

Package ‘invertiforms’

May 8, 2026

Title Invertible Transforms for Matrices

Version 0.1.2

Description Provides composable invertible transforms for (sparse) matrices.

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URL <https://rohelab.github.io/invertiforms/>,
<https://github.com/RoheLab/invertiforms>

BugReports <https://github.com/RoheLab/invertiforms/issues>

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'PerturbedLaplacian.R' 'RegularizedLaplacian.R'
'invertiforms-package.R' 'utils.R'

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DoubleCenter	<i>Construct and use DoubleCenter transformations</i>
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Description

A convenience function to create [DoubleCenter](#) S4 objects, which are useful for **simultaneously row and column centering** a matrix.

Usage

```
DoubleCenter(A)
```

```
## S4 method for signature 'DoubleCenter,sparseMatrix'
transform(iform, A)
```

```
## S4 method for signature 'DoubleCenter,sparseLRMatrix'
inverse_transform(iform, A)
```

```
## S4 method for signature 'DoubleCenter,vsp_fa'
inverse_transform(iform, A)
```

Arguments

A	A matrix to transform.
iform	An Invertiform object describing the transformation.

Value

- `DoubleCenter()` creates a [DoubleCenter](#) object.
- `transform()` returns the transformed matrix, typically as a [sparseLRMatrix::sparseLRMatrix](#).
- `inverse_transform()` returns the inverse transformed matrix, typically as a [sparseLRMatrix::sparseLRMatrix](#) in most cases. When possible reduces the [sparseLRMatrix::sparseLRMatrix](#) to a [Matrix::sparseMatrix\(\)](#).

Examples

```

library(igraph)
library(igraphdata)

data("karate", package = "igraphdata")

A <- get.adjacency(karate)

iform <- DoubleCenter(A)

A_tilde <- transform(iform, A)
A_recovered <- inverse_transform(iform, A_tilde)

all.equal(A, A_recovered)

```

DoubleCenter-class *Row and column centering transformation*

Description

Row and column centering transformation

Slots

row_means numeric.
col_means numeric.
overall_mean numeric.

inverse_transform *Apply the inverse of an invertible transformation*

Description

Apply the inverse of an invertible transformation

Usage

```
inverse_transform(iform, A)
```

Arguments

iform An [Invertiform](#) object describing the transformation.
A A matrix to inverse transform.

Value

The inverse transformed matrix.

Invertiform-class	<i>An abstract S4 class representing an invertible transformation</i>
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Description

An abstract S4 class representing an invertible transformation

NormalizedLaplacian	<i>Construct and use the Normalized Laplacian</i>
---------------------	---

Description

A convenience function to create [NormalizedLaplacian](#) S4 objects, which are useful for finding the normalized Laplacian of the adjacency matrix of a graph.

Usage

```
NormalizedLaplacian(A)
```

```
## S4 method for signature 'NormalizedLaplacian,sparseMatrix'  
transform(iform, A)
```

```
## S4 method for signature 'NormalizedLaplacian,sparseMatrix'  
inverse_transform(iform, A)
```

Arguments

A	A matrix to transform.
iform	An Invertiform object describing the transformation.

Details

We define the *normalized Laplacian* $L(A)$ of an $n \times n$ graph adjacency matrix A as

$$L(A)_{ij} = \frac{A_{ij}}{\sqrt{d_i^{out}} \sqrt{d_j^{in}}}$$

where

$$d_i^{out} = \sum_{j=1}^n \|A_{ij}\|$$

and

$$d_j^{in} = \sum_{i=1}^n \|A_{ij}\|.$$

When A_{ij} denotes the presence of an edge *from* node i to node j , which is fairly standard notation, d_i^{out} denotes the (absolute) out-degree of node i and d_j^{in} denotes the (absolute) in-degree of node j .

Note that this documentation renders most clearly at <https://rohelab.github.io/invertiforms/>.

Value

- `NormalizedLaplacian()` creates a `NormalizedLaplacian` object.
- `transform()` returns the transformed matrix, typically as a `Matrix::Matrix`.
- `inverse_transform()` returns the inverse transformed matrix, typically as a `Matrix::Matrix`.

Examples

```
library(igraph)
library(igraphdata)

data("karate", package = "igraphdata")

A <- get.adjacency(karate)

iform <- NormalizedLaplacian(A)

L <- transform(iform, A)
A_recovered <- inverse_transform(iform, L)

all.equal(A, A_recovered)
```

NormalizedLaplacian-class

Normalized graph Laplacian transformation

Description

Normalized graph Laplacian transformation

Slots

rSA numeric.

csA numeric.

PerturbedLaplacian *Construct and use the Perturbed Laplacian*

Description

Construct and use the Perturbed Laplacian

Usage

```
PerturbedLaplacian(A, tau = NULL)
```

```
## S4 method for signature 'PerturbedLaplacian,sparseMatrix'
transform(iform, A)
```

```
## S4 method for signature 'PerturbedLaplacian,sparseLRMatrix'
inverse_transform(iform, A)
```

Arguments

A	A matrix to transform.
tau	Additive regularizer for row and column sums of abs(A). Typically this corresponds to inflating the (absolute) out-degree and the (absolute) in-degree of each node by tau. Defaults to NULL, in which case we set tau to the mean value of abs(A).
i form	An Invertiform object describing the transformation.

Details

We define the *perturbed Laplacian* $L^\tau(A)$ of an $n \times n$ graph adjacency matrix A as

$$L^\tau(A)_{ij} = \frac{A_{ij} + \frac{\tau}{n}}{\sqrt{d_i^{\text{out}} + \tau} \sqrt{d_j^{\text{in}} + \tau}}$$

where

$$d_i^{\text{out}} = \sum_{j=1}^n \|A_{ij}\|$$

and

$$d_j^{\text{in}} = \sum_{i=1}^n \|A_{ij}\|.$$

When A_{ij} denotes the presence of an edge *from* node i *to* node j , which is fairly standard notation, d_i^{out} denotes the (absolute) out-degree of node i and d_j^{in} denotes the (absolute) in-degree of node j .

Note that this documentation renders more clearly at <https://rohelab.github.io/invertiforms/>.

Value

- PerturbedLaplacian() creates a [PerturbedLaplacian](#) object.
- transform() returns the transformed matrix, typically as a [Matrix::Matrix](#).
- inverse_transform() returns the inverse transformed matrix, typically as a [Matrix::Matrix](#).

Examples

```
library(igraph)
library(igraphdata)

data("karate", package = "igraphdata")

A <- get.adjacency(karate)

iform <- PerturbedLaplacian(A)

L <- transform(iform, A)
L

## Not run:
A_recovered <- inverse_transform(iform, L)
all.equal(A, A_recovered)

## End(Not run)
```

PerturbedLaplacian-class

Perturbed graph Laplacian transformation

Description

Perturbed graph Laplacian transformation

Slots

tau numeric.
rsA numeric.
csA numeric.
tau_choice character.

RegularizedLaplacian *Construct and use the Regularized Laplacian*

Description

Construct and use the Regularized Laplacian

Usage

```
RegularizedLaplacian(A, tau_row = NULL, tau_col = NULL)

## S4 method for signature 'RegularizedLaplacian,Matrix'
transform(iform, A)

## S4 method for signature 'RegularizedLaplacian,matrix'
transform(iform, A)

## S4 method for signature 'RegularizedLaplacian,sparseLRMatrix'
transform(iform, A)

## S4 method for signature 'RegularizedLaplacian,Matrix'
inverse_transform(iform, A)

## S4 method for signature 'RegularizedLaplacian,matrix'
inverse_transform(iform, A)

## S4 method for signature 'RegularizedLaplacian,vsp_fa'
inverse_transform(iform, A)
```

Arguments

A	A matrix to transform.
tau_row	Additive regularizer for row sums of abs(A). Typically this corresponds to inflating the (absolute) out-degree of each node by tau_row. Defaults to NULL, in which case we set tau_row to the mean (absolute) row sum of A.
tau_col	Additive regularizer for column sums of abs(A). Typically this corresponds to inflating the (absolute) in-degree of each node by tau_col. Defaults to NULL, in which case we set tau_col to the mean (absolute) column sum of A.
iform	An Invertiform object describing the transformation.

Details

We define the *regularized Laplacian* $L^\tau(A)$ of an $n \times n$ graph adjacency matrix A as

$$L^\tau(A)_{ij} = \frac{A_{ij}}{\sqrt{d_i^{\text{out}} + \tau_{\text{row}}}\sqrt{d_j^{\text{in}} + \tau_{\text{col}}}}$$

where

$$d_i^{out} = \sum_{j=1}^n \|A_{ij}\|$$

and

$$d_j^{in} = \sum_{i=1}^n \|A_{ij}\|.$$

When A_{ij} denotes the presence of an edge *from* node i *to* node j , which is fairly standard notation, d_i^{out} denotes the (absolute) out-degree of node i and d_j^{in} denotes the (absolute) in-degree of node j . Then τ_{row} is an additive out-degree regularizer and τ_{col} is an additive in-degree regularizer.

Note that this documentation renders more clearly at <https://rohelab.github.io/invertiforms/>.

Value

- `RegularizedLaplacian()` creates a `RegularizedLaplacian` object.
- `transform()` returns the transformed matrix, typically as a `Matrix::Matrix`.
- `inverse_transform()` returns the inverse transformed matrix, typically as a `Matrix::Matrix`.

Examples

```
library(igraph)
library(igraphdata)

data("karate", package = "igraphdata")

A <- get.adjacency(karate)

iform <- RegularizedLaplacian(A)

L <- transform(iform, A)
L

A_recovered <- inverse_transform(iform, L)

all.equal(A, A_recovered)
```

RegularizedLaplacian-class

Regularized graph Laplacian transformation

Description

Regularized graph Laplacian transformation

Slots

tau_row numeric.
tau_col numeric.
rsA numeric.
csA numeric.
tau_choice_row character.
tau_choice_col character.

transform	<i>Apply an invertible transformation</i>
-----------	---

Description

Apply an invertible transformation

Usage

```
transform(iform, A)
```

Arguments

iform An [Invertiform](#) object describing the transformation.
A A matrix to transform.

Value

The transformed matrix.

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