Package 'conics'

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Type Package

Title Plot Conics

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Description plot conics (ellipses, hyperbolas, parabolas)

License GPL (>= 2)

URL http://www.r-project.org

Collate main.R

Encoding latin1

Imports graphics

R topics documented:

conicAsymptotes *Asymptotes of a conic*

Description

Find the slopes of the asymptotic directions of a conic.

Usage

```
conicAsymptotes(x)
```

Arguments

x	a 6-length vector or a symmetric 3x3 matrix

Details

The conicAsymptotes function calculates the slopes of the asymptotic directions of a conic specified by its coefficients or by its symmetric matrix.

If the equation of the conic is

```
v_1 x_1^2 + v_2 x_1x_2 + v_3 x_2^2 + v_4 x_1 + v_5 x_2 + v_6 = 0
```

the slopes of the asymptotes are the roots of the equation at infinity of the conic:

```
v_1 + v_2 t + v_3 t^2 = 0
```

where t=x_2/x_1.

Value

A vector containing the slopes: two values in the case of a hyperbola or of intersecting lines, one value in the case of a parabola or of parallel lines. In the case of an ellipse (which has no points at infinity), the function returns an empty vector.

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See Also

conicAxes, conicCenter, conicMatrix, conicPlot

Examples

```
# Hyperbola
# Equation: 2*x_1^2 + 2*x_1*x_2 - 2*x_2^2 - 20*x_1 + 20*x_2 + 10 = 0
v <- c(2,2,-2,-20,20,10)
conicAsymptotes(v)

# Ellipse
# Equation: 2*x_1^2 + 2*x_1*x_2 + 2*x_2^2 - 20*x_1 - 28*x_2 + 10 = 0
v <- c(2,2,2,-20,-28,10)
# Should return an empty vector (an ellipse has no asymptotes!):
conicAsymptotes(v)
```

---

conicAxes *Axes of a conic*

Description

Find the symmetry axes of a conic.

Usage

```
conicAxes(x)
```

Arguments

x	a 6-length vector or a symmetric 3x3 matrix

Details

The `conicAxes` function calculates the coordinates of the symmetry axes of a conic specified by its coefficients or by its symmetric matrix.

The direction vectors of the axes are the eigenvectors of the top-left 2x2 submatrix of the matrix representing the conic.

Value

A 2x2 matrix whose columns are the direction vectors of the axes. In order to find the coordinates of the center, see the function `conicCenter`.

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See Also

`conicAsymptotes`, `conicCenter`, `conicMatrix`, `conicPlot`

Examples

```
# Ellipse
# Equation: 2*x_1^2 + 2*x_1*x_2 + 2*x_2^2 - 20*x_1 - 28*x_2 + 10 = 0
v <- c(2,2,2,-20,-28,10)
conicAxes(v)

# Hyperbola
# Equation: 2*x_1^2 + 2*x_1*x_2 - 2*x_2^2 - 20*x_1 + 20*x_2 + 10 = 0
v <- c(2,2,-2,-20,20,10)
conicAxes(v)
```

`conicCenter` *Center of a conic*

Description

Find the center of a conic.

Usage

```
conicCenter(x)
```

Arguments

`x`	a 6-length vector or a symmetric 3x3 matrix

Details

The `conicCenter` function calculates the coordinates of the center of a conic specified by its coefficients or by its symmetric matrix.

Value

A two-elements vector containing the coordinates of the center. If the conic has no center the function raises an error.

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See Also

`conicAsymptotes`, `conicAxes`, `conicMatrix`, `conicPlot`

Examples

```
# Ellipse
# Equation: 2*x_1^2 + 2*x_1*x_2 + 2*x_2^2 - 20*x_1 - 28*x_2 + 10 = 0
v <- c(2,2,2,-20,-28,10)
conicCenter(v)

# Hyperbola
# Equation: 2*x_1^2 + 2*x_1*x_2 - 2*x_2^2 - 20*x_1 + 20*x_2 + 10 = 0
v <- c(2,2,-2,-20,20,10)
conicCenter(v)
```

`conicMatrix` *Matrix representing a conic*

Description

Build a symmetric matrix representing a quadratic polynomial in two variables.

Usage

```
conicMatrix(v)
```

Arguments

v	(vector) a 6-length vector containing the coefficients of a quadratic polynomial.

Details

The v argument is a 6-length vector containing the coefficients of a quadratic polynomial of the form:

```
P(x_1,x_2) = v_1 x_1^2 + v_2 x_1 x_2 + v_3 x_2^2 + v_4 x_1 + v_5 x_2 + v_6
```

The associated quadratic form is:

```
Q(x_1,x_2,x_3) = v_1 x_1^2 + v_2 x_1 x_2 + v_3 x_2^2 + v_4 x_1 x_3 + v_5 x_2 x_3 + v_6 x_3^2
```

Value

Return the symmetric 3x3 matrix representing the associated quadratic form.

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See Also

conicAsymptotes, conicAxes, conicCenter, conicPlot

Examples

```
# Equation: 2*x_1^2 + 2*x_1*x_2 + 2*x_2^2 - 20*x_1 - 28*x_2 + 10 = 0
v <- c(2,2,2,-20,-28,10)
conicMatrix(v)
```

`conicPlot` *Plot a conic*

Description

Plot a conic (ellipse, hyperbola, or parabola) specified by a quadratic polynomial or by a symmetric 3x3 matrix.

Usage

```
conicPlot(x, type=l, npoints=100,
        sym.axes=FALSE, center=FALSE, asymptotes=FALSE,
        add=FALSE, xlim=NULL, ylim=NULL,
        ax.lty=1, ax.col=palette()[1],
        as.lty=1, as.col=palette()[1], ...)
```

Arguments

`x`	a 6-length vector or a symmetric 3x3 matrix
`type`	(`character`) the type of plot to draw (same meaning as with the `plot` function)
`npoints`	(`numeric`) number of points to draw
`sym.axes`	(`logical`) if TRUE, display the axes of the conic
`center`	(`logical`) if TRUE, display the center of the conic (if any)
`asymptotes`	(`logical`) if TRUE, display the asymptotes (hyperbolas)
`add`	(`logical`) if TRUE, plot over the current graphical device
`xlim`	(`vector`) interval for the x-coordinate
`ylim`	(`vector`) interval for the y-coordinate
`ax.lty`	(`character` or `numeric`) line type of the axes
`ax.col`	(`character` or `numeric`) color of the axes
`as.lty`	(`character` or `numeric`) line type of the asymptotes
`as.col`	(`character` or `numeric`) color of the asymptotes
`...`	other parameters passed to the `plot` function

Details

The `conicPlot` function identifies the type of the conic and plots it in the current graphical device.

The conic is specified either by a 6-length vector representing the coefficients of the quadratic polynomial, or by the symmetric matrix representing the associated quadratic form. See the function `conicMatrix` to build this matrix given the coefficients of the polynomial.

It is usually a good idea to set explicitely the aspect ratio to 1 (as an additional argument `asp=1` in the `conicPlot` function) in order to avoid distorsions between the units of the x-axis and the y-axis. See examples below.

Value

The return value is invisible, i-e it is not printed on the console by default but can be stored in a variable. It is a list of relevant computed values corresponding to various elements of the conic. The following elements can be found in the return list, depending on the kind of the conic:

`kind`	the kind of the conic: *"ellipse"*, *"hyperbola"*, *"parabola"*, or *"lines"*.
`axes`	the symmetry axes. See also the function `conicAxes`.
`center`	the center of the conic. See also the function `conicCenter`.
`asymptotes`	the slopes of the asymptotes. See also the function `conicAsymptotes`.
`vertices`	the vertices of the conic.
`foci`	the focal points of the conic.
`eccentricity`	the eccentricity of the conic.
`intercepts`	the intercepts in the case of parallel lines.
`points`	the coordinates of the points used to plot the conic.

The `points` component is returned only if the *type* option is equal to `n` and if the conic is non-degenerate. In that case, nothing is drawn.

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See Also

`conicAsymptotes`, `conicAxes`, `conicCenter`, `conicMatrix`

Examples

```
# Ellipse
# -------
# Equation: 2*x_1^2 + 2*x_1*x_2 + 2*x_2^2 - 20*x_1 - 28*x_2 + 10 = 0
v <- c(2,2,2,-20,-28,10)
conicPlot(v)
v[6] <- 20
conicPlot(v, type=p, col="red", add=TRUE)

# Symmetric matrix
m <- rbind( c(5, -3, -21),
            c(-3, 5, -19),
            c(-21, -19, 93) )
conicPlot(m)

# Hyperbola
# ---------
# Equation: 2*x_1^2 + 2*x_1*x_2 - 2*x_2^2 - 20*x_1 + 20*x_2 + 10 = 0
v <- c(2,2,-2,-20,20,10)
conicPlot(v, center=TRUE, sym.axes=TRUE, asp=1)
conicPlot(v, asymptote=TRUE, as.col="grey30", as.lty=2,
          sym.axes=TRUE, ax.col="red", ax.lty=6, col="blue", asp=1)
```

```
# Parabola
# --------
# Equation: 4*x_1^2 + 4*x_1*x_2 + 1*x_2^2 + 20*x_1 + 20*x_2 + 20 = 0
v <- c(4,4,1,20,20,20)
conicPlot(v, sym.axes=TRUE, ax.lty=2, asp=1)

# Degenerate conics
# -----------------
# Intersecting lines
# Equation:  x_1^2 - 2*x_1*x_2 - 8*x_2^2 - 2*x_1 + 14*x_2 - 3 = 0
v <- c(1,-2,-8,-2,14,-3)
conicPlot(v)
# Parallel lines
# Equation: x_1^2 - 2*x_1*x_2 + x_2^2 + 4*x_1 - 4*x_2 + 3 = 0
v <- c(1,-2,1,4,-4,3)
conicPlot(v)
# Coincident lines
# Equation: 4*x_1^2 + 12*x_1*x_2 + 9*x_2^2 - 4*x_1 - 6*x_2 + 1 = 0
v <- c(4,12,9,-4,-6,1)
conicPlot(v)

# Return value
# ------------
v <- c(2,2,2,-20,-28,10)
cp <- conicPlot(v)
cp$kind
cp$vertices
cp$center
cp$axes
cp <- conicPlot(v,type=n)
cp$points
```

`conics` *~ Conics plotting ~*

Description

Package:	conics
Type:	Package
Version:	0.3
Date:	2013-12-10
License:	GPL (>= 2)

Details

The `conics` package provides simple functions to plot conics. A conic is a plane algebraic curve of degree 2: it is the set of zeroes of a polynomial of degree 2 in 2 variables, that is to say the set of points `(x_1,x_2)` satisfying an equation of the form

```
P(x_1,x_2) = v_1 x_1^2 + v_2 x_1x_2 + v_3 x_2^2 + v_4 x_1 + v_5 x_2 + v_6 = 0
```

Non-degenerate conics include the ellipses, the hyperbolas and the parabolas. Degenerate conics are pairs of lines.

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References

For more information about the algebraic background of conics and their matrix representation, see the vignette accompanying this package. To display the vignette, type the following instruction in the R console :

```
> vignette("conics")
```

See Also

The following functions are available: conicAsymptotes, conicAxes, conicCenter, conicMatrix, conicPlot

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