

Package ‘TCGAutils’

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Title TCGA utility functions for data management

Version 1.3.26

Description A suite of helper functions for checking and manipulating TCGA data including data obtained from the curatedTCGAData experiment package. These functions aim to simplify and make working with TCGA data more manageable.

Depends R (>= 3.6.0)

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R topics documented:

TCGAutils-package	2
clinicalNames	3
curatedTCGAData-helpers	3
diseaseCodes	4
findGRangesCols	5
generateMap	6
getFileName	7
ID-translation	7
imputeAssay	9
makeGRangesListFromCopyNumber	10
makeGRangesListFromExonFiles	11
makeSummarizedExperimentFromGISTIC	12
mergeColData	13
sampleTypes	14
simplifyTCGA	14
TCGAbarcode	16
TCGAbiospec	17
TCGAsampleSelect	17
translateBuild	18
trimColData	19
Index	20

TCGAutils-package	<i>TCGAutils: Helper functions for working with TCGA and MultiAssay-Experiment data</i>
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Description

TCGAutils is a toolbox to work with TCGA specific datasets. It allows the user to manipulate and translate TCGA barcodes, conveniently convert a list of data files to [GRangesList](#). Take datasets from GISTIC and return a [SummarizedExperiment](#) class object. The package also provides functions for working with data from the curatedTCGAData experiment data package. It provides convenience functions for extracting subtype metadata data and adding clinical data to existing [MultiAssayExperiment](#) objects.

Author(s)

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See Also

Useful links:

- Report bugs at <https://github.com/waldronlab/TCGAutils/issues>

`clinicalNames`*Clinical dataset names in TCGA*

Description

A dataset of names for each of the TCGA cancer codes available. These names were obtained by the clinical datasets from [getFirehoseData](#). They serve to subset the current datasets provided by `curatedTCGAData`.

Usage

```
clinicalNames
```

Format

A [CharacterList](#) of names for 33 cancer codes

Value

The clinical dataset column names in TCGA as provided by the `RTCGAToolbox`

`curatedTCGAData-helpers`*Helper functions for managing MultiAssayExperiment from curatedTCGAData*

Description

Additional helper functions for cleaning and uncovering metadata within a downloaded `MultiAssayExperiment` from `curatedTCGAData`. The `getSubtypeMap` function provides a 2 column `data.frame` with in-data variable names and an interpreted names. The `getClinicalNames` function provides a vector of variable names that exist in the `colData` slot of a downloaded `MultiAssayExperiment` object. These variables are obtained from [getFirehoseData](#) by default and tend to be present across most cancer codes.

Usage

```
getSubtypeMap(multiassayexperiment)
```

```
getClinicalNames(diseaseCode)
```

```
splitAssays(multiassayexperiment, sampleCodes = NULL)
```

```
sampleTables(multiassayexperiment, vial = FALSE)
```

Arguments

multiassayexperiment	A MultiAssayExperiment object
diseaseCode	A TCGA cancer code (e.g., "BRCA")
sampleCodes	character (default NULL) A string of sample type codes (refer to <code>data(sampleTypes)</code> ; <code>splitAssays</code> section)
vial	(logical default FALSE) whether to display vials in the table output

Value

- `getSubtypeMap`: A `data.frame` with columns representing actual data variables and explanatory names
- `getClinicalNames`: A vector of names that correspond to a particular disease code.

splitAssays

Separates samples by indicated sample codes into different assays in a `MultiAssayExperiment`. Refer to the `sampleTypes` data object for a list of available codes. This operation generates `n` times the number of assays based on the number of sample codes entered. By default, all assays will be split by samples present in the data.

sampleTables

Display all the available samples in each of the assays

Examples

```
## Not run:
library(curatedTCGAData)

coad <- curatedTCGAData(diseaseCode = "COAD",
  assays = "CNA*", dry.run = FALSE)
getSubtypeMap(coad)

## End(Not run)

getClinicalNames("COAD")
```

diseaseCodes

TCGA Cancer Disease Codes Table

Description

A dataset for obtaining the cancer codes in TCGA for about 13 different types of cancers.

Usage

```
diseaseCodes
```

Format

A data frame with 37 rows and 2 variables:

Study.Abbreviation Disease Code used in TCGA

Available Cancer datasets available via curatedTCGAData

SubtypeData Subtype curation data available via curatedTCGAData

Study.Name The full length study name (i.e., type of cancer)

Value

The TCGA ‘diseaseCodes’ table

Source

<https://gdc.cancer.gov/resources-tcga-users/tcga-code-tables/tcga-study-abbreviations>

findGRangesCols	<i>Obtain minimum necessary names for the creation of a GRangesList object</i>
-----------------	--

Description

This function attempts to match chromosome, start position, end position and strand names in the given character vector. Modified helper from the GenomicRanges package.

Usage

```
findGRangesCols(df_colnames, seqnames.field = c("seqnames", "seqname",
"chromosome", "chrom", "chr", "chromosome_name", "seqid", "om"),
start.field = "start", end.field = c("end", "stop"),
strand.field = "strand", ignore.strand = FALSE)
```

Arguments

df_colnames	A character vector of names in a dataset
seqnames.field	A character vector of the chromosome name
start.field	A character vector that indicates the column name of the start positions of ranged data
end.field	A character vector that indicates the end position of ranged data
strand.field	A character vector of the column name that indicates the strand type
ignore.strand	logical (default FALSE) whether to ignore the strand field in the data

Value

Index positions vector indicating columns with appropriate names

Examples

```
myDataColNames <- c("Start_position", "End_position", "strand",
"chromosome", "num_probes", "segment_mean")
findGRangesCols(myDataColNames)
```

generateMap	<i>Create a sampleMap from an experiment list and phenoData dataframe</i>
-------------	---

Description

This function helps create a sampleMap in preparation of a MultiAssayExperiment object. This is especially useful when the sample identifiers are not very different, as in the case of TCGA barcodes. An idConverter function can be provided to truncate such sample identifiers and obtain patient identifiers.

Usage

```
generateMap(experiments, colData, idConverter = identity, sampleCol,
            patientCol, ...)
```

Arguments

experiments	A named list of experiments compatible with the MultiAssayExperiment API
colData	A data.frame of clinical data with patient identifiers as rownames
idConverter	A function to be used against the sample or specimen identifiers to match those in the rownames of the colData (default NULL)
sampleCol	A single string indicating the sample identifiers column in the colData dataset
patientCol	A single string indicating the patient identifiers in colData, "row.names" extracts the colData row names
...	Additional arguments to pass to the 'idConverter' function.

Value

A DataFrame class object of mapped samples and patient identifiers including assays

Author(s)

M. Ramos, M. Morgan, L. Schiffer

Examples

```
## Minimal example
expList <- list(assay1 = matrix(1:6, ncol = 2L,
  dimnames = list(paste0("feature", 1:3), c("A-J", "B-J"))),
  assay2 = matrix(1:4, ncol = 2,
  dimnames = list(paste0("gene", 1:2), c("A-L", "B-L"))))

## Mock colData
myPheno <- data.frame(var1 = c("Yes", "No"), var2 = c("High", "Low"),
  row.names = c("a", "b"))

## A look at the identifiers
vapply(expList, colnames, character(2L))
rownames(myPheno)
```

```
## Use 'idConverter' to correspond sample names to patient identifiers
generateMap(expList, myPheno,
  idConverter = function(x) substr(tolower(x), 1L, 1L))
```

getFileName

Find the file names used in RTCGAToolbox

Description

Part of this function is from the RTCGAToolbox. It aims to extract the file name used inside of the [getFirehoseData](#) function. The arguments of the function parallel those in the [getFirehoseData](#) function. It is only available for select data types.

Usage

```
getFileName(disease, runDate = "20160128", dataType = c("CNASNP",
  "CNVSNP", "CNaseq", "CNACGH", "Mutation"))
```

Arguments

disease	The TCGA cancer disease code, e.g., "COAD"
runDate	The single string used in the getFirehoseData function (default "20160128")
dataType	A single character vector (default "CNASNP") indicating the data type for which to get the source file name

Value

A single character file name

Examples

```
getFileName("COAD", dataType = "CNASNP")
```

ID-translation

Translate study identifiers from barcode to UUID and vice versa

Description

These functions allow the user to enter a character vector of identifiers and use the GDC API to translate from TCGA barcodes to Universally Unique Identifiers (UUID) and vice versa. These relationships are not one-to-one. Therefore, a data.frame is returned for all inputs. The UUID to TCGA barcode translation only applies to file and case UUIDs. Two-way UUID translation is available from 'file_id' to 'case_id' and vice versa. Please double check any results before using these features for analysis. Case / submitter identifiers are translated by default, see the from_type argument for details. All identifiers are converted to lower case.

Usage

```

UUIDtoBarcode(id_vector, from_type = c("case_id", "file_id"),
  legacy = FALSE)

UUIDtoUUID(id_vector, to_type = c("case_id", "file_id"),
  legacy = FALSE)

barcodeToUUID(barcodes, legacy = FALSE)

filenameToBarcode(filenamees, legacy = FALSE)

```

Arguments

id_vector	A character vector of UUIDs corresponding to either files or cases (default assumes case_ids)
from_type	Either case_id or file_id indicating the type of id_vector entered (default "case_id")
legacy	(logical default FALSE) whether to search the legacy archives
to_type	The desired UUID type to obtain, can either be "case_id" or "file_id"
barcodes	A character vector of TCGA barcodes
filenamees	A character vector of filenames obtained from the GenomicDataCommons

Details

Based on the file UUID supplied, the appropriate entity_id (TCGA barcode) is returned. In previous versions of the package, the 'end_point' parameter would require the user to specify what type of barcode needed. This is no longer supported as 'entity_id' returns the appropriate one.

Value

A data.frame of TCGA barcode identifiers and UUIDs

Author(s)

Sean Davis, M. Ramos

Examples

```

## Translate UUIDs >> TCGA Barcode

uuids <- c("0001801b-54b0-4551-8d7a-d66fb59429bf",
"002c67f2-ff52-4246-9d65-a3f69df6789e",
"003143c8-bbbf-46b9-a96f-f58530f4bb82")

UUIDtoBarcode(uuids, from_type = "file_id")

UUIDtoBarcode("ae55b2d3-62a1-419e-9f9a-5ddfacc356db4", from_type = "case_id")

## Translate file UUIDs >> case UUIDs

uuids <- c("0001801b-54b0-4551-8d7a-d66fb59429bf",
"002c67f2-ff52-4246-9d65-a3f69df6789e",
"003143c8-bbbf-46b9-a96f-f58530f4bb82")

```



```

UUIDtoUUID(uuids)

## Translate TCGA Barcode >> UUIDs

fullBarcodes <- c("TCGA-B0-5117-11A-01D-1421-08",
"TCGA-B0-5094-11A-01D-1421-08",
"TCGA-E9-A295-10A-01D-A16D-09")

sample_ids <- TCGAbarcode(fullBarcodes, sample = TRUE)

barcodeToUUID(sample_ids)

participant_ids <- c("TCGA-CK-4948", "TCGA-D1-A17N",
"TCGA-4V-A9QX", "TCGA-4V-A9QM")

barcodeToUUID(participant_ids)

library(GenomicDataCommons)

fquery <- files() %>%
  filter(~ cases.project.project_id == "TCGA-COAD" &
    data_category == "Copy Number Variation" &
    data_type == "Copy Number Segment")

fnames <- results(fquery)$file_name[1:6]

filenameToBarcode(fnames)

```

imputeAssay

This function imputes assays values inside a MultiAssayExperiment

Description

These function allow the user to enter a MultiAssayExperiment and impute all the NA values inside assays.

Usage

```
imputeAssay(multiassayexperiment, i = 1, ...)
```

Arguments

multiassayexperiment A MultiAssayExperiment with genes in the rows, samples in the columns

i A numeric, logical, or character vector indicating the assays to perform imputation on (default 1L)

... Arguments passed on to `impute::impute.knn`

data An expression matrix with genes in the rows, samples in the columns

k Number of neighbors to be used in the imputation (default=10)

- rowmax** The maximum percent missing data allowed in any row (default 50%). For any rows with more than rowmax% missing are imputed using the overall mean per sample.
- colmax** The maximum percent missing data allowed in any column (default 80%). If any column has more than colmax% missing data, the program halts and reports an error.
- maxp** The largest block of genes imputed using the knn algorithm inside `impute.knn` (default 1500); larger blocks are divided by two-means clustering (recursively) prior to imputation. If maxp=p, only knn imputation is done.
- rng.seed** The seed used for the random number generator (default 362436069) for reproducibility.

Value

MultiAssayExperiment with imputed assays values

Examples

```
library(curatedTCGAData)

gbm <- curatedTCGAData("GBM", "RPPA*", FALSE)

## replace DataFrame with "matrix"
gbm[[1L]] <- as.matrix(assay(gbm[[1L]]))

gbm <- imputeAssay(gbm, i = 1L)
```

makeGRangesListFromCopyNumber

Make a GRangesList from TCGA Copy Number data

Description

makeGRangesListFromCopyNumber allows the user to convert objects of class `data.frame` or [DataFrame](#) to a [GRangesList](#). It includes additional features specific to TCGA data such as, hugo symbols, probe numbers, segment means, and ucsc build (if available).

Usage

```
makeGRangesListFromCopyNumber(df, split.field,
  names.field = "Hugo_Symbol", ...)
```

Arguments

- | | |
|-------------|--|
| df | A <code>data.frame</code> or <code>DataFrame</code> class object. <code>list</code> class objects are coerced to <code>data.frame</code> or <code>DataFrame</code> . |
| split.field | A character vector of length one indicating the column to be used as sample identifiers |
| names.field | A character vector of length one indicating the column to be used as names for each of the ranges in the data |
| ... | Additional arguments to pass on to makeGRangesListFromDataFrame |

Value

A [GRangesList](#) class object

Examples

```
library(GenomicDataCommons)
library(magrittr)

manif <- files() %>%
  filter(~ cases.project.project_id == "TCGA-COAD" &
         data_type == "Copy Number Segment") %>%
  manifest(size = 1)

fname <- gdcdata(manif$id)

barcode <- UUIDtoBarcode(names(fname), from_type = "file_id")$cases.submitter_id

cndata <- read.delim(fname[[1L]], nrows = 10L)

cngrl <- makeGRangesListFromCopyNumber(cndata, split.field = "GDC_Aliquot",
                                       keep.extra.columns = TRUE)

names(cngrl) <- barcode
GenomeInfoDb::genome(cngrl) <- extractBuild(fname[[1L]])
cngrl
```

makeGRangesListFromExonFiles

Read Exon level files and create a GRangesList

Description

This function serves to read exon-level expression data. It works for exon quantification (raw counts and RPKM) and junction quantification (raw counts) files paths and represent such data as a [GRangesList](#). The data can be downloaded via the TCGA Legacy Archive. File name and structure requirements are as follows: The third position delimited by dots (".") in the file name should be the universally unique identifier (UUID). The column containing the ranged information is labeled "exon."

Usage

```
makeGRangesListFromExonFiles(filepaths, sampleNames = NULL,
                             fileName = NULL, rangesColumn = "exon", nrows = Inf)
```

Arguments

filepaths	A character vector of valid exon data file paths
sampleNames	A character vector of TCGA barcodes to be applied if not present in the data (default NULL)
fileNames	A character vector of file names as downloaded from the Genomic Data Commons Legacy archive (default NULL)

rangesColumn (default "exon") A single string indicating the name of the column in the data containing the ranges information

nrows The number of rows to return from each of the files read in (all rows by default)

Value

A [GRangesList](#) object

Author(s)

M. Ramos

Examples

```
## Load example file found in package
pkgDir <- system.file("extdata", package = "TCGAutils", mustWork = TRUE)
exonFile <- list.files(pkgDir, pattern = "cation\\.txt$", full.names = TRUE)

filePrefix <- "unc.edu.32741f9a-9fec-441f-96b4-e504e62c5362.1755371."

## Add actual file name manually (due to Windows OS restriction)
makeGRangesListFromExonFiles(exonFile,
  fileNames = paste0(filePrefix, basename(exonFile)),
  sampleNames = "TCGA-AA-3678-01A-01R-0905-07")
```

makeSummarizedExperimentFromGISTIC

Create a SummarizedExperiment from FireHose GISTIC

Description

Use the output of `getFirehoseData` to create a [SummarizedExperiment](#). This can be done for three types of data, G-scores thresholded by gene, copy number by gene, and copy number by peak regions.

Usage

```
makeSummarizedExperimentFromGISTIC(gistic, dataType)
```

Arguments

gistic A [FirehoseGISTIC-class](#) object

dataType Either one of "ThresholdedByGene", "AllByGene", "Peaks"

Value

A `SummarizedExperiment` object

Author(s)

L. Geistlinger, M. Ramos

Examples

```
library(RTCGAToolbox)
co <- getFirehoseData("COAD", clinical = FALSE, GISTIC = TRUE,
  destdir = tempdir())
makeSummarizedExperimentFromGISTIC(co, "AllByGene")
```

mergeColData

Take a MultiAssayExperiment and include curated variables

Description

This function works on the colData of a [MultiAssayExperiment](#) object to merge curated variable columns or other clinical variables that would like to be added. It is recommended that the user run the scripts in the MultiAssayExperiment-TCGA repository that build the "enhanced" type of data but not necessary if using different clinical data. Please see the repository's README for more information.

Usage

```
mergeColData(MultiAssayExperiment, colData)
```

Arguments

MultiAssayExperiment

A [MultiAssayExperiment](#) object

colData

A `DataFrame` or `data.frame` to merge with clinical data in the `MultiAssayExperiment` object

Value

A [MultiAssayExperiment](#) object

Examples

```
library(MultiAssayExperiment)
mergeColData(MultiAssayExperiment(), S4Vectors::DataFrame())
```

sampleTypes	<i>Barcode Sample Type Table</i>
-------------	----------------------------------

Description

A dataset that contains the mappings for sample codes in the TCGA barcodes.

Usage

```
sampleTypes
```

Format

A data frame with 19 rows and 3 variables:

Code Two digit code number found in the barcode

Definition Long name for the sample type

Short.Letter.Code Letter code for the sample type

Value

The TCGA 'sampleTypes' table

Source

<https://gdc.cancer.gov/resources-tcga-users/tcga-code-tables/sample-type-codes>

simplifyTCGA	<i>Functions to convert rows annotations to ranges and RangedExperiment to RangedSummarizedExperiment</i>
--------------	---

Description

This group of functions will convert row annotations as either gene symbols or miRNA symbols to row ranges based on database resources 'TxDB' and 'org.Hs' packages. It will also simplify the representation of [RaggedExperiment](#) objects to [RangedSummarizedExperiment](#).

Usage

```
simplifyTCGA(obj, keep.assay = FALSE, unmapped = TRUE)
```

```
symbolsToRanges(obj, keep.assay = FALSE, unmapped = TRUE)
```

```
mirToRanges(obj, keep.assay = FALSE, unmapped = TRUE)
```

```
CpGtoRanges(obj, keep.assay = FALSE, unmapped = TRUE)
```

```
qreduceTCGA(obj, keep.assay = FALSE, suffix = "_simplified")
```

Arguments

obj	A MultiAssayExperiment object obtained from curatedTCGAData
keep.assay	logical (default FALSE) Whether to keep the SummarizedExperiment assays that have been converted to RangedSummarizedExperiment
unmapped	logical (default TRUE) Include an assay of data that was not able to be mapped in reference database
suffix	character (default "_simplified") A character string to append to the newly modified assay for 'qreduceTCGA'.

Details

The original SummarizedExperiment containing either gene symbol or miR annotations is replaced or supplemented by a [RangedSummarizedExperiment](#) for those that could be mapped to [GRanges](#), and optionally another [SummarizedExperiment](#) for annotations that could not be mapped to [GRanges](#).

RaggedExperiment mutation objects become a genes by patients RangedSummarizedExperiment object containing '1' if there is a non-silent mutation somewhere in the gene, and '0' otherwise. "CNA" and "CNV" segmented copy number are reduced using a weighted mean in the rare cases of overlapping (non-disjoint) copy number regions.

These functions rely on 'TxDb.Hsapiens.UCSC.hg19.knownGene' and 'org.Hs.eg.db' to map to the 'hg19' NCBI build.

Value

A [MultiAssayExperiment](#) with any gene expression, miRNA, copy number, and mutations converted to RangedSummarizedExperiment objects

Author(s)

L. Waldron

Examples

```
library(curatedTCGAData)
library(GenomeInfoDb)

accmae <-
  curatedTCGAData(diseaseCode = "ACC",
    assays = c("CNASNP", "Mutation", "miRNASeqGene", "GISTICT"),
    dry.run = FALSE)

## update genome annotation
rex <- accmae[["ACC_Mutation-20160128"]]

## Translate build to "hg19"
tgenome <- vapply(genome(rex), translateBuild, character(1L))
genome(rex) <- tgenome

accmae[["ACC_Mutation-20160128"]] <- rex

simplifyTCGA(accmae)
```

 TCGAbarcodes

Parse data from TCGA barcode

Description

This function returns the specified snippet of information obtained from the TCGA barcode.

Usage

```
TCGAbarcodes(barcode, participant = TRUE, sample = FALSE,
             portion = FALSE, plate = FALSE, center = FALSE, index = NULL)
```

Arguments

barcode	A character vector of TCGA barcodes
participant	Logical (default TRUE) participant identifier chunk
sample	Logical (default FALSE) includes the numeric sample code of the barcode and the vial letter
portion	Logical (default FALSE) includes the portion and analyte codes of the barcode
plate	Logical (default FALSE) returns the plate value
center	Logical (default FALSE) returns a matrix with the plate and center codes
index	A numerical vector of TCGA barcode positions desired when split by the delimiter (i.e., hyphen '-')

Value

A character vector or data matrix of TCGA barcode information

Author(s)

M. Ramos

Examples

```
barcode <- c("TCGA-B0-5117-11A-01D-1421-08",
            "TCGA-B0-5094-11A-01D-1421-08",
            "TCGA-E9-A295-10A-01D-A16D-09")

## Patient identifiers
TCGAbarcodes(barcode)

## Sample identifiers
TCGAbarcodes(barcode, sample = TRUE)
```

 TCGAbiospec

Extract biospecimen data from the TCGA barcode

Description

This function uses the full TCGA barcode to return a data frame of the data pertinent to laboratory variables such as vials, portions, analytes, plates and the center.

Usage

```
TCGAbiospec(barcodes)
```

Arguments

barcodes A character vector of TCGA barcodes

Value

A dataframe with sample type, sample code, portion, plate, and center columns.

Author(s)

M. Ramos

Examples

```
example("TCGAbarcode")
TCGAbiospec(barcodes)
```

 TCGAsampleSelect

Select samples from barcodes from lookup table

Description

The TCGA barcode contains several pieces of information which can be parsed by the [TCGAbarcode](#) function. To select a specific type of sample, enter the appropriate sampleCode argument from the lookup table. See lookup table in `data("sampleTypes")`. Barcode inputs can be a character vector or a [CharacterList](#) object.

Usage

```
TCGAsampleSelect(barcodes, sampleCodes)
```

Arguments

barcodes Either a TCGA barcode vector or [CharacterList](#) containing patient identifiers, sample, portion, plate, and center codes.

sampleCodes Either a character or numeric vector of TCGA sample codes. See the sampleType dataset.

Value

A logical vector or [LogicalList](#) of the same length as 'barcodes' indicating sample type matches

Examples

```
example("TCGAbarcodes")
TCGAsampleSelect(barcodes, c(11, 01))
```

translateBuild	<i>Utilities for working with build numbers</i>
----------------	---

Description

A few functions are available to search for build versions, either from NCBI or UCSC.

- `translateBuild`: translates between UCSC and NCBI build versions
- `extractBuild`: use grep patterns to find the first build within the string input
- `uniformBuilds`: replace build occurrences below a threshold level of occurrence with the alternative build

Usage

```
translateBuild(from, to = "UCSC")

extractBuild(string, build = c("UCSC", "NCBI"))

uniformBuilds(builds, cutoff = 0.2)
```

Arguments

<code>from</code>	A build version name
<code>to</code>	The name of the desired version
<code>string</code>	A single character string
<code>build</code>	A vector of build version names (default UCSC, NCBI)
<code>builds</code>	A character vector of builds
<code>cutoff</code>	A threshold value for translating builds below the threshold

Examples

```
translateBuild("GRCh35", "UCSC")

extractBuild(
  "SCENA_p_TCGAb29and30_SNP_N_GenomeWideSNP_6_G05_569110.nocnv_grch38.seg.txt"
)

buildvec <- rep(c("GRCh37", "hg19"), times = c(5, 1))
uniformBuilds(buildvec)
```

trimColData	<i>Minimize the number of variables in colData</i>
-------------	--

Description

This function removes variables that have a high number of missing data and contain keywords.

Usage

```
trimColData(multiassayexperiment, maxNAfrac = 0.2,  
            keystring = c("portion", "analyte"))
```

Arguments

multiassayexperiment	A MultiAssayExperiment object with colData
maxNAfrac	(numeric default 0.2) A decimal between 0 and 1 to indicate the amount of NA values allowed per column
keystring	(character) A vector of keywords to match and remove variables

Value

A [MultiAssayExperiment](#) object

Examples

```
library(curatedTCGAData)  
  
gbm <- curatedTCGAData("GBM", "CNASNP", FALSE)  
(gbm_trimmed <- trimColData(gbm))  
head(colData(gbm_trimmed))[1:5]
```

Index

- *Topic **datasets**
 - clinicalNames, 3
 - diseaseCodes, 4
 - sampleTypes, 14
- barcodeToUUID (ID-translation), 7
- CharacterList, 3, 17
- clinicalNames, 3
- CpGtoRanges (simplifyTCGA), 14
- curatedTCGAData-helpers, 3
- DataFrame, 10
- diseaseCodes, 4
- extractBuild (translateBuild), 18
- filenameToBarcode (ID-translation), 7
- findGRangesCols, 5
- FirehoseGISTIC-class, 12
- generateMap, 6
- getClinicalNames
 - (curatedTCGAData-helpers), 3
- getFileName, 7
- getFirehoseData, 3, 7
- getSubtypeMap
 - (curatedTCGAData-helpers), 3
- GRanges, 15
- GRangesList, 2, 10–12
- ID-translation, 7
- imputeAssay, 9
- LogicalList, 18
- makeGRangesListFromCopyNumber, 10
- makeGRangesListFromDataFrame, 10
- makeGRangesListFromExonFiles, 11
- makeSummarizedExperimentFromGISTIC, 12
- mergeColData, 13
- mirToRanges (simplifyTCGA), 14
- MultiAssayExperiment, 2, 4, 13, 15, 19
- qreduceTCGA (simplifyTCGA), 14
- RaggedExperiment, 14
- RangedSummarizedExperiment, 14, 15
- sampleTables (curatedTCGAData-helpers), 3
- sampleTypes, 14
- simplifyTCGA, 14
- splitAssays (curatedTCGAData-helpers), 3
- SummarizedExperiment, 2, 12, 15
- symbolsToRanges (simplifyTCGA), 14
- TCGAbarcodes, 16, 17
- TCGAbiospec, 17
- TCGAsampleSelect, 17
- TCGAutils (TCGAutils-package), 2
- TCGAutils-package, 2
- translateBuild, 18
- trimColData, 19
- uniformBuilds (translateBuild), 18
- UUIDtoBarcode (ID-translation), 7
- UUIDtoUUID (ID-translation), 7