Package 'scbursts'

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Title Single Channel Bursts Analysis

Description Provides tools to import and export from several existing pieces of ion-channel analysis software such as 'TAC', 'QUB', 'SCAN', and 'Clampfit', implements procedures such as dwell-time correction and defining bursts with a critical time, and provides tools for analysis of bursts, such as tools for sorting and plotting.

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`bursts.check_subconductance`
Check if segment contains subconductive states

Description

Check if segment contains subconductive states

Usage

```
bursts.check_subconductance(bursts)
```

Arguments

`bursts`	The list of all bursts

Value

True if it contains an conductance other than 0 or 1, False otherwise.

Examples

```
infile <- system.file("extdata", "example4.dwt", package = "scbursts")
dwells <- dwt.read(infile)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")
bursts <- bursts.defined_by_tcrit(dwells_c, 100, units="ms")

bursts.check_subconductance(bursts)
```

`bursts.conductance_states`
Return a list of all the (sub)conductance states.

Description

Return a list of all the (sub)conductance states.

Usage

```
bursts.conductance_states(bursts)
```

Arguments

`bursts`	The list of all bursts

Value

a list of all the (sub)conductance states.

Examples

```
infile <- system.file("extdata", "example4.dwt", package = "scbursts")
dwells <- dwt.read(infile)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")
bursts <- bursts.defined_by_tcrit(dwells_c, 100, units="ms")

bursts.conductance_states(bursts)
```

---

bursts.copy *Copy a list of bursts (by value)*

Description

Copy a list of bursts (by value)

Usage

```
bursts.copy(bursts)
```

Arguments

bursts	bursts to copy

Value

A copy of the bursts.

---

bursts.defined_by_tcrit *Divide a recording into bursts defined by a critical time.*

Description

Split segment at long pauses, dividing the segment into multiple -shorter- segments (which are the bursts), Along with the interburst closings, which are referred to as "gaps". (Default time units are seconds)

Usage

```
bursts.defined_by_tcrit(segments, t_crit, units = "s")
```

Arguments

segments	A segment or multiple segments with $states and $dwells. NOTE: separate segments will remain split, regardless of why they were originally divided.
t_crit	Critical time at which to divide bursts (in seconds by default)
units	what unit the critical time is in ('s','ms','us', or 'ns')

Value

bursts. Which is a list of segments starting and ending in 1 states (open dwell)

Examples

```
infile <- system.file("extdata", "example1_tac.evt", package = "scbursts")
transitions <- evt.read(infile)
dwells <- evt.to_dwells(transitions)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")

bursts <- bursts.defined_by_tcrit(dwells_c, 100, units="ms")
head(bursts[[1]])
```

---

bursts.get_gaps *Get the gaps between bursts.*

Description

Extract vector of gaps from the bursts. This is done using the start_time attribute, which is mostly hidden in the data. (The gaps at the ends may have length 0)

Usage

```
bursts.get_gaps(bursts)
```

Arguments

bursts	The list of segments

Value

A vector of N+1 gaps for N bursts times

Examples

```
infile <- system.file("extdata", "example1_tac.evt", package = "scbursts")
transitions <- evt.read(infile)
dwells <- evt.to_dwells(transitions)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")

bursts <- bursts.defined_by_tcrit(dwells_c, 100, units="ms")
gaps <- bursts.get_gaps(bursts)

head(gaps)
```

`bursts.impose_deadtime` *Imposes a deadtime to each segment in a burst.*

Description

The user specifies a deadtime in microseconds. The function applies segment.impose_deadtime to each segment in the burst. (See segment.impose_deadtime for details.)

Usage

```
bursts.impose_deadtime(bursts, deadtime)
```

Arguments

`bursts`	a burst containing segments of dwells and states.
`deadtime`	the briefest possible event in microseconds.

Value

A modified copy of the original burst

Examples

```
infile <- system.file("extdata", "example4.dwt", package = "scbursts")
dwells <- dwt.read(infile)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")
bursts <- bursts.defined_by_tcrit(dwells_c, 100, units="ms")

bursts_d <- bursts.impose_deadtime(bursts, deadtime=0.01)
```

bursts.modify_conductance *Transform the conductance states according to a user-defined function of conductance level.*

Description

Transform the conductance states according to a user-defined function of conductance level.

Usage

```
bursts.modify_conductance(bursts, fun)
```

Arguments

bursts	the list of segments
fun	a function on conductance levels

Value

A modified copy of the original bursts

Examples

```
infile <- system.file("extdata", "example4.dwt", package = "scbursts")
dwells <- dwt.read(infile)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")
bursts <- bursts.defined_by_tcrit(dwells_c, 100, units="ms")

### Collapse into three subconductance states
fun <- function(amp) {
    if (amp < 0.3)
        return(0)
    else if (amp >= 0.3 && amp < 0.6)
        return(0.5)
    else
        return(1)
}

bursts_d <- bursts.modify_conductance(bursts, fun)
```

bursts.pcloseds *Return pcloseds of every burst.*

Description

Return pcloseds of every burst.

Usage

```
bursts.pcloseds(bursts)
```

Arguments

bursts	The list of all bursts

Value

The pclosed values

Examples

```
infile <- system.file("extdata", "example1_qub.dwt", package = "scbursts")
dwells <- dwt.read(infile)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")
bursts <- bursts.defined_by_tcrit(dwells_c, 100, units="ms")

pcloseds <- bursts.popens(bursts)
hist(pcloseds)
```

bursts.popens *Return popens of every burst.*

Description

Return popens of every burst.

Usage

```
bursts.popens(bursts)
```

Arguments

bursts	The list of all bursts

Value

The popen values

Examples

```
infile <- system.file("extdata", "example1_qub.dwt", package = "scbursts")
dwells <- dwt.read(infile)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")

bursts <- bursts.defined_by_tcrit(dwells_c, 100, units="ms")

popens <- bursts.popens(bursts)
hist(popens)
```

---

bursts.recombine *Combine bursts into one recording (with obvious spaces between them).*

Description

From a list of segments, return the concatenated segment containing all bursts. Inverse of functions like bursts.defined_by_tcrit

Usage

```
bursts.recombine(bursts)
```

Arguments

bursts	The list of all bursts

Value

The segment containing all bursts.

Examples

```
infile <- system.file("extdata", "example1_qub.dwt", package = "scbursts")
dwells <- dwt.read(infile)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")

bursts <- bursts.defined_by_tcrit(dwells_c, 100, units="ms")

# This is a single segment!
record <- bursts.recombine(bursts)
```

```
# Which means you can do stuff like this
open_dwells <- segment.open_dwells(bursts.recombine(bursts))
```

`bursts.remove_first_and_last` *Remove the first and last burst from the list.*

Description

Remove the first and last burst from the list.

Usage

```
bursts.remove_first_and_last(bursts)
```

Arguments

`bursts`	The list of all bursts

Value

A shorter list of bursts

Examples

```
infile <- system.file("extdata", "example1_tac.evt", package = "scbursts")
transitions <- evt.read(infile)
dwells <- evt.to_dwells(transitions)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")

bursts <- bursts.defined_by_tcrit(dwells_c, 100, units="ms")

# If there seem to be bad bursts at the ends
bursts <- bursts.remove_first_and_last(bursts)
```

`bursts.select` *From a list of bursts, extract those that interest you by passing a selecting function.*

Description

From a list of bursts, extract those that interest you by passing a selecting function.

Usage

```
bursts.select(bursts, func, one_file = FALSE)
```

Arguments

`bursts`	The list of all bursts
`func`	A function of a segment that returns either TRUE or FALSE
`one_file`	TRUE or FALSE: Return a single file to write to disk, or a list of bursts. The one_file will return a file with all unselected bursts zeroed out.

Value

A shorter list of bursts OR if one_file is passed one segment with zeros where the other bursts might have been originally. Defaults to FALSE.

Examples

```
high_popen <- function (seg) {
    segment.popen(seg) > 0.7
}

infile <- system.file("extdata", "example1_qub.dwt", package = "scbursts")
dwells <- dwt.read(infile)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")

bursts <- bursts.defined_by_tcrit(dwells_c, 100, units="ms")

subset <- bursts.select(bursts, high_popen)

# To export to one .dwt file
subset_f <- bursts.select(bursts, high_popen, one_file=TRUE)
```

bursts.sort *Order a list of bursts by some function. For instance, popen.*

Description

Order a list of bursts by some function. For instance, popen.

Usage

```
bursts.sort(bursts, func, reverse = FALSE)
```

Arguments

bursts	The list of all bursts
func	A function of a segment that returns a numeric value
reverse	By default, return in ascending order. Use reverse=TRUE to change that.

Value

A list sorted by func. By default in ascending order (unless reversed)

Examples

```
infile <- system.file("extdata", "example1_qub.dwt", package = "scbursts")
dwells <- dwt.read(infile)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")
bursts <- bursts.defined_by_tcrit(dwells_c, 100, units="ms")

# A sorted list of bursts.
sorted <- bursts.sort(bursts, segment.popen)

# You can also write your own functions. If you want P(Open) =~ P(Closed)
variance_fun <- function (seg) {
    # Any function that maps a segment to a number works.
    return(  segment.popen(seg) * segment.pclosed(seg)  )
}

weird_sort <- bursts.sort(bursts, variance_fun)
```

`bursts.space_out` *Artificially add amount of time between bursts (in absence of recording information).*

Description

Given a list of segments separated by an unknown amount of time, one may want to space the segments by some amount of time, so that they can be plotted. This function takes a separating factor, and splits up the segments by either that factor (in seconds), or that many multiples of the largest observed dwell.

Usage

```
bursts.space_out(segments, sep_factor = 1000)
```

Arguments

`segments`	The segments to space out
`sep_factor`	the factor by which to separate the segments. Either the factor in seconds, or a multiple of the longest observed dwell.

Value

The segments again, but with modified meta-data.

Examples

```
infile <- system.file("extdata", "example_multiple_segments.dwt", package = "scbursts")
dwells <- dwt.read(infile)

# Still a list, but the meta-data is fixed
spaced_records <- bursts.space_out(dwells, sep_factor=1000)

# Combine them, and they'll be nicely spaced out.
single_record <- bursts.recombine(spaced_records)

# You can now plot that single_record using one of the plot functions.
```

`bursts.start_times_update` *(DON'T USE THIS) Fix meta-data of bursts.*

Description

YOU PROBABLY WON'T EVER HAVE TO CALL THIS DIRECTLY. Attach the meta-data to each segment saying when it began. It interleaves the durations of the bursts and gaps, and assigns the sum of those durations up to a point as the starting time.

Usage

```
bursts.start_times_update(bursts, gaps)
```

Arguments

`bursts`	List of segments
`gaps`	vector of gap times.

Value

A list of segments, one per burst, with updated start_times

`bursts.subconductance_as` *Imposes a fixed conductance level (0 or 1) to all dwells with subconductance levels to each segment in a burst*

Description

The user specifies the desired level ('open' or 'closed'). The function applies segment.subconductance_as to each segment in the burst. (See segment.subconductance_as for details.)

Usage

```
bursts.subconductance_as(bursts, level)
```

Arguments

`bursts`	the list of segments
`level`	either 'open' or 'closed'

Value

A modified copy of the original burst

Examples

```
infile <- system.file("extdata", "example4.dwt", package = "scbursts")
dwells <- dwt.read(infile)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")
bursts <- bursts.defined_by_tcrit(dwells_c, 100, units="ms")

bursts_d <- bursts.subconductance_as(bursts, "open")
```

---

clampfit.read *Read a .xlsx file output from clampfit*

Description

Read a .xlsx file output from clampfit. Result is a list of "segments", which is a dataframe extra data. See "segment" for more details. Converts millisecond dwells to seconds.

Usage

```
clampfit.read(filename, separating_factor = 1000, header = FALSE)
```

Arguments

filename	Filename to read from
separating_factor	In lieu of a known time between segments, seperate with a multple of the longest dwell.
header	Does the file include a header?

Value

A list of bursts (possibly a singleton)

Examples

```
infile <- system.file("extdata", "example1_clampfit.xlsx", package = "scbursts")
dwells <- clampfit.read(infile)
head(dwells)
```

cplot.conductance_hist *Histogram of Conductance States*

Description

Histogram of Conductance States

Usage

```
cplot.conductance_hist(bursts, ...)
```

Arguments

bursts	List of multiple segments
...	other arguments passed to histogram

Examples

```
infile <- system.file("extdata", "example4.dwt", package = "scbursts")
dwells <- dwt.read(infile)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")
bursts <- bursts.defined_by_tcrit(dwells_c, 100, units="ms")

cplot.conductance_hist(bursts, main="example4.dwt conductance state histogram")
```

cplot.log_root_axes *Add log-root axes to histogram plot*

Description

Add log-root axes to histogram plot

Usage

```
cplot.log_root_axes(points)
```

Arguments

points	The data to plot

Examples

```
infile <- system.file("extdata", "example1_qub.dwt", package = "scbursts")
dwells <- dwt.read(infile)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")
bursts <- bursts.defined_by_tcrit(dwells_c, 100, units="ms")

open_dwells <- segment.open_dwells(bursts.recombine(bursts))
hist(log10(open_dwells), axes=FALSE, breaks=30)
cplot.log_root_axes(open_dwells)
```

---

cplot.pclosed_ts *Plot Time Series (ts) of P(Closed).*

Description

Plot Time Series (ts) of P(Closed).

Usage

```
cplot.pclosed_ts(bursts, main = "P(Closed) Time Series", ...)
```

Arguments

bursts	List of multiple segments
main	The title of the plot.
...	Options to pass to plot

Examples

```
infile <- system.file("extdata", "example1_qub.dwt", package = "scbursts")
dwells <- dwt.read(infile)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")
bursts <- bursts.defined_by_tcrit(dwells_c, 100, units="ms")

cplot.pclosed_ts(bursts, main="P(Closed) Time Series, 2018-09-20")
```

cplot.popen_ts *Plot Time Series (ts) of P(Open).*

Description

Plot Time Series (ts) of P(Open).

Usage

```
cplot.popen_ts(bursts, main = "P(Open) Time Series", ...)
```

Arguments

bursts	List of multiple segments
main	The title of the plot.
...	Options to pass to plot

Examples

```
infile <- system.file("extdata", "example1_qub.dwt", package = "scbursts")
dwells <- dwt.read(infile)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")
bursts <- bursts.defined_by_tcrit(dwells_c, 100, units="ms")

cplot.popen_ts(bursts, "P(Open) Time Series, 2018-09-20")
```

dwt.read *Read a .dwt file.*

Description

Read a .dwt file. Result is a list of "segments", which is a dataframe extra data. See "segment" for more details. Converts millisecond dwells to seconds.

Usage

```
dwt.read(filename, separating_factor = 1000)
```

Arguments

filename	Filename to read from
separating_factor	In lieu of a known time between segments, seperate with a multple of the longest dwell.

Value

A list of bursts (possibly a singleton)

Examples

```
infile <- system.file("extdata", "example1_tac.evt", package = "scbursts")
transitions <- evt.read(infile)
dwells <- evt.to_dwells(transitions)

dwt.write(dwells, file=file.path(tempdir(), "dwells.dwt"))

# Quit R, come back the next day
## Not run:
dwells <- dwt.read("dwells.dwt")

## End(Not run)
```

`dwt.write` *Write a dwt file to disk. Writes DOS line endings. Dwells are in milliseconds*

Description

Write a dwt file to disk. Writes DOS line endings. Dwells are in milliseconds

Usage

```
dwt.write(segments, file = "", seg = 1, append = FALSE)
```

Arguments

`segments`	A segment or multiple segments with $dwells and $states
`file`	Filename to write to
`seg`	Segment number to write in .dwt header.
`append`	Add ot the end of a file or overwrite? (defaults to false)

Examples

```
infile <- system.file("extdata", "example1_tac.evt", package = "scbursts")
transitions <- evt.read(infile)
dwells <- evt.to_dwells(transitions)

dwt.write(dwells, file=file.path(tempdir(), "dwells.dwt"))
```

evt.extract_header *Extract header from evt file.*

Description

Extract header from evt file.

Usage

```
evt.extract_header(filename)
```

Arguments

filename	The filename

Value

A string containing the header

Examples

```
infile <- system.file("extdata", "example1_tac.evt", package = "scbursts")

# Get Dwells
transitions <- evt.read(infile)
dwells <- evt.to_dwells(transitions)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")

# Get Header
header <- evt.extract_header(infile)

evt.write(dwells_c, header=header, file=file.path(tempdir(), "fixed_example1_tac.evt"))
```

evt.from_dwells *Converts dwell durations to absolute transition times.*

Description

Converts dwell durations to absolute transition times.

Usage

```
evt.from_dwells(segments)
```

Arguments

segments	A segment or multiple segemtns

Value

A dataframe or multiple dataframes of states and transition times

Examples

```
dwells_file <- system.file("extdata", "example1_qub.dwt", package = "scbursts")
dwells <- dwt.read(dwells_file)

transitions <- evt.from_dwells(dwells)
```

`evt.read` *Read a .evt file to a table. Times are in seconds*

Description

Read a .evt file to a table. Times are in seconds

Usage

```
evt.read(filename)
```

Arguments

`filename`	The filename

Value

A list of tables with columns "states" and "times". Each table corresponds to a contiguous segment from a recording.

Examples

```
# import some of the data included with the package
infile <- system.file("extdata", "example1_tac.evt", package = "scbursts")
transitions <- evt.read(infile)

head(transitions[[1]])
```

evt.to_dwells *Calculate pulse lengths. Converts transition times to dwell durations.*

Description

Calculate pulse lengths. Converts transition times to dwell durations.

Usage

```
evt.to_dwells(tables)
```

Arguments

tables	Either a single table or a list of tables with columns "states" and "times"

Value

A segment or a list of segments with one less row, where each row represents pulse in state 0 (closed dwell) of duration 0.51231, instead of the time at which the state transitioned.

Examples

```
infile <- system.file("extdata", "example1_tac.evt", package = "scbursts")
transitions <- evt.read(infile)
dwells <- evt.to_dwells(transitions)
head(dwells[[1]])
```

evt.write *Write bursts to a .evt file.*

Description

Write bursts to a .evt file.

Usage

```
evt.write(segments, filename = "", header = NULL)
```

Arguments

segments	A segment or list of segments to write to filename
filename	The filename
header	The header information for the evt file, if available

Examples

```
infile <- system.file("extdata", "example1_tac.evt", package = "scbursts")

# Get Dwells
transitions <- evt.read(infile)
dwells <- evt.to_dwells(transitions)
dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")

# Get Header
header <- evt.extract_header(infile)

evt.write(dwells_c, header=header, file=file.path(tempdir(), "fixed_example1_tac.evt"))
```

`hst.extract_header` *Extract header from hst file.*

Description

Extract header from hst file.

Usage

```
hst.extract_header(filename)
```

Arguments

`filename`	The filename

Value

A string containing the header

Examples

```
# import some of the data included with the package
infile <- system.file("extdata", "example1_hst.hst", package = "scbursts")

open_table <- hst.read(infile, extract="open")
closed_table <- hst.read(infile, extract="closed")
header <- hst.extract_header(infile)

# Make adjustments to the histogram, if you wish
hst.write(open_table, closed_table, file=file.path(tempdir(), "output_hist.hst"), header=header)
```

hst.read — *Read a MIL ".hst" file to a table.*

Description

Read a MIL ".hst" file to a table. By default these files are in log10(Milliseconds)-sqrt(Freq), but unless "raw" is set to TRUE, this function returns a table containing Seconds-Freq

Usage

```
hst.read(filename, extract = "open", raw = FALSE)
```

Arguments

filename	The filename
extract	Extract either "open" or "closed" histogram
raw	Data is given as log10(milliseconds)-Sqrt(Freq). Setting raw=FALSE yields output as Seconds-Frequency

Value

A tables with columns "bin", "freq" and "fit".

Examples

```
# import some of the data included with the package
infile <- system.file("extdata", "example1_hst.hst", package = "scbursts")
open_hst   <- hst.read(infile, extract="open")
closed_hst <- hst.read(infile, extract="closed")

head(open_hst)
head(closed_hst)
```

hst.write — *Write bursts to a log10(ms)-sqrt(Frequency) .hst file from open and closed tables.*

Description

Write bursts to a log10(ms)-sqrt(Frequency) .hst file from open and closed tables.

Usage

```
hst.write(open_hist, closed_hist, file = "", header = NULL,
  fromraw = FALSE)
```

Arguments

open_hist	The table (bin,freq,fit) for open times
closed_hist	The table (bin,freq,fit) for closed times
file	The filename
header	The header info
fromraw	Unless FALSE, assume we need to write a log10(milliseconds)-sqrt(Frequency) plot

Examples

```
infile <- system.file("extdata", "example1_hst.hst", package = "scbursts")

open = hst.read(infile, extract="open")
closed = hst.read(infile, extract="closed")
header = hst.extract_header(infile)

### Do stuff
hst.write(open, closed, file=file.path(tempdir(), "new_histogram.hst"), header=header)
```

---

risetime.correct_gaussian

Undo the effect of the gaussian filter.

Description

Undo the effect of the gaussian filter. See section 4.1.1 of Colquhoun and Sigworth, "Fitting and Analysis of Single-Channel segments". NOTE: This is potentially problematic, in that this unfiltering lengthens every dwell. A less naive algorithm would take into account the infulence of the surroundings, as they impact the effects of the filter.

Usage

```
risetime.correct_gaussian(Tr, segments, units = "s")
```

Arguments

Tr	Rise time of the filter in (us)
segments	A segment or multiple segments with $states and $dwells to correct.
units	What unit the risetime is input in (defaults to seconds)

Value

A Segment or multiple segments with corrected risetimes.

Examples

```
infile <- system.file("extdata", "example1_tac.evt", package = "scbursts")
transitions <- evt.read(infile)
dwells <- evt.to_dwells(transitions)

dwells_c <- risetime.correct_gaussian(Tr=35.0052278, dwells, units="us")
```

---

scan.read *Read a scan results text file. scan.read returns a 1 segment list Reads in scan results and puts them in the same format as the output of dwt.read. See 'dwt', and 'segment' for more information.*

Description

Data is in seconds.

Usage

```
scan.read(filename, separating_factor = 1000)
```

Arguments

filename,	the file name to read from.
separating_factor	In lieu of a known time between segments, seperate with a multple of the longest dwell.

Value

A list of recording segments from the scan file

Examples

```
infile <- system.file("extdata", "example1_scan.txt", package = "scbursts")
record <- scan.read(infile)
head(record)
```

segment.check_subconductance *Check if segment contains subconductive states*

Description

Check if segment contains subconductive states

Usage

```
segment.check_subconductance(segment)
```

Arguments

segment	The dwells and states table

Value

True if it contains an conductance other than 0 or 1, False otherwise.

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,    0.2,    0,    1,    0,  0.5,    0,  0.7,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

segment.check_subconductance(my_burst)
```

segment.closed_dwells *Extract closed dwells.*

Description

Extract closed dwells.

Usage

```
segment.closed_dwells(segment)
```

Arguments

segment	the segment object

Value

the closed dwells

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,      1,    0,    1,    0,    1,    0,    1,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

closed_dwells <- segment.closed_dwells(my_burst)
head(closed_dwells)
```

---

segment.conductance_states

Return a list of all the (sub)conductance states.

Description

Return a list of all the (sub)conductance states.

Usage

```
segment.conductance_states(segment)
```

Arguments

segment	The dwells and states table

Value

a list of all the (sub)conductance states.

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,    0.2,    0,    1,    0,  0.5,    0,  0.7,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

segment.conductance_states(my_burst)
```

segment.consecutives_to_dwells *Collapses a segment into dwells with alternating conductance levels.*

Description

Segments may contain consecutive dwells with the same conductance level. consecutives_to_dwells sums together all consecutive dwells with the same conductance level. The result is a segment containing dwells that alternate in conductance level (i.e. 1,0,1,0,1,...)

Usage

```
segment.consecutives_to_dwells(segment)
```

Arguments

segment	The dwells and states table

Value

A modified copy of the original segment

segment.copy *Copy a segment*

Description

This is a low-level function, mostly for use internally by other functions. There aren't many reasons to use this.

Usage

```
segment.copy(segment)
```

Arguments

segment	The segment to copy

Value

A duplicate identical content.

segment.count_closed *Extract number of closed dwells. In the case of subconductive states, a dwell is only closed if the conductance is exactly zero.*

Description

Extract number of closed dwells. In the case of subconductive states, a dwell is only closed if the conductance is exactly zero.

Usage

```
segment.count_closed(segment)
```

Arguments

segment	the segment object

Value

number of closed dwells

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,      1,    0,    1,    0,    1,    0,    1,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

segment.count_closed(my_burst)
```

segment.count_dwells *Extract number of dwells in segment.*

Description

Extract number of dwells in segment.

Usage

```
segment.count_dwells(segment)
```

Arguments

segment	the segment object

Value

number of dwells

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,      1,    0,    1,    0,    1,    0,    1,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

segment.count_dwells(my_burst)
```

`segment.count_open` *Extract number of open dwells. In the case of subconductive states, count the number of non-zero states.*

Description

Extract number of open dwells. In the case of subconductive states, count the number of non-zero states.

Usage

```
segment.count_open(segment)
```

Arguments

`segment`	the segment object

Value

number of open dwells

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,      1,    0,    1,    0,    1,    0,    1,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

segment.count_open(my_burst)
```

segment.create *Create a "segment" object*

Description

This is a low-level function, mostly for use internally by other functions. There aren't many reasons to use this. Create object containing table data and metadata. The object can be used as a dataframe, and the metadata can be accessed with the functions: segment.seg, segment.start_time, segment.filename

Usage

```
segment.create(states, dwells, seg = 1, start_time = 0,
  name = "burst", ignore_errors = FALSE)
```

Arguments

states	a vector of states
dwells	a vector of dwell durations (same length as states)
seg	The segment number. Defaults to 1
start_time	When the dwells began. Defaults to 0
name	Suffix-less version of the original filename. 60uM.dwt -> '60uM'
ignore_errors	Do not report faulty segments (not many reasons to do this)

Value

The segment object: A dataframe with extra metadata.

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,      1,    0,    1,    0,    1,    0,    1,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=0, name="example_segment")

segment.name(my_burst)
```

segment.duration *Get duration of a segment.*

Description

Get duration of a segment.

Usage

```
segment.duration(segment)
```

Arguments

segment	the segment object

Value

the duration

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,      1,    0,    1,    0,    1,    0,    1,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

segment.duration(my_burst)
```

segment.dwells_by_conductance *Extract dwells in conductance range. lower <= x <= upper*

Description

Extract dwells in conductance range. lower <= x <= upper

Usage

```
segment.dwells_by_conductance(segment, level)
```

Arguments

segment	the segment object
level	The conductance to extract

Value

the dwells in a given range

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,    0.2,    0,    1,    0,  0.5,    0,  0.7,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

half_open <- segment.dwells_by_conductance(my_burst, 0.5)
head(half_open)
```

---

segment.dwells_by_conductance_range

Extract dwells in conductance range. lower <= x <= upper

Description

Extract dwells in conductance range. lower <= x <= upper

Usage

```
segment.dwells_by_conductance_range(segment, lower = 0, upper = Inf)
```

Arguments

segment	the segment object
lower	lower bound on conductance (defaults to 0)
upper	upper bound on conductance (defaults to infinity)

Value

the dwells in a given range

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,    0.2,    0,    1,    0,  0.5,    0,  0.7,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

half_open <- segment.dwells_by_conductance_range(my_burst, lower=0.2, upper=0.7)
head(half_open)
```

segment.impose_deadtime

Imposes a deadtime to a segment by removing any dwell that is shorter than the deadtime.

Description

The user specifies a deadtime in microseconds. The function effectively undoes the work of the event detection algorithm by reverting the conductance level (of the brief dwell) back to the previous conductance level in the time sequence. The function then returns a collapsed segment containing alternating dwells.

Usage

```
segment.impose_deadtime(segment, deadtime)
```

Arguments

segment	the segment containing dwells and states.
deadtime	the briefest possible event in microseconds.

Value

A modified copy of the original segment

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,    0.2,    0,    1,    0,  0.5,    0,  0.7,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

my_burst_d <- segment.impose_deadtime(my_burst, deadtime=0.3)
```

segment.modify_conductance

Transform the conductance states according to a user-defined function of conductance level.

Description

Transform the conductance states according to a user-defined function of conductance level.

Usage

```
segment.modify_conductance(segment, fun)
```

Arguments

segment	the segment containing dwells and states.
fun	a function on conductance levels (states)

Value

A modified copy of the original segment

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,    0.2,    0,    1,    0,  0.5,    0,  0.7,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

### Collapse into three subconductance states
fun <- function(amp) {
    if (amp < 0.3)
        return(0)
    else if (amp >= 0.3 && amp < 0.6)
        return(0.5)
    else
        return(1)
}

my_burst_d <- segment.modify_conductance(my_burst, fun)
```

---

segment.name *Extract name from segment.*

Description

Extract name from segment.

Usage

```
segment.name(segment)
```

Arguments

segment	the segment object

Value

Segment name (string)

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,      1,    0,    1,    0,    1,    0,    1,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

segment.name(my_burst)
```

---

segment.open_dwells *Extract open dwells. (Any conductance greater than zero)*

Description

Extract open dwells. (Any conductance greater than zero)

Usage

```
segment.open_dwells(segment)
```

Arguments

segment	the segment object

Value

the open dwells

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,      1,    0,    1,    0,    1,    0,    1,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

open_dwells <- segment.open_dwells(my_burst)
head(open_dwells)
```

segment.pclosed *Calculate empirical P(Closed) of a segment.*

Description

Calculate empirical P(Closed) of a segment. NOTE: Assuming that burst starts and ends with 1

Usage

```
segment.pclosed(segment)
```

Arguments

segment	The dwells and states table

Value

The ratio of closed time to total time

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,      1,    0,    1,    0,    1,    0,    1,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

# P(Closed) of this burst
segment.pclosed(my_burst)
```

segment.pconductance *Calculate empirical P(Lower <= Conductance <= Upper) of a segment.*

Description

Calculate empirical P(Lower <= Conductance <= Upper) of a segment.

Usage

```
segment.pconductance(segment, level)
```

Arguments

segment	the segment object
level	conductance level

Value

The probability of being in this conductance state

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,    0.2,    0,    1,    0,  0.5,    0,  0.7,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

segment.pconductance(my_burst, 0.5)
```

---

segment.pconductance_range

Calculate empirical P(Lower <= Conductance <= Upper) of a segment.

Description

Calculate empirical P(Lower <= Conductance <= Upper) of a segment.

Usage

```
segment.pconductance_range(segment, lower = 0, upper = Inf)
```

Arguments

segment	the segment object
lower	lower bound on conductance (defaults to 0)
upper	upper bound on conductance (defaults to infinity)

Value

The probability of being in these conductance states

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,    0.2,    0,    1,    0,  0.5,    0,  0.7,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

segment.pconductance_range(my_burst, lower=0.5, upper=0.5)
```

segment.popen *Calculate empirical P(Open) of a segment. (A state is considered open if the conductance is non-zero)*

Description

Calculate empirical P(Open) of a segment. NOTE: Assuming that burst starts and ends with 1

Usage

```
segment.popen(segment)
```

Arguments

segment	The dwells and states table

Value

The ratio of open time to total time

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,      1,    0,    1,    0,    1,    0,    1,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

# P(Open) of this burst
segment.popen(my_burst)
```

segment.seg *Extract segment number from segment.*

Description

Extract segment number from segment.

Usage

```
segment.seg(segment)
```

Arguments

segment	the segment object

Value

Segment number (integer)

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,      1,    0,    1,    0,    1,    0,    1,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=0, name="example_segment")

segment.seg(my_burst)
```

---

segment.start_time *Extract start_time from segment.*

Description

Extract start_time from segment.

Usage

```
segment.start_time(segment)
```

Arguments

segment	the segment object

Value

Segment start_time (float)

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,      1,    0,    1,    0,    1,    0,    1,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

segment.start_time(my_burst)
```

segment.subconductance_as

Imposes a fixed conductance level (0 or 1) to all dwells with subconductance levels.

Description

The user specifies the desired level ('open' or 'closed'). The function will modify any subconductance level (that is not 0 or 1) to be the desired level 1 for 'open' or 0 for 'closed'. The function then reutrns a collapsed segment containing alternating dwells. (See segment.consecutives_to_dwells for details about the collapsed segment.)

Usage

```
segment.subconductance_as(segment, level)
```

Arguments

segment	the segment containing dwells and states.
level	either 'open' or 'closed'

Value

A modified copy of the original segment

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,    0.2,    0,    1,    0,  0.5,    0,  0.7,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

my_burst_d <- segment.subconductance_as(my_burst, "open")
```

segment.verify

Detect misrecorded data.

Description

Segments should have a very specific shape, but recordings can produce errors that make nonsensical segments. In particular, ones contain multiple consecutive states of equal conductance, or end in closings. This function detects whether a segment satisfies the constraint that the segment conductances are not the same from one dwell to the next, and begin and end with a closing.

Usage

```
segment.verify(segment)
```

Arguments

segment	The dwells and states table

Value

True if a valid segment, False otherwise

Examples

```
# It's more likely that you created states or dwells with some function
states  <-  c(0,      1,    0,    1,    0,    1,    0,    1,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.0,  1.1,  0.6,  1.1,  0.8,  1.1)
my_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="example_segment")

segment.verify(my_burst)

# Now, a bad burst with two adjacent open dwells
states  <-  c(0,      1,    0,    1,    1,    0,    1,    0,    1)
dwells  <-  c(0.1,  1.1,  0.5,  0.2,  1.1,  0.6,  1.1,  0.8,  1.1)

# This will issue a warning
faulty_burst <- segment.create(states, dwells, seg=1, start_time=3.14159, name="faulty_segment")

# This will differentiate good and faulty bursts
segment.verify(faulty_burst)

# If you have a list of bursts, you can select the good ones with
# vbursts <- bursts.select(bursts, segment.verify)
```

---

util.basename *Remove suffix and path from filename.*

Description

Remove suffix and path from filename.

Usage

```
util.basename(filename)
```

Arguments

filename	string to extract basename from

Value

Name with suffix and path removed

Examples

```
util.basename("bursts/60uM-2017-08-18-16-32/60uM-712.dwt")
```

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