Package ‘rtracklayer’

April 26, 2017

Title R interface to genome browsers and their annotation tracks

Version 1.36.0

Author Michael Lawrence, Vince Carey, Robert Gentleman

Depends R (&gt;= 3.3), methods, GenomicRanges (&gt;= 1.21.20)
Imports XML (&gt;= 1.98-0), BiocGenerics (&gt;= 0.13.8), S4Vectors (&gt;= 0.13.13), IRanges (&gt;= 2.3.7), XVector (&gt;= 0.9.4), GenomeInfoDb (&gt;= 1.3.14), Biostrings (&gt;= 2.43.7), zlibbioc, RCurl (&gt;= 1.4-2), Rsamtools (&gt;= 1.17.8), GenomicAlignments (&gt;= 1.5.4), tools

Suggests BSgenome (&gt;= 1.33.4), humanStemCell, microRNA (&gt;= 1.1.1), genefilter, limma, org.Hs.eg.db, hgu133plus2.db, GenomicFeatures, BSgenome.Hsapiens.UCSC.hg19, TxDb.Hsapiens.UCSC.hg19.knownGene, RUnit

LinkingTo S4Vectors, IRanges, XVector

Description Extensible framework for interacting with multiple genome browsers (currently UCSC built-in) and manipulating annotation tracks in various formats (currently GFF, BED, bedGraph, BED15, WIG, BigWig and 2bit built-in). The user may export/import tracks to/from the supported browsers, as well as query and modify the browser state, such as the current viewport.

Maintainer Michael Lawrence &lt;michafla@gene.com&gt;

License Artistic-2.0 + file LICENSE


bioCViews Annotation, Visualization, DataImport

NeedsCompilation yes

R topics documented:

activeView-methods ............................................................... 3
asBED ................................................................. 3
asGFF ............................................................... 4
BamFile-methods .......................................................... 5
BasicTrackLine-class ....................................................... 6
R topics documented:

- Bed15TrackLine-class ............................................. 7
- BEDFile-class ....................................................... 8
- BigWigFile-class .................................................... 12
- BigWigSelection-class ............................................. 14
- blocks-methods ...................................................... 15
- browseGenome ....................................................... 16
- BrowserSession-class .............................................. 17
- browserSession-methods .......................................... 18
- BrowserView-class .................................................. 19
- browserView-methods ............................................... 20
- BrowserViewList-class ............................................. 20
- browserViews-methods .............................................. 21
- Chain-class .......................................................... 21
- cpneTrack ............................................................. 22
- FastaFile-class ....................................................... 23
- genomeBrowsers ..................................................... 24
- GenomicData ........................................................ 25
- GenomicSelection .................................................... 26
- GFFFile-class ........................................................ 26
- GRangesForUCSCGenome ........................................... 30
- GraphTrackLine-class .............................................. 31
- io ........................................................................ 32
- liftOver ................................................................. 35
- Quickload-class ....................................................... 36
- QuickloadGenome-class ............................................. 36
- RangesList-methods .................................................. 38
- readGFF .................................................................. 39
- RTLFile-class .......................................................... 40
- sequence<–methods ................................................... 41
- TabixFile-methods ..................................................... 41
- targets ................................................................. 42
- track<–methods ......................................................... 43
- TrackDb-class .......................................................... 44
- TrackLine-class ........................................................ 44
- tracks-methods ........................................................ 45
- TwoBitFile-class ........................................................ 46
- UCSCData-class ....................................................... 47
- UCSCFile-class ......................................................... 48
- ucsGenomes ............................................................ 50
- UCSCSchema-class .................................................... 51
- UCSCSession-class ................................................... 52
- UCSCTableQuery-class .............................................. 53
- UCSCTrackModes-class ............................................. 55
- ucsTrackModes-methods ............................................. 56
- UCSCView-class ....................................................... 57
- WIGFile-class .......................................................... 58
- wigToBigWig ............................................................ 61

Index 62
activeView-methods  Accessing the active view

Description
Get the active view.

Methods
The following methods are defined by `rtracklayer`.

```r
object = "BrowserSession" activeView(object): Gets the active `BrowserView` from a browser session.
activeView(object) <- value: Sets the active `BrowserView` in a browser session.
```

asBED  Coerce to BED structure

Description
Coerce the structure of an object to one following BED-like conventions, i.e., with columns for blocks and thick regions.

Usage
```r
asBED(x, ...) 
## S4 method for signature 'GRangesList'
asBED(x)
## S4 method for signature 'GAlignments'
asBED(x)
```

Arguments
- `x` Generally, a tabular object to structure as BED
- `...` Arguments to pass to methods

Details
The exact behavior depends on the class of object.

```r
GRangesList  This treats object as if it were a list of transcripts, i.e., each element contains the exons of a transcript. The blockStarts and blockSizes columns are derived from the ranges in each element. Also, add name column from names(object).
GAlignments  Converts to GRangesList via grglist and procedes accordingly.
```

Value
A GRanges, with the columns name, blockStarts and blockSizes added.
asGFF

Coerce to GFF structure

Description

Coerce the structure of an object to one following GFF-like conventions, i.e., using the Parent GFF3 attribute to encode the hierarchical structure. This object is then suitable for export as GFF3.

Usage

```r
asGFF(x, ...)  
## S4 method for signature 'GRangesList'
asGFF(x, parentType = "mRNA", childType = "exon")
```

Arguments

- `x` Generally, a tabular object to structure as GFF(3)
- `parentType` The value to store in the type column for the top-level (e.g., transcript) ranges.
- `childType` The value to store in the type column for the child (e.g., exon) ranges.
- `...` Arguments to pass to methods

Value

For the GRangesList method: A GRanges, with the columns: ID (unique identifier), Name (from names(x), and the names on each element of x, if any), type (as given by parentType and childType), and Parent (to relate each child range to its parent at the top-level).

Author(s)

Michael Lawrence

Examples

```r
## Not run:
library(TxDb.Hsapiens.UCSC.hg19.knownGene)
exons <- exonsBy(TxDb_Hsapiens_UCSC_hg19_knownGene)
mcols(asBED(exons))
## End(Not run)
```
BamFile-methods

Export to BAM Files

Description

Methods for import and export of GAlignments or GAlignmentPairs objects from and to BAM files, represented as BamFile objects.

Usage

## S4 method for signature 'BamFile,ANY,ANY'
import(con, format, text, paired = FALSE,
        use.names = FALSE,
        param = ScanBamParam(...),
        genome = NA_character_, ...)

## S4 method for signature 'ANY,BamFile,ANY'
export(object, con, format, ...)

Arguments

object The object to export, such as a GAlignments or GAlignmentPairs.
con A path, URL, connection or BamFile object.
format If not missing, should be "bam".
text Not supported.
paired If TRUE, return a GAlignmentPairs object, otherwise a GAlignments.
use.names Whether to parse QNAME as the names on the result.
param The ScanBamParam object governing the import.
genome Single string or Seqinfo object identifying the genome.
... Arguments that are passed to ScanBamParam if param is missing.

Details

BAM fields not formally present in the GAlignments[Pairs] object are extracted from the metadata columns, if present; otherwise, the missing value, """, is output. The file is sorted and indexed. This can be useful for subsetting BAM files, although filterBam may eventually become flexible enough to be the favored alternative.

Author(s)

Michael Lawrence

See Also

The readGAlignments and readGAlignmentPairs functions for reading BAM files.
Examples

```r
library(Rsamtools)
ex1_file <- system.file("extdata", "ex1.bam", package="Rsamtools")
gal <- import(ex1_file, param=ScanBamParam(what="flag"))
gal.minus <- gal[strand(gal) == "+-"]
## Not run:
export(gal, BamFile("ex1-minus.bam"))
## End(Not run)
```

BasicTrackLine-class  
Class "BasicTrackLine"

Description
The type of UCSC track line used to annotate most types of tracks (every type except Wiggle).

Objects from the Class
Objects can be created by calls of the form new("BasicTrackLine", ...) or parsed from a character vector track line with as(text, "BasicTrackLine") or converted from a GraphTrackLine using as(wig, "BasicTrackLine").

Slots
- `itemRgb`: Object of class "logical" indicating whether each feature in a track uploaded as BED should be drawn in its specified color.
- `useScore`: Object of class "logical" indicating whether the data value should be mapped to color.
- `group`: Object of class "character" naming a group to which this track should belong.
- `db`: Object of class "character" indicating the associated genome assembly.
- `offset`: Object of class "numeric", a number added to all positions in the track.
- `url`: Object of class "character" referring to additional information about this track.
- `htmlUrl`: Object of class "character" referring to an HTML page to be displayed with this track.
- `name`: Object of class "character" specifying the name of the track.
- `description`: Object of class "character" describing the track.
- `visibility`: Object of class "character" indicating the default visible mode of the track, see UCSCTrackModes.
- `color`: Object of class "integer" representing the track color (as from col2rgb).
- `colorByStrand`: Object of class "matrix" with two columns, as from col2rgb. The two colors indicate the color for each strand (positive, negative).
- `priority`: Object of class "numeric" specifying the rank of the track.

Extends
Class "TrackLine", directly.
**Methods**

as(object, "character") Export line to its string representation.

as(object, "GraphTrackLine") Convert this line to a graph track line, using defaults for slots not held in common.

**Author(s)**

Michael Lawrence

**References**

http://genome.ucsc.edu/goldenPath/help/customTrack.html#TRACK for the official documentation.

**See Also**

GraphTrackLine for Wiggle/bedGraph tracks.

---

**Description**

A UCSC track line for graphical tracks.

**Objects from the Class**

Objects can be created by calls of the form `new("Bed15TrackLine", ...)` or parsed from a character vector track line with `as(text, "Bed15TrackLine")`.

**Slots**

- expStep: A "numeric" scalar indicating the step size for the heatmap color gradient.
- expScale: A positive "numeric" scalar indicating the range of the data to be \([-\text{expScale}, \text{expScale}]\) for determining the heatmap color gradient.
- expNames: A "character" vector naming the experimental samples.
- name: Object of class "character" specifying the name of the track.
- description: Object of class "character" describing the track.
- visibility: Object of class "character" indicating the default visible mode of the track, see `UCSTrackModes`.
- color: Object of class "integer" representing the track color (as from `col2rgb`).
- priority: Object of class "numeric" specifying the rank of this track.

**Extends**

Class "TrackLine", directly.

**Methods**

as(object, "character") Export line to its string representation.
Author(s)

Michael Lawrence

References


See Also

export.bed15 for exporting bed15 tracks.

BEDFile-class

BEDFile objects

Description

These functions support the import and export of the UCSC BED format and its variants, including BEDGraph.

Usage

## S4 method for signature 'BEDFile,ANY,ANY'
import(con, format, text, trackLine = TRUE,
      genome = NA, colnames = NULL,
      which = NULL, seqinfo = NULL, extraCols = character())

import.bed(con, ...)
import.bed15(con, ...)
import.bedGraph(con, ...)

## S4 method for signature 'ANY,BEDFile,ANY'
export(object, con, format, ...)
## S4 method for signature 'GenomicRanges,BEDFile,ANY'
export(object, con, format,
       append = FALSE, index = FALSE,
       ignore.strand = FALSE, trackLine = NULL)

## S4 method for signature 'UCSCData,BEDFile,ANY'
export(object, con, format,
       trackLine = TRUE, ...)

eexport.bed(object, con, ...)
export.bed15(object, con, ...)

## S4 method for signature 'GenomicRanges,BED15File,ANY'
export(object, con, format,
       expNames = NULL, trackLine = NULL, ...)
export.bedGraph(object, con, ...)

Arguments

con

A path, URL, connection or BEDFile object. For the functions ending in .bed, .bedGraph and .bed15, the file format is indicated by the function name. For the base export and import functions, the format must be indicated another way. If con is a path, URL or connection, either the file extension or the format
argument needs to be one of “bed”, “bed15”, “bedGraph” or “bedpe”. Compressed files (“gz”, “bz2” and “xz”) are handled transparently.

**object**
The object to export, should be a GRanges or something coercible to a GRanges. If targeting the BEDPE format, this should be something coercible to Pairs. If the object has a method for asBED (like GRangesList), it is called prior to coercion. This makes it possible to export a GRangesList or TxDb in a way that preserves the hierarchical structure. For exporting multiple tracks, in the UCSC track line metaformat, pass a GenomicRangesList, or something coercible to one.

**format**
If not missing, should be one of “bed”, “bed15”, “bedGraph” or “bedpe”.

**text**
If `con` is missing, a character vector to use as the input

**trackLine**
For import, an imported track line will be stored in a TrackLine object, as part of the returned UCSCData. For the UCSCData method on export, whether to output the UCSC track line stored on the object, for the other export methods, the actual TrackLine object to export.

**genome**
The identifier of a genome, or a Seqinfo, or NA if unknown. Typically, this is a UCSC identifier like “hg19”. An attempt will be made to derive the seqinfo on the return value using either an installed BSgenome package or UCSC, if network access is available.

**colnames**
A character vector naming the columns to parse. These should name columns in the result, not those in the BED spec, so e.g. specify “thick”, instead of “thickStart”.

**which**
A GRanges or other range-based object supported by `findOverlaps`. Only the intervals in the file overlapping the given ranges are returned. This is much more efficient when the file is indexed with the tabix utility.

**index**
If TRUE, automatically compress and index the output file with bgzf and tabix. Note that tabix indexing will sort the data by chromosome and start. Tabix supports a single track in a file.

**ignore.strand**
Whether to output the strand when not required (by the existence of later fields).

**seqinfo**
If not NULL, the Seqinfo object to set on the result. Ignored if genome is a Seqinfo object. If the genome argument is not NA, it must agree with genome(seqinfo).

**extraCols**
A character vector in the same form as colClasses from `read.table`. It should indicate the name and class of each extra/special column to read from the BED file. As BED does not encode column names, these are assumed to be the last columns in the file. This enables parsing of the various BEDX+Y formats.

**append**
If TRUE, and `con` points to a file path, the data is appended to the file. Obviously, if `con` is a connection, the data is always appended.

**expNames**
character vector naming columns in `mcols(object)` to export as data columns in the BED15 file. These correspond to the sample names in the experiment. If NULL (the default), there is an attempt to extract these from `trackLine`. If the attempt fails, no scores are exported.

**...**
Arguments to pass down to methods to other methods. For import, the flow eventually reaches the BEDFile method on import. When `trackLine` is TRUE or the target format is BED15, the arguments are passed through `export.ucsc`, so track line parameters are supported.
Details

The BED format is a tab-separated table of intervals, with annotations like name, score and even sub-intervals for representing alignments and gene models. Official (UCSC) child formats currently include BED15 (adding a number matrix for e.g. expression data across multiple samples) and BEDGraph (a compressed means of storing a single score variable, e.g. coverage; overlapping features are not allowed). Many tools and organizations have extended the BED format with additional columns for particular use cases. The advantage of BED is its balance between simplicity and expressiveness. It is also relatively scalable, because only the first three columns (chrom, start and end) are required. Thus, BED is best suited for representing simple features. For specialized cases, one is usually better off with another format. For example, genome-scale vectors belong in BigWig, alignments from high-throughput sequencing belong in BAM, and gene models are more richly expressed in GFF.

The following is the mapping of BED elements to a GRanges object. NA values are allowed only where indicated. These appear as a “.” in the file. Only the first three columns (chrom, start and end) are required. The other columns can only be included if all previous columns (to the left) are included. Upon export, default values are used to automatically pad the table, if necessary.

- **chrom, start, end** the ranges component.
- **name** character vector (NA’s allowed) in the name column; defaults to NA on export.
- **score** numeric vector in the score column, accessible via the score accessor. Defaults to 0 on export. This is the only column present in BEDGraph (besides chrom, start and end), and it is required.
- **strand** strand factor (NA’s allowed) in the strand column, accessible via the strand accessor; defaults to NA on export.
- **thickStart, thickEnd** Ranges object in a column named thick; defaults to the ranges of the feature on export.
- **itemRgb** an integer matrix of color codes, as returned by col2rgb, or any valid input to col2rgb, in the itemRgb column; default is NA on export, which translates to black.
- **blockSizes, blockStarts, blockCounts** RangesList object in a column named blocks; defaults to empty upon BED15 export.

For BED15 files, there should be a column of scores in mcols(object) for each sample in the experiment. The columns are named according to the expNames (found in the file, or passed as an argument during export). NA scores are stored as “-10000” in the file.

Value

For a “bedpe” file, a Pairs object combining two GRanges. The name and score are carried over to the metadata columns.

Otherwise, a GRanges with the metadata columns described in the details.

BEDX+Y formats

To import one of the multitude of BEDX+Y formats, such as those used to distribute ENCODE data through UCSC (narrowPeaks, etc), specify the extraCols argument to indicate the expected names and classes of the special columns. We assume that the last length(extraCols) columns are special, and that the preceding columns adhere to the BED format.
**BEDFile-class**

**BEDFile objects**

The BEDFile class extends RTLFile and is a formal representation of a resource in the BED format. To cast a path, URL or connection to a BEDFile, pass it to the BEDFile constructor. Classes and constructors also exist for the subclasses BED15File, BEDGraphFile and BEDPEFile.

**Author(s)**

Michael Lawrence

**References**

http://genome.ucsc.edu/goldenPath/help/customTrack.html http://bedtools.readthedocs.org/en/latest/content/general-usage.html

**Examples**

```r
test_path <- system.file("tests", package = "rtracklayer")
test_bed <- file.path(test_path, "test.bed")

test <- import(test_bed)
test

test_bed_file <- BEDFile(test_bed)
import(test_bed_file)

test_bed_con <- file(test_bed)
import(test_bed_con, format = "bed")
close(test_bed_con)

import(test_bed, trackLine = FALSE)
import(test_bed, genome = "hg19")
import(test_bed, colnames = c("name", "strand", "thick"))

which <- GRanges("chr7:1-127473000")
import(test_bed, which = which)

bed15_file <- file.path(test_path, "test.bed15")
bed15 <- import(bed15_file)

## Not run:
test_bed_out <- file.path(tempdir(), "test.bed")
export(test, test_bed_out)

test_bed_out_file <- BEDFile(test_bed_out)
export(test, test_bed_out_file)

export(test, test_bed_out, name = "Alternative name")

test_bed_gz <- paste(test_bed_out, ".gz", sep = "")
export(test, test_bed_gz)

export(test, test_bed_out, index = TRUE)
export(test, test_bed_out, index = TRUE, trackLine = FALSE)

bed_text <- export(test, format = "bed")
test <- import(format = "bed", text = bed_text)
```
test_bed15_out <- file.path(tempdir(), "test.bed15")
export(bed15, test_bed15_out) # UCSCData knows the expNames
export(as(bed15, "GRanges"), test_bed15_out, # have to specify expNames
    expNames=paste0("breast_", c("A", "B", "C")))

## End(Not run)

BigWigFile-class  BigWig Import and Export

Description

These functions support the import and export of the UCSC BigWig format, a compressed, binary form of WIG/BEDGraph with a spatial index and precomputed summaries. These functions do not work on Windows.

Usage

### S4 method for signature 'BigWigFile,ANY,ANY'
import(con, format, text,
    selection = BigWigSelection(which, ...),
    which = con,
    as = c("GRanges", "RleList", "NumericList"), ...)
import.bw(con, ...)

### S4 method for signature 'ANY,BigWigFile,ANY'
export(object, con, format, ...)
### S4 method for signature 'GenomicRanges,BigWigFile,ANY'
export(object, con, format,
    dataFormat = c("auto", "variableStep", "fixedStep",
        "bedGraph"), compress = TRUE, fixedSummaries = FALSE)
export.bw(object, con, ...)

Arguments

- **con**
  A path, URL or BigWigFile object. Connections are not supported. For the functions ending in `.bw`, the file format is indicated by the function name. For the export and import methods, the format must be indicated another way. If `con` is a path, or URL, either the file extension or the `format` argument needs to be “bigWig” or “bw”.

- **object**
  The object to export, should be an RleList, IntegerList, NumericList, GRanges or something coercible to a GRanges.

- **format**
  If not missing, should be “bigWig” or “bw” (case insensitive).

- **text**
  Not supported.

- **as**
  Specifies the class of the return object. Default is GRanges, which has one range per range in the file, and a score column holding the value for each range. For NumericList, one numeric vector is returned for each range in the selection argument. For RleList, there is one Rle per sequence, and that Rle spans the entire sequence.
A **BigWigSelection** object indicating the ranges to load.

A range data structure coercible to **RangesList**, like a **GRanges**, or a **BigWigFile**. Only the intervals in the file overlapping the given ranges are returned. By default, the value is the **BigWigFile** itself. Its **Seqinfo** object is extracted and coerced to a **RangesList** that represents the entirety of the file.

**dataFormat**

Probably best left to “auto”. Exists only for historical reasons.

**compress**

If **TRUE**, compress the data. No reason to change this.

**fixedSummaries**

If **TRUE**, compute summaries at fixed resolutions corresponding to the default zoom levels in the Ensembl genome browser (with some extrapolation): 30X, 65X, 130X, 260X, 450X, 648X, 950X, 1296X, 4800X, 19200X. Otherwise, the resolutions are dynamically determined by an algorithm that computes an initial summary size by initializing to 10X the size of the smallest feature and doubling the size as needed until the size of the summary is less than half that of the data (or there are no further gains). It then computes up to 10 more levels of summary, quadrupling the size each time, until the summaries start to exceed the sequence size.

**Arguments to pass down to methods to other methods.** For import, the flow eventually reaches the **BigWigFile** method on **import**.

**Value**

A **GRanges** (default), **RleList** or **NumericList**. **GRanges** return ranges with non-zero score values in a score metadata column. The length of the **NumericList** is the same length as the selection argument (one list element per range). The return order in the **NumericList** matches the order of the **BigWigSelection** object.

**BigWigFile objects**

A **BigWigFile** object, an extension of **RTLFile** is a reference to a BigWig file. To cast a path, URL or connection to a **BigWigFile**, pass it to the **BigWigFile** constructor.

**BigWig files** are more complex than most track files, and there are a number of methods on **BigWigFile** for accessing the additional information:

```R
seqinfo(x): Gets the **Seqinfo** object indicating the lengths of the sequences for the intervals in the file. No circularity or genome information is available.

summary(ranges = as(seqinfo(object), "GenomicRanges"), size = 1L, type = c("mean", "min", "max", "coverage", "sd"), defaultValue = NA_real_):
Aggregates the intervals in the file that fall into ranges, which should be something coercible to **GRanges**. The aggregation essentially compresses each sequence to a length of size. The algorithm is specified by type; available algorithms include the mean, min, max, coverage (percent sequence covered by at least one feature), and standard deviation. When a window contains no features, **defaultValue** is assumed. The result is an **RleList**, with an element for each element in ranges. The driving use case for this is visualization of coverage when the screen space is small compared to the viewed portion of the sequence. The operation is very fast, as it leverages cached multi-level summaries present in every BigWig file.

If a summary statistic is not available / cannot be computed for a given range a warning is thrown and the **defaultValue** **NA_real_** is returned.

**BigWigFileList objects**

A **BigWigFileList**() provides a convenient way of managing a list of **BigWigFile** instances.
BigWigSelection-class

Author(s)

Michael Lawrence

See Also

wigToBigWig for converting a WIG file to BigWig.

Examples

```r
if (! Sys.isunix()) {
  test_path <- system.file("tests", package = "rtracklayer")
  test_bw <- file.path(test_path, "test.bw")

  # GRanges
  # Returns ranges with non-zero scores.
  which <- GRanges(c("chr2", "chr2"), IRanges(c(1, 300), c(400, 1000)))
  import(test_bw, which = which)

  # RleList
  # Scores returned as an RleList is equivalent to the coverage.
  mini <= narrow(unlist(tile(which, 50)), 2)
  rle <- import(test_bw, which = mini, as = "RleList")
  rle

  # NumericList
  # The 'which' is stored as metadata:
  track <- import(test_bw, which = which, as = "NumericList")
  metadata(track)

  # Not run:
  test_bw_out <- file.path(tempdir(), "test_out.bw")
  export(test, test_bw_out)

  # End(Not run)
}
```

```r
bwf <- BigWigFile(test_bw)
track <- import(bwf)

seqinfo(bwf)

summary(bwf) # for each sequence, average all values into one
summary(bwf, range(head(track))) # just average the first few features
summary(bwf, size = seqlengths(bwf) / 10) # 10X reduction
summary(bwf, type = "min") # min instead of mean
```
Description

A BigWigSelection represents a query against a BigWig file, see `import.bw`. It is simply a RangedSelection that requires its colnames parameter to be "score", if non-empty, as that is the only column supported by BigWig.

Constructor

BigWigSelection(ranges = GRanges(), colnames = "score"): Constructs a BigWigSelection with the given ranges and colnames. ranges can be either something coercible to a RangesList, a character identifying a genome (see GenomicSelection), or a BigWigFile, in which case the ranges are derived from the bounds of its sequences.

Coercion

as(from, "BigWigSelection"): Coerces from to a BigWigSelection object. Typically, from is a GRanges or a RangesList, the ranges of which become the ranges in the new BigWigSelection.

Author(s)

Michael Lawrence

Examples

```r
rl <- IRanges::RangesList(chr1 = IRanges::IRanges(c(1, 5), c(3, 6)))
BigWigSelection(rl)
```

```
as(rl, "BigWigSelection")  # same as above
```

```
# do not select the `score` column
BigWigSelection(rl, character())
```

blocks-methods

Get blocks/exons

Description

Obtains the block ranges (subranges, usually exons) from an object, such as a GRanges imported from a BED file.

Usage

blocks(x, ...)

Arguments

x The instance from which to obtain the block/exon information. Currently must be a GenomicRanges, with a metadata column of name "blocks" and of type RangesList. Such an object is returned by `import.bed` and `asBED`.

... Additional arguments for methods
A `GRangesList` with an element for each range in `x`. The original block ranges are relative to the start of the containing range, so the returned ranges are shifted to absolute coordinates. The seqname and strand are inherited from the containing range.

Author(s)
Michael Lawrence

See Also
`import.bed` for importing a track from BED, which can store block information; `asBED` for coercing a GenomicRanges into a BED-like structure that can be passed to this function.

---

browseGenome

Browse a genome

Description
A generic function for launching a genome browser.

Usage
```
browseGenome(object, ...)  
## S4 method for signature 'GenomicRangesORGenomicRangesList'
browseGenome(object,  
  browser = "UCSC", range = base::range(object),  
  view = TRUE, trackParams = list(), viewParams = list(),  
  name = "customTrack", ...)  
```

Arguments
- `object`: A `GRanges` object or a list of `GRanges` objects (e.g. a `GenomicRangesList` object).
- `browser`: The name of the genome browser.
- `range`: A genome identifier or a `GRanges` or `RangesList` to display in the initial view.
- `view`: Whether to open a view.
- `trackParams`: Named list of parameters to pass to `track<-`.
- `viewParams`: Named list of parameters to pass to `browserView`.
- `name`: The name for the track.
- `...`: Arguments passed to `browserSession`.

Value
Returns a `BrowserSession`.

Author(s)
Michael Lawrence
See Also

`BrowserSession` and `BrowserView`, the two main classes for interfacing with genome browsers.

Examples

```r
## Not run:
## open UCSC genome browser:
browseGenome()
## to view a specific range:
range <- GRangesForUCSCGenome("hg18", "chr22", IRanges(20000, 50000))
browseGenome(range = range)
## a slightly larger range:
browseGenome(range = range, end = 75000)
## with a track:
track <- import(system.file("tests", "v1.gff", package = "rtracklayer"))
browseGenome(GRangesList(track))

## End(Not run)
```

Description

An object representing a genome browser session. As a derivative of `TrackDb`, each session contains a set of loaded tracks. In addition, it has a set of views, in the form of `BrowserView` instances, on those tracks. Note that this is a virtual class; a concrete implementation is provided by each backend driver.

Objects from the Class

A virtual Class: No objects may be created from it. See `browserSession` for obtaining an instance of an implementation for a particular genome browser.

Methods

This specifies the API implemented by each browser backend. Note that a backend is not required to support all operations, and that each backend often has additional parameters for each of the methods. See the backend-specific documentation for more details. The only built-in backend is `UCSCSession`.

If a method is denoted as `virtual`, it must be implemented by the backend to support the corresponding feature. Otherwise, the fallback behavior is described.

```
virtual browserView(object, range = range(object), track = trackNames(object), ...)
    Constructs a `BrowserView` of range for this session.

virtual browserViews(object, ...) Gets the `BrowserView` instances belonging to this session.
activeView(object, ...) Returns the `BrowserView` that is currently active in the session. Fall-back calls browserViews and queries each view with activeView.
range(x, ...) Gets the `GRanges` representing the range of the genome currently displayed by the browser (i.e. the range shown by the active view) or a default value (possibly NULL) if no views exist.
```
virtual getSeq(object, range = range(object), ...) gets a genomic sequence of range from this session.

virtual sequence(object, ...) <- value Loads a sequence into the session.

virtual track(object, name = deparse(substitute(track)), view = TRUE, ...) <- value
Loads one or more tracks into the session and optionally open a view of the track.

x[[i]] <- value Loads the track value into session x, under the name i. Shortcut to above.

x$name <- value Loads the track value into session x, under the name name. Shortcut to above.

virtual track(object, ...) Gets a track from a session.

x[[i]] Gets the track named i from session x. A shortcut to track.

x$name Gets the track named name from session x. A shortcut to track.

virtual trackNames(object, ...) Gets the names of the tracks stored in this session.

virtual genome(x), genome(x) <- value Gets or sets the genome identifier (e.g. “hg18”) for the session.

virtual close(con, ...) Close this session.

show(object, ...) Output a textual description of this session.

Author(s)

Michael Lawrence

See Also

browserSession for obtaining implementations of this class for a particular genome browser.

---

Get a genome browser session

Description

Methods for getting browser sessions.

Methods

The following methods are defined by rtracklayer.

object = "character" browserSession(object, ...): Creates a BrowserSession from a genome browser identifier. The identifier corresponds to the prefix of the session class name (e.g. "UCSC" in "UCSCSession"). The arguments in ... are passed to the initialization function of the class.

object = "browserView" Gets the BrowserSession for the view.

object = "missing" Calls browserSession("ucsc", ...).
BrowserView-class

Class “BrowserView”

Description

An object representing a genome browser view of a particular segment of a genome.

Objects from the Class

A virtual Class: No objects may be created from it directly. See browserView for obtaining an instance of an implementation for a particular genome browser.

Slots

session: Object of class "BrowserSession" the browser session to which this view belongs.

Methods

This specifies the API implemented by each browser backend. Note that a backend is not guaranteed to support all operations. See the backend-specific documentation for more details. The only built-in backend is UCSCView.

browserSession(object) Obtains the BrowserSession to which this view belongs.

close(object) Close this view.

range(object) Obtains the GRanges displayed by this view.

trackNames(object) Gets the names of the visible tracks in the view.

trackNames(object) <- value Sets the visible tracks by their names.

show(object) Outputs a textual description of this view.

visible(object) Get a named logical vector indicating whether each track is visible.

visible(object) <- value Set a logical vector indicating the visibility of each track, with the same names and in the same order as that returned by visible(object).

Author(s)

Michael Lawrence

See Also

browserView for obtaining instances of this class.
browserView-methods  Getting browser views

Description
Methods for creating and getting browser views.

Usage

browserView(object, range, track, ...)

Arguments

object  The object from which to get the views.
range  The GRanges or RangesList to display. If there are multiple elements, a view is created for each element and a BrowserViewList is returned.
track  List of track names to make visible in the view.
...  Arguments to pass to methods

Methods
The following methods are defined by rtracklayer.

object = "UCSCSession" browserView(object, range = range(object), track = trackNames(object), imagewidth = 800, ...):  Creates a BrowserView of range with visible tracks specified by track. The imagewidth parameter specifies the width of the track image in pixels. track may be an instance of UCSCTrackModes. Arguments in ... are passed to ucscTrackModes to create the UCSCTrackModes instance that will override modes indicated by the track parameter.

Examples

## Not run:
  session <- browserSession()
  browserView(session, 
              GRangesForUCSCGenome("hg19", "chr2", IRanges(20000, 50000)))
## only view "knownGene" track
  browserView(session, track = "knownGene")

## End(Not run)

BrowserViewList-class  Lists of BrowserView

Description
A formal list of BrowserView objects. Extends and inherits all its methods from Vector. Usually generated by passing multiple ranges to the browserView function.
Constructor

`BrowserViewList(...)`: Concatenates the `BrowserView` objects in ... into a new `BrowserViewList`. This is rarely called by the user.

Author(s)

Michael Lawrence

Methods for getting browser views.

Methods

The following methods are defined by `rtracklayer`.

- Gets the instances of `BrowserView` in the session.

See Also

`object = "UCSCSession"` `browserView` for creating a browser view.

Examples

```r
## Not run:
session <- browseGenome()
browserViews(session)
## End(Not run)
```

Chain-class

Chain objects

Description

A `Chain` object represents a UCSC chain alignment, typically imported from a chain file, and is essentially a list of `ChainBlock` objects. Each `ChainBlock` has a corresponding chromosome (its name in the list) and is a run-length encoded alignment, mapping a set of intervals on that chromosome to intervals on the same or other chromosomes.
Accessor Methods

In the code snippets below, \( x \) and \( \text{object} \) are ChainBlock objects.

\[ \text{ranges}(x) \]: Get the \texttt{Ranges} object holding the starts and ends of the "from" ranges. Each range is a contiguous block of positions aligned without gaps to the other sequence.

\[ \text{offset}(x) \]: Integer offset from the "from" start to the "end" start (which could be in another chromosome).

\[ \text{score}(x) \]: The score for each mapping.

\[ \text{space}(x) \]: The space (chromosome) of the "to" range.

\[ \text{reversed}(x) \]: Whether the mapping inverts the region, i.e., the alignment is between different strands.

Import

A Chain object can be loaded from a UCSC chain format file simply by passing the path \texttt{import} function. If the file extension is not "chain", then either pass "chain" to the \texttt{format} argument, or cast the path to a ChainFile object. The \texttt{import.chain} function is provided as a (slight) convenience. It is documented below, along with the extra \texttt{exclude} argument to the \texttt{import} method.

\[ \text{import.chain}(\text{con}, \text{exclude} = "\_", ...) \]: Imports a chain file named \texttt{con} as a Chain object, a list of ChainBlocks. Alignments for chromosomes matching the \texttt{exclude} pattern are not imported.

Note

A chain file essentially details many local alignments, so it is possible for the "from" ranges to map to overlapping regions in the other sequence. The "from" ranges are guaranteed to be disjoint (but do not necessarily cover the entire "from" sequence).

Author(s)

Michael Lawrence

See Also

\texttt{liftOver} for performing lift overs using a chain alignment

\begin{verbatim}
cpneTrack CPNE1 SNP track
\end{verbatim}

Description

A \texttt{GRanges} object (created by the \texttt{GGtools} package) with features from a subset of the SNPs on chromosome 20 from 60 HapMap founders in the CEU cohort. Each SNP has an associated data value indicating its association with the expression of the CPNE1 gene according to a Cochran-Armitage 1df test. The top 5000 scoring SNPs were selected for the track.

Usage

\[ \text{data(cpneTrack)} \]
Format

Each feature (row) is a SNP. The association test scores are accessible via `score`.

Source

Vince Carey and the GGtools package.

Examples

data(cpneTrack)
plot(start(cpneTrack), score(cpneTrack))

---

FastaFile-class  FastaFile objects

Description

These functions support the import and export of the Fasta sequence format, using the Biostrings package.

Usage

```r
## S4 method for signature 'FastaFile,ANY,ANY'
import(con, format, text,
   type = c("DNA", "RNA", "AA", "B"), ...)

## S4 method for signature 'ANY,FastaFile,ANY'
export(object, con, format, ...)
## S4 method for signature 'XStringSet,FastaFile,ANY'
export(object, con, format, ...)
```

Arguments

- `con` A path or FastaFile object. URLs and connections are not supported. If `con` is not a FastaFile, either the file extension or the `format` argument needs to be “fasta”. Compressed files (“gz”, “bz2” and “xz”) are handled transparently.
- `object` The object to export, should be an `XStringSet` or something coercible to a `DNAStringSet`, like a character vector.
- `format` If not missing, should be “fasta”.
- `text` If `con` is missing, a character vector to use as the input
- `type` Type of biological sequence.
- `...` Arguments to pass down to `writeXStringSet` (export) or the `readDNAStringSet` family of functions (import).

FastaFile objects

The FastaFile class extends `RTLFile` and is a formal representation of a resource in the Fasta format. To cast a path, URL or connection to a FastaFile, pass it to the FastaFile constructor.
genomeBrowsers

Author(s)

Michael Lawrence

See Also

These functions are implemented by the Biostrings writeXStringSet (export) and the readDNAStringSet family of functions (import).

See export-methods in the BSgenome package for exporting a BSgenome object as a FASTA file.

---

**genomeBrowsers**  
*Get available genome browsers*

Description

Gets the identifiers of the loaded genome browser drivers.

Usage

```r
genomeBrowsers(where = topenv(parent.frame()))
```

Arguments

- `where`  
The environment in which to search for drivers.

Details

This searches the specified environment for classes that extend BrowserSession. The prefix of the class name, e.g. "ucsc" in "UCSCSession", is returned for each driver.

Value

A character vector of driver identifiers.

Author(s)

Michael Lawrence

See Also

browseGenome and browserSession that create browserSession implementations given an identifier returned from this function.
Description

The rtracklayer package adds convenience methods on top of GenomicRanges and RangesList to manipulate data on genomic ranges.

Accessors

In the code snippets below, x is a GenomicRanges or RangesList object.

chrom(x), chrom(x) <- value: Gets or sets the chromosome names for x. The length of value should equal the length of x.

score(x): Gets the “score” column from the element metadata of a GenomicRanges or GRangesList. Many track formats have a score column, so this is often used during export. The ANY fallback for this method simply returns NULL.

Constructor

GenomicData(ranges, ..., strand = NULL, chrom = NULL, genome = NULL):

Constructs a GRanges instance with the given ranges and variables in ... (see the GRanges constructor).

If non-NULL, the strand argument specifies the strand of each range. It should be a character vector or factor of length equal to that of ranges. All values should be either -, +, or *. To get the levels for strand, call levels(strand()).

chrom argument is analogous to seqnames in the GRanges constructor.

The genome argument should be a scalar string. See the examples.

Author(s)

Michael Lawrence and Patrick Aboyoun

Examples

range1 <- IRanges(c(1,2,3), c(5,2,8))

## with some data ##
filter <- c(1L, 0L, 1L)
score <- c(10L, 2L, NA)
strand <- factor(c("+", NA, ":"), levels = levels(strand()))

## GRanges instance
gr <- GenomicData(range1, score, chrom = "chr1", genome = "hg18")

mcols(gr)[["score"]]
strand(gr) ## all '*

gr <- GenomicData(range1, score, filt = filter, strand = strand,
chrom = "chr1")

mcols(gr)[["filt"]]
strand(gr) ## equal to 'strand'

## coercion from data.frame ##
df <- as.data.frame(gr)
GenomicSelection  Genomic data selection

Description

Convenience constructor of a GenomicSelection object for selecting a data on a per-chromosome basis for a given genome.

Usage

GenomicSelection(genome, chrom = NULL, colnames = character(0))

Arguments

genome A string identifying a genome. Should match the end of a BSgenome package name, e.g. "hg19".

chrom Character vector naming chromosomes to select.

colnames The column names to select from the dataset.

Value

A GenomicSelection object, selecting entire chromosomes

Author(s)

Michael Lawrence

See Also

RangedSelection, BigWigSelection

Examples

# every chromosome from hg19
GenomicSelection("hg19")

# chr1 and 2 from hg19, with a score column
GenomicSelection("hg19", c("chr1", "chr2"), "score")

GFFFile-class  GFFFile objects

Description

These functions support the import and export of the GFF format, of which there are three versions and several flavors.
### Usage

```r
## S4 method for signature 'GFFFile,ANY,ANY'
import(con, format, text,
       version = c("", "1", "2", "3"),
       genome = NA, colnames = NULL, which = NULL,
       feature.type = NULL, sequenceRegionsAsSeqinfo = FALSE)
import.gff(con, ...)
import.gff1(con, ...)
import.gff2(con, ...)
import.gff3(con, ...)

## S4 method for signature 'ANY,GFFFile,ANY'
export(object, con, format, ...)
## S4 method for signature 'GenomicRanges,GFFFile,ANY'
export(object, con, format,
       version = c("1", "2", "3"),
       source = "rtracklayer", append = FALSE, index = FALSE)
## S4 method for signature 'GenomicRangesList,GFFFile,ANY'
export(object, con, format, ...)
export.gff(object, con, ...)
export.gff1(object, con, ...)
export.gff2(object, con, ...)
export.gff3(object, con, ...)
```

### Arguments

- **con**
  A path, URL, connection or `GFFFile` object. For the functions ending in `.gff`, `.gff1`, etc, the file format is indicated by the function name. For the base `export` and `import` functions, the format must be indicated another way. If `con` is a path, URL or connection, either the file extension or the `format` argument needs to be one of "gff", "gff1", "gff2", "gff3", "gvf", or "gtf". Compressed files ("gz", "bz2" and "xz") are handled transparently.

- **object**
  The object to export, should be a `GRanges` or something coercible to a `GRanges`. If the object has a method for `asGFF`, it is called prior to coercion. This makes it possible to export a `GenomicRangesList` or `TxDb` in a way that preserves the hierarchical structure. For exporting multiple tracks, in the UCSC track line metaformat, pass a `GenomicRangesList`, or something coercible to one.

- **format**
  If not missing, should be one of "gff", "gff1", "gff2", "gff3", "gvf", or "gtf".

- **version**
  If the format is given as "gff", i.e., it does not specify a version, then this should indicate the GFF version as one of "" (for import only, from the gff-version directive in the file or "1" if none), "1", "2" or "3".

- **text**
  If `con` is missing, a character vector to use as the input.

- **genome**
  The identifier of a genome, or a `Seqinfo`, or NA if unknown. Typically, this is a UCSC identifier like "hg19". An attempt will be made to derive the `Seqinfo` on the return value using either an installed BSgenome package or UCSC, if network access is available.

- **colnames**
  A character vector naming the columns to parse. These should name either fixed fields, like source or type, or, for `GFF2` and `GFF3`, any attribute.

- **which**
  A `GRanges` or other range-based object supported by `findOverlaps`. Only the intervals in the file overlapping the given ranges are returned. This is much more efficient when the file is indexed with the `tabix` utility.
feature.type  NULL (the default) or a character vector of valid feature types. If not NULL, then only the features of the specified type(s) are imported.

sequenceRegionsAsSeqinfo  If TRUE, attempt to infer the Seqinfo (seqlevels and seqlengths) from the "##sequence-region" directives as specified by GFF3.

source  The value for the source column in GFF. This is typically the name of the package or algorithm that generated the feature.

index  If TRUE, automatically compress and index the output file with bgzf and tabix. Note that tabix indexing will sort the data by chromosome and start. Tabix supports a single track in a file.

append  If TRUE, and con points to a file path, the data is appended to the file. Obviously, if con is a connection, the data is always appended.

Arguments to pass down to methods to other methods. For import, the flow eventually reaches the GFFFile method on import. When trackLine is TRUE or the target format is BED15, the arguments are passed through export.ucsc, so track line parameters are supported.

Details

The Generic Feature Format (GFF) format is a tab-separated table of intervals. There are three different versions of GFF, and they all have the same number of columns. In GFF1, the last column is a grouping factor, whereas in the later versions the last column holds application-specific attributes, with some conventions defined for those commonly used. This attribute support facilitates specifying extensions to the format. These include GTF (Gene Transfer Format, an extension of GFF2) and GVF (Genome Variation Format, an extension of GFF3). The rtracklayer package recognizes the "gtf" and "gvf" extensions and parses the extra attributes into columns of the result; however, it does not perform any extension-specific processing. Both GFF1 and GFF2 have been proclaimed obsolete; however, the UCSC Genome Browser only supports GFF1 (and GTF), and GFF2 is still in broad use.

GFF is distinguished from the simpler BED format by its flexible attribute support and its hierarchical structure, as specified by the group column in GFF1 (only one level of grouping) and the Parent attribute in GFF3. GFF2 does not specify a convention for representing hierarchies, although its GTF extension provides this for gene structures. The combination of support for hierarchical data and arbitrary descriptive attributes makes GFF(3) the preferred format for representing gene models.

Although GFF features a score column, large quantitative data belong in a format like BigWig and alignments from high-throughput experiments belong in BAM. For variants, the VCF format (supported by the VariantAnnotation package) seems to be more widely adopted than the GVF extension.

A note on the UCSC track line metaformat: track lines are a means for passing hints to visualization tools like the UCSC Genome Browser and the Integrated Genome Browser (IGB), and they allow multiple tracks to be concatenated in the same file. Since GFF is not a UCSC format, it is not common to annotate GFF data with track lines, but rtracklayer still supports it. To export or import GFF data in the track line format, call export.ucsc or import.ucsc.

The following is the mapping of GFF elements to a GRanges object. NA values are allowed only where indicated. These appear as a "." in the file. GFF requires that all columns are included, so export generates defaults for missing columns.

seqid, start, end  the ranges component.

source  character vector in the source column; defaults to “rtracklayer” on export.
**type** character vector in the type column; defaults to “sequence_feature” in the output, i.e., SO:0000110.

**score** numeric vector (NA’s allowed) in the score column, accessible via the score accessor; defaults to NA upon export.

**strand** strand factor (NA’s allowed) in the strand column, accessible via the strand accessor; defaults to NA upon export.

**phase** integer vector, either 0, 1 or 2 (NA’s allowed); defaults to NA upon export.

**group** a factor (GFF1 only); defaults to the seqid (e.g., chromosome) on export.

In GFF versions 2 and 3, attributes map to arbitrary columns in the result. In GFF3, some attributes (Parent, Alias, Note, DBxref and Ontology_term) can have multiple, comma-separated values; these columns are thus always CharacterList objects.

**Value**

A GRanges with the metadata columns described in the details.

**GFFFile objects**

The GFFFile class extends RTLFile and is a formal representation of a resource in the GFF format. To cast a path, URL or connection to a GFFFile, pass it to the GFFFile constructor. The GFF1File, GFF2File, GFF3File, GVFFile and GTFFile classes all extend GFFFile and indicate a particular version of the format.

It has the following utility methods:

- genome: Gets the genome identifier from the “genome-build” header directive.

**Author(s)**

Michael Lawrence

**References**

- **GFF1, GFF2** [http://www.sanger.ac.uk/resources/software/gff/spec.html](http://www.sanger.ac.uk/resources/software/gff/spec.html)
- **GFF3** [http://www.sequenceontology.org/gff3.shtml](http://www.sequenceontology.org/gff3.shtml)
- **GVF** [http://www.sequenceontology.org/resources/gvf.html](http://www.sequenceontology.org/resources/gvf.html)
- **GTF** [http://mblab.wustl.edu/GTF22.html](http://mblab.wustl.edu/GTF22.html)

**Examples**

```r

test_path <- system.file("tests", package = "rtracklayer")
test_gff3 <- file.path(test_path, "genes.gff3")

## basic import
test <- import(test_gff3)
test

## import.gff functions
import.gff(test_gff3)
import.gff3(test_gff3)

## GFFFile derivatives
test_gff_file <- GFF3File(test_gff3)
import(test_gff_file)
```
test_gff_file <- GFFFile(test_gff3)
import(test_gff_file)

## from connection

## various arguments

## 'which'
which <- GRanges("chr10:90000-93000")
import(test_gff3, which = which)

## Not run:

## 'append'

test_gff3_out <- file.path(tempdir(), "genes.gff3")

export(test[seqnames(test) == "chr10"], test_gff3_out)
export(test[seqnames(test) == "chr12"], test_gff3_out, append = TRUE)
import(test_gff3_out)

## 'index'

test_bed_gz <- paste(test_gff3_out, ".gz", sep = "")
import(test_bed_gz, which = which)

## End(Not run)

GRangesForUCSCGenome  GRanges for a Genome

**Description**

These functions assist in the creation of Seqinfo or GRanges for a genome.

**Usage**

GRangesForUCSCGenome(genome, chrom = NULL, ranges = NULL, ...)
GRangesForBSGenome(genome, chrom = NULL, ranges = NULL, ...)

SeqinfoForUCSCGenome(genome)
SeqinfoForBSGenome(genome)

**Arguments**

- **genome**  
  A string identifying a genome, usually one assigned by UCSC, like "hg19".

- **chrom**  
  A character vector of chromosome names, or NULL.

- **ranges**  
  A Ranges object with the intervals.

- **...**  
  Additional arguments to pass to the GRanges constructor.
GraphTrackLine-class

Details
The genome ID is stored in the metadata of the ranges and is retrievable via the genome function. The sequence lengths are also properly initialized for the genome. This mitigates the possibility of accidentally storing intervals for the wrong genome.

GRangesForUCSCGenome obtains sequence information from the UCSC website, while GRangesForBSGenome looks for it in an installed BSgenome package. Using the latter is more efficient in the long-run, but requires downloading and installing a potentially large genome package, or creating one from scratch if it does not yet exist for the genome of interest.

Value
For the GRangesFor* functions, a GRanges object, with the appropriate seqlengths and genome ID.
The SeqinfoFor* functions return a Seqinfo for the indicated genome.

Author(s)
Michael Lawrence

GraphTrackLine-class Class "GraphTrackLine"

Description
A UCSC track line for graphical tracks.

Objects from the Class
Objects can be created by calls of the form new("GraphTrackLine", ...) or parsed from a character vector track line with as(text, "GraphTrackLine") or converted from a BasicTrackLine using as(basic, "GraphTrackLine").

Slots
altColor: Object of class "integer" giving an alternate color, as from col2rgb.
autoScale: Object of class "logical" indicating whether to automatically scale to min/max of the data.
alwaysZero: Object of class "logical" indicating whether to fix the lower limit of the Y axis at zero.
gridDefault: Object of class "logical" indicating whether a grid should be drawn.
maxHeightPixels: Object of class "numeric" of length three (max, default, min), giving the allowable range for the vertical height of the graph.
graphType: Object of class "character", specifying the graph type, either "bar" or "points".
viewLimits: Object of class "numeric" and of length two specifying the data range (min, max) shown in the graph.
yLineMark: Object of class "numeric" giving the position of a horizontal line.
yLineOnOff: Object of class "logical" indicating whether the yLineMark should be visible.
windowingFunction: Object of class "character", one of "maximum", "mean", "minimum", for removing points when the graph shrinks.

smoothingWindow: Object of class "numeric" giving the window size of a smoother to pass over the graph.

type: Scalar "character" indicating the type of the track, either "wig" or "bedGraph".

name: Object of class "character" specifying the name of the track.

description: Object of class "character" describing the track.

visibility: Object of class "character" indicating the default visible mode of the track, see UCSCTrackModes.

color: Object of class "integer" representing the track color (as from col2rgb).

priority: Object of class "numeric" specifying the rank of this track.

Extends

Class "TrackLine", directly.

Methods

as(object, "character") Export line to its string representation.

as(object, "BasicTrackLine") Convert this line to a basic UCSC track line, using defaults for slots not held in common.

Author(s)

Michael Lawrence

References


See Also

export.wig, export.bedGraph for exporting graphical tracks.

---

io Import and export

Description

The functions import and export load and save objects from and to particular file formats. The rtracklayer package implements support for a number of annotation and sequence formats.

Usage

export(object, con, format, ...) import(con, format, text, ...)
Arguments

object

The object to export.

con

The connection from which data is loaded or to which data is saved. If this is a character vector, it is assumed to be a filename and a corresponding file connection is created and then closed after exporting the object. If a RTLFile derivative, the data is loaded from or saved to the underlying resource. If missing, the function will return the output as a character vector, rather than writing to a connection.

format

The format of the output. If missing and con is a filename, the format is derived from the file extension. This argument is unnecessary when con is a derivative of RTLFile.

text

If con is missing, this can be a character vector directly providing the string data to import.

... Parameters to pass to the format-specific method.

Details

The rtracklayer package supports a number of file formats for representing annotated genomic intervals. These are each represented as a subclass of RTLFile. Below, we list the major supported formats, with some advice for when a particular file format is appropriate:

GFF The General Feature Format is meant to represent any set of genomic features, with application-specific columns represented as “attributes”. There are three principal versions (1, 2, and 3). This is a good format for interoperating with other genomic tools and is the most flexible format, in that a feature may have any number of attributes (in version 2 and above). Version 3 (GFF3) is the preferred version. Its specification lays out conventions for representing various types of data, including gene models, for which it is the format of choice. For variants, rtracklayer has rudimentary support for an extension of GFF called GVF. UCSC supports GFF1, but it needs to be encapsulated in the UCSC metaformat, i.e. export.ucsc(subformat = "gff1"). The BED format is typically preferred over GFF for interaction with UCSC. GFF files can be indexed with the tabix utility for fast range-based queries via rtracklayer and Rsamtools.

BED The Browser Extended Display format is for displaying qualitative tracks in a genome browser, in particular UCSC. It finds a good balance between simplicity and expressiveness. It is much simpler than GFF and yet can still represent multi-exon gene structures. It is somewhat limited by its lack of the attribute support of GFF. To circumvent this, many tools and organizations have extended BED with additional columns. These are not officially valid BED files, and as such rtracklayer does not yet support them (this will be addressed soon). The rtracklayer package does support two official extensions of BED: Bed15 and bedGraph, and the unofficial BEDPE format, see below. BED files can be indexed with the tabix utility for fast range-based queries via rtracklayer and Rsamtools.

BED15 An extension of BED with 15 columns, Bed15 is meant to represent data from microarray experiments. Multiple samples/columns are supported, and the data is displayed in UCSC as a compact heatmap. Few other tools support this format. With 15 columns per feature, this format is probably too verbose for e.g. ChIP-seq coverage (use multiple BigWig tracks instead).

BEDGRAPH A variant of BED that represents a score column more compactly than BED and especially BED15, although only one sample is supported. The data is displayed in UCSC as a bar or line graph. For large data (the typical case), BigWig is preferred.
**BEDPE** A variant of BED that represents pairs of genomic regions, such as interaction data or chromosomal rearrangements. The data cannot be displayed in UCSC directly but can be represented using the BED12 format.

**WIG** The Wiggle format is meant for storing dense numerical data, such as window-based GC and conservation scores. The data is displayed in UCSC as a bar or line graph. The WIG format only works for intervals with a uniform width. For non-uniform widths, consider bedGraph. For large data, consider BigWig.

**BIGWIG** The BigWig format is a binary version of both bedGraph and WIG (which are now somewhat obsolete). A BigWig file contains a spatial index for fast range-based queries and also embeds summary statistics of the scores at several zoom levels. Thus, it is ideal for visualization of and parallel computing on genome-scale vectors, like the coverage from a high-throughput sequencing experiment.

In summary, for the typical use case of combining gene models with experimental data, GFF is preferred for gene models and BigWig is preferred for quantitative score vectors. Note that the Rsamtools package provides support for the BAM file format (for representing read alignments), among others. Based on this, the rtracklayer package provides an export method for GAlignments and GappedReads objects as BAM. For variants, consider VCF, supported by the VariantAnnotation package.

There is also support for reading and writing biological sequences, including the UCSC TwoBit format for compactly storing a genome sequence along with a mask. The files are binary, so they are efficiently queried for particular ranges. A similar format is FA, supported by Rsamtools.

**Value**

If `con` is missing, a character vector containing the string output. Otherwise, nothing is returned.

**Author(s)**

Michael Lawrence

**See Also**

Format-specific options for the popular formats: GFF, BED, BED15, BEDGRAPH, WIG, BIGWIG

**Examples**

```r
track <- import(system.file("tests", "v1.gff", package = "rtracklayer"))
## Not run: export(track, "my.gff", version = "3")
## equivalently,
## Not run: export(track, "my.gff3")
## or
## Not run:
con <- file("my.gff3")
export(track, con, "gff3")
close(con)

## End(Not run)
## or as a string
export(track, format = "gff3")
```
Description

A reimplementation of the UCSC liftover tool for lifting features from one genome build to another. In our preliminary tests, it is significantly faster than the command line tool. Like the UCSC tool, a chain file is required input.

Usage

liftOver(x, chain, ...)

Arguments

x The intervals to lift-over, usually a GRanges.
chain A Chain object, usually imported with import.chain, or something coercible to one.
... Arguments for methods.

Value

A GRangesList object. Each element contains the ranges mapped from the corresponding element in the input (may be one-to-many).

Author(s)

Michael Lawrence

References

http://genome.ucsc.edu/cgi-bin/hgLiftOver

Examples

## Not run:
chain <- import.chain("hg19ToHg18.over.chain")
library(TxDb.Hsapiens.UCSC.hg19.knownGene)
tx_hg19 <- transcripts(TxDb.Hsapiens.UCSC.hg19.knownGene)
tx_hg18 <- liftOver(tx_hg19, chain)
## End(Not run)
Quickload-class

Quickload Access

Description

The Quickload class represents a Quickload data source, essentially directory layout separating tracks and sequences by genome, along with a few metadata files. This interface abstracts those details and provides access to a Quickload at any URL supported by R (HTTP, FTP, and local files). This is an easy way to make data accessible to the Integrated Genome Browser (IGB).

Constructor

Quickload(uri = "quickload", create = FALSE): Constructs a new Quickload object, representing a repository at uri. If create is TRUE, and uri is writeable (i.e., local), the repository is created if it does not already exist. If it does exist, then a message is emitted to indicate that the repository was not recreated.

Accessor Methods

In the code snippets below, x represents a Quickload object.

- x$genome, x[['genome']]: Get the QuickloadGenome object for the genome named genome. This is where all the data is stored.
- length(x): number of genomes in the repository
- uri(x): Get the URI pointing to the Quickload repository.
- genome(x): Get the identifiers of the genomes present in the repository.

Author(s)

Michael Lawrence

Examples

ql <- Quickload(system.file("tests", "quickload", package = "rtracklayer"))
uri(ql)
genome(ql)
ql$T_species_Oct_2011

QuickloadGenome-class

Quickload Genome Access

Description

A Quickload data source is a collection of tracks and sequences, separated by genome. This class, QuickloadGenome provides direct access to the data for one particular genome.
QuickloadGenome-class

Constructor

QuickloadGenome(quickload, genome, create = FALSE, seqinfo = seqinfo(genome), title = toString(genome))

Constructs a new QuickloadGenome object, representing genome in the repository quickload (a URI string or a Quickload object).

The genome argument can be an ID corresponding to a genome (potentially) in quickload or an installed BSgenome package. It can also be any instance of a class which has methods for organism and releaseDate. A good example is BSgenome or any other derivative of GenomeDescription. Those items are necessary for constructing the canonical Quickload genome string (G_Species_Month_Year).

If create is TRUE, and the genome does not already exist, the genome will be created, using seqinfo for the sequence lengths and title for the display name of the genome in a UI.

Creation only works if the repository is local and writeable. Reasonable defaults are used for seqinfo and title when the necessary methods are available (and they are for BSgenome).

Accessor Methods

In the code snippets below, x and object represent a Quickload object.

seqinfo(x), seqinfo(x) <- value: Gets or sets the Seqinfo object indicating the lengths of the sequences in the genome. No circularity information or genome identifier is stored.

quickload(x): Get the Quickload object that contains this genome.

uri(x): Get the uri pointing to the genome directory in the Quickload repository.

genome(x): Get the name of the genome, e.g. “H_sapiens_Feb_2009”.

releaseDate(x): Get the release portion of the genome name, e.g., “Feb_2009”.

organism(object): Get the organism portion of the genome name, e.g., “H sapiens”.

Data Access

length(x): number of datasets

names(x), trackNames(x): names of the datasets

mcols(x): merged metadata on the datasets

track(x, name), x$name: get the track called name

track(x, name, format = bestFileFormat(value), ...) <- value, x$name <- value: store the track value under name. Note that track storing is only supported for local repositories, i.e., those with a file:// URI scheme.

Currently, supported value types include a GenomicRanges, GRangesList, or a file resource (copied to the repository). The file resource may be represented as a path, URL, RTLFile or RsamtoolsFile. If not a file name, value is written in format. For generic interval data, this means a BigWig file (if there is a numeric “score” column) or a BED file otherwise. An RleList (e.g., coverage) is output as BigWig. For UCSCData values, the format is chosen according to the type of track line. For RsamtoolsFile objects, the file and its index are copied.

The arguments in ... become attributes in the XML metadata. The “description” attribute is standard and is a blurb for describing the track in a UI. For the rest, the interpretation is up to the client. IGB supports an ever-growing list; please see its documentation.

referenceSequence(x): Get the reference sequence, as a DNAStringSet.

referenceSequence(x) <- value: Set the reference sequence, as a DNAStringSet. It is written as a 2bit file. This only works on local repositories.
Author(s)

Michael Lawrence

Examples

tests_dir <- system.file("tests", package = "rtracklayer")
ql <- Quickload(file.path(tests_dir, "quickload"))
qlg <- QuickloadGenome(ql, "T_species_Oct_2011")
seqinfo(qlg)
organism(qlg)
releaseDate(qlg)
names(qlg)
mcols(qlg)
if (.Platform$OS.type != "windows") { # temporary
  qlg$bedData
}
## Not run:
## populating the test repository
  ql <- Quickload(file.path(tests_dir, "quickload"), create = TRUE)
reference_seq <- import(file.path(tests_dir, "test.2bit"))
names(reference_seq) <- "test"
qlg <- QuickloadGenome(ql, "T_species_Oct_2011", create = TRUE,
  seqinfo = seqinfo(reference_seq))
referenceSequence(qlg) <- reference_seq
test_bed <- import(file.path(tests_dir, "test.bed"))
names(test_bed) <- "test"
qlg$bedData <- test_bed
test_bedGraph <- import(file.path(tests_dir, "test.bedGraph"))
names(test_bedGraph) <- "test"
start(test_bedGraph) <- seq(1, 90, 10)
width(test_bedGraph) <- 10
track(qlg, "bedGraphData", format = "bw") <- test_bedGraph
## End(Not run)

RangesList-methods

Ranges on a Genome

Description

Genomic coordinates are often specified in terms of a genome identifier, chromosome name, start position and end position. The \texttt{rtracklayer} package adds convenience methods to \texttt{RangesList} for the manipulation of genomic ranges. The spaces (or names) of \texttt{RangesList} are the chromosome names. The universe slot indicates the genome, usually as given by UCSC (e.g. "hg18").

Accessors

In the code snippets below, \texttt{x} is a \texttt{RangesList} object.

\texttt{chrom(x)}, \texttt{chrom(x)} <- \texttt{value}: Gets or sets the chromosome names for \texttt{x}. This is an alias for \texttt{names(x)}. 

**readGFF**

*Reads a file in GFF format*

**Description**

Reads a file in GFF format and creates a data frame or DataFrame object from it. This is a low-level function that should not be called by user code.

**Usage**

```r
readGFF(filepath, version=0, columns=NULL, tags=NULL, filter=NULL, nrows=-1, raw_data=FALSE)
```

**Arguments**

- **filepath**
  - A single string containing the path or URL to the file to read. Alternatively can be a connection.

- **version**
  - `readGFF` should do a pretty descent job at detecting the GFF version. Use this argument only if it doesn’t or if you want to force it to parse and import the file as if its 9-th column was in a different format than what it really is (e.g. specify version=1 on a GTF or GFF3 file to interpret its 9-th column as the "group" column of a GFF1 file). Supported versions are 1, 2, and 3.

- **columns**
  - The standard GFF columns to load. All of them are loaded by default.

- **tags**
  - The tags to load. All of them are loaded by default.

- **filter**

- **nrows**
  - -1 or the maximum number of rows to read in (after filtering).

- **raw_data**

- **GFF1**

**Value**

A DataFrame with columns corresponding to those in the GFF.

**Author(s)**

H. Pages

**See Also**

- `import` for importing a GFF file as a GRanges object.
- `makeGRangesFromDataFrame` in the GenomicRanges package for making a GRanges object from a data frame or DataFrame object.
- `makeTxDbFromGFF` in the GenomicFeatures package for importing a GFF file as a TxDb object.
- The DataFrame class in the S4Vectors package.
Examples

## Standard GFF columns.
GFFcolnames()
GFFcolnames(GFF1=TRUE) # "group" instead of "attributes"

tests_dir <- system.file("tests", package="rtracklayer")
test_gff3 <- file.path(tests_dir, "genes.gff3")

## Load everything.
df0 <- readGFF(test_gff3)
head(df0)

## Load some tags only (in addition to the standard GFF columns).
my_tags <- c("ID", "Parent", "Name", "Dbxref", "geneID")
df1 <- readGFF(test_gff3, tags=my_tags)
head(df1)

## Load no tags (in that case, the "attributes" standard column
## is loaded).
df2 <- readGFF(test_gff3, tags=character(0))
head(df2)

## Load some standard GFF columns only (in addition to all tags).
my_columns <- c("seqid", "start", "end", "strand", "type")
df3 <- readGFF(test_gff3, columns=my_columns)
df3
table(df3$seqid, df3$type)
makeGRangesFromDataFrame(df3, keep.extra.columns=TRUE)

## Combine use of 'columns' and 'tags' arguments.
readGFF(test_gff3, columns=my_columns, tags=c("ID", "Parent", "Name"))
readGFF(test_gff3, columns=my_columns, tags=character(0))

## Use the 'filter' argument to load only features of type "gene"
## or "mRNA" located on chr10.
my_filter <- list(type=c("gene", "mRNA"), seqid="chr10")
readGFF(test_gff3, filter=my_filter)
readGFF(test_gff3, columns=my_columns, tags=character(0), filter=my_filter)

### RTLFile-class

**RTLFile-class**

**RTLFile objects**

**Description**

A RTLFile object is the base class for classes representing files accessible with rtracklayer. It wraps a resource (either a path, URL or connection). We can represent a list of RTLFile objects with a RTLFileList.

**Accessor Methods**

In the code snippets below, x represents a RTLFile object.

- `path(x)`: Gets the path, as a character vector, to the resource represented by the RTLFile object, if possible.
resource(x): Gets the low-level resource, either a character vector (a path or URL) or a connection.

Coercion

as.character(x): Returns the path of the file as a character vector.

Related functions

FileForFormat(path, format = file_ext(path)): Determines the file type of path and returns a high-level file object such as BamFile, BEDFile, BigWigFile etc..

Author(s)

Michael Lawrence

See Also

Implementing classes include: BigWigFile, TwoBitFile, BEDFile, GFFFile, and WIGFile.

sequence<--methods

Load a sequence

Description

Methods for loading sequences.

Methods

No methods are defined by rtracklayer for the sequence(object, ...) <- value generic.

TabixFile-methods

TabixFile Import/Export

Description

These methods support the import and export of Rsamtools:TabixFileTabixFile objects. These are generally useful when working with tabix-indexed files that have a non-standard format (i.e., not BED nor GFF), as well as exporting an object with arbitrary columns (like a GRanges) to an indexed, tab-separated file. This relies on the tabix header, which indicates the columns in the file that correspond to the chromosome, start and end. The BED and GFF parsers handle tabix transparently.

Usage

## S4 method for signature 'TabixFile,ANY,ANY'
import(con, format, text,
    which = if (is.na(genome)) NULL
    else as(seqinfoForGenome(genome), "GenomicRanges"),
    genome = NA, header = TRUE, ...)
exportToTabix(object, con, ...)
targets

Arguments

- **con**
  For import, a TabixFile object; for exportToTabix, a string naming the destination file.

- **object**
  The object to export. It is coerced to a data.frame, written to a tab-separated file, and indexed with tabix for efficient range-based retrieval of the data using import.

- **format**
  If any known format, like “bed” or “gff” (or one of their variants), then the appropriate parser is applied. If any other value, then the tabix header is consulted for the format. By default, this is taken from the file extension.

- **text**
  Ignored.

- **which**
  A range data structure coercible to RangesList, like a GRanges. Only the intervals in the file overlapping the given ranges are returned. The default is to use the range over the entire genome given by genome, if specified.

- **genome**
  The identifier of a genome, or NA if unknown. Typically, this is a UCSC identifier like “hg19”. An attempt will be made to derive the seqinfo on the return value using either an installed BSgenome package or UCSC, if network access is available.

- **header**
  If TRUE, then the header in the indexed file, which might include a track line, is sent to the parser. Otherwise, the initial lines are skipped, according to the skip field in the tabix index header.

- **...**
  Extra arguments to pass to the underlying import routine, which for non-standard formats is read.table or write.table.

Value

For import, a GRanges object.
For exportToTabix, a TabixFile object that is directly passable to import.

Author(s)

Michael Lawrence

References

http://samtools.sourceforge.net/tabix.shtml

See Also

scanTabix and friends

targets  

microRNA target sites

Description

A data frame of human microRNA target sites retrieved from MiRBase. This is a subset of the hsTargets data frame in the microRNA package. See the rtracklayer vignette for more details.
Usage

data(targets)

Format

A data frame with 2981 observations on the following 6 variables.

name  The miRBase ID of the microRNA.
target The Ensembl ID of the targeted transcript.
chrom The name of the chromosome for target site.
start Target start position.
end   Target stop position.
strand The strand of the target site, "+", or "-".

Source

The microRNA package, dataset hsTargets. Originally MiRBase (http://microrna.sanger.ac.uk/).

Examples

data(targets)
targetTrack <- with(targets, 
  GenomicData(IRanges::IRanges(start, end), 
  strand = strand, chrom = chrom))

track<--methods  Laying tracks

Description

Methods for loading tracks into genome browsers.

Usage

track(object, ...) <- value

Arguments

object  A BrowserSession into which the track is loaded.
value   The track(s) to load.
...     Arguments to pass on to methods. Can be:
  • name The name(s) of the track(s) being loaded.
  • view  Whether to create a view of the track after loading it.

See Also

track for getting a track from a session.
TrackLine-class

Class "TrackLine"

Description

An object representing a "track line" in the UCSC format. There are two concrete types of track lines: BasicTrackLine (used for most types of tracks) and GraphTrackLine (used for graphical tracks). This class only declares the common elements between the two.

Objects from the Class

Objects can be created by calls of the form `new("TrackLine", ...)` or parsed from a character vector track line with `as(text, "TrackLine"). But note that UCSC only understands one of the subclasses mentioned above.
Slots

- **name**: Object of class "character" specifying the name of the track.
- **description**: Object of class "character" describing the track.
- **visibility**: Object of class "character" indicating the default visible mode of the track, see `UCSCTrackModes`.
- **color**: Object of class "integer" representing the track color (as from `col2rgb`).
- **priority**: Object of class "numeric" specifying the rank of this track.

Methods

- **as(object, "character")**: Export line to its string representation.

Author(s)

Michael Lawrence

References

http://genome.ucsc.edu/goldenPath/help/customTrack.html#TRACK for the official documentation.

See Also

- `BasicTrackLine` (used for most types of tracks) and `GraphTrackLine` (used for Wiggle/bedGraph tracks).

tracks-methods

Accessing track names

Description

Methods for getting and setting track names.

Methods

The following methods are defined by `rtracklayer` for getting track names via the generic `trackNames(object, ...)`. Get the tracks loaded in the session.

object = "UCSCSession" object = "UCSCTrackModes" Get the visible tracks according to the modes (all tracks not set to "hide").

object = "UCSCView" Get the visible tracks in the view.

The following methods are defined by `rtracklayer` for setting track names via the generic `trackNames(object) <- value`.

object = "UCSCTrackModes" Sets the tracks that should be visible in the modes. All specified tracks with mode "hide" in object are set to mode "full". Any tracks in object that are not specified in the value are set to "hide". No other modes are changed.

object = "UCSCView" Sets the visible tracks in the view. This opens a new web browser with only the specified tracks visible.
TwoBitFile-class

Description

These functions support the import and export of the UCSC 2bit compressed sequence format. The main advantage is speed of subsequence retrieval, as it only loads the sequence in the requested intervals. Compared to the FA format supported by Rsamtools, 2bit offers the additional feature of masking and also has better support in Java (and thus most genome browsers). The supporting TwoBitFile class is a reference to a TwoBit file.

Usage

```r
## S4 method for signature 'TwoBitFile,ANY,ANY'
import(con, format, text,
    which = as(seqinfo(con), "GenomicRanges"), ...)
## S4 method for signature 'TwoBitFile'
getSeq(x, which = as(seqinfo(con), "GenomicRanges"))
import.2bit(con, ...)
## S4 method for signature 'ANY,TwoBitFile,ANY'
export(object, con, format, ...)
## S4 method for signature 'DNAStringSet,TwoBitFile,ANY'
export(object, con, format)
## S4 method for signature 'DNAStringSet,character,ANY'
export(object, con, format, ...)
export.2bit(object, con, ...)
```

Arguments

- `con`: A path, URL or TwoBitFile object. Connections are not supported. For the functions ending in `.2bit`, the file format is indicated by the function name. For the export and import methods, the format must be indicated another way. If `con` is a path, or URL, either the file extension or the `format` argument needs to be “twoBit” or “2bit”.

- `object,x`: The object to export, either a DNAStringSet or something coercible to a DNAStringSet, like a character vector.

- `format`: If not missing, should be “twoBit” or “2bit” (case insensitive).

- `text`: Not supported.

- `which`: A range data structure coercible to RangesList, like a GRanges, or a TwoBitFile. Only the intervals in the file overlapping the given ranges are returned. By default, the value is the TwoBitFile itself. Its Seqinfo object is extracted and coerced to a RangesList that represents the entirety of the file.

- `...`: Arguments to pass down to methods to other methods. For import, the flow eventually reaches the TwoBitFile method on import. For export, the TwoBitFile methods on export are the sink.

Value

For import, a DNAStringSet.
TwoBitFile objects

A TwoBitFile object, an extension of RTLFile is a reference to a TwoBit file. To cast a path, URL or connection to a TwoBitFile, pass it to the TwoBitFile constructor.

A TwoBit file embeds the sequence information, which can be retrieved with the following:

seqinfo(x): Gets the Seqinfo object indicating the lengths of the sequences for the intervals in the file. No circularity or genome information is available.

Author(s)

Michael Lawrence

See Also

export-methods in the BSgenome package for exporting a BSgenome object as a twoBit file.

Examples

test_path <- system.file("tests", package = "rtracklayer")
test_2bit <- file.path(test_path, "test.2bit")

test <- import(test_2bit)

test_2bit_file <- TwoBitFile(test_2bit)
import(test_2bit_file) # the whole file

which_range <- IRanges(c(10, 40), c(30, 42))
which <- GRanges(names(test), which_range)
import(test_2bit, which = which)

seqinfo(test_2bit_file)

## Not run:
test_2bit_out <- file.path(tempdir(), "test_out.2bit")
export(test, test_2bit_out)

## just a character vector

## End(Not run)
Methods

export.bed(object, con, variant = c("base", "bedGraph", "bed15"), color, trackLine = TRUE, ...) Exports the track and its track line (if trackLine is TRUE) to con in the Browser Extended Display (BED) format. The arguments in ... are passed to export.ucsc.

export.bed15(object, con, expNames = NULL, ...) Exports the track and its track line (if trackLine is TRUE) to con in the Bed15 format. The data is taken from the columns named in expNames, which defaults to the expNames in the track line, if any, otherwise all column names. The arguments in ... are passed to export.ucsc.

export.gff(object) Exports the track and its track line (as a comment) to con in the General Feature Format (GFF).

export.ucsc(object, con, subformat, ...) Exports the track and its track line to con in the UCSC meta-format.

as(object, "UCSCData") Constructs a UCSCData from a GRanges instance, by adding a default track line and ensuring that the sequence/chromosome names are compliant with UCSC conventions. If there is a numeric score, the track line type is either "bedGraph" or "wig", depending on the feature density. Otherwise, "bed" is chosen.

Author(s)

Michael Lawrence

See Also

import and export for reading and writing tracks to and from connections (files), respectively.

UCSCFile-class

UCSC File objects

Description

These functions support the import and export of tracks embedded within the UCSC track line metaformat, whereby multiple tracks may be concatenated within a single file, along with metadata mostly oriented towards visualization. Any UCSCData object is automatically exported in this format, if the targeted format is known to be compatible. The BED and WIG import methods check for a track line, and delegate to these functions if one is found. Thus, calling this API directly is only necessary when importing embedded GFF (rare), or when one wants to create the track line during the export process.

Usage

## S4 method for signature 'UCSCFile,ANY,ANY'
import(con, format, text,
       subformat = "auto", drop = FALSE,
       genome = NA, ...) import.ucsc(con, ...)

## S4 method for signature 'ANY,UCSCFile,ANY'
export(object, con, format, ...)

## S4 method for signature 'GenomicRanges,UCSCFile,ANY'
export(object, con, format, ...)
## S4 method for signature 'GenomicRangesList, UCSCFile, ANY'
export(object, con, format,
   append = FALSE, index = FALSE, ...)

## S4 method for signature 'UCSCData, UCSCFile, ANY'
export(object, con, format,
   subformat = "auto", append = FALSE, index = FALSE, ...)
export.ucsc(object, con, ...)

### Arguments

- **con**
  - A path, URL, connection or UCSCFile object. For the functions ending in `.ucsc`, the file format is indicated by the function name. For the base `export` and `import` functions, “ucsc” must be passed as the `format` argument.

- **object**
  - The object to export, should be a `GRanges` or something coercible to a `GRanges`. For exporting multiple tracks pass a `GenomicRangesList`, or something coercible to one.

- **format**
  - If not missing, should be “ucsc”.

- **text**
  - If `con` is missing, a character vector to use as the input

- **subformat**
  - The file format to use for the actual features, between the track lines. Must be a text-based format that is compatible with track lines (most are). If an `RTLFile` subclass other than `UCSCFile` is passed as `con` to `import.ucsc` or `export.ucsc`, the subformat is assumed to be the corresponding format of `con`. Otherwise it defaults to “auto”. The following describes the logic of the “auto” mode. For import, the subformat is taken as the `type` field in the track line. If none, the file extension is consulted. For export, if `object` is a `UCSCData`, the subformat is taken as the `type` in its track line, if present. Otherwise, the subformat is chosen based on whether `object` contains a “score” column. If there is a score, the target is either `BEDGraph` or `WIG`, depending on the structure of the ranges. Otherwise, `BED` is the target.

- **genome**
  - The identifier of a genome, or `NA` if unknown. Typically, this is a UCSC identifier like “hg19”. An attempt will be made to derive the `seqinfo` on the return value using either an installed BSgenome package or UCSC, if network access is available. This defaults to the `db` BED track line parameter, if any.

- **drop**
  - If TRUE, and there is only one track in the file, return the track object directly, rather than embedding it in a list.

- **append**
  - If TRUE, and `con` points to a file path, the data is appended to the file. Obviously, if `con` is a connection, the data is always appended.

- **index**
  - If TRUE, automatically compress and index the output file with bgzf and tabix. Note that tabix indexing will sort the data by chromosome and start. Tabix supports a single track in a file.

- **...**
  - Should either specify track line parameters or arguments to pass down to the import and export routine for the subformat.

### Details

The UCSC track line permits the storage of multiple tracks in a single file by separating them with a so-called “track line”, a line belonging with the word “track” and containing various key=value pairs encoding metadata, most related to visualization. The standard fields in a track depend on the type of track being annotated. See `TrackLine` and its derivatives for how these lines are represented in R. The class `UCSCData` is an extension of `GRanges` with a formal slot for a `TrackLine`. Each
GRanges in the returned GenomicRangesList has the track line stored in its metadata, under the trackLine key.

For each track object to be exported, if the object is not a UCSCData, and there is no trackLine element in the metadata, then a new track line needs to be generated. This happens through the coercion of object to UCSCData. The track line is initialized to have the appropriate type parameter for the subformat, and the required name parameter is taken from the name of the track in the input list (if any). Otherwise, the default is simply “R Track”. The db parameter (specific to BED track lines) is taken as genome(object) if not NA. Additional arguments passed to the export routines override parameters in the provided track line.

If the subformat is either WIG or BEDGraph, and the features are stranded, a separate track will be output in the file for each strand. Neither of those formats encodes the strand and disallow overlapping features (which might occur upon destranding).

Value

A GenomicRangesList unless drop is TRUE and there is only a single track in the file. In that case, the first and only object is extracted from the list and returned. The structure of that object depends on the format of the data. The GenomicRangesList contains UCSCData objects.

UCSCFile objects

The UCSCFile class extends RTLFile and is a formal representation of a resource in the UCSC format. To cast a path, URL or connection to a UCSCFile, pass it to the UCSCFile constructor.

Author(s)

Michael Lawrence

References

http://genome.ucsc.edu/goldenPath/help/customTrack.html

ucscGenomes

Get available genomes on UCSC

Description

Get a data.frame describing the available UCSC genomes.

Usage

ucscGenomes(organism=FALSE)

Arguments

organism A logical(1) indicating whether scientific name should be appended.

Details

For populating the organism column, the web url http://genome.ucsc.edu/cgi-bin is scraped for every assembly version to get the scientific name.
Value

A data.frame with the following columns:

- **db**: UCSC DB identifier (e.g. "hg18")
- **species**: The name of the species (e.g. "Human")
- **date**: The date the genome was built
- **name**: The official name of the genome build
- **organism**: The scientific name of the species (e.g. "Homo sapiens")

Author(s)

Michael Lawrence

See Also

UCSCSession for details on specifying the genome.

Examples

ucscGenomes()
Examples

```r
## Not run:
session <- browserSession()
genome(session) <- "mm9"
query <- ucscTableQuery(session, "knownGene")
schema <- ucscSchema(query)
nrow(schema)
## End(Not run)
```

UCSCSession-class  
Class "UCSCSession"

Description

An implementation of BrowserSession for the UCSC genome browser.

Objects from the Class

Objects can be created by calls of the form browserSession("ucsc", url = "http://genome.ucsc.edu/cgi-bin")
The arguments in ... correspond to libcurl options, see getFetchHandle. Setting these options may be useful e.g. for getting past a proxy.

Slots

url: Object of class "character" holding the base URL of the UCSC browser.
hguid: Object of class "numeric" holding the user identification code.
views: Object of class "environment" containing a list stored under the name "instances". The list holds the instances of BrowserView for this session.

Extends

Class "BrowserSession", directly.

Methods

browserView(object, range = range(object), track = trackNames(object), ...) Creates a BrowserView of range with visible tracks specified by track. track may be an instance of UCSCTrackModes. Arguments in ... should match parameters to a ucsctTrackModes method for creating a UCSCTrackModes instance that will be merged with and override modes indicated by the track parameter.

browserViews(object) Gets the BrowserView instances for this session.

range(x) Gets the GRanges last displayed in this session.

genome(x) Gets the genome identifier of the session, i.e. genome(range(x)).

seqinfo Gets the Seqinfo object with the lengths of the chromosomes in the current genome. No circularity information is available.

range(x) <- value Sets value, usually a GRanges object or RangesList, as the range of session x. Note that this setting only lasts until a view is created or manipulated. This mechanism is useful, for example, when treating the UCSC browser as a database, rather than a genome viewer.
UCSCTableQuery-class

Author(s)
Michael Lawrence

See Also
browserSession for creating instances of this class.

UCSCTableQuery-class Querying UCSC Tables

Description
The UCSC genome browser is backed by a large database, which is exposed by the Table Browser web interface. Tracks are stored as tables, so this is also the mechanism for retrieving tracks. The UCSCTableQuery class represents a query against the Table Browser. Storing the query fields in a formal class facilitates incremental construction and adjustment of a query.

Details
There are five supported fields for a table query:

session The UCSCSession instance from the tables are retrieved. Although all sessions are based on the same database, the set of user-uploaded tracks, which are represented as tables, is not the same, in general.

trackName The name of a track from which to retrieve a table. Each track can have multiple tables. Many times there is a primary table that is used to display the track, while the other tables are supplemental. Sometimes, tracks are displayed by aggregating multiple tables. If NULL, search for a primary table across all of the tracks (will not find secondary tables).

tableName The name of the specific table to retrieve. May be NULL, in which case the behavior depends on how the query is executed, see below.
range A genome identifier, a GRanges or a RangesList indicating the portion of the table to retrieve, in genome coordinates. Simply specifying the genome string is the easiest way to download data for the entire genome, and GRangesForUCSCGenome facilitates downloading data for e.g. an entire chromosome.

names Names/accessions of the desired features

A common workflow for querying the UCSC database is to create an instance of UCSCTableQuery using the ucscTableQuery constructor, invoke tableNames to list the available tables for a track, and finally to retrieve the desired table either as a data.frame via getTable or as a track via track. See the examples.

The reason for a formal query class is to facilitate multiple queries when the differences between the queries are small. For example, one might want to query multiple tables within the track and/or same genomic region, or query the same table for multiple regions. The UCSCTableQuery instance can be incrementally adjusted for each new query. Some caching is also performed, which enhances performance.

Constructor

ucscTableQuery(x, track, range = genome(x), table = NULL, names = NULL): Creates a UCSCTableQuery with the UCSCSession given as x and the track name given by the single string track. range should be a genome string identifier, a GRanges instance or RangesList instance, and it effectively defaults to genome(x). If the genome is missing, it is taken from the session. The table name is given by table, which may be a single string or NULL. Feature names, such as gene identifiers, may be passed via names as a character vector.

Executing Queries

Below, object is a UCSCTableQuery instance.

track(object): Retrieves the indicated table as a track, i.e. a GRanges object. Note that not all tables are available as tracks.

getTable(object): Retrieves the indicated table as a data.frame. Note that not all tables are output in parseable form, and that UCSC will truncate responses if they exceed certain limits (usually around 100,000 records). The safest (and most efficient) bet for large queries is to download the file via FTP and query it locally.

tableNames(object): Gets the names of the tables available for the session, track and range specified by the query.

Accessor methods

In the code snippets below, x/object is a UCSCTableQuery object.

browserSession(object), browserSession(object) <- value: Get or set the UCSCSession to query.

trackName(x), trackName(x) <- value: Get or set the single string indicating the track containing the table of interest.

trackNames(x): List the names of the tracks available for retrieval for the assigned genome.

tableName(x), tableName(x) <- value: Get or set the single string indicating the name of the table to retrieve. May be NULL, in which case the table is automatically determined.
range(x), range(x) <- value: Get or set the GRanges indicating the portion of the table to retrieve in genomic coordinates. Any missing information, such as the genome identifier, is filled in using range(browserSession(x)). It is also possible to set the genome identifier string or a RangesList.

names(x), names(x) <- value: Get or set the names of the features to retrieve. If NULL, this filter is disabled.

ucscSchema(x): Get the UCSCSchema object describing the selected table.

Author(s)
Michael Lawrence

Examples

## Not run:

session <- browserSession()

genome(session) <- "mm9"

trackNames(session) ## list the track names

## choose the Conservation track for a portion of mm9 chr1

query <- ucscTableQuery(session, "Conservation",
                      GRangesForUCSCGenome("mm9", "chr12",
                                      IRanges(57795963, 57815592)))

## list the table names

tableNames(query)

## get the phastCons30way track

tableName(query) <- "phastCons30way"

## retrieve the track data

track(query) # a GRanges object

## get a data.frame summarizing the multiple alignment

tableName(query) <- "multiz30waySummary"

getTable(query)

genome(session) <- "hg18"

query <- ucscTableQuery(session, "snp129",
                      names = c("rs10003974", "rs10087355", "rs10075230"))

ucscSchema(query)

getTable(query)

## End(Not run)

UCSCTrackModes-class

Class "UCSCTrackModes"

Description

A vector of view modes ("hide", "dense", "full", "pack", "squish") for each track in a UCSC view.

Objects from the Class

Objects may be created by calls of the form ucscTrackModes(object = character(), hide = character(), dense = character(), pack = character(), squish = character(), full = character()) where object should be a character vector of mode names (with its names attribute specifying the corresponding track names). The other parameters should contain track names that override the modes in object. Later parameters override earlier ones, so, for example, if a track is named in hide and full, it is shown in the full view mode.
Slots

.Data: Object of class "character" holding the modes ("hide", "dense", "full", "pack", "squish"), with its names attribute holding corresponding track names.

labels: Object of class "character" holding labels (human-readable names) corresponding to each track/mode.

Extends

Class "character", from data part. Class "vector", by class "character", distance 2.

Methods

trackNames(object) Gets the names of the visible tracks (those that do not have mode "hide").

trackNames(object) <- value Sets the names of the visible tracks. Any tracks named in value are set to "full" if the are currently set to "hide" in this object. Any tracks not in value are set to "hide". All other modes are preserved.

object[i] Gets the track mode of the tracks indexed by i, which can be any type of index supported by character vector subsetting. If i is a character vector, it indexes first by the internal track IDs (the names on .Data) and then by the user-level track names (the labels slot).

object[i] <- value Sets the track modes indexed by i (in the same way as in object[i] above) to those specified in value.

Author(s)

Michael Lawrence

See Also

UCSCView on which track view modes may be set.

ucscTrackModes-methods

Accessing UCSC track modes

Description

Generics for getting and setting UCSC track visibility modes ("hide", "dense", "full", "pack", "squish").

Methods

The following methods are defined by rtracklayer for getting the track modes through the generic ucscTrackModes(object, ...).

function(object, hide = character(), dense = character(), pack = character(), squish = character()) Creates an instance of UCSCTrackModes from object, a character vector of mode names, with the corresponding track ids given in the names attribute. Note that object can be a UCSCTrackModes instance, as UCSCTrackModes extends character. The other parameters are character vectors identifying the tracks for each mode and overriding the modes specified by object.
object = "character" object = "missing"  The same interface as above, except object defaults to an empty character vector.

object = "UCSCView"  Gets modes for tracks in the view.

object = "UCSCSession"  Gets default modes for the tracks in the session. These are the modes that will be used as the default for a newly created view.

The following methods are defined by rtracklayer for setting the track modes through the generic ucscTrackModes(object) <- value.

object = "UCSCView", value = "UCSCTrackModes"  Sets the modes for the tracks in the view.

object = "UCSCView", value = "character"  Sets the modes from a character vector of mode names, with the corresponding track names given in the names attribute.

See Also

trackNames and trackNames<- for just getting or setting which tracks are visible (not of mode "hide").

Examples

# Tracks "foo" and "bar" are fully shown, "baz" is hidden
modes <- ucscTrackModes(full = c("foo", "bar"), hide = "baz")
# Update the modes to hide track "bar"
modes2 <- ucscTrackModes(modes, hide = "bar")
Methods

activeView(object) Obtains a logical indicating whether this view is the active view.
range(object) Obtains the GRanges displayed by this view.
range(object) <- value Sets the GRanges or RangesList displayed by this view.
trackNames(object) Gets the names of the visible tracks in this view.
trackNames(object) <- value Sets the visible tracks by name.
visible(object) Get a named logical vector indicating whether each track is visible.
visible(object) <- value Set a logical vector indicating the visibility of each track, in the same
order as returned by visible(object).
ucscTrackModes(object) Obtains the UCSCTrackModes for this view.
ucscTrackModes(object) <- value Sets the UCSCTrackModes for this view. The value may
be either a UCSCTrackModes instance or a character vector that will be coerced by a call to
ucscTrackModes.

Author(s)

Michael Lawrence

See Also

browserView for creating instances of this class.

---

WIGFile-class  WIG Import and Export

Description

These functions support the import and export of the UCSC WIG (Wiggle) format.

Usage

## S4 method for signature 'WIGFile,ANY,ANY'
import(con, format, text, genome = NA,
       trackLine = TRUE, which = NULL, seqinfo = NULL, ...)
import.wig(con, ...)

## S4 method for signature 'ANY,WIGFile,ANY'
export(object, con, format, ...)
## S4 method for signature 'GenomicRanges,WIGFile,ANY'
export(object, con, format,
       dataFormat = c("auto", "variableStep", "fixedStep"),
       writer = .wigWriter, append = FALSE, ...)
## S4 method for signature 'GenomicRangesList,WIGFile,ANY'
export(object, con, format, ...)
## S4 method for signature 'UCSCData,WIGFile,ANY'
export(object, con, format,
       trackLine = TRUE, ...)
export.wig(object, con, ...)

Arguments

con   A path, URL, connection or WIGFile object. For the functions ending in `.wig`, the file format is indicated by the function name. For the base `export` and `import` functions, the format must be indicated another way. If `con` is a path, URL or connection, either the file extension or the `format` argument needs to be “wig”. Compressed files (“gz”, “bz2” and “xz”) are handled transparently.

object  The object to export, should be a GRanges or something coercible to a GRanges. For exporting multiple tracks, in the UCSC track line metaformat, pass a GenomicRangesList, or something coercible to one.

format  If not missing, should be “wig”.

text  If `con` is missing, a character vector to use as the input

trackLine  Whether to parse/output a UCSC track line. An imported track line will be stored in a TrackLine object, as part of the returned UCSCData.

genie  The identifier of a genome, or NA if unknown. Typically, this is a UCSC identifier like “hg19”. An attempt will be made to derive the seqinfo on the return value using either an installed BSgenome package or UCSC, if network access is available.

seqinfo  If not NULL, the Seqinfo object to set on the result. If the genome argument is not NA, it must agree with genome(seqinfo).

which  A range data structure like RangesList or GRanges. Only the intervals in the file overlapping the given ranges are returned. This is inefficient; use BigWig for efficient spatial queries.

append  If TRUE, and `con` points to a file path, the data is appended to the file. Obviously, if `con` is a connection, the data is always appended.

dataFormat  Probably best left to “auto”. Exists only for historical reasons.

writer  Function for writing out the blocks; for internal use only.

...  Arguments to pass down to methods to other methods. For import, the flow eventually reaches the WIGFile method on import. When `trackLine` is TRUE, the arguments are passed through `export.ucsc`, so track line parameters are supported.

Details

The WIG format is a text-based format for efficiently representing a dense genome-scale score vector. It encodes, for each feature, a range and score. Features from the same sequence (chromosome) are grouped together into a block, with a single block header line indicating the chromosome. There are two block formats: fixed step and variable step. For fixed step, the number of positions (or step) between intervals is the same across an entire block. For variable step, the start position is specified for each feature. For both fixed and variable step, the span (or width) is specified in the header and thus must be the same across all features. This requirement of uniform width dramatically limits the applicability of WIG. For scored features of variable width, consider BEDGraph or BigWig, which is generally preferred over both WIG and BEDGraph. To efficiently convert an existing WIG or BEDGraph file to BigWig, call `wigToBigWig`. Neither WIG, BEDGraph nor BigWig allow overlapping features.

Value

A GRanges with the score values in the score metadata column, which is accessible via the score function.
WIGFile objects

The WIGFile class extends RTLFile and is a formal representation of a resource in the WIG format. To cast a path, URL or connection to a WIGFile, pass it to the WIGFile constructor.

Author(s)

Michael Lawrence

References

http://genome.ucsc.edu/goldenPath/help/wiggle.html

Examples

test_path <- system.file("tests", package = "rtracklayer")
test_wig <- file.path(test_path, "step.wig")

## basic import calls
test <- import(test_wig)
test
import.wig(test_wig)
test_wig_file <- WIGFile(test_wig)
import(test_wig_file)
test_wig_con <- file(test_wig)
import(test_wig_con, format = "wig")
close(test_wig_con)
test_wig_con <- file(test_wig)
import(WIGFile(test_wig_con))
close(test_wig_con)

## various options
import(test_wig, genome = "hg19")
import(test_wig, trackLine = FALSE)
which <- as(test[3:4,], "RangesList")
import(test_wig, which = which)

## Not run:
## basic export calls

test_wig_out <- file.path(tempdir(), "test.wig")
export(test, test_wig_out)
export.wig(test, test_wig_out)
test_foo_out <- file.path(tempdir(), "test.foo")
export(test, test_foo_out, format = "wig")
test_wig_out_file <- WIGFile(test_wig_out)
export(test, test_wig_out_file)

## appending

test2 <- test
metadata(test2)$trackLine <- initialize(metadata(test)$trackLine,
    name = "test2")
export(test2, test_wig_out_file, append = TRUE)

## passing track line parameters
export(test, test_wig_out, name = "test2")

## no track line
wigToBigWig

Description

This function calls the Kent C library to efficiently convert a WIG file to a BigWig file, without loading the entire file into memory. This solves the problem where simple tools write out text WIG files, instead of more efficiently accessed binary BigWig files.

Usage

wigToBigWig(x, seqinfo, 
  dest = paste(file_path_sans_ext(x, TRUE), "bw", sep = "."), 
  clip = FALSE)

Arguments

  x  Path or URL to the WIG file. Connections are not supported.
  seqinfo Seqinfo object, describing the genome of the data. All BigWig files must have this defined.
  dest  The path to which to write the BigWig file. Defaults to x with the extension changed to "bw".
  clip  If TRUE, regions outside of seqinfo will be clipped, so that no error is thrown.

Author(s)

  Michael Lawrence

See Also

  BigWig import and export support
Index

∗Topic IO
   io, 32
∗Topic classes
   BasicTrackLine-class, 6
   Bed15TrackLine-class, 7
   BEDFile-class, 8
   BigWigFile-class, 12
   BigWigSelection-class, 14
   BrowserSession-class, 17
   BrowserView-class, 19
   BrowserViewList-class, 20
   Chain-class, 21
   FastFile-class, 23
   GenomicData, 25
   GFFFile-class, 26
   GraphTrackLine-class, 31
   Quickload-class, 36
   QuickloadGenome-class, 36
   RangesList-methods, 38
   RTLFile-class, 40
   TrackDb-class, 44
   TrackLine-class, 44
   TwoBitFile-class, 46
   UCSCData-class, 47
   UCSCFile-class, 48
   UCSCSchema-class, 51
   UCSCSession-class, 52
   UCSCTableQuery-class, 53
   UCSCTrackModes-class, 55
   UCSCView-class, 57
   WIGFile-class, 58

∗Topic datasets
   cpneTrack, 22
   targets, 42

∗Topic interface
   browseGenome, 16
   genomeBrowsers, 24
   ucsGenomes, 50

∗Topic manip
   blocks-methods, 15
   GenomicSelection, 26
   readGFF, 39

∗Topic methods
   activeView-methods, 3
   BEDFile-class, 8
   BigWigFile-class, 12
   BigWigSelection-class, 14
   blocks-methods, 15
   browserSession-methods, 18
   browserView-methods, 20
   browserViews-methods, 21
   Chain-class, 21
   FastFile-class, 23
   GenomicData, 25
   GFFFile-class, 26
   Quickload-class, 36
   QuickloadGenome-class, 36
   RangesList-methods, 38
   RTLFile-class, 40
   sequence<--methods, 41
   track<--methods, 43
   TrackDb-class, 44
   tracks-methods, 45
   TwoBitFile-class, 46
   UCSCFile-class, 48
   UCSCSchema-class, 51
   UCSCTableQuery-class, 53
   ucscTrackModes-methods, 56
   WIGFile-class, 58
   [.,UCSCTrackModes,ANY,ANY,ANY-method (UCSCTrackModes-class), 55
   [<-,UCSCTrackModes,ANY,ANY,ANY-method (UCSCTrackModes-class), 55
   [[..,Quickload,ANY,ANY-method (Quickload-class), 36
   [[..,TrackDb,ANY,ANY-method (TrackDb-class), 44
   [[..,TrackDb,ANY,ANY-method (TrackDb-class), 44
   $,Quickload-method (Quickload-class), 36
   $,TrackDb-method (TrackDb-class), 44
   $<-,TrackDb-method (TrackDb-class), 44
   2BitFile (TwoBitFile-class), 46
   2BitFile-class (TwoBitFile-class), 46
   activeView, 17, 58
   activeView (activeView-methods, 3
activeView, BrowserSession-method
  (activeView-methods), 3
activeView, UCSCView-method
  (activeView-methods), 3
activeView-methods, 3
activeView<- (activeView-methods), 3
activeView<--methods
  (activeView-methods), 3
as.character, RTLFile-method
  (RTLFile-class), 40
asBED, 3, 15, 16
asBED, GALignments-method (asBED), 3
asBED, GRangesList-method (asBED), 3
asGFF, 4
asGFF, GRangesList-method (asGFF), 4
BAM, 10, 28, 34
BamFile, 5
BamFile-methods, 5
BasicTrackLine, 31, 32, 44, 45
BasicTrackLine-class, 6
bcd, 33, 34
bed15, 33, 34
BED15File (BEDFile-class), 8
BED15File-class (BEDFile-class), 8
Bed15TrackLine-class, 7
BEDFile, 41
BEDFile (BEDFile-class), 8
BEDFile-class, 8
BEDGraph, 59
bedgraph, 33, 34
BEDGraphFile (BEDFile-class), 8
BEDGraphFile-class (BEDFile-class), 8
bedpe, 34
BEDPEFile (BEDFile-class), 8
BEDPEFile-class (BEDFile-class), 8
BigWig, 10, 28, 59, 61
bigwig, 34
BigWigFile, 15, 41
BigWigFile (BigWigFile-class), 12
BigWigFile-class, 12
BigWigFileList (BigWigFile-class), 12
BigWigFileList-class
  (BigWigFile-class), 12
BigWigSelection, 13, 26
BigWigSelection
  (BigWigSelection-class), 14
BigWigSelection-class, 14
blocks (blocks-methods), 15
blocks, GenomicRanges-method
  (blocks-methods), 15
blocks-methods, 15
browseGenome, 16, 24
browseGenome, GenomicRangesORGenomicRangesList-method
  (browseGenome), 16
browseGenome, missing-method
  (browseGenome), 16
BrowserSession, 16–19, 24, 43, 44, 52
BrowserSession, 16–19, 24, 52, 53
BrowserSession
  (browseSession-methods), 18
browseSession, BrowserView-method
  (browseSession-methods), 18
browseSession, character-method
  (browseSession-methods), 18
browseSession, missing-method
  (browseSession-methods), 18
browseSession, UCSCTableQuery-method
  (UCSCTableQuery-class), 53
BrowserSession-class, 17
browseSession-methods, 18
browseSession<--
  (UCSCTableQuery-class), 53
browserSession<--.UCSTableQuery, UCSCSession-method
  (UCSTableQuery-class), 53
BrowserView, 3, 17, 20, 21, 52, 57
BrowserView, 16, 17, 19–21, 52, 57, 58
BrowserView (browserView-methods), 20
BrowserView, UCSCSession-method
  (browserView-methods), 20
BrowserView-class, 19
BrowserView-methods, 20
BrowserViewList, 20
BrowserViewList
  (BrowserViewList-class), 20
BrowserViewList-class, 20
browseView, 17, 52
browseView (browserView-methods), 21
browseView, UCSCTableQuery-method
  (browserView-methods), 21
browseView-methods, 21
BSgenome, 24, 37, 47
BWFfile (BWFfile-class), 12
BWFfile-class (BWFfile-class), 12
Chain, 35
Chain-class, 21
ChainBlock-class (Chain-class), 21
ChainFile (Chain-class), 21
ChainFile-class (Chain-class), 21
character, 56
chrom (GenomicData), 25
chrom, GRanges-method (GenomicData), 25
chrom, RangesList-method
  (RangesList-methods), 38
chrom<~ (GenomicData), 25
formatDescription, UCSCSchema-method (UCSCSchema-class), 51
GAlignmentPairs, 5
GAlignments, 5
genome, 18, 31
genome, BrowserSession-method (BrowserSession-class), 17
genome, GFFFile-method (GFFFile-class), 26
genome, Quickload-method (Quickload-class), 36
genome, QuickloadGenome-method (QuickloadGenome-class), 36
genome, ucscCart-method (UCSCSession-class), 52
genome, UCSCSchema-method (UCSCSchema-class), 51
genome, UCSCSession-method (UCSCSession-class), 52
genome<-, BrowserSession-method (BrowserSession-class), 17
genome<-, UCSCSession-method (UCSCSession-class), 52
genomeBrowsers, 24
GenomeDescription, 37
GenomicData, 25
GenomicRangesList, 16
GenomicRangesORGenomicRangesList-class (browseGenome), 16
GenomicSelection, 15, 26
getCurlHandle, 52
getSeq, 18, 53
getSeq, TwoBitFile-method (TwoBitFile-class), 46
getTable, 53
getTable (UCSCTableQuery-class), 53
getTable, UCSCSession-method (UCSCSession-class), 52
getTable, UCSCTableQuery-method (UCSCTableQuery-class), 53
GFF, 10
gff, 33, 34
GFF1File (GFFFile-class), 26
GFF1File-class (GFFFile-class), 26
GFF2File (GFFFile-class), 26
GFF2File-class (GFFFile-class), 26
GFF3File (GFFFile-class), 26
GFF3File-class (GFFFile-class), 26
GFFcolnames (readGFF), 39
GFFfile, 41
GFFfile (GFFFile-class), 26
GFFFile-class, 26
GRanges, 15–17, 19, 20, 25, 30, 35, 39, 52–54, 58
GRangesForBSGenome (GRangesForUCSCGenome), 30
GRangesForUCSCGenome, 30, 54
GRangesList, 16
GraphTrackLine, 6, 7, 44, 45
GraphTrackLine-class, 31
GTFFile (GFFFile-class), 26
GTFFile-class (GFFFile-class), 26
GVFFile (GFFFile-class), 26
GVFFile-class (GFFFile-class), 26
import, 39, 48
import (io), 32
import, BamFile, ANY, ANY-method (BamFile-methods), 5
import, BED15File, ANY, ANY-method (BEDFile-class), 8
import, BEDFile, ANY, ANY-method (BEDFile-class), 8
import, BEDPEFile, ANY, ANY-method (BEDFile-class), 8
import, BigWigFile, ANY, ANY-method (BigWigFile-class), 12
import, ChainFile, ANY, ANY-method (Chain-class), 21
import, character, character, ANY-method (io), 32
import, character, missing, ANY-method (io), 32
import, CompressedFile, missing, ANY-method (io), 32
import, connection, character, ANY-method (io), 32
import, connection, missing, ANY-method (io), 32
import, FastaFile, ANY, ANY-method (FastaFile-class), 23
import, GFFFile, ANY, ANY-method (GFFFile-class), 26
import, missing, ANY, character-method (io), 32
import, TabixFile, ANY, ANY-method (TabixFile-methods), 41
import, TwoBitFile, ANY, ANY-method (TwoBitFile-class), 46
import, UCSCFile, ANY, ANY-method (UCSCFile-class), 48
import, WIGFile, ANY, ANY-method (WIGFile-class), 58
import.2bit (TwoBitFile-class), 46
import.2bit, ANY-method (TwoBitFile-class), 46
import.bed, 15, 16
import.bed (BEDFile-class), 8
import.bed, ANY-method (BEDFile-class), 8
import.bed15 (BEDFile-class), 8
import.bed15, ANY-method (BEDFile-class), 8
import.bedGraph (BEDFile-class), 8
import.bedGraph, ANY-method (BEDFile-class), 8
import.bw, 15
import.bw (BigWigFile-class), 12
import.bw, ANY-method (BigWigFile-class), 12
import.chain, 35
import.chain (Chain-class), 21
import.chain, ANY-method (Chain-class), 21
import.gff (GFFFile-class), 26
import.gff, ANY-method (GFFFile-class), 26
import.gff1 (GFFFile-class), 26
import.gff1, ANY-method (GFFFile-class), 26
import.gff2 (GFFFile-class), 26
import.gff2, ANY-method (GFFFile-class), 26
import.gff3 (GFFFile-class), 26
import.gff3, ANY-method (GFFFile-class), 26
import.ucsc, 28
import.ucsc (UCSCFile-class), 48
import.ucsc, ANY-method (UCSCFile-class), 48
import.ucsc, RTLFile-method (UCSCFile-class), 48
import.wig (WIGFile-class), 58
import.wig, ANY-method (WIGFile-class), 58
initialize, UCSCData-method (UCSCData-class), 47
initialize, UCSCSession-method (UCSCSession-class), 52
io, 32
length, Quickload-method (Quickload-class), 36
length, QuickloadGenome-method (QuickloadGenome-class), 36
liftOver, 22, 35
liftOver, ANY, ANY-method (liftOver), 35
liftOver, GenomicRanges, Chain-method (liftOver), 35
makeGRangesFromDataFrame, 39
makeTxDbFromGFF, 39
mcols, QuickloadGenome-method (QuickloadGenome-class), 36
names, 38
names, BrowserSession-method (BrowserSession-class), 17
names, QuickloadGenome-method (QuickloadGenome-class), 36
names, UCSCTableQuery-method (UCSCTableQuery-class), 53
names<-, UCSCTableQuery-method (UCSCTableQuery-class), 53
nrow, UCSCSchema-method (UCSCSchema-class), 51
offset, ChainBlock-method (Chain-class), 21
organism, QuickloadGenome-method (QuickloadGenome-class), 36
path (RTLFile-class), 40
path, BigWigFileList-method (BigWigFile-class), 12
path, RTLFile-method (RTLFile-class), 40
Quickload, 37
Quickload (Quickload-class), 36
quickload (QuickloadGenome-class), 36
Quickload-class, 36
QuickloadGenome, 36, 44
QuickloadGenome (QuickloadGenome-class), 36
QuickloadGenome-class, 36
range, 17, 19, 52, 58
range, BrowserSession-method (BrowserSession-class), 17
range, ucscCart-method (UCSCSession-class), 52
range, UCSCSession-method (UCSCSession-class), 52
range, UCSCTableQuery-method (UCSCTableQuery-class), 53
range, UCSCView-method (UCSCView-class), 57
range<-, UCSCSession-method (UCSCSession-class), 52
range<-, UCSCSession-method (UCSCSession-class), 52
INDEX

range<-,UCSTableQuery-method (UCSTableQuery-class), 53
range<-,UCSCView-method (UCSCView-class), 57
RangedSelection, 15, 26
Ranges, 22, 30
ranges,ChainBlock-method (Chain-class), 21
RangesList, 15, 16, 20, 53, 54, 58
RangedList-methods, 38
read.table, 9, 42
readDNAStringSet, 23, 24
readGAlignmentPairs, 5
readGAlignments, 5
readGFF, 39
referenceSequence (QuickloadGenome-class), 36
referenceSequence,QuickloadGenome-method (QuickloadGenome-class), 36
referenceSequence<-(QuickloadGenome-class), 36
referenceSequence,QuickloadGenome-method (QuickloadGenome-class), 36
releaseDate,QuickloadGenome-method (QuickloadGenome-class), 36
resource (RTLFile-class), 40
reversed (Chain-class), 21
reversed,ChainBlock-method (Chain-class), 21
RleList, 13
RsamtoolsFile, 37
RTLFile, 11, 13, 23, 29, 33, 37, 47, 50, 60
RTLFile-class, 40
RTLFileList-class (RTLFile-class), 40
ScanBamParam, 5
scanTabix, 42
score, 23
score,ANY-method (GenomicData), 25
score,ChainBlock-method (Chain-class), 21
score,GenomicRangesORGrangesList-method (GenomicData), 25
Seqinfo, 13, 30, 37, 47, 52, 61
Seqinfo,BigWigFile-method (BigWigFile-class), 12
Seqinfo,DSNAStringSet-method (QuickloadGenome-class), 36
Seqinfo,QuickloadGenome-method (QuickloadGenome-class), 36
Seqinfo,TwoBitFile-method (TwoBitFile-class), 46
Seqinfo,UCSCSession-method (UCSCSession-class), 52
Seqinfo<-,QuickloadGenome-method (QuickloadGenome-class), 36
SeqinfoForBSSGenome (GRangesForUCSCGenome), 30
SeqinfoForUCSCGenome (GRangesForUCSCGenome), 30
seqLengths, 31
sequence, 18
sequence<--methods, 41
sequence<-(sequence<--methods), 41
show, 18, 19
show,BrowserSession-method (BrowserSession-class), 17
show,BrowserView-method (BrowserView-class), 19
show,Quickload-method (Quickload-class), 36
show,QuickloadGenome-method (QuickloadGenome-class), 36
show,RTLFile-method (RTLFile-class), 40
show,TrackLine-method (TrackLine-class), 44
show,UCSCData-method (UCSCData-class); 47
show,UCSTableQuery-method (UCSTableQuery-class), 53
space,ChainBlock-method (Chain-class), 21
split,UCSCData,ANY-method (UCSCData-class), 47
split,UCSCData,Vector-method (UCSCData-class), 47
summary,BigWigFile-method (BigWigFile-class), 12
TabixFile-methods, 41
tableName (UCSTableQuery-class), 53
tableName,UCSCSchema-method (UCSCSchema-class), 51
tableName,UCSTableQuery-method (UCSTableQuery-class), 53
tableName<-(UCSTableQuery-class), 53
tableName<-,UCSTableQuery-method (UCSTableQuery-class), 53
tableNames, 53
tableNames (UCSTableQuery-class), 53
tableNames,UCSTableQuery-method (UCSTableQuery-class), 53
targets, 42
track, 18, 43, 53
track (UCSTableQuery-class), 53
track, QuickloadGenome-method
(track<--methods), 43
track, UCSCSession-method
(UCSCSession-class), 36
track, UCSCTableQuery-method
(UCSCTableQuery-class), 53
track<-methods, 43
track<-(track<-methods), 43
track<-, BrowserSession, ANY-method
(track<--methods), 43
track<-, QuickloadGenome, ANY-method
(QuickloadGenome-class), 36
track<-, QuickloadGenome, character-method
(QuickloadGenome-class), 36
track<-, QuickloadGenome, RsamtoolsFile-method
(QuickloadGenome-class), 36
track<-, QuickloadGenome, RTLFile-method
(QuickloadGenome-class), 36
track<-, TrackDb, ANY-method
(TrackDb-class), 44
track<-, UCSCSession, GenomicRangesList-method
(UCSCSession-class), 52
track<-, UCSCSession, RTLFile-method
(UCSCSession-class), 52
TrackDb, 17
TrackDb-class, 44
TrackLine, 6, 7, 9, 32, 47, 49, 53, 59
TrackLine-class, 44
trackName (UCSCTableQuery-class), 53
trackName, UCSCTableQuery-method
(UCSCTableQuery-class), 53
trackName<- (UCSCTableQuery-class), 53
trackName<-, UCSCTableQuery-method
(UCSCTableQuery-class), 53
trackNames, 18, 19, 53, 56–58
trackNames (tracks-methods), 45
trackNames, BrowserSession-method
(BrowserSession-class), 17
trackNames, UCSCSession-method
(tracks-methods), 45
trackNames, UCSCTableQuery-method
(UCSCTableQuery-class), 53
trackNames, UCSCTrackModes-method
(tracks-methods), 45
trackNames, UCSCView-method
(tracks-methods), 45
trackNames-methods (tracks-methods), 45
trackNames<-(tracks-methods), 45
trackNames<-, UCSCTrackModes-method
(tracks-methods), 45
trackNames<-, UCSCView-method
(tracks-methods), 45
trackNames<--methods (tracks-methods), 45
tracks-methods, 45
TwoBit, 34
TwoBitfile, 41
TwoBitfile (TwoBitFile-class), 46
TwoBitfile-class, 46
TxDb, 39
UCSCData, 9, 48, 49, 59
UCSCData-class, 47
UCSCFile (UCSCFile-class), 48
UCSCFile-class, 48
ucscGenomes, 50
UCSCSchema, 55
ucscSchema (UCSCTableQuery-class), 53
ucscSchema, UCSCSchemaDescription-method
(UCSCSchema-class), 51
ucscSchema, UCSCTableQuery-method
(UCSCTableQuery-class), 53
UCSCSchema-class, 51
UCSCSession, 17, 51, 53
UCSCSession-class, 52
ucscTableQuery (UCSCTableQuery-class), 53
ucscTableQuery, UCSCSession-method
(UCSCTableQuery-class), 53
UCSCTableQuery-class, 53
ucscTableQuery, UCSCSession-method
(UCSCTableQuery-class), 53
UCSCTrackModes, 20, 52, 53, 55, 57, 58
ucscTrackModes
(ucscTrackModes-methods), 56
ucscTrackModes, character-method
(ucscTrackModes-methods), 56
ucscTrackModes, missing-method
(ucscTrackModes-methods), 56
ucscTrackModes, UCSCSession-method
(ucscTrackModes-methods), 56
ucscTrackModes, ucscTracks-method
(ucscTrackModes-methods), 56
ucscTrackModes, UCSCView-method
(ucscTrackModes-methods), 56
UCSCTrackModes-class, 55
ucscTrackModes-methods, 56
ucscTrackModes<-
(ucscTrackModes-methods), 56
ucscTrackModes<-, UCSCView, character-method
(ucscTrackModes-methods), 56
ucscTrackModes<-, UCSCView, UCSCTrackModes-method
(ucscTrackModes-methods), 56
ucscTrackModes<--methods
(ucscTrackModes-methods), 56
UCSCView, 19, 56
<table>
<thead>
<tr>
<th>Term</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>UCSCView-class</td>
<td>57</td>
</tr>
<tr>
<td>uri (Quickload-class)</td>
<td>36</td>
</tr>
<tr>
<td>uri,QuickloadGenome-method   (QuickloadGenome-class)</td>
<td>36</td>
</tr>
<tr>
<td>Vector, vector</td>
<td>20, 56</td>
</tr>
<tr>
<td>visible (BrowserView-class)</td>
<td>19</td>
</tr>
<tr>
<td>visible,BrowserView-method (BrowserView-class)</td>
<td>19</td>
</tr>
<tr>
<td>visible,UCSCView-method (UCSCView-class)</td>
<td>57</td>
</tr>
<tr>
<td>visible&lt;- (BrowserView-class)</td>
<td>19</td>
</tr>
<tr>
<td>visible&lt;-,BrowserView-method (BrowserView-class)</td>
<td>19</td>
</tr>
<tr>
<td>visible&lt;-,UCSCView-method (UCSCView-class)</td>
<td>57</td>
</tr>
<tr>
<td>wig</td>
<td>34</td>
</tr>
<tr>
<td>WIGFile, WIGFile (WIGFile-class)</td>
<td>41, 58</td>
</tr>
<tr>
<td>WIGFile-class</td>
<td>58</td>
</tr>
<tr>
<td>wigToBigWig</td>
<td>14, 59, 61</td>
</tr>
<tr>
<td>write.table</td>
<td>42</td>
</tr>
<tr>
<td>writeXStringSet</td>
<td>23, 24</td>
</tr>
</tbody>
</table>