Package 'compeir'

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Type Package

Title Event-specific incidence rates for competing risks data

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Author Nadine Grambauer, Andreas Neudecker

Maintainer Nadine Grambauer <nadine@imbi.uni-freiburg.de>

Description The package enables to compute event-specific incidence rates for competing risks data, to compute rate ratios, event-specific incidence proportions and cumulative incidence functions from these, and to plot these in a comprehensive multi-state type graphic.

License GPL-2

Depends grid, lattice, etm

LazyLoad yes

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`compeir-package` *Competing events incidence rates and corresponding statistics*

Description

The package enables to compute event-specific incidence rates for competing risks data, to compute rate ratios, event-specific incidence proportions and cumulative incidence functions from these, and to plot these in a comprehensive multistate-type graphic.

Details

Package:	compeir
Type:	Package
Version:	1.0
Date:	2010-12-20
License:	GPL-2
Depends:	grid, lattice, etm
LazyLoad:	yes

The most important function contained in this package is `irates`. `irates` returns an object with which further measures can be determined, e.g., incidence rate ratios (`irates.ratio`), incidence proportions (`iprop`) or the cumulative incidence function (`cif`). The latter can easily be plotted using `CIFplot`. Also, a multistate type graphic based on incidence rates can be plotted by `plot.irates`.

Author(s)

Nadine Grambauer and Andreas Neudecker

Maintainer: Nadine Grambauer <nadine@imbi.uni-freiburg.de>

References

Grambauer, N., Schumacher, M., Dettenkofer, M. and Beyersmann, J. (2010) Incidence densities in a competing events setting. *American Journal of Epidemiology* **172**,1077–1084. http://aje.oxfordjournals.org/lookup/doi/10.1093/aje/kwq246

Altman, D., Machin, D., Bryant, T., Gardner, S. (2000) *Statistics with Confidence: Confidence intervals and statistical guidelines*. Second edition. Bristol: BMJ Books.

`cif` *Parametrically estimating the cumulative incidence function*

Description

This function estimates the cumulative incidence function (CIF) for each respective event type using all competing events incidence rates.

Usage

```
cif(irates, t, event.code = NULL, covar.code = NULL, full.sample = FALSE)
```

Arguments

`irates`	`irates` object
`t`	A vector of timepoints for which the CIF shall be calculated
`event.code`	A character or numerical value that specifies the respective competing events for which the CIF shall be calculated. If `NULL`, `event.code` will be inherited from `irates`
`covar.code`	A character or numerical value that specifies the respective covariate vlaues for which the CIF shall be calculated. If `NULL`, `covar.code` will be inherited from `irates`
`full.sample`	A logical value that specifies if the CIF shall also be calculated for the full sample, i.e., irrespective of any covariate value. Default is set to `FALSE`

Details

The cumulative incidence function is the expected proportion of type h events over the course of time.

Value

An object of class `cif`. This object is implemented as a list of the (besides pre-specified) following items:

`t`	Timepoints for which the CIF is calculated
`cif`	CIF estimates corresponding to `t` for each `event.code`

References

Grambauer, N., Schumacher, M., Dettenkofer, M. and Beyersmann, J. (2010) Incidence densities in a competing events setting. *American Journal of Epidemiology* **172**,1077–1084. http://aje.oxfordjournals.org/lookup/doi/10.1093/aje/kwq246

See Also

`irates`, `CIFplot`

Examples

```
### Example data.frame with aggregated count data
dat <- data.frame(
times = c(7948,2899),
no.event = c(6,8),
event.1 = c(589,68),
event.2 = c(55,21),
row.names = c("covar0","covar1"))

### Compute irates object from dat
ir <- irates(dat)

### Compute the cumulative incidence function from irates object, e.g.
cif(irates = ir, t = 1:10)
```

`CIFplot` *Plotting estimates of the cumulative incidence function*

Description

Function for plotting parametric estimates of the cumulative incidence function based on incidence rates. If individual patient data is available, the function also enables to plot the non-parametric, Aalen-Johansen estimates using `etm`.

Usage

```
CIFplot(x, event.code = NULL, covar.code = NULL, indiv.times = NULL, indiv.events = NULL, indiv.covar
xlim = c(0, 30), ylim = NULL, xlab = "Time", ylab = "CIF", legend = TRUE, ...)
```

Arguments

`x`	`irates` object
`event.code`	A character or numerical value that specifies the respective competing events for which the CIF shall be plotted. If `NULL`, `event.code` will be inherited from `irates`
`covar.code`	A character or numerical value that specifies the respective covariate vlaues for which the CIF shall be plotted. If `NULL`, `covar.code` will be inherited from `irates`
`indiv.times`	Timepoints corresponding to event status for each individual (vector or factor). Only relevant if individual patient data is available. Defaults to `NULL`
`indiv.events`	Event status for each individual (vector or factor). Only relevant if individual patient data is available. Defaults to `NULL`
`indiv.covar`	Event status for each individual (vector or factor). Only relevant if individual patient data is available. Defaults to `NULL`
`xlim`	The x limits (x1, x2) of the plot. Defaults to c(0, 30)

ylim	The y limits (y1, y2) of the plot. If NULL, ylim will be determined automatically
xlab	A title for the x axis. Defaults to "Time"
ylab	A title for the y axis. Defaults to "CIF"
legend	Adds a legend to the plot. Defaults to TRUE
...	Further arguments for plot

See Also

cif, etm

Examples

```
### Example data.frame with aggregated count data
dat <- data.frame(
times = c(7948,2899),
no.event = c(6,8),
event.1 = c(589,68),
event.2 = c(55,21),
row.names = c("covar0","covar1"))

### Compute irates object from dat
ir <- irates(dat)

### Compute the cumulative incidence function from irates object
### here: timespan is specified by xlim (default: xlim = c(0,30))
CIFplot(x = ir)


### sir.adm: Individual patient data
data(sir.adm)

### aggregate data
agg.sir.adm <- data.reshape(
times = sir.adm$time,
events = sir.adm$status,
covar = sir.adm$pneu,
no.event.code= "0")

### Plot parametric and non-parametric CIF estimates
CIFplot(
x = irates(agg.sir.adm),
indiv.times = sir.adm$time,
indiv.events = sir.adm$status,
indiv.covar = sir.adm$pneu)


### okiss: Individual patient data
### here: e.g. just event of interest 1 (infection) is plotted
data(okiss)

### aggregate data
```

```
agg.okiss <- data.reshape(
times = okiss$time,
events = okiss$status,
covar = okiss$allo,
no.event.code= "11")

### Plot parametric and non-parametric CIF estimates
CIFplot(
x = irates(agg.okiss),
event.code = "1",
indiv.times = okiss$time,
indiv.events = okiss$status,
indiv.covar = okiss$allo)
```

`data.reshape` *Reshaping individual patient data*

Description

Aggregates individual patient data and combines it in a data.frame format required for `irates`

Usage

```
data.reshape(times, events, covar, no.event.code, event.code = NULL, covar.code = NULL)
```

Arguments

`times`	Timepoints corresponding to event status for each individual (vector or factor)
`events`	Event status for each individual (vector or factor)
`covar`	Event status for each individual (vector or factor)
`no.event.code`	A character or numerical value that specifies the value in `events` corresponding to "no event observed".
`event.code`	A character or numerical value that specifies the respective competing events in `events`. If `NULL`, `event.code` will be automatically extracted from `events`
`covar.code`	A character or numerical value that specifies the respective covariate values in `covar`. If `NULL`, `covar.code` will be automatically extracted from `covar`

Value

An object of class `data.frame` of the form `data.frame(time, no.event.code, event.code)` with row.names given by `covar.code` and corresponding aggregated data entries.

Note

With individual patient data you may also perform non-parametric competing risks analyses, e.g., estimating the cumulative event-specific hazards by applying the package `mvna` or estimating the cumulative incidence function (CIF) by using the package `etm`. `etm` is also required as a diagnostic tool in `CIFplot` that enables to compare parametric and non-parametric CIF estimates.

See Also

irates, CIFplot, mvna, etm

Examples

```
### Example data:
### Pneumonia on admission in intenive care unit patients

data(sir.adm)

data.reshape(
times = sir.adm$time,
events = sir.adm$status,
covar = sir.adm$pneu,
no.event.code = "0")

### Example data:
### Bloodstream infections in stem-cell transplanted patients

data(okiss)

data.reshape(
times = okiss$time,
events = okiss$status,
covar = okiss$allo,
no.event.code = "11")
```

---

iprop *Event-specific incidence proportions*

Description

This function computes event-specific incidence proportions using the competing events incidence rates. Also, corresponding variances and confidence intervals are provided.

Usage

```
iprop(irates, ci.fun = NULL, ci.level = NULL)
```

Arguments

irates	irates object
ci.fun	A character value out of c("lin", "score") that specifies the confidence interval function, either linear or score. If NULL, ci.fun is set to "score"
ci.level	A numerical value between 0 and 1 that specifies the level for the two-sided confidence interval. If NULL, ci.level is inherited from irates

Details

The incidence proportion is defined as the number of new cases of disease in a sample divided by the sample without disease at baseline. It requires complete data. It is a non-parametric statistic, however, it does not account for time at risk.

Value

An object of class `iprop`. This object is implemented as a list of the (besides pre-specified) following items:

`ip`	Competing events incidence proportions
`var`	Variance estimates for competing events incidence proportions
`conf.lower`	Lower confidence interval corresponding to pre-specified function and level
`conf.upper`	Upper confidence interval corresponding to pre-specified function and level

References

Altman, D., Machin, D., Bryant, T., Gardner, S. (2000) *Statistics with Confidence: Confidence intervals and statistical guidelines*. Second edition. Bristol: BMJ Books.

See Also

`print.iprop`, `irates`, `cif`

Examples

```
### Example data.frame with aggregated count data
dat <- data.frame(
times = c(7948,2899),
no.event = c(6,8),
event.1 = c(589,68),
event.2 = c(55,21),
row.names = c("covar0","covar1"))

### Compute irates object from dat
ir <- irates(dat)

### Compute incidence proportions from irates object
iprop(ir)
```

`irates` *Competing events incidence rates*

Description

This function computes event-specific incidence rates (a.k.a incidence densities) for competing risks data together with corresponding variances and confidence intervals. Incidence rates can be computed for separate covariate values of one binary or categorical covariate.

Usage

```
irates(data, time.code = NULL, no.event.code = NULL, no.event.lab = NULL, event.lab = NULL, covar.lab
full.sample.lab = "Full sample", ci.level = 0.95, ci.fun = "log")
```

Arguments

data	A data.frame, where columns contain the aggregated observation time (i.e., time.code), censored events (i.e., no.event.code) and aggregated count data for each event type (i.e., event.code); each row corresponds to a certain covariate value
time.code	A character or numerical value that specifies the time.code colname in data. If NULL, time.code is assumed to be the first colname in data
no.event.code	A character or numerical value that specifies the no.event.code colname in data. If NULL, no.event.code is assumed to be the second colname in data
no.event.lab	A character value that specifies a certain label for no.event.code column name in data. If NULL, no.event.lab equals no.event.code
event.lab	A character value (potentially vector with order and length according to order and number of competing events in data) that specifies a certain label for each event code in data. If NULL, event.lab equals the colname for each event code in data
covar.lab	A character value (potentially vector with order and length according to order and number of covariate values in data) that specifies a certain label for each event code (i.e. rowname) in data. If NULL, covar.lab equals the rowname for each covariate code in data
full.sample.lab	A character value that specifies a certain label for the full sample irates from data. Default is set to "Full sample"
ci.level	A numerical value between 0 and 1 that specifies the level for the two-sided confidence interval. Default is set to .95
ci.fun	A character value out of c("lin", "log") that specifies the confidence interval function, either linear or log-transformed. Default is set to "log"

Details

The incidence rate is defined as the number of new cases of disease in a sample divided by the sample-time at risk.

Value

An object of class irates. This object is implemented as a list of the (besides pre-specified) following items:

ir	Competing events incidence rates
var	Variance estimates for competing events incidence rates
conf.lower	Lower confidence interval corresponding to pre-specified function and level
conf.upper	Upper confidence interval corresponding to pre-specified function and level

N	Distribution of covariate values at baseline
n	data.frame with counts for each event according to covariate value as well as for the full sample

Note

If individual patient data is available and incidence rates shall be computed, the data can be easily reshaped to the required data.frame format by using the function `data.reshape`

References

Grambauer, N., Schumacher, M., Dettenkofer, M. and Beyersmann, J. (2010) Incidence densities in a competing events setting. *American Journal of Epidemiology* **172**,1077–1084. http://aje.oxfordjournals.org/lookup/doi/10.1093/aje/kwq246

See Also

`print.irates`, `summary.irates`, `plot.irates`, `data.reshape`, `grid`

Examples

```
### With individual patient data - sir.adm - using the function data.reshape
data(sir.adm)
dat1 <- data.reshape(
times = sir.adm$time,
events = sir.adm$status,
covar = sir.adm$pneu,
no.event.code = "0")

### With aggregated count data
dat2 <- data.frame(
time = c(7948,2899),
no.event = c(6,8),
event.1 = c(589,68),
event.2 = c(55,21),
row.names = c("covar0","covar1"))

### Compute incidence rates from dat1 or dat2 (here dat2)
irates(dat2)

### Specify columns with time and no.event information
irates(
dat2,
time.code = "time",
no.event.code = "no.event")

### Set specific labels
irates(
dat2,
no.event.lab = "Admission",
event.lab = c("Discharge","Death"),
covar.lab = c("No pneumonia","Pneumonia"))
```

`irates.ratio` *Ratio between two event-specific incidence rates*

Description

This function computes event-specific incidence rate ratios between two groups. Each group is given by a covariate value.

Usage

```
irates.ratio(irates, covar.code, ci.fun = NULL, ci.level = NULL)
```

Arguments

`irates`	`irates` object
`covar.code`	A vector of character or numerical values that specifies the covariate values in `irates` to be compared. The vector must contain two values, the order specifies the ratio
`ci.fun`	A character value out of c("lin", "log") that specifies the confidence interval function, either linear or log-transformed. If `NULL`, `ci.fun` is inherited from `irates`
`ci.level`	A numerical value between 0 and 1 that specifies the level for the two-sided confidence interval. If `NULL`, `ci.level` is inherited from `irates`

Value

An object of class `irates.ratio`. This object is implemented as a list of the (besides pre-specified) following items:

`irr`	Competing events incidence rate ratios
`var`	Variance estimates for competing events incidence rate ratios
`conf.lower`	Lower confidence interval corresponding to pre-specified function and level
`conf.upper`	Upper confidence interval corresponding to pre-specified function and level

See Also

`print.irates.ratio`

Examples

```
### Example data.frame with aggregated count data
dat <- data.frame(
times = c(7948,2899),
no.event = c(6,8),
event.1 = c(589,68),
event.2 = c(55,21),
```

```
row.names = c("covar0","covar1"))

### Compute irates object from dat
ir <- irates(dat)

### Compute incidence rate ratios from irates object
irates.ratio(
ir,
covar.code = c("covar1", "covar0"))
```

---

okiss *Bloodstream infections in stem-cell transplanted patients*

Description

A random subsample of 1000 patients from ONKO-KISS, part of the surveillance program of the German National Reference Centre for Surveillance of Hospital-Acquired Infections. Patients have been treated by peripheral blood stem-cell transplantation. After transplantation, patients are neutropenic. Occurrence of bloodstream infection during neutropenia is a severe complication.

Usage

```
data(okiss)
```

Format

A data frame with 1000 observations on the following 4 variables.

`time` Time of neutropenia until first event in days

`status` Event status indicator. 1: infection, 2: end of neutropenia, 7: death, 11: censored observation

`allo` Covariate transplant type indicator: 0: autologous transplants, 1: allogeneic transplants

`sex` Covariate sex indicator: `f`: female, `m`: male

Details

The challenge in this competing risks example is that autologous transplants in fact decreased the number of infections divided by the number of patients (i.e., iprop), but that they also increased the number of infections divided by the number of patient-days (i.e., irates).

Source

Beyersmann J., Dettenkofer M., Bertz H., Schumacher M. (2007) A competing risks analysis of bloodstream infection after stem-cell transplantation using subdistribution hazards and cause-specific hazards. *Statistics in Medicine*, **26**,5360–5369. http://onlinelibrary.wiley.com/doi/10.1002/sim.3006/abstract

Grambauer, N., Schumacher, M., Dettenkofer, M. and Beyersmann, J. (2010) Incidence densities in a competing events setting. *American Journal of Epidemiology* **172**,1077–1084. http://aje.oxfordjournals.org/lookup/doi/10.1093/aje/kwq246

Examples

```
data(okiss)
```

`plot.irates` *Comprehensive multi-state graphic for competing risks incidence rates analysis*

Description

Function for plotting `irates` objects. For each covariate value, multistate-type graphics will be displayed, i.e., plots with transition arrows from the initial event to each competing event, where the thickness describes the particular amount of every incidence rate. Full sample graphics might also be plotted.

Usage

```
## S3 method for class 'irates'
plot(x, covar.code = NULL, full.sample = FALSE, n.row = 1, viewport.size = list(w = 3.5, h = 2.5),
box.size = list(w = NULL, h = NULL), dist = 0.5, irates.vbw = NULL, arrow.maxlwd = 10, display.digits =
main.gp = gpar(cex = 1.2), ...)
```

Arguments

`x`	`irates` object
`covar.code`	A character or numerical value that specifies the respective covariates value(s) for which the result of `irates` shall be printed. If `NULL`, `covar.code` will be inherited from `irates`
`full.sample`	A `logical` value that specifies if results of `irates` shall also be printed for the full sample, i.e., irrespective of any covariate value. Default is set to FALSE
`n.row`	An integer value that specifies the number of rows to display the plots for each covariate value. Default is set to 1
`viewport.size`	A list with 2 numerical values `list(w, h)` to set the width (w) and height (h) of the viewport. Default is w= 3.5, h = 2.5
`box.size`	A list with 2 numerical values `list(w, h)` to set the width (w) and height (h) of the box(es) for each event. If `NULL`, w and h will be determined automatically corresponding to the specified `event.lab` in `irates`
`dist`	A numerical value to set the distance between plots in a row. Default is 0.5
`irates.vbw`	A numerical value to set the width of the background box for the incidence rate values to be displayed. If `NULL`, `irates.vbw` will be determined automatically corresponding to `display.digits`

arrow.maxlwd	A numerical value to set the maximum arrow width for the transition with the highest incidence rate. Default is 10.
display.digits	An integer value specifying the number of decimal place for all incidence rates that shall be plotted. Default is 2
cex	A numerical value giving the amount by which plotting the incidence rate values should be magnified relative to the default
show.values	A logical value specifying if incidence rate values shall be plotted or not. Default is TRUE
mark	A vector of length event.code with logical values specifying if and which transition arrow shall be marked with a certain color. Defaults to NULL
mark.col	The color to be used for marking transition arrows. Defaults to "red"
main	An overall title for the plot
main.dist	A numerical value to set the distance between the overall title and the plots
main.gp	A numerical value giving the amount by which plotting the title values should be magnified relative to the default
...	Further arguments for plot

References

Grambauer, N., Schumacher, M., Dettenkofer, M. and Beyersmann, J. (2010) Incidence densities in a competing events setting. *American Journal of Epidemiology* **172**,1077–1084. http://aje.oxfordjournals.org/lookup/doi/10.1093/aje/kwq246

See Also

irates

Examples

```
#########################
### Pneumonia on admission data: sir.adm
data(sir.adm)
agg.sir <- data.reshape(
times = sir.adm$time,
events = sir.adm$status,
covar = sir.adm$pneu,
no.event.code = "0")

### Compute irates object from dat
ir1 <- irates(agg.sir)

### Plot multistate-type graphic from irates object
plot(ir1)

#########################
### Compute irates object with certain labels
ir2 <- irates(
agg.sir,
```

```
no.event.lab = "Admission",
event.lab = c("Discharge","Death"),
covar.lab = c("No pneumonia","Pneumonia"))

### Plot multistate-type graphic from irates object
plot(ir2)

#########################
### ONKO-KISS data: okiss
data(okiss)
### Aggregate individual patient data
agg.okiss <- data.reshape(
times = okiss$time,
events = okiss$status,
covar = okiss$allo,
no.event.code = "11")

### Plot multistate-type graphic from irates object
plot(irates(agg.okiss,
no.event.lab = "Neutropenia",
event.lab = c("Infection","End of\n Neutropenia","Death"),
covar.lab = c("Autologous","Allogenic")
),
viewport.size = list(w = 4.5, h = 2.5)
)
```

`print.iprop` *Print method for 'iprop' object*

Description

Print method for an object of class `iprop`. By default it prints all competing events incidence proportions contained in `iprop`. It is also possible to select specific events or covariate values to be printed. Full sample incidence proportions might also be printed.

Usage

```
## S3 method for class 'iprop'
print(x, event.code = NULL, covar.code = NULL, full.sample = FALSE, display.digits = 4, ...)
```

Arguments

`x`	`iprop` object
`event.code`	A character or numerical value that specifies the respective competing events for which the result of `iprop` shall be printed. If `NULL`, `event.code` will be inherited from `iprop`
`covar.code`	A character or numerical value that specifies the respective covariates value(s) for which the result of `iprop` shall be printed. If `NULL`, `covar.code` will be inherited from `iprop`

full.sample	A logical value that specifies if results of iprop shall also be printed for the full sample, i.e., irrespective of any covariate value. Default is set to FALSE
display.digits	An integer value specifying the number of decimal place for all incidence proportions that shall be printed. Default is set to 4
...	Other arguments for print method

Value

No value is returned.

See Also

iprop

---

print.irates *Print method for 'irates' object*

Description

Print method for an object of class irates. By default it prints all competing events incidence rates contained in irates. It is also possible to select specific events or covariate values to be printed. Full sample incidence rates might also be printed.

Usage

```
## S3 method for class 'irates'
print(x, event.code = NULL, covar.code = NULL, full.sample = FALSE, display.digits = 4, ...)
```

Arguments

x	irates object
event.code	A character or numerical value that specifies the respective competing events for which the result of irates shall be printed. If NULL, event.code will be inherited from irates
covar.code	A character or numerical value that specifies the respective covariates value(s) for which the result of irates shall be printed. If NULL, covar.code will be inherited from irates
full.sample	A logical value that specifies if results of irates shall also be printed for the full sample, i.e., irrespective of any covariate value. Default is set to FALSE
display.digits	An integer value specifying the number of decimal place for all incidence rates that shall be printed. Default is set to 4
...	Other arguments for print method

Value

No value returned.

See Also

irates

`print.irates.ratio` *Print method for 'irates.ratio' object*

Description

Print method for an object of class `irates.ratio`. By default it prints all competing events incidence rates contained in `irates`. It is also possible to select specific events to be printed.

Usage

```
## S3 method for class 'irates.ratio'
print(x, event.code = NULL, display.digits = 4, ...)
```

Arguments

`x`	`irates.ratio` object
`event.code`	A character or numerical value that specifies the respective competing events for which the result of `irates.ratio` shall be printed. If `NULL`, `event.code` will be inherited from `irates.ratio`
`display.digits`	An integer value that specifies the number of digits that shall be printed. Default is set to 4
`...`	Other arguments for print method

Value

No value is returned.

See Also

irates.ratio

sir.adm *Pneumonia on admission in intenive care unit patients*

Description

Pneumonia status on admission for intensive care unit (ICU) patients, a random sample from the SIR-3 study (also contained in package mvna).

Usage

```
data(sir.adm)
```

Format

A data frame with 747 observations on the following 4 variables.

`id` Randomly generated patient id

`pneu` Covariate Pneumonia indicator. 0: No pneumonia, 1: Pneumonia

`status` Event status indicator. 0: censored observation, 1: discharged, 2: dead

`time` Follow-up time in days

Source

Beyersmann, J., Gastmeier, P., Grundmann, H., Baerwolff, S., Geffers, C., Behnke, M., Rueden, H., and Schumacher, M. (2006) Use of multistate models to assess prolongation of intensive care unit stay due to nosocomial infection. *Infection Control and Hospital Epidemiology*, **27**,493–499.

See Also

mvna

Examples

```
data(sir.adm)
```

summary.irates *Summary method for 'irates' object*

Description

Summary method for an object of class `irates`. It prints all competing events incidence rates contained in `irates`, including full sample incidence rates. It also prints the baseline covariate characteristics.

Usage

```
## S3 method for class 'irates'
summary(object, ...)
```

Arguments

`object`	`irates` object
`...`	Further arguments

Value

No value is returned

See Also

`irates`, `print.irates`

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