

Package ‘MSA2dist’

January 24, 2026

Type Package

Title MSA2dist calculates pairwise distances between all sequences of a DNASTringSet or a AAStringSet using a custom score matrix and conducts codon based analysis

Version 1.15.0

Description MSA2dist calculates pairwise distances between all sequences of a DNASTringSet or a AAStringSet using a custom score matrix and conducts codon based analysis. It uses scoring matrices to be used in these pairwise distance calculations which can be adapted to any scoring for DNA or AA characters. E.g. by using literal distances MSA2dist calculates pairwise IUPAC distances. DNASTringSet alignments can be analysed as codon alignments to look for synonymous and nonsynonymous substitutions (dN/dS) in a parallelised fashion using a variety of substitution models. Non-aligned coding sequences can be directly used to construct pairwise codon alignments (global/local) and calculate dN/dS without any external dependencies.

License GPL-3 + file LICENSE

Encoding UTF-8

LazyData false

biocViews Alignment, Sequencing, Genetics, GO

Depends R (>= 4.4.0)

Imports Rcpp, Biostrings, GenomicRanges, IRanges, ape, doParallel, dplyr, foreach, methods, parallel, pwalgn, rlang, seqinr, stats, stringi, stringr, tibble, tidyr, utils

Suggests rmarkdown, knitr, devtools, testthat, ggplot2, BiocStyle

LinkingTo Rcpp, RcppThread

VignetteBuilder knitr

NeedsCompilation yes

SystemRequirements C++11

URL <https://gitlab.gwdg.de/mpievolbio-it/MSA2dist>,
<https://mpievolbio-it.pages.gwdg.de/MSA2dist/>

BugReports <https://gitlab.gwdg.de/mpievolbio-it/MSA2dist/issues>

RoxygenNote 7.3.1

git_url <https://git.bioconductor.org/packages/MSA2dist>

git_branch devel

git_last_commit 662eead

git_last_commit_date 2025-10-29

Repository Bioconductor 3.23

Date/Publication 2026-01-23

Author Kristian K Ullrich [aut, cre] (ORCID:
<<https://orcid.org/0000-0003-4308-9626>>)

Maintainer Kristian K Ullrich <ullrich@evolbio.mpg.de>

Contents

aa2selfscore	3
aabin2aastring	4
AAMatrix-data	5
aastring2aabin	5
aastring2aln	6
aastring2dist	7
addmask2string	8
addpop2string	9
addpos2string	11
addregion2string	12
aln2aastring	13
aln2dnastring	14
cds2aa	15
cds2codonaln	16
cdsstring2codonaln	17
codon2numberAMBIG	19
codon2numberTCAG	19
codonmat2pnps	20
codonmat2xy	21
compareCodons	23
dnabin2dnastring	24
dnastring2aln	24
dnastring2codonmat	25
dnastring2dist	26
dnastring2dnabin	28
dnastring2kaks	29
GENETIC_CODE_TCAG	31
getmask	32
getpos	33
globalDeletion	34
globalDeletionAA	34

granthamMatrix	35
hiv-data	36
indices2kaks	36
iupac-data	39
iupacMatrix	39
makePostalignedSeqs	40
pal2nal	41
popinteger	42
popnames	43
rcpp_distSTRING	44
rcpp_KaKs	44
rcpp_pairwiseDeletionAA	45
rcpp_pairwiseDeletionDNA	46
region	47
regionused	48
string2region	49
subString	50
uptriidx	51
Index	52

aa2selfscore	<i>aa2selfscore</i>
--------------	---------------------

Description

This function return the selfscore from an AAStringSet.

Usage

```
aa2selfscore(aa, scorematrix = "BLOSUM62")
```

Arguments

aa	AAStringSet [mandatory]
scorematrix	score matrix to use [default: BLOSUM62]

Value

data.frame

Author(s)

Kristian K Ullrich

See Also

[XStringSet-class](#), [substitution_matrices](#)

Examples

```
data(woodmouse, package="ape")
#cds2aa(dnabin2dnastring(woodmouse), shorten=TRUE,
#genetic.code=Biostrings::getGeneticCode("2"))
woodmouse |> dnabin2dnastring() |> cds2aa(shorten=TRUE,
genetic.code=Biostrings::getGeneticCode("2")) |> aa2selfscore()
```

aabin2aastring	<i>aabin2aastring</i>
----------------	-----------------------

Description

This function converts an ape AAbin into AAStringSet.

Usage

```
aabin2aastring(aabin)
```

Arguments

aabin	ape AAbin [mandatory]
-------	-----------------------

Value

An object of class AAStringSet

Author(s)

Kristian K Ullrich

See Also

[as.alignment](#) [as.DNAbin.alignment](#) [AAStringSet](#)

Examples

```
data(woodmouse, package="ape")
## convert into AAStringSet
#aabin2aastring(ape::trans(woodmouse, 2))
ape::trans(woodmouse, 2) |> aabin2aastring()
```

`AAMatrix-data`*AAMatrix-data*

Description

`getAAMatrix()` from the alakazam package.

Usage

```
data(AAMatrix)
```

Format

an object of class `matrix`

Value

score matrix

References

Gupta N, Vander Heiden J, Uduman M, Gadala-Maria D, Yaari G, Kleinstein S (2015) Change-O: a toolkit for analyzing large-scale B cell immunoglobulin repertoire sequencing data. *Bioinformatics*. **31(20)**, 3356-3358.

Examples

```
data("AAMatrix", package="MSA2dist")
```

`aastring2aabin`*aastring2aabin*

Description

This function converts an `AAStringSet` into an ape `AAbin`.

Usage

```
aastring2aabin(aa)
```

Arguments

`aa` `AAStringSet` [mandatory]

Value

An object of class `AAbin`

Author(s)

Kristian K Ullrich

See Also[as.alignment](#) [as.DNABin.alignment](#)**Examples**

```
## define two cds sequences
cds1 <- Biostrings::DNAString("ATGCAACATTGC")
cds2 <- Biostrings::DNAString("ATG---CATTGC")
cds1.cds2.aln <- c(Biostrings::DNAStringSet(cds1),
  Biostrings::DNAStringSet(cds2))
## convert into AAbin
#aastring2aabin(cds2aa(cds1.cds2.aln))
cds1.cds2.aln |> cds2aa() |> aastring2aabin()
```

aastring2aln

*aastring2aln***Description**

This function converts a AAStringSet into an seqinr alignment.

Usage

```
aastring2aln(aa)
```

Arguments

aa AAStringSet [mandatory]

Value

An object of class alignment which is a list with the following components:

- nb the number of aligned sequences
- nam a vector of strings containing the names of the aligned sequences
- seq a vector of strings containing the aligned sequences
- com a vector of strings containing the commentaries for each sequence or NA if there are no comments

Author(s)

Kristian K Ullrich

See Also[as.alignment](#)

Examples

```
## define two cds sequences
cds1 <- Biostrings::DNAString("ATGCAACATTGC")
cds2 <- Biostrings::DNAString("ATG---CATTGC")
cds1.cds2.aln <- c(Biostrings::DNAStringSet(cds1),
  Biostrings::DNAStringSet(cds2))
#aastring2aln(cds2aa(cds1.cds2.aln))
cds1.cds2.aln |> cds2aa() |> aastring2aln()
```

aastring2dist

*aastring2dist***Description**

This function calculates pairwise distances for all combinations of a AAStringSet.

Usage

```
aastring2dist(
  aa,
  threads = 1,
  symmetric = TRUE,
  score = NULL,
  mask = NULL,
  region = NULL
)
```

Arguments

aa	AAStringSet [mandatory]
threads	number of parallel threads [default: 1]
symmetric	symmetric score matrix [default: TRUE]
score	score matrix use a score matrix to calculate distances [mandatory]
mask	IRanges object indicating masked sites [default: NULL]
region	IRanges object indicating region to use for dist calculation (by default all sites are used) [default: NULL]

Value

A data.frame of pairwise distance values distSTRING, sites used sitesUsed and region used regionUsed

Author(s)

Kristian K Ullrich

See Also[dnastring2dist](#)**Examples**

```
## load example sequence data
data("hiv", package="MSA2dist")
#astring2dist(cds2aa(hiv), score=granthamMatrix())
hiv |> cds2aa() |> astring2dist(score=granthamMatrix())
## create mask
mask1 <- IRanges::IRanges(start=c(11,41,71), end=c(20,50,80))
## use mask
hiv |> cds2aa() |> astring2dist(score=granthamMatrix(), mask=mask1)
## use region
region1 <- IRanges::IRanges(start=c(1,75), end=c(45,85))
hiv |> cds2aa() |> astring2dist(score=granthamMatrix(), region=region1)
## use mask and region
hiv |> cds2aa() |> astring2dist(score=granthamMatrix(),
  mask=mask1, region=region1)
## use asymmetric score matrix
myscore <- granthamMatrix()
myscore[5, 6] <- 0
h <- hiv |> cds2aa() |> astring2dist(score=myscore, symmetric=FALSE)
h$distSTRING[1:2, 1:2]
```

addmask2string*addmask2string*

Description

This function adds mask information as an IRanges object, START and END information, to a DNASTringSet or an AAStringSet and puts them into the metadata information. This information can be used to restrict the distance calculation to specific regions of the DNASTringSet or the AAStringSet.

Usage

```
addmask2string(seq, mask = NULL, append = TRUE)
```

Arguments

seq	DNASTringSet or AAStringSet [mandatory]
mask	IRanges object [mandatory]
append	indicate if mask should be appended or overwritten [default: TRUE]

Value

An object of class DNASTringSet or AAStringSet

Author(s)

Kristian K Ullrich

See Also[addregion2string](#), [addpop2string](#), [addpos2string](#)**Examples**

```
## load example sequence data
data(iupac, package="MSA2dist")
iupac.aa <- iupac |> cds2aa(shorten = TRUE)
## create mask
mask1 <- IRanges::IRanges(start=c(1,41), end=c(20,50))
## add mask
iupac.aa <- iupac.aa |> addmask2string(mask=mask1)
#(iupac.aa |> slot("metadata"))$mask
iupac.aa |> getmask()
## append mask
mask2 <- IRanges::IRanges(start=c(21), end=c(30))
iupac.aa <- iupac.aa |> addmask2string(mask=mask2)
#(iupac.aa |> slot("metadata"))$mask
iupac.aa |> getmask()
## overwrite mask
iupac.aa <- iupac.aa |> addmask2string(mask=mask2, append=FALSE)
#(iupac.aa |> slot("metadata"))$mask
iupac.aa |> getmask()
## reduce by mask
#iupac.aa.region <- iupac.aa |> string2region(mask=
#   (iupac.aa |> slot("metadata"))$mask)
iupac.aa.region <- iupac.aa |> string2region(mask=
  getmask(iupac.aa))
#iupac.aa.region |> slot("metadata")
iupac.aa.region |> getmask()
```

addpop2string

addpop2string

Description

This function adds population information to a DNASTringSet or an AASTringSet and puts them into the metadata information.

__Note__: All unassigned sequences will be put into pop "unassigned"!

Do not use "unassigned" as a population name!

__Note__: Names in a population in the poplist must match sequence names!

__Note__: Duplicated assignments are allowed!

Usage

```
addpop2string(seq, poplist)
```

Arguments

seq	DNAStrngSet or AAStringSet [mandatory]
poplist	named list of populations either as index or names per population (do not mix index and names in one population) [mandatory]

Value

An object of class DNAStrngSet or AAStringSet

Author(s)

Kristian K Ullrich

See Also

[addmask2string](#), [addregion2string](#), [addpos2string](#)

Examples

```
## load example sequence data
data(iupac, package="MSA2dist")
iupac.aa <- iupac |> cds2aa(shorten = TRUE)
## create poplist
poplist <- list(FRA = grep("Mmd.FRA", names(iupac)),
  GER = grep("Mmd.GER", names(iupac)),
  IRA = grep("Mmd.IRA", names(iupac)),
  AFG = grep("Mmm.AFG", names(iupac)))
iupac.aa <- iupac.aa |> addpop2string(poplist)
#(iupac.aa |> slot("metadata"))$pop.integer
iupac.aa |> popinteger()
#(iupac.aa |> slot("metadata"))$pop.names
iupac.aa |> popnames()
## mixing index and names
poplist <- list(FRA = names(iupac)[grep("Mmd.FRA", names(iupac))],
  GER = grep("Mmd.GER", names(iupac)),
  IRA = names(iupac)[grep("Mmd.IRA", names(iupac))],
  AFG = grep("Mmm.AFG", names(iupac)))
iupac.aa <- iupac.aa |> addpop2string(poplist)
iupac.aa |> popinteger()
iupac.aa |> popnames()
## leaving out some sequences which will be assigned as "unassigned"
poplist <- list(FRA = names(iupac)[grep("Mmd.FRA", names(iupac))],
  GER = grep("Mmd.GER", names(iupac)),
  IRA = names(iupac)[grep("Mmd.IRA", names(iupac))])
iupac.aa <- iupac.aa |> addpop2string(poplist)
iupac.aa |> popinteger()
iupac.aa |> popnames()
```

addpos2string	<i>addpos2string</i>
---------------	----------------------

Description

This function adds GenomicRanges information, CHROM, START and END to a DNASTringSet or an AAStringSet and puts them into the metadata information. This information can be used to find overlaps with a chromosome wide mask.

Usage

```
addpos2string(seq, chrom = NULL, start = NULL, end = NULL)
```

Arguments

seq	DNASTringSet or AAStringSet [mandatory]
chrom	chromosome name [mandatory]
start	start position [mandatory]
end	end position [mandatory]

Value

An object of class DNASTringSet or AAStringSet

Author(s)

Kristian K Ullrich

See Also

[addmask2string](#), [addregion2string](#), [addpop2string](#)

Examples

```
## load example sequence data
data(iupac, package="MSA2dist")
## add position
iupac <- iupac |> addpos2string(chrom="chr1", start=1, end=1000)
#(iupac |> slot("metadata"))$GRanges
iupac |> getpos()
```

addregion2string	<i>addregion2string</i>
------------------	-------------------------

Description

This function adds region information as an IRanges object, START and END information, to a DNASTringSet or an AAStringSet and puts them into the metadata information. This information can be used to restrict the distance calculation to specific regions of the DNASTringSet or the AAStringSet.

Usage

```
addregion2string(seq, region = NULL, append = TRUE)
```

Arguments

seq	DNASTringSet or AAStringSet [mandatory]
region	IRanges object [mandatory]
append	indicate if region should be appended or overwritten [default: TRUE]

Value

An object of class DNASTringSet or AAStringSet

Author(s)

Kristian K Ullrich

See Also

[addmask2string](#), [addpop2string](#), [addpos2string](#)

Examples

```
## load example sequence data
data(iupac, package="MSA2dist")
iupac.aa <- iupac |> cds2aa(shorten = TRUE)
## create region
region1 <- IRanges::IRanges(start=c(1,41), end=c(20,50))
## add region
iupac.aa <- iupac.aa |> addregion2string(region=region1)
#(iupac.aa |> slot("metadata"))$region
iupac.aa |> region()
## append region
region2 <- IRanges::IRanges(start=c(21), end=c(30))
iupac.aa <- iupac.aa |> addregion2string(region=region2)
#(iupac.aa |> slot("metadata"))$region
iupac.aa |> region()
```

```
## overwrite region
iupac.aa <- iupac.aa |> addregion2string(region=region2, append=FALSE)
#(iupac.aa |> slot("metadata"))$region
iupac.aa |> region()
## reduce by region
#iupac.aa.region <- iupac.aa |> string2region(region=
#   (iupac.aa |> slot("metadata"))$region)
iupac.aa.region <- iupac.aa |> string2region(region=
  region(iupac.aa))
#iupac.aa.region |> slot("metadata")
iupac.aa.region |> region()
```

aln2aastring

aln2aastring

Description

This function converts a seqinr alignment into an AAStringSet.

Usage

```
aln2aastring(aln)
```

Arguments

aln seqinr alignment [mandatory]

Value

An object of class AAStringSet

Author(s)

Kristian K Ullrich

See Also

[as.alignment AAStringSet](#)

Examples

```
## define two cds sequences
cds1 <- Biostrings::DNAString("ATGCAACATTGC")
cds2 <- Biostrings::DNAString("ATG---CATTGC")
cds1.cds2.aln <- c(Biostrings::DNAStringSet(cds1),
  Biostrings::DNAStringSet(cds2))
#aastring2aln(cds2aa(cds1.cds2.aln))
cds1.cds2.aln |> cds2aa() |> aastring2aln() |> aln2aastring()
```

aln2dnastring	<i>aln2dnastring</i>
---------------	----------------------

Description

This function converts a seqinr alignment into an DNASTringSet.

Usage

```
aln2dnastring(aln)
```

Arguments

aln seqinr alignment [mandatory]

Value

An object of class DNASTringSet

Author(s)

Kristian K Ullrich

See Also

[as.alignment DNASTringSet](#)

Examples

```
## define two cds sequences
cds1 <- Biostrings::DNASTring("ATGCAACATTGC")
cds2 <- Biostrings::DNASTring("ATG---CATTGC")
cds1.cds2.aln <- c(Biostrings::DNASTringSet(cds1),
  Biostrings::DNASTringSet(cds2))
## convert into alignment
#dnastring2aln(cds1.cds2.aln)
cds1.cds2.aln |> dnastring2aln()
## convert back into DNASTringSet
#aln2dnastring(dnastring2aln(cds1.cds2.aln))
cds1.cds2.aln |> dnastring2aln() |> aln2dnastring()
```

`cds2aa`*cds2aa*

Description

This function translates a `DNASet` into an `AASet`.

Usage

```
cds2aa(  
  cds,  
  shorten = FALSE,  
  frame = 1,  
  framelist = NULL,  
  genetic.code = NULL,  
  return.cds = FALSE  
)
```

Arguments

<code>cds</code>	<code>DNASet</code> [mandatory]
<code>shorten</code>	shorten all sequences to multiple of three [default: FALSE]
<code>frame</code>	indicates the first base of a the first codon [default: 1]
<code>framelist</code>	supply vector of frames for each entry [default: NULL]
<code>genetic.code</code>	The genetic code to use for the translation of codons into Amino Acid letters [default: NULL]
<code>return.cds</code>	return shorten cds instead of aa [default: FALSE]

Value

`AASet`

Author(s)

Kristian K Ullrich

See Also

[XSet-class](#), [translate](#)

Examples

```
## define two cds sequences  
cds1 <- Biostrings::DNAString("ATGCAACATTGC")  
cds2 <- Biostrings::DNAString("ATG---CATTGC")  
cds1.cds2.aln <- c(Biostrings::DNAStringSet(cds1),  
  Biostrings::DNAStringSet(cds2))
```

```
#cds2aa(cds1.cds2.aln)
cds1.cds2.aln |> cds2aa()
## alternative genetic code
data(woodmouse, package="ape")
#cds2aa(dnabin2dnastring(woodmouse), shorten=TRUE)
woodmouse |> dnabin2dnastring() |> cds2aa(shorten=TRUE)
#cds2aa(dnabin2dnastring(woodmouse), shorten=TRUE,
#genetic.code=Biostrings::getGeneticCode("2"))
woodmouse |> dnabin2dnastring() |> cds2aa(shorten=TRUE,
genetic.code=Biostrings::getGeneticCode("2"))
woodmouse |> dnabin2dnastring() |> cds2aa(shorten=TRUE, return.cds=TRUE) |>
cds2aa(genetic.code=Biostrings::getGeneticCode("2"))
```

cds2codonaln

cds2codonaln

Description

This function takes two single sequence DNASTring's or two single sequence DNASTringSet's, converts them into aa, calculates a global alignment and converts this alignment back into a codon alignment.

Usage

```
cds2codonaln(
  cds1,
  cds2,
  type = "global",
  substitutionMatrix = "BLOSUM62",
  gapOpening = 10,
  gapExtension = 0.5,
  remove.gaps = FALSE,
  ...
)
```

Arguments

cds1	single sequence DNASTringSet or DNASTring [mandatory]
cds2	single sequence DNASTringSet or DNASTring [mandatory]
type	type of alignment (see pairwiseAlignment) [default: global]
substitutionMatrix	substitution matrix representing the fixed substitution scores for an alignment (see pairwiseAlignment) [default: BLOSUM62]
gapOpening	the cost for opening a gap in the alignment (see pairwiseAlignment) [default: 10]
gapExtension	the incremental cost incurred along the length of the gap in the alignment (see pairwiseAlignment) [default: 0.5]

`remove.gaps` specify if gaps in the codon alignment should be removed [default: FALSE]
`...` other cds2aa parameters

Value

codon alignment as `DNAStringSet`

Author(s)

Kristian K Ullrich

References

Pagès, H et al. (2014) Biostrings: Efficient manipulation of biological strings. *R package version, 2(0)*.

See Also

[pairwiseAlignment](#)

Examples

```
## define two cds sequences
cds1 <- Biostrings::DNAString("ATGCAACATTGC")
cds2 <- Biostrings::DNAString("ATGCATTGC")
cds2codonaln(cds1, cds2)
```

<code>cdsstring2codonaln</code>	<i>cdsstring2codonaln</i>
---------------------------------	---------------------------

Description

This function takes two sequences as `DNAStringSet`, and their corresponding `AAStringSet`, calculates a global alignment and converts this alignment back into a codon alignment.

Usage

```
cdsstring2codonaln(
  cds,
  aa,
  type = "global",
  substitutionMatrix = "BLOSUM62",
  gapOpening = 10,
  gapExtension = 0.5,
  remove.gaps = FALSE
)
```

Arguments

<code>cds</code>	two sequences DNASTringSet [mandatory]
<code>aa</code>	two sequences AAStringSet [mandatory]
<code>type</code>	type of alignment (see pairwiseAlignment) [default: global]
<code>substitutionMatrix</code>	substitution matrix representing the fixed substitution scores for an alignment (see pairwiseAlignment) [default: BLOSUM62]
<code>gapOpening</code>	the cost for opening a gap in the alignment (see pairwiseAlignment) [default: 10]
<code>gapExtension</code>	the incremental cost incurred along the length of the gap in the alignment (see pairwiseAlignment) [default: 0.5]
<code>remove.gaps</code>	specify if gaps in the codon alignment should be removed [default: FALSE]

Value

codon alignment as DNASTringSet

Author(s)

Kristian K Ullrich

References

Pagès, H et al. (2014) Biostrings: Efficient manipulation of biological strings. *R package version, 2(0)*.

See Also

[pairwiseAlignment](#)

Examples

```
## define two cds sequences
cds <- Biostrings::DNASTringSet(c("ATGCAACATTGC", "ATGCATTGC"))
names(cds) <- c("cds1", "cds2")
## get protein alignment
aa <- MSA2dist::cds2aa(cds)
cdsstring2codonaln(cds, aa)
```

codon2numberAMBIG	<i>codon2numberAMBIG</i>
-------------------	--------------------------

Description

This function converts a codon into a number, but accept N and -.

Usage

```
codon2numberAMBIG(codon)
```

Arguments

codon	[mandatory]
-------	-------------

Value

An object of class `numeric`

Author(s)

Kristian K Ullrich

See Also

[GENETIC_CODE](#)

Examples

```
#unlist(lapply(names(Biostrings::GENETIC_CODE), codon2numberAMBIG))
names(Biostrings::GENETIC_CODE) |> codon2numberAMBIG()
```

codon2numberTCAG	<i>codon2numberTCAG</i>
------------------	-------------------------

Description

This function converts a codon into a number.

Usage

```
codon2numberTCAG(codon)
```

Arguments

codon	[mandatory]
-------	-------------

Value

An object of class `numeric`

Author(s)

Kristian K Ullrich

See Also

[GENETIC_CODE](#)

Examples

```
#unlist(lapply(names(Biostrings::GENETIC_CODE), codon2numberTCAG))
names(Biostrings::GENETIC_CODE) |> codon2numberTCAG()
```

codonmat2pnps

codonmat2pnps

Description

This function calculates pn/ps according to *Nei and Gojobori (1986)*.

Usage

```
codonmat2pnps(codonmat)
```

Arguments

codonmat codon matrix of two columns to be compared [mandatory]

Value

An object of class `pnps` which is a list with the following components:

```
seq1 sequence1 name
seq2 sequence2 name
Codons sequence2 name
Compared sequence2 name
Ambiguous sequence2 name
Indels sequence2 name
Ns sequence2 name
Sd sequence2 name
Sn sequence2 name
S sequence2 name
N sequence2 name
ps sequence2 name
pn sequence2 name
pnps sequence2 name
```

ds sequence2 name
 dn sequence2 name
 dnds sequence2 name

Author(s)

Kristian K Ullrich

References

Nei and Gojobori. (1986) Simple methods for estimating the numbers of synonymous and nonsynonymous nucleotide substitutions. *Mol. Biol. Evol.*, **3**(5), 418-426.

Ganeshan et al. (1997) Human immunodeficiency virus type 1 genetic evolution in children with different rates of development of disease. *J. Virology*. **71**(1), 663-677.

Yang et al. (2000) Codon-substitution models for heterogeneous selection pressure at amino acid sites. *Genetics*. **155**(1), 431-449.

See Also

[kaks](#)

Examples

```
## load example sequence data
data("hiv", package="MSA2dist")
#codonmat2pnps(dnastring2codonmat(hiv)[,c(1, 2)])
(hiv |> dnastring2codonmat())[,c(1, 2)] |> codonmat2pnps()
```

codonmat2xy

codonmat2xy

Description

This function calculates average behavior of each codon for all pairwise comparisons for indels, syn, and nonsyn mutations according to *Nei and Gojobori (1986)*.

Usage

```
codonmat2xy(codonmat, threads = 1)
```

Arguments

codonmat	codon matrix obtained via dnastring2codonmat [mandatory]
threads	number of parallel threads [default: 1]

Value

A data.frame object with the following components:

- Codon Codon index
- n number of comparison
- SynSum Sum of syn
- NonSynSum Sum of nonsyn
- IndelSum Sum of indels
- SynMean average syn per codon
- NonSynMean average nonsyn per codon
- IndelMean average indels per codon
- CumSumSynMean cumulative average syn per codon
- CumSumNonSynMean cumulative average nonsyn per codon
- CumSumIndelMean cumulative indels per codon

Author(s)

Kristian K Ullrich

References

Nei and Gojobori. (1986) Simple methods for estimating the numbers of synonymous and nonsynonymous nucleotide substitutions. *Mol. Biol. Evol.*, **3**(5), 418-426.

Ganeshan et al. (1997) Human immunodeficiency virus type 1 genetic evolution in children with different rates of development of disease. *J. Virology*. **71**(1), 663-677.

Yang et al. (2000) Codon-substitution models for heterogeneous selection pressure at amino acid sites. *Genetics*. **155**(1), 431-449.

See Also

[dnastring2codonmat](#) [codonmat2pnps](#) [dnastring2kaks](#) [kaks](#)

Examples

```
## load example sequence data
data("hiv", package="MSA2dist")
#codonmat2xy(dnastring2codonmat(hiv))
hiv |> dnastring2codonmat() |> codonmat2xy()
#codonmat2xy(dnastring2codonmat(hiv), threads=2)
hiv |> dnastring2codonmat() |> codonmat2xy(threads=2)
```

compareCodons	<i>compareCodons</i>
---------------	----------------------

Description

This function compares two codons and returns the number of syn and non-syn sites according to *Nei and Gojobori (1986)*.

Usage

```
compareCodons(codA, codB)
```

Arguments

codA	codon A [mandatory]
codB	codon B [mandatory]

Value

vector of syn and non-syn sites

Author(s)

Kristian K Ullrich

References

Nei and Gojobori. (1986) Simple methods for estimating the numbers of synonymous and nonsynonymous nucleotide substitutions. *Mol. Biol. Evol.*, **3(5)**, 418-426.

Ganeshan et al. (1997) Human immunodeficiency virus type 1 genetic evolution in children with different rates of development of disease. *J. Virology*. **71(1)**, 663-677.

Yang et al. (2000) Codon-substitution models for heterogeneous selection pressure at amino acid sites. *Genetics*. **155(1)**, 431-449.

See Also

[kaks](#)

Examples

```
compareCodons("AAA", "TTA")
compareCodons("AAA", "TAT")
compareCodons("AAA", "ATT")
compareCodons("AAA", "TTT")
## load example sequence data
data("hiv", package="MSA2dist")
compareCodons(dnastring2codonmat(hiv)[1,1], dnastring2codonmat(hiv)[1,2])
```

dnabin2dnastring	<i>dnabin2dnastring</i>
------------------	-------------------------

Description

This function converts an ape DNABin into a DNASTringSet.

Usage

```
dnabin2dnastring(dnabin)
```

Arguments

dnabin ape DNABin [mandatory]

Value

An object of class DNASTringSet

Author(s)

Kristian K Ullrich

See Also

[as.alignment](#) [as.DNABin.alignment](#) [DNASTringSet](#)

Examples

```
data(woodmouse, package="ape")
## convert into DNASTringSet
#dnabin2dnastring(woodmouse)
woodmouse |> dnabin2dnastring()
```

dnastring2aln	<i>dnastring2aln</i>
---------------	----------------------

Description

This function converts a DNASTringSet into an seqinr alignment.

Usage

```
dnastring2aln(dna)
```


Arguments

dna DNASTringSet [mandatory]

Value

An object of class alignment which is a list with the following components:
 nb the number of aligned sequences
 nam a vector of strings containing the names of the aligned sequences
 seq a vector of strings containing the aligned sequences
 com a vector of strings containing the commentaries for each sequence or NA if there are no comments

Author(s)

Kristian K Ullrich

See Also

[as.alignment](#)

Examples

```
## define two cds sequences
cds1 <- Biostrings::DNASTring("ATGCAACATTGC")
cds2 <- Biostrings::DNASTring("ATG---CATTGC")
cds1.cds2.aln <- c(Biostrings::DNASTringSet(cds1),
  Biostrings::DNASTringSet(cds2))
## convert into alignment
#dnastring2aln(cds1.cds2.aln)
cds1.cds2.aln |> dnastring2aln()
```

dnastring2codonmat	<i>dnastring2codonmat</i>
--------------------	---------------------------

Description

This function converts a DNASTringSet into a codon matrix.

Usage

```
dnastring2codonmat(cds, shorten = FALSE, frame = 1, framelist = NULL)
```

Arguments

cds DNASTringSet [mandatory]
 shorten shorten all sequences to multiple of three [default: FALSE]
 frame indicates the first base of a the first codon [default: 1]
 framelist supply vector of frames for each entry [default: NULL]

Value

An object of class alignment which is a list with the following components:

- nb the number of aligned sequences
- nam a vector of strings containing the names of the aligned sequences
- seq a vector of strings containing the aligned sequences
- com a vector of strings containing the commentaries for each sequence or NA if there are no comments

Author(s)

Kristian K Ullrich

See Also

[as.alignment](#)

Examples

```
## define two cds sequences
cds1 <- Biostrings::DNAString("ATGCAACATTGC")
cds2 <- Biostrings::DNAString("ATG---CATTGC")
cds1.cds2.aln <- c(Biostrings::DNAStringSet(cds1),
  Biostrings::DNAStringSet(cds2))
## convert into alignment
#dnastring2codonmat(cds1.cds2.aln)
cds1.cds2.aln |> dnastring2codonmat()
## use frame 2 and shorten to circumvent multiple of three error
cds1 <- Biostrings::DNAString("-ATGCAACATTGC-")
cds2 <- Biostrings::DNAString("-ATG---CATTGC-")
cds1.cds2.aln <- c(Biostrings::DNAStringSet(cds1),
  Biostrings::DNAStringSet(cds2))
cds1.cds2.aln |> dnastring2codonmat(frame=2, shorten=TRUE)
```

dnastring2dist

dnastring2dist

Description

This function calculates pairwise distances for all combinations of a DNAStringSet.

Usage

```
dnastring2dist(
  dna,
  model = "IUPAC",
  threads = 1,
  symmetric = TRUE,
  score = NULL,
```

```

    mask = NULL,
    region = NULL,
    ...
)

```

Arguments

<code>dna</code>	DNAStrngSet [mandatory]
<code>model</code>	specify model either "IUPAC" or any model from <code>ape::dist.dna</code> [default: IUPAC]
<code>threads</code>	number of parallel threads [default: 1]
<code>symmetric</code>	symmetric score matrix [default: TRUE]
<code>score</code>	score matrix use score matrix to calculate distances [default: NULL]
<code>mask</code>	IRanges object indicating masked sites [default: NULL]
<code>region</code>	IRanges object indicating region to use for dist calculation. Default is null, meaning all sites are used [default: NULL]
<code>...</code>	other <code>ape::dist.dna</code> parameters (see dist.dna)

Value

A data.frame of pairwise distance values `distSTRING` and sites used `sitesUsed`

Author(s)

Kristian K Ullrich

See Also

[dist.dna](#)

Examples

```

## load example sequence data
data("hiv", package="MSA2dist")
#dnastring2dist(hiv, model="IUPAC")
hiv |> dnastring2dist(model="IUPAC")
#dnastring2dist(hiv, model="K80")
hiv |> dnastring2dist(model="K80")
data("woodmouse", package="ape")
#dnastring2dist(dnabin2dnastring(woodmouse), score=iupacMatrix())
woodmouse |> dnabin2dnastring() |> dnastring2dist()
#dnastring2dist(hiv, model = "IUPAC", threads = 2)
hiv |> dnastring2dist(model = "IUPAC", threads = 2)
## create mask
mask1 <- IRanges::IRanges(start=c(1,61,121), end=c(30,90,150))
## use mask
hiv |> dnastring2dist(model="IUPAC", mask=mask1)
## use region
region1 <- IRanges::IRanges(start=c(1,139), end=c(75,225))

```

```

hiv |> dnastring2dist(model="IUPAC", region=region1)
## use mask and region
hiv |> dnastring2dist(model="IUPAC", mask=mask1, region=region1)
## use asymmetric score matrix
myscore <- iupacMatrix()
myscore[1, 4] <- 0.5
(hiv |> dnastring2dist(score=myscore, symmetric=FALSE))$distSTRING[1:2, 1:2]

```

dnastring2dnabin	<i>dnastring2dnabin</i>
------------------	-------------------------

Description

This function converts a DNASTringSet into an ape DNABin.

Usage

```
dnastring2dnabin(dna)
```

Arguments

dna DNASTringSet [mandatory]

Value

An object of class DNABin

Author(s)

Kristian K Ullrich

See Also

[as.alignment as.DNABin.alignment](#)

Examples

```

## define two cds sequences
cds1 <- Biostrings::DNASTring("ATGCAACATTGC")
cds2 <- Biostrings::DNASTring("ATG---CATTGC")
cds1.cds2.aln <- c(Biostrings::DNASTringSet(cds1),
  Biostrings::DNASTringSet(cds2))
## convert into DNABin
#dnastring2dnabin(cds1.cds2.aln)
cds1.cds2.aln |> dnastring2dnabin()

```

dnastring2kaks	<i>dnastring2kaks</i>
----------------	-----------------------

Description

This function calculates Ka/Ks (pN/pS) for all combinations of a DNASTringSet. If the sequences in the DNASTringSet are not a multiple-sequence alignment, pairwise codon alignments can be calculated on the fly. Models used and implemented according to *Li (1993)* (using seqinr) or *Nei and Gojobori (1986)* (own implementation) or models from KaKs_Calculator2 ported to MSA2dist with Rcpp.

Usage

```
dnastring2kaks(
  cds,
  model = "Li",
  threads = 1,
  isMSA = TRUE,
  sgc = "1",
  verbose = FALSE,
  ...
)
```

Arguments

cds	DNASTringSet coding sequence alignment [mandatory]
model	specify codon model either "Li" or "NG86" or one of KaKs_Calculator2 model "NG", "LWL", "LPB", "MLWL", "MLPB", "GY", "YN", "MYN", "MS", "MA", "GNG", "GLWL", "GLPB", "GMLWL", "GMLPB", "GYN", "GMYN" [default: Li]
threads	number of parallel threads [default: 1]
isMSA	cds DNASTringSet represents MSA [default: TRUE]
sgc	standard genetic code (for KaKs Calculator models) [default: 1]
verbose	verbosity (for KaKs Calculator models) [default: FALSE]
...	other codon alignment parameters

Value

A data.frame of KaKs values

Author(s)

Kristian K Ullrich

References

- "MS/MA/GNG/GLWL/GLPB/GMLWL/GMLPB/GYN:" Wang et al. (2010) KaKs_Calculator 2.0: a toolkit incorporating gamma-series methods and sliding window strategies. *Genomics, proteomics & bioinformatics*. **8(1)**, 77-80.
- "Li/LWL:" Li et al. (1985) A new method for estimating synonymous and nonsynonymous rates of nucleotide substitution considering the relative likelihood of nucleotide and codon changes. *Mol. Biol. Evol.*, **2(2)**, 150-174.
- "Li/LPB:" Li (1993). Unbiased estimation of the rates of synonymous and nonsynonymous substitution. *Journal of molecular evolution*, 36(1), pp.96-99.
- "NG86/NG:" Nei and Gojobori. (1986) Simple methods for estimating the numbers of synonymous and nonsynonymous nucleotide substitutions. *Mol. Biol. Evol.*, **3(5)**, 418-426.
- "LPB:" Pamilo and Bianchi. (1993) Evolution of the Zfx and Zfy genes: Rates and interdependence between genes. *Mol. Biol. Evol.*, **10**, 271-281.
- "MLWL/MLPB:" Tzeng et al. (2004). Comparison of three methods for estimating rates of synonymous and nonsynonymous nucleotide substitutions. *Mol. Biol. Evol.*, **21(12)**, 2290-2298.
- "GY:" Goldman and Yang (1994). A codon-based model of nucleotide substitution for protein-coding DNA sequences. *Mol. Biol. Evol.*, **11(5)** 725-736.
- "YN:" Yang et al. (2000) Codon-substitution models for heterogeneous selection pressure at amino acid sites. *Genetics*. **155(1)**, 431-449.
- "MYN:" Zhang et al. (2006). Computing Ka and Ks with a consideration of unequal transitional substitutions. *BMC evolutionary biology*, **6(1)**, 1-10.
- "data(hiv):" Ganeshan et al. (1997) Human immunodeficiency virus type 1 genetic evolution in children with different rates of development of disease. *J. Virology*. **71(1)**, 663-677.
- Wang et al. (2009). gamma-MYN: a new algorithm for estimating Ka and Ks with consideration of variable substitution rates. *Biology Direct*, **4(1)**, 1-18.

See Also

[kaks](#)

Examples

```
## load example sequence data
data("hiv", package="MSA2dist")
#dnastring2kaks(hiv, model="Li")
hiv |> dnastring2kaks(model="Li")
#dnastring2kaks(hiv, model="NG86")
hiv |> dnastring2kaks(model="NG86")
#dnastring2kaks(hiv, model="NG86", threads=2)
hiv |> dnastring2kaks(model="NG86", threads=2)

## define three unaligned cds sequences
cds1 <- Biostrings::DNAString("ATGCAACATTGC")
cds2 <- Biostrings::DNAString("ATGCATTGC")
cds3 <- Biostrings::DNAString("ATGCAATGC")
cds_sequences <- Biostrings::DNAStringSet(list(cds1, cds2, cds3))
```

```
names(cds_sequences) <- c("cds1", "cds2", "cds3")
## set isMSA to FALSE to automatically create pairwise codon alignments
#dnastring2kaks(cds_sequences, model="Li", isMSA=FALSE)
cds_sequences |> dnastring2kaks(model="Li", isMSA=FALSE)
```

GENETIC_CODE_TCAG	<i>GENETIC_CODE_TCAG</i>
-------------------	--------------------------

Description

GENETIC_CODE from Biostrings extended by codon number and number of syn sites.

Usage

```
codon2number(codon)
```

Arguments

codon	codon [mandatory]
-------	-------------------

Value

An object of class `numeric`

Author(s)

Kristian K Ullrich

See Also

[GENETIC_CODE](#)

Examples

```
GENETIC_CODE_TCAG
```

getmask	<i>getmask</i>
---------	----------------

Description

This function shows the mask slot from a DNASTringSet or an AAStringSet metadata information.

Usage

```
getmask(seq)
```

Arguments

seq	DNASTringSet or AAStringSet [mandatory]
-----	---

Value

IRanges information from metadata

Author(s)

Kristian K Ullrich

See Also

[addpop2string](#)

Examples

```
## load example sequence data
data(iupac, package="MSA2dist")
iupac.aa <- iupac |> cds2aa(shorten = TRUE)
## create mask
mask1 <- IRanges::IRanges(start=c(1,41), end=c(20,50))
## add mask
iupac.aa <- iupac.aa |> addmask2string(mask=mask1)
#(iupac.aa |> slot("metadata"))$mask
iupac.aa |> getmask()
```

getpos	<i>getpos</i>
--------	---------------

Description

This function shows the position slot from a DNASTringSet or an AAStringSet metadata information.

Usage

```
getpos(seq)
```

Arguments

seq	DNASTringSet or AAStringSet [mandatory]
-----	---

Value

GenomicRanges information from metadata

Author(s)

Kristian K Ullrich

See Also

[addpop2string](#)

Examples

```
## load example sequence data
data(iupac, package="MSA2dist")
## add position
iupac <- iupac |> addpos2string(chrom="chr1", start=1, end=1000)
#(iupac |> slot("metadata"))$GRanges
iupac |> getpos()
```

globalDeletion	<i>globalDeletion</i>
----------------	-----------------------

Description

This function returns a DNASTringSet reduced by all sites containing any gaps ("-", "+", ".") or missing ("N") sites.

Usage

```
globalDeletion(dna)
```

Arguments

dna	DNASTringSet [mandatory]
-----	--------------------------

Value

DNASTringSet

Author(s)

Kristian K Ullrich

Examples

```
## define two cds sequences
cds1 <- Biostrings::DNASTring("ATGCAACATTGC")
cds2 <- Biostrings::DNASTring("ATG---CATTGC")
cds1.cds2.aln <- c(Biostrings::DNASTringSet(cds1),
  Biostrings::DNASTringSet(cds2))
globalDeletion(cds1.cds2.aln)
```

globalDeletionAA	<i>globalDeletionAA</i>
------------------	-------------------------

Description

This function returns an AAStringSet reduced by all sites containing any gaps ("-", "+", ".") or missing ("X") sites.

Usage

```
globalDeletionAA(aa)
```

Arguments

aa AAStringSet [mandatory]

Value

AAStringSet

Author(s)

Kristian K Ullrich

Examples

```
## define two cds sequences
cds1 <- Biostrings::DNAString("ATGCAACATTGC")
cds2 <- Biostrings::DNAString("ATG---CATTGC")
cds1.cds2.aln <- c(Biostrings::DNAStringSet(cds1),
  Biostrings::DNAStringSet(cds2))
#globalDeletionAA(cds2aa(cds1.cds2.aln))
cds1.cds2.aln |> cds2aa() |> globalDeletionAA()
```

granthamMatrix

granthamMatrix

Description

This function creates a `granthamMatrix` object to be used with the `rcpp_distSTRING` function. By default, the `grantham` matrix is defined as from Grantham 1974. (see <https://link.springer.com/article/10.1007/s00335-017-9704-9>)

Usage

```
granthamMatrix()
```

Value

matrix

Author(s)

Kristian K Ullrich

References

Grantham R. (1974). Amino Acid Difference Formula to Help Explain Protein Evolution. *Science*, **185**(4154), 862-864.

See Also

[aastring2dist,dist.dna](#)

Examples

```
granthamMatrix()
```

hiv-data	<i>hiv-data</i>
----------	-----------------

Description

Example cds sequences from HIV-1 sample 136 patient 1 from Sweden envelope glycoprotein (env) gene, V3 region as DNASTringSet.

Usage

```
data(hiv)
```

Format

an object of class DNASTringSet see [XStringSet-class](#)

References

Yang et al. (2000) Codon-substitution models for heterogeneous selection pressure at amino acid sites. *Genetics*. **155**(1), 431-449.

Examples

```
data("hiv", package="MSA2dist")
```

indices2kaks	<i>indices2kaks</i>
--------------	---------------------

Description

This function calculates Ka/Ks (pN/pS) for all combinations given in an indices list of a DNASTringSet. If the sequences in the DNASTringSet are not a multiple-sequence alignment, pairwise codon alignments can be calculated on the fly. Models used and implemented according to *Li (1993)* (using seqinr) or *Nei and Gojobori (1986)* (own implementation) or models from KaKs_Calculator2 ported to MSA2dist with Rcpp.

Usage

```
indices2kaks(
  cds,
  indices,
  model = "Li",
  threads = 1,
  isMSA = TRUE,
  sgc = "1",
  verbose = FALSE,
  ...
)
```

Arguments

cds	DNAStringSet coding sequence alignment [mandatory]
indices	list list of indices to calculate Ks/Ks [mandatory]
model	specify codon model either "Li" or "NG86" or one of KaKs_Calculator2 model "NG", "LWL", "LPB", "MLWL", "MLPB", "GY", "YN", "MYN", "MS", "MA", "GNG", "GLWL", "GLPB", "GMLWL", "GMLPB", "GYN", "GMYN" [default: Li]
threads	number of parallel threads [default: 1]
isMSA	cds DNAStringSet represents MSA [default: TRUE]
sgc	standard genetic code (for KaKs Calculator models) [default: 1]
verbose	verbosity (for KaKs Calculator models) [default: FALSE]
...	other codon alignment parameters

Value

A data.frame of KaKs values

Author(s)

Kristian K Ullrich

References

"MS/MA/GNG/GLWL/GLPB/GMLWL/GMLPB/GYN:" Wang et al. (2010) KaKs_Calculator 2.0: a toolkit incorporating gamma-series methods and sliding window strategies. *Genomics, proteomics & bioinformatics*. **8(1)**, 77-80.

"Li/LWL:" Li et al. (1985) A new method for estimating synonymous and nonsynonymous rates of nucleotide substitution considering the relative likelihood of nucleotide and codon changes. *Mol. Biol. Evol.*, **2(2)**, 150-174.

"Li/LPB:" Li (1993). Unbiased estimation of the rates of synonymous and nonsynonymous substitution. *Journal of molecular evolution*, 36(1), pp.96-99.

"NG86/NG:" Nei and Gojobori. (1986) Simple methods for estimating the numbers of synonymous and nonsynonymous nucleotide substitutions. *Mol. Biol. Evol.*, **3(5)**, 418-426.

"LPB:" Pamilo and Bianchi. (1993) Evolution of the Zfx and Zfy genes: Rates and interdependence between genes. *Mol. Biol. Evol.*, **10**, 271-281.

"MLWL/MLPB:" Tzeng et al. (2004). Comparison of three methods for estimating rates of synonymous and nonsynonymous nucleotide substitutions. *Mol. Biol. Evol.*, **21(12)**, 2290-2298.

"GY:" Goldman and Yang (1994). A codon-based model of nucleotide substitution for protein-coding DNA sequences. *Mol. Biol. Evol.*, **11(5)** 725-736.

"YN:" Yang et al. (2000) Codon-substitution models for heterogeneous selection pressure at amino acid sites. *Genetics*. **155(1)**, 431-449.

"MYN:" Zhang et al. (2006). Computing Ka and Ks with a consideration of unequal transitional substitutions. *BMC evolutionary biology*, **6(1)**, 1-10.

"data(hiv):" Ganeshan et al. (1997) Human immunodeficiency virus type 1 genetic evolution in children with different rates of development of disease. *J. Virology*. **71(1)**, 663-677.

Wang et al. (2009). gamma-MYN: a new algorithm for estimating Ka and Ks with consideration of variable substitution rates. *Biology Direct*, **4(1)**, 1-18.

See Also

[kaks](#)

Examples

```
## load example sequence data
data("hiv", package="MSA2dist")
## create indices
idx <- list(c(2, 3), c(5,7,9))
#indices2kaks(hiv, idx, model="Li")
hiv |> indices2kaks(idx, model="Li")
#indices2kaks(hiv, idx, model="NG86")
hiv |> indices2kaks(idx, model="NG86")
#indices2kaks(hiv, idx, model="NG86", threads=2)
hiv |> indices2kaks(idx, model="NG86", threads=2)

## define three unaligned cds sequences
cds1 <- Biostrings::DNAString("ATGCAACATTGC")
cds2 <- Biostrings::DNAString("ATGCATTGC")
cds3 <- Biostrings::DNAString("ATGCAATGC")
cds_sequences <- Biostrings::DNAStringSet(list(cds1, cds2, cds3))
names(cds_sequences) <- c("cds1", "cds2", "cds3")
## create indices
idx <- list(c(1, 2), c(1,3))
## set isMSA to FALSE to automatically create pairwise codon alignments
#indices2kaks(cds_sequences, idx, model="Li", isMSA=FALSE)
cds_sequences |> indices2kaks(idx, model="Li", isMSA=FALSE)
```

iupac-data

*iupac-data***Description**

Example IUPAC sequences created with angsd from different house mouse (*Mus musculus*) sub-populations from Harr et al. (2016) DNASTringSet.

Usage

```
data(iupac)
```

Format

an object of class DNASTringSet see [XStringSet-class](#)

References

Harr et al. (2016) Genomic resources for wild populations of the house mouse, *Mus musculus* and its close relative *Mus spretus*. *Scientific data*. **3**(1), 1-14.

Examples

```
data("iupac", package="MSA2dist")
```

iupacMatrix

*iupacMatrix***Description**

This function creates a *iupacMatrix* object to be used with the `rcpp_distSTRING` function. By default, the *iupac matrix* is defined as literal distance obtained from Chang et al. 2017. (see <https://link.springer.com/article/10.1007/s00335-017-9704-9>)

Usage

```
iupacMatrix()
```

Value

score matrix

Author(s)

Kristian K Ullrich

References

Chang,P. L.,Kopania,E.,Keeble,S.,Sarver,B. A.,Larson, E.,Orth,A,... & Dean,M. D. (2017). Whole exome sequencing of wild-derived inbred strains of mice improves power to link phenotype and genotype. *Mammalian genome*,**28(9-10)**,416-425.

See Also

[dnastring2dist,dist.dna](#)

Examples

```
iupacMatrix()
```

makePostalignedSeqs	<i>makePostalignedSeqs</i>
---------------------	----------------------------

Description

This function is a fork from an internal function from Biostrings

Usage

```
makePostalignedSeqs(x)
```

Arguments

x	x
---	---

Value

get internal function makePostalignedSeqs

Author(s)

Kristian K Ullrich

See Also

[pairwiseAlignment,cds2codonaln](#)

Examples

```
## define two cds sequences
cds1 <- Biostrings::DNAString("ATGCAACATTGC")
cds2 <- Biostrings::DNAString("ATGCATTGC")
makePostalignedSeqs(pwalign::pairwiseAlignment(
  cds2aa(Biostrings::DNAStringSet(cds1)),
  cds2aa(Biostrings::DNAStringSet(cds2))))
```

pal2nal	<i>pal2nal</i>
---------	----------------

Description

This function takes an `AAStringSet` alignment and its corresponding coding sequences `DNASTringSet` and converts the protein alignment into a codon alignment.

Usage

```
pal2nal(pal, nal, remove.gaps = FALSE)
```

Arguments

<code>pal</code>	<code>AAStringSet</code> [mandatory]
<code>nal</code>	<code>DNASTringSet</code> [mandatory]
<code>remove.gaps</code>	specify if gaps in the codon alignment should be removed [default: FALSE]

Value

codon alignment as `DNASTringSet`

Author(s)

Kristian K Ullrich

References

Pagès, H et al. (2014) Biostrings: Efficient manipulation of biological strings. *R package version, 2(0)*.

See Also

[pairwiseAlignment](#)

Examples

```
## define two cds sequences
cds <- Biostrings::DNASTringSet(c("ATGCAACATTGC", "ATGCATTGC"))
names(cds) <- c("cds1", "cds2")
## get protein alignment
aa <- MSA2dist::cds2aa(cds)
msa <- makePostalignedSeqs(pwalign::pairwiseAlignment(aa[1], aa[2]))[[1L]]
names(msa) <- names(aa)
## get codon alignment
nal <- MSA2dist::pal2nal(pal=msa, nal=cds)
nal
```

popinteger

popinteger

Description

This function shows the population integer slot from a DNASTringSet or an AAStringSet metadata information.

Usage

```
popinteger(seq)
```

Arguments

seq DNASTringSet or AAStringSet [mandatory]

Value

population integer from metadata

Author(s)

Kristian K Ullrich

See Also

[addpop2string](#)

Examples

```
## load example sequence data
data(iupac, package="MSA2dist")
iupac.aa <- iupac |> cds2aa(shorten = TRUE)
## create poplist
poplist <- list(FRA = grep("Mmd.FRA", names(iupac)),
               GER = grep("Mmd.GER", names(iupac)),
               IRA = grep("Mmd.IRA", names(iupac)),
               AFG = grep("Mmm.AFG", names(iupac)))
iupac.aa <- iupac.aa |> addpop2string(poplist)
popinteger(iupac.aa)
```

popnames	<i>popnames</i>
----------	-----------------

Description

This function shows the population names slot from a DNASTringSet or an AAStringSet metadata information.

Usage

```
popnames(seq)
```

Arguments

seq	DNASTringSet or AAStringSet [mandatory]
-----	---

Value

population names from metadata

Author(s)

Kristian K Ullrich

See Also

[addpop2string](#)

Examples

```
## load example sequence data
data(iupac, package="MSA2dist")
iupac.aa <- iupac |> cds2aa(shorten = TRUE)
## create poplist
poplist <- list(FRA = grep("Mmd.FRA", names(iupac)),
               GER = grep("Mmd.GER", names(iupac)),
               IRA = grep("Mmd.IRA", names(iupac)),
               AFG = grep("Mmm.AFG", names(iupac)))
iupac.aa <- iupac.aa |> addpop2string(poplist)
popnames(iupac.aa)
```

rcpp_distSTRING	<i>rcpp_distSTRING</i>
-----------------	------------------------

Description

calculates pairwise distances using a score matrix

Usage

```
rcpp_distSTRING(dnavector, scoreMatrix, ncores = 1L, symmetric = 1L)
```

Arguments

dnavector	StringVector [mandatory]
scoreMatrix	NumericMatrix [mandatory]
ncores	number of cores [default: 1]
symmetric	symmetric score matrix [default: 1]

Value

list

Author(s)

Kristian K Ullrich

Examples

```
## load example sequence data
data("hiv", package="MSA2dist")
rcpp_distSTRING(dnavector=as.character(hiv), scoreMatrix=iupacMatrix())
```

rcpp_KaKs	<i>rcpp_KaKs</i>
-----------	------------------

Description

calculates KaKs as implemented in KaKs Calculator 2.0 MSA2dist with Rcpp.

Usage

```
rcpp_KaKs(cdsstr, sgc = "1", method = "YN", verbose = FALSE)
```

Arguments

cdsstr	StringVector [mandatory]
sgc	standard genetic code to use [default: 1]
method	KaKs Calculator 2.0 codon model [default: YN]
verbose	specify if verbose output [default: FALSE]

Value

list

Author(s)

Kristian K Ullrich

References

Wang et al. (2010) KaKs_Calculator 2.0: a toolkit incorporating gamma-series methods and sliding window strategies. *Genomics, proteomics & bioinformatics*. **8(1)**, 77-80.

Examples

```
## load example sequence data
data("hiv", package="MSA2dist")
rcpp_KaKs(cdsstr=as.character(hiv[1:3]))
```

```
rcpp_pairwiseDeletionAA
      rcpp_pairwiseDeletionAA
```

Description

returns number of AA sites used

Usage

```
rcpp_pairwiseDeletionAA(aavector, ncores = 1L, symmetric = 1L)
```

Arguments

aavector	StringVector [mandatory]
ncores	number of cores [default: 1]
symmetric	symmetric score matrix [default: 1]

Value

list

Author(s)

Kristian K Ullrich

Examples

```
## load example sequence data
data("hiv", package="MSA2dist")
h <- hiv |> cds2aa() |> as.character()
rcpp_pairwiseDeletionAA(aavector=h, ncores=1)
```

```
rcpp_pairwiseDeletionDNA
```

```
rcpp_pairwiseDeletionDNA
```

Description

returns number of DNA sites used

Usage

```
rcpp_pairwiseDeletionDNA(dnavector, ncores = 1L, symmetric = 1L)
```

Arguments

dnavector	StringVector [mandatory]
ncores	number of cores [default: 1]
symmetric	symmetric score matrix [default: 1]

Value

list

Author(s)

Kristian K Ullrich

Examples

```
## load example sequence data
data("woodmouse", package="ape")
w <- woodmouse |> dnabin2dnastring() |> as.character()
rcpp_pairwiseDeletionDNA(dnavector=w, ncores=1)
```

region	<i>region</i>
--------	---------------

Description

This function shows the region slot from a DNASTringSet or an AAStringSet metadata information.

Usage

```
region(seq)
```

Arguments

seq	DNASTringSet or AAStringSet [mandatory]
-----	---

Value

region IRanges object from metadata

Author(s)

Kristian K Ullrich

See Also

[addpop2string](#)

Examples

```
## load example sequence data
data(iupac, package="MSA2dist")
iupac.aa <- iupac |> cds2aa(shorten = TRUE)
## create region
region1 <- IRanges::IRanges(start=c(1,41), end=c(20,50))
## add region
iupac.aa <- iupac.aa |> addregion2string(region=region1)
iupac.aa |> region()
```

regionused	<i>regionused</i>
------------	-------------------

Description

This function shows the region used slot from a DNASTringSet or an AAStringSet metadata information.

Usage

```
regionused(seq)
```

Arguments

seq	DNASTringSet or AAStringSet [mandatory]
-----	---

Value

population names from metadata

Author(s)

Kristian K Ullrich

See Also

[addpop2string](#)

Examples

```
## load example sequence data
data("hiv", package="MSA2dist")
## create mask
mask1 <- IRanges::IRanges(start=c(11,41,71), end=c(20,50,80))
## use mask
hiv.region <- hiv |> cds2aa() |> string2region(mask=mask1)
#(hiv.region |> slot("metadata"))$regionUsed
hiv.region |> regionused()
```

string2region	<i>string2region</i>
---------------	----------------------

Description

This function subsets a DNASTringSet or an AAStringSet by a mask and region given one or both options as IRanges.

Usage

```
string2region(seq, mask = NULL, region = NULL, add = TRUE)
```

Arguments

seq	DNASTringSet or AAStringSet [mandatory]
mask	IRanges object indicating masked sites [default: NULL]
region	IRanges object indicating region to use for dist calculation (by default all sites are used) [default: NULL]
add	indicate if mask and region should be added to metadata [default: TRUE]

Value

A list object with the following components:
 DNASTringSet or AAStringSet
 regionUsed

Author(s)

Kristian K Ullrich

See Also

[dnastring2dist](#)

Examples

```
## load example sequence data
data("hiv", package="MSA2dist")
## create mask
mask1 <- IRanges::IRanges(start=c(11,41,71), end=c(20,50,80))
## use mask
hiv.region <- hiv |> cds2aa() |> string2region(mask=mask1)
#(hiv.region |> slot("metadata"))$regionUsed
hiv.region |> regionused()
## use region
region1 <- IRanges::IRanges(start=c(1,75), end=c(45,85))
hiv.region <- hiv |> cds2aa() |> string2region(region=region1)
```

```

#(hiv.region |> slot("metadata"))$regionUsed
hiv.region |> regionused()
## use mask and region
hiv.region <- hiv |> cds2aa() |> string2region(mask=mask1, region=region1)
#(hiv.region |> slot("metadata"))$regionUsed
hiv.region |> regionused()

```

subString

subString

Description

This function gets a subsequence from a DNAString, RNAString, AAString, BString, DNAStringSet, RNAStringSet, AAStringSet, BStringSet object from the Biostrings package.

Usage

```
subString(x, s, e)
```

Arguments

x	DNAStringSet, RNAString, AAString, BString, DNAStringSet, RNAStringSet, AAStringSet, BStringSet [mandatory]
s	start vector [mandatory]
e	end vector [mandatory]

Value

subsequence of an Biostrings object

Author(s)

Kristian K Ullrich

See Also

[subseq](#)

Examples

```

## define two cds sequences
cds1 <- Biostrings::DNAString("ATGCAACATTGC")
cds2 <- Biostrings::DNAString("ATG---CATTGC")
cds1.cds2.aln <- c(Biostrings::DNAStringSet(cds1),
  Biostrings::DNAStringSet(cds2))
subString(cds1.cds2.aln, c(1,7), c(3,12))

```

uptriidx	<i>uptriidx</i>
----------	-----------------

Description

This function returns upper tri index for usage with `pivot_long` reduction.

Usage

```
uptriidx(n, diag = FALSE)
```

Arguments

n	dimension of initial matrix [mandatory]
diag	indicate if diag should be retained [default: FALSE]

Value

list of positions

Author(s)

Kristian K Ullrich

Examples

```
uptriidx(10)
```

Index

* datasets

- AAMatrix-data, 5
- hiv-data, 36
- iupac-data, 39

- aa2selfscore, 3
- aabin2aastring, 4
- AAMatrix (AAMatrix-data), 5
- AAMatrix-data, 5
- aastring2aabin, 5
- aastring2aln, 6
- aastring2dist, 7, 36
- AAStringSet, 4, 13
- addmask2string, 8, 10–12
- addpop2string, 9, 9, 11, 12, 32, 33, 42, 43, 47, 48
- addpos2string, 9, 10, 11, 12
- addregion2string, 9–11, 12
- aln2aastring, 13
- aln2dnastring, 14
- as.alignment, 4, 6, 13, 14, 24–26, 28
- as.DNABin.alignment, 4, 6, 24, 28

- cds2aa, 15
- cds2codonaln, 16, 40
- cdsstring2codonaln, 17
- codon2number (GENETIC_CODE_TCAG), 31
- codon2numberAMBIG, 19
- codon2numberTCAG, 19
- codonmat2pnps, 20, 22
- codonmat2xy, 21
- compareCodons, 23

- dist.dna, 27, 36, 40
- dnabin2dnastring, 24
- dnastring2aln, 24
- dnastring2codonmat, 21, 22, 25
- dnastring2dist, 8, 26, 40, 49
- dnastring2dnabin, 28
- dnastring2kaks, 22, 29

- DNABin, 14, 24

- GENETIC_CODE, 19, 20, 31
- GENETIC_CODE_TCAG, 31
- getmask, 32
- getpos, 33
- globalDeletion, 34
- globalDeletionAA, 34
- granthamMatrix, 35

- hiv (hiv-data), 36
- hiv-data, 36

- indices2kaks, 36
- iupac (iupac-data), 39
- iupac-data, 39
- iupacMatrix, 39

- kaks, 21–23, 30, 38

- makePostalignedSeqs, 40

- pairwiseAlignment, 16–18, 40, 41
- pal2nal, 41
- popinteger, 42
- popnames, 43

- rcpp_distSTRING, 44
- rcpp_KaKs, 44
- rcpp_pairwiseDeletionAA, 45
- rcpp_pairwiseDeletionDNA, 46
- region, 47
- regionused, 48

- string2region, 49
- subseq, 50
- substitution_matrices, 3
- subString, 50

- translate, 15

- uptriidx, 51