# Package 'etm'

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**Title** Empirical Transition Matrix

**Version** 0.4-7

**Author** Arthur Allignol

**Description** Matrix of transition probabilities for any time-inhomogeneous multistate model with finite state space

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**License** GPL (>= 2)

**Depends** lattice

**Suggests** changeLOS

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## R topics documented:

## abortion *Pregnancies exposed to coumarin derivatives*

### Description

Outcomes of pregnancies exposed to coumarin derivatives. The aim is to investigate whether exposition to coumarin derivatives increases the probability of spontaneous abortions. Apart from spontaneous abortion, pregnancy may end in induced abortion or live birth, leading to a competing risks situation. Moreover, data are left-truncated as women usually enter the study several weeks after conception.

### Usage

```
data(abortion)
```

### Format

A data frame with 1186 observations on the following 5 variables.

`id` Identification number

`entry` Entry times into the cohort

`exit` Event times

`group` Group. 0: control, 1: exposed to coumarin derivatives

`cause` Cause of failure. 1: induced abortion, 2: life birth, 3: spontaneous abortion

### Source

Meiester, R. and Schaefer, C (2008). Statistical methods for estimating the probability of spontaneous abortion in observational studies – Analyzing pregnancies exposed to coumarin derivatives. Reproductive Toxicology, 26, 31–35

### Examples

```
data(abortion)
```

## clos *Change in Length of Stay*

### Description

The function estimates the expected change in length of stay (LOS) associated with an intermediate event in the same way as does the `clos` function in the **changeLOS** package. The difference between the 2 implementations is that this function can handle left-truncated data, and does not require a competing outcome.

## Usage

```
clos(x, aw = FALSE)
```

## Arguments

| | |
|---|---|
| x | An object of class etm. Argument delta.na in etm must be set to TRUE in order to use this function. |
| aw | Logical. Whether to compute the expected change of LOS using alternative weighting. Default is FALSE. |

## Details

See clos for more details on the method

## Value

An object of class clos.etm with the following components:

| | |
|---|---|
| e.phi | Change in length of stay |
| phi.case | Estimates of $E(\text{LOS}\|X_s = \text{intermediate event})$ for all observed transition times $s$, where $X_s$denotes the state by time $s$ |
| phi.control | Estimates of $E(\text{LOS}\|X_s = \text{initial state})$ for all observed transition times $s$. |
| e.phi2 | Weighted average of the difference between phi2.case and phi2.control. |
| phi2.case | Estimates of $E(\text{LOS}\mathbf{1}(X_{\text{LOS}} = \text{discharge})\|X_s = \text{intermediate event})$, where $\mathbf{1}$ denotes the indicator function. |
| phi2.control | $E(\text{LOS}\mathbf{1}(X_{\text{LOS}} = \text{discharge})\|X_s = \text{initial state})$. |
| e.phi3 | Weighted average of the difference between phi3.case and phi3.control. |
| phi3.case | Estimates of $E(\text{LOS}\mathbf{1}(X_{\text{LOS}} = \text{death})\|X_s = \text{intermediate event})$. |
| phi3.control | $E(\text{LOS}\mathbf{1}(X_{\text{LOS}} = \text{death})\|X_s = \text{initial state})$. |
| weights | Weights used to compute the weighted averages. |
| w.time | Times at which the weights are computed. |
| time | All transition times. |
| e.phi.weights.1 | Expected change in LOS using weights.1 |
| e.phi.weights.other | Expected change in LOS using weights.other |
| weights.1 | Weights corresponding to the conditional waiting time in the intial state given one experiences the intermediate event. |
| weights.other | Weights corresponding to the conditional waiting time given one does not experience the intermediate event. |

## Author(s)

Arthur Allignol <arthur.allignol@fdm.uni-freiburg.de>, Matthias Wangler, Jan Beyersmann

## See Also

clos, etm

## Examples

```
require(changeLOS)
data(los.data) # in package changeLOS

## putting los.data in the long format (see changeLOS)
my.observ <- prepare.los.data(x=los.data)

tra <- matrix(FALSE, 4, 4)
tra[1, 2:4] <- TRUE
tra[2, 3:4] <- TRUE

tr.prob <- etm(my.observ, c("0","1","2","3"), tra, NULL, 0)

cLOS <- etm::clos(tr.prob)
plot(cLOS)


### Compute bootstrapped SE

## function that performs the bootstrap
## nboot: number of bootstrap samples. Other arguments are as in etm()
boot.clos <- function(data, state.names, tra, cens.name, s = 0, nboot) {
    res <- double(nboot)
    for (i in seq_len(nboot)) {
        index <- sample(unique(data$id), replace = TRUE)
        inds <- new.id <- NULL
        for (j in seq_along(index)){
            ind <- which(data$id == index[j])
            new.id <- c(new.id, rep(j, length(ind)))
            inds <- c(inds, ind)
        }
        dboot <- cbind(data[inds, ], new.id)
        dboot[, which(names(dboot) == "id")]
        dboot$id <- dboot$new.id
        tr.prob <- etm(dboot, state.names, tra, cens.name, s, cova = FALSE)
        res[i] <- etm::clos(tr.prob)$e.phi
    }
    res
}

## bootstrap
se <- sqrt(var(boot.clos(my.observ, c("0","1","2","3"), tra, NULL, 0,
                         nboot = 10)))
```

---

etm *Computation of the empirical transition matrix*

---

## Description

This function computes the empirical transition matrix, also called Aalen-Johansen estimator, of the transition probability matrix of any multistate model. The covariance matrix is also computed.

## Usage

```
etm(data, state.names, tra, cens.name, s, t = "last",
    covariance = TRUE, delta.na = TRUE)
```

## Arguments

| | |
|---|---|
| `data` | data.frame of the form data.frame(id,from,to,time) or (id,from,to,entry,exit)<br>**id:** patient id<br>**from:** the state from where the transition occurs<br>**to:** the state to which a transition occurs<br>**time:** time when a transition occurs<br>**entry:** entry time in a state<br>**exit:** exit time from a state<br>This data.frame is transition-oriented, *i.e.* it contains one row per transition, and possibly several rows per patient. Specifying an entry and exit time permits to take into account left-truncation. |
| `state.names` | A vector of characters giving the states names. |
| `tra` | A quadratic matrix of logical values describing the possible transitions within the multistate model. |
| `cens.name` | A character giving the code for censored observations in the column 'to' of `data`. If there is no censored observations in your data, put 'NULL'. |
| `s` | Starting value for computing the transition probabilities. |
| `t` | Ending value. Default is "last", meaning that the transition probabilities are computed over $(s, t]$, $t$ being the last time in the data set. |
| `covariance` | Logical. Decide whether or not computing the covariance matrix. May be useful for, say, simulations, as the variance computation is a bit long. Default is TRUE. |
| `delta.na` | Logical. Whether to export the array containing the increments of the Nelson-Aalen estimator. Default is `TRUE`. |

## Details

Data are considered to arise from a time-inhomogeneous Markovian multistate model with finite state space, and possibly subject to independent right-censoring and left-truncation.

The matrix of the transition probabilities is estimated by the Aalen-Johansen estimator / empirical transition matrix (Andersen et al., 1993), which is the product integral over the time period $(s, t]$ of I + the matrix of the increments of the Nelson-Aalen estimates of the cumulative transition hazards. The $(i, j) - th$ entry of the empirical transition matrix estimates the transition probability of being in state $j$ at time $t$ given that one has been in state j at time $s$.

The covariance matrix is computed using the recursion formula (4.4.19) in Anderson et al. (1993, p. 295). This estimator of the covariance matrix is an estimator of the Greenwood type.

If the multistate model is not Markov, but censorship is entirely random, the Aalen-Johansen estimator still consistently estimates the state occupation probabilities of being in state $i$ at time $t$ (Datta & Satten, 2001; Glidden, 2002)

## Value

| | |
|---|---|
| `est` | Transition probability estimates. This is a 3 dimension array with the first dimension being the state from where transitions occur, the second the state to which transitions occur, and the last one being the event times. |
| `cov` | Estimated covariance matrix. Each cell of the matrix gives the covariance between the transition probabilities given by the rownames and the colnames, respectively. |
| `time` | Event times at which the transition probabilities are computed. That is all the observed times between $(s, t]$. |
| `s` | Start of the time interval. |
| `t` | End of the time interval. |
| `trans` | A `data.frame` giving the possible transitions. |
| `state.names` | A vector of character giving the state names. |
| `cens.name` | How the censored observation are coded in the data set. |
| `n.risk` | Matrix indicating the number of individuals at risk just before an event |
| `n.event` | Array containing the number of transitions at each times |
| `delta.na` | A 3d array containing the increments of the Nelson-Aalen estimator. |

## Note

Transitions into a same state, mathematically superfluous, are not allowed. If transitions into the same state are detected in the data, the function will stop. Equally, `diag(tra)` must be set to FALSE, see the example below.

## Author(s)

Arthur Allignol, <arthur.allignol@fdm.uni-freiburg.de>

## References

Andersen, P.K., Borgan, O., Gill, R.D. and Keiding, N. (1993). *Statistical models based on counting processes*. Springer Series in Statistics. New York, NY: Springer.

Aalen, O. and Johansen, S. (1978). An empirical transition matrix for non-homogeneous Markov chains based on censored observations. *Scandinavian Journal of Statistics*, 5: 141-150.

Gill, R.D. and Johansen, S. (1990). A survey of product-integration with a view towards application in survival analysis. *Annals of statistics*, 18(4): 1501-1555.

Datta, S. and Satten G.A. (2001). Validity of the Aalen-Johansen estimators of stage occupation probabilities and Nelson-Aalen estimators of integrated transition hazards for non-Markov models. *Statistics and Probability Letters*, 55(4): 403-411.

Glidden, D. (2002). Robust inference for event probabilities with non-Markov data. *Biometrics*, 58: 361-368.

## See Also

print.etm, summary.etm, sir.cont, xyplot.etm

## Examples

```
data(sir.cont)

# Modification for patients entering and leaving a state
# at the same date
# Change on ventilation status is considered
# to happen before end of hospital stay
sir.cont <- sir.cont[order(sir.cont$id, sir.cont$time), ]
for (i in 2:nrow(sir.cont)) {
  if (sir.cont$id[i]==sir.cont$id[i-1]) {
    if (sir.cont$time[i]==sir.cont$time[i-1]) {
      sir.cont$time[i-1] <- sir.cont$time[i-1] - 0.5
    }
  }
}

### Computation of the transition probabilities
# Possible transitions.
tra <- matrix(ncol=3,nrow=3,FALSE)
tra[1, 2:3] <- TRUE
tra[2, c(1, 3)] <- TRUE

# etm
tr.prob <- etm(sir.cont, c("0", "1", "2"), tra, "cens", 1)

tr.prob
summary(tr.prob)

# plotting
xyplot(tr.prob, tr.choice=c("0 0", "1 1", "0 1", "0 2", "1 0", "1 2"),
       layout=c(2, 3), strip=strip.custom(bg="white",
         factor.levels=
     c("0 to 0", "1 to 1", "0 to 1", "0 to 2", "1 to 0", "1 to 2")))

### example with left-truncation

data(abortion)

# Data set modification in order to be used by etm
names(abortion) <- c("id", "entry", "exit", "from", "to")
abortion$to <- abortion$to + 1

## computation of the matrix giving the possible transitions
tra <- matrix(FALSE, nrow = 5, ncol = 5)
tra[1:2, 3:5] <- TRUE

## etm
fit <- etm(abortion, as.character(0:4), tra, NULL, s = 0)
```

```
## plot
xyplot(fit, tr.choice = c("0 0", "1 1", "0 4", "1 4"),
       ci.fun = c("log-log", "log-log", "cloglog", "cloglog"),
       strip = strip.custom(factor.levels = c("P(T > t) -- control",
                                              "P(T > t) -- exposed",
                                    "CIF spontaneous abortion -- control",
                                    "CIF spontaneous abortion -- exposed")))
```

---

`etmprep` *Data transformation function for using etm*

---

## Description

The function transforms a data set in the wide format (i.e., one raw per subject) into the long format (i.e., one raw per transition, and possibly several raws per subjects) in a suitable way for using the `etm` function

## Usage

```
etmprep(time, status, data, tra, state.names, cens.name = NULL,
start = NULL, id = NULL, keep)
```

## Arguments

| | |
|---|---|
| `time` | A character vector giving the name of the columns containing the transition times or last follow-up times. The length of `time` have to be equal to the number of states, some elements may be NA. See Details. |
| `status` | A character vector giving the name of the columns indicating whether a state has been visited (0 if not, 1 otherwise). |
| `data` | A data frame in which to look for the columns specified in `time` and `status`. |
| `tra` | A quadratic matrix of logical values describing the possible transitions within the multistate model. The $(i, j)$th element of `tra` is TRUE if a transition from state $i$ to state $j$ is possible, FALSE otherwise. The diagonal must be set to FALSE. |
| `state.names` | A vector of characters giving the states names. If missing, state names are set to be 0:(number of states). |
| `cens.name` | A character string specifying how censored observations will be indicated in the new data set. Default is NULL, i.e., no censored observation. |
| `start` | A list containing two elements, `state` and `time`, giving the starting states and times for all individuals. Default is NULL, in which case all individuals are considered to start in the initial state at time 0. |
| `id` | A character string specifying in which column of `data` the user ids are. Default is NULL, and the ids will be `1:n`. |
| `keep` | A character vector indicating the column names of the covariate one might want to keep in the new data.frame. |

## Details

This function only works for irreversible acyclic Markov processes. Therefore, the multistate model will have initial states, into which no transition are possible. For these, NAs are allowed in `time` and `status`.

## Value

The function returns a data.frame suitable for using the `etm` function. The data frame contains the following components:

| | |
|---|---|
| `id` | Individual id number |
| `entry` | Entry time into a state |
| `exit` | Exit time from a state |
| `from` | State from which a transition occurs |
| `to` | State into which a transition occurs |
| `...` | Further columns specified in `keep` |

## Author(s)

Arthur Allignol, <arthur.allignol@fdm.uni-freiburg.de>

## See Also

etm

## Examples

```
### creation of fake data in the wild format, following an illness-death model
## transition times
tdisease <- c(3, 4, 3, 6, 8, 9)
tdeath <- c(6, 9, 8, 6, 8, 9)

## transition status
stat.disease <- c(1, 1, 1, 0, 0, 0)
stat.death <- c(1, 1, 1, 1, 1, 0)

## a covariate that we want to keep in the new data
cova <- rbinom(6, 1, 0.5)

dat <- data.frame(tdisease, tdeath,
                  stat.disease, stat.death,
                  cova)

## Possible transitions
tra <- matrix(FALSE, 3, 3)
tra[1, 2:3] <- TRUE
tra[2, 3] <- TRUE

## data preparation
newdat <- etmprep(c(NA, "tdisease", "tdeath"),
```

```
                    c(NA, "stat.disease", "stat.death"),
                    data = dat, tra = tra, cens.name = "cens")
```

---

`lines.etm` *Lines method for 'etm' objects*

---

## Description

Lines method for `etm` objects

## Usage

```
## S3 method for class 'etm':
lines(x, tr.choice, col = 1, lty,
      conf.int = FALSE, level = 0.95, ci.fun = "linear",
      ci.col = col, ci.lty = 3, ...)
```

## Arguments

| | |
|---|---|
| `x` | An object of class `etm`. |
| `tr.choice` | character vector of the form `c("from to","from to")` specifying which transitions should be plotted. By default, all the direct transition probabilities are plotted |
| `col` | Vector of colours. Default is black. |
| `lty` | Vector of line type. Default is 1:number of transitions |
| `conf.int` | Logical specifying whether to plot confidence intervals. Default is FALSE. |
| `level` | Level of the confidence interval. Default is 0.95. |
| `ci.fun` | Transformation applied to the confidence intervals. It could be different for all transition probabilities, though if `length(ci.fun) != number of transitions`, only `ci.fun[1]` will be used. Possible choices are "linear", "log", "log-log" and "cloglog". Default is "linear". |
| `ci.col` | Colours of the confidence intervals. Default value is the same as `col`. |
| `ci.lty` | Line types for the confidence intervals. Default is 3. |
| `...` | Further arguments for `lines`. |

## Value

No value returned.

## Author(s)

Arthur Allignol, <arthur.allignol@fdm.uni-freiburg.de>

## See Also

`etm`, `plot.etm`, `xyplot.etm`

`plot.clos.etm` *Plot method for 'clos.etm' objects*

## Description

Plot method for objects of class `clos.etm`.

## Usage

```
## S3 method for class 'clos.etm':
plot(x, xlab = "Time", ylab.e = "Expected LOS",
ylab.w = "Weights", xlim, ylim.e, ylim.w, col.e = c(1, 2), col.w = 1,
lty.e = c(1, 1), lty.w = 1, legend = TRUE, legend.pos, curvlab,
legend.bty = "n", ...)
```

## Arguments

| | |
|---|---|
| `x` | An object of class `clos.etm` |
| `xlab` | Label for the x-axis |
| `ylab.e` | Label for the y-axis in the plot of the expected LOS |
| `ylab.w` | Label for the y-axis in the plot of the weights |
| `xlim` | Limits of x-axis for the plots |
| `ylim.e` | Limits of the y-axis for the expected LOS plot |
| `ylim.w` | Limits of the y-axis for the weights plot |
| `col.e` | Vector of colours for the plot of expected LOS |
| `col.w` | Vector of colours for the plot of the weights |
| `lty.e` | Vector of line type for the plot of expected LOS |
| `lty.w` | Vector of line type for the plot of the weights |
| `legend` | Logical. Whether to draw a legend for the plot of expected LOS |
| `legend.pos` | A vector giving the legend's position. See `legend` for details |
| `curvlab` | Character or expression vector to appear in the legend. Default is `c("Intermediate event by time t", "No intermediate event by time t")` |
| `legend.bty` | Box type for the legend |
| `...` | Further arguments for plot |

## Details

Two graphs are drawn. The lower graph displays the expected LOS for patients who have experienced the intermediate event and for those who have not. The upper graph displays the weights used to compute the weighted average.

### Value

No value returned

### Author(s)

Arthur Allignol <arthur.allignol@fdm.uni-freiburg.de>, Matthias Wangler

### See Also

clos

---

`plot.etm` *Plot method for an etm object*

---

### Description

Plot method for an object of class 'etm'. It draws the estimated transition probabilities in a basic scatterplot.

### Usage

```
## S3 method for class 'etm':
plot(x, tr.choice, xlab = "Time",
     ylab = "Transition Probability", col = 1, lty, xlim, ylim,
     conf.int = FALSE, level = 0.95, ci.fun = "linear",
     ci.col = col, ci.lty = 3,
     legend = TRUE, legend.pos, curvlab, legend.bty = "n", ...)
```

### Arguments

| | |
|---|---|
| `x` | An object of class 'etm' |
| `tr.choice` | character vector of the form 'c("from to","from to")' specifying which transitions should be plotted. Default, all the transition probabilities are plotted |
| `xlab` | x-axis label. Default is "Time" |
| `ylab` | y-axis label. Default is "Transition Probability" |
| `col` | Vector of colour. Default is black |
| `lty` | Vector of line type. Default is 1:number of transitions |
| `xlim` | Limits of x-axis for the plot |
| `ylim` | Limits of y-axis for the plot |
| `conf.int` | Logical. Whether to display pointwise confidence intervals. Default is FALSE. |
| `level` | Level of the conficence intervals. Default is 0.95. |
| `ci.fun` | Transformation applied to the confidence intervals. It could be different for all transition probabilities, though if `length(ci.fun) != number of transitions`, only `ci.fun[1]` will be used. Possible choices are "linear", "log", "log-log" and "cloglog". Default is "linear". |

| | |
|---|---|
| ci.col | Colour of the confidence intervals. Default is col. |
| ci.lty | Line type of the confidence intervals. Default is 3. |
| legend | A logical specifying if a legend should be added |
| legend.pos | A vector giving the legend's position. See legend for further details |
| curvlab | A character or expression vector to appear in the legend. Default is the name of the transitions |
| legend.bty | Box type for the legend |
| ... | Further arguments for plot |

## Value

No value returned

## Author(s)

Arthur Allignol, <arthur.allignol@fdm.uni-freiburg.de>

## See Also

plot.default, legend, etm

## Examples

```
data(sir.cont)

# Modification for patients entering and leaving a state
# at the same date
sir.cont <- sir.cont[order(sir.cont$id, sir.cont$time), ]
for (i in 2:nrow(sir.cont)) {
  if (sir.cont$id[i]==sir.cont$id[i-1]) {
    if (sir.cont$time[i]==sir.cont$time[i-1]) {
      sir.cont$time[i-1] <- sir.cont$time[i-1] - 0.5
    }
  }
}

tra <- matrix(ncol=3,nrow=3,FALSE)
tra[1, 2:3] <- TRUE
tra[2, c(1, 3)] <- TRUE

my.etm <- etm(sir.cont,c("0","1","2"),tra,"cens", s = 0)

plot(my.etm, tr.choice = c("0 0"))
```

## print.clos.etm *Print function for 'clos.etm' objects*

### Description

Print method for object of class `clos.etm`

### Usage

```
## S3 method for class 'clos.etm':
print(x, ...)
```

### Arguments

| | |
|---|---|
| `x` | An object of class `clos.etm` |
| `...` | Further arguments |

### Value

No value returned

### Author(s)

Arthur Allignol, <arthur.allignol@fdm.uni-freiburg.de>

### See Also

`clos`

## print.etm *Print method for object of class 'etm'*

### Description

Print method for objects of class `etm`.

### Usage

```
## S3 method for class 'etm':
print(x, covariance = TRUE, whole = TRUE, ...)
```

### Arguments

| | |
|---|---|
| x | An object of class etm. |
| covariance | Whether print the covariance matrix. Default is TRUE |
| whole | Whether to plot the entire covariance matrix. If set to FALSE, rows and columns containing only 0 will be removed for printing. |
| ... | Further arguments for print or summary. |

### Details

The function prints a matrix giving the possible transitions, along with the estimates of $P(s,t)$ and $cov(P(s,t))$.

### Value

No value returned

### Author(s)

Arthur Allignol, <arthur.allignol@fdm.uni-freiburg.de>

### See Also

etm

---

## sir.cont *Ventilation status in intensive care unit patients*

---

### Description

Time-dependent ventilation status for intensive care unit (ICU) patients, a random sample from the SIR-3 study.

### Usage

```
data(sir.cont)
```

### Format

A data frame with 1161 rows and 4 columns:

**id:** Randomly generated patient id

**from:** State from which a transition occurs

**to:** State to which a transition occurs

**time:** Time when a transition occurs

The possible states are:

0: No ventilation

1: Ventilation

2: End of stay

And `cens` stands for censored observations.

## Details

This data frame consists in a random sample of the SIR-3 cohort data. It focuses on the effect of ventilation on the length of stay (combined endpoint discharge/death). Ventilation status is considered as a transcient state in an illness-death model.

The data frame is directly formated to be used with the `etm` function, i.e. it is transition-oriented with one row per transition.

## References

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

## Examples

```
data(sir.cont)
```

---

`summary.etm` *Summary methods for an 'etm' object*

---

## Description

Summary method for objects of class `etm`

## Usage

```
## S3 method for class 'etm':
summary(object, all = FALSE,
        ci.fun = "linear", level = 0.95, ...)
## S3 method for class 'summary.etm':
print(x, ...)
```

## Arguments

| | |
|---|---|
| `object` | An object of class `etm`. |
| `all` | If set to TRUE, a data.frame will be computed for all transitions that are not 0 in the empirical transition matrix. |

| | |
|---|---|
| ci.fun | A character vector specifying the transformation to be applied to the pointwise confidence intervals. It could be different for each transition probability, though if `length(ci.fun) != number of transitions`, only `ci.fun[1]` will be used. The function displays the transition probabilities in the following order: first the direct transitions in alphabetical order, e.g., 0 to 1, 0 to 2, 1 to 2, ..., then the state occupation probabilities in alphabetical order, e.g., 0 to 0, 1 to 1, ... The possible transformations are "linear", "log", "log-log" and "cloglog". Default is "linear". |
| level | Level of the two-sided confidence intervals. Default is 0.95. |
| x | A `summary.cpf` object |
| ... | Further arguments |

## Value

A list of data.frames giving the transition probability and stage occupation probability estimates. List items are named after the possible transition.

| | |
|---|---|
| P | Transition probability estimates |
| var | Variance estimates |
| lower | Lower confidence limit |
| upper | Upper confidence limit |
| time | Transition times |
| n.risk | Number of individuals at risk of experiencing a transition just before time $t$ |
| n.event | Number of events at time $t$ |

## Author(s)

Arthur Allignol <arthur.allignol@fdm.uni-freiburg.de>

## See Also

etm

---

# trprob.etm *Function to extract transition probabilities and (co)variance*

---

## Description

The `trprob` method is used to extract transition probabilities, while `trcov` is used to obtain the (co)variance.

## Usage

```
## S3 method for class 'etm':
trprob(x, tr.choice, timepoints, ...)
## S3 method for class 'etm':
trcov(x, tr.choice, timepoints, ...)
```

### Arguments

| | |
|---|---|
| x | An object of class etm. |
| tr.choice | A character vector of the form "from to" describing for which transition one wishes to obtain the transition probabilities or covariance estimates. For trprob, tr.choice must be of length 1, while it can be of length 2 for trcov. |
| timepoints | Time points at which one want the estimates. When missing, estimates are obtained for all event times. |
| ... | Further arguments. |

### Value

A vector containing the transition probabilities or covariance estimates either at the time specified in timepoints or at all transition times.

### Author(s)

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### See Also

etm

### Examples

```
data(sir.cont)

# Modification for patients entering and leaving a state
# at the same date
# Change on ventilation status is considered
# to happen before end of hospital stay
sir.cont <- sir.cont[order(sir.cont$id, sir.cont$time), ]
for (i in 2:nrow(sir.cont)) {
  if (sir.cont$id[i]==sir.cont$id[i-1]) {
    if (sir.cont$time[i]==sir.cont$time[i-1]) {
      sir.cont$time[i-1] <- sir.cont$time[i-1] - 0.5
    }
  }
}

### Computation of the transition probabilities
# Possible transitions.
tra <- matrix(ncol=3,nrow=3,FALSE)
tra[1, 2:3] <- TRUE
tra[2, c(1, 3)] <- TRUE

# etm
fit.etm <- etm(sir.cont, c("0", "1", "2"), tra, "cens", 0)

## extract P_01(0, t) and variance
p01 <- trprob(fit.etm, "0 1")
```

```
var.p01 <- trcov(fit.etm, "0 1")

## covariance between P_00 and P_01
cov.00.01 <- trcov(fit.etm, c("0 0", "0 1"))

## P_01 at some time points
trprob(fit.etm, "0 1", c(0, 15, 50, 100))
```

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`xyplot.etm` *xyplot method for object of class 'etm'*

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## Description

xyplot function for objects of class `etm`. Estimates of the transition probabilities are plotted as a function of time for all the transitions specified by the user.

## Usage

```
## S3 method for class 'etm':
xyplot(x, data = NULL, tr.choice, col = c(1, 1, 1),
       lty = c(1, 3, 3),  xlab = "Time",
       ylab = "Transition probability",
       conf.int = TRUE, ci.fun = "linear", level = 0.95, ...)
```

## Arguments

| | |
|---|---|
| `x` | An object of class `etm`. |
| `data` | *Useless*. |
| `tr.choice` | A character vector of the form c("from to", "from to", ...) specifying the transition probabilities to be plotted. By default, all the direct transition probabilities are displayed. |
| `col` | Vector of colours for the curves. |
| `lty` | Vector of line types. |
| `xlab` | x-axis label. Default is "Time". |
| `ylab` | y-axis label. Default is "Estimated transition probability". |
| `conf.int` | Logical. Whether to draw pointwise confidence intervals. Default is TRUE. |
| `ci.fun` | A character vector specifying the transformation to be applied to the pointwise confidence intervals. It could be different for each transition probability, though if `length(ci.fun) != length(tr.choice)`, only `ci.fun[1]` will be used. The possible transformations are "linear", "log", "log-log" and "cloglog". Default is "linear". |
| `level` | Level of the two-sided confidence intervals. Default is 0.95. |
| `...` | Further arguments for `xyplot`. |

## Value

An object of class `trellis`.

## Author(s)

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## See Also

`etm`, `xyplot`

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