Package 'HilbertVis'

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Title Hilbert curve visualization

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Suggests IRanges, EBImage

Description Functions to visualize long vectors of integer data by means of Hilbert curves

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Contents

hilbertCurve 2
hilbertImage 3
makeRandomTestData 4
makeWiggleVector 5
plotHilbertCurve 6
plotLongVector 6
showHilbertImage 7
shrinkVector 8

Index **10**

hilbertCurve *calculate finite approximations of the Hilbert curve*

Description

These functions calculate the Hilbert curve in its finite approximations. `hilbertCurvePoint` gives the coordinates of one point and `hilbertCurve` returns an array with the coordinates of all `4^lv` points. The functions are not needed for `hilbertImage` and only provided for demonstration purposes. `plotHilbertCurve` makes use of them.

Usage

```
hilbertCurve( lv )
hilbertCurvePoint( t, lv )
```

Arguments

`lv`	The iteration level. A Hilbert curve of level `lv` spans a square with side length `2^lv` (coordinates ranging from 0 to `2^lv-1`) and has `4^lv` points.
`t`	The point index in the Hilbert curve. Must be an integer in `0:(4^lv-1)`.

Value

`hilbertCurvePoint` returns a vector of two integer numbers, both in the range `0:(2^lv-1)`, indicating the coordinates of point `t`. `huilbertCurve` returns a matrix with `4^lv` rows and 2 columns, giving all points of the curve at level `lv`.

Author(s)

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See Also

`plotHilbertCurve`

Examples

```
hilbertCurvePoint( 67, 4 )
hilbertCurve( 4 )
```

`hilbertImage` *Produce a matrix that visualizes a long data vector along a Hilbert curve*

Description

Calculate a Hilbert curve visualization of a long data vector and return it as a square matrix.

Usage

```
hilbertImage(data, level = 9, mode = "absmax")
```

Arguments

`data`	A (potentially very long) vector of numerical data.
`level`	The level of the Hilbert curve, determining the size of the returned matrix
`mode`	The binning mode. See `shrinkVector` for details.

Details

See the package vignette for an explanation of this visualization technique.

Value

A matrix of dimension `2^level` x `2^level`. Each matrix element corresponds to a bin of consecutive elements of the data vector, the bins arranged to follow the Hilbert curve of the given level. By default, the value of a matrix element is either the largest or smallest element in the bin, whichever is larger by absolute value. (See `shrinkVector` for other possible binning modes.)

To display such a matrix graphically, you can use the standard functions `image` or `levelplot` but the function `showHilbertImage` may be more convenient.

Note

For an interactive GUI to explore a Hilbert curve visualisation, use the function `hilbertDisplay` in the `HilbertVisGUI` package.

Author(s)

Simon Anders, EMBL-EBI, sanders@fs.tum.de

Examples

```
# Get a vector with example data
dataVec <- makeRandomTestData( )

# Plot it in conventional (linear) fashion
plotLongVector( dataVec )

# Note how the peaks look quite uniform

# Get the Hilbert curve matrix
hMat <- hilbertImage( dataVec )
```

```
# Plot it with the 'showHilbertImage' function
showHilbertImage( hMat )

# Note how you can now see the non-uniformity hidden in the previous plot.
# Note also the ugly aliasing when you change the size of the plot window.
# Using EBImage allows to display in each matrix element as one pixel:

# if( require ( EBImage ) )
#    showHilbertImage( hMat, mode="EBImage" )
```

`makeRandomTestData` *generate a long vector of example data that is suitable to demonstrate the Hilbert curve visualisation*

Description

This function generates a long numeric vector and fills it with many narrow Gaussian peaks of varying width and position. Around 30 the distribution of peak width is changed to be substantially larger. This feature is easily visible with the Hilbert curve visualization but much harder to spot with conventional 1D plots.

Usage

```
makeRandomTestData(len = 1e+07, numPeaks = 500)
```

Arguments

`len`	Length of the vector
`numPeaks`	Number of peaks to be placed in the vector

Value

A vector, of type 'numeric', with sample data.

Author(s)

Simon Anders, EMBL-EBI, sanders@fs.tum.de

Examples

```
# See the help page of function 'hilbertImage' for an example.
```

makeWiggleVector *generate a "wiggle vector" from start/end/value data*

Description

Given intervals in the form of a "start" and an "end" vectors and corresponding values, generate a "wiggle vector" of a given length that contains the specified values in the vector elements indicated by the intervals.

Usage

```
makeWiggleVector(start, end, value, chrlength )
```

Arguments

start	The start coordinates of the intervals. As usual in R, these are 1-based.
end	The end coordinates of the intervals. As usual, the end points are included.
value	The values to be put in the wiggle vector. Where intervals overlap, the values are added.
chrlength	The desired length of the returned vector.

Value

A vector as described above.

Author(s)

Simon Anders, EMBL-EBI, sanders\@fs.tum.de

See Also

For a value vector containing only ones, this function acts similar as the pileup function in the ShortRead package.

Examples

```
intervalStarts <- c(3,10,17,22)
intervalEnds <- c(7,13,20,26)
values <- c(2, 1.5, .3, 4)
chrlength <- 30
wig <- makeWiggleVector( intervalStarts, intervalEnds, values, chrlength )
# The same effect can be achieved with the following R code, which, however
# is much slower:
wig2 <- numeric(chrlength)
for( i in 1:length(values) )
   wig2[ intervalStarts[i]:intervalEnds[i] ] <-
      wig2[ intervalStarts[i]:intervalEnds[i] ] + values[i]
# Let's check that we got the same:
all( wig == wig2 )
```

plotHilbertCurve *Plotting the Hilbert curve (for demonstation purposes).*

Description

This function plots the Hilbert curve fractal at a chosen iteration level in order to give you an impression how it looks like.

Usage

```
plotHilbertCurve( lv, new.page = TRUE )
```

Arguments

lv	The iteration level. A Hilbert curve of level lv spans a square with side length 2^lv (coordinates ranging from 0 to 2^lv-1) and has 4^lv points. Values lv > 7 will take very long and yield a cluttered mesh of indistuingishable lines.
new.page	Boolean indicating whether to start a new graphics page (default: yes).

Value

An invisble NULL is returned. Furthermore, a plot is created.

Author(s)

Simon Anders, EMBL-EBI, <sanders@fs.tum.de>

See Also

hilbertCurve

Examples

```
plotHilbertCurve( 3 )
```

plotLongVector *A simple function to plot a very long vector.*

Description

This function does basically the same as just calling plot(vec) but is much faster in case of a very long vector. This is because it first calls shrinkVector.

Usage

```
plotLongVector(vec, offset = 1, shrinkLength = 4000, xlab = "", ylab = "", ...)
```

Arguments

vec	The numerical vector to be plotted. May be an ordinary or an IRanges::Rle vector.
offset	The x axis is labelled with numbers from offset to offset+length(vec)-1.
shrinkLength	To which length to shrink the vector before plotting it. Should be at least the width of your plot in pixels.
xlab	The label of the x axis, to be passed to plot.
ylab	The label of the y axis, to be passed to plot.
...	Further arguments to be passed to plot.

Value

Invisible Null and a plot.

Author(s)

Simon Anders, EMBL-EBI, sanders@fs.tum.de

Examples

```
plotLongVector( rep( 1:100000, 20 ) )
```

---

showHilbertImage *display a hilbert*

Description

A convenient wrapper around levelplot to display a hilbert image matrix as it is returned by hilbertImage. Alternatively to levelplot, EBImage is available as well.

Usage

```
showHilbertImage( mat,
   palettePos = colorRampPalette(c("white", "red"))(300),
   paletteNeg = colorRampPalette(c("white", "blue"))(300),
   maxPaletteValue = max(abs(mat)),
   mode = c("lattice", "EBImage", "EBImage-batch") )
```

Arguments

mat	The matrix to be displayed. In principle this can be any matrix, but typically, it is one returned by hilbertImage.
palettePos	The colour palette to be used for the positive entries in mat (including 0).
paletteNeg	The colour palette to be used for the negative entries in mat.
maxPaletteValue	The absolute value to which the right end of the palettes should correspond. (The left ends correspond to 0.)

mode — For mode "lattice", the function `levelplot` from the `lattice` package is used. An (invisible) lattice object is returned that can be displayed with `show`. In interactive mode, the image is displayed automatically. For mode "EBImage" the image is displayed with the `EBImage` package, and for "EBImage-batch", the same image is produced and not displayed but rather returned as a value suitable to be passed to EBImage's `display` function.

Value

A lattice or EBImage graphics object. For all modes except "EBImage-batch" it is marked "invisible".

Author(s)

Simon Anders, EMBL-EBI (sanders\@fs.tum.de)

See Also

`hilbertImage`

Examples

```
# See ?hilbertImage for examples.
```

---

shrinkVector — *shrink a vector by partitioning it into bins and taking the maxima in the bins*

Description

Given a (potentially very long) vector, the vector is partitioned into a given number of (up to rounding errors) equally long bins, and a vector summerizing each of the bins with one number it returned.

Usage

```
shrinkVector(vec, newLength,  mode = c("max", "min", "absmax", "mean"))
```

Arguments

vec — The vector to be shrunk. May be an ordinary numeric or integer vector or an IRanges::Rle vector.

newLength — The desired size of the return vector, i.e., the number of partitions

mode — the summerization mode: 'max': take the maximal value of each bin; 'min': take the minimal value of each bin; 'absmax': take the value with largest absolute value; 'mean': take the mean of the bin values.

Value

A vector of length `newLength` with the summary values of each of the bin of `vector`.

Author(s)

Simon Anders, EMBL-EBI (sanders\@fs.tum.de)

See Also

plotLongVector, Rsamtools::pileup, HilbertVisGui::simpleLinPlot

Examples

```
shrinkVector( 100000 + 1:1000, 17 )
```

Index

hilbertCurve, 2, *6*
hilbertCurvePoint *(*hilbertCurve*)*, 2
hilbertDisplay, *3*
hilbertImage, *2*, 3, *7, 8*
HilbertVisGui::simpleLinPlot, *9*

makeRandomTestData, 4
makeWiggleVector, 5

plot, *7*
plotHilbertCurve, *2*, 6
plotLongVector, 6, *9*

Rsamtools::pileup, *9*

showHilbertImage, *3*, 7
shrinkVector, *3*, *6*, 8