Package ‘tigre’
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Reconstruction of Expression
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Description The tigre package implements our methodology of Gaussian
process differential equation models for analysis of gene
expression time series from single input motif networks. The
package can be used for inferring unobserved transcription
factor (TF) protein concentrations from expression measurements
of known target genes, or for ranking candidate targets of a
TF.
License AGPL-3
URL https://github.com/ahonkela/tigre
BugReports https://github.com/ahonkela/tigre/issues
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R topics documented:

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This package implements the method of Gao et al. (2008) and Honkela et al. (2010) for Gaussian process modelling single input motif regulatory systems with time-series expression data. The method can be used to rank potential targets of transcription factors based on such data.

For details of using the package please refer to the Vignette.

Author(s)
Antti Honkela, Pei Gao, Jonatan Ropponen, Miika-Petteri Matikainen, Magnus Rattray, Neil D. Lawrence

Maintainer: Antti Honkela <antti.honkela@hiit.fi>
References


See Also

puma

Examples

```r
## Not run:
# Load a mmgmos preprocessed fragment of the Drosophila developmental
time series
data(drosophila_gpsim_fragment)

# Get the target probe names
library(annotate)
aliasMapping <- getAnnMap("ALIAS2PROBE",
annotation(drosophila_gpsim_fragment))
twi <- get("twi", env=aliasMapping)
fbgnMapping <- getAnnMap("FLYBASE2PROBE",
annotation(drosophila_gpsim_fragment))
targetProbe <- get("FBgn0035257", env=fbgnMapping)

# Learn the model
model <- GPLearn(drosophila_gpsim_fragment,
TF=twi, targets=targetProbe,
useGpdisim=TRUE, quiet=TRUE)

# Plot it
GPPlot(model, nameMapping=getAnnMap("FLYBASE",
annotation(drosophila_gpsim_fragment)))
## End(Not run)
```

drosophila_gpsim_fragment

Fragment of 12 time point Drosophila embryonic development microarray gene expression time series

Description

Four genes from the 12 time point Drosophila embryonic development Affymetrix microarray gene expression data set by Tomancak et al. (2002).

The data has been processed using mmgmos from puma package and processData.
**Usage**

```r
data(drosophila_gpsim_fragment)
```

**Format**

An `ExpressionTimeSeries` object with 3 repeats of the 12 time points for 4 probes.

**Source**


**References**


---

**Usage**

```r
data(drosophila_mmgmos_fragment)
```

**Format**

A `puma` package `exprReslt` object with 3 repeats of the 12 time points for 4 probes.

**Source**


**References**

**export.scores**

**Export results to an SQLite database**

**Description**

Exports the results to an SQLite database which can then be browsed with a result browser. The function will export log likelihoods, z-scores, model figures and gene aliases.

**Usage**

```r
export.scores(scores, datasetName='', experimentSet='', databaseFile='database.sqlite', preprocData=NULL, models=NULL, figpath=NULL, aliasTypes=c("SYMBOL", "GENENAME", "ENTREZID"), datasetSource='', datasetDescription='', datasetSaveLocation='', datasetFigureFilename='', experimentTimestamp=as.character(Sys.Date()), figureDesc='', figurePrio=0, regulator=NULL)
```

**Arguments**

- `scores` The scoreList to export.
- `datasetName` Name of the dataset in the database.
- `experimentSet` Name of the experiment set in the database.
- `databaseFile` Filename of the database. New database is created if the file does not exist.
- `preprocData` Preprocessed data. This is required in order to generate models and figures and to calculate z-scores. Also, inserting aliases requires preprocessed data.
- `models` Learned models. If not given, the function will generate models if preprocessed data is available.
- `figpath` Figure path. If this is defined, the function will generate figures to the given path instead of inserting them to the database.
- `aliasTypes` Types of aliases that are inserted to the database.
- `datasetSource` Additional information that is inserted to the database if defined.
- `datasetDescription` Additional information that is inserted to the database if defined.
- `datasetSaveLocation` Additional information that is inserted to the database if defined.
- `datasetFigureFilename` Additional information that is inserted to the database if defined.
- `experimentTimestamp` Timestamp that is inserted to the database. The default value is current date in ISO-8601 format.
- `figureDesc` Additional information that is inserted to the database if defined.
- `figurePrio` Additional information that is inserted to the database if defined.
- `regulator` If defined, override the regulator name from scoreList.

**Author(s)**

Miika-Petteri Matikainen, Antti Honkela
See Also

GPRankTargets, GPRankTFs.

Examples

```r
## Not run:
# Load a mmgmos preprocessed fragment of the Drosophila developmental
time series
data(drosophila_gpsim_fragment)

# FBgn names of target genes
targets <- c('FBgn0003486', 'FBgn0033188', 'FBgn0035257')
# Load gene annotations
library(annotate)
aliasMapping <- getAnnMap("ALIAS2PROBE",
    annotation(drosophila_gpsim_fragment))

# Get the probe identifiers for TF 'twi'
twi <- get('twi', env=aliasMapping)
# Load alternative gene annotations
fbgnMapping <- getAnnMap("FLYBASE2PROBE",
    annotation(drosophila_gpsim_fragment))

# Get the probe identifiers for target genes
targetProbes <- mget(targets, env=fbgnMapping)

# Rank the targets, filtering weakly expressed genes with average
# expression z-score below 1.8
scores <- GPRankTargets(drosophila_gpsim_fragment, TF=twi,
    testTargets=targetProbes,
    options=list(quiet=TRUE),
    filterLimit=1.8)

# Export data from scoreList and preprocessed data to a database
export.scores(scores, datasetName="Drosophila",
    experimentSet='GPSIM/GPDISIM',
    database='database.sqlite',
    preprocData=drosophila_gpsim_fragment,
    aliasTypes=c('SYMBOL', 'GENENAME', 'FLYBASE', 'ENTREZID'))

## End(Not run)
```

ExpressionTimeSeries-class

Class to contain time series expression assays

Description

Container for time series expression assays and experimental metadata. ExpressionTimeSeries class is derived from ExpressionSet, and requires fields experiments and modeltime in phenoData.

Extends

Directly extends class ExpressionSet.
Objects from the Class

new("ExpressionTimeSeries")
new("ExpressionTimeSeries",  phenoData = new("AnnotatedDataFrame"), featureData = new("AnnotatedDataFrame"), ...

This creates an ExpressionTimeSeries with assayData implicitly created to contain exprs and var.exprs.

new("ExpressionTimeSeries",  assayData = assayDataNew(exprs=new("matrix")),  phenoData = new("

This creates an ExpressionTimeSeries with assayData provided explicitly. In this form, the only required named argument is assayData.

ExpressionTimeSeries instances are usually created through new("ExpressionTimeSeries", ...). Usually the arguments to new include exprs (a matrix of expression data, with features corresponding to rows and samples to columns), var.exprs, phenoData, featureData, experimentData, annotation, and protocolData. phenoData, featureData, experimentData, annotation, and protocolData can be missing, in which case they are assigned default values.

Slots

assayData: Inherited from ExpressionSet. The models in gpim package assume that exprs contains absolute (i.e. non-logarithmic) expression values. The member var.exprs may contain variances of the values.

phenoData: Inherited from ExpressionSet. The following fields are required: experiments which contains integers from 1 to N with measurements from the same biological assay having the same number; modeltime which contains observation times in model units.

featureData: Inherited from ExpressionSet.

experimentData: Inherited from ExpressionSet.

annotation: Inherited from ExpressionSet.

protocolData: Inherited from ExpressionSet.

__classVersion__: Inherited from ExpressionSet.

Methods

See also methods for ExpressionSet.

var.exprs(object), var.exprs(object)<- value  Access and set var.exprs

initialize("ExpressionTimeSeries")  Object instantiation, used by new; not to be called directly by the user.

Author(s)

Antti Honkela, Jonatan Ropponen

See Also

processData, processRawData.

Examples

showClass("ExpressionTimeSeries")
expTransform  

*Constrains a parameter.*

**Description**

contains commands to constrain parameters to be positive via exponentiation or within a fixed interval via the sigmoid function.

**Usage**

```r
expTransform(x, transform)
sigmoidTransform(x, transform)
boundedTransform(x, transform, bounds)
```

**Arguments**

- **x**: input argument.
- **transform**: type of transform, 'atotx' maps a value into the transformed space (i.e. makes it positive). 'xtoa' maps the parameter back from transformed space to the original space. 'gradfact' gives the factor needed to correct gradients with respect to the transformed parameter.
- **bounds**: a 2-vector of bounds of allowed values in boundedTransform

**Value**

Return value as selected by transform

**See Also**

- `modelOptimise`

**Examples**

```
# Transform unconstrained parameter -4 to a positive value
expTransform(-4, 'atotx')

# Transform a bounded parameter in (1,3) to an unconstrained one
boundedTransform(2, 'xtoa', c(1, 3))
```

generateModels  

*Generating models with the given data*

**Description**

'generateModels' recreates models based on the parameters stored in a scoreList.

**Usage**

```r
generateModels(preprocData, scores)
```
**Arguments**

- **preprocData** The preprocessed data to be used.
- **scores** A scoreList object containing data of the models to be generated.

**Value**

'generateModels' returns a list of the generated models.

**Author(s)**

Antti Honkela, Jonatan Ropponen

**See Also**

GPLearn, GPRankTargets, GPRankTFs, scoreList.

**Examples**

```r
## Not run:
# Load a mmgmos preprocessed fragment of the Drosophila developmental
time series
data(drosophila_gpsim_fragment)

# Get the target probe names
targets <- c("FBgn003486", "FBgn0033188", "FBgn0035257")
library(annotate)
aliasMapping <- getAnnMap("ALIAS2PROBE",
    annotation(drosophila_gpsim_fragment))
twi <- get("twi", env=aliasMapping)
fbgnMapping <- getAnnMap("FLYBASE2PROBE",
    annotation(drosophila_gpsim_fragment))
targetProbes <- mget(targets, env=fbgnMapping)

scores <- GPRankTargets(drosophila_gpsim_fragment, TF=twi,
testTargets=targetProbes,
options=list(quiet=TRUE),
    filterLimit=1.8)

models <- generateModels(drosophila_gpsim_fragment, scores)
## End(Not run)
```

**GPLearn**

*Fit a GP model*

**Description**

Forms an optimized model of the desired genes. The function can form a model with GPsim or GPdisim and it's also possible to use initial parameters or fix parameters for future use. The genes can also be filtered based on ratios calculated from the expression values. The given data can also be searched for the data of specific genes.
GPLearn

Usage

GPLearn(preprocData, TF = NULL, targets = NULL,
useGpdisim = !is.null(TF), randomize = FALSE, addPriors = FALSE,
fixedParams = FALSE, initParams = NULL, initialZero = TRUE,
fixComps = NULL, dontOptimise = FALSE,
allowNegativeSensitivities = FALSE, quiet = FALSE,
gpsimOptions = NULL, allArgs = NULL)

Arguments

preprocData  The preprocessed data to be used.
TF  The probe corresponding to the transcription factor (TF) mRNA if TF protein
translation model is used, or NULL (default) if the translation model is not used.
targets  The target genes of the model.
useGpdisim  A logical value determining whether a model of translation is included. By
default TRUE if TF is set, FALSE if TF is unset.
randomize  A logical value determining whether the parameters of the model are random-
ized before optimization.
addPriors  A logical value determining whether priors are added to the model.
fixedParams  A logical value determining whether the initial parameters are fixed.
initParams  The initial parameters for the model. In combination with fixedParams a value
NA denotes parameters to learn.
initialZero  Assume a zero initial TF protein concentration, default = TRUE.
fixComps  The blocks of the kernel the parameters of which are to be fixed. To be used
together with fixedParams and initParams.
dontOptimise  Just create the model, do not run optimisation.
allowNegativeSensitivities  Allow sensitivities to go negative. This is an experimental feature, and the nega-
tive values have no physical interpretation.
quiet  Suppress optimiser output.
gpsimOptions  Internal: additional options to pass to gp[di]simCreate.
allArgs  A list of arguments that can be used to override ones with the same name.

Value

Returns the optimized model.

Author(s)

Antti Honkela, Pei Gao, Jonatan Ropponen, Magnus Rattray, Neil D. Lawrence

See Also

GPRankTargets, GPRankTFs.
Examples

# Load a mmgmos preprocessed fragment of the Drosophila developmental
# time series
data(drosophila_gpsim_fragment)

# Get the target probe names
library(annotate)
aliasMapping <- getAnnMap("ALIAS2PROBE",
                           annotation(drosophila_gpsim_fragment))
twi <- get('twi', env=aliasMapping)
fbgnMapping <- getAnnMap("FLYBASE2PROBE",
                          annotation(drosophila_gpsim_fragment))
targetProbe <- get("FBgn0035257", env=fbgnMapping)

# Create the model but do not optimise (rarely needed...)
model <- GPLearn(drosophila_gpsim_fragment,
                 TF=twi, targets=targetProbe,
                 useGpdisim=TRUE, quiet=TRUE,
                 dontOptimise=TRUE)

## Not run:
# Create and learn the model
# Create and learn the model
model <- GPLearn(drosophila_gpsim_fragment,
                 TF=twi, targets=targetProbe,
                 useGpdisim=TRUE, quiet=TRUE)

## End(Not run)

---

GPModel-class

A container for gpsim models

Description

The class is a container for the internal representation of models used by the gpsim package.

Objects from the Class

Objects can be created by calls of the form new("GPModel", model).

Slots

model: A model object used internally by the code of the gpsim package
type: Type of the model object

Methods

modelStruct(object), modelStruct(object)<- value Access and set the internal model structure
modelType(object) Access the internal type values
show(object) Informatively display object contents.
is.GPModel(object) Check if object is a GPModel.
initialize("GPModel") Object instantiation, used by new; not to be called directly by the user.
GPPlot

Author(s)
Antti Honkela, Jonatan Ropponen

See Also
GPLearn, GPRankTargets, GPRankTFs, generateModels, modelExtractParam, modelLogLikelihood.

Examples
showClass("GPModel")

GPPlot

Plot GP(DI)SIM models

Description
Plots GP(DI)SIM models.

Usage
GPPlot(data, savepath = '', nameMapping = NULL, predt = NULL, fileOutput=FALSE, plotTime=NULL)

Arguments
data
savepath
nameMapping
predt
fileOutput
plotTime

The model to plot as returned by GPLearn.
The location in the file system where the images are saved.
The annotation used for mapping the names of the genes for the figures.
The set of time points to use in plotting (default: the time interval covering the data).
Is the plot being saved to a file? If yes, do not open new interactive devices for each plot.
The times of observations to use in the plot. Should usually not be changed!

Details
The function plots the fitted expression level of the transcription factor (if applicable), the inferred activity of the transcription factor, and the fitted expression level of the target(s).

Author(s)
Antti Honkela

See Also
GPLearn.
Examples

```r
## Not run:
# Load a mmgmos preprocessed fragment of the Drosophila developmental
time series
data(drosophila_gpsim_fragment)

# Get the target probe names
library(annotate)
aliasMapping <- getAnnMap("ALIAS2PROBE",
    annotation(drosophila_gpsim_fragment))
twi <- get('twi', env=aliasMapping)
fbgnMapping <- getAnnMap("FLYBASE2PROBE",
    annotation(drosophila_gpsim_fragment))
targetProbe <- get('FBgn0035257', env=fbgnMapping)

# Learn the model
model <- GPLearn(drosophila_gpsim_fragment,
    TF=twi, targets=targetProbe,
    useGpdisim=TRUE, quiet=TRUE)

# Plot it
GPPlot(model, nameMapping=getAnnMap("FLYBASE",
    annotation(drosophila_gpsim_fragment)))

## End(Not run)
```

GPRankTargets

**Ranking possible target genes or regulators**

**Description**

GPRankTargets ranks possible target genes by forming optimized models with a fixed transcription factor, a set of known target genes and targets to be tested. The transcription factor and the known targets are always included in the models while the tested targets are tested by including them in the models one at a time. The function determines itself whether to use GPSIM or GPDISIM based on the input arguments.

**Usage**

```r
GPRankTargets(preprocData, TF = NULL, knownTargets = NULL,
    testTargets = NULL, filterLimit = 1.8,
    returnModels = FALSE, options = NULL,
    scoreSaveFile = NULL, 
    datasetName = "", experimentSet = "")
```

**Arguments**

- **preprocData** The preprocessed data to be used.
TF
The transcription factor (TF) probe present in all models when TF protein translation model is used. Set to NULL (default) when translation model is not used.

knownTargets
The target genes present in all models.

testTargets
Target genes that are tested by including them in the models one at a time. Can be names of genes, or a set of indices in preprocData.

filterLimit
Genes with an average expression z-score above this figure are accepted after filtering. If this value is 0, all genes will be accepted.

returnModels
A logical value determining whether the function returns the calculated models.

options
A list of additional arguments to pass to GPLearn.

scoreSaveFile
Name of file to save the scores to after processing each gene.

TFs
The transcription factors that are tested by including them in the models one at a time.

targets
The target genes present in all models.

datasetName
For exporting the scores using `export.scores`: Name of the dataset in the database.

experimentSet
For exporting the scores using `export.scores`: Name of the experiment set in the database.

Details
The models are formed by calling `GPLearn`. If there is no value given to the transcription factor, a model without protein translation is used. Without protein translation model, some known targets are needed. If known targets are given, a model is first created with only the transcription factor and the known targets. The parameters extracted from this model are used as initial parameters of the models with test targets.

`GPRankTFs` is very similar to `GPRankTargets`, except it loops over candidate regulators, not candidate targets.

Value
The function returns a scoreList containing the genes, parameters and log-likelihoods of the models. If `returnModels` is true, the function returns a list of the calculated models.

Author(s)
Antti Honkela, Jonatan Ropponen, Magnus Rattray, Neil D. Lawrence

See Also
`GPLearn`, `scoreList`, `generateModels`, `export.scores`.

Examples
```r
## Not run:
# Load a mmgmos preprocessed fragment of the Drosophila developmental time series
data(drosophila_gpsim_fragment)

# Get the target probe names
targets <- c("FBgn0003486", "FBgn00035257")
library(annotate)
```
gpsimCreate <- getAnnMap("ALIAS2PROBE", annotation(drosophila_gpsim_fragment))
twi <- get('twi', env=aliasMapping)
fbgnMapping <- getAnnMap("FLYBASE2PROBE", annotation(drosophila_gpsim_fragment))
targetProbes <- mget(targets, env=fbgnMapping)

scores <- GPRankTargets(drosophila_gpsim_fragment, TF=twi,
testTargets=targetProbes,
options=list(quiet=TRUE),
filterLimit=1.8)

## End(Not run)

gpsimCreate

Create a GPSIM/GPDISIM model.

Description
creates a model for single input motifs with Gaussian processes.

Usage

gpsimCreate(Ngenes, Ntf, times, y,
yvar, options, genes=NULL, annotation=NULL)
gpdisimCreate(Ngenes, Ntf, times, y,
yvar, options, genes=NULL, annotation=NULL)

Arguments

Ngenes number of genes to be modelled in the system.
Ntf number of proteins to be modelled in the system.
times the time points where the data is to be modelled.
y the values of each gene at the different time points.
yvar the variances of each gene at the different time points.
options options structure (optional).
genes names of the probes the model is for
annotation (optional) annotation for the probe names

Details
These functions are meant to be used through GPLearn.

Value
model model structure containing default parameterisation.

See Also
modelExtractParam, modelOptimise, GPLearn.
Examples

## missing, see GPLearn

kernCompute

**Compute the kernel given the parameters and X.**

Description

Compute the kernel given the parameters and X.

Usage

```r
kernCompute(kern, x, x2)
kernDiagCompute(kern, x)
```

Arguments

- `kern`: kernel structure to be computed.
- `x`: first or only input data matrix (rows are data points) to the kernel computation.
- `x2`: (optional) second input matrix to the kernel computation (forms the columns of the kernel).

Details

- `K <- kernCompute(kern, X)` computes a kernel matrix for the given kernel type given an input data matrix.
- `K <- kernCompute(kern, X1, X2)` computes a kernel matrix for the given kernel type given two input data matrices, one for the rows and one for the columns.
- `K <- kernDiagCompute(kern, X)` computes the diagonal of a kernel matrix for the given kernel.
- `K <- *X*kernCompute(kern1, kern2, X)` computes elements as above, but for cross combinations of two kernels, `kern1` and `kern2`.

Value

- `K`: computed elements of the kernel structure.
- `Kd`: vector containing computed diagonal elements of the kernel structure.

See Also

- `kernCreate`

Examples

```r
kern <- kernCreate(1, 'rbf')
K <- kernCompute(kern, as.matrix(3:8))
```
kernCreate

Initialise a kernel structure.

Description

Initialise a kernel structure.

Usage

kernCreate(x, kernType, kernOptions=NULL)

Arguments

x
If list, array or matrix: input data values (from which kernel will later be computed). If scalar: input dimension of the design matrix (i.e. number of features in the design matrix).

kernType
Type of kernel to be created, some standard types are 'rbf', 'white', 'sim' and 'disim'. If a list of the form list(type='compnd', comp=c('rbf', 'rbf', 'white')) is used a compound kernel based on the sum of the individual kernels will be created. Parameters can be passed to kernels using type list(type='parametric', options=list(opt=val), realType=...), where realType is the type that would be used otherwise.

kernOptions
(optional) list of kernel options

Details

kern <- kernCreate(X, type) input points and a kernel type.

kern <- kernCreate(dim, type) creates a kernel matrix structure given the dimensions of the design matrix and the kernel type.

The *KernParamInit functions perform initialisation specific to different types of kernels. They should not be called directly.

Value

dim
The kernel structure.

See Also

kernDisplay, modelTieParam.

Examples

# Create a multi kernel with two rbf blocks with bounded inverse widths
invWidthBounds <- c(0.5, 2)
kernType <- list(type="multi", comp=list())
for (i in 1:2)
  kernType$comp[[i]] <- list(type="parametric", realType="rbf",
    options=list(isNormalised=TRUE,
      inverseWidthBounds=invWidthBounds))
kern <- kernCreate(1, kernType)

# Tie the inverse with parameters of the component RBF kernels
kern <- modelTieParam(kern, list(tieWidth="inverseWidth"))
kernDisplay(kern)
**kernDiagGradX**  
*Compute the gradient of the kernel wrt X.*

**Description**

computes the gradient of the (diagonal of the) kernel matrix with respect to the elements of the design matrix given in X.

**Usage**

```r
kernDiagGradX(kern, x)
kernGradX(kern, x, x2)
```

**Arguments**

- **kern**: the kernel structure for which gradients are being computed.
- **x**: if only argument: the input data in the form of a design matrix, if two arguments: row locations against which gradients are being computed.
- **x2**: (optional) column locations against which gradients are being computed.

**Value**

- **gX**: the gradients of the diagonal with respect to each element of X. The returned matrix has the same dimensions as X.
- **gX2**: the returned gradients. The gradients are returned in a matrix which is numData x numInputs x numData. Where numData is the number of data points and numInputs is the number of input dimensions in X.

**See Also**

- `kernGradient`

**Examples**

```r
kern <- kernCreate(1, 'mlp')
g <- kernDiagGradX(kern, as.matrix(3:8))
```

---

**kernGradient**  
*Compute the gradient wrt the kernel parameters.*

**Description**

Compute the gradient wrt the kernel parameters.

**Usage**

```r
kernGradient(kern, x, ...)
```
Arguments

- **kern**: the kernel structure for which the gradients are being computed.
- **x**: the input locations for which the gradients are being computed, specifically those associated with the rows of the kernel matrix if there are two arguments of input locations.
- ...: optional arguments including potentially: the input locations associated with the columns of the kernel matrix; matrix of partial derivatives of the function of interest with respect to the kernel matrix. With single input, the argument takes the form of a square matrix of dimension numData, where numData is the number of rows in x, with two input arguments the matrix should have the same number of rows as the first and the same number of columns as the second has rows.

Details

\[ g \leftarrow \text{kernGradient}(\text{kern}, x, \text{partial}) \]

computes the gradient of functions with respect to the kernel parameters. As well as the kernel structure and the input positions, the user provides a matrix \text{PARTIAL} which gives the partial derivatives of the function with respect to the relevant elements of the kernel matrix.

\[ g \leftarrow \text{kernGradient}(\text{kern}, x_1, x_2, \text{partial}) \]

computes the derivatives as above, but input locations are now provided in two matrices associated with rows and columns of the kernel matrix.

\[ g \leftarrow \star X \star \text{kernGradient}(\text{kern}_1, \text{kern}_2, x, \text{partial}) \]

same as above, but for cross combinations of two kernels, \text{kern}_1 and \text{kern}_2.

Value

\[ g \]

gradients of the function of interest with respect to the kernel parameters. The ordering of the vector should match that provided by the function \text{kernExtractParam}.

See Also

- \text{kernCompute}, \text{kernExtractParam}.

Examples

```r
kern <- kernCreate(1, 'rbf')
g <- kernGradient(kern, as.matrix(c(1, 4)), array(1, c(2, 2)))
```

### lnDiffErfs

**Helper function for computing the log of difference**

**Description**

Helper function for computing the log of difference

**Usage**

```r
lnDiffErfs(x1, x2)
```
Arguments

- **x1**: argument of the positive erf
- **x2**: argument of the negative erf

Details

\[ v \leftarrow \ln \text{DiffErfs}(x1, x2) \]
computes the log of the difference of two erfs in a numerically stable manner.

Value

\[ v \rightarrow \text{list}(\log(\text{abs}(\text{erf}(x1) - \text{erf}(x2))), \text{sign}(\text{erf}(x1) - \text{erf}(x2))) \]

Examples

\[ \ln \text{DiffErfs}(100, 10) \]

---

**modelDisplay**

*Display a model.*

Description

displays the parameters of the model/kernel and the model/kernel type to the console.

Usage

\[ \text{modelDisplay}(\text{model}, ...) \]

Arguments

- **model**: the model/kernel structure to be displayed.
- **...**: (optional) indent level for the display.

See Also

- `modelExtractParam`

Examples

# Load a mmgmos preprocessed fragment of the Drosophila developmental
# time series
data(drosophila_gpsim_fragment)

# The probe identifier for TF 'twi'
twi <- "143396_at"

# The probe identifier for the target gene
targetProbe <- "152715_at"

# Create the model, but do not optimise
model <- GPLearn(drosophila_gpsim_fragment,
                 TF=twi, targets=targetProbe,
                 useGpdisim=TRUE, quiet=TRUE,
modelExpandParam

dontOptimise=TRUE)

# Display the initial model
modelDisplay(model)

modelExpandParam  Update a model structure with new parameters or update the posterior processes.

Description
Update a model structure or component with new parameters, or update the posterior processes.

Usage
modelExpandParam(model, params)
modelUpdateProcesses(model, predt=NULL)

Arguments
model  the model structure to be updated.
params  vector of parameters.
predt  (optional) a vector of times to infer the posterior at. By default this is 100 points spanning the time range of the data.

Details
model <- modelExpandParam(model, params) returns a model structure filled with the parameters in the given vector. This is used as a helper function to enable parameters to be optimised in, for example, the optimisation functions.
model <- modelUpdateProcesses(model) updates posterior processes of the given model.

Value
model  updated model structure.

See Also
GPLearn, modelExtractParam

Examples
## Not run:
# Learn the model
model <- GPLearn(...) 
params <- modelExtractParam(model, only.values=TRUE) 
params[1] <- 0 
new_model <- modelExpandParam(model, params) 
new_model <- modelUpdateProcesses(new_model) 

## End(Not run)
modelExtractParam Extract the parameters of a model.

Description
Extract parameters from the model into a vector of parameters for optimisation.

Usage
modelExtractParam(model, only.values=TRUE, untransformed.values=FALSE)

Arguments
- `model`: the model structure containing the parameters to be extracted.
- `only.values`: include parameter names in the returned vector.
- `untransformed.values`: return actual values, not transformed values used by the optimisers.

Value
- `param`: vector of parameters extracted from the model.

See Also
- modelExpandParam

Examples
```r
# Load a mmgmos preprocessed fragment of the Drosophila developmental # time series
data(drosophila_gpsim_fragment)

# The probe identifier for TF 'twi'
twi <- "143396_at"
# The probe identifier for the target gene
targetProbe <- "152715_at"

# Create the model, but do not optimise
model <- GPLearn(drosophila_gpsim_fragment, 
                  TF=twi, targets=targetProbe, 
                  useGpdisim=TRUE, quiet=TRUE, 
                  dontOptimise=TRUE)

# Get the initial parameter values
params <- modelExtractParam(model, only.values=FALSE)
```
modelGradient

Model description and objective error function and its gradient.

Description

modelGradient gives the gradient of the objective function for a model. By default the objective function (modelObjective) is a negative log likelihood (modelLogLikelihood).

Usage

modelObjective(params, model, ...)
modelLogLikelihood(model)
modelGradient(params, model, ...)

Arguments

params parameter vector to evaluate at.
model model structure.
... optional additional arguments.

Value

g the gradient of the error function to be minimised.
v the objective function value (lower is better).
ll the log-likelihood value.

See Also

modelOptimise.

Examples

# Load a mmgmos preprocessed fragment of the Drosophila developmental
# time series
data(drosophila_gpsim_fragment)

# The probe identifier for TF 'twi'
twi <- "143396_at"
# The probe identifier for the target gene
targetProbe <- "152715_at"

# Create the model but do not optimise
model <- GPLearn(drosophila_gpsim_fragment,
  TF=twi, targets=targetProbe,
  useGpdisim=TRUE, quiet=TRUE,
  dontOptimise=TRUE)
params <- modelExtractParam(model, only.values=FALSE)
ll <- modelLogLikelihood(model)
paramValues <- modelExtractParam(model, only.values=TRUE)
modelGradient(paramValues, model)
Tie parameters of a model together.

Description

Groups of parameters of a model to be seen as one parameter during optimisation of the model.

Usage

modelTieParam(model, paramsList)

Arguments

model
the model for which parameters are being tied together.

paramsList
indices of parameters to group together. The indices are provided in a list. Each element in the list contains a vector of indices of parameters that should be considered as one parameter. Each group of parameters in each cell should obviously be mutually exclusive.

Alternatively, the specification may consist of strings, which are interpreted as regular expressions that are matched against the parameter names returned by modelExtractParam or kernExtractParam, as appropriate for the current object.

Value

model
the model with the parameters grouped together.

See Also

modelExtractParam, modelExpandParam, modelGradient.

Examples

# Create a multi kernel with two rbf blocks with bounded inverse widths
invWidthBounds <- c(0.5, 2)
kernType <- list(type="multi", comp=list())
for (i in 1:2)
kernType$comp[[i]] <- list(type="parametric", realType="rbf",
  options=list(isNormalised=TRUE,
    inverseWidthBounds=invWidthBounds))
kern <- kernCreate(1, kernType)

# Tie the inverse with parameters of the component RBF kernels
kern <- modelTieParam(kern, list(tieWidth="inverseWidth"))
kernDisplay(kern)
optimiDefaultConstraint

Returns function for parameter constraint.

Description

returns the current default function for constraining a parameter.

Usage

optimiDefaultConstraint(constraint)

Arguments

constraint the type of constraint you want to place on the parameter, options include 'positive' (gives an 'exp' constraint) and 'zeroone' (gives a 'sigmoid' constraint).

Value

val a list with two components: 'func' for the name of function used to apply the constraint, and 'hasArgs' for a boolean flag if the function requires additional arguments.

See Also

expTransform, sigmoidTransform.

Examples

optimiDefaultConstraint('positive')
optimiDefaultConstraint('bounded')

plotTimeseries

Plot ExpressionTimeSeries data

Description

Plots ExpressionTimeSeries data.

Usage

plotTimeseries(data, nameMapping = NULL)

Arguments

data An ExpressionTimeSeries object.
nameMapping The annotation used for mapping the names of the genes for the figures. By default, the SYMBOL annotation for the array is used, if available.
The function plots the expression levels from an ExpressionTimeSeries object and the associated standard deviations. If the object includes multiple time series, they will be plotted in the same figure, but slightly shifted.

Author(s)
Antti Honkela

See Also
processData.

Examples

```r
# Load a mmgmos preprocessed fragment of the Drosophila developmental
# time series
data(drosophila_gpsim_fragment)

# Plot the first two genes
plotTimeseries(drosophila_gpsim_fragment[1:2,])
```

Description

processData further processes time series data preprocessed by puma or lumi. processRawData performs similar processing for other data.

Both functions return ExpressionTimeSeries objects that can be used as input for the functions GPLearn and GPRankTargets.

Usage

```r
processData(data, times = NULL, experiments = NULL,
do.normalisation = TRUE)
processRawData(rawData, times, experiments = NULL,
is.logged = TRUE, do.normalisation = ifelse(is.logged, TRUE, FALSE))
```

Arguments
data  The preprocessed data from mmgMOS in the puma package (an exprReslt object) or from the lumi package (a LumiBatch object).
rawData  Raw data matrix to be used. Each row corresponds to a gene and each column to a data point.
times  Observation times of each data point. If unspecified or NULL, processData attempts to infer this from phenoData(data) field containing 'time' in the name.
experiments  The replicate structure of the data indicating which expression data points arise from which experiments. This should be an array in integers from 1 to N with length equal to the number of data points. By default all the data points are assumed to be from same replicate.
**is.logged** Indicates whether the expression values are on log scale or not. Normalisation of non-logged data is unsupported.

**do.normalisation** Indicates whether to perform the normalisation.

**Details**

The expression data (and percentiles, if available) are normalized by equalising the mean of log-expression in each time points. In `processData`, a normal distribution is then fitted into the data with `distfit`.

**Value**

An `ExpressionTimeSeries` object containing all provided information.

**Author(s)**

Antti Honkela, Jonatan Ropponen

**See Also**

GPLearn, GPRankTargets.

**Examples**

```r
## Load a mmgmos preprocessed fragment of the Drosophila developmental time series
data(drosophila_mmgmos_fragment)

## Process the data (3 experiments containing 12 time points each)
drosophila_gpsim_fragment <- processData(drosophila_mmgmos_fragment, experiments=rep(1:3, each=12))
```

---

**SCGoptim**

*Optimise the given function using (scaled) conjugate gradients.*

**Description**

Optimise the given function using (scaled) conjugate gradients.

**Usage**

```r
optimDefaultOptions()
SCGoptim(x, fn, grad, options, ...)
CGoptim(x, fn, grad, options, ...)
modelOptimise(model, options, ...)
```
scoreList-class

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>model</code></td>
<td>the model to be optimised.</td>
</tr>
<tr>
<td><code>x</code></td>
<td>initial parameter values.</td>
</tr>
<tr>
<td><code>fn</code></td>
<td>objective function to minimise</td>
</tr>
<tr>
<td><code>grad</code></td>
<td>gradient function of the objective</td>
</tr>
</tbody>
</table>

... extra arguments to pass to `fn` and `grad`

Value

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>options</code></td>
<td>an options structure</td>
</tr>
<tr>
<td><code>newParams</code></td>
<td>optimised parameter values</td>
</tr>
<tr>
<td><code>model</code></td>
<td>the optimised model.</td>
</tr>
</tbody>
</table>

See Also

`modelObjective, modelGradient`

Examples

```r
## Not run to speed up package checks
model <- GPLearn(..., dontOptimise=TRUE)
options <- optimiDefaultOptions()
model <- modelOptimise(model, options)
```

scoreList-class

Class “scoreList”

Description

'scoreList' is an object which contain the genes, parameters, log-likelihoods and arguments of models. With the data in a scoreList item and the original data used for creating the models, the models can be reconstructed with the function 'generateModels'.

Objects from the Class

Objects can be created by calls of the form `scoreList(params, loglikelihoods, genes, modelArgs, knownTargets)`. 

Slots

- `params`: The parameters of the models.
- `loglikelihoods`: The log-likelihoods of the models.
- `baseloglikelihoods`: The log-likelihoods of corresponding null models.
- `genes`: The genes used in the models.
scoreList-class

modelArgs: A list of arguments used to generate the models.
knownTargets: The list of known targets used in the ranking.
TF: The TF used in the ranking.
sharedModel: Shared model for known targets.
datasetName: Dataset name, used when exporting scores to a database.
experimentSet: Experiment set name, used when exporting scores to a database.

Methods

Class-specific methods:

write.scores(object, ...) Writes the log-likelihoods and null log-likelihoods. Accepts any options write.table does.
genes(object), genes(object)<- value Access and set genes
knownTargets(object), knownTargets(object)<- value Access and set knownTargets
loglikelihoods(object), loglikelihoods(object)<- value Access and set loglikelihoods
baseloglikelihoods(object), baseloglikelihoods(object)<- value Access and set baseloglikelihoods
modelArgs(object), modelArgs(object)<- value Access and set modelArgs
params(object), params(object)<- value Access and set params
sharedModel(object), sharedModel(object)<- value Access and set sharedModel
TF(object), TF(object)<- value Access and set TF
datasetName(object), datasetName(object)<- value Access and set datasetName
experimentSet(object), experimentSet(object)<- value Access and set experimentSet

Standard generic methods:

object[(index) Conducts subsetting of the scoreList.
c(object, ...) Concatenates scoreLists.
length(object) Returns the length of the list.
show(object) Informatively display object contents.
sort(object, decreasing=FALSE) Sort the list according to log-likelihood

Author(s)

Antti Honkela, Jonatan Ropponen

See Also

GPRankTargets, GPRankTFs, generateModels, write.table.

Examples

showClass("scoreList")
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