaveformValues Method

Variable.WaveformValues Method

For waveform variable, returns all the waveform values in milliVolts. The values are returned in a two-dimensional array. Each row of the array represents one waveform.

This method is valid only for waveform variables.

Syntax

SAFEARRAY(double) WaveformValues()

Parameters

None.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% get the first waveform variable
wave1= doc.Wave(1);
% get all the values
wave1Values = wave1.WaveformValues();
```

See Also

Variable Interface

Document Interface

COM/ActiveX Interfaces

6.3.11. SamplingRate Property

Variable.SamplingRate Property

Read-only property that returns the sampling rate (in Hz) of a continuous or waveform variable. For other variable types, returns zero.

Syntax

double SamplingRate

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% get the first continuous variable
cont1= doc.Continuous(1);
% get sampling rate
samplingRate = cont1.SamplingRate;
```

See Also

Variable Interface

Document Interface

COM/ActiveX Interfaces

6.3.12. Select Method

Variable.Select Method

Selects the variable. Selected variables are used in analysis when ApplyTemplate document method is called.

Syntax

void Select()

Parameters

None.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% deselect all variables
doc.DeselectAll();
% select variable with the name 'Neuron01'
doc.Variable('Neuron01').Select();
% run Interspike Interval Histogram analysis saved in 'ISI' template
doc.ApplyTemplate('ISI');
% get numerical results
results = doc.GetNumericalResults();
% close NeuroExplorer
nex.delete;
```

See Also

Variable Interface

Document Interface

COM/ActiveX Interfaces

6.3.13. Deselect Method

Variable.Deselect Method

Deselects the variable. Only selected variables are used in analysis when ApplyTemplate document method is called.

Syntax

void Deselect()

Parameters

None.

Usage

Matlab

```
nex = actxserver('NeuroExplorer.Application');
doc = nex.OpenDocument('C:\Data\MyDataFile.nex');
% deselect all variables
doc.DeselectAll();
% select all neurons
doc.SelectAllNeurons();
% deselect variable with the name 'Neuron01'
doc.Variable('Neuron01').Deselect();
% run Interspike Interval Histogram analysis saved in 'ISI' template
doc.ApplyTemplate('ISI');
% get numerical results
results = doc.GetNumericalResults();
% close NeuroExplorer
nex.delete;
```

See Also

Variable Interface

Document Interface

COM/ActiveX Interfaces

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