Chapter 5

The graphics package

graphics-package   *The R Graphics Package*

Description

R functions for base graphics

Details

This package contains functions for ‘base’ graphics. Base graphics are traditional S-like graphics, as opposed to the more recent grid graphics.

For a complete list of functions with individual help pages, use `library(help = "graphics")`.

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References

Becker, R. A., Chambers, J. M. and Wilks, A. R. (1988) *The New S Language*. Wadsworth & Brooks/Cole.

Murrell, P. (2005) *R Graphics*. Chapman & Hall/CRC Press.

abline   *Add Straight Lines to a Plot*

Description

This function adds one or more straight lines through the current plot.

Usage

```
abline(a = NULL, b = NULL, h = NULL, v = NULL, reg = NULL,
       coef = NULL, untf = FALSE, ...)
```

Arguments

`a, b` the intercept and slope, single values.

`untf` logical asking whether to *untransform*. See ‘Details’.

`h` the y-value(s) for horizontal line(s).

`v` the x-value(s) for vertical line(s).

`coef` a vector of length two giving the intercept and slope.

`reg` an object with a `coef` method. See ‘Details’.

`...` graphical parameters such as `col`, `lty` and `lwd` (possibly as vectors: see ‘Details’) and `xpd` and the line characteristics `lend`, `ljoin` and `lmitre`.

Details

Typical usages are

```
abline(a, b, ...)
abline(h =, ...)
abline(v =, ...)
abline(coef =, ...)
abline(reg =, ...)
```

The first form specifies the line in intercept/slope form (alternatively `a` can be specified on its own and is taken to contain the slope and intercept in vector form).

The `h=` and `v=` forms draw horizontal and vertical lines at the specified coordinates.

The `coef` form specifies the line by a vector containing the slope and intercept.

`reg` is a regression object with a `coef` method. If this returns a vector of length 1 then the value is taken to be the slope of a line through the origin, otherwise, the first 2 values are taken to be the intercept and slope.

If `untf` is true, and one or both axes are log-transformed, then a curve is drawn corresponding to a line in original coordinates, otherwise a line is drawn in the transformed coordinate system. The `h` and `v` parameters always refer to original coordinates.

The graphical parameters `col`, `lty` and `lwd` can be specified; see `par` for details. For the `h=` and `v=` usages they can be vectors of length greater than one, recycled as necessary.

Specifying an `xpd` argument for clipping overrides the global `par("xpd")` setting used otherwise.

References

Becker, R. A., Chambers, J. M. and Wilks, A. R. (1988) *The New S Language*. Wadsworth & Brooks/Cole.

Murrell, P. (2005) *R Graphics*. Chapman & Hall/CRC Press.

See Also

`lines` and `segments` for connected and arbitrary lines given by their *endpoints*. `par`.

Examples

```
## Setup up coordinate system (with x == y aspect ratio):
plot(c(-2,3), c(-1,5), type = "n", xlab = "x", ylab = "y", asp = 1)
## the x- and y-axis, and an integer grid
abline(h = 0, v = 0, col = "gray60")
text(1,0, "abline( h = 0 )", col = "gray60", adj = c(0, -.1))
abline(h = -1:5, v = -2:3, col = "lightgray", lty = 3)
abline(a = 1, b = 2, col = 2)
text(1,3, "abline( 1, 2 )", col = 2, adj = c(-.1, -.1))

## Simple Regression Lines:
require(stats)
sale5 <- c(6, 4, 9, 7, 6, 12, 8, 10, 9, 13)
plot(sale5)
abline(lsfit(1:10, sale5))
abline(lsfit(1:10, sale5, intercept = FALSE), col = 4) # less fitting

z <- lm(dist ~ speed, data = cars)
plot(cars)
abline(z) # equivalent to abline(reg = z) or
abline(coef = coef(z))

## trivial intercept model
abline(mC <- lm(dist ~ 1, data = cars)) ## the same as
abline(a = coef(mC), b = 0, col = "blue")
```

`arrows` *Add Arrows to a Plot*

Description

Draw arrows between pairs of points.

Usage

```
arrows(x0, y0, x1 = x0, y1 = y0, length = 0.25, angle = 30,
       code = 2, col = par("fg"), lty = par("lty"),
       lwd = par("lwd"), ...)
```

Arguments

`x0, y0`	coordinates of points **from** which to draw.
`x1, y1`	coordinates of points **to** which to draw. At least one must the supplied
`length`	length of the edges of the arrow head (in inches).
`angle`	angle from the shaft of the arrow to the edge of the arrow head.
`code`	integer code, determining *kind* of arrows to be drawn.
`col, lty, lwd`	graphical parameters, possible vectors. `NA` values in `col` cause the arrow to be omitted.
`...`	graphical parameters such as `xpd` and the line characteristics `lend`, `ljoin` and `lmitre`: see `par`.

Details

For each i, an arrow is drawn between the point (x0[i], y0[i]) and the point (x1[i], y1[i]). The coordinate vectors will be recycled to the length of the longest.

If code = 1 an arrowhead is drawn at (x0[i], y0[i]) and if code = 2 an arrowhead is drawn at (x1[i], y1[i]). If code = 3 a head is drawn at both ends of the arrow. Unless length = 0, when no head is drawn.

The graphical parameters col, lty and lwd can be vectors of length greater than one and will be recycled if necessary.

The direction of a zero-length arrow is indeterminate, and hence so is the direction of the arrowheads. To allow for rounding error, arrowheads are omitted (with a warning) on any arrow of length less than 1/1000 inch.

Note

The first four arguments in the comparable S function are named x1, y1, x2, y2.

References

Becker, R. A., Chambers, J. M. and Wilks, A. R. (1988) *The New S Language*. Wadsworth & Brooks/Cole.

See Also

segments to draw segments.

Examples

```
x <- stats::runif(12); y <- stats::rnorm(12)
i <- order(x, y); x <- x[i]; y <- y[i]
plot(x,y, main = "arrows(.) and segments(.)")
## draw arrows from point to point :
s <- seq(length(x)-1)  # one shorter than data
arrows(x[s], y[s], x[s+1], y[s+1], col = 1:3)
s <- s[-length(s)]
segments(x[s], y[s], x[s+2], y[s+2], col = "pink")
```

---

assocplot *Association Plots*

Description

Produce a Cohen-Friendly association plot indicating deviations from independence of rows and columns in a 2-dimensional contingency table.

Usage

```
assocplot(x, col = c("black", "red"), space = 0.3,
          main = NULL, xlab = NULL, ylab = NULL)
```

Arguments

`x`	a two-dimensional contingency table in matrix form.
`col`	a character vector of length two giving the colors used for drawing positive and negative Pearson residuals, respectively.
`space`	the amount of space (as a fraction of the average rectangle width and height) left between each rectangle.
`main`	overall title for the plot.
`xlab`	a label for the x axis. Defaults to the name (if any) of the row dimension in `x`.
`ylab`	a label for the y axis. Defaults to the name (if any) of the column dimension in `x`.

Details

For a two-way contingency table, the signed contribution to Pearson's χ^2 for cell i, j is $d_{ij} = (f_{ij} - e_{ij})/\sqrt{e_{ij}}$, where f_{ij} and e_{ij} are the observed and expected counts corresponding to the cell. In the Cohen-Friendly association plot, each cell is represented by a rectangle that has (signed) height proportional to d_{ij} and width proportional to $\sqrt{e_{ij}}$, so that the area of the box is proportional to the difference in observed and expected frequencies. The rectangles in each row are positioned relative to a baseline indicating independence ($d_{ij} = 0$). If the observed frequency of a cell is greater than the expected one, the box rises above the baseline and is shaded in the color specified by the first element of `col`, which defaults to black; otherwise, the box falls below the baseline and is shaded in the color specified by the second element of `col`, which defaults to red.

A more flexible and extensible implementation of association plots written in the grid graphics system is provided in the function `assoc` in the contributed package **vcd** (Meyer, Zeileis and Hornik, 2006).

References

Cohen, A. (1980), On the graphical display of the significant components in a two-way contingency table. *Communications in Statistics—Theory and Methods*, **9**, 1025–1041. doi:10.1080/03610928008827940.

Friendly, M. (1992), Graphical methods for categorical data. *SAS User Group International Conference Proceedings*, **17**, 190–200. `http://datavis.ca/papers/sugi/sugi17.pdf`

Meyer, D., Zeileis, A., and Hornik, K. (2006) The strucplot Framework: Visualizing Multi-Way Contingency Tables with **vcd**. *Journal of Statistical Software*, **17(3)**, 1–48. doi:10.18637/jss.v017.i03.

See Also

`mosaicplot`, `chisq.test`.

Examples

```
## Aggregate over sex:
x <- marginSums(HairEyeColor, c(1, 2))
x
assocplot(x, main = "Relation between hair and eye color")
```

Axis *Generic Function to Add an Axis to a Plot*

Description

Generic function to add a suitable axis to the current plot.

Usage

```
Axis(x = NULL, at = NULL, ..., side, labels = NULL)
```

Arguments

x	an object which indicates the range over which an axis should be drawn
at	the points at which tick-marks are to be drawn.
side	an integer specifying which side of the plot the axis is to be drawn on. The axis is placed as follows: 1=below, 2=left, 3=above and 4=right.
labels	this can either be a logical value specifying whether (numerical) annotations are to be made at the tickmarks, or a character or expression vector of labels to be placed at the tick points. If this is specified as a character or expression vector, at should be supplied and they should be the same length.
...	arguments to be passed to methods and perhaps then to axis.

Details

This is a generic function. It works in a slightly non-standard way: if x is supplied and non-NULL it dispatches on x, otherwise if at is supplied and non-NULL it dispatches on at, and the default action is to call axis, omitting argument x.

The idea is that for plots for which either or both of the axes are numerical but with a special interpretation, the standard plotting functions (including boxplot, contour, coplot, filled.contour, pairs, plot.default, rug and stripchart) will set up user coordinates and Axis will be called to label them appropriately.

There are "Date" and "POSIXt" methods which can pass an argument format on to the appropriate axis method (see axis.POSIXct).

Value

The numeric locations on the axis scale at which tick marks were drawn when the plot was first drawn (see 'Details').

This function is usually invoked for its side effect, which is to add an axis to an already existing plot.

See Also

axis (which is eventually called from all Axis() methods) in package **graphics**.

axis *Add an Axis to a Plot*

Description

Adds an axis to the current plot, allowing the specification of the side, position, labels, and other options.

Usage

```
axis(side, at = NULL, labels = TRUE, tick = TRUE, line = NA,
     pos = NA, outer = FALSE, font = NA, lty = "solid",
     lwd = 1, lwd.ticks = lwd, col = NULL, col.ticks = NULL,
     hadj = NA, padj = NA, gap.axis = NA, ...)
```

Arguments

side	an integer specifying which side of the plot the axis is to be drawn on. The axis is placed as follows: 1=below, 2=left, 3=above and 4=right.
at	the points at which tick-marks are to be drawn. Non-finite (infinite, NaN or NA) values are omitted. By default (when NULL) tickmark locations are computed, see 'Details' below.
labels	this can either be a logical value specifying whether (numerical) annotations are to be made at the tickmarks, or a character or expression vector of labels to be placed at the tick points. (Other objects are coerced by as.graphicsAnnot.) If this is not logical, at should also be supplied and of the same length. If labels is of length zero after coercion, it has the same effect as supplying TRUE.
tick	a logical value specifying whether tickmarks and an axis line should be drawn.
line	the number of lines into the margin at which the axis line will be drawn, if not NA.
pos	the coordinate at which the axis line is to be drawn: if not NA this overrides the value of line.
outer	a logical value indicating whether the axis should be drawn in the outer plot margin, rather than the standard plot margin.
font	font for text. Defaults to par("font").
lty	line type for both the axis line and the tick marks.
lwd, lwd.ticks	line widths for the axis line and the tick marks. Zero or negative values will suppress the line or ticks.
col, col.ticks	colors for the axis line and the tick marks respectively. col = NULL means to use par("fg"), possibly specified inline, and col.ticks = NULL means to use whatever color col resolved to.
hadj	adjustment (see par("adj")) for all labels *parallel* ('horizontal') to the reading direction. If this is not a finite value, the default is used (centring for strings parallel to the axis, justification of the end nearest the axis otherwise).
padj	adjustment for each tick label *perpendicular* to the reading direction. For labels parallel to the axes, padj = 0 means left or bottom alignment, and padj = 1 means right or top alignment (relative to the line). This can be a vector given a value for each string, and will be recycled as necessary.

If padj is not a finite value (the default), the value of par("las") determines the adjustment. For strings plotted perpendicular to the axis the default is to centre the string.

gap.axis
: an optional (typically non-negative) numeric factor to be multiplied with the size of an 'm' to determine the minimal gap between labels that are drawn, see 'Details'. The default, NA, corresponds to 1 for tick labels drawn *parallel* to the axis and 0.25 otherwise, i.e., the default is equivalent to

```
perpendicular <- function(side, las) {
  is.x <- (side %% 2 == 1) # is horizontal x-axis
  ( is.x && (las %in% 2:3)) ||
  (!is.x && (las %in% 1:2))
}
gap.axis <- if(perpendicular(side, las)) 0.25 else 1
```

gap.axis may typically be relevant when at = .. tick-mark positions are specified explicitly.

...
: other graphical parameters may also be passed as arguments to this function, particularly, cex.axis, col.axis and font.axis for axis annotation, i.e. tick labels, mgp and xaxp or yaxp for positioning, tck or tcl for tick mark length and direction, las for vertical/horizontal label orientation, or fg instead of col, and xpd for clipping. See par on these.

Parameters xaxt (sides 1 and 3) and yaxt (sides 2 and 4) control if the axis is plotted at all.

Note that lab will partial match to argument labels unless the latter is also supplied. (Since the default axes have already been set up by plot.window, lab will not be acted on by axis.)

Details

The axis line is drawn from the lowest to the highest value of at, but will be clipped at the plot region. By default, only ticks which are drawn from points within the plot region (up to a tolerance for rounding error) are plotted, but the ticks and their labels may well extend outside the plot region. Use xpd = TRUE or xpd = NA to allow axes to extend further.

When at = NULL, pretty tick mark locations are computed internally (the same way axTicks(side) would) from par("xaxp") or "yaxp" and par("xlog") (or "ylog"). Note that these locations may change if an on-screen plot is resized (for example, if the plot argument asp (see plot.window) is set.)

If labels is not specified, the numeric values supplied or calculated for at are converted to character strings as if they were a numeric vector printed by print.default(digits = 7).

The code tries hard not to draw overlapping tick labels, and so will omit labels where they would abut or overlap previously drawn labels. This can result in, for example, every other tick being labelled. The ticks are drawn left to right or bottom to top, and space at least the size of an 'm', multiplied by gap.axis, is left between labels. In previous R versions, this applied only for labels written *parallel* to the axis direction, hence not for e.g., las = 2. Using gap.axis = -1 restores that (buggy) previous behaviour (in the perpendicular case).

If either line or pos is set, they (rather than par("mgp")[3]) determine the position of the axis line and tick marks, and the tick labels are placed par("mgp")[2] further lines into (or towards for pos) the margin.

Several of the graphics parameters affect the way axes are drawn. The vertical (for sides 1 and 3) positions of the axis and the tick labels are controlled by mgp[2:3] and mex, the size and direction of the ticks is controlled by tck and tcl and the appearance of the tick labels by cex.axis, col.axis and font.axis with orientation controlled by las (but not srt, unlike S which uses srt if at is supplied and las if it is not). Note that adj is not supported and labels are always centered. See par for details.

Value

The numeric locations on the axis scale at which tick marks were drawn when the plot was first drawn (see 'Details').

This function is usually invoked for its side effect, which is to add an axis to an already existing plot.

References

Becker, R. A., Chambers, J. M. and Wilks, A. R. (1988) *The New S Language*. Wadsworth & Brooks/Cole.

See Also

Axis for a generic interface.

axTicks returns the axis tick locations corresponding to at = NULL; pretty is more flexible for computing pretty tick coordinates and does *not* depend on (nor adapt to) the coordinate system in use.

Several graphics parameters affecting the appearance are documented in par.

Examples

```
require(stats) # for rnorm
plot(1:4, rnorm(4), axes = FALSE)
axis(1, 1:4, LETTERS[1:4])
axis(2)
box() #- to make it look "as usual"

plot(1:7, rnorm(7), main = "axis() examples",
     type = "s", xaxt = "n", frame.plot = FALSE, col = "red")
axis(1, 1:7, LETTERS[1:7], col.axis = "blue")
# unusual options:
axis(4, col = "violet", col.axis = "dark violet", lwd = 2)
axis(3, col = "gold", lty = 2, lwd = 0.5)

# one way to have a custom x axis
plot(1:10, xaxt = "n")
axis(1, xaxp = c(2, 9, 7))

## Changing default gap between labels:
plot(0:100, type="n", axes=FALSE, ann=FALSE)
title(quote("axis(1, .., gap.axis = f)," ~~ f >= 0))
axis(2, at = 5*(0:20), las = 1, gap.axis = 1/4)
gaps <- c(4, 2, 1, 1/2, 1/4, 0.1, 0)
chG <- paste0(ifelse(gaps == 1, "default:  ", ""),
              "gap.axis=", formatC(gaps))
jj <- seq_along(gaps)
linG <- -2.5*(jj-1)
for(j in jj) {
    isD <- gaps[j] == 1 # is default
    axis (1, at=5*(0:20), gap.axis = gaps[j], padj=-1, line = linG[j],
          col.axis = if(isD) "forest green" else 1, font.axis= 1+isD)
}
mtext(chG, side=1, padj=-1, line = linG -1/2, cex=3/4,
      col = ifelse(gaps == 1, "forest green", "blue3"))
## now shrink the window (in x- and y-direction) and observe the axis labels drawn
```

axis.POSIXct *Date and Date-time Plotting Functions*

Description

Add a date/time axis to the current plot of an object of class "POSIXt" or "Date", respectively.

Usage

```
axis.POSIXct(side, x, at, format, labels = TRUE, ...)
axis.Date(side, x, at, format, labels = TRUE, ...)
```

Arguments

side	see axis.
x, at	optional date-time or Date objects, or other types of objects that can be converted appropriately.
format	an optional character string specifying the label format, see strftime.
labels	either a logical value specifying whether annotations are to be made at the tickmarks, or a character vector of labels to be placed at the tick points specified by at.
...	further arguments to be passed from or to other methods, typically graphical parameters.

Details

If at is unspecified, axis.POSIXct and axis.Date work quite hard (from R 4.3.0 via pretty for date-time classes) to choose suitable time units (years, months, days, hours, minutes, or seconds) and a sensible label format based on the axis range. par("lab") controls the approximate number of intervals.

If at is supplied it specifies the locations of the ticks and labels. If the label format is unspecified, a good guess is made by looking at the granularity of at. Printing of tick labels can be suppressed with labels = FALSE.

The date-times for a "POSIXct" input are interpreted in the time zone give by the "tzone" attribute if there is one, otherwise the current time zone.

The way the date-times are rendered (especially month names) is controlled by the locale setting of category "LC_TIME" (see Sys.setlocale).

Value

The locations on the axis scale at which tick marks were drawn.

See Also

DateTimeClasses, Dates for details of the classes.

Axis.

Examples

```
with(beaver1, {
    opar <- par(mfrow = c(3,1))
    time <- strptime(paste(1990, day, time %/% 100, time %% 100),
                     "%Y %j %H %M")
    plot(time, temp, type = "l") # axis at 6-hour intervals
    # request more ticks
    olab <- par(lab = c(10, 10, 7))
    plot(time, temp, type = "l")
    par(olab)
    # now label every hour on the time axis
    plot(time, temp, type = "l", xaxt = "n")
    r <- as.POSIXct(round(range(time), "hours"))
    axis.POSIXct(1, at = seq(r[1], r[2], by = "hour"), format = "%H")
    par(opar) # reset changed par settings
})

plot(.leap.seconds, seq_along(.leap.seconds), type = "n", yaxt = "n",
     xlab = "leap seconds", ylab = "", bty = "n")
rug(.leap.seconds)
## or as dates
lps <- as.Date(.leap.seconds)
plot(lps, seq_along(.leap.seconds),
     type = "n", yaxt = "n", xlab = "leap seconds",
     ylab = "", bty = "n")
rug(lps)

## 100 random dates in a 10-week period
random.dates <- as.Date("2001/1/1") + 70*sort(stats::runif(100))
plot(random.dates, 1:100)
# or for a better axis labelling
plot(random.dates, 1:100, xaxt = "n")
axis.Date(1, at = seq(as.Date("2001/1/1"), max(random.dates)+6, "weeks"))
axis.Date(1, at = seq(as.Date("2001/1/1"), max(random.dates)+6, "days"),
     labels = FALSE, tcl = -0.2)

## axis.Date() with various data types:
x <- seq(as.Date("2022-01-20"), as.Date("2023-03-21"), by = "days")
plot(data.frame(x, y = 1), xaxt = "n")
legend("topleft", title = "input",
       legend = c("character", "Date", "POSIXct", "POSIXlt", "numeric"),
       fill = c("violet", "red", "orange", "coral1", "darkgreen"))
axis.Date(1)
axis.Date(3, at = "2022-04-01", col.axis = "violet")
axis.Date(3, at = as.Date("2022-07-01"), col.axis = "red")
axis.Date(3, at = as.POSIXct(as.Date("2022-10-01")), col.axis = "orange")
axis.Date(3, at = as.POSIXlt(as.Date("2023-01-01")), col.axis = "coral1")
axis.Date(3, at = as.integer(as.Date("2023-04-01")), col.axis = "darkgreen")
## automatically extends the format:
axis.Date(1, at = "2022-02-15", col.axis = "violet",
         col = "violet", tck = -0.05, mgp = c(3,2,0))
```

```
## axis.POSIXct() with various data types (2 minutes):
x <- as.POSIXct("2022-10-01") + c(0, 60, 120)
attributes(x)   # no timezone
plot(data.frame(x, y = 1), xaxt = "n")
legend("topleft", title = "input",
       legend = c("character", "Date", "POSIXct", "POSIXlt", "numeric"),
       fill = c("violet", "red", "orange", "coral1", "darkgreen"))
axis.POSIXct(1)
axis.POSIXct(3, at = "2022-10-01 00:01", col.axis = "violet")
axis.POSIXct(3, at = as.Date("2022-10-01"), col.axis = "red")
axis.POSIXct(3, at = as.POSIXct("2022-10-01 00:01:30"), col.axis = "orange")
axis.POSIXct(3, at = as.POSIXlt("2022-10-01 00:02"), col.axis = "coral1")
axis.POSIXct(3, at = as.numeric(as.POSIXct("2022-10-01 00:00:30")),
                col.axis = "darkgreen")
## automatically extends format (here: subseconds):
axis.POSIXct(3, at = as.numeric(as.POSIXct("2022-10-01 00:00:30")) + 0.25,
                col.axis = "forestgreen", col = "darkgreen", mgp = c(3,2,0))

## axis.POSIXct: 2 time zones
HST <- as.POSIXct("2022-10-01", tz = "HST") + c(0, 60, 60*60)
CET <- HST
attr(CET, "tzone") <- "CET"
plot(data.frame(HST, y = 1), xaxt = "n", xlab = "Hawaii Standard Time (HST)")
axis.POSIXct(1, HST)
axis.POSIXct(1, HST, at = "2022-10-01 00:10", col.axis = "violet")
axis.POSIXct(3, CET)
mtext(3, text = "Central European Time (CET)", line = 3)
axis.POSIXct(3, CET, at="2022-10-01 12:10", col.axis = "violet")
```

axTicks *Compute Axis Tickmark Locations*

Description

Compute pretty tickmark locations, the same way as R does internally. This is only non-trivial when **log** coordinates are active. By default, gives the at values which axis(side) would use.

Usage

```
axTicks(side, axp = NULL, usr = NULL, log = NULL, nintLog = NULL)
```

Arguments

side   integer in 1:4, as for axis.

axp   numeric vector of length three, defaulting to par("xaxp") or par("yaxp") depending on the side argument (par("xaxp") if side is 1 or 3, par("yaxp") if side is 2 or 4).

usr   numeric vector of length two giving user coordinate limits, defaulting to the relevant portion of par("usr") (par("usr")[1:2] or par("usr")[3:4] for side in (1,3) or (2,4) respectively).

log   logical indicating if log coordinates are active; defaults to par("xlog") or par("ylog") depending on side.

nintLog (only used when log is true): approximate (lower bound for the) number of tick intervals; defaults to par("lab")[j] where j is 1 or 2 depending on side. Set this to Inf if you want the same behavior as in earlier R versions (than 2.14.x).

Details

The axp, usr, and log arguments must be consistent as their default values (the par(..) results) are. If you specify all three (as non-NULL), the graphics environment is not used at all. Note that the meaning of axp differs significantly when log is TRUE; see the documentation on par(xaxp = .).

axTicks() may be seen as an R implementation of the C function CreateAtVector() in '..../src/main/plot.c' which is called by axis(side, *) when no argument at is specified or directly by axisTicks() (in package **grDevices**).
The delicate case, log = TRUE, now makes use of axisTicks unless nintLog = Inf which exists for back compatibility.

Value

numeric vector of coordinate values at which axis tickmarks can be drawn. By default, when only the first argument is specified, these values should be identical to those that axis(side) would use or has used. Note that the values are decreasing when usr is ("reverse axis" case).

See Also

axis, par. pretty uses the same algorithm (but independently of the graphics environment) and has more options. However it is not available for log = TRUE.

axisTicks() (package **grDevices**).

Examples

```
 plot(1:7, 10*21:27)
 axTicks(1)
 axTicks(2)
 stopifnot(identical(axTicks(1), axTicks(3)),
           identical(axTicks(2), axTicks(4)))

## Show how axTicks() and axis() correspond :
op <- par(mfrow = c(3, 1))
for(x in 9999 * c(1, 2, 8)) {
    plot(x, 9, log = "x")
    cat(formatC(par("xaxp"), width = 5),";", T <- axTicks(1),"\n")
    rug(T, col =  adjustcolor("red", 0.5), lwd = 4)
}
par(op)

x <- 9.9*10^(-3:10)
plot(x, 1:14, log = "x")
axTicks(1) # now length 7
axTicks(1, nintLog = Inf) # rather too many

## An example using axTicks() without reference to an existing plot
## (copying R's internal procedures for setting axis ranges etc.),
## You do need to supply _all_ of axp, usr, log, nintLog
## standard logarithmic y axis labels
ylims <- c(0.2, 88)
```

```
get_axp <- function(x) 10^c(ceiling(x[1]), floor(x[2]))
## mimic par("yaxs") == "i"
usr.i <- log10(ylims)
(aT.i <- axTicks(side = 2, usr = usr.i,
                axp = c(get_axp(usr.i), n = 3), log = TRUE, nintLog = 5))
## mimic (default) par("yaxs") == "r"
usr.r <- extendrange(r = log10(ylims), f = 0.04)
(aT.r <- axTicks(side = 2, usr = usr.r,
                axp = c(get_axp(usr.r), 3), log = TRUE, nintLog = 5))

## Prove that we got it right :
plot(0:1, ylims, log = "y", yaxs = "i")
stopifnot(all.equal(aT.i, axTicks(side = 2)))

plot(0:1, ylims, log = "y", yaxs = "r")
stopifnot(all.equal(aT.r, axTicks(side = 2)))
```

barplot *Bar Plots*

Description

Creates a bar plot with vertical or horizontal bars.

Usage

```
barplot(height, ...)

## Default S3 method:
barplot(height, width = 1, space = NULL,
        names.arg = NULL, legend.text = NULL, beside = FALSE,
        horiz = FALSE, density = NULL, angle = 45,
        col = NULL, border = par("fg"),
        main = NULL, sub = NULL, xlab = NULL, ylab = NULL,
        xlim = NULL, ylim = NULL, xpd = TRUE, log = "",
        axes = TRUE, axisnames = TRUE,
        cex.axis = par("cex.axis"), cex.names = par("cex.axis"),
        inside = TRUE, plot = TRUE, axis.lty = 0, offset = 0,
        add = FALSE, ann = !add && par("ann"), args.legend = NULL, ...)

## S3 method for class 'formula'
barplot(formula, data, subset, na.action,
        horiz = FALSE, xlab = NULL, ylab = NULL, ...)
```

Arguments

`height`	either a vector or matrix of values describing the bars which make up the plot. If `height` is a vector, the plot consists of a sequence of rectangular bars with heights given by the values in the vector. If `height` is a matrix and `beside` is `FALSE` then each bar of the plot corresponds to a column of `height`, with the values in the column giving the heights of stacked sub-bars making up the bar. If `height` is a matrix and `beside` is `TRUE`, then the values in each column are juxtaposed rather than stacked.

`width` optional vector of bar widths. Re-cycled to length the number of bars drawn. Specifying a single value will have no visible effect unless `xlim` is specified.

`space` the amount of space (as a fraction of the average bar width) left before each bar. May be given as a single number or one number per bar. If `height` is a matrix and `beside` is `TRUE`, `space` may be specified by two numbers, where the first is the space between bars in the same group, and the second the space between the groups. If not given explicitly, it defaults to `c(0,1)` if `height` is a matrix and `beside` is `TRUE`, and to 0.2 otherwise.

`names.arg` a vector of names to be plotted below each bar or group of bars. If this argument is omitted, then the names are taken from the `names` attribute of `height` if this is a vector, or the column names if it is a matrix.

`legend.text` a vector of text used to construct a legend for the plot, or a logical indicating whether a legend should be included. This is only useful when `height` is a matrix. In that case given legend labels should correspond to the rows of `height`; if `legend.text` is true, the row names of `height` will be used as labels if they are non-null.

`beside` a logical value. If `FALSE`, the columns of `height` are portrayed as stacked bars, and if `TRUE` the columns are portrayed as juxtaposed bars.

`horiz` a logical value. If `FALSE`, the bars are drawn vertically with the first bar to the left. If `TRUE`, the bars are drawn horizontally with the first at the bottom.

`density` a vector giving the density of shading lines, in lines per inch, for the bars or bar components. The default value of `NULL` means that no shading lines are drawn. Non-positive values of `density` also inhibit the drawing of shading lines.

`angle` the slope of shading lines, given as an angle in degrees (counter-clockwise), for the bars or bar components.

`col` a vector of colors for the bars or bar components. By default, `"grey"` is used if `height` is a vector, and a gamma-corrected grey palette if `height` is a matrix; see `grey.colors`.

`border` the color to be used for the border of the bars. Use `border = NA` to omit borders. If there are shading lines, `border = TRUE` means use the same colour for the border as for the shading lines.

`main, sub` main title and subtitle for the plot.

`xlab` a label for the x axis.

`ylab` a label for the y axis.

`xlim` limits for the x axis.

`ylim` limits for the y axis.

`xpd` logical. Should bars be allowed to go outside region?

`log` string specifying if axis scales should be logarithmic; see `plot.default`.

`axes` logical. If `TRUE`, a vertical (or horizontal, if `horiz` is true) axis is drawn.

`axisnames` logical. If `TRUE`, and if there are `names.arg` (see above), the other axis is drawn (with `lty = 0`) and labeled.

`cex.axis` expansion factor for numeric axis labels (see `par('cex')`).

`cex.names` expansion factor for axis names (bar labels).

`inside` logical. If `TRUE`, the lines which divide adjacent (non-stacked!) bars will be drawn. Only applies when `space = 0` (which it partly is when `beside = TRUE`).

`plot` logical. If `FALSE`, nothing is plotted.

`axis.lty` the graphics parameter `lty` (see `par('lty')`) applied to the axis and tick marks of the categorical (default horizontal) axis. Note that by default the axis is suppressed.

`offset` a vector indicating how much the bars should be shifted relative to the x axis.

`add` logical specifying if bars should be added to an already existing plot; defaults to `FALSE`.

`ann` logical specifying if the default annotation (`main`, `sub`, `xlab`, `ylab`) should appear on the plot, see `title`.

`args.legend` list of additional arguments to pass to `legend()`; names of the list are used as argument names. Only used if `legend.text` is supplied.

`formula` a formula where the `y` variables are numeric data to plot against the categorical `x` variables. The formula can have one of three forms:

```
y ~ x
y ~ x1 + x2
cbind(y1, y2) ~ x
```

(see the examples).

`data` a data frame (or list) from which the variables in formula should be taken.

`subset` an optional vector specifying a subset of observations to be used.

`na.action` a function which indicates what should happen when the data contain `NA` values. The default is to ignore missing values in the given variables.

`...` arguments to be passed to/from other methods. For the default method these can include further arguments (such as `axes`, `asp` and `main`) and graphical parameters (see `par`) which are passed to `plot.window()`, `title()` and `axis`.

Value

A numeric vector (or matrix, when `beside = TRUE`), say `mp`, giving the coordinates of *all* the bar midpoints drawn, useful for adding to the graph.

If `beside` is true, use `colMeans(mp)` for the midpoints of each *group* of bars, see example.

Author(s)

R Core, with a contribution by Arni Magnusson.

References

Becker, R. A., Chambers, J. M. and Wilks, A. R. (1988) *The New S Language*. Wadsworth & Brooks/Cole.

Murrell, P. (2005) *R Graphics*. Chapman & Hall/CRC Press.

See Also

`plot(..., type = "h")`, `dotchart`; `hist` for bars of a *continuous* variable. `mosaicplot()`, more sophisticated to visualize *several* categorical variables.

Examples

```
# Formula method
barplot(GNP ~ Year, data = longley)
barplot(cbind(Employed, Unemployed) ~ Year, data = longley)

## 3rd form of formula - 2 categories :
op <- par(mfrow = 2:1, mgp = c(3,1,0)/2, mar = .1+c(3,3:1))
summary(d.Titanic <- as.data.frame(Titanic))
barplot(Freq ~ Class + Survived, data = d.Titanic,
        subset = Age == "Adult" & Sex == "Male",
     main = "barplot(Freq ~ Class + Survived, *)", ylab = "# {passengers}", legend.text = TRUE)
# Corresponding table :
(xt <- xtabs(Freq ~ Survived + Class + Sex, d.Titanic, subset = Age=="Adult"))
# Alternatively, a mosaic plot :
mosaicplot(xt[,,"Male"], main = "mosaicplot(Freq ~ Class + Survived, *)", color=TRUE)
par(op)


# Default method
require(grDevices) # for colours
tN <- table(Ni <- stats::rpois(100, lambda = 5))
r <- barplot(tN, col = rainbow(20))
#- type = "h" plotting *is* 'bar'plot
lines(r, tN, type = "h", col = "red", lwd = 2)

barplot(tN, space = 1.5, axisnames = FALSE,
        sub = "barplot(..., space= 1.5, axisnames = FALSE)")

barplot(VADeaths, plot = FALSE)
barplot(VADeaths, plot = FALSE, beside = TRUE)

mp <- barplot(VADeaths) # default
tot <- colMeans(VADeaths)
text(mp, tot + 3, format(tot), xpd = TRUE, col = "blue")
barplot(VADeaths, beside = TRUE,
        col = c("lightblue", "mistyrose", "lightcyan",
                "lavender", "cornsilk"),
        legend.text = rownames(VADeaths), ylim = c(0, 100))
title(main = "Death Rates in Virginia", font.main = 4)

hh <- t(VADeaths)[, 5:1]
mybarcol <- "gray20"
mp <- barplot(hh, beside = TRUE,
        col = c("lightblue", "mistyrose",
                "lightcyan", "lavender"),
        legend.text = colnames(VADeaths), ylim = c(0,100),
        main = "Death Rates in Virginia", font.main = 4,
        sub = "Faked upper 2*sigma error bars", col.sub = mybarcol,
        cex.names = 1.5)
segments(mp, hh, mp, hh + 2*sqrt(1000*hh/100), col = mybarcol, lwd = 1.5)
stopifnot(dim(mp) == dim(hh))  # corresponding matrices
mtext(side = 1, at = colMeans(mp), line = -2,
      text = paste("Mean", formatC(colMeans(hh))), col = "red")

# Bar shading example
barplot(VADeaths, angle = 15+10*1:5, density = 20, col = "black",
        legend.text = rownames(VADeaths))
title(main = list("Death Rates in Virginia", font = 4))

# Border color
barplot(VADeaths, border = "dark blue")

# Log scales (not much sense here)
barplot(tN, col = heat.colors(12), log = "y")
barplot(tN, col = gray.colors(20), log = "xy")

# Legend location
barplot(height = cbind(x = c(465, 91) / 465 * 100,
                       y = c(840, 200) / 840 * 100,
                       z = c(37, 17) / 37 * 100),
        beside = FALSE,
        width = c(465, 840, 37),
        col = c(1, 2),
        legend.text = c("A", "B"),
        args.legend = list(x = "topleft"))
```

box *Draw a Box around a Plot*

Description

This function draws a box around the current plot in the given color and line type. The bty parameter determines the type of box drawn. See par for details.

Usage

```
box(which = "plot", lty = "solid", ...)
```

Arguments

which character, one of "plot", "figure", "inner" and "outer".

lty line type of the box.

... further graphical parameters, such as bty, col, or lwd, see par. Note that xpd is not accepted as clipping is always to the device region.

Details

The choice of colour is complicated. If col was supplied and is not NA, it is used. Otherwise, if fg was supplied and is not NA, it is used. The final default is par("col").

References

Becker, R. A., Chambers, J. M. and Wilks, A. R. (1988) *The New S Language*. Wadsworth & Brooks/Cole.

See Also

rect for drawing of arbitrary rectangles.

Examples

```
plot(1:7, abs(stats::rnorm(7)), type = "h", axes = FALSE)
axis(1, at = 1:7, labels = letters[1:7])
box(lty = '1373', col = 'red')
```

`boxplot` *Box Plots*

Description

Produce box-and-whisker plot(s) of the given (grouped) values.

Usage

```
boxplot(x, ...)

## S3 method for class 'formula'
boxplot(formula, data = NULL, ..., subset, na.action = NULL,
        xlab = mklab(y_var = horizontal),
        ylab = mklab(y_var =!horizontal),
        add = FALSE, ann = !add, horizontal = FALSE,
        drop = FALSE, sep = ".", lex.order = FALSE)

## Default S3 method:
boxplot(x, ..., range = 1.5, width = NULL, varwidth = FALSE,
        notch = FALSE, outline = TRUE, names, plot = TRUE,
        border = par("fg"), col = "lightgray", log = "",
        pars = list(boxwex = 0.8, staplewex = 0.5, outwex = 0.5),
         ann = !add, horizontal = FALSE, add = FALSE, at = NULL)
```

Arguments

`formula` a formula, such as `y ~ grp`, where `y` is a numeric vector of data values to be split into groups according to the grouping variable `grp` (usually a factor). Note that `~ g1 + g2` is equivalent to `g1:g2`.

`data` a data.frame (or list) from which the variables in `formula` should be taken.

`subset` an optional vector specifying a subset of observations to be used for plotting.

`na.action` a function which indicates what should happen when the data contain `NA`s. The default is to ignore missing values in either the response or the group.

`xlab, ylab` x- and y-axis annotation, since R 3.6.0 with a non-empty default. Can be suppressed by `ann=FALSE`.

`ann` `logical` indicating if axes should be annotated (by `xlab` and `ylab`).

`drop, sep, lex.order`
passed to `split.default`, see there.

`x` for specifying data from which the boxplots are to be produced. Either a numeric vector, or a single list containing such vectors. Additional unnamed arguments specify further data as separate vectors (each corresponding to a component boxplot). `NA`s are allowed in the data.