Package ‘ternvis’

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Description

A suite of functions for visualising ternary probabilistic forecasts.

Details

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</tr>
<tr>
<td>Version:</td>
<td>1.0</td>
</tr>
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<td>2012-03-29</td>
</tr>
<tr>
<td>License:</td>
<td>GPL-2</td>
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</tbody>
</table>

Colours can be assigned to ternary probabilistic forecasts using `tcolour`. These colours can be used to produce forecast maps as in the example function `tmap`. A set of ternary forecasts `p` can be compared with subsequent ternary observations `o` using the function `tverify`. `plotNtverify` then displays this information in a Ternary Reliability Diagram. Calibration is performed using `tgetcal` and `tcalibrate`.

Author(s)

Tim Jupp
Maintainer: Tim Jupp <t.e.jupp@exeter.ac.uk>

References


http://rsta.royalsocietypublishing.org/content/370/1962/1100.full
http://arxiv.org/abs/1103.1303

See Also

Some concepts adapted from those in package `vcd`.

Examples

data(foot)
# see the distribution of forecasts
```r
foot = read.table("football-odds.txt", header=TRUE) # read betting odds data

# plot distributions of forecasts
tplot(foot$p, main="Bookmaker forecasts of football matches", dimnames=c("Home Win","Draw","Away Win"))

# see how well forecasts compare with results
# create object of class tverify
foot.verify <- tverify(p=foot$p, o=foot$o)

# plot ternary reliability diagram
dev.new()
plot(foot.verify, thresh=3)

# get a (linear) calibration of these data
# create an object of class tverify
foot.calib <- tgetcal(foot.verify)

# plot ternary reliability diagram of calibrated
dev.new()
plot(foot.calib, thresh=3)

data(rain)
tmap(rain, yr=17, palette=TRUE, circles=FALSE, fac=10)
```

---

**Description**

A collection of bookmakers’ football odds (for home win/draw/away win, expressed as ternary probabilistic forecasts) and subsequent results. The data cover several years of English league games.

**Usage**

```r
data(foot)
```

**Format**

The quoted odds, transformed to probabilities, are in `foot$p` (a 3-column matrix). The corresponding results of the games are in `foot$o` (a 3-column matrix).

**Source**

Data taken from www.football-data.co.uk.

**Examples**

```r
data(foot)
# see the distribution of forecasts
tplot(foot$p, main="Bookmaker forecasts of football matches", dimnames=c("Home Win","Draw","Away Win"))
```
# see how well forecasts compare with results
# create object of class tverify
foot.verify <- tverify(p=foot$p, o=foot$o)

# plot ternary reliability diagram
dev.new()
plot(foot.verify, thresh=3)

# get a (linear) calibration of these data
# create an object of class tverify
foot.calib <- tgetcal(foot.verify)

# plot ternary reliability diagram of calibrated forecasts
dev.new()
plot(foot.calib, thresh=3)

---

**rain**  
*Ternary precipitation forecast data set*

**Description**

An array of monthly seasonal precipitation forecasts and observations over South America, covering 25 years.

**Usage**

data(rain)

**Format**

A list containing 7 objects
- `rain$lats`: a vector of 35 latitudes
- `rain$lons`: a vector of 27 longitudes
- `rain$obs`: array of ternary observations
- `rain$preds`: array of ternary forecast probabilities
- `rain$rel`: array of reliabilities
- `rain$res`: array of resolutions
- `rain$q`: array of climatologies

**Source**

Data from Caio Coelho at [http://eurobrisa.cptec.inpe.br](http://eurobrisa.cptec.inpe.br).
Examples

data(rain)

ilon <- 5  # pick a longitude
ilat <- 6  # pick a latitude
iyr  <- 17 # pick a year (in the range 1:25)

rain$lons[ilon]  # the longitude
rain$lats[ilat]  # the latitude
rain$pred[ilon,ilat,iyr,] # the ternary forecast
rain$obs[ilon,ilat,iyr,] # the ternary observation

tcalibrate

Calibration of ternary forecasts

Description

Function to apply a calibration to a matrix of ternary forecasts.

Usage

tcalibrate(tv, p)

Arguments

 tv An object of class tverify, for example produced by tgetcal.
 p An n-by-3 matrix of ternary forecasts which will be calibrated according to the calibration function embedded in dat.

Value

An n-by-3 array of calibrated ternary forecasts.

Author(s)

Tim Jupp

References

http://rsta.royalsocietypublishing.org/content/370/1962/1100.full
http://arxiv.org/abs/1103.1303
See Also
tverify, tplot, tgetcal

Examples

# get football betting data
data(foot)

# get verification info for these data
tv <- tverify(p=foot$p, o=foot$o)

# get a linear calibration based on verification info
tc <- tgetcal(tv)

# consider an uncalibrated forecast p
p <- cbind(0, 0, 1)

# see where p is mapped by this calibration
pcal <- tcalibrate(tc, cbind(0, 0, 1))

# plot the uncalibrated forecast
tplot(p)
# plot the calibrated forecast
tplot(pcal, col="blue", newpage=FALSE, bg="transparent")

tcolour Assign a colour to a ternary forecast

description

Function to assign a colour to a ternary forecast p, given a ternary climatology q.

Usage
tcolour(p = cbind(1, 1, 1)/3, q = cbind(1, 1, 1)/3, m = 0.7,
flip = FALSE, dich = "none", theta0 = 0)

Arguments

p An n-by-3 matrix of ternary forecasts.
q A 1-by-3 matrix containing the climatology.
m Exponent controlling rate of colour saturation.
flip Logical to transpose categories "B" and "A" in barycentric coordinates.
dich Option to render colours as they would appear to a dichromat. Default choice dich = "none" leaves colours unchanged. Choices dich = "deutan" and dich = "protan" show colours as they would appear to those with deutanopia or protanopia (see dichromat).
theta0 Angle (degrees) through which to rotate colour palette around climatology q in barycentric coordinates.
Value

A colour, of the format produced by `rgb`.

Author(s)

Tim Jupp

References


http://rsta.royalsocietypublishing.org/content/370/1962/1100.full
http://arxiv.org/abs/1103.1303

Examples

```r
p <- cbind(0.7,0.2,0.1)  # define a forecast
q <- cbind(1,1)/3        # define a climatology
pcol <- tcolour(p=q)     # assign a colour
pcol                     # print the colour code to terminal
plot(p, col=pcol)        # use this colour in a plot
```

`tgetcal`  

Get a linear or quadratic calibration of ternary forecast / observation data

Description

Function to obtain a best-fitting calibration to a set of ternary forecasts `p` and corresponding observations `o`.

Usage

`tgetcal(tv, quad = FALSE)`

Arguments

- `tv` An object of the `tverify` class (as produced by `tverify`).
- `quad` A logical describing which functional form to use for calibration. Linear calibration (`quad = FALSE`) is faster. Quadratic calibration (`quad = TRUE`) is more sophisticated but can be slow for large data sets.

Author(s)

Tim Jupp


References

http://rsta.royalsocietypublishing.org/content/370/1962/1100.full
http://arxiv.org/abs/1103.1303

See Also

tverify, tcalibrate

Examples

data(foot)
# see the distribution of forecasts
tplot(foot$p,main="Bookmaker forecasts of \n football matches",
       dimnames=c("Home Win","Draw","Away Win"))

# see how well forecasts compare with results
# create object of class tverify
foot.verify <- tverify(p=foot$p,o=foot$o)

# plot ternary reliability diagram
dev.new()
plot(foot.verify, thresh=3)

# get a (linear) calibration of these data
# create an object of class tverify
foot.calib <- tgetcal(foot.verify)

# plot ternary reliability diagram of calibrated forecasts
dev.new()
plot(foot.calib, thresh=3)


tgrid

Create a grid of points in barycentric coordinates

Description

Utility function to generate a grid of ternary forecasts equally spaced in barycentric coordinates.

Usage

tgrid(n)

Arguments

n An integer describing the number of ‘bins’ along each side of the barycentric triangle.
**tmap**

**Value**

An n-by-3 matrix of ternary forecasts.

**Author(s)**

Tim Jupp

**References**


http://rsta.royalsocietypublishing.org/content/370/1962/1100.full

http://arxiv.org/abs/1103.1303

**See Also**

tpplot

**Examples**

```r
tg <- tgrid(6) # make a grid of forecasts in the triangle
tg                  # print forecasts to the terminal
tplot(tg)          # plot forecasts
```

---

**tmap**

*Demonstration of how to make coloured maps of ternary forecasts*

**Description**

An example of how one might make forecast maps using tpalette.

**Usage**

`tmap(dat, iyr, circles = FALSE, fac = 10, theta0 = 0, dich = "none", m = 0.7, palette = TRUE, flip = FALSE)`

**Arguments**

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>dat</td>
<td>An array of forecasts in a suitable format. See <em>Example</em> code below</td>
</tr>
<tr>
<td>iyr</td>
<td>In this example, an integer in the range 1 to 25.</td>
</tr>
<tr>
<td>circles</td>
<td>circles = FALSE (the default) fills map with coloured polygons. circles = TRUE fills map with circles whose radii are dependent on verification information.</td>
</tr>
<tr>
<td>fac</td>
<td>Scaling factor for size of circles when circles = TRUE.</td>
</tr>
</tbody>
</table>
theta0 Angle to rotate colours on palette. See tcolour.
dich Optionally render colours as they would appear to a dichromat. See tcolour.
m Parameter controlling rate at which colours saturate in palette. See tcolour.

palette Logical. If palette = TRUE a colour palette is included.
flip Logical to choose whether to switch categories B and A. See tcolour.

Author(s)
Tim Jupp

References
http://rsta.royalsocietypublishing.org/content/370/1962/1100.full
http://arxiv.org/abs/1103.1303

Examples
data(rain)

tmap(rain, lyr=17, palette=TRUE, circles=FALSE, fac=10)

---

tpalette **Draw a palette of the colours assigned to ternary forecasts**

Description
Function to fill barycentric coordinates with a colour palette.

Usage
tpalette(q = cbind(1, 1, 1)/3, bars = TRUE, m = 0.7,
   flip = FALSE, lmain = FALSE, theta0 = 0,
   dich = "none", cex = 1, nhist = 12)

Arguments
q A 1-by-3 matrix containing a climatology.
bars Logical. If "FALSE" a simple colour palette is produced. If "TRUE" barplots representing the forecasts are overlain.
m Parameter controlling the rate at which colours saturate towards the corners of the triangle.
flip Logical to transpose categories "B" and "A" in barycentric coordinates.
lmain Logical. If "TRUE" text is overlaid.
theta0 Angle (degrees) through which to rotate colour palette around climatology q in barycentric coordinates.
dich Option to render colours as they would appear to a dichromat. Default choice dich = "none" leaves colours unchanged. Choices dich = "deutan" and dich = "protan" show colours as they would appear to those with deutanopia or protanopia (see dichromat).
cex Factor for expanding the size of the dots when bars is "FALSE".
nhist Number of barplots along each side of the triangle when bars is "TRUE".

Author(s)
Tim Jupp

References
http://rsta.royalsocietypublishing.org/content/370/1962/1100.full
http://arxiv.org/abs/1103.1303

See Also
tmap

Examples
dev.new()
tpalette(bars=FALSE) # standard palette

dev.new()
tpalette(bars=TRUE) # palette with histograms overlaid

\begin{verbatim}
tplot \end{verbatim}

\begin{verbatim}
Plot ternary forecasts in barycentric coordinates.
\end{verbatim}

Description
This function is almost exactly the same as the ternaryplot function in package vcd (on which it is based) except that the ordering of the vertices has been change to bottom left/top/bottom right, and the code has been extended work for an arbitrary scoring matrix L.
Usage

tplot(x = cbind(1, 1, 1)/3, L = diag(c(1, 1, 1))/sqrt(2),
  scale = 1, dimnames = NULL,
  dimnames_position = c("corner", "none"),
  dimnames_color = "black", id = NULL, id_color = "black",
  coordinates = FALSE, grid = TRUE, grid_color = "gray",
  labels = c("inside", "outside", "none"),
  labels_color = "darkgray", border = "grey",
  bg = "white", pch = 19, cex = 1, prop_size = FALSE,
  col = "red", main = "ternary plot", sub = NULL,
  newpage = TRUE, pop = TRUE, col.main = "black",
  col.sub = "black", ...)

Arguments

x an n-by-3 matrix of ternary forecasts.
L A matrix describing the quadratic score function. (Default corresponds to the
  Brier score).
scale row sums scale to be used.
dimnames dimension labels (defaults to the column names of x).
dimnames_position, dimnames_color
  position and color of dimension labels.
id optional labels to be plotted below the plot symbols. coordinates and id are
  mutually exclusive.
id_color color of these labels.
coordinates if TRUE, the coordinates of the points are plotted below them. coordinates and
  id are mutually exclusive.
grid if TRUE, a grid is plotted. May optionally be a string indicating the line type
  (default: "dotted").
grid_color grid colour.
labels, labels_color
  position and colour of the grid labels.
border colour of the triangle border.
bg triangle background.
pch plotting character. Defaults to filled dots.
cex a numerical value giving the amount by which plotting text and symbols should
  be scaled relative to the default. Ignored for the symbol size if prop_size is not
  FALSE.
prop_size if TRUE, the symbol size is plotted proportional to the row sum of the three
  variables, i.e., represents the weight of the observation.
col plotting colour.
main main title.
sub a sub title.
tscale

newpage  if ‘TRUE’, the plot will appear on a new graphics page.
pop     logical; if ‘TRUE’, all newly generated viewports are popped after plotting.
col.main     colour for the title.
col.sub     colour for the sub title.
...     additional graphics parameters (see par).

Author(s)

Tim Jupp (using code for vcd:ternaryplot as source).

Examples

tg <- tgrid(6) # make a grid of forecasts in the triangle
tg # print to terminal
tplot(tg) # plot them

tsname          Rescale a 3-vector to yield a ternary forecast

Description

Utility function to rescale 3-vectors to be probability distributions.

Usage

tscale(p)

Arguments

p     a vector of length 3.

Details

A utility function.

Value

A vector of length 3 rescaled so that elements are all >= 0 and sum to unity.

Author(s)

Tim Jupp

Examples

tsname(cbind(1,2,3)) # rescale (1,2,3) to be a ternary forecast.
**tscore**

*Calculate the (Brier) score associated with ternary forecasts and observations*

**Description**

A utility function.

**Usage**

```r
tscore(p, o, L = diag(c(1, 1, 1))/sqrt(2))
```

**Arguments**

- `p`: An n-by-3 matrix of ternary forecasts.
- `o`: An n-by-3 matrix of ternary observations.
- `L`: A 3-by-3 matrix defining the quadratic score being used. (Default corresponds to Brier score.)

**Author(s)**

Tim Jupp

**References**


[http://rsta.royalsocietypublishing.org/content/370/1962/1100.full](http://rsta.royalsocietypublishing.org/content/370/1962/1100.full)


**Examples**

```r
data(foot)
tscore(p=foot$p, o=foot$o)
```
Utility function to calculate geometry associated with a quadratic score matrix

Description

This is just a useful internal function.

Usage

tsetup(L = diag(c(1, 1, 1))/sqrt(2), q = cbind(1, 1, 1)/3)

Arguments

L
A 3-by-3 matrix defining the quadratic score being used. (Default corresponds to Brier score.)

q
A 1-by-3 matrix containing the climatology.

Author(s)

Tim Jupp

References


http://rsta.royalsocietypublishing.org/content/370/1962/1100.full
http://arxiv.org/abs/1103.1303

Examples

tsetup() # returns a set of useful objects

Verification of ternary forecasts / observations

Description

Function to create verification information associated with a set of forecasts p and associated observations o.
Usage

tverify(p, o, q, forceq, ncirc, L)

## Default S3 method:
tverify(p = cbind(1, 1, 1)/3, o = cbind(0, 0, 1),
         q = cbind(1, 1, 1)/3, forceq = FALSE,
         ncirc = 11, L = diag(c(1, 1, 1))/sqrt(2))

## S3 method for class 'tverify'
plot(x, thresh = 0, lsharp = TRUE,
     L = diag(c(1, 1, 1))/sqrt(2), ...)  

Arguments

p An n-by-3 matrix of ternary forecasts.
o An n-by-3 matrix of ternary observations.
q A 1-by-3 matrix containing the climatology.
forceq A logical. If forceq = TRUE then the input climatology q is used. If forceq = FALSE a climatology is calculated from o.
ncirc Controls discretisation of barycentric coordinates. (The number of hexagons along each side of the triangle.)
x An object of the tverify class (as produced by tverify or tgetcal).
thresh A ‘threshold’ number of forecasts in a ‘bin’, below which the forecast will not be plotted. (Prevents diagram being cluttered by very rare forecasts).
lsharp Logical controlling whether a ternary sharpness diagram is to be included.
L A quadratic scoring matrix. The matrix for the Brier score is the default. Full functionality for other scores not yet implemented.
... Not used.

Value

An object of class tverify, which is a list containing the following components:

pbin array of bins in barycentric coordinates.
Nobs number of forecasts in each bin.
obar mean observation associated with each forecast bin.
score score associated with each forecast bin.
unc uncertainty associated with each forecast bin.
rel reliability associated with each forecast bin.
res resolution associated with each forecast bin.
scorebar overall score.
uncbar overall uncertainty.
relbar overall reliability.
resbar overall resolution.
xf

ncirc number of bins along each side of triangle.
p input forecast data.
o input observation data.
assigned index of bin assigned to each forecast.
L scoring matrix used.
hexc array of hexagon centres.
q climatology.
pk forecasts set to centre of each bin (tverify) or recalibrated (tgetcal)
ok mean observations corresponding to forecasts pk
pars parameters in calibration (tgetcal only).
opt details of calibration (tgetcal only).
f calibration function (tgetcal only, for use with tcalibrate).

Author(s)
Tim Jupp

References
http://rsta.royalsocietypublishing.org/content/370/1962/1100.full
http://arxiv.org/abs/1103.1303

Examples
data(foot) # get football betting data
tv <- tverify(p=foot$p, o=foot$o) # get verification info
plot(tv) # plot verification info

---

xf x coordinate of a ternary forecast in barycentric coordinates

Description
This is a utility function to calculate the x-coordinate of a point in barycentric coordinates. It is unlikely that the user will want to use this function directly.

Usage
xf(p = cbind(1, 1, 1)/3, M = tsetup$M32)
Arguments

p  An n-by-3 matrix of ternary forecasts.
M  A 2-by-3 matrix describing the transformation for R^3 to R^2.

Value

An n-by-1 array of x-values for use in plotting.

Author(s)

Tim Jupp

References

http://rsta.royalsocietypublishing.org/content/370/1962/1100.full
http://arxiv.org/abs/1103.1303

See Also

tsetup, yf

Examples

xf(p=cbind(.1,.2,.7))

---

yf  y coordinate of a ternary forecast in barycentric coordinates

Description

This is a utility function to calculate the y-coordinate of a point in barycentric coordinates. It is unlikely that the user will want to use this function directly.

Usage

yf(p = cbind(1, 1, 1)/3, M = tsetup())

Arguments

p  An n-by-3 matrix of ternary forecasts.
M  A 2-by-3 matrix describing the transformation for R^3 to R^2.
Value

An n-by-1 array of y-values for use in plotting.

Author(s)

Tim Jupp

References


http://rsta.royalsocietypublishing.org/content/370/1962/1100.full
http://arxiv.org/abs/1103.1303

See Also

tsetup, xf

Examples

yf(p=cbind(.1,.2,.7))
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