Package 'MEAanalysis'

May 6, 2025

Version 0.1.0

Title Analyse and Visualise Multi Electrode Array Burst Data

Maintainer Emily Gordon <emily.gordon@wadham.ox.ac.uk>

Description Analyse and visualise multi electrode array data at the single electrode and whole well level, downstream of 'AxIS Navigator 3.6.2 Software' processing. Compare bursting parameters between time intervals and recordings using the bar chart visualisation functions. Compatible with 12- and 24- well plates.

License GPL (>= 2)

Imports data.table (>= 1.15.4), dplyr (>= 1.1.4), ggplot2 (>= 3.5.0), janitor (>= 2.2.0), kableExtra (>= 1.4.0), knitr (>= 1.46), readr (>= 2.1.5), readxl (>= 1.4.3), reshape2 (>= 1.4.4), stringr (>= 1.5.1), tidyr (>= 1.3.1), tidyverse (>= 2.0.0)

Depends R (>= 4.3.0)

Encoding UTF-8

RoxygenNote 7.3.1

LazyData true

Suggests rmarkdown (>= 2.26), testthat (>= 3.2.1)

VignetteBuilder knitr

Config/testthat/edition 3

URL https://egordon2.github.io/MEA-analysis-package/

BugReports https://github.com/egordon2/MEA-analysis-package/issues

NeedsCompilation no

Author Emily Gordon [aut, cre]

Repository CRAN

Date/Publication 2025-05-06 08:30:06 UTC

Contents

`create_electrode_dataset`

Create Electrode Data Set

Description

This function reads in, filters, and reformats electrode burst csv files produced by the axis navigator tool (Axion Biosystems) for use in analysis. This function filters the data to only contain information relating to single electrodes and burst characteristics. It also adds a 'Recording_identifier' column to enable other MEAanalysis functions to calculate burst parameters for a specific recording, as well as a column to identify the well a burst was recorded in.

Usage

```
create_electrode_dataset(data_path, recording_identifier)
```

Arguments

`data_path`	Include path to electrode burst dataset csv or excel file produced by the axis navigator tool. This path should be written within quotation marks and with respect to the current working directory.
`recording_identifier`	Include a unique identifier for the MEA recording being loaded. This identifier will be added to the 'Recording_identifier' column and be used by other MEAanalysis functions to filter the data and calculate burst parameters.

Value

A reformatted and filtered electrode burst list for use in analysis.

Examples

```
output_electrode_burst <- create_electrode_dataset(
                          data_path = system.file("extdata", "input_electrode_burst.csv",
                                                  package = "MEAanalysis"),
                                    recording_identifier = "burst_recording_1")
```

`create_synchrony_dataset` *Create Synchrony Data Set*

Description

This function reads in, filters, and reformats neural metric csv files produced by the axis navigator neural metric tool (Axion Biosystems) for use in synchrony index analysis.

Usage

```
create_synchrony_dataset(data_path, heatmap_condition)
```

Arguments

`data_path`	Include path to neural metric dataset csv or excel file produced by the axis navigator neural metric tool. This path should be written within quotation marks and with respect to the current working directory.
`heatmap_condition`	Include a unique identifier for this neuralMetric dataset's experimental condition, this argument will be used by the MEA_heatmap function to group data.

Value

A reformatted and filtered neural metric dataset for use in synchrony index analysis.

Examples

```
output_neuralMetric <- create_synchrony_dataset(
                           data_path = system.file("extdata", "input_neuralMetric.csv",
                                                   package = "MEAanalysis"),
                                heatmap_condition = "SI_condition_1")
```

`electrode_burst_duration` *Electrode Burst Duration*

Description

Function reads in electrode burst list data and creates new columns with the mean, SD, and SEM burst duration recorded by single electrodes (within the specified time interval and recording).

Usage

```
electrode_burst_duration(
  data = output_table,
  time_lower_bound = 0,
  time_upper_bound = Inf,
  recording_identifier
)
```

Arguments

`data`	Electrode burst list dataset preprocessed using the create_electrode_dataset function.
`time_lower_bound`	Define lower bound of time interval for which to calculate the MEA parameter (seconds).
`time_upper_bound`	Define upper bound of time interval for which to calculate the MEA parameter (seconds).
`recording_identifier`	Define recording for which to calculate the MEA parameter. Use recording_identifier defined in create_electrode_dataset function.

Value

An electrode burst list table with three additional columns (mean, SD and SEM burst duration for single electrodes within the specified time interval and recording).

Examples

```
output_MEA_data <- electrode_burst_duration(data = input_MEA_data,
                                            time_lower_bound = 0,
                                            time_upper_bound = 30,
                                            recording_identifier = "burst_recording_1")
```

`electrode_mean_burst_ISI` *Electrode Mean Burst ISI*

Description

Function reads in electrode burst list data and creates new columns with the mean, SD, and SEM mean ISI within a burst (sec) recorded by single electrodes (within the specified time interval and recording).

Usage

```
electrode_mean_burst_ISI(
  data = output_table,
  time_lower_bound = 0,
  time_upper_bound = Inf,
  recording_identifier
)
```

Arguments

`data`	Electrode burst list dataset preprocessed using the create_electrode_dataset function.
`time_lower_bound`	Define lower bound of time interval for which to calculate the MEA parameter (seconds).
`time_upper_bound`	Define upper bound of time interval for which to calculate the MEA parameter (seconds).
`recording_identifier`	Define recording for which to calculate the MEA parameter. Use recording_identifier defined in create_electrode_dataset function.

Value

An electrode burst list dataset with three additional columns (mean, SD and SEM mean ISI within a burst (sec) for single electrodes within the specified time interval and recording)

Examples

```
output_MEA_data <- electrode_mean_burst_ISI(data = input_MEA_data,
                                            time_lower_bound = 0,
                                            time_upper_bound = 30,
                                            recording_identifier = "burst_recording_1")
```

`electrode_number_of_bursts` *Electrode Number of Bursts*

Description

Function reads in electrode burst list data and creates new columns with the mean, SD, and SEM number of bursts recorded by single electrodes (within the specified time interval and recording).

Usage

```
electrode_number_of_bursts(
  data = output_table,
  time_lower_bound = 0,
  time_upper_bound = Inf,
  recording_identifier
)
```

Arguments

`data`	Electrode burst list dataset preprocessed using the create_electrode_dataset function.
`time_lower_bound`	Define lower bound of time interval for which to calculate the MEA parameter (seconds).
`time_upper_bound`	Define upper bound of time interval for which to calculate the MEA parameter (seconds).
`recording_identifier`	Define recording for which to calculate the MEA parameter. Use recording_identifier defined in create_electrode_dataset function.

Value

An electrode burst list table with three additional columns (mean, SD and SEM number of bursts for single electrodes within the specified time interval and recording).

Examples

```
output_MEA_data <- electrode_number_of_bursts(data = input_MEA_data,
                                              time_lower_bound = 0,
                                              time_upper_bound = 30,
                                             recording_identifier = "burst_recording_1")
```

`electrode_spikes_per_burst` *Electrode Spikes per Burst*

Description

Function reads in electrode burst list data and creates new columns with the mean, SD, and SEM number of spikes per burst recorded by single electrodes (within the specified time interval and recording).

Usage

```
electrode_spikes_per_burst(
  data = output_table,
  time_lower_bound = 0,
  time_upper_bound = Inf,
  recording_identifier
)
```

Arguments

`data`	Electrode burst list dataset preprocessed using the create_electrode_dataset function.
`time_lower_bound`	Define lower bound of time interval for which to calculate the MEA parameter (seconds).
`time_upper_bound`	Define upper bound of time interval for which to calculate the MEA parameter (seconds).
`recording_identifier`	Define recording for which to calculate the MEA parameter. Use recording_identifier defined in create_electrode_dataset function.

Value

An electrode burst list table with three additional columns (mean, SD and SEM number of spikes per burst for single electrodes within the specified time interval and recording).

Examples

```
output_MEA_data <- electrode_spikes_per_burst(data = input_MEA_data,
                                              time_lower_bound = 0,
                                              time_upper_bound = 30,
                                             recording_identifier = "burst_recording_1")
```

input_electrode_barchart *Input dataset for single_electrode_barchart function*

Description

A data set containing electrode burst data with additional columns calculated for various MEA parameters.

Usage

```
input_electrode_barchart
```

Format

A data frame with 8886 rows and 58 variables

Source

<https://www.github.com/egordon2/MEAanalysis>

input_heatmap_data *Input dataset for MEA_heatmap function*

Description

A data set with well average synchrony index data for a baseline and comparison experimental condition.

Usage

```
input_heatmap_data
```

Format

A data frame with 24 rows and 3 variables

Well

synchrony_index: Baseline

synchrony_index: Agonist Challenge

Source

<https://www.github.com/egordon2/MEAanalysis>

input_MEA_data *Input dataset for electrode and well MEA parameter functions.*

Description

A data set containing electrode burst list data filtered and reformated for use in analysis.

Usage

```
input_MEA_data
```

Format

A data frame with 8886 rows and 36variables:

Electrode

Time_s

Size_spikes

Duration_s

Recording_identifier

well

Source

<https://www.github.com/egordon2/MEAanalysis>

input_well_barchart *Input dataset for well_barchart function*

Description

A data set containing electrode burst data with additional columns calculated for various MEA parameters.

Usage

```
input_well_barchart
```

Format

A data frame with 8886 rows and 70 variables

Source

<https://www.github.com/egordon2/MEAanalysis>

MEA_heatmap *MEA_heatmap*

Description

Function creates a heatmap of the synchrony index for each well grouped by heatmap condition.

Usage

```
MEA_heatmap(
  data,
  x_axis_title = "Experimental Condition",
 well_filter = "A1|A2|A3|A4|A5|A6|B1|B2|B3|B4|B5|B6|C1|C2|C3|C4|C5|C6|D1|D2|D3|D4|D5|D6"
)
```

Arguments

data	Dataset containing well average synchrony index data.
x_axis_title	Include title for heatmap x axis. Default is "Experimental Condition"
well_filter	Argument can be used to filter for specific MEA wells to include in the heatmap.

Value

A heatmap of the synchrony index for each well grouped by heatmap condition.

Examples

```
p <- MEA_heatmap(data = input_heatmap_data,
            x_axis_title = "Experimental Condition",
        well_filter = "A1|A2|A3|A4|A5|A6|B1|B2|B3|B4|B5|B6|C1|C2|C3|C4|C5|C6|D1|D2|D3|D4|D5|D6")
```

single_electrode_barchart

Single Electrode Bar chart

Description

Function creates a bar chart of calculated MEA parameters by single electrode for a given time interval and recording.

Usage

```
single_electrode_barchart(
  data = output_table,
  electrode_parameter,
  electrode_filter =
    "A1|A2|A3|A4|A5|A6|B1|B2|B3|B4|B5|B6|C1|C2|C3|C4|C5|C6|D1|D2|D3|D4|D5|D6",
  statistic = se
)
```

Arguments

data	Dataset containing electrode burst data and calculated MEA parameter. Use create_electrode_dataset and electrode parameter functions to preprocess data before use in this function (i.e., electrode_burst_duration, electrode_mean_burst_ISI, electrode_number_of_bursts, electrode_spikes_per_burst).
electrode_parameter	Include "number_of_bursts"/ "burst_duration"/ "spikes_per_burst"/ "mean_burst_ISI" to determine the parameter visualised in the barchart.
electrode_filter	Argument can be used to filter for single electrodes to include in the barchart.
statistic	Include "se" or "sd" to determine whether bar chart error bars represent the standard error or standard deviation of the mean.

Value

A bar chart of calculated MEA parameters by single electrode for a given time interval and recording.

Examples

```
p <- single_electrode_barchart(data = input_electrode_barchart,
                           electrode_parameter = "burst_duration",
                           electrode_filter = "A1_",
                           statistic = se)

p <- single_electrode_barchart(data = input_electrode_barchart,
                           electrode_parameter = "spikes_per_burst",
                           electrode_filter = "A1_",
                           statistic = se)

p <- single_electrode_barchart(data = input_electrode_barchart,
                           electrode_parameter = "mean_burst_ISI",
                           electrode_filter = "A1_",
                           statistic = se)

p <- single_electrode_barchart(data = input_electrode_barchart,
                           electrode_parameter = "number_of_bursts",
                           electrode_filter = "A1_")
```

well_barchart *Well Bar chart*

Description

Function creates a bar chart of calculated MEA parameters by well for a given time interval and recording.

Usage

```
well_barchart(
  data = output_table,
  well_parameter,
 well_filter = "A1|A2|A3|A4|A5|A6|B1|B2|B3|B4|B5|B6|C1|C2|C3|C4|C5|C6|D1|D2|D3|D4|D5|D6",
  statistic = se
)
```

Arguments

data	Dataset containing electrode burst data and calculated MEA parameter. Use create_electrode_dataset and well parameter functions to preprocess data before use in this function (i.e., well_burst_duration, well_mean_burst_ISI, well_number_of_bursts, well_spikes_per_burst).
well_parameter	Include "number_of_bursts"/ "burst_duration"/ "spikes_per_burst"/ "mean_burst_ISI" to determine the parameter visualised in the barchart.
well_filter	Argument can be used to filter for specific MEA wells to include in the barchart.
statistic	Include "se" or "sd" to determine whether bar chart error bars represent the standard error or standard deviation of the mean.

Value

A bar chart of calculated MEA parameters by single electrode for a given time interval and recording.

Examples

```
p <- well_barchart(data = input_well_barchart,
              well_parameter = "burst_duration",
              well_filter = "A1|A2|A3|A4",
              statistic = se)

p <- well_barchart(data = input_well_barchart,
              well_parameter = "spikes_per_burst",
              well_filter = "A1|A2|A3|A4",
              statistic = se)

p <- well_barchart(data = input_well_barchart,
```

```
                well_parameter = "mean_burst_ISI",
                well_filter = "A1|A2|A3|A4",
                statistic = se)

p <- well_barchart(data = input_well_barchart,
                well_parameter = "number_of_bursts",
                well_filter = "A1|A2|A3|A4",
                statistic = se)
```

`well_burst_duration` *Well Burst Duration*

Description

Function reads in electrode burst list data and creates new columns with the mean, SD, and SEM burst duration recorded for each well (within the specified time interval and recording).

Usage

```
well_burst_duration(
  data = output_table,
  time_lower_bound = 0,
  time_upper_bound = Inf,
  recording_identifier
)
```

Arguments

`data`	Electrode burst list dataset preprocessed using the create_electrode_dataset function.
`time_lower_bound`	Define lower bound of time interval for which to calculate the MEA parameter (seconds).
`time_upper_bound`	Define upper bound of time interval for which to calculate the MEA parameter (seconds).
`recording_identifier`	Define recording for which to calculate the MEA parameter. Use recording_identifier defined in create_electrode_dataset function.

Value

An electrode burst list table with three additional columns (mean, SD and SEM burst duration recorded for each well within the specified time interval and recording).

Examples

```
output_MEA_data <- well_burst_duration(data = input_MEA_data,
                                       time_lower_bound = 0,
                                       time_upper_bound = 30,
                                       recording_identifier = "burst_recording_1")
```

`well_mean_burst_ISI` *Well Mean Burst ISI*

Description

Function reads in electrode burst list data and creates new columns with the mean, SD, and SEM mean ISI within a burst (sec) recorded for each well (within the specified time interval and recording).

Usage

```
well_mean_burst_ISI(
  data = output_table,
  time_lower_bound = 0,
  time_upper_bound = Inf,
  recording_identifier
)
```

Arguments

`data`	Electrode burst list dataset preprocessed using the create_electrode_dataset function.
`time_lower_bound`	Define lower bound of time interval for which to calculate the MEA parameter (seconds).
`time_upper_bound`	Define upper bound of time interval for which to calculate the MEA parameter (seconds).
`recording_identifier`	Define recording for which to calculate the MEA parameter. Use recording_identifier defined in create_electrode_dataset function.

Value

An electrode burst list table with three additional columns (mean, SD and SEM mean ISI within a burst (sec) recorded for each well within the specified time interval and recording).

Examples

```
output_MEA_data <- well_mean_burst_ISI(data = input_MEA_data,
                                       time_lower_bound = 0,
                                       time_upper_bound = 30,
                                       recording_identifier = "burst_recording_1")
```

well_number_of_bursts *Well Number of Bursts*

Description

Function reads in electrode burst list data and creates new columns with the mean, SD, and SEM number of bursts recorded for each well (within the specified time interval and recording).

Usage

```
well_number_of_bursts(
  data = output_table,
  time_lower_bound = 0,
  time_upper_bound = Inf,
  recording_identifier
)
```

Arguments

data	Electrode burst list dataset preprocessed using the create_electrode_dataset function.
time_lower_bound	Define lower bound of time interval for which to calculate the MEA parameter (seconds).
time_upper_bound	Define upper bound of time interval for which to calculate the MEA parameter (seconds).
recording_identifier	Define recording for which to calculate the MEA parameter. Use recording_identifier defined in create_electrode_dataset function.

Value

An electrode burst list table with three additional columns (mean, SD and SEM number of bursts recorded for each well within the specified time interval and recording).

Examples

```
output_MEA_data <- well_number_of_bursts(data = input_MEA_data,
                                         time_lower_bound = 0,
                                         time_upper_bound = 30,
                                         recording_identifier = "burst_recording_1")
```

`well_spikes_per_burst` *Well Spikes per Burst*

Description

Function reads in electrode burst list data and creates new columns with the mean, SD, and SEM number of spikes per burst recorded for each well (within the specified time interval and recording).

Usage

```
well_spikes_per_burst(
  data = output_table,
  time_lower_bound = 0,
  time_upper_bound = Inf,
  recording_identifier
)
```

Arguments

`data`	Electrode burst list dataset preprocessed using the create_electrode_dataset function.
`time_lower_bound`	Define lower bound of time interval for which to calculate the MEA parameter (seconds).
`time_upper_bound`	Define upper bound of time interval for which to calculate the MEA parameter (seconds).
`recording_identifier`	Define recording for which to calculate the MEA parameter. Use recording_identifier defined in create_electrode_dataset function.

Value

An electrode burst list table with three additional columns (mean, SD and SEM number of spikes per burst recorded for each well within the specified time interval and recording).

Examples

```
output_MEA_data <- well_spikes_per_burst(data = input_MEA_data,
                                         time_lower_bound = 0,
                                         time_upper_bound = 30,
                                         recording_identifier = "burst_recording_1")
```

Index