

Package ‘FuzzyClass’

August 25, 2022

Title Fuzzy and Non-Fuzzy Classifiers

Version 0.1.2

Description It provides classifiers which can be used for discrete variables and for continuous variables based on the Naive Bayes and Fuzzy Naive Bayes hypothesis. Those methods were developed by researchers belong to the 'Laboratory of Technologies for Virtual Teaching and Statistics (LabTEVE)' (<<http://www.de.ufpb.br/~labteve/>>) and 'Laboratory of Applied Statistics to Image Processing and Geoprocessing (LEAPIG)' (<<http://www.de.ufpb.br/~leapig/>>) at 'Federal University of Paraiba, Brazil'. They considered some statistical distributions and their papers were published in the scientific literature, as for instance, the Gaussian classifier using fuzzy parameters, proposed by 'Moraes, Ferreira and Machado' (2021) <[doi:10.1007/s40815-020-00936-4](https://doi.org/10.1007/s40815-020-00936-4)>.

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LazyData true

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Imports caTools, doParallel, e1071, EnvStats, foreach, MASS, parallel, Rdpack, rootSolve, stats

RdMacros Rdpack

Depends R (>= 2.10)

Suggests spelling, testthat (>= 3.0.0)

Config/testthat/edition 3

URL <https://github.com/Jodavid/FuzzyClass>

BugReports <https://github.com/Jodavid/FuzzyClass/issues>

Language en-US

NeedsCompilation no

Author Jodavid Ferreira [aut, cre] (<<https://orcid.org/0000-0002-2131-6464>>),
Ronei Moraes [ctb] (<<https://orcid.org/0000-0001-8436-8950>>),
Arthur Ricardo [ctb]

Maintainer Jodavid Ferreira <jodavid@protonmail.com>

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ExpNBFuzzyParam	<i>Fuzzy Exponential Naive Bayes Classifier with Fuzzy parameters</i>
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Description

ExpNBFuzzyParam Fuzzy Exponential Naive Bayes Classifier with Fuzzy parameters

Usage

```
ExpNBFuzzyParam(train, cl, metd = 1, cores = 2)
```

Arguments

train	matrix or data frame of training set cases.
cl	factor of true classifications of training set
metd	Method of transforming the triangle into scalar, It is the type of data entry for the test sample, use metd 1 if you want to use the Baricentro technique and use metd 2 if you want to use the Q technique of the uniformity test (article: Directional Statistics and Shape analysis).
cores	how many cores of the computer do you want to use (default = 2)

Value

A vector of classifications

References

Rodrigues AK, Batista TV, Moraes RM, Machado LS (2016). “A new exponential naive bayes classifier with fuzzy parameters.” In *2016 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*, 1188–1194. IEEE.

Examples

```
set.seed(1) # determining a seed
data(VirtualRealityData)

# Splitting into Training and Testing
split <- caTools::sample.split(t(VirtualRealityData[, 1]), SplitRatio = 0.7)
Train <- subset(VirtualRealityData, split == "TRUE")
Test <- subset(VirtualRealityData, split == "FALSE")

# -----
# matrix or data frame of test set cases.
# A vector will be interpreted as a row vector for a single case.
test <- Test[, -4]
fit_FENB <- ExpNBFuzzyParam(
  train = Train[, -4],
  cl = Train[, 4], metd = 1, cores = 2
)

pred_FENB <- predict(fit_FENB, test)

head(pred_FENB)
head(Test[, 4])
```

FuzzyBetaNaiveBayes *Fuzzy Beta Naive Bayes*

Description

FuzzyBetaNaiveBayes Fuzzy Beta Naive Bayes

Usage

```
FuzzyBetaNaiveBayes(train, cl, cores = 2, fuzzy = TRUE)
```

Arguments

train	matrix or data frame of training set cases.
cl	factor of true classifications of training set
cores	how many cores of the computer do you want to use (default = 2)
fuzzy	boolean variable to use the membership function

Value

A vector of classifications

References

Moraes RM, Rodrigues AKG, Soares EAMG, Machado LS (2020). “A new fuzzy beta naive Bayes classifier.” In *Developments of Artificial Intelligence Technologies in Computation and Robotics: Proceedings of the 14th International FLINS Conference (FLINS 2020)*, 437–445. World Scientific.

Examples

```
set.seed(1) # determining a seed
data(iris)

# Splitting into Training and Testing
split <- caTools::sample.split(t(iris[, 1]), SplitRatio = 0.7)
Train <- subset(iris, split == "TRUE")
Test <- subset(iris, split == "FALSE")
#-----
# matrix or data frame of test set cases.
# A vector will be interpreted as a row vector for a single case.
test <- Test[, -5]
fit_NBT <- FuzzyBetaNaiveBayes(
  train = Train[, -5],
  cl = Train[, 5], cores = 2
)

pred_NBT <- predict(fit_NBT, test)

head(pred_NBT)
head(Test[, 5])
```

FuzzyBinomialNaiveBayes

Fuzzy Binomial Naive Bayes

Description

FuzzyBinomialNaiveBayes Fuzzy Binomial Naive Bayes

Usage

```
FuzzyBinomialNaiveBayes(train, cl, cores = 2, fuzzy = TRUE)
```

Arguments

train	matrix or data frame of training set cases.
cl	factor of true classifications of training set
cores	how many cores of the computer do you want to use (default = 2)
fuzzy	boolean variable to use the membership function

Value

A vector of classifications

References

Moraes RM, Machado LS (2016). "A Fuzzy Binomial Naive Bayes classifier for epidemiological data." In *2016 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*, 745–750. IEEE.

Examples

```

set.seed(1) # determining a seed
class1 <- data.frame(vari1 = rbinom(100,size = 10, prob = 0.2),
                    vari2 = rbinom(100,size = 10, prob = 0.2),
                    vari3 = rbinom(100,size = 10, prob = 0.2), class = 1)
class2 <- data.frame(vari1 = rbinom(100,size = 10, prob = 0.5),
                    vari2 = rbinom(100,size = 10, prob = 0.5),
                    vari3 = rbinom(100,size = 10, prob = 0.5), class = 2)
class3 <- data.frame(vari1 = rbinom(100,size = 10, prob = 0.8),
                    vari2 = rbinom(100,size = 10, prob = 0.8),
                    vari3 = rbinom(100,size = 10, prob = 0.8), class = 3)
data <- rbind(class1,class2,class3)

# Splitting into Training and Testing
split <- caTools::sample.split(t(data[, 1]), SplitRatio = 0.7)
Train <- subset(data, split == "TRUE")
Test <- subset(data, split == "FALSE")
# -----
# matrix or data frame of test set cases.
# A vector will be interpreted as a row vector for a single case.
test <- Test[, -4]
fit_NBT <- FuzzyBinomialNaiveBayes(
  train = Train[, -4],
  cl = Train[, 4], cores = 2
)

pred_NBT <- predict(fit_NBT, test)

head(pred_NBT)
head(Test[, 4])

```

FuzzyExponentialNaiveBayes

Fuzzy Exponential Naive Bayes

Description

FuzzyExponentialNaiveBayes Fuzzy Exponential Naive Bayes

Usage

```
FuzzyExponentialNaiveBayes(train, cl, cores = 2, fuzzy = TRUE)
```

Arguments

train	matrix or data frame of training set cases.
cl	factor of true classifications of training set
cores	how many cores of the computer do you want to use (default = 2)
fuzzy	boolean variable to use the membership function

Value

A vector of classifications

References

Moraes RM, Machado LS (2016). “A fuzzy exponential naive bayes classifier.” In *Uncertainty Modelling in Knowledge Engineering and Decision Making: Proceedings of the 12th International FLINS Conference*, 207–212. World Scientific.

Examples

```
set.seed(1) # determining a seed
data(iris)

# Splitting into Training and Testing
split <- caTools::sample.split(t(iris[, 1]), SplitRatio = 0.7)
Train <- subset(iris, split == "TRUE")
Test <- subset(iris, split == "FALSE")
# -----
# matrix or data frame of test set cases.
# A vector will be interpreted as a row vector for a single case.
test <- Test[, -5]
fit_NBT <- FuzzyExponentialNaiveBayes(
  train = Train[, -5],
  cl = Train[, 5], cores = 2
)
```

```
pred_NBT <- predict(fit_NBT, test)

head(pred_NBT)
head(Test[, 5])
```

FuzzyGammaNaiveBayes *Fuzzy Gamma Naive Bayes*

Description

FuzzyGammaNaiveBayes Fuzzy Gamma Naive Bayes

Usage

```
FuzzyGammaNaiveBayes(train, cl, cores = 2, fuzzy = TRUE)
```

Arguments

train	matrix or data frame of training set cases.
cl	factor of true classifications of training set
cores	how many cores of the computer do you want to use (default = 2)
fuzzy	boolean variable to use the membership function

Value

A vector of classifications

References

Moraes RM, Soares EAMG, Machado LS (2018). "A Fuzzy Gamma Naive Bayes Classifier." In *Data Science and Knowledge Engineering for Sensing Decision Support: Proceedings of the 13th International FLINS Conference (FLINS 2018)*, 691–699. World Scientific.

Examples

```
set.seed(1) # determining a seed
data(iris)

# Splitting into Training and Testing
split <- caTools::sample.split(t(iris[, 1]), SplitRatio = 0.7)
Train <- subset(iris, split == "TRUE")
Test <- subset(iris, split == "FALSE")
# -----
# matrix or data frame of test set cases.
# A vector will be interpreted as a row vector for a single case.
test <- Test[, -5]
fit_NBT <- FuzzyGammaNaiveBayes(
```

```
train = Train[, -5],
cl = Train[, 5], cores = 2
)

pred_NBT <- predict(fit_NBT, test)

head(pred_NBT)
head(Test[, 5])
```

FuzzyGaussianNaiveBayes

Fuzzy Gaussian Naive Bayes Classifier Zadeh-based

Description

FuzzyGaussianNaiveBayes Fuzzy Gaussian Naive Bayes Classifier Zadeh-based

Usage

```
FuzzyGaussianNaiveBayes(train, cl, cores = 2, fuzzy = TRUE)
```

Arguments

train	matrix or data frame of training set cases.
cl	factor of true classifications of training set
cores	how many cores of the computer do you want to use (default = 2)
fuzzy	boolean variable to use the membership function

Value

A vector of classifications

References

Moraes RM, Machado LS (2012). "Online Assessment in Medical Simulators Based on Virtual Reality Using Fuzzy Gaussian Naive Bayes." *Journal of Multiple-Valued Logic & Soft Computing*, **18**.

Examples

```
set.seed(1) # determining a seed
data(iris)

# Splitting into Training and Testing
split <- caTools::sample.split(t(iris[, 1]), SplitRatio = 0.7)
Train <- subset(iris, split == "TRUE")
Test <- subset(iris, split == "FALSE")
```



```

# -----
# matrix or data frame of test set cases.
# A vector will be interpreted as a row vector for a single case.
test <- Test[, -5]
fit_GNB <- FuzzyGaussianNaiveBayes(
  train = Train[, -5],
  cl = Train[, 5], cores = 2
)

pred_GNB <- predict(fit_GNB, test)

head(pred_GNB)
head(Test[, 5])

```

FuzzyNaiveBayes

Fuzzy Naive Bayes

Description

FuzzyNaiveBayes Fuzzy Naive Bayes

Usage

```
FuzzyNaiveBayes(train, cl, fuzzy = TRUE, m = NULL, Pi = NULL)
```

Arguments

train	matrix or data frame of training set cases.
cl	factor of true classifications of training set
fuzzy	boolean variable to use the membership function
m	is M/N, where M is the number of classes and N is the number of train lines
Pi	is 1/M, where M is the number of classes

Value

A vector of classifications

References

Moraes RM, Machado LS (2009). “Another approach for fuzzy naive bayes applied on online training assessment in virtual reality simulators.” In *Proceedings of Safety Health and Environmental World Congress*, 62–66.

Examples

```

set.seed(1) # determining a seed
data(HouseVotes84)

# Splitting into Training and Testing
split <- caTools::sample.split(t(HouseVotes84[, 1]), SplitRatio = 0.7)
Train <- subset(HouseVotes84, split == "TRUE")
Test <- subset(HouseVotes84, split == "FALSE")
# -----
# matrix or data frame of test set cases.
# A vector will be interpreted as a row vector for a single case.
test <- Test[, -1]
fit_FNB <- FuzzyNaiveBayes(
  train = Train[, -1],
  cl = Train[, 1]
)

pred_FNB <- predict(fit_FNB, test)

head(pred_FNB)
head(Test[, 1])

```

FuzzyPoissonNaiveBayes

Fuzzy Poisson Naive Bayes

Description

FuzzyPoissonNaiveBayes Fuzzy Poisson Naive Bayes

Usage

```
FuzzyPoissonNaiveBayes(train, cl, cores = 2, fuzzy = TRUE)
```

Arguments

train	matrix or data frame of training set cases.
cl	factor of true classifications of training set
cores	how many cores of the computer do you want to use (default = 2)
fuzzy	boolean variable to use the membership function

Value

A vector of classifications

References

Moraes RM, Machado LS (2015). “A fuzzy poisson naive bayes classifier for epidemiological purposes.” In *2015 7th International Joint Conference on Computational Intelligence (IJCCI)*, volume 2, 193–198. IEEE.

Examples

```
set.seed(1) # determining a seed
class1 <- data.frame(vari1 = rpois(100,lambda = 2),
                    vari2 = rpois(100,lambda = 2),
                    vari3 = rpois(100,lambda = 2), class = 1)
class2 <- data.frame(vari1 = rpois(100,lambda = 1),
                    vari2 = rpois(100,lambda = 1),
                    vari3 = rpois(100,lambda = 1), class = 2)
class3 <- data.frame(vari1 = rpois(100,lambda = 5),
                    vari2 = rpois(100,lambda = 5),
                    vari3 = rpois(100,lambda = 5), class = 3)
data <- rbind(class1,class2,class3)

# Splitting into Training and Testing
split <- caTools::sample.split(t(data[, 1]), SplitRatio = 0.7)
Train <- subset(data, split == "TRUE")
Test <- subset(data, split == "FALSE")
# -----
# matrix or data frame of test set cases.
# A vector will be interpreted as a row vector for a single case.
test <- Test[, -4]
fit_NBT <- FuzzyPoissonNaiveBayes(
  train = Train[, -4],
  cl = Train[, 4], cores = 2
)

pred_NBT <- predict(fit_NBT, test)

head(pred_NBT)
head(Test[, 4])
```

FuzzyTrapezoidalNaiveBayes

Fuzzy Naive Bayes Trapezoidal Classifier

Description

FuzzyTrapezoidalNaiveBayes Fuzzy Naive Bayes Trapezoidal Classifier

Usage

```
FuzzyTrapezoidalNaiveBayes(train, cl, cores = 2, fuzzy = T)
```

Arguments

train	matrix or data frame of training set cases.
c1	factor of true classifications of training set
cores	how many cores of the computer do you want to use (default = 2)
fuzzy	boolean variable to use the membership function

Value

A vector of classifications

References

Lopes A, Ferreira J, Machado LS, Moraes RM (2022). "A New Fuzzy Trapezoidal Naive Bayes Network as basis for Assessment in Training based on Virtual Reality." In *The 15th International FLINS Conference on Machine learning, Multi agent and Cyber physical systems (FLINS 2022)*. Nankai University.

Examples

```
set.seed(1) # determining a seed
data(iris)

# Splitting into Training and Testing
split <- caTools::sample.split(t(iris[, 1]), SplitRatio = 0.7)
Train <- subset(iris, split == "TRUE")
Test <- subset(iris, split == "FALSE")
# -----
# matrix or data frame of test set cases.
# A vector will be interpreted as a row vector for a single case.
test <- Test[, -5]
fit_NBT <- FuzzyTrapezoidalNaiveBayes(
  train = Train[, -5],
  c1 = Train[, 5], cores = 2
)

pred_NBT <- predict(fit_NBT, test)

head(pred_NBT)
head(Test[, 5])
```

FuzzyTriangularNaiveBayes

Fuzzy Naive Bayes Triangular Classifier

Description

FuzzyTriangularNaiveBayes Fuzzy Naive Bayes Triangular Classifier

Usage

```
FuzzyTriangularNaiveBayes(train, cl, cores = 2, fuzzy = TRUE)
```

Arguments

train	matrix or data frame of training set cases.
cl	factor of true classifications of training set
cores	how many cores of the computer do you want to use (default = 2)
fuzzy	boolean variable to use the membership function

Value

A vector of classifications

References

Moraes RM, Silva ILA, Machado LS (2020). “Online skills assessment in training based on virtual reality using a novel fuzzy triangular naive Bayes network.” In *Developments of Artificial Intelligence Technologies in Computation and Robotics: Proceedings of the 14th International FLINS Conference (FLINS 2020)*, 446–454. World Scientific.

Examples

```
set.seed(1) # determining a seed
data(iris)

# Splitting into Training and Testing
split <- caTools::sample.split(t(iris[, 1]), SplitRatio = 0.7)
Train <- subset(iris, split == "TRUE")
Test <- subset(iris, split == "FALSE")
# -----
# matrix or data frame of test set cases.
# A vector will be interpreted as a row vector for a single case.
test <- Test[, -5]
fit_NBT <- FuzzyTriangularNaiveBayes(
  train = Train[, -5],
  cl = Train[, 5], cores = 2
)

pred_NBT <- predict(fit_NBT, test)

head(pred_NBT)
head(Test[, 5])
```

GauNBFuzzyParam

*Fuzzy Gaussian Naive Bayes Classifier with Fuzzy parameters***Description**

GauNBFuzzyParam Fuzzy Gaussian Naive Bayes Classifier with Fuzzy parameters

Usage

```
GauNBFuzzyParam(train, cl, metd = 1, cores = 2)
```

Arguments

train	matrix or data frame of training set cases.
cl	factor of true classifications of training set
metd	Method of transforming the triangle into scalar, It is the type of data entry for the test sample, use metd 1 if you want to use the Baricentro technique and use metd 2 if you want to use the Q technique of the uniformity test (article: Directional Statistics and Shape analysis).
cores	how many cores of the computer do you want to use (default = 2)

Value

A vector of classifications

References

Moraes RM, Ferreira JA, Machado LS (2021). “A New Bayesian Network Based on Gaussian Naive Bayes with Fuzzy Parameters for Training Assessment in Virtual Simulators.” *International Journal of Fuzzy Systems*, **23**(3), 849–861.

Examples

```
set.seed(1) # determining a seed
data(iris)

# Splitting into Training and Testing
split <- caTools::sample.split(t(iris[, 1]), SplitRatio = 0.7)
Train <- subset(iris, split == "TRUE")
Test <- subset(iris, split == "FALSE")
# -----
# matrix or data frame of test set cases.
# A vector will be interpreted as a row vector for a single case.
test <- Test[, -5]
fit_FGNB <- GauNBFuzzyParam(
  train = Train[, -5],
  cl = Train[, 5], metd = 1, cores = 2
```

```
)  
  
pred_FGNB <- predict(fit_FGNB, test)  
  
head(pred_FGNB)  
head(Test[, 5])
```

HouseVotes84

United States Congressional Voting Records 1984

Description

This data set includes votes for each of the U.S. House of Representatives Congressmen on the 16 key votes identified by the CQA. The CQA lists nine different types of votes: voted for, paired for, and announced for (these three simplified to yea), voted against, paired against, and announced against (these three simplified to nay), voted present, voted present to avoid conflict of interest, and did not vote or otherwise make a position known (these three simplified to an unknown disposition).

Usage

```
data(HouseVotes84)
```

Format

A data frame with 435 observations on 17 variables:

- 1 Class Name: 2 (democrat, republican)
- 2 handicapped-infants: 2 (y,n)
- 3 water-project-cost-sharing: 2 (y,n)
- 4 adoption-of-the-budget-resolution: 2 (y,n)
- 5 physician-fee-freeze: 2 (y,n)
- 6 el-salvador-aid: 2 (y,n)
- 7 religious-groups-in-schools: 2 (y,n)
- 8 anti-satellite-test-ban: 2 (y,n)
- 9 aid-to-nicaraguan-contras: 2 (y,n)
- 10 mx-missile: 2 (y,n)
- 11 immigration: 2 (y,n)
- 12 synfuels-corporation-cutback: 2 (y,n)
- 13 education-spending: 2 (y,n)
- 14 superfund-right-to-sue: 2 (y,n)
- 15 crime: 2 (y,n)
- 16 duty-free-exports: 2 (y,n)
- 17 export-administration-act-south-africa: 2 (y,n)

Source

- Source: Congressional Quarterly Almanac, 98th Congress, 2nd session 1984, Volume XL: Congressional Quarterly Inc., ington, D.C., 1985
- Donor: Jeff Schlimmer (Jeffrey.Schlimmer@a.gp.cs.cmu.edu)

These data have been taken from the UCI Repository Of Machine Learning Databases at

- <https://archive.ics.uci.edu/ml/machine-learning-databases/>
- <http://www.ics.uci.edu/~mlearn/MLRepository.html>

and were converted to R format by Friedrich Leisch.

References

Newman, D.J. & Hettich, S. & Blake, C.L. & Merz, C.J. (1998). UCI Repository of machine learning databases [<http://www.ics.uci.edu/~mlearn/MLRepository.html>]. Irvine, CA: University of California, Department of Information and Computer Science.

Examples

```
data(HouseVotes84)
summary(HouseVotes84)
```

PoiNBFuzzyParam

Fuzzy Poisson Naive Bayes Classifier with Fuzzy parameters

Description

PoiNBFuzzyParam Fuzzy Poisson Naive Bayes Classifier with Fuzzy parameters

Usage

```
PoiNBFuzzyParam(train, cl, metd = 1, cores = 2)
```

Arguments

train	matrix or data frame of training set cases.
cl	factor of true classifications of training set
metd	Method of transforming the triangle into scalar, It is the type of data entry for the test sample, use metd 1 if you want to use the Baricentro technique and use metd 2 if you want to use the Q technique of the uniformity test (article: Directional Statistics and Shape analysis).
cores	how many cores of the computer do you want to use (default = 2)

Value

A vector of classifications

References

Soares E, Machado L, Moraes R (2016). “Assessment of poisson naive bayes classifier with fuzzy parameters using data from different statistical distributions.” In *IV Brazilian Congress on Fuzzy Systems (CBSF 2016)*, volume 1, 57–68.

Examples

```
set.seed(1) # determining a seed
class1 <- data.frame(vari1 = rpois(100,lambda = 2),
                    vari2 = rpois(100,lambda = 2),
                    vari3 = rpois(100,lambda = 2), class = 1)
class2 <- data.frame(vari1 = rpois(100,lambda = 1),
                    vari2 = rpois(100,lambda = 1),
                    vari3 = rpois(100,lambda = 1), class = 2)
class3 <- data.frame(vari1 = rpois(100,lambda = 5),
                    vari2 = rpois(100,lambda = 5),
                    vari3 = rpois(100,lambda = 5), class = 3)
data <- rbind(class1,class2,class3)

# Splitting into Training and Testing
split <- caTools::sample.split(t(data[, 1]), SplitRatio = 0.7)
Train <- subset(data, split == "TRUE")
Test <- subset(data, split == "FALSE")
# -----
# matrix or data frame of test set cases.
# A vector will be interpreted as a row vector for a single case.
test <- Test[, -4]
fit_FPoiNB <- PoiNBFuzzyParam(
  train = Train[, -4],
  cl = Train[, 4], metd = 1, cores = 2
)

pred_FPoiNB <- predict(fit_FPoiNB, test)

head(pred_FPoiNB)
head(Test[, 4])
```

SimulatedData

Simulated Data

Description

A dataset containing training data from Gamma Distribution

Usage

SimulatedData

Format

A dataset with 600 rows and 4 variables with 1 label.

VirtualRealityData *Virtual Reality Simulator Data*

Description

A dataset containing training data from a virtual reality simulator

Usage

VirtualRealityData

Format

A dataset with 600 rows and 4 variables with 1 label.

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