

# Package ‘ARpLMEC’

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**Type** Package

**Title** Censored Mixed-Effects Models with Different Correlation Structures

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**Description** Left, right or interval censored mixed-effects linear model with autoregressive errors of order  $p$  or DEC correlation structure using the type-EM algorithm. The error distribution can be Normal or t-Student. It provides the parameter estimates, the standard errors and prediction of future observations (available only for the normal case). Olivari et al (2021) <[doi:10.1080/10543406.2020.1852246](https://doi.org/10.1080/10543406.2020.1852246)>.

**Depends** R (>= 2.14)

**Imports** numDeriv, stats, MASS, mnormt, tcltk, expm, relliptical, TruncatedNormal, LaplacesDemon

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**License** GPL (>= 2)

**RoxygenNote** 7.2.0

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## R topics documented:

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ARpMMEC.est

*Censored Mixed-Effects Models with Autoregressive Correlation Structure and DEC for Normal and t-Student Errors*

### Description

This function fits left, right or interval censored mixed-effects linear model, with autoregressive errors of order  $p$ , using the EM algorithm. It returns estimates, standard errors and prediction of future observations.

### Usage

```
ARpMMEC.est(
  y,
  x,
  z,
  tt,
  cc,
  nj,
  struc = "UNC",
  order = 1,
  initial = NULL,
  nu.fixed = TRUE,
  typeModel = "Normal",
  cens.type = "left",
  LI = NULL,
  LS = NULL,
  MaxIter = 200,
  error = 1e-04,
  Prev = FALSE,
  step = NULL,
  isubj = NULL,
  xpre = NULL,
  zpre = NULL
)
```

### Arguments

|                 |   |
|-----------------|---|
| <code>y</code>  | Vector $1 \times n$ of censored responses, where $n$ is the sum of the number of observations of each individual  |
| <code>x</code>  | Design matrix of the fixed effects of order $n \times s$ , corresponding to vector of fixed effects.  |
| <code>z</code>  | Design matrix of the random effects of order $n \times b$ , corresponding to vector of random effects.  |
| <code>tt</code> | Vector $1 \times n$ with the time the measurements were made, where $n$ is the total number of measurements for all individuals. Default it's considered regular times. |

|           |   |
|-----------|---|
| cc        | Vector of censoring indicators of length n, where n is the total of observations. For each observation: 0 if non-censored, 1 if censored.                                       |
| nj        | Vector 1 x m with the number of observations for each subject, where m is the total number of individuals.  |
| struc     | UNC,ARp,DEC,SYM or DEC(AR) for uncorrelated ,autoregressive, DEC(phi1,phi2), DEC(phi1,phi2=1), DEC(DEC(phi1,phi2=1)) structure, respectively                                    |
| order     | Order of the autoregressive process. Must be a positive integer value.  |
| initial   | List with the initial values in the next orden: betas,sigma2,alphas,phi and nu. If it is not indicated it will be provided automatically. Default is NULL                       |
| nu.fixed  | Logical. Should estimate the parameter "nu" for the t-student distribution?. If is False indicates the value in the list of initial values. Default is FALSE                    |
| typeModel | Normal for Normal distribution and Student for t-Student distribution. Default is Normal  |
| cens.type | left for left censoring, right for right censoring and interval for intervalar censoring. Default is left   |
| LI        | Vector censoring lower limit indicator of length n. For each observation: 0 if non-censored, -inf if censored. It is only indicated for when cens.type is both. Default is NULL |
| LS        | Vector censoring upper limit indicator of length n. For each observation: 0 if non-censored, inf if censored.It is only indicated for when cens.type is both. Default is NULL   |
| MaxIter   | The maximum number of iterations of the EM algorithm. Default is 200  |
| error     | The convergence maximum error. Default is 0.0001  |
| Prev      | Indicator of the prediction process. Available at the moment only for the typeModel=normal case. Default is FALSE   |
| step      | Number of steps for prediction. Default is NULL   |
| isubj     | Vector indicator of subject included in the prediction process. Default is NULL   |
| xpre      | Design matrix of the fixed effects to be predicted. Default is NULL.  |
| zpre      | Design matrix of the random effects to be predicted. Default is NULL.   |

### Value

returns list of class "ARpMMEC":

|            |  |
|------------|--|
| FixEffect  | Data frame with: estimate, standar errors and confidence intervals of the fixed effects.                       |
| Sigma2     | Data frame with: estimate, standar errors and confidence intervals of the variance of the white noise process. |
| Phi        | Data frame with: estimate, standar errors and confidence intervals of the autoregressive parameters.           |
| RandEffect | Data frame with: estimate, standar errors and confidence intervals of the random effects.                      |
| nu         | the parameter "nu" for the t-student distribution  |

|          |  |
|----------|--|
| Est      | Vector of parameters estimate (fixed Effects, sigma2, phi, random effects).    |
| SE       | Vector of the standard errors of (fixed Effects, sigma2, phi, random effects). |
| Residual | Vector of the marginal residuals.  |
| loglik   | Log-likelihood value.  |
| AIC      | Akaike information criterion.  |
| BIC      | Bayesian information criterion.  |
| AICc     | Corrected Akaike information criterion.  |
| iter     | Number of iterations until convergence.  |
| Yfit     | Vector "y" fitted  |
| MI       | Information matrix   |
| Prev     | Predicted values (if xpre and zpre is not NULL).                               |
| time     | Processing time.   |
| others   | The first and second moments of the random effect and vector Y                 |

## References

Olivari, R. C., Garay, A. M., Lachos, V. H., & Matos, L. A. (2021). Mixed-effects models for censored data with autoregressive errors. *Journal of Biopharmaceutical Statistics*, 31(3), 273-294. doi:10.1080/10543406.2020.1852246

## Examples

```
## Not run:
p.cens = 0.1
m = 10
D = matrix(c(0.049,0.001,0.001,0.002),2,2)
sigma2 = 0.30
phi = 0.6
beta = c(1,2,1)
nj=rep(4,10)
tt=rep(1:4,length(nj))
x<-matrix(runif(sum(nj)*length(beta),-1,1),sum(nj),length(beta))
z<-matrix(runif(sum(nj)*dim(D)[1],-1,1),sum(nj),dim(D)[1])
data=ARpMMEC.sim(m,x,z,tt,nj,beta,sigma2,D,phi,struc="ARp",typeModel="Normal",p.cens=p.cens)

teste1=ARpMMEC.est(data$y_cc,x,z,tt,data$cc,nj,struc="ARp",order=1,typeModel="Normal",MaxIter = 2)
teste2=ARpMMEC.est(data$y_cc,x,z,tt,data$cc,nj,struc="ARp",order=1,typeModel="Student",MaxIter = 2)

xx=matrix(runif(6*length(beta),-1,1),6,length(beta))
zz=matrix(runif(6*dim(D)[1],-1,1),6,dim(D)[1])
isubj=c(1,4,5)
teste3=ARpMMEC.est(data$y_cc,x,z,tt,data$cc,nj,struc="ARp",order=1,typeModel="Normal",
                    MaxIter = 2,Prev=TRUE,step=2,isubj=isubj,xpre=xx,zpre=zz)
teste3$Prev

## End(Not run)
```

ARpMMEC.sim

*Generating Censored Autoregressive Dataset with Mixed Effects, for normal distribution.***Description**

This function simulates a censored response variable with autoregressive errors of order  $p$ , with mixed effect and a established censoring rate. This function returns the censoring vector and censored response vector.

**Usage**

```
ARpMMEC.sim(
  m,
  x = NULL,
  z = NULL,
  tt = NULL,
  nj,
  beta,
  sigmae,
  D,
  phi,
  struc = "ARp",
  order = 1,
  typeModel = "Normal",
  p.cens = NULL,
  n.cens = NULL,
  cens.type = "left",
  nu = NULL
)
```

**Arguments**

|        |  |
|--------|--|
| m      | Number of individuals  |
| x      | Design matrix of the fixed effects of order $n \times s$ , corresponding to vector of fixed effects.                             |
| z      | Design matrix of the random effects of order $n \times b$ , corresponding to vector of random effects.                           |
| tt     | Vector $1 \times n$ with the time the measurements were made, where $n$ is the total number of measurements for all individuals. |
| nj     | Vector $1 \times m$ with the number of observations for each subject, where $m$ is the total number of individuals.              |
| beta   | Vector of values fixed effects.  |
| sigmae | It's the value for sigma.  |
| D      | Covariance Matrix for the random effects.  |

|           |   |
|-----------|---|
| phi       | Vector of length Arp, of values for autoregressive parameters.  |
| struc     | Correlation structure. This must be one of UNC,ARp,DEC,SYM or DEC(AR).                                    |
| order     | Order of the autoregressive process. Must be a positive integer value.                                    |
| typeModel | Normal for Normal distribution and Student for t-Student distribution. Default is Normal                  |
| p.cens    | Censoring percentage for the process. Default is NULL   |
| n.cens    | Censoring level for the process. Default is NULL  |
| cens.type | left for left censoring, right for right censoring and interval for intervalar censoring. Default is left |
| nu        | degrees of freedom for t-Student distibution (nu > 0, maybe non-integer).                                 |

### Value

returns list:

|      |                                 |
|------|---------------------------------|
| cc   | Vector of censoring indicators. |
| y_cc | Vector of responses censoring.  |

### Examples

```
## Not run:
p.cens = 0.1
m      = 10
D = matrix(c(0.049,0.001,0.001,0.002),2,2)
sigma2 = 0.30
phi    = 0.6
beta   = c(1,2,1)
nj=rep(4,10)
tt=rep(1:4,length(nj))
x<-matrix(runif(sum(nj)*length(beta),-1,1),sum(nj),length(beta))
z<-matrix(runif(sum(nj)*dim(D)[1],-1,1),sum(nj),dim(D)[1])
data=ARpMMEC.sim(m,x,z,tt,nj,beta,sigma2,D,phi,struc="ARp",typeModel="Normal",p.cens=p.cens)
y<-data$y_cc
cc<-data$cc

## End(Not run)
```

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