

# Package ‘systemPipeR’

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**Type** Package

**Title** systemPipeR: NGS workflow and report generation environment

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**biocViews** Genetics, Infrastructure, DataImport, Sequencing, RNASeq, RiboSeq, ChIPSeq, MethylSeq, SNP, GeneExpression, Coverage, GeneSetEnrichment, Alignment, QualityControl

**Description** R package for building and running automated end-to-end analysis workflows for a wide range of next generation sequence (NGS) applications such as RNA-Seq, ChIP-Seq, VAR-Seq and Ribo-Seq. Important features include a uniform workflow interface across different NGS applications, automated report generation, and support for running both R and command-line software, such as NGS aligners or peak/variant callers, on local computers or compute clusters. Efficient handling of complex sample sets and experimental designs is facilitated by a consistently implemented sample annotation infrastructure. Instructions for using systemPipeR are given in the Overview Vignette (HTML). The remaining Vignettes, linked below, are workflow templates for common NGS use cases.

**Depends** Rsamtools (>= 1.31.2), Biostrings, ShortRead (>= 1.37.1), methods

**Imports** BiocGenerics, GenomicRanges, GenomicFeatures (>= 1.31.3), SummarizedExperiment, VariantAnnotation (>= 1.25.11), rjson, ggplot2, grid, limma, edgeR, DESeq2, GOstats, GO.db, annotate, pheatmap, BatchJobs

**Suggests** ape, RUnit, BiocStyle, knitr, rmarkdown, biomaRt, BiocParallel

**VignetteBuilder** knitr

**SystemRequirements** systemPipeR can be used to run external command-line software (e.g. short read aligners), but the corresponding tool needs to be installed on a system.

**License** Artistic-2.0

**URL** <http://tgirke.github.io/systemPipeR>

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alignStats	<i>Alignment statistics</i>
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### Description

Generate data frame containing important read alignment statistics such as the total number of reads in the FASTQ files, the number of total alignments, as well as the number of primary alignments in the corresponding BAM files.

### Usage

```
alignStats(args)
```

### Arguments

args                    Object of class SYSargs.

### Value

data.frame with alignment statistics.

### Author(s)

Thomas Girke

### Examples

```
## Construct SYSargs object from param and targets files
param <- system.file("extdata", "tophat.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)
args
names(args); modules(args); cores(args); outpaths(args); sysargs(args)

## Not run:
## Execute SYSargs on single machine
runCommandline(args=args)

## Execute SYSargs on multiple machines
qsubargs <- getQsubargs(queue="batch", Nnodes="nodes=1", cores=cores(tophat), memory="mem=10gb", time="wallt")
qsubRun(args=args, qsubargs=qsubargs, Nqsubs=1, package="systemPipeR")
## Alignment stats
read_statsDF <- alignStats(args)
read_statsDF <- cbind(read_statsDF[targets$FileName,], targets)
write.table(read_statsDF, "results/alignStats.xls", row.names=FALSE, quote=FALSE, sep="\t")

## End(Not run)
```

---

catDB-class

*Class "catDB"*


---

### Description

Container for storing mappings of genes to annotation categories such as gene ontologies (GO), pathways or conserved sequence domains. The `catmap` slot stores a list of `data.frames` providing the direct assignments of genes to annotation categories (e.g. gene-to-GO mappings); `catlist` is a list of lists of all direct and indirect associations to the annotation categories (e.g. genes mapped to a pathway); and `idconv` allows to store a lookup-table for converting identifiers (e.g. array feature ids to gene ids).

### Objects from the Class

Objects can be created by calls of the form `new("catDB", ...)`.

### Slots

`catmap`: Object of class "list" list of `data.frames`

`catlist`: Object of class "list" list of lists

`idconv`: Object of class "ANY" list of `data.frames`

### Methods

**catlist** signature(`x = "catDB"`): extracts data from `catlist` slot

**catmap** signature(`x = "catDB"`): extracts data from `catmap` slot

**coerce** signature(`from = "list", to = "catDB"`): `as(list, "catDB")`

**idconv** signature(`x = "catDB"`): extracts data from `idconv` slot

**names** signature(`x = "catDB"`): extracts slot names

**show** signature(`object = "catDB"`): summary view of `catDB` objects

### Author(s)

Thomas Girke

### See Also

`makeCATdb`, `GOHyperGAll`, `GOHyperGAll_Subset`, `GOHyperGAll_Simplify`, `GOCluster_Report`, `goBarplot`

### Examples

```
showClass("catDB")
## Not run:
## Obtain annotations from BioMart
listMarts() # To choose BioMart database
m <- useMart("ENSEMBL_MART_PLANT"); listDatasets(m)
m <- useMart("ENSEMBL_MART_PLANT", dataset="athaliana_eg_gene")
listAttributes(m) # Choose data types you want to download
go <- getBM(attributes=c("go_accession", "tair_locus", "go_namespace_1003"), mart=m)
```

```

go <- go[go[,3]!="",,]; go[,3] <- as.character(go[,3])
write.table(go, "GOannotationsBiomart_mod.txt", quote=FALSE, row.names=FALSE, col.names=FALSE, sep="\t")

## Create catDB instance (takes a while but needs to be done only once)
catdb <- makeCATdb(myfile="GOannotationsBiomart_mod.txt", lib=NULL, org="", colno=c(1,2,3), idconv=NULL)
catdb

## End(Not run)

```

---

catmap

*catDB accessor methods*


---

## Description

Methods to access information from catDB object.

## Usage

```
catmap(x)
```

## Arguments

x                    object of class catDB

## Value

various outputs

## Author(s)

Thomas Girke

## Examples

```

## Not run:
## Obtain annotations from BioMart
m <- useMart("ENSEMBL_MART_PLANT"); listDatasets(m)
m <- useMart("ENSEMBL_MART_PLANT", dataset="athaliana_eg_gene")
listAttributes(m) # Choose data types you want to download
go <- getBM(attributes=c("go_accession", "tair_locus", "go_namespace_1003"), mart=m)
go <- go[go[,3]!="",,]; go[,3] <- as.character(go[,3])
write.table(go, "GOannotationsBiomart_mod.txt", quote=FALSE, row.names=FALSE, col.names=FALSE, sep="\t")

## Create catDB instance (takes a while but needs to be done only once)
catdb <- makeCATdb(myfile="GOannotationsBiomart_mod.txt", lib=NULL, org="", colno=c(1,2,3), idconv=NULL)
catdb

## Access methods for catDB
catmap(catdb)$D_MF[1:4,]
catlist(catdb)$L_MF[1:4]
idconv(catdb)

## End(Not run)

```

clusterRun

*Submit command-line tools to cluster***Description**

Submits non-R command-line software to queueing/scheduling systems of compute clusters using run specifications defined by functions similar to runCommandline. runCluster can be used with most queueing systems since it is based on utilities from the BatchJobs package which supports the use of template files (\*.tmpl) for defining the run parameters of the different schedulers. The path to the \*.tmpl file needs to be specified in a conf file provided under the conffile argument.

**Usage**

```
clusterRun(args, FUN=runCommandline, conffile = ".BatchJobs.R", template = "torque.tmpl", Njobs, r
```

**Arguments**

args	Object of class SYSargs.
FUN	Accepts functions such as runCommandline(args, ...) where the args argument is mandatory and needs to be of class SYSargs.
conffile	Path to conf file (default location ./BatchJobs.R). This file contains in its simplest form just one command, such as this line for the Torque scheduler: cluster.functions <- makeClusterFunctionsTorque("torque.tmpl"). For more detailed information visit this page: <a href="https://code.google.com/p/batchjobs/wiki/DortmundUS">https://code.google.com/p/batchjobs/wiki/DortmundUS</a>
template	The template files for a specific queueing/scheduling systems can be downloaded from here: <a href="https://github.com/tudo-r/BatchJobs/blob/master/examples/cfTorque/simple.tmpl">https://github.com/tudo-r/BatchJobs/blob/master/examples/cfTorque/simple.tmpl</a>
Njobs	Integer defining the number of cluster jobs. For instance, if args contains 18 command-line jobs and Njobs=9, then the function will distribute them across 9 cluster jobs each running 2 command-line jobs. To increase the number of CPU cores used by each process, one can do this under the corresponding argument of the command-line tool, e.g. -p argument for Tophat.
runid	Run identifier used for log file to track system call commands. Default is "01".
resourceList	List for reserving for each cluster job sufficient computing resources including memory, number of nodes, CPU cores, walltime, etc. For more details, one can consult the template file for each queueing/scheduling system.

**Value**

Object of class Registry, as well as files and directories created by the executed command-line tools.

**Author(s)**

Thomas Girke

**References**

For more details on BatchJobs, please consult the following pages: <http://sfb876.tu-dortmund.de/PublicPublicationFiles>  
<https://github.com/tudo-r/BatchJobs> <http://goo.gl/k3Tu5Y>

**See Also**

clusterRun replaces the older functions getQsubargs and qsubRun.

**Examples**

```
## Construct SYSargs object from param and targets files
param <- system.file("extdata", "tophat.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)
args
names(args); modules(args); cores(args); outpaths(args); sysargs(args)

## Not run:
## Execute SYSargs on single machine
runCommandLine(args=args)

## Execute SYSargs on multiple machines of a compute cluster. The following
## example uses the conf and template files for the Torque scheduler. Please
## read the instructions above how to obtain the corresponding files for other schedulers.
file.copy(system.file("extdata", ".BatchJobs.R", package="systemPipeR"), ".")
file.copy(system.file("extdata", "torque.tpl", package="systemPipeR"), ".")
resources <- list(walltime="00:25:00", nodes=paste0("1:ppn=", cores(args)), memory="2gb")
reg <- clusterRun(args, conffile=".BatchJobs", template="torque.tpl", Njobs=18, runid="01", resourceList=re

## Monitor progress of submitted jobs
showStatus(reg)
file.exists(outpaths(args))
sapply(1:length(args), function(x) loadResult(reg, x)) # Works once all jobs have completed successfully.

## Alignment stats
read_statsDF <- alignStats(fqpaths=tophatargs$infile1, bampaths=bampaths, fqgz=TRUE)
read_statsDF <- cbind(read_statsDF[targets$FileName,], targets)
write.table(read_statsDF, "results/alignStats.xls", row.names=FALSE, quote=FALSE, sep="\t")

## End(Not run)
```

---

countRangeset

*Read counting for several range sets*


---

**Description**

Convenience function to perform read counting iteratively for several range sets, e.g. peak range sets or feature types. Internally, the read counting is performed with the summarizeOverlaps function from the GenomicAlignments package. The resulting count tables are directly saved to files.

**Usage**

```
countRangeset(bf1, args, format="tabular", ...)
```

**Arguments**

bfl	BamFileList object containing paths to one or more BAM files.
args	Object of class SYSargs where infile1(args) specifies the paths to the tabular range data files (e.g. peak ranges) used for counting.
format	Format of input range files. Currently, supported are tabular or bed. If tabular is selected then the input range files need to contain the proper column titles to coerce with as(..., "GRanges") to GRanges objects after importing them with read.delim. The latter is the case for the peak files (*peaks.xls) generated by the MACS2 software.
...	Arguments to be passed on to internally used summarizeOverlaps function.

**Value**

Named character vector containing the paths from outpaths(args) to the resulting count table files.

**Author(s)**

Thomas Girke

**See Also**

summarizeOverlaps

**Examples**

```
## Paths to BAM files
param <- system.file("extdata", "bowtieSE.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args_bam <- systemArgs(sysma=param, mytargets=targets)
bfl <- BamFileList(outpaths(args_bam), yieldSize=50000, index=character())

## Not run:
## SYSargs with paths to range data and count files
args <- systemArgs(sysma="param/count_rangesets.param", mytargets="targets_macs.txt")

## Iterative read counting
countDFnames <- countRangeset(bfl, args, mode="Union", ignore.strand=TRUE)
writeTargetsout(x=args, file="targets_countDF.txt", overwrite=TRUE)

## End(Not run)
```



## Description

Computes read coverage along single and multi component features based on genomic alignments. The coverage segments of component features are spliced to continuous ranges, such as exons to transcripts or CDSs to ORFs. The results can be obtained with single nucleotide resolution (e.g. around start and stop codons) or as mean coverage of relative bin sizes, such as 100 bins for each feature. The latter allows comparisons of coverage trends among transcripts of variable length. The results can be obtained for single or many features (e.g. any number of transcripts) at once. Visualization of the coverage results is facilitated by a downstream `plotfeatureCoverage` function.

## Usage

```
featureCoverage(bfl, grl, resizereads = NULL, readlengthrange = NULL, Nbins = 20,
               method = mean, fixedmatrix, resizefeatures, upstream, downstream,
               outfile, overwrite = FALSE)
```

## Arguments

<code>bfl</code>	Paths to BAM files provided as <code>BamFileList</code> object. The name slot of the BAM files will be used for naming samples in the results.
<code>grl</code>	Genomic ranges provided as <code>GRangesList</code> typically generated from <code>txdb</code> instances with operations like: <code>cdsBy(txdb, "tx")</code> or <code>exonsBy(txdb, "tx")</code> . Single component features will be processed the same way as multi component features.
<code>resizereads</code>	Positive integer defining the length alignments should be resized to prior to the coverage calculation. <code>NULL</code> will omit the resizing step.
<code>readlengthrange</code>	Positive integer of length 2 determining the read length range to use for the coverage calculation. Reads falling outside of the specified length range will be excluded from the coverage calculation. For instance, <code>readlengthrange=c(30:40)</code> will base the coverage calculation on reads between 30 to 40 bps. Assigning <code>NULL</code> will skip this filtering step.
<code>Nbins</code>	Single positive integer defining the number of segments the coverage of each feature should be binned into in order to obtain coverage summaries of constant length, e.g. for plotting purposes.
<code>method</code>	Defines the summary statistics to use for binning. The default is <code>method=mean</code> .
<code>fixedmatrix</code>	If set to <code>TRUE</code> , a coverage matrix with single nucleotide resolution will be returned for any number of transcripts centered around precise anchor points in a genome annotation, such as stop/start codons or transcription start sites. For instance, a matrix with coverage information 20bps upstream and downstream of the stop/start codons can be obtained with <code>fixedmatrix=TRUE, upstream=20, downstream=20</code> along with a <code>grl</code> instance containing the CDS exon ranges required for this operation, e.g. generated with <code>cdsBy(txdb, "tx")</code> .
<code>resizefeatures</code>	Needs to be set to <code>TRUE</code> when <code>fixedmatrix=TRUE</code> . Internally, this will use the <code>systemPipeR::resizeFeature</code> function to extend single and multi component features at their most left and most right end coordinates. The corresponding extension values are specified under the <code>upstream</code> and <code>downstream</code> arguments.
<code>upstream</code>	Single positive integer specifying the upstream extension length relative to the orientation of each feature in the genome. More details are given above.

downstream	Single positive integer specifying the downstream extension length relative to the orientation of each feature in the genome. More details are given above.
outfile	Default NULL omits writing of the results to a file. If a file name is specified then the results are written to a tabular file. If bf1 contains the paths to several BAM files then the results will be appended to the same file where the first column specifies the sample labels. Redirecting the results to file is particularly useful when processing large files of many sample where computation times can be significant.
overwrite	If set to TRUE any existing file assigned to outfile will be overwritten.

### Value

The function allows to return the following four distinct outputs. The settings to return these instances are illustrated below in the example section.

- (A) data.frame containing binned coverage where rows are features and columns coverage bins. The first four columns contain (i) the sample names, (ii) the number of total aligned reads in the corresponding BAM files (useful for normalization), (iii) the feature IDs, (iv) strand of the coverage. All following columns are numeric and contain the actual coverage data for the sense and antisense strand of each feature.
- (B) data.frame containing coverage with single nucleotide resolution around anchor points such as start and stop codons. The two matrix components are appended column-wise. To clearly distinguish the two data components, they are separated by a specialty column containing pipe characters. The first four columns are the same as described under (A). The column title for the anchor point is 0. For instance, if the features are CDSs then the first 0 corresponds to the first nucleotide of the start codon and the second 0 to the last nucleotide of the stop codon. Upstream and downstream positions are indicated by negative and positive column numbers, respectively.
- (C) data.frame containing combined results of (A) and (B) where the first set of columns contains to the coverage around the start codons, the second one the binned coverage of the CDSs and the third one the coverage around the stop codons separated by the same pipe columns mentioned under (B).
- (D) Rle list containing the nucleotide level coverage of each feature

### Author(s)

Thomas Girke

### See Also

plotfeatureCoverage

### Examples

```
## Construct SYSargs object from param and targets files
param <- system.file("extdata", "tophat.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)

## Not run:
## Features from sample data of systemPipeRdata package
```

```

library(GenomicFeatures)
file <- system.file("extdata/annotation", "tair10.gff", package="systemPipeRdata")
txdb <- makeTxDbFromGFF(file=file, format="gff3", organism="Arabidopsis")

## (A) Generate binned coverage for two BAM files and 4 transcripts
grl <- cdsBy(txdb, "tx", use.names=TRUE)
fcov <- featureCoverage(bfl=BamFileList(outpaths(args)[1:2]), grl=grl[1:4], resizereads=NULL,
  readlengthrange=NULL, Nbins=20, method=mean, fixedmatrix=FALSE,
  resizefeatures=TRUE, upstream=20, downstream=20)
plotfeatureCoverage(covMA=fcov, method=mean, scales="fixed", scale_count_val=10^6)

## (B) Coverage matrix upstream and downstream of start/stop codons
fcov <- featureCoverage(bfl=BamFileList(outpaths(args)[1:2]), grl=grl[1:4], resizereads=NULL,
  readlengthrange=NULL, Nbins=NULL, method=mean, fixedmatrix=TRUE,
  resizefeatures=TRUE, upstream=20, downstream=20)
plotfeatureCoverage(covMA=fcov, method=mean, scales="fixed", scale_count_val=10^6)

## (C) Combined matrix for both binned and start/stop codon
fcov <- featureCoverage(bfl=BamFileList(outpaths(args)[1:2]), grl=grl[1:4], resizereads=NULL,
  readlengthrange=NULL, Nbins=20, method=mean, fixedmatrix=TRUE,
  resizefeatures=TRUE, upstream=20, downstream=20)
plotfeatureCoverage(covMA=fcov, method=mean, scales="fixed", scale_count_val=10^6)

## (D) Rle coverage objects one for each query feature
fcov <- featureCoverage(bfl=BamFileList(outpaths(args)[1:2]), grl=grl[1:4], resizereads=NULL,
  readlengthrange=NULL, Nbins=NULL, method=mean, fixedmatrix=FALSE,
  resizefeatures=TRUE, upstream=20, downstream=20)

## End(Not run)

```

---

featuretypeCounts      *Plot read distribution across genomic features*

---

## Description

Counts how many reads in short read alignment files (BAM format) overlap with entire annotation categories. This utility is useful for analyzing the distribution of the read mappings across feature types, e.g. coding versus non-coding genes. By default the read counts are reported for the sense and antisense strand of each feature type separately. To minimize memory consumption, the BAM files are processed in a stream using utilities from the Rsamtools and GenomicAlignment packages. The counts can be reported for each read length separately or as a single value for reads of any length. Subsequently, the counting results can be plotted with the associated plotfeaturetypeCounts function.

## Usage

```
featuretypeCounts(bfl, grl, singleEnd = TRUE, readlength = NULL, type = "data.frame")
```

## Arguments

**bfl** BamFileList object containing the paths to the target BAM files stored on disk. Note, memory-efficient processing is achieved by streaming through BAM files rather than reading entire files into memory at once. The maximum number of

	alignments to process in each iteration is determined by the <code>yieldSize</code> value passed on to the <code>BamFileList</code> function. For details see <code>?BamFileList</code> .
<code>grl</code>	<code>GRangesList</code> object containing in each list component the range set of a feature type. Typically, this object is generated with the <code>genFeatures</code> function. For details see the example section below and <code>?genFeatures</code> .
<code>singleEnd</code>	Specifies whether the targets BAM files contain alignments for single-end (SE) or paired-end read data. <code>TRUE</code> is for SE and <code>FALSE</code> for PE data.
<code>readlength</code>	Integer vector specifying the read length values for which to report counts separately. If <code>readlength=NULL</code> the length of the reads will be ignored resulting in a single value for each feature type and strand. Note, for PE data the two reads in a pair may differ in length. In those cases the length of the two reads is averaged and then assigned to the corresponding length category after rounding the mean length to the closest integer. This is not an ideal solution but a reasonable compromise for the purpose of the summary statistics generated by <code>featuretypeCounts</code> .
<code>type</code>	Determines whether the results are returned as <code>data.frame</code> ( <code>type="data.frame"</code> ) or as <code>list</code> ( <code>type="list"</code> ). Each list component contains the counting results for one BAM file and is named after the corresponding sample. The <code>data.frame</code> result contains this sample assignment information in a separate column.

### Value

The results are returned as `data.frame` or `list` of `data.frames`. For details see above under `types` argument. The result `data.frames` contain the following columns in the given order:

<code>SampleName</code>	Sample names obtained from <code>BamFileList</code> object.
<code>Strand</code>	Sense or antisense strand of read mappings.
<code>Featuretype</code>	Name of feature type provided by <code>GRangesList</code> object. Note, the total number of aligned reads is reported under the special feature type <code>'N_total_aligned'</code> . This value is useful for scaling/normalization purposes in plots, e.g. counts per million reads.
<code>Featuretypelength</code>	Total genomic length of each reduced feature type in bases. This value is useful to normalize the read counts by genomic length units, e.g. in plots.
Subsequent columns	Counts for reads of any length or for individual read lengths.

### Author(s)

Thomas Girke

### See Also

`plotfeaturetypeCounts`, `genFeatures`

### Examples

```
## Construct SYSargs object from param and targets files
param <- system.file("extdata", "tophat.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)
```

```
## Not run:
## Features from sample data of systemPipeRdata package
library(GenomicFeatures)
file <- system.file("extdata/annotation", "tair10.gff", package="systemPipeRdata")
txdb <- makeTxDbFromGFF(file=file, format="gff3", organism="Arabidopsis")
feat <- genFeatures(txdb, featuretype="all", reduce_ranges=TRUE, upstream=1000, downstream=0, verbose=TRUE)

## Generate and plot feature counts for specific read lengths
fc <- featuretypeCounts(bfl=BamFileList(outpaths(args), yieldSize=50000), grl=feat, singleEnd=TRUE, readlen
p <- plotfeaturetypeCounts(x=fc, graphicsfile="featureCounts.pdf", graphicsformat="pdf", scales="fixed", any

## Generate and plot feature counts for any read length
fc2 <- featuretypeCounts(bfl=BamFileList(outpaths(args), yieldSize=50000), grl=feat, singleEnd=TRUE, readlen
p2 <- plotfeaturetypeCounts(x=featureCounts2, graphicsfile="featureCounts2.pdf", graphicsformat="pdf", scal

## End(Not run)
```

---

filterDEGs

*Filter and plot DEG results*


---

## Description

Filters and plots DEG results for a given set of sample comparisons. The gene identifiers of all (i) Up\_or\_Down, (ii) Up and (iii) Down regulated genes are stored as separate list components, while the corresponding summary statistics, stored in a fourth list component, is plotted in form of a stacked bar plot.

## Usage

```
filterDEGs(degDF, filter, plot = TRUE)
```

## Arguments

degDF	data.frame generated by run_edgeR
filter	Named vector with filter cutoffs of format c(Fold=2, FDR=1) where Fold refers to the fold change cutoff (unlogged) and FDR to the p-value cutoff.
plot	Allows to turn plotting behavior on and off with default set to TRUE.

## Details

Currently, there is no community standard available how to calculate fold changes (here logFC) of genomic ranges, such as gene or feature ranges, to unambiguously refer to them as features with increased or decreased read abundance; or in case of gene expression experiments to up or down regulated genes, respectively. To be consistent within systemPipeR, the corresponding functions, such as filterDEGs, use here the following definition. Genomic ranges with positive logFC values are classified as up and those with negative logFC values as down. This means if a comparison among two samples a and b is specified in the corresponding targets file as a-b then the feature with a positive logFC has a higher `_normalized_` read count value in sample a than in sample b, and vice versa. To inverse this assignment, users want to change the specification of their chosen sample comparison(s) in the targets file accordingly, e.g. change a-b to b-a. Alternatively, one can swap the column order of the matrix assigned to the `cmp` argument of the `run_edgeR` or `run_DESeq2` functions. Users should also be aware that for logFC values close to zero (noise range), the direction

of the fold change (sign of logFC) can be very sensitive to minor differences in the normalization method, while this assignment is much more robust for more pronounced changes or higher absolute logFC values.

### Value

Returns list with four components

UpOrDown	List of up or down regulated gene/transcript identifiers meeting the chosen filter settings for all comparisons defined in data frames pval and log2FC.
Up	Same as above but only for up regulated genes/transcript.
Down	Same as above but only for down regulated genes/transcript.

### Author(s)

Thomas Girke

### See Also

run\_edgeR

### Examples

```
targetspath <- system.file("extdata", "targets.txt", package="systemPipeR")
targets <- read.delim(targetspath, comment="#")
cmp <- readComp(file=targetspath, format="matrix", delim="-")
countfile <- system.file("extdata", "countDFeByg.xls", package="systemPipeR")
countDF <- read.delim(countfile, row.names=1)
edgeDF <- run_edgeR(countDF=countDF, targets=targets, cmp=cmp[[1]], independent=FALSE, mdsplot="")
pval <- edgeDF[, grep("_FDR$", colnames(edgeDF)), drop=FALSE]
fold <- edgeDF[, grep("_logFC$", colnames(edgeDF)), drop=FALSE]
DEG_list <- filterDEGs(degDF=edgeDF, filter=c(Fold=2, FDR=10))
names(DEG_list)
DEG_list$Summary
```

---

filterVars

*Filter VCF files*

---

### Description

Convenience function for filtering VCF files based on user definable quality parameters. The function imports each VCF file into R, applies the filtering on an internally generated VRanges object and then writes the results to a new VCF file.

### Usage

```
filterVars(args, filter, varcaller, organism)
```

**Arguments**

args	Object of class SYSargs. The paths of the input VCF files are specified under infile1(args) and the paths of the output files under outfile1(args).
filter	Character vector of length one specifying the filter syntax that will be applied to the internally created VRanges object.
varcaller	Character vector of length one specifying the variant caller used for generating the input VCFs. Currently, this argument can be assigned 'gatk', 'bcftools' or 'vartools'.
organism	Character vector specifying the organism name of the reference genome.

**Value**

Output files in VCF format. Their paths can be obtained with outpaths(args).

**Author(s)**

Thomas Girke

**See Also**

variantReport combineVarReports, varSummar

**Examples**

```
## Alignment with BWA (sequentially on single machine)
param <- system.file("extdata", "bwa.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)
sysargs(args)[1]

## Not run:
system("bwa index -a bwtsv ./data/tair10.fasta")
bampaths <- runCommandline(args=args)

## Alignment with BWA (parallelized on compute cluster)
resources <- list(walltime="20:00:00", nodes=paste0("1:ppn=", cores(args)), memory="10gb")
reg <- clusterRun(args, conffile=".BatchJobs.R", template="torque.tmpl", Njobs=18, runid="01",
  resourceList=resources)

## Variant calling with GATK
## The following creates in the initial step a new targets file
## (targets_bam.txt). The first column of this file gives the paths to
## the BAM files created in the alignment step. The new targets file and the
## parameter file gatk.param are used to create a new SYSargs
## instance for running GATK. Since GATK involves many processing steps, it is
## executed by a bash script gatk_run.sh where the user can specify the
## detailed run parameters. All three files are expected to be located in the
## current working directory. Samples files for gatk.param and
## gatk_run.sh are available in the subdirectory ./inst/extdata/ of the
## source file of the systemPipeR package.
writeTargetnout(x=args, file="targets_bam.txt")
system("java -jar CreateSequenceDictionary.jar R=./data/tair10.fasta O=./data/tair10.dict")
# system("java -jar /opt/picard/1.81/CreateSequenceDictionary.jar R=./data/tair10.fasta O=./data/tair10.dict")
args <- systemArgs(sysma="gatk.param", mytargets="targets_bam.txt")
```

```

resources <- list(walltime="20:00:00", nodes=paste0("1:ppn=", 1), memory="10gb")
reg <- clusterRun(args, conffile=".BatchJobs.R", template="torque.tmpl", Njobs=18, runid="01",
                 resourceList=resources)
writeTargetsout(x=args, file="targets_gatk.txt")

## Variant calling with BCFtools
## The following runs the variant calling with BCFtools. This step requires in
## the current working directory the parameter file sambcf.param and the
## bash script sambcf_run.sh.
args <- systemArgs(sysma="sambcf.param", mytargets="targets_bam.txt")
resources <- list(walltime="20:00:00", nodes=paste0("1:ppn=", 1), memory="10gb")
reg <- clusterRun(args, conffile=".BatchJobs.R", template="torque.tmpl", Njobs=18, runid="01",
                 resourceList=resources)
writeTargetsout(x=args, file="targets_sambcf.txt")

## Filtering of VCF files generated by GATK
args <- systemArgs(sysma="filter_gatk.param", mytargets="targets_gatk.txt")
filter <- "totalDepth(vr) >= 2 & (altDepth(vr) / totalDepth(vr) >= 0.8) & rowSums(softFilterMatrix(vr))==4"
# filter <- "totalDepth(vr) >= 20 & (altDepth(vr) / totalDepth(vr) >= 0.8) & rowSums(softFilterMatrix(vr))==6"
filterVars(args, filter, varcaller="gatk", organism="A. thaliana")
writeTargetsout(x=args, file="targets_gatk_filtered.txt")

## Filtering of VCF files generated by BCFtools
args <- systemArgs(sysma="filter_sambcf.param", mytargets="targets_sambcf.txt")
filter <- "rowSums(vr) >= 2 & (rowSums(vr[,3:4])/rowSums(vr[,1:4]) >= 0.8)"
# filter <- "rowSums(vr) >= 20 & (rowSums(vr[,3:4])/rowSums(vr[,1:4]) >= 0.8)"
filterVars(args, filter, varcaller="bcftools", organism="A. thaliana")
writeTargetsout(x=args, file="targets_sambcf_filtered.txt")

## Annotate filtered variants from GATK
args <- systemArgs(sysma="annotate_vars.param", mytargets="targets_gatk_filtered.txt")
txdb <- loadDb("./data/tair10.sqlite")
fa <- FaFile(systemPipeR::reference(args))
variantReport(args=args, txdb=txdb, fa=fa, organism="A. thaliana")

## Annotate filtered variants from BCFtools
args <- systemArgs(sysma="annotate_vars.param", mytargets="targets_sambcf_filtered.txt")
txdb <- loadDb("./data/tair10.sqlite")
fa <- FaFile(systemPipeR::reference(args))
variantReport(args=args, txdb=txdb, fa=fa, organism="A. thaliana")

## Combine results from GATK
args <- systemArgs(sysma="annotate_vars.param", mytargets="targets_gatk_filtered.txt")
combineDF <- combineVarReports(args, filtercol=c(Consequence="nonsynonymous"))
write.table(combineDF, "./results/combineDF_nonsyn_gatk.xls", quote=FALSE, row.names=FALSE, sep="\t")

## Combine results from BCFtools
args <- systemArgs(sysma="annotate_vars.param", mytargets="targets_sambcf_filtered.txt")
combineDF <- combineVarReports(args, filtercol=c(Consequence="nonsynonymous"))
write.table(combineDF, "./results/combineDF_nonsyn_sambcf.xls", quote=FALSE, row.names=FALSE, sep="\t")

## Summary for GATK
args <- systemArgs(sysma="annotate_vars.param", mytargets="targets_gatk_filtered.txt")
write.table(varSummary(args), "./results/variantStats_gatk.xls", quote=FALSE, col.names = NA, sep="\t")

## Summary for BCFtools
args <- systemArgs(sysma="annotate_vars.param", mytargets="targets_sambcf_filtered.txt")

```



```

write.table(varSummary(args), "./results/variantStats_sambcf.xls", quote=FALSE, col.names = NA, sep="\t")

## Venn diagram of variants
args <- systemArgs(sysma="annotate_vars.param", mytargets="targets_gatk_filtered.txt")
varlist <- sapply(names(outpaths(args))[1:4], function(x) as.character(read.delim(outpaths(args)[x])$VARID))
vennset_gatk <- overLapper(varlist, type="vennsets")
args <- systemArgs(sysma="annotate_vars.param", mytargets="targets_sambcf_filtered.txt")
varlist <- sapply(names(outpaths(args))[1:4], function(x) as.character(read.delim(outpaths(args)[x])$VARID))
vennset_bcf <- overLapper(varlist, type="vennsets")
vennPlot(list(vennset_gatk, vennset_bcf), mymain="", mysub="GATK: red; BCFtools: blue", colmode=2, ccol=c("b

## End(Not run)

```

---

genFeatures	<i>Generate feature ranges from TxDb</i>
-------------	--

---

## Description

Function to generate a variety of feature types from TxDb objects using utilities provided by the GenomicFeatures package. The feature types are organized per gene and can be returned on that level in their non-reduced or reduced form.

Currently, supported features include intergenic, promoter, intron, exon, cds, 5'/3'UTR and different transcript types. The latter contains as many transcript types as available in the tx\_type column when extracting transcripts from TxDb objects as follows: transcripts(txdb, c("tx\_name", "gene\_id", "tx

## Usage

```
genFeatures(txdb, featuretype = "all", reduce_ranges, upstream = 1000, downstream = 0, verbose = TRUE)
```

## Arguments

txdb	TxDb object
featuretype	Feature types can be specified by assigning a character vector containing any of the following: c("tx_type", "promoter", "intron", "exon", "cds", "fiveUTR", "threeUTR", "intergenic"). The default all is a shorthand to select all supported features.
reduce_ranges	If set to TRUE the feature ranges will be reduced on the gene level. As a result overlapping feature components of the same type and from the same gene will be merged to a single range, e.g. two overlapping exons from the same gene are merged to one. Intergenic ranges are not affected by this setting. Note, all reduced feature types are labeled with the suffix '_red'.
upstream	Defines for promoter features the number of bases upstream from the transcription start site.
downstream	Defines for promoter features the number of bases downstream from the transcription start site.
verbose	verbose=FALSE turns off all print messages.

**Value**

The results are returned as a GRangesList where each component is a GRanges object containing the range set of each feature type. Intergenic ranges are assigned unique identifiers and recorded in the featuretype\_id column of the metadata block. For this the ids of their adjacent genes are concatenated with two underscores as separator. If the adjacent genes overlap with other genes then their identifiers are included in the id string as well and separated by a single underscore.

**Author(s)**

Thomas Girke

**See Also**

transcripts and associated TxDb accessor functions from the GenomicFeatures package.

**Examples**

```
## Sample from GenomicFeatures package
library(GenomicFeatures)
gfffile <- system.file("extdata", "GFF3_files", "a.gff3", package="GenomicFeatures")
txdb <- makeTxDbFromGFF(file=gfffile, format="gff3", organism="Solanum lycopersicum")
feat <- genFeatures(txdb, featuretype="all", reduce_ranges=FALSE, upstream=1000, downstream=0)

## List extracted feature types
names(feat)

## Obtain feature lists by genes, here for promoter
split(feat$promoter, unlist(mcols(feat$promoter)$feature_by))

## Return all features in single GRanges object
unlist(feat)

## Not run:
## Sample from systemPipeRdata package
file <- system.file("extdata/annotation", "tair10.gff", package="systemPipeRdata")
txdb <- makeTxDbFromGFF(file=file, format="gff3", organism="Arabidopsis")
feat <- genFeatures(txdb, featuretype="all", reduce_ranges=FALSE, upstream=1000, downstream=0)

## End(Not run)
```

---

getQsubargs

*Arguments for qsub*

---

**Description**

Note: This function has been deprecated. Please use clusterRun instead. getQsubargs defines arguments to submit runX job(s) to queuing system (e.g. Torque) via qsub.

**Usage**

```
getQsubargs(software = "qsub", queue = "batch", Nnodes = "nodes=1", cores = as.numeric(gsub("^.* "
```

**Arguments**

software	Software to use for submission to queuing system. Default is qsub.
queue	Name of queue to use. Default is batch.
Nnodes	Number of compute nodes to use for processing. Default is nodes=1.
cores	Number of CPU cores to use per compute node. Default will use what is provided by under -p in myargs of systemArgs() output.
memory	Amount of RAM to reserve per node.
time	Walltime limit each job is allowed to run per node.

**Value**

list

**Author(s)**

Thomas Girke

**Examples**

```
## Construct SYSargs object from param and targets files
param <- system.file("extdata", "tophat.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)
args
names(args); modules(args); cores(args); outpaths(args); sysargs(args)

## Not run:
## Execute SYSargs on single machine
runCommandline(args=args)

## Execute SYSargs on multiple machines
qsubargs <- getQsubargs(queue="batch", Nnodes="nodes=1", cores=cores(tophat), memory="mem=10gb", time="wallt")
qsubRun(args=args, qsubargs=qsubargs, Nqsubs=1, package="systemPipeR")
## Alignment stats
read_statsDF <- alignStats(fqpaths=tophatargs$infile1, bampaths=bampaths, fqgz=TRUE)
read_statsDF <- cbind(read_statsDF[targets$FileName,], targets)
write.table(read_statsDF, "results/alignStats.xls", row.names=FALSE, quote=FALSE, sep="\t")

## End(Not run)
```

**Description**

To test a sample population of genes for over-representation of GO terms, the core function GOHyperGAll computes for all nodes in the three GO networks (BP, CC and MF) an enrichment test based on the hypergeometric distribution and returns the corresponding raw and Bonferroni corrected p-values. Subsequently, a filter function supports GO Slim analyses using default or custom GO Slim categories. Several convenience functions are provided to process large numbers of gene sets (e.g. clusters from partitioning results) and to visualize the results.

Note: GOHyperGAll provides similar utilities as the GOHyperG function in the GOstats package. The main difference is that GOHyperGAll simplifies processing of large numbers of gene sets, as well as the usage of custom array-to-gene and gene-to-GO mappings.

### Usage

```
## Generate gene-to-GO mappings and store as catDB object
makeCATdb(myfile, lib = NULL, org = "", colno = c(1, 2, 3), idconv = NULL, rootUK=FALSE)

## Enrichment function
GOHyperGAll(catdb, gocat = "MF", sample, Nannot = 2)

## GO slim analysis
GOHyperGAll_Subset(catdb, GOHyperGAll_result, sample = test_sample, type = "goSlim", myslimv)

## Reduce GO term redundancy
GOHyperGAll_Simplify(GOHyperGAll_result, gocat = "MF", cutoff = 0.001, correct = TRUE)

## Batch analysis of many gene sets
GOCluster_Report(catdb, setlist, id_type = "affy", method = "all", CLSZ = 10, cutoff = 0.001, gocat)

## Bar plot of GOCluster_Report results
goBarplot(GOBatchResult, gocat)
```

### Arguments

myfile	File with gene-to-GO mappings. Sample files can be downloaded from geneontology.org ( <a href="http://geneontology.org/GO.downloads.annotations.shtml">http://geneontology.org/GO.downloads.annotations.shtml</a> ) or from BioMart as shown in example below.
colno	Column numbers referencing in myfile the three target columns containing GOID, GeneID and GOCAT, in that order.
org	Optional argument. Currently, the only valid option is org="Arabidopsis" to get rid of transcript duplications in this particular annotation.
lib	If the gene-to-GO mappings are obtained from a *.db package from Bioconductor then the package name can be specified under the lib argument of the sampleDFgene2GO function.
idconv	Optional id conversion data.frame
catdb	catdb object storing mappings of genes to annotation categories. For details, see ?"SYSargs-class".
rootUK	If the argument rootUK is set to TRUE then the root nodes are treated as terminal nodes to account for the new unknown terms.
sample	character vector containing the test set of gene identifiers
Nannot	Defines the minimum number of direct annotations per GO node from the sample set to determine the number of tested hypotheses for the p-value adjustment.
gocat	Specifies the GO type, can be assigned one of the following character values: "MF", "BP" and "CC".
GOHyperGAll_result	data.frame generated by GOHyperGAll
type	The function GOHyperGAll_Subset subsets the GOHyperGAll results by directly assigned GO nodes or custom goSlim categories. The argument type can be assigned the values goSlim or assigned.

<code>myslimv</code>	optional argument to provide custom <code>goSlim</code> vector
<code>cutoff</code>	p-value cutoff for GO terms to show in <code>result.data.frame</code>
<code>correct</code>	If TRUE the function will favor the selection of terminal (informationich) GO terms that have at the same time a large number of sample matches.
<code>setlist</code>	list of character vectors containing gene IDs (or array feature IDs). The names of the list components correspond to the set labels, e.g. DEG comparisons or cluster IDs.
<code>id_type</code>	specifies type of IDs in input, can be assigned <code>gene</code> or <code>affy</code>
<code>method</code>	Specifies analysis type. Current options are <code>all</code> for <code>GOHyperGAll</code> , <code>slim</code> for <code>GOHyperGAll_Subset</code> or <code>simplify</code> for <code>GOHyperGAll_Simplify</code> .
<code>CLSZ</code>	minimum gene set (cluster) size to consider. Gene sets below this cutoff will be ignored.
<code>gocats</code>	Specifies GO type, can be assigned the values "MF", "BP" and "CC".
<code>recordSpecGO</code>	argument to report in the <code>result.data.frame</code> specific GO IDs for any of the 3 ontologies disregarding whether they meet the specified p-value cutoff, e.g: <code>recordSpecGO=c("GO:0003674", "GO:0008150", "GO:0005575")</code>
<code>GOBatchResult</code>	<code>data.frame</code> generated by <code>GOCluster_Report</code>
<code>...</code>	additional arguments to pass on

## Details

`GOHyperGAll_Simplify`: The result data frame from `GOHyperGAll` will often contain several connected GO terms with significant scores which can complicate the interpretation of large sample sets. To reduce this redundancy, the function `GOHyperGAll_Simplify` subsets the data frame by a user specified p-value cutoff and removes from it all GO nodes with overlapping children sets (OFFSPRING), while the best scoring nodes are retained in the `result.data.frame`.

`GOCluster_Report`: performs the three types of GO term enrichment analyses in batch mode: `GOHyperGAll`, `GOHyperGAll_Subset` or `GOHyperGAll_Simplify`. It processes many gene sets (e.g. gene expression clusters) and returns the results conveniently organized in a single result data frame.

## Value

`makeCATdb` generates `catDB` object from file.

## Author(s)

Thomas Girke

## References

This workflow has been published in *Plant Physiol* (2008) 147, 41-57.

## See Also

`GOHyperGAll_Subset`, `GOHyperGAll_Simplify`, `GOCluster_Report`, `goBarplot`

**Examples**

```

## Not run:

## Obtain annotations from BioMart
listMarts() # To choose BioMart database
m <- useMart("ENSEMBL_MART_PLANT"); listDatasets(m)
m <- useMart("ENSEMBL_MART_PLANT", dataset="athaliana_eg_gene")
listAttributes(m) # Choose data types you want to download
go <- getBM(attributes=c("go_accession", "tair_locus", "go_namespace_1003"), mart=m)
go <- go[go[,3]!="",,]; go[,3] <- as.character(go[,3])
write.table(go, "GOannotationsBiomart_mod.txt", quote=FALSE, row.names=FALSE, col.names=FALSE, sep="\t")

## Create catDB instance (takes a while but needs to be done only once)
catdb <- makeCATdb(myfile="GOannotationsBiomart_mod.txt", lib=NULL, org="", colno=c(1,2,3), idconv=NULL)
catdb

## Create catDB from Bioconductor annotation package
# catdb <- makeCATdb(myfile=NULL, lib="ath1121501.db", org="", colno=c(1,2,3), idconv=NULL)

## AffyID-to-GeneID mappings when working with AffyIDs
# affy2locusDF <- systemPipeR::.AffyID2GeneID(map = "ftp://ftp.arabidopsis.org/home/tair/Microarrays/Affymetrix")
# catdb_conv <- makeCATdb(myfile="GOannotationsBiomart_mod.txt", lib=NULL, org="", colno=c(1,2,3), idconv=NULL)
# systemPipeR::.AffyID2GeneID(catdb=catdb_conv, affyIDs=c("244901_at", "244902_at"))

## Next time catDB can be loaded from file
save(catdb, file="catdb.RData")
load("catdb.RData")

## Perform enrichment test on single gene set
test_sample <- unique(as.character(catmap(catdb)$D_MF[1:100,"GeneID"]))
GOHyperGAll(catdb=catdb, gocat="MF", sample=test_sample, Nannot=2)[1:20,]

## GO Slim analysis by subsetting results accordingly
GOHyperGAll_result <- GOHyperGAll(catdb=catdb, gocat="MF", sample=test_sample, Nannot=2)
GOHyperGAll_Subset(catdb, GOHyperGAll_result, sample=test_sample, type="goSlim")

## Reduce GO term redundancy in 'GOHyperGAll_results'
simplifyDF <- GOHyperGAll_Simplify(GOHyperGAll_result, gocat="MF", cutoff=0.001, correct=T)
# Returns the redundancy reduced data set.
data.frame(GOHyperGAll_result[GOHyperGAll_result[,1]])

## Batch Analysis of Gene Clusters
testlist <- list(Set1=test_sample)
GOBatchResult <- GOCluster_Report(catdb=catdb, setlist=testlist, method="all", id_type="gene", CLSZ=10, cutoff=0.001)

## Plot 'GOBatchResult' as bar plot
goBarplot(GOBatchResult, gocat="MF")

## End(Not run)

```

---

INTERSECTset-class      *Class* "INTERSECTset"

---

**Description**

Container for storing standard intersect results created by the `overLapper` function. The `setlist` slot stores the original label sets as vectors in a `list`; `intersectmatrix` organizes the label sets in a present-absent matrix; `complexitylevels` represents the number of comparisons considered for each comparison set as vector of integers; and `intersectlist` contains the standard intersect vectors.

**Objects from the Class**

Objects can be created by calls of the form `new("INTERSECTset", ...)`.

**Slots**

`setlist`: Object of class "list": list of vectors  
`intersectmatrix`: Object of class "matrix": binary matrix  
`complexitylevels`: Object of class "integer": vector of integers  
`intersectlist`: Object of class "list": list of vectors

**Methods**

**as.list** signature(`x = "INTERSECTset"`): coerces INTERSECTset to list  
**coerce** signature(`from = "list"`, `to = "INTERSECTset"`): `as(list, "INTERSECTset")`  
**complexitylevels** signature(`x = "INTERSECTset"`): extracts data from complexitylevels slot  
**intersectlist** signature(`x = "INTERSECTset"`): extracts data from intersectlist slot  
**intersectmatrix** signature(`x = "INTERSECTset"`): extracts data from intersectmatrix slot  
**length** signature(`x = "INTERSECTset"`): returns number of original label sets  
**names** signature(`x = "INTERSECTset"`): extracts slot names  
**setlist** signature(`x = "INTERSECTset"`): extracts data from setlist slot  
**show** signature(`object = "INTERSECTset"`): summary view of INTERSECTset objects

**Author(s)**

Thomas Girke

**See Also**

`overLapper`, `vennPlot`, `olBarplot`, `VENNset-class`

**Examples**

```
showClass("INTERSECTset")

## Sample data
setlist <- list(A=sample(letters, 18), B=sample(letters, 16),
               C=sample(letters, 20), D=sample(letters, 22),
               E=sample(letters, 18), F=sample(letters, 22))

## Create VENNset
intersset <- overLapper(setlist[1:5], type="intersects")
class(intersset)
```

```
## Accessor methods for VENNset/INTERSECTset objects
names(interset)
setlist(interset)
intersectmatrix(interset)
complexitylevels(interset)
intersectlist(interset)

## Coerce VENNset/INTERSECTset object to list
as.list(interset)
```

---

mergeBamByFactor	<i>Merge BAM files based on factor</i>
------------------	--

---

### Description

Merges BAM files based on sample groupings provided by a factor using internally the mergeBam function from the Rsamtools package. The function also returns an updated SYSargs object containing the paths to the merged BAM files as well as to the unmerged BAM files if there are any. All rows of merged parent samples are removed.

The functionality provided by mergeBamByFactor is useful for experiments where pooling of replicates is advantageous to maximize the depth of read coverage, such as prior to peak calling in ChIP-Seq or miRNA gene prediction experiments.

### Usage

```
mergeBamByFactor(args, mergefactor = targetsin(args)$Factor, overwrite = FALSE, silent = FALSE, ...)
```

### Arguments

args	An instance of SYSargs constructed from a targets file where the first column (targetsin(args)) contains the paths to the BAM files along with the column title FileName.
mergefactor	factor containing the grouping information required for merging the BAM files referenced in the first column of targetsin(args). The default uses targetsin(args)\$Factor as factor. The latter merges BAM files for which replicates are specified in the Factor column.
overwrite	If overwrite=FALSE existing BAM files of the same name will not be overwritten.
silent	If silent=TRUE print statements will be suppressed.
...	To pass on additional arguments to the internally used mergeBam function from Rsamtools.

### Value

The merged BAM files will be written to output files with the following naming convention: <first\_BAM\_file\_name>\_<grouping>. In addition, the function returns an updated SYSargs object where all output file paths contain the paths to the merged BAM files. The rows of the merged parent samples are removed and the rows of the unmerged samples remain unchanged.

### Author(s)

Thomas Girke



**See Also**

writeTargetsout, writeTargetsRef

**Examples**

```
## Construct initial SYSargs object
targetspath <- system.file("extdata", "targets_chip.txt", package="systemPipeR")
parampath <- system.file("extdata", "bowtieSE.param", package="systemPipeR")
args <- systemArgs(sysma=parampath, mytargets=targetspath)

## Not run:
## After running alignmets (e.g. with Bowtie2) generate targets file
## for the corresponding BAM files. The alignment step is skipped here.
writeTargetsout(x=args, file="targets_bam.txt", overwrite=TRUE)
args <- systemArgs(sysma=NULL, mytargets="targets_bam.txt")

## Merge BAM files and return updated SYSargs object
args_merge <- mergeBamByFactor(args, overwrite=TRUE, silent=FALSE)

## Export modified targets file
writeTargetsout(x=args_merge, file="targets_mergeBamByFactor.txt", overwrite=TRUE)

## End(Not run)
```

---

moduleload

*Interface to module system*

---

**Description**

Functions to list and load software from a module system in R. The functions are the equivalent of `module avail` and `module load` on the Linux command-line, respectively.

**Usage**

```
moduleload(module, envir="PATH")
```

```
modulelist()
```

**Arguments**

`module` Name of software to load character vector.

`envir` One or many environment variables passed on as character vector.

**Author(s)**

Tyler Backman and Thomas Girke

**Examples**

```
## Not run:
## List all software from module system
modulelist()

## Examples for loading software from module system
moduleload(module="bowtie2/2.0.6", envir="PATH")
moduleload(module="python", envir=c("PATH", "LD_LIBRARY_PATH", "PYTHONPATH"))

## End(Not run)
```

olBarplot

*Bar plot for intersect sets***Description**

Generates bar plots of the intersect counts of VENNset and INTERSECTset objects generated by the overLapper function. It is an alternative to Venn diagrams (e.g. vennPlot) that scales to larger numbers of label sets. By default the bars in the plot are colored and grouped by complexity levels of the intersect sets.

**Usage**

```
olBarplot(x, mincount = 0, complexity="default", myxlabel = "default", myylabel="Counts", mytitle
```

**Arguments**

x	Object of class VENNset or INTERSECTset.
mincount	Sets minimum number of counts to consider in the bar plot. Default mincount=0 considers all counts.
complexity	Allows user to limit the bar plot to specific complexity levels of intersects by specifying the chosen ones with an integer vector. Default complexity="default" considers all complexity levels.
myxlabel	Defines label of x-axis.
myylabel	Defines label of y-axis.
mytitle	Defines main title of plot.
...	Allows to pass on additional arguments to geom_bar from ggplot2. For instance, fill=seq(along=vennlist(x)) or fill=seq(along=intersectlist(x)) will assign a different color to each bar, or fill="blue" will color all of them blue. The default bar coloring is by complexity levels of the intersect sets.

**Value**

Bar plot.

**Note**

The functions provided here are an extension of the Venn diagram resources on this site: <http://manuals.bioinformatics.ucr.edu/home/venn-diagrams>

**Author(s)**

Thomas Girke

**See Also**

overLapper, vennPlot

**Examples**

```
## Sample data: list of vectors with object labels
setlist <- list(A=sample(letters, 18), B=sample(letters, 16),
               C=sample(letters, 20), D=sample(letters, 22),
               E=sample(letters, 18), F=sample(letters, 22))

## 2-way Venn diagram
vennset <- overLapper(setlist[1:2], type="vennsets")
vennPlot(vennset)

## 3-way Venn diagram
vennset <- overLapper(setlist[1:3], type="vennsets")
vennPlot(vennset)

## 4-way Venn diagram
vennset <- overLapper(setlist[1:4], type="vennsets")
vennPlot(list(vennset, vennset))

## Pseudo 4-way Venn diagram with circles
vennPlot(vennset, type="circle")

## 5-way Venn diagram
vennset <- overLapper(setlist[1:5], type="vennsets")
vennPlot(vennset)

## Alternative Venn count input to vennPlot (not recommended!)
counts <- sapply(vennlist(vennset), length)
vennPlot(counts)

## 6-way Venn comparison as bar plot
vennset <- overLapper(setlist[1:6], type="vennsets")
olBarplot(vennset, mincount=1)

## Bar plot of standard intersect counts
intersect <- overLapper(setlist, type="intersects")
olBarplot(intersect, mincount=1)

## Accessor methods for VENNset/INTERSECTset objects
names(vennset)
names(intersect)
setlist(vennset)
intersectmatrix(vennset)
complexitylevels(vennset)
vennlist(vennset)
intersectlist(intersect)

## Coerce VENNset/INTERSECTset object to list
as.list(vennset)
```

```

as.list(intersect)

## Pairwise intersect matrix and heatmap
olMA <- sapply(names(setlist),
function(x) sapply(names(setlist),
function(y) sum(setlist[[x]] %in% setlist[[y]])))
olMA
heatmap(olMA, Rowv=NA, Colv=NA)

## Presence-absence matrices for large numbers of sample sets
intersect <- overLapper(setlist=setlist, type="intersects", complexity=2)
(paMA <- intersectmatrix(intersect))
heatmap(paMA, Rowv=NA, Colv=NA, col=c("white", "gray"))

```

---

overLapper

*Set Intersect and Venn Diagram Functions*


---

### Description

Function for computing Venn intersects or standard intersects among large numbers of label sets provided as list of vectors. The resulting intersect objects can be used for plotting 2-5 way Venn diagrams or intersect bar plots using the functions `vennPlot` or `olBarplot`, respectively. The `overLapper` function scales to 2-20 or more label vectors for Venn intersect calculations and to much larger sample numbers for standard intersects. The different intersect types are explained below under the definition of the `type` argument. The upper Venn limit around 20 label sets is unavoidable because the complexity of Venn intersects increases exponentially with the label set number  $n$  according to this relationship:  $2^n - 1$ . The current implementation of the plotting function `vennPlot` supports Venn diagrams for 2-5 label sets. To visually analyze larger numbers of label sets, a variety of intersect methods are introduced in the `olBarplot` help file. These methods are much more scalable than Venn diagrams, but lack their restrictive intersect logic.

### Usage

```
overLapper(setlist, complexity = "default", sep = "_", cleanup = FALSE, keepdups = FALSE, type)
```

### Arguments

<code>setlist</code>	Object of class <code>list</code> where each list component stores a label set as vector and the name of each label set is stored in the name slot of each list component. The names are used for naming the label sets in all downstream analysis steps and plots.
<code>complexity</code>	Complexity level of intersects specified as integer vector. For Venn intersects it needs to be assigned <code>1:length(setlist)</code> (default). If <code>complexity=2</code> the function returns all pairwise intersects.
<code>sep</code>	Character used to separate set labels.
<code>cleanup</code>	If set to <code>TRUE</code> then all characters of the label sets are set to upper case, and leading and trailing spaces are removed. The default <code>cleanup=FALSE</code> omits this step.
<code>keepdups</code>	By default all duplicates are removed from the label sets. The setting <code>keepdups=TRUE</code> will retain duplicates by appending a counter to each entry.

`type` With the default setting `type="vennsets"` the `overLapper` function computes the typical Venn intersects for the label sets provided under `setlist`. With the setting `type="intersects"` the function will compute pairwise intersects (not compatible with Venn diagrams). Venn intersects follow the typical 'only in' intersect logic of Venn comparisons, such as: labels present only in set A, labels present only in the intersect of A & B, etc. Due to this restrictive intersect logic, the combined Venn sets contain no duplicates. In contrast to this, regular intersects follow this logic: labels present in the intersect of A & B, labels present in the intersect of A & B & C, etc. This approach results usually in many duplications of labels among the intersect sets.

### Details

Additional Venn diagram resources are provided by the packages `limma`, `gplots`, `venn`, `vennDiagram`, or online resources such as `shapes`, `Venn Diagram Generator` and `Venny`.

### Value

`overLapper` returns standard intersect and Venn intersect results as `INTERSECTset` or `VENNset` objects, respectively. These S4 objects contain the following components:

<code>setlist</code>	Original label sets accessible with <code>setlist()</code> .
<code>intersectmatrix</code>	Present-absent matrix accessible with <code>intersectmatrix()</code> , where each overlap set in the <code>vennlist</code> data component is labeled according to the label set names provided under <code>setlist</code> . For instance, the composite name 'ABC' indicates that the entries are restricted to A, B and C. The separator used for naming the intersect sets can be specified under the <code>sep</code> argument.
<code>complexitylevels</code>	Complexity levels accessible with <code>complexitylevels()</code> .
<code>vennlist</code>	Venn intersects for <code>VENNset</code> objects accessible with <code>vennlist()</code> .
<code>intersectlist</code>	Standard intersects for <code>INTERSECTset</code> objects accessible with <code>intersectlist()</code> .

### Note

The functions provided here are an extension of the Venn diagram resources on this site: <http://manuals.bioinformatics.ucr.edu/home/Venn-Diagrams>

### Author(s)

Thomas Girke

### References

See examples in 'The Electronic Journal of Combinatorics': <http://www.combinatorics.org/files/Surveys/ds5/VennSymm>

### See Also

`vennPlot`, `olBarplot`

**Examples**

```

## Sample data
setlist <- list(A=sample(letters, 18), B=sample(letters, 16),
               C=sample(letters, 20), D=sample(letters, 22),
               E=sample(letters, 18), F=sample(letters, 22))

## 2-way Venn diagram
vennset <- overLapper(setlist[1:2], type="vennsets")
vennPlot(vennset)

## 3-way Venn diagram
vennset <- overLapper(setlist[1:3], type="vennsets")
vennPlot(vennset)

## 4-way Venn diagram
vennset <- overLapper(setlist[1:4], type="vennsets")
vennPlot(list(vennset, vennset))

## Pseudo 4-way Venn diagram with circles
vennPlot(vennset, type="circle")

## 5-way Venn diagram
vennset <- overLapper(setlist[1:5], type="vennsets")
vennPlot(vennset)

## Alternative Venn count input to vennPlot (not recommended!)
counts <- sapply(vennlist(vennset), length)
vennPlot(counts)

## 6-way Venn comparison as bar plot
vennset <- overLapper(setlist[1:6], type="vennsets")
olBarplot(vennset, mincount=1)

## Bar plot of standard intersect counts
intersect <- overLapper(setlist, type="intersects")
olBarplot(intersect, mincount=1)

## Accessor methods for VENNset/INTERSECTset objects
names(vennset)
names(intersect)
setlist(vennset)
intersectmatrix(vennset)
complexitylevels(vennset)
vennlist(vennset)
intersectlist(intersect)

## Coerce VENNset/INTERSECTset object to list
as.list(vennset)
as.list(intersect)

## Pairwise intersect matrix and heatmap
olMA <- sapply(names(setlist),
               function(x) sapply(names(setlist),
                                   function(y) sum(setlist[[x]] %in% setlist[[y]])))
olMA
heatmap(olMA, Rowv=NA, Colv=NA)

```

```
## Presence-absence matrices for large numbers of sample sets
interaset <- overLapper(setlist=setlist, type="intersects", complexity=2)
(paMA <- intersectmatrix(interaset))
heatmap(paMA, Rowv=NA, Colv=NA, col=c("white", "gray"))
```

---

plotfeatureCoverage *Plot feature coverage results*

---

### Description

Plots the 3 tabular data types (A-C) generated by the featureCoverage function. It accepts data from single or many features (e.g. CDSs) and samples (BAM files). The coverage from multiple features will be summarized using methods such as mean, while the data from multiple samples will be plotted in separate panels.

### Usage

```
plotfeatureCoverage(covMA, method = mean, scales = "fixed", extendylim=2, scale_count_val = 10^6)
```

### Arguments

covMA	Object of class data.frame generated by featureCoverage function.
method	Defines the summary statistics to use when covMA contains coverage data from multiple features (e.g. transcripts). The default calculates the mean coverage for each position and/or bin of the corresponding coverage vectors.
scales	Scales setting passed on to the facet_wrap function of ggplot2. For details see ggplot2::facet_wrap. The default fixed assures a constant scale across all bar plot panels, while free uses the optimum scale within each bar plot panel. To evaluate plots in all their details, it may be necessary to generate two graphics files one for each scaling option.
extendylim	Allows to extend the upper limit of the y axis when scales=fixed. Internally, the function identifies the maximum value in the data and then multiplies this maximum value by the value provided under extendylim. The default is set to extendylim=2.
scale_count_val	Scales (normalizes) the read counts to a fixed value of aligned reads in each sample such as counts per million aligned reads (default is 10 <sup>6</sup> ). For this calculation the N_total_aligned values are used that are reported in the input data.frame generated by the upstream featureCoverage function. Assign NULL to turn off scaling.

### Value

Currently, the function returns ggplot2 bar plot graphics.

### Author(s)

Thomas Girke

**See Also**

featureCoverage

**Examples**

```
## Construct SYSargs object from param and targets files
param <- system.file("extdata", "tophat.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)

## Not run:
## Features from sample data of systemPipeRdata package
library(GenomicFeatures)
file <- system.file("extdata/annotation", "tair10.gff", package="systemPipeRdata")
txdb <- makeTxDbFromGFF(file=file, format="gff3", organism="Arabidopsis")

## (A) Generate binned coverage for two BAM files and 4 transcripts
gr1 <- cdsBy(txdb, "tx", use.names=TRUE)
fcov <- featureCoverage(bfl=BamFileList(outpaths(args)[1:2]), gr1=gr1[1:4], resizereads=NULL,
  readlengthrange=NULL, Nbins=20, method=mean, fixedmatrix=FALSE,
  resizefeatures=TRUE, upstream=20, downstream=20)
fcov <- featureCoverage(bfl=BamFileList(outpaths(args)[1:2]), gr1=gr1[1:4], resizereads=NULL,
  readlengthrange=NULL, Nbins=20, method=mean, fixedmatrix=TRUE,
  resizefeatures=TRUE, upstream=20, downstream=20)
plotfeatureCoverage(covMA=fcov, method=mean, scales="fixed", scale_count_val=10^6)

## (B) Coverage matrix upstream and downstream of start/stop codons
fcov <- featureCoverage(bfl=BamFileList(outpaths(args)[1:2]), gr1=gr1[1:4], resizereads=NULL,
  readlengthrange=NULL, Nbins=NULL, method=mean, fixedmatrix=TRUE,
  resizefeatures=TRUE, upstream=20, downstream=20)
plotfeatureCoverage(covMA=fcov, method=mean, scales="fixed", scale_count_val=10^6)

## (C) Combined matrix for both binned and start/stop codon
fcov <- featureCoverage(bfl=BamFileList(outpaths(args)[1:2]), gr1=gr1[1:4], resizereads=NULL,
  readlengthrange=NULL, Nbins=20, method=mean, fixedmatrix=TRUE,
  resizefeatures=TRUE, upstream=20, downstream=20, outfile="results/test.xls")
plotfeatureCoverage(covMA=fcov, method=mean, scales="fixed", scale_count_val=10^6)

## (D) Rle coverage objects one for each query feature
fcov <- featureCoverage(bfl=BamFileList(outpaths(args)[1:2]), gr1=gr1[1:4], resizereads=NULL,
  readlengthrange=NULL, Nbins=NULL, method=mean, fixedmatrix=FALSE,
  resizefeatures=TRUE, upstream=20, downstream=20)

## End(Not run)
```

---

plotfeaturetypeCounts *Plot read distribution across genomic features*

---

**Description**

Function to visualize the distribution of reads across different feature types for many alignment files in parallel. The plots are stacked bar plots representing the raw or normalized read counts for the sense and antisense strand of each feature. The graphics results are generated with ggplot2. Typically, the expected input is generated with the affiliated featuretypeCounts function.



**Usage**

```
plotfeaturetypeCounts(x, graphicsfile, graphicsformat = "pdf", scales = "fixed", anyreadlength = F,
                      drop_N_total_aligned = TRUE, scale_count_val = 10^6, scale_length_val = NULL)
```

**Arguments**

- x** data.frame with feature counts generated by the featuretypeCounts function.
- graphicsfile** Path to file where to write the output graphics. Note, the function returns the graphics instructions from ggplot2 for interactive plotting in R. However, due to the complexity of the graphics generated here, the finished results are written to a file directly.
- graphicsformat** Graphics file format. Currently, supported formats are: pdf, png or jpeg. Argument accepts one of them as character string.
- scales** Scales setting passed on to the facet\_wrap function of ggplot2. For details see ggplot2::facet\_wrap. The default fixed assures a constant scale across all bar plot panels, while free uses the optimum scale within each bar plot panel. To evaluate plots in all their details, it may be necessary to generate two graphics files one for each scaling option.
- anyreadlength** If set to TRUE read length specific read counts will be summed up to a single count value to plot read counts for any read length. Otherwise the bar plots will show the counts for each read length value.
- drop\_N\_total\_aligned**  
If set to TRUE the special feature count N\_total\_aligned will not be included as a separate feature in the plots. However, the information will still be used internally for scaling the read counts to a fixed value if this option is requested under the scale\_count\_val argument.
- scale\_count\_val**  
Scales (normalizes) the read counts to a fixed value of aligned reads in each sample such as counts per million aligned reads (default is 10<sup>6</sup>). For this calculation the N\_total\_aligned values are used that are reported in the input data.frame generated by the upstream featuretypeCounts function. Assign NULL to turn off scaling by aligned reads.
- scale\_length\_val**  
Allows to adjust the raw or scaled read counts to a constant length interval (e.g. scale\_length\_val=10<sup>3</sup> in bps) considering the total genomic length of the corresponding feature type. The required genomic length information for each feature type is obtained from the FeaturetypeLength column of the input data.frame generated by the featuretypeCount function. To turn off feature length adjustment, assign NULL (default).

**Value**

The function returns bar plot graphics for aligned read counts with read length resolution if the input contains this information and argument anyreadlength is set to FALSE. If the input contains counts for any read length and/or anyreadlength=TRUE then there will be only one bar per feature and sample. Due to the complexity of the plots, the results are directly written to file in the chosen graphics format. However, the function also returns the plotting instructions returned by ggplot2 to display the result components using R's plotting device.

**Author(s)**

Thomas Girke

**See Also**

featuretypeCounts, genFeatures

**Examples**

```
## Construct SYSargs object from param and targets files
param <- system.file("extdata", "tophat.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)

## Not run:
## Features from sample data of systemPipeRdata package
library(GenomicFeatures)
file <- system.file("extdata/annotation", "tair10.gff", package="systemPipeRdata")
txdb <- makeTxDbFromGFF(file=file, format="gff3", organism="Arabidopsis")
feat <- genFeatures(txdb, featuretype="all", reduce_ranges=TRUE, upstream=1000, downstream=0, verbose=TRUE)

## Generate and plot feature counts for specific read lengths
fc <- featuretypeCounts(bfl=BamFileList(outpaths(args), yieldSize=50000), grl=feat, singleEnd=TRUE, readlen=
p <- plotfeaturetypeCounts(x=fc, graphicsfile="featureCounts.pdf", graphicsformat="pdf", scales="fixed", any

## Generate and plot feature counts for any read length
fc2 <- featuretypeCounts(bfl=BamFileList(outpaths(args), yieldSize=50000), grl=feat, singleEnd=TRUE, readlen=
p2 <- plotfeaturetypeCounts(x=featureCounts2, graphicsfile="featureCounts2.pdf", graphicsformat="pdf", scale

## End(Not run)
```

---

 predORF

*Predict ORFs*


---

**Description**

Predicts open reading frames (ORFs) and coding sequences (CDSs) in DNA sequences provided as DNASTring or DNASTringSet objects.

**Usage**

```
predORF(x, n = 1, type = "grl", mode = "orf", strand = "sense", longest_disjoint=FALSE, startcodon
```

**Arguments**

x	DNA query sequence(s) provided as DNASTring or DNASTringSet object.
n	Defines the maximum number of ORFs to return for each input sequence. The ORFs identified are sorted decreasingly by their length. For instance, n=1 (default) returns the longest ORF, n=2 the two longest ones, and so on.
type	One of three options provided as character values: 'df' returns results as data.frame, while 'gr' and 'grl' (default) return them as GRanges or GRangesList objects, respectively.

mode	The setting mode='ORF' returns a continuous reading frame that begins with a start codon and ends with a stop codon. The setting mode='CDS' return continuous reading frames that do not need to begin or end with start or stop codons, respectively.
strand	One of three options passed on as character vector of length one: 'sense' performs the predictions only for the sense strand of the query sequence(s), 'antisense' does it only for the antisense strand and 'both' does it for both strands.
longest_disjoint	If set to TRUE and n='all', the results will be subsetted to non-overlapping ORF set containing longest ORF.
startcodon	Defines the start codon(s) for ORF predictions. The default is set to the standard start codon 'ATG'. Any custom set of triplet DNA sequences can be assigned here.
stopcodon	Defines the stop codon(s) for ORF predictions. The default is set to the three standard stop codons 'TAA', 'TAG' and 'TGA'. Any custom set of triplet DNA sequences can be assigned here.

### Value

Returns ORF/CDS ranges identified in query sequences as GRanges or data.frame object. The type argument defines which one of them will be returned. The objects contain the following columns:

- seqnames: names of query sequences
- subject\_id: identified ORF/CDS ranges numbered by query
- start/end: start and end positions of ORF/CDS ranges
- strand: strand of query sequence used for prediction
- width: length of subject range in bases
- inframe2end: frame of identified ORF/CDS relative to 3' end of query sequence. This can be important if the query sequence was extracted directly upstream of an ORF (e.g. 5' UTR upstream of main ORF). The value 1 stands for in-frame with downstream ORF, while 2 or 3 indicates a shift of one or two bases, respectively.

### Author(s)

Thomas Girke

### See Also

scaleRanges

### Examples

```
## Load DNA sample data set from Biostrings package
file <- system.file("extdata", "someORF.fa", package="Biostrings")
dna <- readDNAStringSet(file)

## Predict longest ORF for sense strand in each query sequence
(orf <- predORF(dna[1:4], n=1, type="gr", mode="orf", strand="sense"))

## Not run:
```

```
## Usage for more complex example
library(GenomicFeatures); library(systemPipeRdata)
gff <- system.file("extdata/annotation", "tair10.gff", package="systemPipeRdata")
txdb <- makeTxDbFromGFF(file=gff, format="gff3", organism="Arabidopsis")
futr <- fiveUTRsByTranscript(txdb, use.names=TRUE)
genome <- system.file("extdata/annotation", "tair10.fasta", package="systemPipeRdata")
dna <- extractTranscriptSeqs(FaFile(genome), futr)
uorf <- predORF(dna, n="all", mode="orf", longest_disjoint=TRUE, strand="sense")
grl_scaled <- scaleRanges(subject=futr, query=uorf, type="uORF", verbose=TRUE)
export.gff3(unlist(grl_scaled), "uorf.gff")

## End(Not run)
```

---

```
preprocessReads      Run custom read preprocessing functions
```

---

## Description

Applies custom read preprocessing functions to single-end or paired-end FASTQ files. The function uses the `FastqStreamer` function from the `ShortRead` package to stream through large files in a memory-efficient manner.

## Usage

```
preprocessReads(args, Fct, batchsize = 1e+05, overwrite = TRUE, ...)
```

## Arguments

<code>args</code>	Object of class <code>SYSargs</code>
<code>Fct</code>	character string of custom read preprocessing function call where both the input and output needs to be an object of class <code>ShortReadQ</code> . The name of the input <code>ShortReadQ</code> object needs to be <code>fq</code> .
<code>batchsize</code>	Number of reads to process in each iteration by the internally used <code>FastqStreamer</code> function.
<code>overwrite</code>	If <code>TRUE</code> existing file will be overwritten.
<code>...</code>	To pass on additional arguments to the internally used <code>writeFastq</code> function.

## Value

Writes to files in FASTQ format. Their names are specified by `outpaths(args)`.

## Author(s)

Thomas Girke

## See Also

`FastqStreamer`

**Examples**

```

## Preprocessing of single-end reads
param <- system.file("extdata", "trim.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)
## Not run:
preprocessReads(args=args, Fct="trimLRPatterns(Rpattern='GCCCGGGTAA', subject=fq)", batchsize=100000, overw

## End(Not run)

## Preprocessing of paired-end reads
param <- system.file("extdata", "trimPE.param", package="systemPipeR")
targets <- system.file("extdata", "targetsPE.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)
## Not run:
preprocessReads(args=args, Fct="trimLRPatterns(Rpattern='GCCCGGGTAA', subject=fq)", batchsize=100000, overw

## End(Not run)

```

qsubRun

*Submit command-line tools to cluster***Description**

Note: This function has been deprecated. Please use `clusterRun` instead. `qsubRun` submits command-line tools to queue (e.g. Torque) of compute cluster using run specifications defined by `runX` and `getQsubargs` functions.

**Usage**

```
qsubRun(appfct="runCommandline(args=args, runid='01')", args, qsubargs, Nqsubs = 1, package = "sys
```

**Arguments**

<code>appfct</code>	Accepts <code>runX</code> functions, such as <code>appfct="runCommandline(args, runid)"</code>
<code>args</code>	Argument list returned by <code>systemArgs()</code> .
<code>qsubargs</code>	Argument list returned by <code>getQsubargs()</code> .
<code>Nqsubs</code>	Integer defining the number of <code>qsub</code> processes. Note: the function will not assign more <code>qsub</code> processes than there are FASTQ files. E.g. if there are 10 FASTQ files and <code>Nqsubs=20</code> then the function will generate only 10 <code>qsub</code> processes. To increase the number of CPU cores used by each process, one can increase the <code>p</code> value under <code>systemArgs()</code> .
<code>package</code>	Package to load. Name provided as character vector of length one. Default is <code>systemPipeR</code> .
<code>shebang</code>	defines shebang (first line) used in submission shell script; default is set to <code>#!/bin/bash</code> .

**Value**

Returns list where list components contain FASTQ file names and their names are the qsub process IDs assigned by the queuing system. In addition, three files will be generated for each qsub submission process: `submitargs0X` (R object containing appargs), `submitargs0X.R` (R script using appargs) and `submitargs0X.sh` (shell submission script). In addition, the chosen `runX` function will output a `submitargs0X_log` file for each qsub process containing the executable commands processed by each qsub instance.

**Author(s)**

Thomas Girke

**Examples**

```
## Construct SYSargs object from param and targets files
param <- system.file("extdata", "tophat.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)
args
names(args); modules(args); cores(args); outpaths(args); sysargs(args)

## Not run:
## Execute SYSargs on single machine
runCommandLine(args=args)

## Execute SYSargs on multiple machines
qsubargs <- getQsubargs(queue="batch", Nnodes="nodes=1", cores=cores(tophat), memory="mem=10gb", time="walltime=100000")
qsubRun(args=args, qsubargs=qsubargs, Nqsubs=1, package="systemPipeR")
## Alignment stats
read_statsDF <- alignStats(fqpaths=tophatargs$infile1, bampaths=bampaths, fqgz=TRUE)
read_statsDF <- cbind(read_statsDF[targets$FileName,], targets)
write.table(read_statsDF, "results/alignStats.xls", row.names=FALSE, quote=FALSE, sep="\t")

## End(Not run)
```

---

readComp

*Import sample comparisons from targets file*

---

**Description**

Parses sample comparisons specified in <CMP> line(s) of targets file or in targetsheader slot of SYSargs object. All possible comparisons can be specified with 'CMPset: ALL'.

**Usage**

```
readComp(file, format = "vector", delim = "-")
```

**Arguments**

file	Path to targets file. Alternatively, a SYSargs object can be assigned.
format	Object type to return: vector or matrix.
delim	Delimiter to use when sample comparisons are returned as vector.

**Value**

list where each component is named according to the name(s) used in the <CMP> line(s) of the targets file. The list will contain as many sample comparisons sets (list components) as there are sample comparisons lines in the corresponding targets file.

**Author(s)**

Thomas Girke

**Examples**

```
## Return comparisons from targets file
targetspath <- system.file("extdata", "targets.txt", package="systemPipeR")
read.delim(targetspath, comment.char = "#")
readComp(file=targetspath, format="vector", delim="-")

## Return comparisons from SYSargs object
param <- system.file("extdata", "tophat.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)
readComp(args, format = "vector", delim = "-")
```

---

returnRPKM

*RPKM Normalization*


---

**Description**

Converts read counts to RPKM normalized values.

**Usage**

```
returnRPKM(counts, ranges)
```

**Arguments**

counts	Count data frame, e.g. from an RNA-Seq experiment.
ranges	GRangesList object, e.g. generated by exonsBy(txdb, by="gene").

**Value**

data.frame

**Author(s)**

Thomas Girke

**Examples**

```
## Not run:
countDFrpkm <- apply(countDF, 2, function(x) returnRPKM(counts=x, gffsub=eByg))

## End(Not run)
```

---

runCommandline	<i>Execute SYSargs</i>
----------------	------------------------

---

## Description

Function to execute system parameters specified in SYSargs object

## Usage

```
runCommandline(args, runid = "01", make_bam=TRUE, ...)
```

## Arguments

args	object of class SYSargs
runid	Run identifier used for log file to track system call commands. Default is "01".
make_bam	Autodetects SAM file outputs and converts them to sorted and indexed BAM files. Default is make_bam=TRUE.
...	Additional arguments to pass on to runCommandline().

## Value

Output files, their paths can be obtained with outpaths() from SYSargs container. In addition, a character vector is returned containing the same paths.

## Author(s)

Thomas Girke

## Examples

```
## Construct SYSargs object from param and targets files
param <- system.file("extdata", "tophat.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)
args
names(args); modules(args); cores(args); outpaths(args); sysargs(args)

## Not run:
## Execute SYSargs on single machine
runCommandline(args=args)

## Execute SYSargs on multiple machines of a compute cluster
resources <- list(walltime="00:25:00", nodes=paste0("1:ppn=", cores(args)), memory="2gb")
reg <- clusterRun(args, conffile=".BatchJobs.R", template="torque.tmpl", Njobs=18, runid="01", resourceList=resources)

## Monitor progress of submitted jobs
showStatus(reg)
file.exists(outpaths(args))
sapply(1:length(args), function(x) loadResult(reg, x)) # Works once all jobs have completed successfully.

## Alignment stats
read_statsDF <- alignStats(fqpaths=tophatargs$infile1, bampaths=bampaths, fqgz=TRUE)
```



```

read_statsDF <- cbind(read_statsDF[targets$FileName,], targets)
write.table(read_statsDF, "results/alignStats.xls", row.names=FALSE, quote=FALSE, sep="\t")

## End(Not run)

```

runDiff

*Differential abundance analysis for many range sets***Description**

Convenience wrapper function for `run_edgeR` and `run_DESeq2` to perform differential expression or abundance analysis iteratively for several count tables. The latter can be peak calling results for several samples or counts generated for different genomic feature types. The function also returns the filtering results and plots from `filterDEGs`.

**Usage**

```
runDiff(args, diffFct, targets, cmp, dbrfilter, ...)
```

**Arguments**

<code>args</code>	Object of class <code>SYSargs</code> where <code>infile1(args)</code> specifies the paths to the tabular read count data files and <code>outpaths(args)</code> to the result files.
<code>diffFct</code>	Defines which function should be used for the differential abundance analysis. Can be <code>diffFct=run_edgeR</code> or <code>diffFct=run_DESeq2</code> .
<code>targets</code>	<code>targets data.frame</code>
<code>cmp</code>	character matrix where comparisons are defined in two columns. This matrix should be generated with <code>readComp()</code> from the targets file. Values used for comparisons need to match those in the <code>Factor</code> column of the targets file.
<code>dbrfilter</code>	Named vector with filter cutoffs of format <code>c(Fold=2, FDR=1)</code> where <code>Fold</code> refers to the fold change cutoff (unlogged) and <code>FDR</code> to the p-value cutoff. Those values are passed on to the <code>filterDEGs</code> function.
<code>...</code>	Arguments to be passed on to the internally used <code>run_edgeR</code> or <code>run_DESeq2</code> function.

**Value**

Returns list containing the `filterDEGs` results for each count table. Each result set is a list with four components which are described under `?filterDEGs`. The result files contain the `edgeR` or `DESeq2` results from the comparisons specified under `cmp`. The base names of the result files are the same as the corresponding input files specified under `countfiles` and the value of extension appended.

**Author(s)**

Thomas Girke

**See Also**

`run_edgeR`, `run_DESeq2`, `filterDEGs`

## Examples

```
## Paths to BAM files
param <- system.file("extdata", "bowtieSE.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args_bam <- systemArgs(sysma=param, mytargets=targets)
bfl <- BamFileList(outpaths(args_bam), yieldSize=50000, index=character())

## Not run:
## SYSargs with paths to range data and count files
args <- systemArgs(sysma="param/count_rangesets.param", mytargets="targets_mac.s.txt")

## Iterative read counting
countDFnames <- countRangeset(bfl, args, mode="Union", ignore.strand=TRUE)
writeTargetsout(x=args, file="targets_countDF.txt", overwrite=TRUE)

## Run differential abundance analysis
cmp <- readComp(file=args_bam, format="matrix")
args_diff <- systemArgs(sysma="param/rundiff.param", mytargets="targets_countDF.txt")
dbrlist <- runDiff(args, diffFct=run_edgeR, targets=targetsin(args_bam), cmp=cmp[[1]], independent=TRUE, dbr
writeTargetsout(x=args_diff, file="targets_rundiff.txt", overwrite=TRUE)

## End(Not run)
```

---

run\_DESeq2

*Runs DESeq2*


---

## Description

Convenience wrapper function to identify differentially expressed genes (DEGs) in batch mode with DESeq2 for any number of pairwise sample comparisons specified under the `cmp` argument. Users are strongly encouraged to consult the DESeq2 vignette for more detailed information on this topic and how to properly run DESeq2 on data sets with more complex experimental designs.

## Usage

```
run_DESeq2(countDF, targets, cmp, independent = FALSE)
```

## Arguments

<code>countDF</code>	date.frame containing raw read counts
<code>targets</code>	targets data.frame
<code>cmp</code>	character matrix where comparisons are defined in two columns. This matrix should be generated with the <code>readComp()</code> function from the targets file. Values used for comparisons need to match those in the Factor column of the targets file.
<code>independent</code>	If <code>independent=TRUE</code> then the <code>countDF</code> will be subsetted for each comparison. This behavior can be useful when working with samples from unrelated studies. For samples from the same or comparable studies, the setting <code>independent=FALSE</code> is usually preferred.

**Value**

data.frame containing DESeq2 results from all comparisons. Comparison labels are appended to column titles for tracking.

**Author(s)**

Thomas Girke

**References**

Please properly cite the DESeq2 papers when using this function: <http://www.bioconductor.org/packages/devel/bioc/html/>

**See Also**

run\_edgeR, readComp and DESeq2 vignette

**Examples**

```
targetspath <- system.file("extdata", "targets.txt", package="systemPipeR")
targets <- read.delim(targetspath, comment="#")
cmp <- readComp(file=targetspath, format="matrix", delim="-")
countfile <- system.file("extdata", "countDFeByg.xls", package="systemPipeR")
countDF <- read.delim(countfile, row.names=1)
degseqDF <- run_DESeq2(countDF=countDF, targets=targets, cmp=cmp[[1]], independent=FALSE)
pval <- degseqDF[, grep("_FDR$", colnames(degseqDF)), drop=FALSE]
fold <- degseqDF[, grep("_logFC$", colnames(degseqDF)), drop=FALSE]
DEG_list <- filterDEGs(degDF=degseqDF, filter=c(Fold=2, FDR=10))
names(DEG_list)
DEG_list$Summary
```

---

run\_edgeR

*Runs edgeR*

---

**Description**

Convenience wrapper function to identify differentially expressed genes (DEGs) in batch mode with the edgeR GML method for any number of pairwise sample comparisons specified under the `cmp` argument. Users are strongly encouraged to consult the edgeR vignette for more detailed information on this topic and how to properly run edgeR on data sets with more complex experimental designs.

**Usage**

```
run_edgeR(countDF, targets, cmp, independent = TRUE, paired = NULL, mdsplot = "")
```

**Arguments**

countDF	date.frame containing raw read counts
targets	targets data.frame
cmp	character matrix where comparisons are defined in two columns. This matrix should be generated with readComp() from the targets file. Values used for comparisons need to match those in the Factor column of the targets file.

independent	If independent=TRUE then the countDF will be subsetted for each comparison. This behavior can be useful when working with samples from unrelated studies. For samples from the same or comparable studies, the setting independent=FALSE is usually preferred.
paired	Defines pairs (character vector) for paired analysis. Default is unpaired (paired=NULL).
mdsplot	Directory where plotMDS should be written to. Default setting mdsplot="" will omit the plotting step.

**Value**

data.frame containing edgeR results from all comparisons. Comparison labels are appended to column titles for tracking.

**Author(s)**

Thomas Girke

**References**

Please properly cite the edgeR papers when using this function: <http://www.bioconductor.org/packages/devel/bioc/html/e>

**See Also**

run\_DESeq2, readComp and edgeR vignette

**Examples**

```
targetspath <- system.file("extdata", "targets.txt", package="systemPipeR")
targets <- read.delim(targetspath, comment="#")
cmp <- readComp(file=targetspath, format="matrix", delim="-")
countfile <- system.file("extdata", "countDFeByg.xls", package="systemPipeR")
countDF <- read.delim(countfile, row.names=1)
edgeDF <- run_edgeR(countDF=countDF, targets=targets, cmp=cmp[[1]], independent=FALSE, mdsplot="")
pval <- edgeDF[, grep("_FDR$", colnames(edgeDF)), drop=FALSE]
fold <- edgeDF[, grep("_logFC$", colnames(edgeDF)), drop=FALSE]
DEG_list <- filterDEGs(degDF=edgeDF, filter=c(Fold=2, FDR=10))
names(DEG_list)
DEG_list$Summary
```

---

scaleRanges

*Scale spliced ranges to genome coordinates*

---

**Description**

Function to scale mappings of spliced features (query ranges) to their corresponding genome coordinates (subject ranges). The method accounts for introns in the subject ranges that are absent in the query ranges. A use case example are uORFs predicted in the 5' UTRs sequences using predORF. These query ranges are given relative to the 5' UTR sequence. The scaleRanges function will scale them to the corresponding genome coordinates. This way they can be used in RNA-Seq expression experiments like other gene ranges.

**Usage**

```
scaleRanges(subject, query, type = "custom", verbose = TRUE)
```

**Arguments**

subject	Genomic ranges provided as GRangesList object. Their name and length requirements are described under query.
query	Feature level ranges provided as GRangesList object. The names of the query ranges need to match the names of the GRangesList object assigned to the subject argument. In addition, the length of each query range cannot exceed the total length of the corresponding subject range set.
type	Feature name to use in type column of GRangesList result.
verbose	The setting verbose=FALSE suppresses all print messages.

**Value**

Object of class GRangesList

**Author(s)**

Thomas Girke

**See Also**

predORF

**Examples**

```
## Usage for simple example
subject <- GRanges(seqnames="Chr1", IRanges(c(5,15,30),c(10,25,40)), strand="+")
query <- GRanges(seqnames="myseq", IRanges(1, 9), strand="+")
scaleRanges(GRangesList(myid1=subject), GRangesList(myid1=query), type="test")

## Not run:
## Usage for more complex example
library(GenomicFeatures); library(systemPipeRdata)
gff <- system.file("extdata/annotation", "tair10.gff", package="systemPipeRdata")
txdb <- makeTxDbFromGFF(file=gff, format="gff3", organism="Arabidopsis")
futr <- fiveUTRsByTranscript(txdb, use.names=TRUE)
genome <- system.file("extdata/annotation", "tair10.fasta", package="systemPipeRdata")
dna <- extractTranscriptSeqs(FaFile(genome), futr)
uorf <- predORF(dna, n="all", mode="orf", longest_disjoint=TRUE, strand="sense")
grl_scaled <- scaleRanges(subject=futr, query=uorf, type="uORF", verbose=TRUE)
export.gff3(unlist(grl_scaled), "uorf.gff")

## End(Not run)
```

---

`seeFastq`*Quality reports for FASTQ files*

---

### Description

The following `seeFastq` and `seeFastqPlot` functions generate and plot a series of useful quality statistics for a set of FASTQ files including per cycle quality box plots, base proportions, base-level quality trends, relative k-mer diversity, length and occurrence distribution of reads, number of reads above quality cutoffs and mean quality distribution. The functions allow processing of reads with variable length, but most plots are only meaningful if the read positions in the FASTQ file are aligned with the sequencing cycles. For instance, constant length clipping of the reads on either end or variable length clipping on the 3' end maintains this relationship, while variable length clipping on the 5' end without reversing the reads erases it.

The function `seeFastq` computes the summary stats and stores them in a relatively small list object that can be saved to disk with `save()` and reloaded with `load()` for later plotting. The argument `'klength'` specifies the k-mer length and `'batchsize'` the number of reads to random sample from each fastq file.

### Usage

```
seeFastq(fastq, batchsize, klength = 8)
```

```
seeFastqPlot(fqlist, arrange = c(1, 2, 3, 4, 5, 8, 6, 7), ...)
```

### Arguments

<code>fastq</code>	Named character vector containing paths to FASTQ file in the data fields and sample labels in the name slots.
<code>batchsize</code>	Number of reads to random sample from each FASTQ file that will be considered in the QC analysis. Smaller numbers reduce the memory footprint and compute time.
<code>klength</code>	Specifies the k-mer length in the plot for the relative k-mer diversity.
<code>fqlist</code>	list object returned by <code>seeFastq()</code> .
<code>arrange</code>	Integer vector from 1 to 7 specifying the row order of the QC plot. Dropping numbers eliminates the corresponding plots.
<code>...</code>	Additional plotting arguments to pass on to <code>seeFastqPlot()</code> .

### Value

The function `seeFastq` returns the summary stats in a list containing all information required for the quality plots. The function `seeFastqPlot` plots the information generated by `seeFastq` using `ggplot2`.

### Author(s)

Thomas Girke

**Examples**

```
## Not run:
args <- systemArgs(sysma="tophat.param", mytargets="targets.txt")
fqlist <- seeFastq(fastq=infile1(args), batchsize=10000, klength=8)
pdf("fastqReport.pdf", height=18, width=4*length(fastq))
seeFastqPlot(fqlist)
dev.off()

## End(Not run)
```

symLink2bam

*Symbolic links for IGV***Description**

Function for creating symbolic links to view BAM files in a genome browser such as IGV.

**Usage**

```
symLink2bam(sysargs, command="ln -s", htmldir, ext = c(".bam", ".bai"), urlbase, urlfile)
```

**Arguments**

sysargs	Object of class SYSargs
command	Shell command, defaults to "ln -s"
htmldir	Path to HTML directory with http access.
ext	File name extensions to use for BAM and index files.
urlbase	The base URL structure to use in URL file.
urlfile	Name and path of URL file.

**Value**

symbolic links and url file

**Author(s)**

Thomas Girke

**Examples**

```
## Construct SYSargs object from param and targets files
param <- system.file("extdata", "tophat.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)

## Not run:
## Create sym links and URL file for IGV
symLink2bam(sysargs=args, command="ln -s", htmldir=c("~/html/", "somedir/"), ext=c(".bam", ".bai"), urlbase

## End(Not run)
```

---

 sysargs

*SYSargs accessor methods*


---

**Description**

Methods to access information from SYSargs object.

**Usage**

```
sysargs(x)
```

**Arguments**

x                    object of class SYSargs

**Value**

various outputs

**Author(s)**

Thomas Girke

**Examples**

```
## Construct SYSargs object from param and targets files
param <- system.file("extdata", "tophat.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)
args
names(args); modules(args); cores(args); outpaths(args); sysargs(args)
```

---

 SYSargs-class

*Class "SYSargs"*


---

**Description**

S4 class container for storing parameters of command-line- or R-based software. SYSargs instances are constructed by the `systemArgs` function from two simple tabular files: a `targets` file and a `param` file. The latter is optional for workflow steps lacking command-line software. Typically, a SYSargs instance stores all sample-level inputs as well as the paths to the corresponding outputs generated by command-line- or R-based software generating sample-level output files. Each sample level input/outfile operation uses its own SYSargs instance. The outpaths of SYSargs usually define the sample inputs for the next SYSargs instance. This connectivity is achieved by writing the outpaths with the `writeTargetsout` function to a new `targets` file that serves as input to the next `systemArgs` call. By chaining several SYSargs steps together one can construct complex workflows involving many sample-level input/output file operations with any combination of command-line or R-based software.



## Objects from the Class

Objects can be created by calls of the form `new("SYSargs", ...)`.

## Slots

**targetsin**: Object of class "data.frame" storing tabular data from targets input file  
**targetsout**: Object of class "data.frame" storing tabular data from targets output file  
**targetsheader**: Object of class "character" storing header/comment lines of targets file  
**modules**: Object of class "character" storing software versions from module system  
**software**: Object of class "character" name of executable of command-line software  
**cores**: Object of class "numeric" number of CPU cores to use  
**other**: Object of class "character" additional arguments  
**reference**: Object of class "character" path to reference genome file  
**results**: Object of class "character" path to results directory  
**infile1**: Object of class "character" paths to first FASTQ file  
**infile2**: Object of class "character" paths to second FASTQ file if data is PE  
**outfile1**: Object of class "character" paths to output files generated by command-line software  
**sysargs**: Object of class "character" full commands used to execute external software  
**outpaths**: Object of class "character" paths to final outputs including postprocessing by Rsamtools

## Methods

**SampleName** signature(x = "SYSargs"): extracts sample names  
 [ signature(x = "SYSargs"): subsetting of class with bracket operator  
**coerce** signature(from = "list", to = "SYSargs"): as(list, "SYSargs")  
**cores** signature(x = "SYSargs"): extracts data from cores slot  
**infile1** signature(x = "SYSargs"): extracts data from infile1 slot  
**infile2** signature(x = "SYSargs"): extracts data from infile2 slot  
**modules** signature(x = "SYSargs"): extracts data from modules slot  
**names** signature(x = "SYSargs"): extracts slot names  
**length** signature(x = "SYSargs"): extracts number of samples  
**other** signature(x = "SYSargs"): extracts data from other slot  
**outfile1** signature(x = "SYSargs"): extracts data from outfile1 slot  
**outpaths** signature(x = "SYSargs"): extracts data from outpath slot  
**reference** signature(x = "SYSargs"): extracts data from reference slot  
**results** signature(x = "SYSargs"): extracts data from results slot  
**show** signature(object = "SYSargs"): summary view of SYSargs objects  
**software** signature(x = "SYSargs"): extracts data from software slot  
**targetsheader** signature(x = "SYSargs"): extracts data from targetsheader slot  
**targetsin** signature(x = "SYSargs"): extracts data from targetsin slot  
**targetsout** signature(x = "SYSargs"): extracts data from targetsout slot

**Author(s)**

Thomas Girke

**See Also**

systemArgs and runCommandline

**Examples**

```

showClass("SYSargs")
## Construct SYSargs object from param and targets files
param <- system.file("extdata", "tophat.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)
args
names(args); targetsin(args); targetsout(args); targetsheader(args);
software(args); modules(args); cores(args); outpaths(args)
sysargs(args); other(args); reference(args); results(args); infile1(args)
infile2(args); outfile1(args); SampleName(args)

## Return sample comparisons
readComp(args, format = "vector", delim = "-")

## The subsetting operator '[' allows to select specific samples
args[1:4]

## Not run:
## Execute SYSargs on single machine
runCommandline(args=args)

## Execute SYSargs on multiple machines
qsubargs <- getQsubargs(queue="batch", Nnodes="nodes=1", cores=cores(args), memory="mem=10gb", time="walltime")
qsubRun(appfct="runCommandline(args=args)", appargs=args, qsubargs=qsubargs, Nqsubs=1, submitdir="results",

## Write outpaths to new targets file for next SYSargs step
writeTargetsout(x=args, file="default")

## End(Not run)

```

systemArgs

*Constructs SYSargs object from param and targets files***Description**

Constructs SYSargs S4 class objects from two simple tabular files: a targets file and a param file. The latter is optional for workflow steps lacking command-line software. Typically, a SYSargs instance stores all sample-level inputs as well as the paths to the corresponding outputs generated by command-line- or R-based software generating sample-level output files. Each sample level input/outfile operation uses its own SYSargs instance. The outpaths of SYSargs usually define the sample inputs for the next SYSargs instance. This connectivity is established by writing the outpaths with the writeTargetsout function to a new targets file that serves as input to the next systemArgs call. By chaining several SYSargs steps together one can construct complex workflows involving many sample-level input/output file operations with any combination of command-line or R-based software.

**Usage**

```
systemArgs(sysma, mytargets, type = "SYSargs")
```

**Arguments**

sysma	path to 'param' file; file structure follows a simple name/value syntax that converted into JSON format; for details about the file structure see sample files provided by package. Assign NULL to run the pipeline without 'param' file. This can be useful for running partial workflows, e.g. with pregenerated BAM files.
mytargets	path to targets file
type	type="SYSargs" returns SYSargs, type="json" returns param file content in JSON format (requires rjson library)

**Value**

SYSargs object or character string in JSON format

**Author(s)**

Thomas Girke

**See Also**

```
showClass("SYSargs")
```

**Examples**

```
## Construct SYSargs object from param and targets files
param <- system.file("extdata", "tophat.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)
args
names(args); modules(args); cores(args); outpaths(args); sysargs(args)

## Not run:
## Execute SYSargs on single machine
runCommandLine(args=args)

## Execute SYSargs on multiple machines of a compute cluster
resources <- list(walltime="00:25:00", nodes=paste0("1:ppn=", cores(args)), memory="2gb")
reg <- clusterRun(args, conffile=".BatchJobs.R", template="torque.tmpl", Njobs=18, runid="01", resourceList=

## Monitor progress of submitted jobs
showStatus(reg)
file.exists(outpaths(args))
sapply(1:length(args), function(x) loadResult(reg, x)) # Works once all jobs have completed successfully.

## Alignment stats
read_statsDF <- alignStats(fqpaths=infile1(args), bampaths=outpaths(args), fqgz=TRUE)
read_statsDF <- cbind(read_statsDF[targets$FileName,], targets)
write.table(read_statsDF, "results/alignStats.xls", row.names=FALSE, quote=FALSE, sep="\t")

## Write outpaths to new targets file for next SYSargs step
writeTargetsout(x=args, file="default")
```

```
## End(Not run)
```

---

```
variantReport          Generate Variant Report
```

---

## Description

Functions for generating tabular variant reports including genomic context annotations and confidence statistics of variants. The annotations are obtained with utilities provided by the VariantAnnotation package and the variant statistics are retrieved from the input VCF files.

## Usage

```
## Variant report
variantReport(args, txdb, fa, organism)

## Combine variant reports
combineVarReports(args, filtercol, ncol = 15)

## Create summary statistics of variants
varSummary(args)
```

## Arguments

args	Object of class SYSargs. The paths of the input VCF files are specified under infile1(args) and the paths of the output files under outfile1(args).
txdb	Annotation data stored as TranscriptDb object, which can be obtained from GFF/GTF files, BioMart, Bioc Annotation packages, UCSC, etc. For details see the vignette of the GenomicFeatures package. It is important to use here matching versions of the txdb and fa objects. The latter is the genome sequence used for read mapping and variant calling.
fa	FaFile object pointing to the sequence file of the corresponding reference genome stored in FASTA format or a BSgenome instance.
organism	Character vector specifying the organism name of the reference genome.
filtercol	Named character vector containing in the name field the column titles to filter on, and in the data field the corresponding values to include in the report. For instance, the setting filtercol=c(Consequence="nonsynonymous") will include only nonsynonymous variances listed in the Consequence column. To omit the filtering step, one can use the setting filtercol="All".
ncol	Integer specifying the number of columns in the tabular input files. Default is set to 15.

## Value

Tabular output files.

## Author(s)

Thomas Girke

**See Also**

filterVars

**Examples**

```

## Alignment with BWA (sequentially on single machine)
param <- system.file("extdata", "bwa.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)
sysargs(args)[1]

## Not run:
system("bwa index -a bwtsv ./data/tair10.fasta")
bampaths <- runCommandline(args=args)

## Alignment with BWA (parallelized on compute cluster)
resources <- list(walltime="20:00:00", nodes=paste0("1:ppn=", cores(args)), memory="10gb")
reg <- clusterRun(args, conffile=".BatchJobs.R", template="torque.tmpl", Njobs=18, runid="01",
                  resourceList=resources)

## Variant calling with GATK
## The following creates in the initial step a new targets file
## (targets_bam.txt). The first column of this file gives the paths to
## the BAM files created in the alignment step. The new targets file and the
## parameter file gatk.param are used to create a new SYSargs
## instance for running GATK. Since GATK involves many processing steps, it is
## executed by a bash script gatk_run.sh where the user can specify the
## detailed run parameters. All three files are expected to be located in the
## current working directory. Samples files for gatk.param and
## gatk_run.sh are available in the subdirectory ./inst/extdata/ of the
## source file of the systemPipeR package.
writeTargetsout(x=args, file="targets_bam.txt")
system("java -jar CreateSequenceDictionary.jar R=./data/tair10.fasta O=./data/tair10.dict")
# system("java -jar /opt/picard/1.81/CreateSequenceDictionary.jar R=./data/tair10.fasta O=./data/tair10.dict")
args <- systemArgs(sysma="gatk.param", mytargets="targets_bam.txt")
resources <- list(walltime="20:00:00", nodes=paste0("1:ppn=", 1), memory="10gb")
reg <- clusterRun(args, conffile=".BatchJobs.R", template="torque.tmpl", Njobs=18, runid="01",
                  resourceList=resources)
writeTargetsout(x=args, file="targets_gatk.txt")

## Variant calling with BCFtools
## The following runs the variant calling with BCFtools. This step requires in
## the current working directory the parameter file sambcf.param and the
## bash script sambcf_run.sh.
args <- systemArgs(sysma="sambcf.param", mytargets="targets_bam.txt")
resources <- list(walltime="20:00:00", nodes=paste0("1:ppn=", 1), memory="10gb")
reg <- clusterRun(args, conffile=".BatchJobs.R", template="torque.tmpl", Njobs=18, runid="01",
                  resourceList=resources)
writeTargetsout(x=args, file="targets_sambcf.txt")

## Filtering of VCF files generated by GATK
args <- systemArgs(sysma="filter_gatk.param", mytargets="targets_gatk.txt")
filter <- "totalDepth(vr) >= 2 & (altDepth(vr) / totalDepth(vr) >= 0.8) & rowSums(softFilterMatrix(vr))==4"
# filter <- "totalDepth(vr) >= 20 & (altDepth(vr) / totalDepth(vr) >= 0.8) & rowSums(softFilterMatrix(vr))==6"
filterVars(args, filter, varcaller="gatk", organism="A. thaliana")
writeTargetsout(x=args, file="targets_gatk_filtered.txt")

```

```

## Filtering of VCF files generated by BCFtools
args <- systemArgs(sysma="filter_sambcf.param", mytargets="targets_sambcf.txt")
filter <- "rowSums(vr) >= 2 & (rowSums(vr[,3:4])/rowSums(vr[,1:4]) >= 0.8)"
# filter <- "rowSums(vr) >= 20 & (rowSums(vr[,3:4])/rowSums(vr[,1:4]) >= 0.8)"
filterVars(args, filter, varcaller="bcftools", organism="A. thaliana")
writeTargetsout(x=args, file="targets_sambcf_filtered.txt")

## Annotate filtered variants from GATK
args <- systemArgs(sysma="annotate_vars.param", mytargets="targets_gatk_filtered.txt")
txdb <- loadDb("./data/tair10.sqlite")
fa <- FaFile(systemPipeR::reference(args))
variantReport(args=args, txdb=txdb, fa=fa, organism="A. thaliana")

## Annotate filtered variants from BCFtools
args <- systemArgs(sysma="annotate_vars.param", mytargets="targets_sambcf_filtered.txt")
txdb <- loadDb("./data/tair10.sqlite")
fa <- FaFile(systemPipeR::reference(args))
variantReport(args=args, txdb=txdb, fa=fa, organism="A. thaliana")

## Combine results from GATK
args <- systemArgs(sysma="annotate_vars.param", mytargets="targets_gatk_filtered.txt")
combinedDF <- combineVarReports(args, filtercol=c(Consequence="nonsynonymous"))
write.table(combinedDF, "./results/combinedDF_nonsyn_gatk.xls", quote=FALSE, row.names=FALSE, sep="\t")

## Combine results from BCFtools
args <- systemArgs(sysma="annotate_vars.param", mytargets="targets_sambcf_filtered.txt")
combinedDF <- combineVarReports(args, filtercol=c(Consequence="nonsynonymous"))
write.table(combinedDF, "./results/combinedDF_nonsyn_sambcf.xls", quote=FALSE, row.names=FALSE, sep="\t")

## Summary for GATK
args <- systemArgs(sysma="annotate_vars.param", mytargets="targets_gatk_filtered.txt")
write.table(varSummary(args), "./results/variantStats_gatk.xls", quote=FALSE, col.names = NA, sep="\t")

## Summary for BCFtools
args <- systemArgs(sysma="annotate_vars.param", mytargets="targets_sambcf_filtered.txt")
write.table(varSummary(args), "./results/variantStats_sambcf.xls", quote=FALSE, col.names = NA, sep="\t")

## Venn diagram of variants
args <- systemArgs(sysma="annotate_vars.param", mytargets="targets_gatk_filtered.txt")
varlist <- sapply(names(outpaths(args))[1:4], function(x) as.character(read.delim(outpaths(args)[x])$VARID))
vennset_gatk <- overLapper(varlist, type="vennsets")
args <- systemArgs(sysma="annotate_vars.param", mytargets="targets_sambcf_filtered.txt")
varlist <- sapply(names(outpaths(args))[1:4], function(x) as.character(read.delim(outpaths(args)[x])$VARID))
vennset_bcf <- overLapper(varlist, type="vennsets")
vennPlot(list(vennset_gatk, vennset_bcf), mymain="", mysub="GATK: red; BCFtools: blue", colmode=2, ccol=c("b
## End(Not run)

```

---

vennPlot

*Plot 2-5 way Venn diagrams*


---

## Description

Plotting function of 2-5 way Venn diagrams from 'VENNset' objects or count set vectors. A useful feature is the possibility to combine the counts from several Venn comparisons with the same number

of label sets in a single Venn diagram.

### Usage

```
vennPlot(x, mymain = "Venn Diagram", mysub = "default", setlabels = "default", yoffset = seq(0, 10,
```

### Arguments

x	VENNset or list of VENNset objects. Alternatively, a vector of Venn counts or a list of vectors of Venn counts can be provided as input. If several Venn comparisons are provided in a list then their results are combined in a single Venn diagram, where the count sets are organized above each other.
mymain	Main title of plot.
mysub	Subtitle of plot. Default mysub="default" reports the number of unique items in all sets, as well as the number of unique items in each individual set, respectively.
setlabels	The argument setlabels allows to provide a vector of custom sample labels. However, assigning the proper names in the name slots of the initial setlist is preferred for tracking purposes.
yoffset	The results from several Venn comparisons can be combined in a single Venn diagram by assigning to x a list with several VENNsets or count vectors. The positional offset of the count sets in the plot can be controlled with the yoffset argument. The argument setting colmode allows to assign different colors to each count set. For instance, with colmode=2 one can assign to ccol a color vector or a list, such as ccol=c("blue", "red") or ccol=list(1:8, 8:1).
ccol	Character or numeric vector to define colors of count values, e.g. ccol=c("black", "black", "red")
colmode	See argument yoffset.
lcol	Character or numeric vector to define colors of set labels, e.g. lcol=c("red", "green")
lines	Character or numeric vector to define colors of lines in plot.
mylwd	Defines line width of shapes used in plot.
diacol	See argument type.
type	Defines shapes used to plot 4-way Venn diagram. Default type="ellipse" uses ellipses. The setting type="circle" returns an incomplete 4-way Venn diagram as circles. This representation misses two overlap sectors, but is sometimes easier to navigate than the default ellipse version. The missing Venn intersects are reported below the Venn diagram. Their font color can be controlled with the argument diacol.
ccex	Controls font size for count values.
lcex	Controls font size for set labels.
sepsplit	Character used to separate sample labels in Venn counts.
...	Additional arguments to pass on.

### Value

Venn diagram plot.

### Note

The functions provided here are an extension of the Venn diagram resources on this site: <http://manuals.bioinformatics.ucr.edu/home/venn/Venn-Diagrams>

**Author(s)**

Thomas Girke

**References**

See examples in 'The Electronic Journal of Combinatorics': <http://www.combinatorics.org/files/Surveys/ds5/VennSymm>

**See Also**

overLapper, olBarplot

**Examples**

```
## Sample data
setlist <- list(A=sample(letters, 18), B=sample(letters, 16),
               C=sample(letters, 20), D=sample(letters, 22),
               E=sample(letters, 18), F=sample(letters, 22))

## 2-way Venn diagram
vennset <- overLapper(setlist[1:2], type="vennsets")
vennPlot(vennset)

## 3-way Venn diagram
vennset <- overLapper(setlist[1:3], type="vennsets")
vennPlot(vennset)

## 4-way Venn diagram
vennset <- overLapper(setlist[1:4], type="vennsets")
vennPlot(list(vennset, vennset))

## Pseudo 4-way Venn diagram with circles
vennPlot(vennset, type="circle")

## 5-way Venn diagram
vennset <- overLapper(setlist[1:5], type="vennsets")
vennPlot(vennset)

## Alternative Venn count input to vennPlot (not recommended!)
counts <- sapply(vennlist(vennset), length)
vennPlot(counts)

## 6-way Venn comparison as bar plot
vennset <- overLapper(setlist[1:6], type="vennsets")
olBarplot(vennset, mincount=1)

## Bar plot of standard intersect counts
intersect <- overLapper(setlist, type="intersects")
olBarplot(intersect, mincount=1)

## Accessor methods for VENNset/INTERSECTset objects
names(vennset)
names(intersect)
setlist(vennset)
intersectmatrix(vennset)
complexitylevels(vennset)
vennlist(vennset)
```



```

intersectlist(interset)

## Coerce VENNset/INTERSECTset object to list
as.list(vennset)
as.list(interset)

## Pairwise intersect matrix and heatmap
olMA <- sapply(names(setlist),
function(x) sapply(names(setlist),
function(y) sum(setlist[[x]] %in% setlist[[y]])))
olMA
heatmap(olMA, Rowv=NA, Colv=NA)

## Presence-absence matrices for large numbers of sample sets
interset <- overLapper(setlist=setlist, type="intersects", complexity=2)
(paMA <- intersectmatrix(interset))
heatmap(paMA, Rowv=NA, Colv=NA, col=c("white", "gray"))

```

---

VENNset-class

*Class "VENNset"*


---

## Description

Container for storing Venn intersect results created by the `overLapper` function. The `setlist` slot stores the original label sets as vectors in a list; `intersectmatrix` organizes the label sets in a present-absent matrix; `complexitylevels` represents the number of comparisons considered for each comparison set as vector of integers; and `vennlist` contains the Venn intersect vectors.

## Objects from the Class

Objects can be created by calls of the form `new("VENNset", ...)`.

## Slots

**setlist:** Object of class "list": list of vectors  
**intersectmatrix:** Object of class "matrix": binary matrix  
**complexitylevels:** Object of class "integer": vector of integers  
**vennlist:** Object of class "list": list of vectors

## Methods

**as.list** signature(x = "VENNset"): coerces VENNset to list  
**coerce** signature(from = "list", to = "VENNset"): as(list, "VENNset")  
**complexitylevels** signature(x = "VENNset"): extracts data from complexitylevels slot  
**intersectmatrix** signature(x = "VENNset"): extracts data from intersectmatrix slot  
**length** signature(x = "VENNset"): returns number of original label sets  
**names** signature(x = "VENNset"): extracts slot names  
**setlist** signature(x = "VENNset"): extracts data from setlist slot  
**show** signature(object = "VENNset"): summary view of VENNset objects  
**vennlist** signature(x = "VENNset"): extracts data from vennset slot

**Author(s)**

Thomas Girke

**See Also**

overLapper, vennPlot, olBarplot, INTERSECTset-class

**Examples**

```
showClass("VENNset")

## Sample data
setlist <- list(A=sample(letters, 18), B=sample(letters, 16),
               C=sample(letters, 20), D=sample(letters, 22),
               E=sample(letters, 18), F=sample(letters, 22))

## Create VENNset
vennset <- overLapper(setlist[1:5], type="vennsets")
class(vennset)

## Accessor methods for VENNset/INTERSECTset objects
names(vennset)
setlist(vennset)
intersectmatrix(vennset)
complexitylevels(vennset)
vennlist(vennset)

## Coerce VENNset/INTERSECTset object to list
as.list(vennset)
```

---

writeTargetsout

*Write updated targets out to file*


---

**Description**

Convenience write function for generating targets files with updated FileName columns containing the paths to files generated by input/output processes. These processes can be commandline- or R-based software. Typically, the paths to the inputs are stored in the targets infile (`targetsin(args)`) and the outputs are stored in the targets outfile (`targetsout(args)`). Note: by default the function cannot overwrite any existing files. If a file exists then the user has to explicitly remove it or set `overwrite=TRUE`.

**Usage**

```
writeTargetsout(x, file = "default", silent = FALSE, overwrite=FALSE, ...)
```

**Arguments**

x	Object of class SYSargs.
file	Name and path of output file. If set to "default" then the name of the output file will have the pattern 'targets_<software>.txt', where <software> will be what <code>software(x)</code> returns.

silent	If set to TRUE, all messages returned by the function will be suppressed.
overwrite	If set to TRUE, existing files of same name will be overwritten.
...	To pass on additional arguments.

**Value**

Writes tabular targets files containing the header/comment lines from targetsheader(x) and the columns from targetsout(x).

**Author(s)**

Thomas Girke

**See Also**

writeTargetsRef

**Examples**

```
## Create SYSargs object
param <- system.file("extdata", "tophat.param", package="systemPipeR")
targets <- system.file("extdata", "targets.txt", package="systemPipeR")
args <- systemArgs(sysma=param, mytargets=targets)

## Not run:
## Write targets out file
writeTargetsout(x=args, file="default")

## End(Not run)
```

---

writeTargetsRef	<i>Generate targets file with reference</i>
-----------------	---

---

**Description**

Generates targets file with sample-wise reference as required for some NGS applications, such as ChIP-Seq containing input samples. The reference sample information needs to be provided in the input file in a column called SampleReference where the values reference the labels used in the SampleName column. Sample rows without reference assignments will be removed automatically.

**Usage**

```
writeTargetsRef(infile, outfile, silent = FALSE, overwrite = FALSE, ...)
```

**Arguments**

infile	Path to input targets file.
outfile	Path to output targets file.
silent	If set to TRUE, all messages returned by the function will be suppressed.
overwrite	If set to TRUE, existing files of same name will be overwritten.
...	To pass on additional arguments.

**Value**

Generates modified targets file with the paths to the reference samples in the second column named FileName2. Note, sample rows not assigned reference samples are removed automatically.

**Author(s)**

Thomas Girke

**See Also**

`writeTargetsout`, `mergeBamByFactor`

**Examples**

```
## Path to input targets file
targets <- system.file("extdata", "targets_chip.txt", package="systemPipeR")

## Not run:
## Write modified targets file with reference (e.g. input) sample
writeTargetsRef(infile=targets, outfile="~/targets_refsample.txt", silent=FALSE, overwrite=FALSE)

## End(Not run)
```

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