Package ‘HilbertVis’

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Description Functions to visualize long vectors of integer data by means of Hilbert curves
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R topics documented:

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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 $4^l$ 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. hilbertCurve 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 )

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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 $2^{\text{level}} \times 2^{\text{level}}$. 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

```r
# 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.

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
plotHilbertCurve

See Also

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

Examples

```r
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 )
```

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

```r
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 indistinguishable lines.
- **new.page**: Boolean indicating whether to start a new graphics page (default: yes).

Value

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

Author(s)

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See Also

- `hilbertCurve`
**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**

```r
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**

```r
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**

```r
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)**

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**See Also**

- `hilbertImage`

**Examples**

```r
# 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 summarizing 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 summarization 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 )
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