Package ‘tigre’

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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.
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**tigre-package**

**tigre** - Transcription factor Inference through Gaussian process Reconstruction of Expression

### Description

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.
Details

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Type: Package
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License: A-GPL Version 3

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
## 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**

data(drosophila_gpsim_fragment)

**Format**

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

**Source**

ftp://ftp.fruitfly.org/pub/embryo_tc_array_data/

**References**

**drosophila_mmgmos_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 the `puma` package.

**Usage**

```r
data(drosophila_mmgmos_fragment)
```

**Format**

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

**Source**

ftp://ftp.fruitfly.org/pub/embryo_tc_array_data/

**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",
```
# Get the probe identifier 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"), experimentData = new("MIAME"), annotation = character(0), protocolData = phenoData[,integer(0)],
exprs = new("matrix"), var.exprs = new("matrix"))

This creates an ExpressionTimeSeries with assayData implicitly created to contain exprs and var.exprs.
new("ExpressionTimeSeries", assayData = assayDataNew(exprs=new("matrix")), phenoData = new("AnnotatedDataFrame"), featureData = new("AnnotatedDataFrame"), experimentData = new("MIAME"), annotation = character(0), protocolData = phenoData[,integer(0)])

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 gpsi 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

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

Arguments

x input argument.

transform type of transform, 'atox' 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, 'atox')

# 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

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

## 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', '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)
GPLearn

models <- generateModels(drosophila_gpsim_fragment, scores)

## End(Not run)

### 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.

### 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 randomized 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 negative 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

```r
# 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
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.

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

## 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))
```r
# Load necessary packages
library(GPlearn)

# Define target probe
FBgn0035257 <- get('FBgn0035257', env=fbgnMapping)

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

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

---

**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 = "")
GPRankTFs(preprocData, TFs, targets, filterLimit = 1.8, returnModels = FALSE, options = NULL, scoreSaveFile = NULL, datasetName = "", experimentSet = "")
```

**Arguments**

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>preprocData</td>
<td>The preprocessed data to be used.</td>
</tr>
<tr>
<td>TF</td>
<td>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.</td>
</tr>
<tr>
<td>knownTargets</td>
<td>The target genes present in all models.</td>
</tr>
<tr>
<td>testTargets</td>
<td>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.</td>
</tr>
</tbody>
</table>
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', 'FBgn0033188', 'FBgn0035257')
library(annotate)
aliasMapping <- getAnnMap("ALIAS2PROBE",
    annotation(drosophila_gpsim_fragment))
```
gpsimCreate

Create a GPSIM/GPDISIM model.

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

Usage

```r
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

```r
## 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

- \( K \leftarrow \text{kernCompute}(\text{kern}, X) \) computes a kernel matrix for the given kernel type given an input data matrix.
- \( K \leftarrow \text{kernCompute}(\text{kern}, X_1, X_2) \) computes a kernel matrix for the given kernel type given two input data matrices, one for the rows and one for the columns.
- \( K \leftarrow \text{kernDiagCompute}(\text{kern}, X) \) computes the diagonal of a kernel matrix for the given kernel.
- \( K \leftarrow X \ast \text{kernCompute}(\text{kern1}, \text{kern2}, X) K \leftarrow X \ast \text{kernCompute}(\text{kern1}, \text{kern2}, X_1, X_2) \) same 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`
kernCreate

Examples
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='cmpnd', 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
kern The kernel structure.

See Also
kernDisplay, modelTieParam.
Examples

```r
# 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`
kernGradient

Examples

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

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

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

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 PARTIAL which gives the partial derivatives of the
function with respect to the relevant elements of the kernel matrix.

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

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

\[ g = \text{XkernGradient}(\text{kern}_1, \text{kern}_2, x, \text{partial}) \]
\[ g = \text{XkernGradient}(\text{kern}_1, \text{kern}_2, x, \text{partial}) \]

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 kernExtract-
Param.
lnDiffErfs

See Also

kernCompute, kernExtractParam.

Examples

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

lnDiffErfs(x1, x2)

Arguments

x1 argument of the positive erf
x2 argument of the negative erf

Details

v <- lnDiffErfs(x1, x2) computes the log of the difference of two erfs in a numerically stable manner.

Value

v list(c(log(abs(erf(x1) - erf(x2))), sign(erf(x1) - erf(x2))))

Examples

lnDiffErfs(100, 10)
modelDisplay

Display a model.

Description

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

Usage

modelDisplay(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,

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, param) 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

# 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 log-likelihood/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 mmgos 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)
modelTieParam

```r
paramValues <- modelExtractParam(model, only.values=TRUE)
modelGradient(paramValues, model)
```

**modelTieParam**  
*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
---

```r
# 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

```r
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

```r
optimiDefaultConstraint('positive')
optimiDefaultConstraint('bounded')
```

---

plotTimeseries

*Plot ExpressionTimeSeries data*

Description

Plots ExpressionTimeSeries data.

Usage

```r
plotTimeseries(data, nameMapping = NULL)
```
processData

**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.

**Details**

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

optimiDefaultOptions()
SCGoptim(x, fn, grad, options, ...)
CGoptim(x, fn, grad, options, ...)
modelOptimise(model, options, ...)

Arguments

- model: the model to be optimised.
- x: initial parameter values.
- fn: objective function to minimise
- grad: gradient function of the objective
- options: options structure like one returned by optimiDefaultOptions. The fields are interpreted as: option[1]: number of iterations; option[2]: interval for the line search; option[3]: tolerance for x to terminate the loop; option[4]: tolerance for fn to terminate the loop; option$display: option of showing the details of optimisation
- ...: extra arguments to pass to fn and grad

Value

- options: an options structure
- newParams: optimised parameter values
- model: the optimised model.

See Also

modelObjective, modelGradient

Examples

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

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.
- 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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