Package 'mrfse'

October 21, 2024

Title Markov Random Field Structure Estimator

Version 0.4.2

Date 2024-10-21

Description Three algorithms for estimating a Markov random field structure.Two of them are an exact version and a simulated annealing version of a penalized maximum conditional likelihood method similar to the Bayesian Information Criterion. These algorithm are described in Frondana (2016) <doi:10.11606/T.45.2018.tde-02022018-151123>.The third one is a greedy algorithm, described in Bresler (2015) <doi:10.1145/2746539.2746631).

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LinkingTo Rcpp

Imports Rcpp

Depends gtools, Rfast

NeedsCompilation yes

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Repository CRAN

Date/Publication 2024-10-21 17:40:01 UTC

Contents

`mrfse.ci` *Bresler's non-binary Markov random field structure estimator*

Description

A greedy algorithm to estimate Markovian neighborhoods.

Usage

```
mrfse.ci(a_size, sample, tau, max_degree=ncol(sample)-1)
```

Arguments

`a_size`	Size of the alphabet.
`sample`	A integer-valued matrix. Each value must belong range `0` and `a_size - 1`. Matrix has dimension `n x V`, where `n` is number of samples and `V` is number of nodes.
`tau`	A hyperparameter. See references.
`max_degree`	The maximum length of a candidate Markovian neighborhood. Must be non-negative and less than `ncol(sample)`.

Value

A list filled with estimated Markov neighborhood for each graph vertex

Author(s)

Rodrigo Carvalho

References

Guy Bresler. 2015. Efficiently Learning Ising Models on Arbitrary Graphs. In Proceedings of the forty-seventh annual ACM symposium on Theory of Computing (STOC '15). Association for Computing Machinery, New York, NY, USA, 771–782. DOI:https://doi.org/10.1145/2746539.2746631

Examples

```
library(mrfse)
a_size = c(0, 1)
s = matrix(sample(a_size, size=1000, replace=TRUE), ncol=5)
mrfse.ci(length(a_size), s, 0.2)
```

`mrfse.ci.con` *Conservative approach for Bresler's non-binary estimator*

Description

A greedy algorithm to estimate Markovian neighborhoods.

Usage

```
mrfse.ci.con(a_size, sample, tau, max_degree=ncol(sample)-1)
```

Arguments

`a_size`	Size of the alphabet.
`sample`	A integer-valued matrix. Each value must belong range `0` and `a_size - 1`. Matrix has dimension `n x V`, where `n` is number of samples and `V` is number of nodes.
`tau`	A hyperparameter. See references.
`max_degree`	The maximum length of a candidate Markovian neighborhood. Must be non-negative and less than `ncol(sample)`.

Value

A adjacency matrix of the estimated Markov random field graph.

Author(s)

Rodrigo Carvalho

References

Guy Bresler. 2015. Efficiently Learning Ising Models on Arbitrary Graphs. In Proceedings of the forty-seventh annual ACM symposium on Theory of Computing (STOC '15). Association for Computing Machinery, New York, NY, USA, 771–782. DOI:https://doi.org/10.1145/2746539.2746631

Examples

```
library(mrfse)
a_size = c(0, 1)
s = matrix(sample(a_size, size=1000, replace=TRUE), ncol=5)
mrfse.ci.con(length(a_size), s, 0.2)
```

`mrfse.ci.ncon` *Non-conservative approach for Bresler's non-binary estimator*

Description

A greedy algorithm to estimate Markovian neighborhoods.

Usage

```
mrfse.ci.ncon(a_size, sample, tau, max_degree=ncol(sample)-1)
```

Arguments

`a_size`	Size of the alphabet.
`sample`	A integer-valued matrix. Each value must belong range `0` and `a_size - 1`. Matrix has dimension `n x V`, where `n` is number of samples and `V` is number of nodes.
`tau`	A hyperparameter. See references.
`max_degree`	The maximum length of a candidate Markovian neighborhood. Must be non-negative and less than `ncol(sample)`.

Value

A adjacency matrix of the estimated Markov random field graph.

Author(s)

Rodrigo Carvalho

References

Guy Bresler. 2015. Efficiently Learning Ising Models on Arbitrary Graphs. In Proceedings of the forty-seventh annual ACM symposium on Theory of Computing (STOC '15). Association for Computing Machinery, New York, NY, USA, 771–782. DOI:https://doi.org/10.1145/2746539.2746631

Examples

```
library(mrfse)
a_size = c(0, 1)
s = matrix(sample(a_size, size=1000, replace=TRUE), ncol=5)
mrfse.ci.ncon(length(a_size), s, 0.2)
```

`mrfse.create.sampler` *Create a sampler for Markov random field.*

Description

Create a sampler for Markov random field from a DAG

Usage

```
mrfse.create.sampler(dag_adj, A)
```

Arguments

`dag_adj`	An direct acyclic graph adjacency matrix
`A`	Size of alphabet

Value

A list filled with the following components:

neigh: A list of neighborhood. For each i, neigh[[i]] is a markovian neighborhood of vertex i

probs: A list of probabilities. For each i, probs[[i]] is matrix of probabilities of vertex i given your markovian neighborhood. Those probabilites will be used to generate a sample.

moral_adj: moral graph of adj_dag

topol_sort: topological sort of adj_dag

num_nodes: number of nodes de adj_dag

A: alphabet size

Author(s)

Rodrigo Carvalho

Examples

```
library(mrfse)
adj = matrix(c(0, 1, 0, 0, 0, 0, 0, 1, 0), byrow=TRUE, ncol=3)
mrfse.create.sampler(adj, 3)
```

`mrfse.exact` *A Markov random field structure estimator*

Description

A penalized likelihood BIC-based to estimate Markovian neighborhoods.

Usage

```
mrfse.exact(a_size, sample, c, max_neigh= ncol(sample) - 1)
```

Arguments

`a_size`	Size of the alphabet.
`sample`	A integer-valued matrix. Each value must belong range `0` and `a_size - 1`. Matrix has dimension `n x V`, where `n` is number of samples and `V` is number of nodes.
`c`	The penalization constant. Must be positive.
`max_neigh`	The maximum length of a candidate Markovian neighborhood. Must be non-negative and less than `ncol(sample)`.

Value

A list filled with estimated Markov neighborhood for each graph vertex

Author(s)

Rodrigo Carvalho

References

FRONDANA, Iara Moreira. *Model selection for discrete Markov random fields on graphs*. São Paulo : Instituto de Matemática e Estatística, University of São Paulo, 2016. Doctoral Thesis in Estatística. <doi:10.11606/T.45.2018.tde-02022018-151123> http://www.teses.usp.br/teses/disponiveis/45/45133/tde-02022018-151123/publico/tese_Iara_Frondana.pdf

Examples

```
library(mrfse)
a_size = c(0, 1)
s = matrix(sample(a_size, size=1000, replace=TRUE), ncol=5)
mrfse.exact(length(a_size), s, 1.0)
```

`mrfse.exact.con` *Conservative approach for Frondana's mrfse*

Description

Conservative construction of the estimated Markov random field graph.

Usage

```
mrfse.exact.con(a_size, sample, c, max_neigh = ncol(sample) - 1)
```

Arguments

`a_size`	Size of the alphabet.
`sample`	A integer-valued matrix. Each value must belong range `0` and `a_size - 1`. Matrix has dimension `n` x `V`, where `n` is number of samples and `V` is number of nodes.
`c`	The penalization constant. Must be positive.
`max_neigh`	The maximum length of a candidate Markovian neighborhood. Must be non-negative and less than `ncol(sample)`.

Value

A adjacency matrix of the estimated Markov random field graph.

Author(s)

Rodrigo Carvalho

References

FRONDANA, Iara Moreira. *Model selection for discrete Markov random fields on graphs*. São Paulo : Instituto de Matemática e Estatística, University of São Paulo, 2016. Doctoral Thesis in Estatística. <doi:10.11606/T.45.2018.tde-02022018-151123> http://www.teses.usp.br/teses/disponiveis/45/45133/tde-02022018-151123/publico/tese_Iara_Frondana.pdf

Examples

```
library(mrfse)
a = c(0, 1)
s = matrix(sample(a, size=1000, replace=TRUE), ncol=5)
mrfse.exact.con(length(a), s, 1.0)
```

`mrfse.exact.ncon` *Non-conservative approach for Frondana's mrfse*

Description

Conservative construction of the estimated Markov random field graph.

Usage

```
mrfse.exact.ncon(a_size, sample, c, max_neigh = ncol(sample) - 1)
```

Arguments

`a_size`	Size of the alphabet.
`sample`	A integer-valued matrix. Each value must belong range `0` and `a_size - 1`. Matrix has dimension `n` x `V`, where `n` is number of samples and `V` is number of nodes.
`c`	The penalization constant. Must be positive.
`max_neigh`	The maximum length of a candidate Markovian neighborhood. Must be non-negative and less than `ncol(sample)`.

Value

A adjacency matrix of the estimated Markov random field graph.

Author(s)

Rodrigo Carvalho

References

FRONDANA, Iara Moreira. *Model selection for discrete Markov random fields on graphs*. São Paulo : Instituto de Matemática e Estatística, University of São Paulo, 2016. Doctoral Thesis in Estatística. <doi:10.11606/T.45.2018.tde-02022018-151123> http://www.teses.usp.br/teses/disponiveis/45/45133/tde-02022018-151123/publico/tese_Iara_Frondana.pdf

Examples

```
library(mrfse)
a = c(0, 1)
s = matrix(sample(a, size=1000, replace=TRUE), ncol=5)
mrfse.exact.ncon(length(a), s, 1.0)
```

`mrfse.sa` *A Markov random field structure estimator using simulated annealing approach*

Description

A penalized likelihood BIC-based to estimate Markovian neighborhoods.

Usage

```
mrfse.sa(a_size, sample, c, t0, iterations=1000, max_neigh=ncol(sample)-1)
```

Arguments

`a_size`	Size of the alphabet.
`sample`	A integer-valued matrix. Each value must belong range `0` and `a_size - 1`. Matrix has dimension `n x V`, where `n` is number of samples and `V` is number of nodes.
`c`	The penalization constant. Must be positive.
`t0`	Inital temperature
`iterations`	Number of simulated annealing iterations
`max_neigh`	The maximum length of a candidate Markovian neighborhood. Must be non-negative and less than `ncol(sample)`.

Value

A list filled with estimated Markov neighborhood for each graph vertex

Author(s)

Rodrigo Carvalho

References

FRONDANA, Iara Moreira. *Model selection for discrete Markov random fields on graphs*. São Paulo : Instituto de Matemática e Estatística, University of São Paulo, 2016. Doctoral Thesis in Estatística. <doi:10.11606/T.45.2018.tde-02022018-151123> http://www.teses.usp.br/teses/disponiveis/45/45133/tde-02022018-151123/publico/tese_Iara_Frondana.pdf

Examples

```
library(mrfse)
a_size = c(0, 1)
s = matrix(sample(a_size, size=1000, replace=TRUE), ncol=5)
mrfse.sa(length(a_size), s, 1.0, 500, 1000)
```

`mrfse.sa.con` *Cnservative approach for Frondana's mrfse using simulated annealing*

Description

A penalized likelihood BIC-based to estimate Markovian neighborhoods.

Usage

```
mrfse.sa.con(a_size, sample, c, t0, iterations=1000, max_neigh=ncol(sample)-1)
```

Arguments

`a_size`	Size of the alphabet.
`sample`	A integer-valued matrix. Each value must belong range `0` and `a_size - 1`. Matrix has dimension `n x V`, where `n` is number of samples and `V` is number of nodes.
`c`	The penalization constant. Must be positive.
`t0`	Inital temperature
`iterations`	Number of simulated annealing iterations
`max_neigh`	The maximum length of a candidate Markovian neighborhood. Must be non-negative and less than `ncol(sample)`.

Value

A adjacency matrix of the estimated Markov random field graph.

Author(s)

Rodrigo Carvalho

References

FRONDANA, Iara Moreira. *Model selection for discrete Markov random fields on graphs*. São Paulo : Instituto de Matemática e Estatística, University of São Paulo, 2016. Doctoral Thesis in Estatística. <doi:10.11606/T.45.2018.tde-02022018-151123> http://www.teses.usp.br/teses/disponiveis/45/45133/tde-02022018-151123/publico/tese_Iara_Frondana.pdf

Examples

```
library(mrfse)
a_size = c(0, 1)
s = matrix(sample(a_size, size=1000, replace=TRUE), ncol=5)
mrfse.sa.con(length(a_size), s, 1.0, 500, 1000)
```

`mrfse.sa.ncon` *Non-conservative approach for Frondana's mrfse using simulated annealing*

Description

A penalized likelihood BIC-based to estimate Markovian neighborhoods.

Usage

```
mrfse.sa.ncon(a_size, sample, c, t0, iterations=1000, max_neigh=ncol(sample)-1)
```

Arguments

`a_size`	Size of the alphabet.
`sample`	A integer-valued matrix. Each value must belong range `0` and `a_size - 1`. Matrix has dimension `n x V`, where `n` is number of samples and `V` is number of nodes.
`c`	The penalization constant. Must be positive.
`t0`	Inital temperature
`iterations`	Number of simulated annealing iterations
`max_neigh`	The maximum length of a candidate Markovian neighborhood. Must be non-negative and less than `ncol(sample)`.

Value

A adjacency matrix of the estimated Markov random field graph.

Author(s)

Rodrigo Carvalho

References

FRONDANA, Iara Moreira. *Model selection for discrete Markov random fields on graphs*. São Paulo : Instituto de Matemática e Estatística, University of São Paulo, 2016. Doctoral Thesis in Estatística. <doi:10.11606/T.45.2018.tde-02022018-151123> http://www.teses.usp.br/teses/disponiveis/45/45133/tde-02022018-151123/publico/tese_Iara_Frondana.pdf

Examples

```
library(mrfse)
a_size = c(0, 1)
s = matrix(sample(a_size, size=1000, replace=TRUE), ncol=5)
mrfse.sa.ncon(length(a_size), s, 1.0, 500, 1000)
```

`mrfse.sample` *Generate a independent sample of a Markov random field*

Description

Generate a independent sample of a Markov random field according to the probilities of the sampler.

Usage

```
mrfse.sample(sampler, n)
```

Arguments

`sampler`	A sampler created by `mrfse.create.sampler` function
`n`	Size of sample

Value

A matrix whose number of columns is the number of nodes. Each line is a single independent sample of Markov random field given by the probabilites of sampler.

Author(s)

Rodrigo Carvalho

Examples

```
library(mrfse)
adj = matrix(c(0, 1, 0, 0, 0, 0, 0, 1, 0), byrow=TRUE, ncol=3)
sampler = mrfse.create.sampler(adj, 3)
mrfse.sample(sampler, 3000)
```

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