Package ‘twl’

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Type Package

Title Two-Way Latent Structure Clustering Model

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Description Implementation of a Bayesian two-way latent structure model for integrative genomic clustering. The model clusters samples in relation to distinct data sources, with each subject-dataset receiving a latent cluster label, though cluster labels have across-dataset meaning because of the model formulation. A common scaling across data sources is unneeded, and inference is obtained by a Gibbs Sampler. The model can fit multivariate Gaussian distributed clusters or a heavier-tailed modification of a Gaussian density. Uniquely among integrative clustering models, the formulation makes no nestedness assumptions of samples across data sources -- the user can still fit the model if a study subject only has information from one data source. The package provides a variety of post-processing functions for model examination including ones for quantifying observed alignment of clusterings across genomic data sources. Run time is optimized so that analyses of datasets on the order of thousands of features on fewer than 5 datasets and hundreds of subjects can converge in 1 or 2 days on a single CPU. See "Swanson DM, Lien T, Bergholtz H, Sorlie T, Frigessi A, Investigating Coordinated Architectures Across Clusters in Integrative Studies: a Bayesian Two-Way Latent Structure Model, 2018, <doi:10.1101/387076>, Cold Spring Harbor Laboratory" at <https://www.biorxiv.org/content/early/2018/08/07/387076.full.pdf> for model details.

License GPL (>= 2)

Imports Rfast

Depends R (>= 2.10), data.table, MCMCpack, corrplot

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**Description**

Implementation of a Bayesian two-way latent structure model for integrative genomic clustering. The model clusters samples in relation to distinct data sources, with each subject-dataset receiving a latent cluster label, though cluster labels have across-dataset meaning because of the model formulation. A common scaling across data sources is unneeded, and inference is obtained by a Gibbs Sampler. The model can fit multivariate Gaussian distributed clusters or a heavier-tailed modification of a Gaussian density. Uniquely among integrative clustering models, the formulation makes no nestedness assumptions of samples across data sources – the user can still fit the model if a study subject only has information from one data source. The package provides a variety of post-processing functions for model examination including ones for quantifying observed alignment of clusterings across genomic data sources. Run time is optimized so that analyses of datasets on the order of thousands of features on fewer than 5 datasets and hundreds of subjects can converge in 1 or 2 days on a single CPU. See "Swanson DM, Lien T, Bergholtz H, Sorlie T, Frigessi A, Investigating Coordinated Architectures Across Clusters in Integrative Studies: a Bayesian Two-Way Latent Structure Model, 2018, doi:10.1101/387076, Cold Spring Harbor Laboratory" at <https://www.biorxiv.org/content/early/2018/08/07/387076.full.pdf> for model details.

**Details**

The DESCRIPTION file:

- Package: twl
- Type: Package
- Title: Two-Way Latent Structure Clustering Model
- Version: 1.0
- Date: 2018-08-17
- Author: Michael Swanson
- Maintainer: Michael Swanson <dms866@mail.harvard.edu>
- Description: Implementation of a Bayesian two-way latent structure model for integrative genomic clustering. The model
clus_save

License: GPL (>= 2)
Imports: Rfast
Depends: data.table, MCMCpack, corrplot
RoxygenNote: 6.0.1
LazyData: true

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misaligned_mat  Progressively misaligned cluster data matrices
output_new      Output PSMs
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post_analy_clus  Assigns cluster labels by building dendrogram and thresholding at specified height
post_analy_cor   Creates and saves correlation plots based on posterior similarity matrices
twl-package     Two-Way Latent Structure Clustering Model

Author(s)

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References


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clus_save       Output samples

Description

5000 iterations from output of TWLsample function

Usage

data(data_and_output)
cross_dat_analy

Format
A list of data.tables

Source
output of TWLsample function

Examples
data(data_and_output)
ls()

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cross_dat_analy  Compares clustering across datasets using metrics described in associated TWL manuscript

Description
Compares clustering across datasets using metrics described in associated TWL manuscript

Usage
cross_dat_analy(clus_save, BURNIN)

Arguments
clus_save  list of samples outputted from TWLsample function.
BURNIN  number of samples devoted to burn-in. Defaults to 2000.

Value
output_lists a list of output metrics. The first element is a list of lists of sample-specific pairwise
cluster overlap. The second element is an estimate of across all datasets cluster correspondence
by averaging pairwise cluster overlap (the length is the vector therefore is the number of unique
samples associated with at least 2 data sources.

Examples
data(data_and_output)
## Not run: clus_save <- TWLsample(misaligned_mat,misaligned,output_every=50,num_its=5000,manip=FALSE)
output_new <- pairwise_clus(clus_save,BURNIN=2000)
post_analy_cor(output_new,c("title1","title2","title3","title4","title5"),
tempfile(),ords='none')
clus_labs <- post_analy_clus(output_new,clus_save,c(2:6),rep(0,6,5),c("title1","title2",
"title3","title4","title5"),tempfile())
output_nest <- cross_dat_analy(clus_save,4750)
## End(Not run)
**Description**

Example annotation information for simulated data of progressively misaligned clusters.

**Usage**

```r
data(data_and_output)
```

**Format**

A list of data.tables

**Source**

simulated

**Examples**

```r
data(data_and_output)
ls()
```

---

**misaligned_mat**  
*Progressively misaligned cluster data matrices*

**Description**

Simulated data of progressively misaligned clusters on which to fit a TWL model.

**Usage**

```r
data(data_and_output)
```

**Format**

A list of matrices

**Source**

simulated

**Examples**

```r
data(data_and_output)
ls()
```
Description

Posterior similar matrices, output of pairwise_clus function

Usage

data(data_and_output)

Format

A list of matrices

Source

output of pairwise_clus function

Examples

data(data_and_output)
ls()

pairwise_clus

Create posterior similarity matrix from outputted list of clustering samples

Description

Create posterior similarity matrix from outputted list of clustering samples

Usage

pairwise_clus(clus_save, BURNIN = 2000)

Arguments

clus_save list of samples outputted from TWLSample function.
BURNIN number of samples devoted to burn-in. Defaults to 2000.

Value

output a list whose length is the number of datasets being integrated, and each element of which is a posterior similarity matrix. The dimension of each symmetric matrix is the number of samples in the respective dataset, and elements in the matrix are values between 0 and 1, and estimate of the probability 2 samples find themselves in the same clustering.
**post_analy_clus**

Assigns cluster labels by building dendrogram and thresholding at specified height

**Description**

Assigns cluster labels by building dendrogram and thresholding at specified height

**Usage**

```r
post_analy_clus(outpu_new, clus_sav_new, num_clusts, height_clusts_vec = NULL, titles, pdf_path)
```

**Arguments**

- `outpu_new` the output of the pairwise_clus function, and a list whose length is the number of datasets being integrated, and each element of which is a posterior similarity matrix. The dimension of each symmetric matrix is the number of samples in the respective dataset, and elements in the matrix are values between 0 and 1, and estimate of the probability 2 samples find themselves in the same clustering.

- `clus_sav_new` list of samples outputted from TWLsample function. See details for additional explanation of this parameter and height_clusts_vec.

- `num_clusts` a vector of length the number of integrated datasets, specifying the number of cluster labels to be identified from the generated dendrogram for each dataset

- `height_clusts_vec` vector of dendrogram heights of length the number of integrated datasets (if the analyst prefers manual inspection of outputted dendrograms and specification of the heights at which to threshold, thereby defining cluster membership). Defaults to NULL. See details for additional explanation of this parameter and num_clusts.

- `titles` Vector of strings of length the number of datasets, used as prefixes in column labels of the outputted list of data.tables.

- `pdf_path` file path where the dendrogram figures will be saved as a pdf.

**Examples**

```r
# Not run: clus_save <- TWLsample(misaligned_mat,misaligned,output_every=50,num_its=5000,manip=FALSE)
outpu_new <- pairwise_clus(clus_save,BURNIN=2000)
post_analy_cor(outpu_new,c("title1","title2","title3","title4","title5"),
tempfile(),ords='none')
clus_labs <- post_analy_clus(outpu_new,clus_save,c(2:6),rep(0.6,5),c("title1","title2",
"title3","title4","title5"),tempfile())
output_est <- cross_dat_analy(clus_save,4750)

# End(Not run)
```
Details

At least one of either num_clusts or height_clusts_vec, or both, can be specified. If both are specified, then heights is first used within the dendrogram for preliminary cluster assignment, then the X largest clusters of these receive final, outputted, assignment (the rest receiving a "clus_unknown" label), where X is the corresponding element in the num_clusts argument vector.

Value

post_lab a list of data.tables of 2 columns each with names 'nam' and '*_clus', the nam specifying sample name annotation, and *_clus with the assigned cluster, where * is the corresponding element in the title argument vector.

Examples

```r
data(data_and_output)
## Not run: clus_save <- TWLSample(misaligned_mat,misaligned,output_every=50,num_its=5000,manip=FALSE)
outpu_new <- pairwise_clus(clus_save,BURNIN=2000)
post_analy_cor(outpu_new,c("title1","title2","title3","title4","title5"),
tempfile(),ords='none')
clus_labs <- post_analy_clus(outpu_new,clus_save,c(2:6),rep(0.6,5),c("title1","title2",
"title3","title4","title5"),tempfile())
output_nest <- cross_dat_analy(clus_save,4750)
## End(Not run)
```

Description

Creates and saves correlation plots based on posterior similarity matrices

Usage

`post_analy_cor(outpu_new, titles, pdf_path, ords = "none")`

Arguments

- `outpu_new` the output of the pairwise_clus function, and a list whose length is the number of datasets being integrated, and each element of which is a posterior similarity matrix. The dimension of each symmetric matrix is the number of samples in the respective dataset, and elements in the matrix are values between 0 and 1, and estimate of the probability 2 samples find themselves in the same clustering.
- `titles` a vector of strings of length number of integrated datasets. Elements of the vector are titles in the respective correlation plots
- `pdf_path` file path where the plots will be saved as a pdf.
ords whether the correlation plots should be reordered according to that of hierarchical clustering for a more comprehensible plot. Defaults to 'none'. Passing any string apart from 'none' (i.e., 'yes') will result in the re-ordering.

Value
dendro_ord regardless of whether correlation plots are reordered according to hierarchical clustering, a list of reorderings is returned of length the number of datasets on which analysis was performed.

Examples
data(data_and_output)
## Not run: clus_save <- TWLsample(misaligned_mat,misaligned,output_every=50,num_its=5000,manip=FALSE)
output_new <- pairwise_clus(clus_save,BURNIN=2000)
post_analy_cor(output_new,c("title1","title2","title3","title4","title5"),
tempfile(),ords='none')
clus_labs <- post_analy_clus(output_new,clus_save,c(2:6),rep(0.6,5),c("title1","title2",
"title3","title4","title5"),tempfile())
output_nest <- cross_dat_analy(clus_save,4750)

## End(Not run)

---

**TWLsample**

*Main function to obtain posterior samples from a TWL model.*

**Description**

Main function to obtain posterior samples from a TWL model.

**Usage**

```r
TWLsample(full_dat_mat, full_dat, alpha_re = 7, beta_re = 0.4,
            num_its = 5000, num_all_clus = 30, output_every = 20, manip = TRUE,
            sav_inter = FALSE)
```

**Arguments**

- **full_dat_mat** list of matrices of the different data types.
- **full_dat** list of data.tables with a single column labelled 'nam', denoting sample annotation. A consistent naming convention of samples must be used across data types.
- **alpha_re** Hyperparameter for the dirichlet prior model within each data type, influencing sparsity of clusterings. A smaller number encourages fewer clusters. Defaults to 7 and should be chosen as a function of sample size.
beta_re Hyperparameter for the dirichlet prior model across datatypes within each sample, influencing the degree to which each data type's sample cluster labels affect those of the other data types. Defaults to 0.4 and should be chosen as a function of the total number of data types being integrated in the analysis.

num_its Number of iterations. Defaults to 5000.

num_all_clus Ceiling on the number of clusters. Defaults to 30. Should be chosen as some factor greater (for example, 5), than maximum number of hypothesized clusters in the data types.

output_every Frequency of sampling log statistics, reporting mixing, cluster distribution, and proportion of cluster sharing across data types. Defaults to once every 20 iterations.

manip TRUE/FALSE for whether likelihood manipulation should be used to increase mixing in situations where cluster means are far from one another in Euclidean distance. This should not influence identified clusters nor parameters associated with them. Defaults to TRUE.

sav_inter A logical indicating whether a temporary file of the samples should be written out in the working directory every 50 iterations. Allows for restarts when sampling is interrupted, and defaults to FALSE.

Value A list of lists of data.tables. The list length is the number of iterations. The length of each element is the number of data types. The data.tables have 2 columns, sample annotation called 'nam' and cluster assignment called 'clus'.

Examples

data(data_and_output)
## Not run: clus_save <- TWLsample(misaligned_mat,misaligned,output_every=50,num_its=5000,manip=FALSE)
outpu_new <- pairwise_clus(clus_save,BURNIN=2000)

## End(Not run)
post_analy_cor(outpu_new,c("title1","title2","title3","title4","title5"),
tempfile(),ords='none')
clus_labs <- post_analy_clus(outpu_new,clus_save,c(2:6),rep(0.6,5),c("title1","title2",
"title3","title4","title5"),tempfile())
output_nest <- cross_dat_analy(clus_save,4900)
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