Package 'afc'

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Title Generalized Discrimination Score

Description This is an implementation of the Generalized Discrimination Score (also known as Two Alternatives Forced Choice Score, 2AFC) for various representations of forecasts and verifying observations. The Generalized Discrimination Score is a generic forecast verification framework which can be applied to any of the following verification contexts: dichotomous, polychotomous (ordinal and nominal), continuous, probabilistic, and ensemble. A comprehensive description of the Generalized Discrimination Score, including all equations used in this package, is provided by Mason and Weigel (2009).

License GPL (>= 3)

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`afc-package` *Generalized Discrimination Score 2AFC*

Description

This package is a collection of routines to calculate the "generalized discrimination score", which is also known as "two alternatives forced-choice score" or short: "2AFC-score". The 2AFC is a generic forecast verification framework which can be applied to any of the following verification contexts: dichotomous, polychotomous (ordinal and nominal), continuous, probabilistic, and ensemble. A comprehensive description of the 2AFC-score, including all equations used in this package, is provided by Mason and Weigel (2009).

Details

The master routine is afc. For a given set of observation and forecast data, and for a specified verification context, afc calls the appropriate functions which are necessary to calculate the 2AFC score.

Why the 2AFC-score? There are numerous reasons for calculating forecast verification scores, and considerable attention has been given to designing and analyzing the properties of scores that can be used for scientific purposes. Much less attention has been given to scores that may be useful for administrative reasons, such as communicating changes in forecast quality to bureaucrats, and providing indications of forecast quality to the general public. The 2AFC test a scoring procedure that is sufficiently generic to be useable on forecasts ranging from simply "yes"/"no" forecasts of dichotomous outcomes to continuous variables, and can be used with deterministic or probabilistic forecasts without seriously reducing the more complex information when available. Although, as with any single verification score, the 2AFC has limitations, it does have broad intuitive appeal in that the expected score of an unskilled set of forecasts (random guessing or perpetually identical forecasts) is 50%, and is interpretable as an indication of how often the forecasts are correct, even when the forecasts are expressed probabilistically and/or the observations are not discrete.

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Author(s)

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References

Mason, S.J. and A.P. Weigel, 2009: A generic forecast verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

`afc` *Calculate Generalized Discrimination Score 2AFC*

Description

This is the master routine for the calculation the Generalized Discrimination Score (aka Two-Alternatives Forced Choice Score - 2AFC) as described in the Paper of Mason and Weigel (2009). This routine requires, as input, datasets of forecasts and corresponding observations, as well as a

specification of the verification context. The routine checks whether the input data are consistent with the verification context, then calls the appropriate function to calculate the 2AFC, and finally returns the 2AFC skill value.

Usage

```
afc(obsv, fcst, obsv.type, fcst.type, m = 0, m2 = 0, na.rm = FALSE)
```

Arguments

obsv	Vector of observations. The required format depends on the specific verification context. More details below.
fcst	Vector or two-dimensional array of forecasts. The required format depends on the specific verification context. More details below.
obsv.type	Character specifying the type of the observations. Possible values: "d" (dichotomous), "m" (polychotomous with ordinal categories), "n" (polychotomous with nominal categories), "c" (continuous).
fcst.type	Character specifying the type of the forecasts. Possible values: "d" (dichotomous), "m" (polychotomous with ordinal categories), "n" (polychotomous with nominal categories), "p" (probabilistic), "c" (continuous) and "e" (ensemble).
m	Number of observation or forecast categories (only required if obsv.type or fcst.type equals "m" or "n")
m2	Number of forecast categories (only required if both obsv.type and fcst.type equal "m"). The number of observation categories is then specified by the argument *m* above.
na.rm	logical; if TRUE pairs where obsv or fcst is NA are removed before scoring. Default FALSE returns NA if any input contains NA.

Details

Depending on the specific verification context (i.e. the choice for *obsv.type* and *fcst.type*), this routine calls the appropriate function(s) to calculate the 2AFC score. The following combinations of *obsv.type* and *fcst.type* are possible: (1) "d-d"; (2) "d-m"; (3) "d-p"; (4) "d-c"; (5) "d-e"; (6) "m-m"; (7) "m-p"; (8) "m-c"; (9) "m-e"; (10) "n-n"; (11) "n-p"; (12) "c-c"; (13) "c-e". The required format of the input data *obsv* and *fcst* depends on the verification context:

(1) "d-d":
obsv: vector with dichotomous observations (values in {0,1})
fcst: vector of same length as *obsv* with dichotomous forecasts (values in {0,1})

(2) "d-m":
obsv: vector with dichotomous observations (values in {0,1})
fcst: vector of same length as *obsv* with polychotomous forecasts (values in {1,..,m})

(3) "d-p":
obsv: vector with dichotomous observations (values in {0,1})

fcst: vector of same length as *obsv* with forecast probabilities for the event to happen

(4) "d-c":
obsv: vector with dichotomous observations (values in {0,1})
fcst: vector of same length as *obsv* with real-valued forecasts

(5) "d-e":
obsv: vector with dichotomous observations (values in {0,1})
fcst: two-dimensional array with ensemble forecasts; dim(fcst)[1] = length(obsv); dim(fcst)[2] = ensemble size.

(6) "m-m":
obsv: vector with polychotomous observations (values in {1,..,m})
fcst: vector of same length as *obsv* with polychotomous forecasts (values in {1,..,m2})

(7) "m-p":
obsv: vector with polychotomous observations (values in {1,..,m})
fcst: two-dimensional array with forecast probabilities for the m categories; dim(fcst)[1] = length(obsv); dim(fcst)[2] = m

(8) "m-c":
obsv: vector with polychotomous observations (values in {1,..,m})
fcst: vector of same length as *obsv* with real-valued forecasts

(9) "m-e":
obsv: vector with polychotomous observations (values in {1,..,m})
fcst: two-dimensional array with ensemble forecasts; dim(fcst)[1] = length(obsv); dim(fcst)[2] = ensemble size.

(10) "n-n":
obsv: vector with polychotomous observations (values in {1,..,m})
fcst: vector of same length as *obsv* with polychotomous forecasts (values in {1,..,m})

(11) "n-p":
Same as "m-p".

(12) "c-c":
obsv: vector with real-valued observations
fcst: vector of same length as *obsv* with real-valued forecasts

(13) "c-e":
obsv: vector with real-valued observations
fcst: two-dimensional array with ensemble forecasts; dim(fcst)[1] = length(obsv); dim(fcst)[2] = ensemble size.

Value

p.afc	Value of Generalized Discrimination Score (2AFC)

Author(s)

Andreas Weigel, Federal Office of Meteorology and Climatology, MeteoSwiss, Zurich, Switzerland

References

S.J. Mason and A.P. Weigel, 2009. A generic verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

See Also

afc.dd afc.dm afc.dp afc.dc afc.de afc.mm afc.mp afc.mc afc.me afc.nn afc.np afc.cc afc.ce

Examples

```
data(cnrm.nino34.dd)
obsv = cnrm.nino34.dd$obsv
fcst = cnrm.nino34.dd$fcst
afc(obsv, fcst, obsv.type="d", fcst.type="d")

data(cnrm.nino34.dm)
obsv = cnrm.nino34.dm$obsv
fcst = cnrm.nino34.dm$fcst
afc(obsv, fcst, obsv.type="d", fcst.type="m", m=4)

data(cnrm.nino34.dp)
obsv = cnrm.nino34.dp$obsv
fcst = cnrm.nino34.dp$fcst
afc(obsv, fcst, obsv.type="d", fcst.type="p")

data(cnrm.nino34.dc)
obsv = cnrm.nino34.dc$obsv
fcst = cnrm.nino34.dc$fcst
afc(obsv, fcst, obsv.type="d", fcst.type="c")

data(cnrm.nino34.de)
obsv = cnrm.nino34.de$obsv
fcst = cnrm.nino34.de$fcst
afc(obsv, fcst, obsv.type="d", fcst.type="e")

data(cnrm.nino34.mm)
obsv = cnrm.nino34.mm$obsv
fcst = cnrm.nino34.mm$fcst
afc(obsv, fcst, obsv.type="m", fcst.type="m", m=4, m2=4)

data(cnrm.nino34.mp)
obsv = cnrm.nino34.mp$obsv
fcst = cnrm.nino34.mp$fcst
```

```
afc(obsv, fcst, obsv.type="m", fcst.type="p", m=4)

data(cnrm.nino34.mc)
obsv = cnrm.nino34.mc$obsv
fcst = cnrm.nino34.mc$fcst
afc(obsv, fcst, obsv.type="m", fcst.type="c", m=4)

data(cnrm.nino34.me)
obsv = cnrm.nino34.me$obsv
fcst = cnrm.nino34.me$fcst
afc(obsv, fcst, obsv.type="m", fcst.type="e", m=4)

data(cnrm.nino34.mm)
obsv = cnrm.nino34.mm$obsv
fcst = cnrm.nino34.mm$fcst
afc(obsv, fcst, obsv.type="n", fcst.type="n", m=4)

data(cnrm.nino34.mp)
obsv = cnrm.nino34.mp$obsv
fcst = cnrm.nino34.mp$fcst
afc(obsv, fcst, obsv.type="n", fcst.type="p", m=4)

data(cnrm.nino34.cc)
obsv = cnrm.nino34.cc$obsv
fcst = cnrm.nino34.cc$fcst
afc(obsv, fcst, obsv.type="c", fcst.type="c")

data(cnrm.nino34.ce)
obsv = cnrm.nino34.ce$obsv
fcst = cnrm.nino34.ce$fcst
afc(obsv, fcst, obsv.type="c", fcst.type="e")
```

`afc.cc` *2AFC For Continuous Observations And Continuous Forecasts*

Description

Routine to calculate the Generalized Discrimination Score (aka Two-Alternatives Forced Choice Score 2AFC) for the situation of continuous observations and continuous forecasts

Usage

```
afc.cc(obsv, fcst, na.rm = FALSE)
```

Arguments

`obsv`	vector with real-valued observations
`fcst`	vector of same length as *obsv* with real-valued forecasts
`na.rm`	logical; if `TRUE` pairs where `obsv` or `fcst` is `NA` are removed before scoring. Default `FALSE` returns `NA` if any input contains `NA`.

Details

This routine applies Eq.22 of Mason and Weigel (2009) to calculate the 2AFC.

Value

p.afc	Value of Generalized Discrimination (2AFC) Score

Author(s)

Andreas Weigel, Federal Office of Meteorology and Climatology, MeteoSwiss, Zurich, Switzerland

References

S.J. Mason and A.P. Weigel, 2009. A generic verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

See Also

afc

Examples

```
data(cnrm.nino34.cc)
obsv = cnrm.nino34.cc$obsv
fcst = cnrm.nino34.cc$fcst
afc.cc(obsv,fcst)
```

---

afc.ce *2AFC For Continuous Observations And Ensemble Forecasts*

Description

Routine to calculate the Generalized Discrimination Score (aka Two-Alternatives Forced Choice Score 2AFC) for the situation of continuous observations and ensemble forecasts

Usage

```
afc.ce(obsv, fcst, na.rm = FALSE)
```

Arguments

obsv	vector with real-valued observations
fcst	two-dimensional array with ensemble forecasts; dim(fcst)[1] = length(obsv); dim(fcst)[2] = ensemble size
na.rm	logical; if TRUE pairs where obsv or fcst is NA are removed before scoring. Default FALSE returns NA if any input contains NA.

Details

This routine applies Eq.24 of Mason and Weigel (2009) to calculate the 2AFC.

Value

p.afc	Value of Generalized Discrimination (2AFC) Score

Author(s)

Andreas Weigel, Federal Office of Meteorology and Climatology, MeteoSwiss, Zurich, Switzerland

References

S.J. Mason and A.P. Weigel, 2009. A generic verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

See Also

afc

Examples

```
data(cnrm.nino34.ce)
obsv = cnrm.nino34.ce$obsv
fcst = cnrm.nino34.ce$fcst
afc.ce(obsv,fcst)
```

---

afc.dc *2AFC For Dichotomous Observations And Continuous Forecasts*

Description

Routine to calculate the Generalized Discrimination Score (aka Two-Alternatives Forced Choice Score 2AFC) for the situation of dichotomous observations and continuous forecasts

Usage

```
afc.dc(obsv, fcst, na.rm = FALSE)
```

Arguments

obsv	vector with dichotomous observations (values in {0,1})
fcst	vector of same length as *obsv* with real-valued forecasts
na.rm	logical; if TRUE pairs where obsv or fcst is NA are removed before scoring. Default FALSE returns NA if any input contains NA.

Details

This routine applies Eq.4 of Mason and Weigel (2009) to calculate the 2AFC.

Value

p.afc	Value of Generalized Discrimination (2AFC) Score

Author(s)

Andreas Weigel, Federal Office of Meteorology and Climatology, MeteoSwiss, Zurich, Switzerland

References

S.J. Mason and A.P. Weigel, 2009. A generic verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

See Also

afc

Examples

```
data(cnrm.nino34.dc)
obsv = cnrm.nino34.dc$obsv
fcst = cnrm.nino34.dc$fcst
afc.dc(obsv,fcst)
```

---

afc.dd *2AFC For Dichotomous Observations And Dichotomous Forecasts*

Description

Routine to calculate the Generalized Discrimination Score (aka Two-Alternatives Forced Choice Score 2AFC) for the situation of dichotomous observations and dichotomous forecasts

Usage

```
afc.dd(obsv, fcst, na.rm = FALSE)
```

Arguments

obsv	vector with dichotomous observations (values in {0,1})
fcst	vector of same length as *obsv* with dichotomous forecasts (values in {0,1})
na.rm	logical; if TRUE pairs where obsv or fcst is NA are removed before scoring. Default FALSE returns NA if any input contains NA.

Details

This routine applies Eq.2 of Mason and Weigel (2009) to calculate the 2AFC.

Value

p.afc	Value of Generalized Discrimination (2AFC) Score

Author(s)

Andreas Weigel, Federal Office of Meteorology and Climatology, MeteoSwiss, Zurich, Switzerland

References

S.J. Mason and A.P. Weigel, 2009. A generic verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

See Also

afc

Examples

```
data(cnrm.nino34.dd)
obsv = cnrm.nino34.dd$obsv
fcst = cnrm.nino34.dd$fcst
afc.dd(obsv,fcst)
```

---

afc.de *2AFC For Dichotomous Observations And Ensemble Forecasts*

Description

Routine to calculate the Generalized Discrimination Score (aka Two-Alternatives Forced Choice Score 2AFC) for the situation of dichotomous observations and ensemble forecasts

Usage

```
afc.de(obsv, fcst, na.rm = FALSE)
```

Arguments

obsv	vector with dichotomous observations (values in {0,1})
fcst	two-dimensional array with ensemble forecasts; dim(fcst)[1] = length(obsv); dim(fcst)[2] = ensemble size
na.rm	logical; if TRUE pairs where obsv or fcst is NA are removed before scoring. Default FALSE returns NA if any input contains NA.

Details

This routine first ranks the ensemble forecasts (see rank.ensembles) and then calculates the 2AFC-score with Eq.2 of Mason and Weigel (2009).

Value

p.afc	Value of Generalized Discrimination (2AFC) Score

Author(s)

Andreas Weigel, Federal Office of Meteorology and Climatology, MeteoSwiss, Zurich, Switzerland

References

S.J. Mason and A.P. Weigel, 2009. A generic verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

See Also

afc rank.ensembles

Examples

```
data(cnrm.nino34.de)
obsv = cnrm.nino34.de$obsv
fcst = cnrm.nino34.de$fcst
afc.de(obsv,fcst)
```

---

afc.dm *2AFC For Dichotomous Observations And Ordinal Polychotomous Forecasts*

Description

Routine to calculate the Generalized Discrimination Score (aka Two-Alternatives Forced Choice Score 2AFC) for the situation of dichotomous observations and (ordinal) polychotomous forecasts

Usage

```
afc.dm(obsv, fcst, mf = 3, na.rm = FALSE)
```

Arguments

obsv	vector with dichotomous observations (values in {0,1})
fcst	vector of same length as *obsv* with polychotomous forecasts (values in {1,..,m})
mf	number of forecast categories (default = 3)
na.rm	logical; if TRUE pairs where obsv or fcst is NA are removed before scoring. Default FALSE returns NA if any input contains NA.

Details

This routine applies Eq.5 of in Mason and Weigel (2009) to calculate the 2AFC.

Value

p.afc	Value of Generalized Discrimination (2AFC) Score

Author(s)

Andreas Weigel, Federal Office of Meteorology and Climatology, MeteoSwiss, Zurich, Switzerland

References

S.J. Mason and A.P. Weigel, 2009. A generic verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

See Also

afc

Examples

```
data(cnrm.nino34.dm)
obsv = cnrm.nino34.dm$obsv
fcst = cnrm.nino34.dm$fcst
afc.dm(obsv,fcst,4)
```

---

afc.dp *2AFC For Dichotomous Observations And Probabilistic Forecasts*

Description

Routine to calculate the Generalized Discrimination Score (aka Two-Alternatives Forced Choice Score 2AFC) for the situation of dichotomous observations and probabilistic forecasts

Usage

```
afc.dp(obsv, fcst, na.rm = FALSE)
```

Arguments

obsv	vector with dichotomous observations (values in {0,1})
fcst	vector of same length as *obsv* with forecast probabilities for the event to happen
na.rm	logical; if TRUE pairs where obsv or fcst is NA are removed before scoring. Default FALSE returns NA if any input contains NA.

Details

This routine applies Eq.3 of Mason and Weigel (2009) to calculate the 2AFC.

Value

p.afc	Value of Generalized Discrimination (2AFC) Score

Author(s)

Andreas Weigel, Federal Office of Meteorology and Climatology, MeteoSwiss, Zurich, Switzerland

References

S.J. Mason and A.P. Weigel, 2009. A generic verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

See Also

afc

Examples

```
data(cnrm.nino34.dp)
obsv = cnrm.nino34.dp$obsv
fcst = cnrm.nino34.dp$fcst
afc.dp(obsv,fcst)
```

---

afc.mc *2AFC For Ordinal Polychotomous Observations And Continuous Forecasts*

Description

Routine to calculate the Generalized Discrimination Score (aka Two-Alternatives Forced Choice Score 2AFC) for the situation of polychotomous observations (ordinal) and continuous forecasts

Usage

```
afc.mc(obsv, fcst, m = 3, na.rm = FALSE)
```

Arguments

obsv	vector with polychotomous observations (values in {1,..,m})
fcst	vector of same length as *obsv* with real-valued forecasts
m	number of observation categories (default = 3)
na.rm	logical; if TRUE pairs where obsv or fcst is NA are removed before scoring. Default FALSE returns NA if any input contains NA.

Details

This routine applies Eq.18 of Mason and Weigel (2009) to calculate the 2AFC.

Value

p.afc	Value of Generalized Discrimination (2AFC) Score

Author(s)

Andreas Weigel, Federal Office of Meteorology and Climatology, MeteoSwiss, Zurich, Switzerland

References

S.J. Mason and A.P. Weigel, 2009. A generic verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

See Also

afc

Examples

```
data(cnrm.nino34.mc)
obsv = cnrm.nino34.mc$obsv
fcst = cnrm.nino34.mc$fcst
afc.mc(obsv,fcst,4)
```

---

afc.me *2AFC For Ordinal Polychotomous Observations And Ensemble Forecasts*

Description

Routine to calculate the Generalized Discrimination Score (aka Two-Alternatives Forced Choice Score 2AFC) for the situation of polychotomous observations (ordinal) and ensemble forecasts

Usage

```
afc.me(obsv, fcst, m = 3, na.rm = FALSE)
```

Arguments

obsv	vector with polychotomous observations (values in {1,..,m})
fcst	two-dimensional array with ensemble forecasts; dim(fcst)[1] = length(obsv); dim(fcst)[2] = ensemble size
m	number of observation categories (default = 3)
na.rm	logical; if TRUE pairs where obsv or fcst is NA are removed before scoring. Default FALSE returns NA if any input contains NA.

Details

This routine first ranks the ensemble forecasts (see rank.ensembles) and then calculates the 2AFC-score with Eq.18 of Mason and Weigel (2009).

Value

p.afc	Value of Generalized Discrimination (2AFC) Score

Author(s)

Andreas Weigel, Federal Office of Meteorology and Climatology, MeteoSwiss, Zurich, Switzerland

References

S.J. Mason and A.P. Weigel, 2009. A generic verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

See Also

afc rank.ensembles

Examples

```
data(cnrm.nino34.me)
obsv = cnrm.nino34.me$obsv
fcst = cnrm.nino34.me$fcst
afc.me(obsv,fcst,4)
```

---

afc.mm *2AFC For Ordinal Polychotomous Observations And Ordinal Polychotomous Forecasts*

Description

Routine to calculate the Generalized Discrimination Score (aka Two-Alternatives Forced Choice Score 2AFC) for the situation of polychotomous observations (ordinal) and polychotomous forecasts (ordinal)

Usage

```
afc.mm(obsv, fcst, mv = 3, mf = 3, na.rm = FALSE)
```

Arguments

obsv	vector with polychotomous observations (values in {1,..,mv})
fcst	vector of same length as *obsv* with polychotomous forecasts (values in {1,..,mf})
mv	number of observation categories (default = 3)
mf	number of forecast categories (default = 3)
na.rm	logical; if TRUE pairs where obsv or fcst is NA are removed before scoring. Default FALSE returns NA if any input contains NA.

Details

This routine applies Eq.14 of Mason and Weigel (2009) to calculate the 2AFC.

Value

p.afc	Value of Generalized Discrimination (2AFC) Score

Author(s)

Andreas Weigel, Federal Office of Meteorology and Climatology, MeteoSwiss, Zurich, Switzerland

References

S.J. Mason and A.P. Weigel, 2009. A generic verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

See Also

afc

Examples

```
data(cnrm.nino34.mm)
obsv = cnrm.nino34.mm$obsv
fcst = cnrm.nino34.mm$fcst
afc.mm(obsv,fcst,4,4)
```

---

afc.mp *2AFC For Ordinal Polychotomous Observations And Probabilistic Forecasts*

Description

Routine to calculate the Generalized Discrimination Score (aka Two-Alternatives Forced Choice Score 2AFC) for the situation of polychotomous observations (ordinal) and discrete probabilistic forecasts

Usage

```
afc.mp(obsv, fcst, m = 3, na.rm = FALSE)
```

Arguments

obsv	vector with polychotomous observations (values in {1,..,m})
fcst	two-dimensional array with forecast probabilities for the m categories; dim(fcst)[1] = length(obsv); dim(fcst)[2] = m
m	number of observation categories (default = 3)
na.rm	logical; if TRUE pairs where obsv or fcst is NA are removed before scoring. Default FALSE returns NA if any input contains NA.

Details

This routine applies Eq.16 of Mason and Weigel (2009) to calculate the 2AFC.

Value

p.afc	Value of Generalized Discrimination (2AFC) Score

Author(s)

Andreas Weigel, Federal Office of Meteorology and Climatology, MeteoSwiss, Zurich, Switzerland

References

S.J. Mason and A.P. Weigel, 2009. A generic verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

See Also

afc

Examples

```
data(cnrm.nino34.mp)
obsv = cnrm.nino34.mp$obsv
fcst = cnrm.nino34.mp$fcst
afc.mp(obsv,fcst,4)
```

`afc.nn` *2AFC For Nominal Polychotomous Observations And Nominal Polychotomous Forecasts*

Description

Routine to calculate the Generalized Discrimination Score (aka Two-Alternatives Forced Choice Score 2AFC) for the situation of nominal polychotomous observations and polychotomous forecasts (nominal)

Usage

```
afc.nn(obsv, fcst, m = 3, na.rm = FALSE)
```

Arguments

`obsv`	vector with polychotomous observations (values in {1,..,m})
`fcst`	vector of same length as *obsv* with polychotomous forecasts (values in {1,..,m})
`m`	number of observation and forecast categories (default = 3)
`na.rm`	logical; if `TRUE` pairs where `obsv` or `fcst` is `NA` are removed before scoring. Default `FALSE` returns `NA` if any input contains `NA`.

Details

This routine applies Eq.15 of Mason and Weigel (2009) to calculate the 2AFC.

Value

`p.afc`	Value of Generalized Discrimination (2AFC) Score

Author(s)

Andreas Weigel, Federal Office of Meteorology and Climatology, MeteoSwiss, Zurich, Switzerland

References

S.J. Mason and A.P. Weigel, 2009. A generic verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

See Also

`afc`

Examples

```
data(cnrm.nino34.mm)
obsv = cnrm.nino34.mm$obsv
fcst = cnrm.nino34.mm$fcst
afc.nn(obsv,fcst,4)
```

`afc.np` *2AFC For Nominal Polychotomous Observations And Probabilistic Forecasts*

Description

Routine to calculate the Generalized Discrimination Score (aka Two-Alternatives Forced Choice Score 2AFC) for the situation of polychotomous (nominal) observations and discrete probabilistic forecasts

Usage

```
afc.np(obsv, fcst, m = 3, na.rm = FALSE)
```

Arguments

`obsv`	vector with polychotomous observations (values in {1,..,m})
`fcst`	two-dimensional array with forecast probabilities for the m categories; dim(fcst)[1] = length(obsv); dim(fcst)[2] = m
`m`	number of observation categories (default = 3)
`na.rm`	logical; if `TRUE` pairs where `obsv` or `fcst` is `NA` are removed before scoring. Default `FALSE` returns `NA` if any input contains `NA`.

Details

This routine applies Eq.17 of Mason and Weigel (2009) to calculate the 2AFC.

Value

`p.afc`	Value of Generalized Discrimination (2AFC) Score

Author(s)

Andreas Weigel, Federal Office of Meteorology and Climatology, MeteoSwiss, Zurich, Switzerland

References

S.J. Mason and A.P. Weigel, 2009. A generic verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

See Also

`afc`

Examples

```
data(cnrm.nino34.mp)
obsv = cnrm.nino34.mp$obsv
fcst = cnrm.nino34.mp$fcst
afc.np(obsv,fcst,4)
```

---

cnrm.nino34.cc *Example Data of Continuous Observations and Continuous Forecasts*

Description

Continuous observations (obsv) and continuous forecasts (fcst) of the Nino-3.4 index for January 1961-2000. The forecast data stem from model runs initialized using data for the preceding August 1960-1999.

Format

A data frame with 40 rows and 3 columns:

years integer, year of observation (1961-2000)

obsv numeric, continuous observations of Nino-3.4 index (degrees C)

fcst numeric, continuous forecasts of Nino-3.4 index (degrees C)

Details

The forecast data are from the coupled ocean-atmosphere model of the Centre National de Recherches Meteorologiques (CNRM) of Meteo France and were generated as part of the "Development of a European Multimodel Ensemble System for Seasonal to Interannual Prediction (DEMETER)" project (Palmer et al. 2004). Note that also the examples presented in the 2AFC paper by Mason and Weigel (2009) are based on these data.

References

Palmer, T.N. and Coauthors, 2004: Development of a European ensemble system for seasonal to inter-annual prediction (DEMETER). Bull. Amer. Meteor. Soc., 85, 853-872.
Mason, S.J. and A.P. Weigel, 2009: A generic forecast verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

cnrm.nino34.ce *Example Data of Continuous Observations and Ensemble Forecasts*

Description

Continuous observations (obsv) and 9-member ensemble forecasts (fcst) of the Nino-3.4 index for January 1961-2000. The forecast data stem from model runs initialized using data for the preceding August 1960-1999.

Format

A data frame with 40 rows and 3 columns:

years integer, year of observation (1961-2000)

obsv numeric, continuous observations of Nino-3.4 index (degrees C)

fcst numeric matrix [40 x 9], 9-member ensemble forecasts of Nino-3.4 index (degrees C)

Details

The forecast data are from the coupled ocean-atmosphere model of the Centre National de Recherches Meteorologiques (CNRM) of Meteo France and were generated as part of the "Development of a European Multimodel Ensemble System for Seasonal to Interannual Prediction (DEMETER)" project (Palmer et al. 2004). Note that also the examples presented in the 2AFC paper by Mason and Weigel (2009) are based on these data.

References

Palmer, T.N. and Coauthors, 2004: Development of a European ensemble system for seasonal to inter-annual prediction (DEMETER). Bull. Amer. Meteor. Soc., 85, 853-872.
Mason, S.J. and A.P. Weigel, 2009: A generic forecast verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

cnrm.nino34.dc *Example Data of Dichotomous Observations and Continuous Forecasts*

Description

Dichotomous observations (obsv) and continuous forecasts (fcst) of the Nino-3.4 index for January 1961-2000. The forecast data stem from model runs initialized using data for the preceding August 1960-1999. Definition of an "event" in the observations: obsv >= 27 C.

Format

A data frame with 40 rows and 3 columns:

years integer, year of observation (1961-2000)

obsv integer, dichotomous observations (0/1; event defined as Nino-3.4 index >= 27 C)

fcst numeric, continuous forecasts of Nino-3.4 index (degrees C)

Details

The forecast data are from the coupled ocean-atmosphere model of the Centre National de Recherches Meteorologiques (CNRM) of Meteo France and were generated as part of the "Development of a European Multimodel Ensemble System for Seasonal to Interannual Prediction (DEMETER)" project (Palmer et al. 2004). Note that also the examples presented in the 2AFC paper by Mason and Weigel (2009) are based on these data.

References

Palmer, T.N. and Coauthors, 2004: Development of a European ensemble system for seasonal to inter-annual prediction (DEMETER). Bull. Amer. Meteor. Soc., 85, 853-872.
Mason, S.J. and A.P. Weigel, 2009: A generic forecast verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

`cnrm.nino34.dd` *Example Data of Dichotomous Observations and Dichotomous Forecasts*

Description

Dichotomous observations (obsv) and dichotomous forecasts (fcst) of the Nino-3.4 index for January 1961-2000. The forecast data stem from model runs initialized using data for the preceding August 1960-1999. Definition of an "event" in the observations respectively forecasts: obsv/fcst >= 27 C.

Format

A data frame with 40 rows and 3 columns:

years integer, year of observation (1961-2000)

obsv integer, dichotomous observations (0/1; event defined as Nino-3.4 index >= 27 C)

fcst integer, dichotomous forecasts (0/1; event defined as Nino-3.4 index >= 27 C)

Details

The forecast data are from the coupled ocean-atmosphere model of the Centre National de Recherches Meteorologiques (CNRM) of Meteo France and were generated as part of the "Development of a European Multimodel Ensemble System for Seasonal to Interannual Prediction (DEMETER)" project (Palmer et al. 2004). Note that also the examples presented in the 2AFC paper by Mason and Weigel (2009) are based on these data.

References

Palmer, T.N. and Coauthors, 2004: Development of a European ensemble system for seasonal to inter-annual prediction (DEMETER). Bull. Amer. Meteor. Soc., 85, 853-872.
Mason, S.J. and A.P. Weigel, 2009: A generic forecast verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

`cnrm.nino34.de` *Example Data of Dichotomous Observations and Ensemble Forecasts*

Description

Dichotomous observations (obsv) and 9-member ensemble forecasts (fcst) of the Nino-3.4 index for January 1961-2000. The forecast data stem from model runs initialized using data for the preceding August 1960-1999. Definition of an "event" in the observations: obsv >= 27 C.

Format

A data frame with 40 rows and 3 columns:

years integer, year of observation (1961-2000)

obsv integer, dichotomous observations (0/1; event defined as Nino-3.4 index >= 27 C)

fcst numeric matrix [40 x 9], 9-member ensemble forecasts of Nino-3.4 index (degrees C)

Details

The forecast data are from the coupled ocean-atmosphere model of the Centre National de Recherches Meteorologiques (CNRM) of Meteo France and were generated as part of the "Development of a European Multimodel Ensemble System for Seasonal to Interannual Prediction (DEMETER)" project (Palmer et al. 2004). Note that also the examples presented in the 2AFC paper by Mason and Weigel (2009) are based on these data.

References

Palmer, T.N. and Coauthors, 2004: Development of a European ensemble system for seasonal to inter-annual prediction (DEMETER). Bull. Amer. Meteor. Soc., 85, 853-872.
Mason, S.J. and A.P. Weigel, 2009: A generic forecast verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

cnrm.nino34.dm — *Example Data of Dichotomous Observations and Polychotomous Forecasts*

Description

Dichotomous observations (obsv) and polychotomous forecasts with four categories (fcst) of the Nino-3.4 index for January 1961-2000. The forecast data stem from model runs initialized using data for the preceding August 1960-1999. Definition of an "event" in the observations: obsv >= 27 C. Definition of the four forecast "categories": (1) fcst < 26 C; (2) fcst in [26 C,27 C[; (3) fcst in [27 C,28 C[; (4) fcst >= 28 C.

Format

A data frame with 40 rows and 3 columns:

years integer, year of observation (1961-2000)

obsv integer, dichotomous observations (0/1; event defined as Nino-3.4 index >= 27 C)

fcst integer, polychotomous forecasts (categories 1-4; (1) < 26 C; (2) 26-27 C; (3) 27-28 C; (4) >= 28 C)

Details

The forecast data are from the coupled ocean-atmosphere model of the Centre National de Recherches Meteorologiques (CNRM) of Meteo France and were generated as part of the "Development of a European Multimodel Ensemble System for Seasonal to Interannual Prediction (DEMETER)" project (Palmer et al. 2004). Note that also the examples presented in the 2AFC paper by Mason and Weigel (2009) are based on these data.

References

Palmer, T.N. and Coauthors, 2004: Development of a European ensemble system for seasonal to inter-annual prediction (DEMETER). Bull. Amer. Meteor. Soc., 85, 853-872.
Mason, S.J. and A.P. Weigel, 2009: A generic forecast verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

cnrm.nino34.dp — *Example Data of Dichotomous Observations and Probabilistic Forecasts*

Description

Dichotomous observations (obsv) and discrete probabilistic forecasts (fcst) of the Nino-3.4 index for January 1961-2000. The forecast data stem from model runs initialized using data for the preceding August 1960-1999. Definition of an "event" in the observations: obsv >= 27 C. The probabilistic forecasts have been estimated by taking the fraction of ensemble members predicting the event.

Format

A data frame with 40 rows and 3 columns:

years integer, year of observation (1961-2000)

obsv integer, dichotomous observations (0/1; event defined as Nino-3.4 index >= 27 C)

fcst numeric, probabilistic forecasts (fraction of ensemble members predicting the event, values in [0, 1])

Details

The forecast data are from the coupled ocean-atmosphere model of the Centre National de Recherches Meteorologiques (CNRM) of Meteo France and were generated as part of the "Development of a European Multimodel Ensemble System for Seasonal to Interannual Prediction (DEMETER)" project (Palmer et al. 2004). Note that also the examples presented in the 2AFC paper by Mason and Weigel (2009) are based on these data.

References

Palmer, T.N. and Coauthors, 2004: Development of a European ensemble system for seasonal to inter-annual prediction (DEMETER). Bull. Amer. Meteor. Soc., 85, 853-872.
Mason, S.J. and A.P. Weigel, 2009: A generic forecast verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

`cnrm.nino34.mc` *Example Data of Polychotomous Observations and Continuous Forecasts*

Description

Polychotomous observations with four categories (obsv) and continuous forecasts (fcst) of the Nino-3.4 index for January 1961-2000. The forecast data stem from model runs initialized using data for the preceding August 1960-1999. Definition of the four observation "categories": (1) obsv < 26 C; (2) obsv in [26 C,27 C[; (3) obsv in [27 C,28 C[; (4) obsv >= 28 C.

Format

A data frame with 40 rows and 3 columns:

years integer, year of observation (1961-2000)

obsv integer, polychotomous observations (categories 1-4; (1) < 26 C; (2) 26-27 C; (3) 27-28 C; (4) >= 28 C)

fcst numeric, continuous forecasts of Nino-3.4 index (degrees C)

Details

The forecast data are from the coupled ocean-atmosphere model of the Centre National de Recherches Meteorologiques (CNRM) of Meteo France and were generated as part of the "Development of a European Multimodel Ensemble System for Seasonal to Interannual Prediction (DEMETER)" project (Palmer et al. 2004). Note that also the examples presented in the 2AFC paper by Mason and Weigel (2009) are based on these data.

References

Palmer, T.N. and Coauthors, 2004: Development of a European ensemble system for seasonal to inter-annual prediction (DEMETER). Bull. Amer. Meteor. Soc., 85, 853-872.
Mason, S.J. and A.P. Weigel, 2009: A generic forecast verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

`cnrm.nino34.me` *Example Data of Polychotomous Observations and Ensembles Forecasts*

Description

Polychotomous observations with four categories (obsv) and 9-member ensemble forecasts (fcst) of the Nino-3.4 index for January 1961-2000. The forecast data stem from model runs initialized using data for the preceding August 1960-1999. Definition of the four observation "categories": (1) obsv < 26 C; (2) obsv in [26 C,27 C[; (3) obsv in [27 C,28 C[; (4) obsv >= 28 C.

Format

A data frame with 40 rows and 3 columns:

years integer, year of observation (1961-2000)

obsv integer, polychotomous observations (categories 1-4; (1) < 26 C; (2) 26-27 C; (3) 27-28 C; (4) >= 28 C)

fcst numeric matrix [40 x 9], 9-member ensemble forecasts of Nino-3.4 index (degrees C)

Details

The forecast data are from the coupled ocean-atmosphere model of the Centre National de Recherches Meteorologiques (CNRM) of Meteo France and were generated as part of the "Development of a European Multimodel Ensemble System for Seasonal to Interannual Prediction (DEMETER)" project (Palmer et al. 2004). Note that also the examples presented in the 2AFC paper by Mason and Weigel (2009) are based on these data.

References

Palmer, T.N. and Coauthors, 2004: Development of a European ensemble system for seasonal to inter-annual prediction (DEMETER). Bull. Amer. Meteor. Soc., 85, 853-872.
Mason, S.J. and A.P. Weigel, 2009: A generic forecast verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

cnrm.nino34.mm *Example Data of Polychotomous Observations and Polychotomous Forecasts*

Description

Polychotomous observations with four categories (obsv) and polychotomous forecasts with four categories (fcst) of the Nino-3.4 index for January 1961-2000. The forecast data stem from model runs initialized using data for the preceding August 1960-1999. Definition of the four observation respectively forecast "categories": (1) obsv/fcst < 26 C; (2) obsv/fcst in [26 C,27 C[; (3) obsv/fcst in [27 C,28 C[; (4) obsv >= 28 C.

Format

A data frame with 40 rows and 3 columns:

years integer, year of observation (1961-2000)

obsv integer, polychotomous observations (categories 1-4; (1) < 26 C; (2) 26-27 C; (3) 27-28 C; (4) >= 28 C)

fcst integer, polychotomous forecasts (categories 1-4; (1) < 26 C; (2) 26-27 C; (3) 27-28 C; (4) >= 28 C)

Details

The forecast data are from the coupled ocean-atmosphere model of the Centre National de Recherches Meteorologiques (CNRM) of Meteo France and were generated as part of the "Development of a European Multimodel Ensemble System for Seasonal to Interannual Prediction (DEMETER)" project (Palmer et al. 2004). Note that also the examples presented in the 2AFC paper by Mason and Weigel (2009) are based on these data.

References

Palmer, T.N. and Coauthors, 2004: Development of a European ensemble system for seasonal to inter-annual prediction (DEMETER). Bull. Amer. Meteor. Soc., 85, 853-872.
Mason, S.J. and A.P. Weigel, 2009: A generic forecast verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

cnrm.nino34.mp *Example Data of Polychotomous Observations and Probabilistic Forecasts*

Description

Polychotomous observations with four categories (obsv) and discrete probabilistic forecasts (fcst) of the Nino-3.4 index for January 1961-2000. The forecast data stem from model runs initialized using data for the preceding August 1960-1999. Definition of the four observation "categories": (1) obsv < 26 C; (2) obsv in [26 C,27 C[; (3) obsv in [27 C,28 C[; (4) obsv >= 28 C. The probabilistic forecasts have been estimated by taking the fraction of ensemble members falling into each of the four categories.

Format

A data frame with 40 rows and 3 columns:

years integer, year of observation (1961-2000)

obsv integer, polychotomous observations (categories 1-4; (1) < 26 C; (2) 26-27 C; (3) 27-28 C; (4) >= 28 C)

fcst numeric matrix [40 x 4], probabilistic forecasts (fraction of ensemble members in each of the 4 categories)

Details

The forecast data are from the coupled ocean-atmosphere model of the Centre National de Recherches Meteorologiques (CNRM) of Meteo France and were generated as part of the "Development of a European Multimodel Ensemble System for Seasonal to Interannual Prediction (DEMETER)" project (Palmer et al. 2004). Note that also the examples presented in the 2AFC paper by Mason and Weigel (2009) are based on these data.

References

Palmer, T.N. and Coauthors, 2004: Development of a European ensemble system for seasonal to inter-annual prediction (DEMETER). Bull. Amer. Meteor. Soc., 85, 853-872.
Mason, S.J. and A.P. Weigel, 2009: A generic forecast verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

`rank.ensembles` *Rank Ensembles*

Description

Routine to rank a set of given ensemble forecasts according to their "value"

Usage

```
rank.ensembles(fcst)
```

Arguments

`fcst`	two-dimensional array with ensemble forecasts; dim(fcst)[1] = number of ensemble forecasts; dim(fcst)[2] = number of ensemble members

Details

This routine ranks a set of ensemble forecasts according to their "value". The higher the "value" of an ensemble forecasts, the higher the rank. The following principle is applied: Assume two ensembles A and B are to be ranked. Without loss of generality, we define A>B if the probability of a random ensemble member of A being larger than a random ensemble member of B exceeds 0.5. This probability is calculated by a 2AFC-like approach based on Eq. 8 of Mason and Weigel (2009). By pairwise comparison of all ensembles, the final ranking is obtained.

Value

`ranks`	vector with the ranks of the ensemble forecasts

Author(s)

Andreas Weigel, Federal Office of Meteorology and Climatology, MeteoSwiss, Zurich, Switzerland

References

S.J. Mason and A.P. Weigel, 2009. A generic verification framework for administrative purposes. Mon. Wea. Rev., 137, 331-349

See Also

`afc.de` `afc.me` `afc.ce` `afc`

Examples

```
data(cnrm.nino34.ce)
fcst = cnrm.nino34.ce$fcst
rank.ensembles(fcst)
```

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