Package 'randomLCA'

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Type Package

Title Random Effects Latent Class Analysis

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Description Fits random effects latent class models, as well as standard latent class models.

Depends R(>= 2.6.0), lattice, nlme, boot

Suggests xtable

LazyLoad yes

LazyData yes

License GPL (>= 2)

Repository CRAN

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R topics documented:

`AIC` *AIC for randomLCA object*

Description

Returns AIC for a randomLCA object.

Usage

```
## S3 method for class 'randomLCA'
AIC(object, ...)
```

Arguments

`object`	randomLCA object
`...`	additional argument; currently none is used.

Details

Not complete.

Author(s)

Ken Beath

BIC *BIC for randomLCA object*

Description

Returns BIC for a randomLCA object.

Usage

```
## S3 method for class 'randomLCA'
BIC(object, ...)
```

Arguments

object	randomLCA object
...	additional argument; currently none is used.

Details

Not complete.

Author(s)

Ken Beath

calc.cond.prob *Calculate Conditional Outcome Probabilities*

Description

Calculates the conditional outcome probabilities for random effects models or for standard latent class returns the outcome probabilities. For random effects, the outcome probabilities may be calculated for various levels of the random effect.

Usage

```
calc.cond.prob(object, conditionalp = 0.5)
```

Arguments

object	RandomLCA object
conditionalp	the p value for the random effect

Value

Returns a data frame containing class, block, outcome, outcomep (outcome probability) and perc (p value for random effect) if conditionalp is specified.

Author(s)

Ken Beath <ken@kjbeath.com.au>

`calc.cond2.prob` *Calculate Conditional Outcome Probabilities for 2 Level Models*

Description

The conditional probabilities are obtained integrating over the period random effect.

Usage

```
calc.cond2.prob(object, conditionalp = 0.5)
```

Arguments

`object`	RandomLCA object
`conditionalp`	the p value for the subject random effect

Value

Returns a data frame containing perc (p value for random effect) , class, block, outcome and outcomep (outcome probability).

Author(s)

Ken Beath <ken@kjbeath.com.au>

`calc.marg.prob` *Calculates Marginal Outcome Probabilities*

Description

Calculates the marginal outcome probabilities for a random effects latent class model, by integrating the outcome probability over the random effect. This is performed using Gauss-Hermite quadrature with the number of quadrature points specified for the model fitting.

Usage

```
calc.marg.prob(object)
```

Arguments

object	randomLCA object

Value

Returns a data frame containing class, block, outcome, outcomep (outcome probability).

Author(s)

Ken Beath

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dentistry *Dental X-ray data*

Description

Six dentists evaluated dental x-rays for incipient caries in Handelman et al (1986), data consistss of 5 of the dentists analysed by Espeland and Handelman (1989) using a latent class model. Further analysis incorprating a random effects latent class model by Qu et al (1996), and by Albert and Dodd (2004)

Usage

```
data(dentistry)
```

Format

A data frame with 32 observations on the following 6 variables.

`V1` Dentist 1

`V2` Dentist 2

`V3` Dentist 3

`V4` Dentist 4

`V5` Dentist 5

`freq` Number of subjects

Source

Espeland and Handelman (1989)

References

Handelman, S.L., Leverett, D.H., Espeland, M.A. and Curzon, J.A. (1986) Clinical radiographic evaluation of sealed carious and sound tooth surfaces. *Journal of the American Dental Association*, **113**, 751–754.

Espeland, M.A. and Handelman, S.L. (1989) Using latent class models to characterize and assess relative error in discrete distributions. *Biometrics*, **45**, 587–599.

Qu, Y., Tan, M. and Kutner, M.H. (1996) Random effects models in latent class analysis for evaluating accuracy of diagnostic tests. *Biometrics*, **52**, 797–810.

Albert P.S. and Dodd, L.E. (2004) A cautionary note on the robustness of Latent Class Models for estimating diagnostic error without a gold standard. *Biometrics*, **60**, 427–435.

Examples

```
data(dentistry)
# fit LCR model from Qu et al (1996)
dentistry.lca <- randomLCA(dentistry[,1:5],freq=dentistry$freq,blocksize=5)
dentistry.lcarandom <- randomLCA(dentistry[,1:5],freq=dentistry$freq,
initmodel=dentistry.lca,random=TRUE,blocksize=1,probit=TRUE)
dentistry.lcarandomunequal <- randomLCA(dentistry[,1:5],freq=dentistry$freq,
initmodel=dentistry.lcarandom,random=TRUE,blocksize=5,probit=TRUE)
```

---

fitted *fitteded values*

Description

Extract fitteded values for randomLCA object

Usage

```
## S3 method for class 'randomLCA'
fitted(object, ...)
```

Arguments

`object`	randomLCA object
`...`	additional argument; currently none is used.

Value

Vector of fitteded values corresponding to the observed frequencies.

Author(s)

Ken Beath <ken@kjbeath.com.au>

genderrole *Gender Role Opinion Items*

Description

Opinions collected on gender roles in a study by Felling et al (1987). This was originally published in Heinen (1996) and subsequently in Galindo Garre and Vermunt (2006).

Usage

```
data(genderrole)
```

Format

A data frame with 16 observations on the following 5 variables.

`Q1` Women's liberation sets women against men.

`Q2` It's better for a wife not to have a job because that always poses problems in the household, especially if there are children.

`Q3` The most natural situation occurs when the man is the breadwinner and the woman runs the household and takes care of the children.

`Q4` It isn't really as important for a girl to get a good education as it is for a boy.

`Q5` A woman is better suited to raise small children than a man.

`Freq` Number of subjects

Source

Galindo Garre and Vermunt (2006)

References

Felling, A., Peters, J., and Schreuder, O. (1987) Religion in Dutch society 85: Documentation of a national survey on religious and secular attitudes in 1985. Amsterdam: Steinmetz Archive.

Galindo Garre, F. and Vermunt, J.K. (2006) Avoiding boundary estimates in latent class analysis by Bayesian posterior mode estimation. *Behaviormetrika*, **33**, 43–59.

Heinen, T. (1996) Latent Class and Discrete Latent Trait Models: Similarities and Differences.

Examples

```
data(genderrole)
# standard latent class
genderrole.lca1 <- randomLCA(genderrole[,1:5],freq=genderrole$Freq,nclass=1)
genderrole.lca2 <- randomLCA(genderrole[,1:5],freq=genderrole$Freq)
genderrole.lca3 <- randomLCA(genderrole[,1:5],freq=genderrole$Freq,nclass=3)
# repeat with random effect
genderrole.lca1random <- randomLCA(genderrole[,1:5],freq=genderrole$Freq,
```

```
nclass=1,initmodel=genderrole.lca1,random=TRUE)
genderrole.lca2random <- randomLCA(genderrole[,1:5],freq=genderrole$Freq,
random=TRUE,initmodel=genderrole.lca2,quadpoints=31)
genderrole.lca3random <- randomLCA(genderrole[,1:5],freq=genderrole$Freq,
nclass=3,random=TRUE,initmodel=genderrole.lca3,quadpoints=31)
# improved BIC for 1 class random
print(c(BIC(genderrole.lca1),BIC(genderrole.lca2),BIC(genderrole.lca3)))
print(c(BIC(genderrole.lca1random),BIC(genderrole.lca2random),
BIC(genderrole.lca3random)))
# can also repeat fits with blocksize=5 to give mixture of IRT models
genderrole.lca1random2 <- randomLCA(genderrole[,1:5],freq=genderrole$Freq,
nclass=1,initmodel=genderrole.lca1,random=TRUE,blocksize=5)
genderrole.lca2random2 <- randomLCA(genderrole[,1:5],freq=genderrole$Freq,
random=TRUE,initmodel=genderrole.lca2,blocksize=5,quadpoints=31)
genderrole.lca3random2 <- randomLCA(genderrole[,1:5],freq=genderrole$Freq,
nclass=3,random=TRUE,initmodel=genderrole.lca3,blocksize=5,quadpoints=31)
# no improvement in fit
print(c(BIC(genderrole.lca1random2),BIC(genderrole.lca2random2),
BIC(genderrole.lca3random2)))
```

`hivtests` *HIV testing data*

Description

Serum samples are tested for HIV by 4 different biossays in Alvord et al (1988) and sensitivity and specificity determined using latent class analysis. Qu et al (1996) repeat the analysis using a model incorporating a random effect.

Usage

```
data(hivtests)
```

Format

A data frame with 16 observations on the following 5 variables.

`V1` Test 1

`V2` Test 2

`V3` Test 3

`V4` Test 4

`freq` Number of subjects

Source

Qu, Tan and Kutner (1989)

References

Alvord, W.G., Drummond, J.E., Arthur, L.O., Goedert, J.J., Levine, P.H., Murphy, E.L., Weiss, S.H., and Blattner, W.A. (1988) A method for predicting individual HIV infection status in teh absence of clinical information. *AIDS Research and Human Retroviruses*, **4**, 295–304.

Qu, Y., Tan, M. and Kutner, M.H. (1996) Random effects models in latent class analysis for evaluating accuracy of diagnostic tests. *Biometrics*, **52**, 797–810.

Examples

```
data(hivtests)
# fit 2LC model from Qu et al (1996)
hivtests.lca <- randomLCA(hivtests[,1:4],freq=hivtests$freq)
# fit model with random effect
# this is different to teh Qu paper which only applies the RE to tests 2 and 3
hivtests.lcarandom <- randomLCA(hivtests[,1:4],freq=hivtests$freq,
initmodel=hivtests.lca,random=TRUE,blocksize=1,quadpoints=41,probit=TRUE)
```

---

logLik *log Likelikelihood for randomLCA object*

Description

Returns log Likelihood for a randomLCA object.

Usage

```
## S3 method for class 'randomLCA'
logLik(object, ...)
```

Arguments

`object`	randomLCA object
`...`	additional argument; currently none is used.

Details

Not complete.

Author(s)

Ken Beath

`myocardial` *Myocardial Infarction (MI)*

Description

Four tests were performed on hospital patients to determine if a myocardial infarction had occurred.

Usage

```
data(myocardial)
```

Format

A data frame with 32 observations on the following 6 variables.

`Q.wave` result from ECG test

`History` clinical history

`LDH` flipped, enzyme related to tissue breakdown

`CPK` high, creatine kinase or creatine phosphokinase, related to muscle damage

`freq` Number of subjects

Source

Rindskopf and Rindskopf (1986)

References

Galen, R.S. and Gambino, S.R. (1975) Beyond Normality: The Predictive Value and Efficiency of Medical Diagnosis. Wiley:New York.

Rindskopf, D. and Rindskopf, W. (1986) The Value of Latent Class Analysis in Medical Diagnosis. *Statistics in Medicine*, **5**, 21–27.

Examples

```
data(myocardial)
# fit 2 class model from Rindskopf and Rindskopf (1986)
myocardial.lca2 <- randomLCA(myocardial[,1:4],freq=myocardial$freq)
```

`outcome.probs` *Extract outcome probabilities for randomLCA object*

Description

Extract outcome probabilities and confidence intervals for a randomLCA object.

Usage

```
## S3 method for class 'randomLCA'
outcome.probs(object, level = 0.95, boot=FALSE, type="perc",
R=ifelse(type=="perc",999,200),...)
```

Arguments

`object`	randomLCA object
`level`	confidence interval
`boot`	use parametric bootstrap to obtain confidence interval
`type`	type of bootstrap confidence intervals to use "perc", "normal" and "basic" are valid, see boot.ci for description. There is a risk of excessively large confidence limits when using other than "perc"
`R`	replications for parametric bootstrap
`...`	additional argument; currently none is used.

Details

Confidence intervals are calculated based on asymptotic normality of the estimates transformed by either the inverse of the probit or logistic, or using parametric bootstrap. The asymptotic confidence intervals are currently only available for models without random effects.

Author(s)

Ken Beath

Examples

```
# dentist data
data(dentistry)
# standard latent class with 2 classes
dentistry.lca2 <- randomLCA(dentistry[,1:5],freq=dentistry$freq,nclass=2)
print(outcome.probs(dentistry.lca2))
```

plot *Plot a randomLCA object*

Description

Plots the outcome probabilities for a randomLCA object, for random effects objects this can be either marginal or conditional or both. For a 2 level random effects model conditional2 will condition on the subject random effect and integrate over the period random effects.

Usage

```
## S3 method for class 'randomLCA'
plot(x, ... ,graphtype = c("conditional", "marginal",
"conditional2","both"), conditionalp = 0.5, classhorizontal = TRUE)
```

Arguments

x	randomLCA object
graphtype	Type of graph
conditionalp	For a conditional graph the percentile corresponding to the random effect at which the outcome probability is to be calculated
classhorizontal	classes to be plotted across the page
...	additional parameters to xyplot

Author(s)

Ken Beath <ken@kjbeath.com.au>

See Also

calc.cond.prob,calc.cond.prob

Examples

```
data(uterinecarcinoma)
# standard latent class with 2 classes
uterinecarcinoma.lca2 <- randomLCA(uterinecarcinoma[,1:7],freq=uterinecarcinoma$freq)
plot(uterinecarcinoma.lca2)
```

randomLCA *Fits a Latent Class Model including a Random Effect*

Description

Fit latent class models, which may include a random effect.

Usage

```
randomLCA(patterns,freq,nclass=2,calcSE=TRUE,initmodel=NULL,
blocksize=1,notrials=20,random=FALSE,byclass=FALSE,
quadpoints=21,level2=FALSE,probit=FALSE,qniterations=5,
penalty=0.0001,
verbose=FALSE,
seed = as.integer(runif(1, 0, .Machine$integer.max)))
```

Arguments

patterns	Matrix of 0 and 1 definging the outcome patterns
freq	Frequency for each outcome pattern, if missing this is calculated from the patterns
nclass	Number of classes to be fitted
calcSE	Calculate standard errors for parameters
initmodel	Initial model of class randomLCA
blocksize	Size of blocks of outcomes
notrials	For a standard latent class model, the number of random starting values used
random	Random effect
byclass	Random effect by class
quadpoints	Number of quadrature points for adaptive quadrature
level2	Fit 2 level random effects model (further details to follow)
probit	Probit model for random effect
qniterations	Number of Quasi-Newton iterations within each adaptive cycle. Decrease if there is a failure to converge
penalty	penalty applied to likelihood for outcome probabilities. Shrinks outcome probabilities in slightly and can prevent extreme values. Setting penalty to 0 will produce an unpenalised fit.
verbose	Prints verbose of fit progress
seed	Initial random seed for generating starting values

Details

The structure of the patterns is assumed to be a number of blocks of different outcomes each of blocksize, allowing outcomes to be repeated. Each outcome is assumed to have it's own loading. An example is the width of the patterns is n and the blocksize is n, resulting in n outcomes and therefore n loadings. Alternatively if the blocksize is 1, then there are n repeats of the same outcome (but with different probabilities) with the same loading. In practice they may not be the same type of outcome, but usually will be.

The algorithm used is EM for the standard latent class and adaptive (in the sense of moving the location of teh quadrature points) Gauss-Hermite quadrature for the random effects models. The number of quadrature points defaults to 21.

NOTE: in the returned object there a fields for patterns and frequencies. If frequecncies are not supplied then the patterns and frequencies are constructed. If frequencies are supplied then zero rows are removed. When frequenciues are supplied it is assumed that the data has been simplified. The returned class probabilities etc, all correspond to the simplified patterns, not to the original data.

Value

randomLCA object This contains

`outcomep`	Outcome probability
`classp`	Class probabilities
`lambdacoef`	Loadings

Author(s)

Ken Beath

Examples

```
# dentist data
data(dentistry)
# standard latent class with 2 classes
dentistry.lca2 <- randomLCA(dentistry[,1:5],freq=dentistry$freq,nclass=2)
# random effects model with constant random effect loading
dentistry.lca2random <- randomLCA(dentistry[,1:5],freq=dentistry$freq,
initmodel=dentistry.lca2,nclass=2,random=TRUE,probit=TRUE)
# allow loading to vary by dentist
# this is the 2LCR model from Qu et al (1996)
dentistry.lca2random1 <- randomLCA(dentistry[,1:5],freq=dentistry$freq,
initmodel=dentistry.lca2random,nclass=2,random=TRUE,probit=TRUE,
blocksize=5)
```

ranef *Extract random effects from a randomLCA object*

Description

Extracts the Empirical Bayes estimates of the random effects.

Usage

```
## S3 method for class 'randomLCA'
ranef(object, ...)
```

Arguments

object	randomLCA object with a random effect
...	additional argument; currently none is used.

Value

A matrix with the first column containg the random effects and the second column the standard error of the random effects.

Author(s)

Ken Beath

simulate *Simulate*

Description

Simulate data from a fitted randomLCA model

Usage

```
## S3 method for class 'randomLCA'
simulate(object, nsim, seed, ...)
```

Arguments

object	randomLCA object
nsim	number of data sets to be simulated
seed	random seed
...	additional optional arguments.

Author(s)

Ken Beath

summary *Summary for randomLCA object*

Description

Summarises the fit of a randomLCA object.

Usage

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

Arguments

object	randomLCA object
...	additional argument; currently none is used.

Details

Not complete.

Value

logLik	Log Likelihood
AIC	AIC
BIC	BIC
nclass	no of classes
probit	link is probit
classp	class probabilities
outcomep	outcome probabilities (conditional)
margoutcomep	outcome probabilities (marginal), if model contains random effects
random	model includes random effects
level2	model has 2 level hierarchy
byclass	lambda and tau vary by class
lambdacoef	lambda coefficients
taucoef	tau coefficients

Author(s)

Ken Beath

`symptoms` *Symptoms data*

Description

This is the data for Beath and Heller (2009).

Allergy and respiratory symptoms for infants 0 to 2 years in six month periods. Outcome is presence or absence of symptom in the six months. Original data was collected at Visits 1-7 over the 2 year period which were summarised to six month periods.

Note that these models can be slow to fit, with the "symptoms.lca2random2" model taking about 1-2 hours.

Thanks to the investigators of the CAPS study for making the data available.

Usage

```
data(symptoms)
```

Format

A data frame with 444 observations on the following 17 variables.

`Nightcough.13` Night cough in visits 1-3

`Wheeze.13` Wheeze in visits 1-3

`Itchyrash.13` Itchy rash in visits 1-3

`FlexDerma.13` Flexural Dermatitis in visits 1-3

`Nightcough.45` Night cough in visits 1-3

`Wheeze.45` Wheeze in visits 4-5

`Itchyrash.45` Itchy rash in visits 4-5

`FlexDerma.45` Flexural Dermatitis in visits 4-5

`Nightcough.6` Night cough in visit 6

`Wheeze.6` Wheeze in visit 6

`Itchyrash.6` Itchy rash in visit 6

`FlexDerma.6` Flexural Dermatitis in visits 1-3

`Nightcough.7` Night cough in visit 7

`Wheeze.7` Wheeze in visit 7

`Itchyrash.7` Itchy rash in visit 7

`FlexDerma.7` Flexural Dermatitis in visit 7

`Freq` Number of subjects

Source

Mihrshai et al (2001)

References

Mihrshahi, S., Peat, J.K., Webb, K., Tovey, R.E., Marks, G.B., Mellis, C.M. and Leeder S.R. (2001) The Childhood Asthma Prevention Study (CAPS): Design and research protocol of a randomized trial for the primary prevention of asthma. Control led Clinical Trials, **22**:333–354. Beath, K.J. and Heller, G.Z. (2009) Latent trajectory modelling of multivariate binary data. Statistical Modelling, **9(3)**:199–213.

Examples

```
data(symptoms)
## Not run:
symptoms.lca2 <- randomLCA(symptoms[,1:16],freq=symptoms$Freq,nclass=2)
symptoms.lca2random <- randomLCA(symptoms[,1:16],freq=symptoms$Freq,
initmodel=symptoms.lca2,random=TRUE,nclass=2,blocksize=4)
symptoms.lca2random2 <- randomLCA(symptoms[,1:16],freq=symptoms$Freq,
initmodel=symptoms.lca2random,random=TRUE,level2=TRUE,nclass=2,
blocksize=4)

## End(Not run)
```

---

uterinecarcinoma *Uterine Carcinoma Data*

Description

Classification of 118 histology samples by 118 pathologists. Original classification in Holmquist et al (1967) was to one of five categories, this has been reduced to two. Analysed by a number of authors, with a random effects in Qu et al (1996).

Usage

```
data(uterinecarcinoma)
```

Format

A data frame with 20 observations on the following 8 variables.

`V1` Pathologist 1

`V2` Pathologist 2

`V3` Pathologist 3

`V4` Pathologist 4

`V5` Pathologist 5

`V6` Pathologist 6

`V7` Pathologist 7

`freq` Number of observed pattern

Source

Qu et al (1996)

References

Holmquist, N.D., McMahan, C.A., and Williams, O.D. (1967) Variability in classificationof carcinoma in situ of the uterine cervix. *Archives of Pathology*, **84**, 344–345. Qu, Y., Tan, M. and Kutner, M.H. (1996) Random effects models in latent class analysis for evaluating accuracy of diagnostic tests. *Biometrics*, **52**, 797–810.

Examples

```
data(uterinecarcinoma)
uterinecarcinoma.lca2 <- randomLCA(uterinecarcinoma[,1:7],
freq=uterinecarcinoma$freq)

uterinecarcinoma.lcarandom2 <- randomLCA(uterinecarcinoma[,1:7],
freq=uterinecarcinoma$freq,initmodel=uterinecarcinoma.lca2,
random=TRUE,probit=TRUE,quadpoints=41)
# LCR1 model of Que et al. This is fairly unstable and requires
# starting values from the simpler model without loadings by class
# it is also slow and doesn't improve the model fit
## Not run: uterinecarcinoma.lcarandom2by <- randomLCA(uterinecarcinoma[,1:7],freq=uterinecarcinoma$freq,
initmodel=uterinecarcinoma.lcarandom2,byclass=TRUE,
random=TRUE,probit=TRUE,quadpoints=61)
## End(Not run)
```

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