

# R documentation

of all in ‘.’

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## Contents

active_cells_percentage . . . . .	1
binarize . . . . .	2
coactive_cells . . . . .	3
degrees . . . . .	3
events_per_min . . . . .	4
make_network . . . . .	5
normalize . . . . .	5
pca . . . . .	6
pipeline . . . . .	7
plot_network . . . . .	8
population_activity.plt . . . . .	9
PSD . . . . .	10
PSD.plt . . . . .	10
<b>Index</b>	<b>12</b>

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active\_cells\_percentage

*Calculate the Percentage of Active Cells Over Time*

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## Description

This function calculates the percentage of active cells over time in a binarized calcium matrix. It can optionally plot the percentage of active cells over time.

## Usage

```
active_cells_percentage(  
  calcium_matrix_binarized,  
  binarize = FALSE,  
  plot = FALSE  
)
```

**Arguments**

calcium_matrix_binarized	A binarized matrix where each row represents a cell and each column represents a timepoint. This matrix can be generated using the 'binarize()' function.
binarize	A logical value indicating whether to binarize the calcium matrix. If TRUE, the function will apply the 'binarize()' function to the calcium_matrix_binarized before calculation. Defaults to FALSE.
plot	A logical value indicating whether to generate a plot of the percentage of active cells over time. Defaults to FALSE.

**Value**

If 'plot' is FALSE, returns a data frame containing the time points and the percentage of active cells.  
 If 'plot' is TRUE, returns a ggplot object of the percentage of active cells over time.

**Examples**

```
calcium_matrix <- matrix(runif(1000), nrow = 10)
result <- active_cells_percentage(calcium_matrix, binarize = TRUE)
plot <- active_cells_percentage(calcium_matrix, binarize = TRUE, plot = TRUE)
```

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binarize	<i>Binarize Calcium Imaging Data</i>
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**Description**

This function binarizes the timeseries calcium data for each cell using a specified cutoff function.

**Usage**

```
binarize(
  calcium_matrix,
  cutoff_func = function(x) {
    th <- 2 * sd(x)
    x[x <= th] <- 0
    x[x > th] <-
      1
    return(x)
  }
)
```

**Arguments**

calcium_matrix	A matrix where each row represents a cell and each column represents a time-point.
cutoff_func	A function to determine the threshold for binarizing the data. Default is twice the standard deviation of each cell.

**Value**

A binary matrix where each cell's timeseries data is converted to 0 or 1 based on the cutoff function.

**Examples**

```
data <- matrix(runif(100), nrow = 10)
binary_data <- binarize(data)
```

coactive\_cells

*Calculate and Plot Percentage of Coactive Cells Over Time***Description**

This function calculates the percentage of coactive cells over time from a binarized calcium matrix. It returns a data frame with the time points and corresponding percentage of active cells. Optionally, it can also generate a plot.

**Usage**

```
coactive_cells(binarized_calcium_matrix, binarize = FALSE, plot = FALSE)
```

**Arguments**

binarized_calcium_matrix	A binary matrix where each row represents a cell and each column represents a timepoint.
binarize	A logical value indicating whether to binarize the calcium matrix. If TRUE, the matrix will be binarized using binarize(). Defaults to FALSE.
plot	A logical value indicating whether to generate a plot of the percentage of coactive cells over time. Defaults to FALSE.

**Value**

A data frame showing the percentage of coactive cells at each timepoint.

**Examples**

```
calcium_matrix <- matrix(runif(1000), nrow = 10)
coactive_cells.df <- coactive_cells(calcium_matrix, binarize = TRUE, plot = TRUE)
```

degrees

*Degree Distribution Analysis***Description**

This function calculates the degree of each node in the network, generates a histogram of the degree distribution, and returns either the plot or the mean degree based on the 'plot' argument.

**Usage**

```
degrees(graph, plot = TRUE)
```

**Arguments**

graph	An igraph object representing the network.
plot	A logical value indicating whether to generate and return the degree histogram plot. Defaults to TRUE.

**Value**

If 'plot' is TRUE, a ggplot object representing the degree histogram. If 'plot' is FALSE, a numeric value representing the mean degree.

**Examples**

```
graph <- make_network(binarized_calcium_matrix)
result <- degree_analysis(graph, plot = TRUE)
```

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events_per_min	<i>Calculate Event Frequency per Minute</i>
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**Description**

This function calculates the frequency of events per minute for each cell in a binarized calcium matrix.

**Usage**

```
events_per_min(binarized_calcium_matrix, frame_rate, mean_all = FALSE)
```

**Arguments**

binarized_calcium_matrix	A binarized matrix where each row represents a cell and each column represents a timepoint. Can be created with 'binarize()'.
frame_rate	The frame rate of the calcium imaging data (frames per second).
mean_all	A logical value indicating whether to return the mean frequency of events per minute for all cells. Defaults to FALSE.

**Value**

A numeric array representing the event frequency per minute for each cell, or a single numeric value representing the mean frequency if 'mean\_all' is TRUE.

**Examples**

```
binarized_data <- matrix(sample(c(0, 1), 100, replace = TRUE), nrow = 10)
frame_rate <- 30
event_frequency <- events_per_min(binarized_data, frame_rate)
mean_event_frequency <- events_per_min(binarized_data, frame_rate, TRUE)
```

make\_network

*Create a Network object from a binarized calcium matrix***Description**

This function produces a network based on the maximum cross-correlation between cells' calcium activity. The user can specify the lag for the cross-correlation function and the correlation threshold for filtering edges.

**Usage**

```
make_network(
  binarized_calcium_matrix,
  lag.max = 1,
  correlation_threshold = "none"
)
```

**Arguments**

**binarized\_calcium\_matrix** A binarized matrix where each row represents a cell and each column represents a timepoint. This matrix can be generated using the 'binarize()' function.

**lag.max** The maximum lag to use in the cross-correlation function (CCF). Defaults to 1.

**correlation\_threshold** The threshold value for filtering edges in the network (Pearson's coefficients go from -1 to +1). Set to "none" to disable filtering. Defaults to "none".

**Value**

An 'igraph' object representing the network of correlated cells.

**Examples**

```
binarized_calcium_matrix <- matrix(sample(c(0, 1), 1000, replace = TRUE), nrow = 10)
network <- make_network(binarized_calcium_matrix)
network_no_filter <- make_network(binarized_calcium_matrix, correlation_threshold = "none")
```

normalize

*Normalize Calcium Imaging Data***Description**

This function normalizes the timeseries calcium data for each cell.

**Usage**

```
normalize(calcium_matrix)
```

**Arguments**

`calcium_matrix` A matrix where each row represents a cell and each column represents a time-point.

**Value**

A normalized matrix where each cell's timeseries data is scaled to [0, 1].

**Examples**

```
data <- matrix(runif(100), nrow = 10)
normalized_data <- normalize(data)
```

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pca	<i>Perform PCA on Calcium Imaging Data</i>
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**Description**

This function performs Principal Component Analysis (PCA) on the calcium imaging data and optionally plots the scree plot of the eigenvalues.

**Usage**

```
pca(calcium_matrix, binarize = TRUE, plot = TRUE)
```

**Arguments**

`calcium_matrix` A matrix where each row represents a cell and each column represents a time-point.

`binarize` A logical value indicating whether to binarize the calcium matrix before performing PCA. Defaults to TRUE.

`plot` A logical value indicating whether to plot the scree plot of eigenvalues. Defaults to TRUE.

**Value**

If `plot = FALSE`, returns a list containing the PCA results and eigenvalues. If `plot = TRUE`, displays the scree plot and does not return anything.

**Examples**

```
calcium_matrix <- matrix(runif(1000), nrow = 10)
pca_results <- pca(calcium_matrix, binarize = TRUE, plot = TRUE)
```

pipeline

*Run Analysis Pipeline on Calcium Imaging Data***Description**

This function runs a comprehensive analysis pipeline on calcium imaging data, including normalization, binarization, population activity plotting, network creation and plotting, PCA analysis, power spectral density (PSD) analysis, and degree distribution analysis. The function requires the user to provide coordinates for the cells.

**Usage**

```
pipeline(
  calcium_matrix,
  coordinates,
  dendrogram = FALSE,
  correlation_threshold = 0.3,
  frame_rate = 0.5
)
```

**Arguments**

calcium_matrix	A matrix where each row represents a cell and each column represents a time-point.
coordinates	A data frame containing X and Y coordinates for each cell. Must include columns "X", "Y", and "Cell".
dendrogram	A logical value indicating whether to include a dendrogram in the population activity plot. Defaults to FALSE.
correlation_threshold	A numeric value specifying the threshold for filtering edges by weight in the network analysis. Set to "none" to disable filtering. Defaults to 0.3.
frame_rate	A numeric value specifying the frame rate (in Hz) for the PSD analysis. Defaults to 0.5.

**Value**

A list containing the results of each analysis step, including plots.

- `normalized_matrix`: The normalized calcium matrix.
- `binarized_matrix`: The binarized calcium matrix.
- `population_activity_plot`: The population activity plot.
- `network`: The network object created from the binarized matrix.
- `network_plot`: The plot of the network graph.
- `degree_plot`: The degree distribution plot of the network.
- `pca_plot`: The scree plot from PCA analysis.
- `psd_plot`: The power spectral density (PSD) plot.

## Examples

```
calcium_matrix <- matrix(runif(1000), nrow = 10)
coordinates <- data.frame(X = runif(10), Y = runif(10), Cell = 1:10)
results <- pipeline(calcium_matrix, coordinates = coordinates)
```

---

plot\_network

*Plot a Network Graph from Calcium Data*

---

## Description

This function plots a network graph where nodes represent cells and edges represent connections between them. The nodes can be color-coded based on the selected label, either by community membership or by the frequency of events per minute.

## Usage

```
plot_network(
  graph,
  coordinates,
  label = "communities",
  cell_ID = "none",
  reverse_y_scale = FALSE,
  frequency_values = NULL,
  correlation_threshold = 0.3
)
```

## Arguments

graph	An igraph object representing the network. Can be created with ‘make_network()’.
coordinates	A data frame containing X and Y coordinates for each cell ID. Must include columns "X", "Y", and "Cell".
label	A character string indicating what to label the cells with. Options are "communities" or "frequency". Defaults to "communities".
cell_ID	A dataframe of cell IDs (should contain X and Y columns). If set to "none", the nodes will be labeled with their numbers. Defaults to "none".
reverse_y_scale	A logical value indicating whether to reverse the Y scale in the plot (useful for matching image coordinates). Defaults to FALSE.
frequency_values	A numeric vector containing the frequency of events per minute for each cell. Required if ‘label = "frequency"’.
correlation_threshold	A numeric value specifying the threshold for filtering edges by weight. Set to "none" to disable filtering. Defaults to 0.3.

## Value

A ggplot object representing the network graph.



**Examples**

```
# Simulate a binarized calcium matrix
binarized_calcium_matrix <- matrix(sample(c(0, 1), 100, replace = TRUE), nrow = 10)

# Generate the network graph
graph <- make_network(binarized_calcium_matrix)

# Simulate XY coordinates for the cells
posXY <- data.frame(X = runif(10), Y = runif(10), Cell = 1:10)

# Simulate frequency values for the cells
frequency_values <- runif(10, 0, 5)

# Plot the network graph with frequency as the label
plot <- plot_network(graph, coordinates = posXY, label = "frequency", frequency_values = frequency_values)
print(plot)
```

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population\_activity.plt

*Generate Population Activity Plots*

---

**Description**

Generates a raster plot and line plot after performing hierarchical clustering on the data to sort similar cells.

**Usage**

```
population_activity.plt(
  binarized_calcium_matrix,
  binarize = FALSE,
  dendrogram = FALSE
)
```

**Arguments**

binarized_calcium_matrix	A binary matrix where each row represents a cell and each column represents a timepoint.
binarize	A logical value indicating whether to binarize the calcium matrix. If TRUE, the matrix will be binarized using binarize(). Defaults to FALSE.
dendrogram	A logical value indicating whether to include the dendrogram plot. Defaults to FALSE.

**Value**

A combined plot showing the raster plot with hierarchical clustering and a line plot of population activity.

**Examples**

```
calcium_matrix <- matrix(runif(1000), nrow = 10)
plot <- population_activity.plt(calcium_matrix, binarize = TRUE, dendrogram = TRUE)
```

PSD

*Power Spectral Density (PSD) Analysis***Description**

This function performs a Power Spectral Density (PSD) analysis on a calcium imaging matrix. The user can specify whether to binarize the matrix before the analysis, set the frame rate, and choose to either plot the PSD or return the resulting data frame.

**Usage**

```
PSD(calcium_matrix, binarize = TRUE, frame_rate = 0.5, plot = TRUE)
```

**Arguments**

<code>calcium_matrix</code>	A matrix where each row represents a cell and each column represents a time-point.
<code>binarize</code>	A logical value indicating whether to binarize the calcium matrix before performing the PSD analysis. Defaults to TRUE.
<code>frame_rate</code>	The frame rate of the calcium imaging data in frames per second. Defaults to 0.5 Hz (2 seconds per frame).
<code>plot</code>	A logical value indicating whether to plot the PSD. Defaults to TRUE.

**Value**

A data frame containing the PSD values and corresponding frequencies. If 'plot' is TRUE, a PSD plot is also displayed.

**Examples**

```
calcium_matrix <- matrix(runif(1000), nrow = 10)
PSD_results <- PSD(calcium_matrix, binarize = TRUE, frame_rate = 0.5, plot = TRUE)
```

PSD.plt

*Plot Power Spectral Density (PSD)***Description**

This function performs a Power Spectral Density (PSD) analysis on a calcium imaging matrix and returns only the PSD plot. The user can specify whether to binarize the matrix before the analysis and set the frame rate.

**Usage**

```
PSD.plt(calcium_matrix, binarize = TRUE, frame_rate = 0.5)
```

**Arguments**

<code>calcium_matrix</code>	A matrix where each row represents a cell and each column represents a time-point.
<code>binarize</code>	A logical value indicating whether to binarize the calcium matrix before performing the PSD analysis. Defaults to TRUE.
<code>frame_rate</code>	The frame rate of the calcium imaging data in frames per second. Defaults to 0.5 Hz (2 seconds per frame).

**Value**

A ggplot object representing the PSD plot.

**Examples**

```
calcium_matrix <- matrix(runif(1000), nrow = 10)
PSD_plot <- PSD.plt(calcium_matrix, binarize = TRUE, frame_rate = 0.5)
print(PSD_plot)
```

# Index

active\_cells\_percentage, [1](#)  
binarize, [2](#)  
coactive\_cells, [3](#)  
degrees, [3](#)  
events\_per\_min, [4](#)  
make\_network, [5](#)  
normalize, [5](#)  
pca, [6](#)  
pipeline, [7](#)  
plot\_network, [8](#)  
population\_activity.plt, [9](#)  
PSD, [10](#)  
PSD.plt, [10](#)