Package 'INSPEcT'

November 12, 2026

Type Package

Title Modeling RNA synthesis, processing and degradation with RNA-seq data

Version 1.42.0

Date 2025-07-22

Author Stefano de Pretis

Maintainer Stefano de Pretis <ste.depo@gmail.com>, Mattia Furlan <Mattia.Furlan@iit.it>

Description INSPEcT (INference of Synthesis, Processing and dEgradation rates from Transcriptomic data) RNA-seq data in time-course experiments or steady-state conditions, with or without the support of nascent RNA data.

License GPL-2

Depends R (>= 3.6), methods, Biobase, BiocParallel

Imports pROC, deSolve, rootSolve, KernSmooth, readxl, GenomicFeatures, GenomicRanges, IRanges, BiocGenerics, GenomicAlignments, Rsamtools, S4Vectors, Seqinfo, DESeq2, plgem, rtracklayer, SummarizedExperiment, TxDb.Mmusculus.UCSC.mm9.knownGene, shiny

Suggests BiocStyle, knitr, rmarkdown

VignetteBuilder knitr

biocViews Sequencing, RNASeq, GeneRegulation, TimeCourse, SystemsBiology

NeedsCompilation no

RoxygenNote 7.1.1

git_url https://git.bioconductor.org/packages/INSPEcT

git_branch RELEASE_3_23

git_last_commit da30461

git_last_commit_date 2026-04-28

Repository Bioconductor 3.23

Date/Publication 2026-11-11

Contents

AIC-INSPEcT-method . . . 3
allcounts . . . 4
calculateRatePvals . . . 4
chisqmodel . . . 6
chisqtest . . . 6
combine . . . 7
compareSteady . . . 8
compareSteadyNoNascent . . . 9
computeConfidenceIntervals . . . 11
convergence . . . 11
correlationPlot . . . 12
dim,INSPEcT-method . . . 12
Extract . . . 13
featureNames,INSPEcT-method . . . 14
featureWidths . . . 14
geneClass . . . 15
inHeatmap . . . 16
INSPEcT . . . 17
INSPEcT-class . . . 18
INSPEcT-shinyApps . . . 20
inspectFromBAM . . . 20
inspectFromPCR . . . 21
INSPEcT_diffsteady-class . . . 23
INSPEcT_model-class . . . 25
INSPEcT_steadyNoNascent-class . . . 26
labeledSF . . . 27
libsizes . . . 28
logLik . . . 28
makeModelRates . . . 29
makeOscillatorySimModel . . . 30
makeSimDataset . . . 31
makeSimModel . . . 32
mature . . . 34
matureVar . . . 34
modelingParams . . . 35
modelRates . . . 36
modelRatesNF . . . 37
modelSelection . . . 38
newINSPEcT . . . 39
nGenes . . . 41
nTpts . . . 41
plotGene . . . 42
plotMA . . . 43
plotPMgene . . . 45
plotPMtrend . . . 45
premature . . . 46

prematureVar . . . 46
processingDelay . . . 47
PTratio . . . 48
PTreg . . . 49
quantifyExpressionsFromBAMs . . . 50
quantifyExpressionsFromBWs . . . 52
quantifyExpressionsFromTrAbundance . . . 53
quantifyExpressionsFromTrCounts . . . 54
ratePvals . . . 55
ratesFirstGuess . . . 56
ratesFirstGuessVar . . . 57
removeModel . . . 58
rocCurve . . . 59
rocThresholds . . . 60
setConfidenceIntervals . . . 61
simData3rep_Nascent . . . 62
simData3rep_NoNascent . . . 62
simData4rep_Nascent . . . 62
simData4rep_NoNascent . . . 63
split . . . 63
tpts . . . 64
viewConfidenceIntervals . . . 64
viewModelRates . . . 65

Index **66**

`AIC-INSPEcT-method` *Akaike information criterion calculated for the models evaluated by INSPEcT*

Description

This method is used to retrieve AIC values for all models tested for all genes.

Usage

```
## S4 method for signature 'INSPEcT_model'
AIC(object, ..., k = 2)

## S4 method for signature 'INSPEcT'
AIC(object, ..., k = 2)
```

Arguments

`object`	An object of class INSPEcT or INSPEcT_model
`...`	Additional arguments for the generic
`k`	Additional parameter for the generic

Value

A matrix of AIC values

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
AIC(nascentInspObj10)
```

`allcounts` *A list containing mature and nascent counts for exons and introns, three replicates and 11 time points: 0,1/6,1/3,1/2,1,1.5,2,4,8,12,16 hours.*

Description

A list containing mature and nascent counts for exons and introns, three replicates and 11 time points: 0,1/6,1/3,1/2,1,1.5,2,4,8,12,16 hours.

Format

A list of 4 matrices 500 x 33

`calculateRatePvals` *Calculate a single p-value for each rate*

Description

This method is used to calculate all the p-values relative to the variability of synthesis, processing and degradation rates. For object modeled with nascent RNA or when non-functional modeling was used, the variability is calculated using the confidence intervals. For objects modeled without nascent RNA, model selection is performed by comparing the likelihood of different (nested) models.

Usage

```
calculateRatePvals(
  object,
  modelSelection = c("aic", "llr", "hib"),
  preferPValue = TRUE,
  padj = TRUE,
  p_goodness_of_fit = 0.1,
  p_variability = rep(0.05, 3),
  limitModelComplexity = FALSE
)
```

```
## S4 method for signature 'INSPEcT'
calculateRatePvals(
  object,
  modelSelection = c("aic", "llr", "hib"),
  preferPValue = TRUE,
  padj = TRUE,
  p_goodness_of_fit = 0.1,
  p_variability = rep(0.05, 3),
  limitModelComplexity = FALSE
)
```

Arguments

`object`	An object of class INSPEcT or INSPEcT_model
`modelSelection`	'aic' compares nested models closest to the one with lowest AIC, 'llr' compares all nested models, 'hib' is a mix between the previous two. (default 'aic')
`preferPValue`	a logical, if TRUE (default) limit the search for best models among the ones with succeded the goodness of fit test.
`padj`	a logical, if TRUE (default) correct the p-values for multiple testing
`p_goodness_of_fit`	a numeric, the threshold for the goodness-of-fit test (default = .1)
`p_variability`	a numeric, a vector with the thresholds for the p-value of the variability test (one threshold for each rate, default = rep(.05, 3))
`limitModelComplexity`	a logical that limits the complexity of the function used to describe dynamics to the length of the time-course (default = FALSE)

Details

ratePvals retrieve a single p-value for each rate and gene associated to its variability (null hypothesis = the rate is not changing between the conditions)

Value

A matrix containing p-values calculated for each rate

See Also

`makeSimModel`, `makeSimDataset`

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
# Set the chi-squared threshold at .2 for nascentInspObj10 object
nascentInspObj10 <- calculateRatePvals(nascentInspObj10, p_goodness_of_fit=.2)
```

chisqmodel *Retrieve results of chi-squared test for the selected models*

Description

This method is used to retrieve the chi-squared test results for the models that have been selected to better represent the behavior of each gene.

Usage

```
chisqmodel(object, gc = NULL, tpts = NULL, ...)

## S4 method for signature 'INSPEcT'
chisqmodel(object, gc = NULL, tpts = NULL, ...)
```

Arguments

object	An object of class INSPEcT or INSPEcT_model
gc	Additional arguments for the generic
tpts	Additional arguments for the generic
...	Additional arguments for the generic

Value

A vector of chi-squared test results

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
chisqmodel(nascentInspObj10)
```

chisqtest *Retrieve all results of chi-squared test*

Description

This method is used to retrieve all the chi-squared test results for all models tested for all genes.

Usage

```
chisqtest(object, ...)

## S4 method for signature 'INSPEcT_model'
chisqtest(object, ...)

## S4 method for signature 'INSPEcT'
chisqtest(object, ...)
```

Arguments

object	An object of class INSPEcT or INSPEcT_model
...	Additional arguments for the generic

Value

A matrix of chi-squared test results for all the tested models

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
chisqtest(nascentInspObj10)
```

---

combine *Combine different Objects of Class INSPEcT*

Description

This method combines the information coming from different Objects of INSPEcT class. Requirements for two or more object to be combined together are:

- they must be either modeled or either not modeled
- they must have the same time points
- they must have the same modeling parameters

Usage

```
## S4 method for signature 'INSPEcT,INSPEcT'
combine(x, y, ...)
```

Arguments

x	An object of class INSPEcT
y	An object of class INSPEcT
...	Additional objects of class INSPEcT

Details

In case the same gene is contained in more than one object that the user tries to combine, the information from one object will be used and a warning will be reported

Value

An Object of class INSPEcT

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
nascentInspObj10_2genes <- nascentInspObj10[1:2]
nascentInspObj10_5genes <- nascentInspObj10[6:10]
nascentInspObj10_7genes <- combine(nascentInspObj10_2genes, nascentInspObj10_5genes)
```

`compareSteady` *Generate an object of class INSPEcT_diffsteady from an object of class INSPEcT*

Description

This method compares two object of class INSPEcT in order to identify differential usage of synthesis, processing or degradation rates in two different steady-state conditions. The two INSPEcT objects must have been profiled with replicates in order to provide a statistical significance to the differences between their rates.

Usage

```
compareSteady(inspectIds, BPPARAM = SerialParam())

## S4 method for signature 'INSPEcT'
compareSteady(inspectIds, BPPARAM = SerialParam())
```

Arguments

`inspectIds`	An object of calss INSPEcT with two conditions
`BPPARAM`	Configuration for BiocParallel parallelization. By default is set to SerialParam()

Value

An object of class INSPEcT_diffsteady which contains both the absolute quantification of the rates as well as the comparison with the statistical significance associated for each gene and rate. (See `INSPEcT_diffsteady-class`)

Examples

```
if( Sys.info()["sysname"] != "Windows" ) {
  data('allcounts', package='INSPEcT')
  data('featureWidths', package='INSPEcT')
  data('libsizes', package='INSPEcT')

  nascentCounts<-allcounts$nascent
  matureCounts<-allcounts$mature
  conditions<-letters[1:11]
  expDes<-rep(conditions,3)
  tL<-1/6
```

```
  nasExp_DESeq2<-quantifyExpressionsFromTrCounts(
        allcounts=nascentCounts
        ,libsize=nascentLS
        ,exonsWidths=exWdths
        ,intronsWidths=intWdths
        ,experimentalDesign=expDes)

  matExp_DESeq2<-quantifyExpressionsFromTrCounts(
        allcounts=matureCounts
        ,libsize=totalLS
        ,exonsWidths=exWdths
        ,intronsWidths=intWdths
        ,experimentalDesign=expDes)

  nasFullObj <- newINSPEcT(
        tpts=conditions
        ,labeling_time=tL
        ,nascentExpressions=nasExp_DESeq2
        ,matureExpressions=matExp_DESeq2)

  diffrates = compareSteady(nasFullObj[,c(1,11)])
}
```

`compareSteadyNoNascent` *Identify post-transcriptionally regulated genes from an object of class INSPEcT_diffsteady*

Description

This function compare exons and introns expression level matrices, from two up to an arbitrary number of samples, in order to identify genes which are oddly regluated, compared to an expected standard behaviour, from the post transcriptional point of view.

Usage

```
compareSteadyNoNascent(
  inspectIds,
  expressionThreshold = 0.25,
  log2FCThreshold = 2,
  trivialAngle = NaN,
  returnNormScores = FALSE,
  referenceCondition = "median"
)

## S4 method for signature 'INSPEcT_steadyNoNascent'
compareSteadyNoNascent(
  inspectIds,
```

```
  expressionThreshold = 0.25,
  log2FCThreshold = 2,
  trivialAngle = NaN,
  returnNormScores = FALSE,
  referenceCondition = "median"
)
```

Arguments

inspectIds	An object of class INSPEcT_steadyNoNascent
expressionThreshold	A parameter which sets how many log2 fold changes of distance from the median behaviour are imputable to noise.
log2FCThreshold	A parameter which sets the log2 fold change distance from the median behaviour that is imputable to noise.
trivialAngle	A numeric between 0 and 90 to define the standard behavior, if NaN (default) it is computed internally from the data.
returnNormScores	A logical, if TRUE returned the deviations from the standard behavior normalized by the sd.
referenceCondition	The label of the condition to use as reference, if NaN (default) the medians are used.

Examples

```
data('allcounts', package='INSPEcT')
data('featureWidths', package='INSPEcT')
data('libsizes', package='INSPEcT')

nascentCounts<-allcounts$nascent
matureCounts<-allcounts$mature
conditions<-letters[1:11]
expDes<-rep(conditions,3)

matExp_DESeq2<-quantifyExpressionsFromTrCounts(
      allcounts=matureCounts
      ,libsize=totalLS
      ,exonsWidths=exWdths
      ,intronsWidths=intWdths
      ,experimentalDesign=expDes)

matureInspObj <- newINSPEcT(tpts=conditions,matureExpressions=matExp_DESeq2)

matureInspObj<-compareSteadyNoNascent(inspectIds=matureInspObj
         ,expressionThreshold=0.25
        ,log2FCThreshold=.5)
regGenes <- PTreg(matureInspObj)
head(regGenes)
```

```
table(regGenes)
```

`computeConfidenceIntervals` *Compute confidence intervals*

Description

This function is used to compute the confidence intervals for a given set of modeled genes in the NoNascent scenario.

Usage

```
computeConfidenceIntervals(object, BPPARAM = SerialParam())

## S4 method for signature 'INSPEcT'
computeConfidenceIntervals(object, BPPARAM = SerialParam())
```

Arguments

`object`	An object of class INSPEcT_model
`BPPARAM`	Parallelization parameters for bplapply. By default SerialParam()

Value

An object of class INSPEcT.

`convergence` *Retrieve the convergence for the selected models of each gene*

Description

This method is used to retrieve the convergence of the models that have been selected to better represent the behavior of each gene. 0 is converged, 1 not converged, 10 degenerated

Usage

```
convergence(object)

## S4 method for signature 'INSPEcT'
convergence(object)
```

Arguments

`object`	An object of class INSPEcT or INSPEcT_model

Value

A vector of numeric

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
convergence(nascentInspObj10)
```

---

correlationPlot *Display rate classification performance*

Description

This function plot the rates of a simulated dataset against the modeled ones and compute their correlations.

Usage

```
correlationPlot(object, object2, plot = TRUE)

## S4 method for signature 'INSPEcT_model,INSPEcT'
correlationPlot(object, object2, plot = TRUE)
```

Arguments

object	An object of class INSPEcT_model with simulated rates.
object2	An object of class INSPEcT.
plot	A logical indicating whether to draw or not the plot. (default=TRUE)

Value

An list with the correlation values.

---

dim,INSPEcT-method *Dimensions of an Object of Class INSPEcT*

Description

A method to obtain the dimension of the object of class INSPEcT reported as a vector containing of the genes and the number of time points

Usage

```
## S4 method for signature 'INSPEcT'
dim(x)
```

Arguments

x	An object of class INSPEcT

Value

A numeric that indicates the number of genes within the object and the number of time points contained the object

See Also

nGenes, nTpts

Extract *Extract Parts of an INSPEcT or an INSPEcT_model Object*

Description

Operators acting on INSPEcT, INSPEcT_model or INSPEcT_diffsteady objects to extract parts. INSPEcT_model objects can be subsetted only by gene. INSPEcT objects can be subsetted either by gene id or time point. In case of subsetting an INSPEcT object by time point, the model should be empty.

Usage

```
## S4 method for signature 'INSPEcT_model,ANY,ANY,ANY'
x[i]

## S4 method for signature 'INSPEcT,ANY,ANY,ANY'
x[i, j]

## S4 method for signature 'INSPEcT_diffsteady,ANY,ANY,ANY'
x[i, j]
```

Arguments

x	An object of class INSPEcT or INSPEcT_model
i	A numeric, a vector of logicals or a vector of names indicating the features to be extracted
j	A numeric, a vector of logicals indicating the time points to be extracted

Value

An Object of class INSPEcT

See Also

removeModel

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
nascentInspObj10_5genes <- nascentInspObj10[1:5]
## Not run:
## This will turn out into an error:
nascentInspObj10_5genes_5tpts <- nascentInspObj10[1:5, 1:5]

## End(Not run)
## Before subsetting time points, the model should be removed:
nascentInspObj10_5genes_5tpts <- removeModel(nascentInspObj10)[1:5, 1:5]
```

---

featureNames,INSPEcT-method *Gene Names Associated with an Object of Class INSPEcT*

Description

A method to visualize gene names associated with the object of class INSPEcT

Usage

```
## S4 method for signature 'INSPEcT'
featureNames(object)

## S4 replacement method for signature 'INSPEcT'
featureNames(object) <- value
```

Arguments

object	An object of class INSPEcT
value	A character that will replace the current feature names

Value

A character that contains gene names associated with the object of class INSPEcT

---

featureWidths *Contains two variables: "exWdths" and "intWdths" containing the lenght of the exons and introns, respectively, relative to the genes in "allcounts"*

Description

Contains two variables: "exWdths" and "intWdths" containing the lenght of the exons and introns, respectively, relative to the genes in "allcounts"

Format

numeric vector of length 500

`geneClass` *Retrieve the regulatory class for each gene*

Description

This method returns a factor that summarise the gene class (transcriptional regulatory mechanism) that INSPEcT has assigned to each gene. The variability of each rate is indicated with a letter, 's' for synthesis, 'p' for processing and 'd' for degradation. In case more than one rate is variable, the letters associated to each variable rate are merged, for example 'sd' stands for a gene where synthesis and degradation cotributed to transcriptional changes. 'no-reg' is associated to genes with no change in transcription. The classification depends on the thresholds of the goodness-of-fit and rate variability tests that can be changed via the method `calculateRatePvals`.

Usage

```
geneClass(object, ...)

## S4 method for signature 'INSPEcT'
geneClass(object, ...)

## S4 method for signature 'INSPEcT_model'
geneClass(object, ...)

## S4 method for signature 'INSPEcT_diffsteady'
geneClass(object, ...)
```

Arguments

`object`	An object of class INSPEcT or INSPEcT_model
`...`	specify the threshold for rate variability 'bTsh' in case of 'INSPEcT_diffsteady' objects (default = .1)

Value

A character containing the regulatory class for each gene

See Also

`ratePvals`

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
geneClass(nascentInspObj10)
# see the classification with another threshold for rate variability
nascentInspObj10 <- calculateRatePvals(nascentInspObj10, p_variability=rep(1,3))
geneClass(nascentInspObj10)
```

`inHeatmap` *Heatmap that represent the fold changes of all the five features*

Description

A method to see as an heatmap the logRatios of synthesis, degradation and processing rates and pre-RNA and total RNA concentration of a population of genes, either at the level of etimated or modeled rates.

Usage

```
inHeatmap(
  object,
  type = "pre-model",
  breaks = seq(-1, 1, length.out = 51),
  palette = colorRampPalette(c("green", "black", "firebrick3")),
  plot_matureRNA = FALSE,
  absoluteExpression = TRUE,
  show_rowLabels = TRUE,
  clustering = TRUE,
  clustIdx = 3:5
)

## S4 method for signature 'INSPEcT'
inHeatmap(
  object,
  type = "pre-model",
  breaks = seq(-1, 1, length.out = 51),
  palette = colorRampPalette(c("green", "black", "firebrick3")),
  plot_matureRNA = FALSE,
  absoluteExpression = TRUE,
  show_rowLabels = TRUE,
  clustering = TRUE,
  clustIdx = 3:5
)
```

Arguments

`object`	An object of class INSPEcT

type	Eiher "pre-model" or "model" to switch between pre-modeled or modeled features
breaks	A vector of breaks for the heatmap
palette	A color generating function, output of colorRampPalette
plot_matureRNA	A logical. If set to TRUE, matrue-RNA is displayed instead of total-RNA (default: FALSE)
absoluteExpression	A logical. If set to FALSE, the plot representing the intensity of expression is omitted. (default=TRUE)
show_rowLabels	A logical defining whether rownames are reported or not. (default=TRUE)
clustering	A logical. If set to FALSE, it displys genes the order they are, with no clustering (default: TRUE)
clustIdx	A numeric. Indicates which of the features are used for the clustering. 0=absoluteExpression; 1=total-RNA/mature-RNA; 2=preMRNA; 3=synthesis; 4=degradation; 5=processing (default=3:5, meaning that synthesis, degradation and processing are used for the clustering)

Value

A list of matrices containing the logRatios for total RNA levels, pre-RNA levels, synthesis rates, degradation rates and processing rates. Matrices are ordered according to the clustering.

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
inHeatmap(nascentInspObj10, 'pre-model')
inHeatmap(nascentInspObj10, 'model')
```

`INSPEcT` *INSPEcT package*

Description

INSPEcT (INference of Synthesis, Processing and dEgradation rates from Transcriptomic data), is a package that analyse RNA-seq data in order to evaluate synthesis, processing and degradation rates and asses via modeling the rates that determines changes in RNA levels.

To see how the typical workflow of INSPEcT works, type:
`vignette('INSPEcT')`

INSPEcT implements two main classes (`INSPEcT` and `INSPEcT_diffsteady`) and their corresponding methods. To have a detailed description of how the two classes are structured and which methods apply on, type:

```
?'INSPEcT-class'
?'INSPEcT_diffsteady-class'
```

To obtain the citation, type:
`citation('INSPEcT')`

INSPEcT-class *An S4 class to contain all rates and models generated by INSPEcT*

Description

INSPEcT is a class able to store all the estimated rates and concentrations (slot ratesFirstGuess), the modeled rates and concentrations (slot modelRates) and the model themselves (slot model). Within the class INSPEcT other information regarding the experimental design are stored, such as the time points where experiments were performed (slot tpts) and, if provided, the nascent RNA collecting time (slot tL) and the normalization scale fators used for nascent (labeledSF) RNA-seq libraries. A list of parameters that will be used during the modeling process is stored within the slot params and can be accessed by `modelingParams`. A new instance of the class INSPEcT can be generated by the constructor function `newINSPEcT`.

Usage

```
## S4 method for signature 'INSPEcT'
show(object)
```

Arguments

`object`	An object of class INSPEcT

Details

Methods that apply to INSPEcT class are `AIC`
`[`
`calculateDelta`
`calculateRatePvals`
`calculateTau`
`chisqmodel`
`chisqtest`
`combine`
`compareSteady`
`compareSteadyNoNascent`
`computeConfidenceIntervals`
`correlationPlot`
`dim`
`featureNames`
`geneClass`
`inHeatmap`
`labeledSF`
`logLik`
`makeModelRates`
`makeOscillatorySimModel`
`makeSimModel`
`modelRates`

modelRatesNF
modelSelection
modelingParams
nGenes
nTpts
plotGene
processingDelay
ratePvals
ratesFirstGuess
ratesFirstGuessVar
removeModel
rocCurve
rocThresholds
setConfidenceIntervals
show
split
tpts
viewConfidenceIntervals
viewModelRates

Value

Method show for objects of class INSPEcT displays the main features of the slots ratesFirstGuess, model and modelRates

Slots

`params` A list of parameters of the modeling part

`ratesFirstGuess` An object of class ExpressionSet that contains all the rates and concentrations guessed from the first part of INSPEcT analysis (before modeling)

`ratesFirstGuessVar` An object of class ExpressionSet that contains the variances related to rates and concentrations guessed from the first part of INSPEcT analysis (before modeling)

`confidenceIntervals` An object of class ExpressionSet that contains the confidence intervals.

`model` An object of class INSPEcT_model that contains the output of the mdoeling.

`modelRates` An object of class ExpressionSet that contains all modeled the rates and concentrations.

`ratePvals` A matrix containing the p-value relative to the variability of synthesis, processing and degradation for each gene.

`tpts` A numeric vector of the time-points.

`labeledSF` A numeric vector of the scaling factor used for inter time-point normalization of Nascent-seq libraries.

`tL` A numeric containing the length of the Nascent pulse.

`NoNascent` A logical indicating if the nascent RNA was included into the analysis.

`NF` A logical indicating if the modeling approach is Non-Functional

`degDuringPulse` A logical indicating if degradation of RNA during the 4sU pulse was considered.

`version` A character indicating the version of INSPEcT that created the object

---

`INSPEcT-shinyApps` *Run shiny applications contained in the package INSPEcT*

Description

Two shiny apps are encoded into the package inspect: - runProcessingRateDelay: plots single genes as well as genome wide plots associated to the processing induced delay loading the data from an INSPEcT object. - runINSPEcTGUI: is a way to visualize and interact with the RNAdynamics at the level of a single gene, either loading the data from ad INSPEcT object or from scratch.

Usage

```
runProcessingRateDelay()

runINSPEcTGUI()
```

`inspectFromBAM` *Wrapper function from BAM files*

Description

Function to run the whole INSPEcT differential rate analysis procedure with a single line. The function save the output analysis to file that can be later loaded in the R environment or in the INSPEcT-GUI.

Usage

```
inspectFromBAM(
  txdb,
  annotation_table,
  labeling_time = NULL,
  strandSpecific = 0,
  isPairedEnd = FALSE,
  estimateRatesWith = "der",
  useSigmoidFun = TRUE,
  file = NULL
)
```

Arguments

txdb	A TranscriptDB object for the selected organism
annotation_table	Paths and experimental design associated to bam files. They could be provided directly as a 'data.frame', or as a path to the file containing the information. Possible file formats are csv' (comma-separated-values), 'tsv' (comma-separated-values), or 'xls' (Excel). In case 'annotation_table' has 2 colums named 'condition' and 'total', INSPEcT- analysis is run. In case 'annotation_table' has 3 colums named 'condition', 'total' and 'nascent', INSPEcT+ analysis is run. 'condition' is a colums indicating the experimental condition, a character vector (containing, for example, 'WT' or 'KD') in case of steady-state experiments, or numerical values indicating the time from the unperturbed condition in case of time-course analysis. 'total' and 'nascent' contains the path to totalRNA and nascentRNA BAM files, respectively.
labeling_time	A numeric indicating the time of labeling exposure to the modified nucleotide. To be indicated only in case of INSPEcT+ analysis.
strandSpecific	A numeric indicating the strandness of the BAM files, 0 for non strand-specific, 1 for stranded, 2 for reversely-stranded. 0 by default.
isPairedEnd	A logical indicating if paired-end sequencing have been performed. FALSE by default.
estimateRatesWith	Either "int" or "der". With "int" the degradation and processing rates are estimated integrating the system between one time point and the following. With "der" degradation and processing rates are estimated using the derivative of total and pre mRNA. (default is "der")
useSigmoidFun	A logical, whether to choose between sigmoid and impulse function to fit rates and concentrations. In case not, always impulse function is used. (default is TRUE)
file	A character indicating where the output of the analysis will be stored. If not provided the file name will be created automaticcally and saved on the current folder.

---

inspectFromPCR *Wrapper function from PCR quantifications*

Description

Function to run the whole INSPEcT differential rate analysis procedure with a single line. The function save the output analysis to file that can be later loaded in the R environment or in the INSPEcT-GUI.

Usage

```
inspectFromPCR(
  totalRNA_table,
  nascentRNA_table = NULL,
  labeling_time = NULL,
  estimateRatesWith = "der",
  useSigmoidFun = TRUE,
  file = NULL
)
```

Arguments

totalRNA_table	Exonic quantification, intronic quantification and experimental design associated to totalRNA of a single gene quantified by PCR. They could be provided directly as a 'data.frame', or as a path to the file containing the information. Possible file formats are csv' (comma-separated-values), 'tsv' (comma-separated-values), or 'xls' (Excel). 'totalRNA_table' must have 3 colums named 'condition', 'total_exonic' and 'total_intronic'. 'condition' is a column indicating the experimental condition, a character vector (containing, for example, 'WT' or 'KD') in case of steady-state experiments, or numerical values indicating the time from the unperturbed condition in case of time-course analysis. 'total_exonic' and 'total_intronic' contains abundance of gene measured in its exonic and intronic regions, respectively, in the total RNA fraction.
nascentRNA_table	similar to 'totalRNA_table' but referred to nascent RNA fraction. In this case, colums names must be 'condition', 'nascent_exonic' and 'nascent_intronic'. In case this infromation is not provided, INSPEcT- analysis is run. If otherwise this information is present, INSPEcT+ analysis is run.
labeling_time	A numeric indicating the time of labeling exposure to the modified nucleotide. To be indicated only in case of INSPEcT+ analysis.
estimateRatesWith	Either "int" or "der". With "int" the degradation and processing rates are estimated integrating the system between one time point and the following. With "der" degradation and processing rates are estimated using the derivative of total and pre mRNA. (default is "der")
useSigmoidFun	A logical, whether to choose between sigmoid and impulse function to fit rates and concentrations. In case not, always impulse function is used. (default is TRUE)
file	A character indicating where the output of the analysis will be stored. If not provided the file name will be created automaticcally and saved on the current folder.

Examples

```
if( Sys.info()["sysname"] != "Windows" ) {
totalAnnTabPCR <- system.file(package = 'INSPEcT', 'totalAnnTabPCR.csv')
nascentAnnTabPCR <- system.file(package = 'INSPEcT', 'nascentAnnTabPCR.csv')
```

```
inspectFromPCR(totalAnnTabPCR, nascentAnnTabPCR, labeling_time=1/6)
}
```

INSPEcT_diffsteady-class

An S4 class to represent comparisons between two steady-state conditions

---

Description

INSPEcT_diffsteady is a class able to store the results of the comparisons between two steady states. An object of class INSPEcT_diffsteady is created with the method "compareSteady" applied on two "INSPEcT" objects (see compareSteady).

Usage

```
synthesis(object)

processing(object)

degradation(object)

## S4 method for signature 'INSPEcT_diffsteady'
show(object)

## S4 method for signature 'INSPEcT_diffsteady'
synthesis(object)

## S4 method for signature 'INSPEcT_diffsteady'
processing(object)

## S4 method for signature 'INSPEcT_diffsteady'
degradation(object)

## S4 method for signature 'INSPEcT_diffsteady'
featureNames(object)
```

Arguments

object	An object of class INSPEcT_model

Details

Methods associated to the class INSPEcT_diffsteady are:

- synthesis: Accessor to the synthesis rates and their comparisons.
- degradation: Accessor to the degradation rates and their comparisons.
- processing: Accessor to the processing rates and their comparisons.
- plotMA: visualization fuction for rates comparisons, see plotMA

Value

Method show for objects of class INSPEcT_model returns the number of the genes that have been modeled

Slots

`synthesis` A data.frame which contains both input data and comparisons results regarding synthesis rates

`degradation` A data.frame which contains both input data and comparisons results regarding degradation rates

`processing` A data.frame which contains both input data and comparisons results regarding processing rates

`modeling_res` A data.frame which contains modeling results

Examples

```
if( Sys.info()["sysname"] != "Windows" ) {
  data('allcounts', package='INSPEcT')
  data('featureWidths', package='INSPEcT')
  data('libsizes', package='INSPEcT')

  nascentCounts<-allcounts$nascent
  matureCounts<-allcounts$mature
  conditions<-letters[1:11]
  expDes<-rep(conditions,3)
  tL<-1/6

  nasExp_DESeq2<-quantifyExpressionsFromTrCounts(
        allcounts=nascentCounts
        ,libsize=nascentLS
        ,exonsWidths=exWdths
        ,intronsWidths=intWdths
        ,experimentalDesign=expDes)

  matExp_DESeq2<-quantifyExpressionsFromTrCounts(
        allcounts=matureCounts
        ,libsize=totalLS
        ,exonsWidths=exWdths
        ,intronsWidths=intWdths
        ,experimentalDesign=expDes)

  nasFullObj <- newINSPEcT(tpts=conditions,labeling_time=tL
        ,nascentExpressions=nasExp_DESeq2,matureExpressions=matExp_DESeq2)

  diffrates = compareSteady(nasFullObj[,c(1,11)])
  head(synthesis(diffrates))
}
if( Sys.info()["sysname"] != "Windows" ) {
  head(processing(diffrates))
}
```

```
if( Sys.info()["sysname"] != "Windows" ) {
  head(degradation(diffrates))
}
if( Sys.info()["sysname"] != "Windows" ) {
  featureNames(diffrates)
}
```

INSPEcT_model-class *An S4 class to represent models generated by INSPEcT*

Description

INSPEcT_model is a class able to store all the results of the modeling of synthesis, processing and degradation rates made via the method modelRates (slot ratesSpecs). It also stores the criteria (slot parameter) to choose between the many models tested for each gene the one that better describes the data and the results. The slot simple is a flag that distinguish wheter the model contains the information of the introns or not. In case not, the flag simple is set to TRUE. Also the method makeSimModel of class INSPEcT-class creates an object of class INSPEcT_model. This object will be used by makeSimDataset to generate a complete simulated data-set, whose classification performance can be tested.

Usage

```
## S4 method for signature 'INSPEcT_model'
show(object)
```

Arguments

object	An object of class INSPEcT_model

Details

Methods that apply to INSPEcT_model class are [
AIC
chisqtest
correlationPlot
geneClass
logLik
makeModelRates
makeSimDataset
modelSelection
rocCurve
rocThresholds
show

Value

Method show for objects of class INSPEcT_model returns the number of the genes that have been modeled

Slots

`params` A list that defines thresholds and how to perform log likelihood ratio tests

`ratesSpecs` A list containing the modeling output

`simple` A logical that indicates whether the mode of INSPEcT is simple (no pre-mRNA and degradation rates) or not.

INSPEcT_steadyNoNascent-class

An S4 class to represent steady-state analysis without nascent RNA

Description

INSPEcT_steadyNoNascent is a class able to store data and arguments that are necessary to make the analysis concerning premature and mature expressions in different samples. In particular, the ratio between mature and premature can be calculated, which reflects the ratio between the rates of processing and degradation in individaul genes (see `PTratio`), and the analysis of post-transcriptionally regualted genes can be run to identify genes that in specfic samples show a trand which cannot be attributed to transcriptional regulation alone (see `PTreg`).

Usage

```
## S4 method for signature 'INSPEcT_steadyNoNascent,ANY,ANY,ANY'
x[i, j]

## S4 method for signature 'INSPEcT_steadyNoNascent'
show(object)
```

Arguments

`x`	An object of class INSPEcT_steadyNoNascent
`i`	A numeric, a vector of logicals indicating the rows to be extracted
`j`	A numeric, a vector of logicals indicating the columns to be extracted
`object`	An object of class INSPEcT_steadyNoNascent

Value

Method show for objects of class INSPEcT_steadyNoNascent

Slots

`sampleNames` Vector with the names of the samples (columns of the dataset)

`geneNames` Vector with the names of the genes (rows of the dataset)

`premature` Matrix containing the expressions of the premature RNAs (row=genes, columns=samples)

`mature` Matrix containing the expressions of the emature RNAs (row=genes, columns=samples)

`prematureVar` Matrix containing the expressions variances of the premature RNAs (row=genes, columns=samples)

`matureVar` Matrix containing the expressions variances of the emature RNAs (row=genes, columns=samples)

`trivialAngle` Numeric that indicates the angle (slope) of the linear model between mature and premature expressions

`log2FCThreshold` Numeric that describes the threshold of the variation to be considered significant

`expressionThreshold` Numeric that describes the threshold of the expression to consider the gene expressed

`referenceCondition` A sample identifier that set the reference for the post-transcriptional regulation analysis, if NULL the median of all samples is used

`ptreg` Matrix containing the post-transcriptioanl regulation state of each gene in the different samples (row=genes, columns=samples)

`labeledSF` *Accessor to the slot labeledSF of an INSPEcT object*

Description

Accessor to obtain the labeledSF slot associated with the object of class INSPEcT

Usage

```
labeledSF(object)

## S4 method for signature 'INSPEcT'
labeledSF(object)
```

Arguments

`object`	An object of class INSPEcT

Value

A numeric that indicates the scaling factors applied between time points of the data coming from Nascent-seq library (applies directly to synthesis rates and indirectly to degradation rates)

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
labeledSF(nascentInspObj10)
```

libsizes *Contains two variables: "nascentLS" and "totalLS" containing the sequencing depth of nascent and total libraries respectively, relative to the experiments in "allcounts"*

Description

Contains two variables: "nascentLS" and "totalLS" containing the sequencing depth of nascent and total libraries respectively, relative to the experiments in "allcounts"

Format

numeric vector of length 33

logLik *Retrieve results of log likelihood test*

Description

This method is used to retrieve all the log likelihood ratio test results for all pairs tested for all genes.

Usage

```
logLik(object, ...)

## S4 method for signature 'INSPEcT_model'
logLik(object, ...)

## S4 method for signature 'INSPEcT'
logLik(object, ...)
```

Arguments

object	An object of class INSPEcT or INSPEcT_model
...	Additional arguments for the generic

Value

A matrix of log likelihood test results for all the tested model comparisons

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
logLik(nascentInspObj10)
```

makeModelRates *Calculate modeled rates and concentrations*

Description

This function is used to evaluate rates and concentrations after modeling of the rates has been run with modelRates. The modeled rates are in functional form and can be evaluated at any time points.

This method can be used to regenerate the rates assiciated to the modeling, in case some testing parameters has changed.

Usage

```
makeModelRates(object, ...)

## S4 method for signature 'INSPEcT_model'
makeModelRates(object, ...)

## S4 method for signature 'INSPEcT'
makeModelRates(object, ...)
```

Arguments

object	An object of class INSPEcT_model
...	additional arguments tpts : A vector of time points where rates and concentrations have to be evaluated

Value

An object of class ExpressionSet containing the modeled rates and concentrations

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
viewModelRates(nascentInspObj10, 'degradation')
## force every degradation rate to be accepted as variable (makeModelRates is called internally)
nascentInspObj10 <- calculateRatePvals(nascentInspObj10, p_variability = c(.05,.05,1))
viewModelRates(nascentInspObj10, 'degradation')
```

`makeOscillatorySimModel` *Build the synthetic rates with oscillatory pattern*

Description

This method allow the creation of synthesis, degradation and processing rates that generate an oscillatory expression with a period of 24 hours. Two modes are available: one where oscillations arise just by oscillations in the synthesis of the genes (oscillatoryk3=FALSE, default) and another one where both synthesis and degradation rates oscillates (oscillatoryk3=TRUE). In this latter case, the oscillations of the two rates can be coupled by a cetrain delay (parametrer k3delay). After the creation of the synthetic rates, a dataset with noise and contamination added can be made by `makeSimDataset`.

Usage

```
makeOscillatorySimModel(
  object,
  nGenes,
  oscillatoryk3 = FALSE,
  k3delay = NULL,
  na.rm = TRUE,
  seed = NULL
)

## S4 method for signature 'INSPEcT'
makeOscillatorySimModel(
  object,
  nGenes,
  oscillatoryk3 = FALSE,
  k3delay = NULL,
  na.rm = TRUE,
  seed = NULL
)
```

Arguments

`object`	An object of class INSPEcT
`nGenes`	A numeric with the number of synthtic genes to be created
`oscillatoryk3`	A logical that enables also degradation rate to oscillate
`k3delay`	A numeric that set the delay between synthesis and degradation oscillations. When NULL, no coupling between the two oscillations is set.
`na.rm`	A logical that set whether missing values in the real dataset should be removed
`seed`	A numeric to obtain reproducible results

Value

An object of class INSPEcT_model with synthetic rates

See Also

makeSimModel

Examples

```
nascentInspObj <- readRDS(system.file(package='INSPEcT', 'nascentInspObj.rds'))
simRates<-makeOscillatorySimModel(nascentInspObj, 1000, seed=1)
table(geneClass(simRates))
```

---

makeSimDataset *Generate synthetic rates and concentrations*

Description

This method generates rates and concentrations where noise is added according to the desired number of replicates that the user set as an arguments from the INSPEcT_model object that has been created by the method of the class INSPEcT makeSimModel. Rates and concentrations can be generated at the time-points of interest within the original time window. This method generates an INSPEcT object that can be modeled and the performance of the modeling can be tested directly aginst the INSPEcT_model object created by makeSimModel.

Usage

```
makeSimDataset(
  object,
  tpts,
  nRep,
  NoNascent = FALSE,
  seed = NULL,
  b = 0.3,
  tL = 1/6,
  noise_sd = 4
)

## S4 method for signature 'INSPEcT_model'
makeSimDataset(
  object,
  tpts,
  nRep,
  NoNascent = FALSE,
  seed = NULL,
  b = 0.3,
  tL = 1/6,
```

```
  noise_sd = 4
)
```

Arguments

object	An object of class INSPEcT_model, usually the output of makeSimModel
tpts	A numeric vector of time points where rates and concentrations have to be evaluated
nRep	Number of replicates to simulate
NoNascent	A logical which, if true, makes the output of the method suitable for an analysis without Nascent. (default=FALSE)
seed	A numeric to obtain reproducible results. When NULL (default) no seed is set.
b	A numeric which represents the probability of contamination of the unlabeled sample due to the labled one
tL	A numeric which represents the labeling time for an ideal nascent RNA profiling, it is required for the contamination analysis. (default=1/6)
noise_sd	A numeric which represents the noise standard deviation. (default=4)

Value

An object of the class ExpressionSet containing rates and concentrations

See Also

makeSimModel

Examples

```
if( Sys.info()["sysname"] != "Windows" ) {
  nascentInspObj <- readRDS(system.file(package='INSPEcT', 'nascentInspObj.rds'))
  simRates<-makeSimModel(nascentInspObj, 1000, seed=1)
  tpts <- tpts(nascentInspObj)
 nascentSim2replicates <- makeSimDataset(object=simRates,tpts=tpts,nRep=3,NoNascent=FALSE,seed=1)
}
```

---

makeSimModel *Build the synthetic rates shaped on a dataset*

Description

This method allow the creation of synthesis, degradation and processing rates for a certain number of genes. The rates are created according to the distributions of the real data-set which is given as an input of the method. Different proportions of constant varying rates can be set and a new vector of time points can be provided. This method has to be used before the makeSimDataset method.

Usage

```
makeSimModel(
  object,
  nGenes,
  newTpts = NULL,
  probs = c(constant = 0.5, sigmoid = 0.3, impulse = 0.2),
  na.rm = TRUE,
  seed = NULL
)

## S4 method for signature 'INSPEcT'
makeSimModel(
  object,
  nGenes,
 probs = rbind(synthesis = c(constant = 0.5, sigmoid = 0.3, impulse = 0.2), processing
  = c(constant = 0.5, sigmoid = 0.3, impulse = 0.2), degradation = c(constant = 0.5,
    sigmoid = 0.3, impulse = 0.2)),
  na.rm = TRUE,
  seed = NULL
)
```

Arguments

object	An object of class INSPEcT
nGenes	A numeric with the number of synthtic genes to be created
newTpts	A numeric verctor with time points of the synthtic dataset, if NULL the time points of the real dataset will be used
probs	A numeric matrix wich describes the probability of each rate (rows) to be constant, shaped like a sigmoid or like an impulse model (columns)
na.rm	A logical that set whether missing values in the real dataset should be removed
seed	A numeric to obtain reproducible results

Details

The method makeSimModel generates an object of class INSPEcT_model that stores the parametric functions to genrate clean rates of a time-course. To any of the rates also a noise variance is associate but not used yet. In a typical workflow the output of makeSimModel is the input of the method makeSimDataset, that build the noisy rates and concentrations, given a specified number of replicates.

Value

An object of class INSPEcT_model with synthetic rates

See Also

makeSimDataset

Examples

```
nascentInspObj <- readRDS(system.file(package='INSPEcT', 'nascentInspObj.rds'))
simRates<-makeSimModel(nascentInspObj, 1000, seed=1)
table(geneClass(simRates))
```

`mature` *Get mature RNA expressions from an object of class INSPEcT_diffsteady*

Description

Extract mature RNA expressions

Usage

```
mature(object)

## S4 method for signature 'INSPEcT_steadyNoNascent'
mature(object)
```

Arguments

`object`	An object of class INSPEcT_steadyNoNascent

Value

A matrix containing mature RNA expressions

`matureVar` *Get mature RNA expressions variances from an object of class INSPEcT_diffsteady*

Description

Extract mature RNA expressions variances

Usage

```
matureVar(object)

## S4 method for signature 'INSPEcT_steadyNoNascent'
matureVar(object)
```

Arguments

`object`	An object of class INSPEcT_steadyNoNascent

Value

A matrix containing mature RNA expressions variances

`modelingParams` *Get and set number parameters for the modeling*

Description

A method to get the parameters used for modeling rates and concentrations by the method `modelRates`

Usage

```
modelingParams(object)

## S4 method for signature 'INSPEcT'
modelingParams(object)
```

Arguments

`object`	An object of class INSPEcT

Value

List of parameters and their values

- estimateRatesWith Either "int" or "der". With "int" the degradation and processing rates are estimated integrating the system between one time point and the following. With "der" degradation and processing rates are estimated using the derivative of total and pre mRNA.
- useSigmoidFun A logical, whether to choose between sigmoid and impulse function to fit rates and concentrations. In case not, always impulse function is used.
- testOnSmooth A logical, wheter models should be tested on smoothed pre-mRNA, total mRNA and eventually synthesis rates or not.
- nInit number of optimization to find the best functional representation of each rate
- nIter number of max iteration during optimization
- Dmin lower bondary for degradation rates in the NoNascent mode
- Dmax upper bondary for degradation rates in the NoNascent mode
- seed A numeric, indicatindg the seed set for reproducible results.

See Also

`modelRates`

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
modelingParams(nascentInspObj10)
```

`modelRates` *Launch the modeling process*

Description

Launch the modeling process with parameters set with `modelingParams`

This method model the synthesis, degradation and processing rates after their estimation by the constructor function `newINSPEcT`. Estimated rates are not guaranteed to optimally describes provided input data yet. To this purpose, modeled rates can be generated and genes can be assigned to a transcriptional regulatory mechanism. Modeled rates can be accessed via the method `viewModelRates` and gene classification according to the regulatory mechanism can be accessed by `geneClass`. The modeling options used for the modeling can be later accessed by the user via `modelingParams`. After modeling, model selection is run by the method `calculateRatePvals` with default parameters.

Usage

```
modelRates(
  object,
  estimateRatesWith = c("der", "int"),
  useSigmoidFun = TRUE,
  nInit = 10,
  nIter = 300,
  Dmin = 1e-06,
  Dmax = 10,
  seed = NULL,
  BPPARAM = SerialParam()
)

## S4 method for signature 'INSPEcT'
modelRates(
  object,
  estimateRatesWith = c("der", "int"),
  useSigmoidFun = TRUE,
  nInit = 10,
  nIter = 300,
  Dmin = 1e-06,
  Dmax = 10,
  seed = NULL,
  BPPARAM = SerialParam()
)
```

Arguments

`object`	An object of class INSPEcT
`estimateRatesWith`	Either "int" or "der". With "int" the degradation and processing rates are estimated integrating the system between one time point and the following. With

	"der" degradation and processing rates are estimated using the derivative of total and pre mRNA. (default is "der")
useSigmoidFun	A logical, whether to choose between sigmoid and impulse function to fit rates and concentrations. In case not, always impulse function is used. (default is TRUE)
nInit	number of optimization to find the best functional representation of each rate (by default 10)
nIter	number of max iteration during optimization (default is 300)
Dmin	lower bondary for degradation rates in the NoNascent mode (default 1e-06)
Dmax	upper bondary for degradation rates in the NoNascent mode (default 10)
seed	A numeric, indicatindg the seed to be set for reproducible results. If NULL it is randomly selected (default NULL)
BPPARAM	Parallelization parameters for bplapply. By default SerialParam()

Value

An object of class INSPEcT with modeled rates

See Also

viewModelRates, calculateRatePvals, geneClass

Examples

```
if( Sys.info()["sysname"] != "Windows" ) {
 nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
 ## models removal
 nascentInspObjThreeGenes <- removeModel(nascentInspObj10[1:3])
 nascentInspObjThreeGenes <- modelRates(nascentInspObjThreeGenes,
   seed=1, BPPARAM=SerialParam())
 ## view modeled synthesis rates
 viewModelRates(nascentInspObjThreeGenes, 'synthesis')
 ## view gene classes
 geneClass(nascentInspObjThreeGenes)
}
```

---

modelRatesNF *Launch the modeling process without imposing sigmoid/impulse functional form*

Description

This method compute confidence intervals for the rates of synthesis, degradation and processing estimated by newINSPEcT that will be used to estimate the variability of each rate in ratePvals method.

Usage

```
modelRatesNF(object, BPPARAM = SerialParam())

## S4 method for signature 'INSPEcT'
modelRatesNF(object, BPPARAM = SerialParam())
```

Arguments

object	An object of class INSPEcT
BPPARAM	Parallelization parameters for bplapply. By default SerialParam()

Value

An object of class INSPEcT with modeled rates

Examples

```
if( Sys.info()["sysname"] != "Windows" ) {
 nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
 ## models removal
 nascentInspObjThreeGenes <- removeModel(nascentInspObj10[1:3])
 nascentInspObjThreeGenes <- modelRatesNF(nascentInspObjThreeGenes,
   BPPARAM=SerialParam())
 ## view modeled synthesis rates
 viewModelRates(nascentInspObjThreeGenes, 'synthesis')
 ## view gene classes
 geneClass(nascentInspObjThreeGenes)
}
```

---

modelSelection *Visualize criteria used for rate variability*

Description

Method to visualize the criteria used to assess variability of rates.

Usage

```
modelSelection(object)

## S4 method for signature 'INSPEcT'
modelSelection(object)

## S4 method for signature 'INSPEcT_model'
modelSelection(object)
```

Arguments

object	An object of class INSPEcT or INSPEcT_model

Value

- modelSelection 'aic' compares nested models closest to the one with lowest AIC, 'llr' compares all nested models, 'hib' is a mix between the previous two. (default 'aic')
- preferPValue a logical, if TRUE (default) limit the search for best models among the ones with succeded the goodness of fit test.
- padj a logical, if TRUE (default) correct the p-values for multiple testing
- goodness_of_fit a numeric, the threshold for the goodness-of-fit test (default = .1)
- variability a numeric, a vector with the thresholds for the variability test (one threshold for each rate, default = c('s'=05, 'p'=.05, 'd'=.05))
- limitModelComplexity a logical that limits the complexity of the function used to describe dynamics to the length of the time-course (default = FALSE)

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
modelSelection(nascentInspObj10)
```

---

newINSPEcT *Create a new INSPEcT object*

Description

The function newINSPEcT creates a new instance of the class INSPEcT provided the experimental time points, expression data (like RPKMs) of mature and eventually nascent RNA. For the nascent analysis, it is also requires a collecting time and the scaling factor to normalize the nascent RNA-seq libraries. This latter parameter can also be calculated by the function itself if both exonic and intronic expression data are provided; otherwise it must be given as an input and it is essential to guarantee the robustness of the analysis.

Usage

```
newINSPEcT(
  tpts,
  labeling_time = NULL,
  nascentExpressions = NULL,
  matureExpressions,
  preexisting = FALSE,
  BPPARAM = SerialParam(),
  labeledSF = NULL,
  simulatedData = FALSE,
  degDuringPulse = FALSE,
  Dmin = 1e-06,
  Dmax = 10,
  genesFilter = TRUE,
  genesFilterThreshold = 2/3,
  imputeNAs = TRUE
)
```

Arguments

tpts	A vector of time points, one for each sample
labeling_time	A number, lenght of the Nascent pulse
nascentExpressions	A list which contains exons and introns expression matrices and variances for the nascent RNA
matureExpressions	A list which contains exons and introns expression matrices and variances for the mature RNA
preexisting	A logical, indicating if the mature expression refers to the pre-exising (unlabeled) population. Not implemented yet for the "degDuringPulse" mode.
BPPARAM	Configuration for BiocParallel parallelization. By default is set to SerialParam()
labeledSF	A vector storing user defined normalization scale over Nascent RNA exons and introns quantifications
simulatedData	A logical, set to TRUE in case the analysis is on simulated data
degDuringPulse	A logical, set to TRUE in case of a long labelling time. Also degradation of newly synthesized transcripts will be taken into account
Dmin	A numerical, it is the lower bound of the degradation rate domain for the prior optimization
Dmax	A numerical, it is the upper bound of the degradation rate domain for the prior optimization
genesFilter	A logical, if TRUE, filters out genes which have no signal in at least a given fraction (2/3 by default) of the observations
genesFilterThreshold	A number, threshold to use for genes filtering (2/3 by default)
imputeNAs	A logical, if TRUE the rates first guess which are not finite are imputed from the neighbours.

Value

An object of class INSPEcT with a first estimation of the rates which can be accessed by the method ratesFirstGuess

Examples

```
data('allcounts', package='INSPEcT')
data('featureWidths', package='INSPEcT')
data('libsizes', package='INSPEcT')

matureCounts<-allcounts$mature
tpts <- c(0,1/6,1/3,1/2,1,1.5,2,4,8,12,16)
expDes<-rep(tpts,3)

matExp_DESeq2<-quantifyExpressionsFromTrCounts(
  allcounts=matureCounts
  ,libsize=totalLS
```

```
  ,exonsWidths=exWdths
  ,intronsWidths=intWdths
  ,experimentalDesign=expDes)

matureInspObj<-newINSPEcT(tpts=tpts
                          ,labeling_time=NULL
                          ,nascentExpressions=NULL
                          ,matureExpressions=matExp_DESeq2)
```

`nGenes` *Get the number of genes within the INSPEcT object*

Description

A method to obtain the number of the genes associated with the object of class INSPEcT

Usage

```
nGenes(object)

## S4 method for signature 'INSPEcT'
nGenes(object)
```

Arguments

`object`	An object of class INSPEcT

Value

A numeric that indicates the number of genes within the object

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
nGenes(nascentInspObj10)
```

`nTpts` *Get the number of time points within the INSPEcT object*

Description

A method to obtain the number of the tpts associated with the object of class INSPEcT

Usage

```
nTpts(object)

## S4 method for signature 'INSPEcT'
nTpts(object)
```

Arguments

object	An object of class INSPEcT

Value

A numeric that indicates the number of time points contained the object

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
nTpts(nascentInspObj10)
```

---

plotGene *Plot the pre-modeled and modeled profiles for one gene*

Description

A method to see the shapes of the estimated synthesis, degradation and processing rates, pre-RNA and total RNA concentrations (solid thin lines) their variances (dashed lines) and the modeled rates and concentrations (ticker solid line) of a single gene.

Usage

```
plotGene(
  object,
  ix,
  relative_expression = FALSE,
  fix.yaxis = FALSE,
  priors = TRUE,
  constantModel = FALSE
)

## S4 method for signature 'INSPEcT'
plotGene(
  object,
  ix,
  relative_expression = FALSE,
  fix.yaxis = FALSE,
  priors = TRUE,
  constantModel = FALSE
)
```

Arguments

object	An object of class INSPEcT
ix	Eiher a rowname or a row number to select one single gene
relative_expression	A logical, indicating whether expressions are rates should be plotted relative to their initial value (Default=FALSE).
fix.yaxis	A logical, indicating whether the limits for y-axis of degradation and processing rates should be fixed relative to their distributions
priors	A logical, if true the priors of the rates are plotted
constantModel	A logical, if true the constant model for the + nascent modeling are shown

Value

A list containing total RNA levels and their confidence interval (levels plus and minus one standard deviation), pre-RNA lelevs and their confidence intervals, synthsis rates and their confidence intervals, degradation rates and processing rates of the selected gene.

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
plotGene(nascentInspObj10, 1)
```

---

plotMA *MA-plot from base means and log fold changes*

Description

Visualize the comparison between the rates calculated from two different INSPEcT objects profiled in steady-state conditions.

Usage

```
## S4 method for signature 'INSPEcT_diffsteady'
plotMA(object, ...)
```

Arguments

object	An object of calss INSPEcT_diffsteady
...	Additional parameters, see Details section

Details

Possible arguments to "plotMA":

- "rate" - A character, which represent the rate to be visualized, either "synthesis", "processing" or "degradation". By default, "synthesis" is chosen.
- "padj" - A numeric, The p-adjusted threshold for significance. Genes with p-adjusted lower than the threshold will be depicted as orange triangles. By default set to -Inf, meaning that no genes will be highlighted.
- "xlim" - A numeric vector of length 2, limits of x-axis, by default the range of the data.
- "xlab" - A character, the label of x-axis, by default "log2 geometric mean"
- "ylim" - A numeric vector of length 2, limits of y-axis, by default the range of the data.
- "ylab" - A character, the label of y-axis, by default "log2 fold change"
- "main" - A character, the title of the plot, by default the name of the visualized rate.

See Also

http://en.wikipedia.org/wiki/MA_plot

Examples

```
if( Sys.info()["sysname"] != "Windows" ) {
  data('allcounts', package='INSPEcT')
  data('featureWidths', package='INSPEcT')
  data('libsizes', package='INSPEcT')

  nascentCounts<-allcounts$nascent
  matureCounts<-allcounts$mature
  conditions<-letters[1:11]
  expDes<-rep(conditions,3)
  tL<-1/6

  nasExp_DESeq2<-quantifyExpressionsFromTrCounts(
        allcounts=nascentCounts
        ,libsize=nascentLS
        ,exonsWidths=exWdths
        ,intronsWidths=intWdths
        ,experimentalDesign=expDes)

  matExp_DESeq2<-quantifyExpressionsFromTrCounts(
        allcounts=matureCounts
        ,libsize=totalLS
        ,exonsWidths=exWdths
        ,intronsWidths=intWdths
        ,experimentalDesign=expDes)

  nasFullObj <- newINSPEcT(tpts=conditions
        ,labeling_time=tL
        ,nascentExpressions=nasExp_DESeq2
        ,matureExpressions=matExp_DESeq2)
```

```
  diffrates = compareSteady(nasFullObj[,c(1,11)])

  plotMA(diffrates, padj=.01)
}
```

`plotPMgene` *Plot the premature/mature expression of a gene and the global trend from an object of class INSPEcT_diffsteady*

Description

Plot the premature and mature expressions of a specific gene in the different samples of the dataset along with the null model and the log2 fold change threshold. Individual observations that fall outside of the dashed lines are considered post-transcriptional events.

Usage

```
plotPMgene(object, gene_id, samples_colors = 1)

## S4 method for signature 'INSPEcT_steadyNoNascent'
plotPMgene(object, gene_id, samples_colors = 1)
```

Arguments

`object`	An object of class INSPEcT_steadyNoNascent
`gene_id`	A numeric that indicated the index of the gene to be plotted
`samples_colors`	The color code relative to the samples

`plotPMtrend` *Plot the premature/mature trend from an object of class INSPEcT_diffsteady*

Description

Plot the null model estimated for the specific dataset. The null model is the trend between premature and mature expression, which is usually linear in the log-log scale and generally points to an increase in the ratio between premature and mature RNA at increased levels of expression

Usage

```
plotPMtrend(inspectIds)

## S4 method for signature 'INSPEcT_steadyNoNascent'
plotPMtrend(inspectIds)
```

Arguments

inspectIds	An object of class INSPEcT_steadyNoNascent

---

premature *Get premature RNA expressions from an object of class INSPEcT_diffsteady*

Description

Extract premature RNA expressions

Usage

```
premature(object)

## S4 method for signature 'INSPEcT_steadyNoNascent'
premature(object)
```

Arguments

object	An object of class INSPEcT_steadyNoNascent

Value

A matrix containing premature RNA expressions

---

prematureVar *Get premature RNA expressions variances from an object of class INSPEcT_diffsteady*

Description

Extract premature RNA expressions variances

Usage

```
prematureVar(object)

## S4 method for signature 'INSPEcT_steadyNoNascent'
prematureVar(object)
```

Arguments

object	An object of class INSPEcT_steadyNoNascent

Value

A matrix containing premature RNA expressions variances

`processingDelay` *Classify genes as delayed by the processing using the delta and tau metrics*

Description

These functions calculates the tau and delta metrics for all genes with introns and exons in an oblect of class INSPEcT. If the INSPEcT dataset was obtained with nascent RNA the metrics are caluclated using RNA dynamics and solving numerically the system of equations. If the INSPEcT dataset was obtained without nascent RNA the metrics are approximated using premature and mature levels.

Usage

```
processingDelay(
  inspectIds,
  tauThreshold = 1.2,
  deltaThreshold = 1,
  silent = TRUE
)

calculateDelta(inspectIds, silent = FALSE)

calculateTau(inspectIds, silent = FALSE)

## S4 method for signature 'INSPEcT'
processingDelay(
  inspectIds,
  tauThreshold = 1.2,
  deltaThreshold = 1,
  silent = TRUE
)

## S4 method for signature 'INSPEcT'
calculateTau(inspectIds, silent = FALSE)

## S4 method for signature 'INSPEcT'
calculateDelta(inspectIds, silent = FALSE)
```

Arguments

`inspectIds`	An object of class INSPEcT.
`tauThreshold`	A numeric representing the tau threshold to define a gene affected by processing. Default: 1.2
`deltaThreshold`	A numeric representing the delta threshold to define a gene affected by processing. Default: 1.0
`silent`	A logical indicating whether informaiton about the procedure should be printed or not.

Examples

```
data('allcounts', package='INSPEcT')
data('featureWidths', package='INSPEcT')
data('libsizes', package='INSPEcT')

nascentCounts<-allcounts$nascent
matureCounts<-allcounts$mature
conditions<-c(0,1/6,1/3,1/2,1,1.5,2,4,8,12,16)
expDes<-rep(conditions,3)
tL <- 1/6

nasExp_DESeq2<-quantifyExpressionsFromTrCounts(
      allcounts=matureCounts
      ,libsize=totalLS
      ,exonsWidths=exWdths
      ,intronsWidths=intWdths
      ,experimentalDesign=expDes)

matExp_DESeq2<-quantifyExpressionsFromTrCounts(
      allcounts=matureCounts
      ,libsize=totalLS
      ,exonsWidths=exWdths
      ,intronsWidths=intWdths
      ,experimentalDesign=expDes)

matureInspObj <- newINSPEcT(
      tpts=conditions
      ,labeling_time=tL
      ,nascentExpressions=nasExp_DESeq2
      ,matureExpressions=matExp_DESeq2)

procDelay<- processingDelay(inspectIds=matureInspObj
      ,tauThreshold=1.2
      ,deltaThreshold=1.0)

head(procDelay)
table(procDelay)

head(calculateTau(matureInspObj))

head(calculateDelta(matureInspObj))
```

`PTratio` *Calculate post-transcriptional ratio from an object of class INSPEcT_diffsteady*

Description

Extract the ratio between mature and premature RNAs

Usage

```
PTratio(object, infToNA = TRUE)

## S4 method for signature 'INSPEcT_steadyNoNascent'
PTratio(object, infToNA = TRUE)
```

Arguments

object	An object of class INSPEcT_steadyNoNascent
infToNA	A logical indicating whether infinite values (originating from zero valued premature expressions) should be set artificially to NA or not

Value

A matrix containing the PTratios

PTreg *Calculate the post-transcriptional ratio from an object of class INSPEcT_diffsteady*

Description

Extract the post-transcriptional regulation matrix

Usage

```
PTreg(object)

## S4 method for signature 'INSPEcT_steadyNoNascent'
PTreg(object)
```

Arguments

object	An object of class INSPEcT_steadyNoNascent

Value

A matrix containing the post-transcriptional regulated genes. This matrix is generated by the method compareSteadyStateNoNascent. It generally report 1 for regulated genes in specific samples, 0 for non regulated genes and NA for genes that do not passed the expression threshold. In case the argument returnNormScores was set to TRUE, instead of discretes values, the deviations from the expected model normalized by the experimental standard deviation is reported.

quantifyExpressionsFromBAMs *Evaluate introns and exons expressions from BAM or SAM files*

Description

Given a TranscriptDb object and a list of BAM or SAM files "quantifyExpressionsFormBAMs" evaluates exons and introns expressions and the associated variances per each gene.

Usage

```
quantifyExpressionsFromBAMs(
  txdb,
  BAMfiles,
  experimentalDesign,
  by = c("gene", "tx"),
  countMultiMappingReads = FALSE,
  allowMultiOverlap = FALSE,
  prioritizeExons = TRUE,
  libsize = c("assigned", "all"),
  strandSpecific = 0,
  isPairedEnd = FALSE,
  DESeq2 = TRUE,
  varSamplingCondition = NULL,
  BPPARAM = SerialParam()
)
```

Arguments

txdb	A TranscriptDB object
BAMfiles	A vector of paths
experimentalDesign	A numerical which reports the desing of the experiment in terms of time points and replicates. Time points must be ordered according to the sequence of files submitted for the analysis, these labels characterize different files as replicates of a given condition.
by	A character, either "gene" or "tx", indicating if expressions and counts should be summarized at the levels of genes or transcripts. "gene" by default. In case "tx" is selected, we suggest to set argument "allowMultiOverlap" to TRUE, otherwise the reads mapping to overlapping transcripts of the same gene will remain unassigned.
countMultiMappingReads	A logical, if multimapping reads should be counted, FALSE by default. Multimap reads are identified using the tag "NH" in the bam/sam file.

`allowMultiOverlap`
: A logical, indicating if a read is allowed to be assigned to more than one feature, FALSE by default

`prioritizeExons`
: A logical, indicating whether reads assigned to exon shold not be accounted for intron counts. If set to FALSE, reads with shared overlap between an exon and the following intron will be assigned also to introns. This could improve intronic quantification in experimental settings (including polyA library preparation) or compact genomes were intronic reads are sampled at a very low rate compared to exonic reads. By default, TRUE.

`libsize`
: A character, either "assigned" or "all", indicating whether the libsize for expression normalization should include all mapped reads or only the reads assigned to any of the features. By default, "assigned" is selected.

`strandSpecific`
: Numeric, 0 if no strand-specific read counting should be performed, 1 stranded, 2 reversely-stranded. 0 by default

`isPairedEnd`
: A logical, if paired-end reads are used, FALSE by default

`DESeq2`
: A logical, if TRUE exons and introns variances are evaluated through the package DESeq2, if FALSE through plgem

`varSamplingCondition`
: A character reporting which experimental condition should be used to sample the variance if DESeq2 = FALSE.

`BPPARAM`
: Parallelization parameters for bplapply. By default SerialParam() By default, the first element of "experimentalDesign" with replicates.

Value

A list containing expressions and associated variances for exons and introns.

Examples

```
if( Sys.info()["sysname"] != "Windows" ) {
  require(TxDb.Mmusculus.UCSC.mm9.knownGene)
  txdb<-TxDb.Mmusculus.UCSC.mm9.knownGene
  expDes<-c(0,0,1,1)

  paths_total<-system.file('extdata/', c('bamRep1.bam'
                                         ,'bamRep2.bam'
                                         ,'bamRep3.bam'
                                         ,'bamRep4.bam')
                           ,package='INSPEcT')

  matExp<-quantifyExpressionsFromBAMs(txdb=txdb
                                      ,BAMfiles=paths_total
                                      ,experimentalDesign=expDes)
}
```

quantifyExpressionsFromBWs *Evaluate introns and exons expressions from BAM or SAM files*

Description

Given a TranscriptDb object and a list of bigWig (BW) files "quantifyExpressionsFormBWs" evaluates exons and introns expressions and the associated variances per each gene.

Usage

```
quantifyExpressionsFromBWs(
  txdb,
  BWfiles,
  experimentalDesign,
  readLength = 50,
  by = c("gene", "tx"),
  libsize = c("assigned", "all"),
  DESeq2 = TRUE,
  varSamplingCondition = NULL,
  BPPARAM = SerialParam()
)
```

Arguments

txdb	A TranscriptDB object
BWfiles	A vector of paths
experimentalDesign	A numerical which reports the desing of the experiment in terms of time points and replicates. Time points must be ordered according to the sequence of files submitted for the analysis, these labels characterize different files as replicates of a given condition.
readLength	A numerical that indicates the read length of the RNA-seq experiment. Used to normalize the coverage. By default, 50.
by	A character, either "gene" or "tx", indicating if expressions and counts should be summarized at the levels of genes or transcripts. "gene" by default. In case "tx" is selected, we suggest to set argument "allowMultiOverlap" to TRUE, otherwise the reads mapping to overlapping transcripts of the same gene will remain unassigned.
libsize	A character, either "assigned" or "all", indicating whether the libsize for expression normalization should include all mapped reads or only the reads assigned to any of the features. By default, "assigned" is selected.
DESeq2	A logical, if TRUE exons and introns variances are evaluated through the package DESeq2, if FALSE through plgem

varSamplingCondition
: A character reporting which experimental condition should be used to sample the variance if DESeq2 = FALSE.

BPPARAM
: Parallelization parameters for bplapply. By default SerialParam() By default, the first element of "experimentalDesign" with replicates.

Value

A list containing expressions and associated variances for exons and introns.

---

quantifyExpressionsFromTrAbundance

Given introns and exons abundances (for example RPKMs) this method returns their variances evaluated thorugh plgem.

Description

Given introns and exons abundances (for example RPKMs) this method returns their variances evaluated thorugh plgem.

Usage

```
quantifyExpressionsFromTrAbundance(
  trAbundaces,
  experimentalDesign,
  varSamplingCondition = NULL,
  simulatedData = FALSE
)
```

Arguments

trAbundaces
: A a list with elements "exonsAbundances" and "intronsAbundances".

experimentalDesign
: A numerical which reports the desing of the experiment in terms of time points and replicates. The time points must be ordered according to the columns of the count matrices submitted for the analysis; these labels define conditions and replicates.

varSamplingCondition
: A character reporting which experimental condition should be used to sample the variance if DESeq2 = FALSE.

simulatedData
: A boolean which is TRUE if the data under analysis are simulated.

Value

A list containing RPKMs and associated variances for exons and introns.

quantifyExpressionsFromTrCounts *Evaluates introns and exons RPKMs, per gene, from counts data.*

Description

Evaluates introns and exons RPKMs, per gene, from counts data.

Usage

```
quantifyExpressionsFromTrCounts(
  allcounts,
  experimentalDesign,
  exonsWidths,
  intronsWidths,
  libsize = NULL,
  DESeq2 = TRUE,
  varSamplingCondition = NULL
)
```

Arguments

allcounts	A named list containing "exonsCounts" and "intronsCounts".
experimentalDesign	A numerical which reports the desing of the experiment in terms of time points and replicates. Time points must be ordered according to the sequence of files submitted for the analysis, these labels characterize different files as replicates of a given condition.
exonsWidths	A numeric containing the exons widths.
intronsWidths	A numeric containing the intorns widths.
libsize	A numeric containing the library size.
DESeq2	A logical, if TRUE the RPKMs variances are evaluated through the package DESeq2, if FALSE plgem is used.
varSamplingCondition	A character reporting which experimental condition should be used to sample the variance if DESeq2 = FALSE. By default, the first element of "experimentalDesign" with replicates.

Value

A list containing RPKMs and associated variances for exons and introns.

Examples

```
data('allcounts', package='INSPEcT')
data('featureWidths', package='INSPEcT')
data('libsizes', package='INSPEcT')

nascentCounts<-allcounts$nascent
matureCounts<-allcounts$mature

expDes<-rep(c(0,1/6,1/3,1/2,1,1.5,2,4,8,12,16),3)

nasExp_DESeq2<-quantifyExpressionsFromTrCounts(libsize=nascentLS
                                               ,exonsWidths=exWdths
                                               ,intronsWidths=intWdths
                                               ,allcounts=nascentCounts
                                               ,experimentalDesign=expDes)

matExp_DESeq2<-quantifyExpressionsFromTrCounts(libsize=totalLS
                                               ,exonsWidths=exWdths
                                               ,intronsWidths=intWdths
                                               ,allcounts=matureCounts
                                               ,experimentalDesign=expDes)

nasExp_plgem<-quantifyExpressionsFromTrCounts(libsize=nascentLS
                                              ,exonsWidths=exWdths
                                              ,intronsWidths=intWdths
                                              ,allcounts=nascentCounts
                                              ,DESeq2=FALSE
                                              ,experimentalDesign=expDes)

matExp_plgem<-quantifyExpressionsFromTrCounts(libsize=totalLS
                                              ,exonsWidths=exWdths
                                              ,intronsWidths=intWdths
                                              ,allcounts=matureCounts
                                              ,DESeq2=FALSE
                                              ,experimentalDesign=expDes)
```

`ratePvals` *Retrieve a single p-value for each rate*

Description

This method is used to retrieve all the p-values relative to the variability of synthesis, processing and degradation rates.

Usage

```
ratePvals(object)

## S4 method for signature 'INSPEcT'
ratePvals(object)
```

Arguments

object	An object of class INSPEcT

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
ratePvals(nascentInspObj10)
```

---

ratesFirstGuess *Retrieve pre-modeling rates and concentrations*

Description

This method allow to access to the estimated synthesis, degradation, processing rates and pre mRNA and total mRNA concentrations the way they were calculated by the constructor function newINSPEcT.

Usage

```
ratesFirstGuess(object, feature)

## S4 method for signature 'INSPEcT'
ratesFirstGuess(object, feature)
```

Arguments

object	An object of class INSPEcT
feature	A character indicating the feature to retireve, "synthesis", "degradation", "processing" for rates, "total" for total mRNA concentrations or "preMRNA" for premature mRNA concentrations

Value

A numeric matrix containing the values for the selected feature

See Also

newINSPEcT, ratesFirstGuessVar

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))

ratesFirstGuess(nascentInspObj10, 'total')
ratesFirstGuess(nascentInspObj10, 'preMRNA')
ratesFirstGuess(nascentInspObj10, 'synthesis')
```

ratesFirstGuessVar *Retrieve pre-modeling rates and concentrations variance*

Description

This method allow to access to the estimated variance of synthesis rates and pre mRNA and total mRNA concentrations the way they were calculated by the constructor function newINSPEcT.

Usage

```
ratesFirstGuessVar(object, feature)

## S4 method for signature 'INSPEcT'
ratesFirstGuessVar(object, feature)
```

Arguments

object	An object of class INSPEcT
feature	A character indicating the feature to retireve, "synthesis", "degradation", "processing" for rates, "total" for total mRNA concentrations or "preMRNA" for premature mRNA concentrations

Value

A numeric vector containing the values for the selected feature

See Also

newINSPEcT, ratesFirstGuess

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))

ratesFirstGuessVar(nascentInspObj10, 'total')
ratesFirstGuessVar(nascentInspObj10, 'preMRNA')
ratesFirstGuessVar(nascentInspObj10, 'synthesis')
```

removeModel *remove modelling information from INSPEcT object*

Description

Remove the model from an INSPEcT object. It is required when subsetting an INSPEcT object per time points because when removing time points the modeling is not valid anymore.

Usage

```
removeModel(object)

## S4 method for signature 'INSPEcT'
removeModel(object)
```

Arguments

object	An Object of class INSPEcT

Value

An Object of class INSPEcT

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
nascentInspObj10_5genes <- nascentInspObj10[1:5]

## This will turn out into an error:
## Not run: nascentInspObj10_5genes_5tpts <- nascentInspObj10[1:5, 1:5]


## Before subsetting time points, the model should be removed:
nascentInspObj10_5genes_5tpts <- removeModel(nascentInspObj10)[1:5, 1:5]

## Also this will turn out into an error:
## Not run: nascentInspObj10 <- modelRates(nascentInspObj10)

## Before running the model again, or changing modeling parameters,
## the previous model should be removed:
nascentInspObj10_old <- nascentInspObj10
nascentInspObj10_new <- removeModel(nascentInspObj10)
## Not run: nascentInspObj10_new <- modelRates(nascentInspObj10_new, useSigmoidFun = FALSE)
```

rocCurve *Display rate classification performance*

Description

A method to visualize the performance in the classification of synthesis, degradation and processing rates based on the comparison of the original simulated rates and the one obtained by the function modelRates. For each rate, classification performance is measured in terms of sensitivity and specificity using a ROC curve analysis. False negatives (FN) represent cases where the rate is identified as constant while it was simulated as varying. False positives (FP) represent cases where INSPEcT identified a rate as varying while it was simulated as constant. On the contrary, true positives (TP) and negatives (TN) are cases of correct classification of varying and constant rates, respectively. Consequently, sensitivity and specificity are computed using increasing thresholds for the brown p-values, and the ability of correctly classifying a rate is measured through the area under the curve (AUC) for each rate.

Usage

```
rocCurve(object, object2, plot = TRUE, comparative = FALSE)

## S4 method for signature 'INSPEcT_model,INSPEcT'
rocCurve(object, object2, plot = TRUE, comparative = FALSE)
```

Arguments

object	An object of class INSPEcT_model, with true rates
object2	An modeled object of class INSPEcT
plot	A logical indicating whether ROC curves should be plotted or not
comparative	A logical indicating whether the cross-prediction should be visualized. When this mode is selected, the p-values assigned to the variability of one rate (e.g. synthesis) are tested against the variability the other rates (e.g. processing and degradation). Cross-prediction ROC curves are plotted with dashed lines.

Value

A list of objects of class pROC with summary of each roc curve

See Also

makeSimModel, makeSimDataset, rocThresholds

Examples

```
if( Sys.info()["sysname"] != "Windows" ) {
  nascentInspObj <- readRDS(system.file(package='INSPEcT', 'nascentInspObj.rds'))

  simRates<-makeSimModel(nascentInspObj, 1000, seed=1)
```

```
  # newTpts<-simRates@params$tpts
  # nascentSim2replicates<-makeSimDataset(object=simRates
  #                                       ,tpts=newTpts
  #                                       ,nRep=3
  #                                       ,NoNascent=FALSE
  #                                       ,seed=1)
  # nascentSim2replicates<-modelRates(nascentSim2replicates[1:100]
  #                                   ,seed=1)
  # (not evaluated to save computational time)

  data("nascentSim2replicates",package='INSPEcT')

  rocCurve(simRates[1:100],nascentSim2replicates)
  title("3rep. 11t.p. Total and nascent RNA", line=3)
}
```

`rocThresholds` *Display rate classification performance with thresholds visible at x-axis*

Description

A method to visualize the performance in the classification of synthesis, degradation and processing rates based on the comparison of the original simulated rates and the one obtained by the function `modelRates`. For each rate, classification performance is measured in terms of sensitivity and specificity using a ROC curve analysis. False negatives (FN) represent cases where the rate is identified as constant while it was simulated as varying. False positives (FP) represent cases where INSPEcT identified a rate as varying while it was simulated as constant. On the contrary, true positives (TP) and negatives (TN) are cases of correct classification of varying and constant rates, respectively. Consequently, at increasing brown p-values different sensitivity and specificity can be achieved.

Usage

```
rocThresholds(object, object2, xlim = c(1e-05, 1), plot = TRUE)

## S4 method for signature 'INSPEcT_model,INSPEcT'
rocThresholds(object, object2, xlim = c(1e-05, 1), plot = TRUE)
```

Arguments

`object`	An object of class INSPEcT_model, with true rates
`object2`	An object of class INSPEcT or INSPEcT_model, with modeled rates
`xlim`	A numeric representing limits for the x-axis (default is c(1-e-5,1))
`plot`	A logical that indicates whether to plot or not. (default=TRUE)

Value

The thresholds that maximize both sensitivity and specificity

See Also

makeSimModel, makeSimDataset, rocCurve

Examples

```
if( Sys.info()["sysname"] != "Windows" ) {
  nascentInspObj <- readRDS(system.file(package='INSPEcT', 'nascentInspObj.rds'))

  simRates<-makeSimModel(nascentInspObj, 1000, seed=1)

  # newTpts<-simRates@params$tpts
  # nascentSim2replicates<-makeSimDataset(object=simRates
  #                                       ,tpts=newTpts
  #                                       ,nRep=3
  #                                       ,NoNascent=FALSE
  #                                       ,seed=1)
  # nascentSim2replicates<-modelRates(nascentSim2replicates[1:100]
  #                                   ,seed=1)
  # (not evaluated to save computational time)

  data("nascentSim2replicates",package='INSPEcT')

  rocThresholds(simRates[1:100],nascentSim2replicates)
}
```

---

setConfidenceIntervals

Set confidence intervals

Description

This function is used to set the confidence intervals in the nascent RNA mode.

Usage

```
setConfidenceIntervals(object, confidenceIntervals)

## S4 method for signature 'INSPEcT'
setConfidenceIntervals(object, confidenceIntervals)
```

Arguments

object	An object of class INSPEcT_model
confidenceIntervals	list of confidence intervals.

Value

An object of class ExpressionSet containing the confidence intervals.

`simData3rep_Nascent` *An INSPEcT object with 1000 simulated rates and concentration and their modeled rates*

Description

A dataset containing the rates and concentrations obtained from the dataset simRates; 3 replicates and time points corresponding to: 0,1/6,1/3,1/2,1,1.5,2,4,8,12,16 hours.

Format

An INSPEcT object

`simData3rep_NoNascent` *An INSPEcT object with 1000 simulated rates and concentration and their modeled rates*

Description

A dataset containing the rates and concentrations obtained from the dataset simRates with 1 replicates and time points corresponding to: 0, 1/6, 1/3, 1/2, 1, 2, 4, 8, 16 hours. On this dataset rates and concentrations have been modeled with the method modelRates

Format

An INSPEcT object

`simData4rep_Nascent` *An INSPEcT object with 1000 simulated rates and concentration and their modeled rates*

Description

A dataset containing the rates and concentrations obtained from the dataset simRates; 3 replicates and time points corresponding to: 0,1/6,1/3,1/2,1,1.25,1.5,2,3,4,6,8,10,12,16 hours.

Format

An INSPEcT object

simData4rep_NoNascent *An INSPEcT object with 1000 simulated rates and concentration and their modeled rates*

Description

A dataset containing the rates and concentrations obtained from the dataset simRates with 1 replicates and time points corresponding to: 0, 1/6, 1/3, 1/2, 1, 2, 4, 8, 16 hours. On this dataset rates and concentrations have been modeled with the method modelRates

Format

An INSPEcT object

split *Divide an INSPEcT Object into groups*

Description

Divides the INSPEcT object into the groups defined by 'f',

Usage

```
## S4 method for signature 'INSPEcT,ANY'
split(x, f, drop = FALSE, ...)
```

Arguments

x	An object of class INSPEcT
f	A vector of length equal to the number of genes in x which defines the groups
drop	A logical belonging to the generic funciton, useless in this context.
...	Additional arguments to match the generic function

Value

A list containing objects of class INSPEcT

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
splitIdx <- c(1,1,1,2,2,2,3,3,3,4)
nascentInspObj10Split <- split(nascentInspObj10, splitIdx)
```

`tpts` *Accessor to the slot tpts of an INSPEcT object*

Description

Accessor to obtain the tpts associated with the object of class INSPEcT

Usage

```
tpts(object)

## S4 method for signature 'INSPEcT'
tpts(object)
```

Arguments

`object`	An object of class INSPEcT

Value

A numeric that indicates time points contained the object

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
tpts(nascentInspObj10)
```

`viewConfidenceIntervals`
Retrieve the modeled Confidence Intervals

Description

A method to access the modeld confidence intervals computed via the method `computeConfidenceIntervals`

Usage

```
viewConfidenceIntervals(object, feature)

## S4 method for signature 'INSPEcT'
viewConfidenceIntervals(object, feature)
```

Arguments

`object`	An object of class INSPEcT
`feature`	A character indicating the feature to retireve: "synthesis", "degradation", "processing".

Value

A numeric matrix containing the values for the selected feature

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
viewConfidenceIntervals(nascentInspObj10, 'synthesis')
```

---

viewModelRates *Retrieve the modeled rates and concentrations*

Description

A method to access the modeld rates via the method modelRates

Usage

```
viewModelRates(object, feature)

## S4 method for signature 'INSPEcT'
viewModelRates(object, feature)
```

Arguments

object	An object of class INSPEcT
feature	A character indicating the feature to retireve, "synthesis", "degradation", "processing" for rates, "total" for total mRNA concentrations or "preMRNA" for premature mRNA concentrations

Value

A numeric matrix containing the values for the selected feature

Examples

```
nascentInspObj10 <- readRDS(system.file(package='INSPEcT', 'nascentInspObj10.rds'))
viewModelRates(nascentInspObj10, 'synthesis')
```

Index

[, *18*, *25*
[,INSPEcT,ANY,ANY,ANY-method *(*Extract*)*, 13
[,INSPEcT_diffsteady,ANY,ANY,ANY-method *(*Extract*)*, 13
[,INSPEcT_model,ANY,ANY,ANY-method *(*Extract*)*, 13
[,INSPEcT_steadyNoNascent,ANY,ANY,ANY-method *(*INSPEcT_steadyNoNascent-class*)*, 26

AIC, *18*, *25*
AIC,INSPEcT-method *(*AIC-INSPEcT-method*)*, 3
AIC,INSPEcT_model-method *(*AIC-INSPEcT-method*)*, 3
AIC-INSPEcT-method, 3
allcounts, 4

calculateDelta, *18*
calculateDelta *(*processingDelay*)*, 47
calculateDelta,INSPEcT-method *(*processingDelay*)*, 47
calculateRatePvals, 4, *15*, *18*, *36, 37*
calculateRatePvals,INSPEcT-method *(*calculateRatePvals*)*, 4
calculateTau, *18*
calculateTau *(*processingDelay*)*, 47
calculateTau,INSPEcT-method *(*processingDelay*)*, 47
chisqmodel, 6, *18*
chisqmodel,INSPEcT-method *(*chisqmodel*)*, 6
chisqtest, 6, *18*, *25*
chisqtest,INSPEcT-method *(*chisqtest*)*, 6
chisqtest,INSPEcT_model-method *(*chisqtest*)*, 6
combine, 7, *18*
combine,INSPEcT,INSPEcT-method *(*combine*)*, 7
compareSteady, 8, *18*, *23*
compareSteady,INSPEcT-method *(*compareSteady*)*, 8
compareSteadyNoNascent, 9, *18*
compareSteadyNoNascent,INSPEcT_steadyNoNascent-method *(*compareSteadyNoNascent*)*, 9
computeConfidenceIntervals, 11, *18*, *64*
computeConfidenceIntervals,INSPEcT-method *(*computeConfidenceIntervals*)*, 11
convergence, 11
convergence,INSPEcT-method *(*convergence*)*, 11
correlationPlot, 12, *18*, *25*
correlationPlot,INSPEcT_model,INSPEcT-method *(*correlationPlot*)*, 12

degradation *(*INSPEcT_diffsteady-class*)*, 23
degradation,INSPEcT_diffsteady-method *(*INSPEcT_diffsteady-class*)*, 23
dim, *18*
dim,INSPEcT-method, 12

Extract, 13

featureNames, *18*
featureNames,INSPEcT-method, 14
featureNames,INSPEcT_diffsteady-method *(*INSPEcT_diffsteady-class*)*, 23
featureNames<-,INSPEcT-method *(*featureNames,INSPEcT-method*)*, 14
featureWidths, 14

geneClass, 15, *18*, *25*, *36, 37*
geneClass,INSPEcT-method *(*geneClass*)*, 15
geneClass,INSPEcT_diffsteady-method *(*geneClass*)*, 15
geneClass,INSPEcT_model-method *(*geneClass*)*, 15

inHeatmap, 16, *18*
inHeatmap,INSPEcT-method *(*inHeatmap*)*, 16
INSPEcT, *17*, 17
INSPEcT-class, 18
INSPEcT-shinyApps, 20
INSPEcT_diffsteady, *17*
INSPEcT_diffsteady-class, 23
INSPEcT_model-class, 25
INSPEcT_steadyNoNascent-class, 26
inspectFromBAM, 20
inspectFromPCR, 21

labeledSF, *18*, 27
labeledSF,INSPEcT-method *(*labeledSF*)*, 27
libsizes, 28
logLik, *18*, *25*, 28
logLik,INSPEcT-method *(*logLik*)*, 28
logLik,INSPEcT_model-method *(*logLik*)*, 28

makeModelRates, *18*, *25*, 29
makeModelRates,INSPEcT-method *(*makeModelRates*)*, 29
makeModelRates,INSPEcT_model-method *(*makeModelRates*)*, 29
makeOscillatorySimModel, *18*, 30
makeOscillatorySimModel,INSPEcT-method *(*makeOscillatorySimModel*)*, 30
makeSimDataset, *5*, *25*, *30*, 31, *32*, *33*, *59*, *61*
makeSimDataset,INSPEcT_model-method *(*makeSimDataset*)*, 31
makeSimModel, *5*, *18*, *25*, *31*, *32*, 32, *33*, *59*, *61*
makeSimModel,INSPEcT-method *(*makeSimModel*)*, 32
mature, 34
mature,INSPEcT_steadyNoNascent-method *(*mature*)*, 34
matureVar, 34
matureVar,INSPEcT_steadyNoNascent-method *(*matureVar*)*, 34
modelingParams, *18*, *19*, 35, *36*
modelingParams,INSPEcT-method *(*modelingParams*)*, 35
modelRates, *18*, *25*, *29*, *35*, 36, *59*, *60*, *65*
modelRates,INSPEcT-method *(*modelRates*)*, 36
modelRatesNF, *19*, 37
modelRatesNF,INSPEcT-method *(*modelRatesNF*)*, 37
modelSelection, *19*, *25*, 38
modelSelection,INSPEcT-method *(*modelSelection*)*, 38
modelSelection,INSPEcT_model-method *(*modelSelection*)*, 38

newINSPEcT, *18*, *36*, *37*, 39, *56*, *57*
nGenes, *13*, *19*, 41
nGenes,INSPEcT-method *(*nGenes*)*, 41
nTpts, *13*, *19*, 41
nTpts,INSPEcT-method *(*nTpts*)*, 41

plotGene, *19*, 42
plotGene,INSPEcT-method *(*plotGene*)*, 42
plotMA, *23*, 43
plotMA,INSPEcT_diffsteady-method *(*plotMA*)*, 43
plotPMgene, 45
plotPMgene,INSPEcT_steadyNoNascent-method *(*plotPMgene*)*, 45
plotPMtrend, 45
plotPMtrend,INSPEcT_steadyNoNascent-method *(*plotPMtrend*)*, 45
premature, 46
premature,INSPEcT_steadyNoNascent-method *(*premature*)*, 46
prematureVar, 46
prematureVar,INSPEcT_steadyNoNascent-method *(*prematureVar*)*, 46
processing *(*INSPEcT_diffsteady-class*)*, 23
processing,INSPEcT_diffsteady-method *(*INSPEcT_diffsteady-class*)*, 23
processingDelay, *19*, 47
processingDelay,INSPEcT-method *(*processingDelay*)*, 47
PTratio, *26*, 48
PTratio,INSPEcT_steadyNoNascent-method *(*PTratio*)*, 48
PTreg, *26*, 49
PTreg,INSPEcT_steadyNoNascent-method *(*PTreg*)*, 49

quantifyExpressionsFromBAMs, 50
quantifyExpressionsFromBWs, 52
quantifyExpressionsFromTrAbundance, 53
quantifyExpressionsFromTrCounts, 54

ratePvals, *15*, *19*, *37*, 55
ratePvals,INSPEcT-method *(*ratePvals*)*, 55

ratesFirstGuess, *19*, *40*, 56, *57*
ratesFirstGuess,INSPEcT-method
(ratesFirstGuess), 56
ratesFirstGuessVar, *19*, *56*, 57
ratesFirstGuessVar,INSPEcT-method
(ratesFirstGuessVar), 57
removeModel, *19*, 58
removeModel,INSPEcT-method
(removeModel), 58
rocCurve, *19*, *25*, 59, *61*
rocCurve,INSPEcT_model,INSPEcT-method
(rocCurve), 59
rocThresholds, *19*, *25*, *59*, 60
rocThresholds,INSPEcT_model,INSPEcT-method
(rocThresholds), 60
runINSPEcTGUI (INSPEcT-shinyApps), 20
runProcessingRateDelay
(INSPEcT-shinyApps), 20

setConfidenceIntervals, *19*, 61
setConfidenceIntervals,INSPEcT-method
(setConfidenceIntervals), 61
show, *19*, *25*
show,INSPEcT-method (INSPEcT-class), 18
show,INSPEcT_diffsteady-method
(INSPEcT_diffsteady-class), 23
show,INSPEcT_model-method
(INSPEcT_model-class), 25
show,INSPEcT_steadyNoNascent-method
(INSPEcT_steadyNoNascent-class),
26
simData3rep_Nascent, 62
simData3rep_NoNascent, 62
simData4rep_Nascent, 62
simData4rep_NoNascent, 63
split, *19*, 63
split,INSPEcT,ANY-method (split), 63
synthesis (INSPEcT_diffsteady-class), 23
synthesis,INSPEcT_diffsteady-method
(INSPEcT_diffsteady-class), 23

tpts, *19*, 64
tpts,INSPEcT-method (tpts), 64

viewConfidenceIntervals, *19*, 64
viewConfidenceIntervals,INSPEcT-method
(viewConfidenceIntervals), 64
viewModelRates, *19*, *36*, *37*, 65
viewModelRates,INSPEcT-method
(viewModelRates), 65