Package ‘TRMF’

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Description Functions to estimate temporally regularized matrix factorizations (TRMF) for forecasting and imputing values in short but high-dimensional time series. Uses regularized alternating least squares to compute the factorization, allows for several types of constraints on matrix factors and natively handles weighted and missing data.
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R topics documented:

  coef.TRMF ........................................... 2
  components.TRMF ................................... 3
  create_TRMF ....................................... 4
  fitted.TRMF ...................................... 5
  impute_TRMF ...................................... 6
  NormalizeMatrix ................................... 7
  plot.TRMF ........................................ 8
  predict.TRMF ..................................... 9
  residuals.TRMF ................................... 10
coef.TRMF

coef.TRMF

Description

Returns the Fm (transposed) matrix from the matrix factorization Xm*Fm.

Usage

## S3 method for class 'TRMF'
coef(object, ...)

Arguments

object a trained TRMF object.
...
other arguments.

Value

the coefficient matrix, t(Fm)

Author(s)

Chad Hammerquist

See Also

create_TRMF, TRMF_columns, TRMF_trend
components.TRMF

Examples

```r
xm = poly(x = (-10:10)/10, degree=4)
fm = matrix(runif(40),4,10)
Am = xm%*%fm+rnorm(210,0,.2)

# create model
obj = create_TRMF(Am)
out = train(obj)
coef(out)
```

Description

This function returns the factors (Xm, Fm) from a trained TRMF object.

Usage

```r
## S3 method for class 'TRMF'
components(object, XorF = c("Xm","Fm"), ...)
```

Arguments

- `object`: trained TRMF object
- `XorF`: which factor to return
- `...`: ignored

Details

Returns the matrix factors. Could also use `object$Factors$Xm`, `object$Factors$Fm`. If matrix normalization was used in `create_TRMF`, `Xm%*%Fm` could look much different than the input data matrix.

Value

A matrix.

Author(s)

Chad Hammerquist

See Also

`create_TRMF`, `TRMF_columns`, `TRMF_trend`
Examples

# create test data
xm = poly(x = (-10:10)/10, degree=4)
fm = matrix(rnorm(40),4,10)
Am = xm%*%fm+rnorm(210,0,.2)

# create model
obj = create_TRMF(Am)
out = train(obj)
plot(out)
components(out,"Xm")

create_TRMF  Create a TRMF object

Description

Creates a TRMF object from a data matrix. This function is always needed to initialize a TRMF model.

Usage

create_TRMF(dataM, weight = 1,
            normalize = c("none", "standard", "robust", "range"),
            normalize.type = c("global", "columnwise", "rowwise"),
            na.action = c("impute", "fail"))

Arguments

dataM     The data matrix, each column represents a time series.
weight    An optional matrix of weights to be used in the fitting process. If used, \(\sum(w^2e^2)\) is minimized.
normalize Type of scaling/centering for the data. Recommended to reduce bias when using regularization. none does nothing, standard centers with mean, and scales by \(sd()\), robust centers with the median and scales by \(mad(), constant=1\), range maps to \([0-1]\) interval
normalize.type how should normalization be applied. global scales and centers matrix by one value. columnwise and rowwise normalize each column or row separately.
na.action  what action to take when data contains NAs

Details

This function doesn’t do any computation, it is the entry point for creating a TRMF model. To train the model or add additional details, see examples. Normalization is recommended in general. Regularization biases the factorization toward zero a little bit, centering changes that to bias towards
the mean. Scaling makes the choosing of regularization parameters easier. If the factorization is to be used for forward forecasting, rowwise normalization is not recommended as it could remove some temporal information.

Value

create_TRMF returns an object of class "TRMF" to be passed to other TRMF functions.

Author(s)

Chad Hammerquist

References


See Also

train.TRMF,TRMF_columns,TRMF_trend

Examples

# create test data
xm = poly(x = (-10:10)/10,degree=4)
fm = matrix(runif(40),4,10)
Am = xm%*%fm+rnorm(210,0,.2)

# create model
obj = create_TRMF(Am)
obj = TRMF_columns(obj,reg_type ="interval")
obj = TRMF_trend(obj,numTS=4,order=2)
out = train(obj)
plot(out)

fitted.TRMF

Extract TRMF fitted values.

Description

A function to extract fitted values from a trained TRMF object.

Usage

## S3 method for class 'TRMF'
fitted(object,impute = FALSE,...)
Arguments

object  a trained TRMF object.
impute  logical, should imputed values be returned?
...  other arguments.

Value

Fitted values extracted from object. If impute is TRUE then entire fitted (unscaled and uncentered) matrix is returned, otherwise there are NAs in the same locations as the time series matrix.

Author(s)

Chad Hammerquist

See Also

create_TRMF, TRMF_columns, TRMF_trend

Examples

```
xm = poly(x = (-10:10)/10, degree=4)
fm = matrix(rnorm(40), 4, 10)
Am = xm*x%*%fm + rnorm(210, 0, .2)

# create model
obj = create_TRMF(Am)
out = train(obj)
fitted(out)
```

---

**impute_TRMF**

*Impute missing values in a matrix*

Description

Impute missing values in matrix from a pre-trained TRMF object.

Usage

```
impute_TRMF(obj)
```

Arguments

obj  a trained TRMF object

Details

Essentially an accessor function. Replaces the missing values in data matrix with values from the fitted TRMF object.
NormalizeMatrix

Value

data matrix with missing values imputed

Author(s)

Chad Hammerquist

References


See Also

train.TRMF, create_TRMF, TRMF_trend

Examples

# create test data
xm = poly(x = (-10:10)/10, degree=4)
fm = matrix(rnorm(40),4,10)
Am = xm%*%fm+rnorm(210,0,.2)
Am[sample.int(210,20)] = NA

# create model
obj = create_TRMF(Am)
obj = TRMF_trend(obj,numTS=4,order=2)
out = train(obj)
impute_TRMF(out)
Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>a numeric matrix-like object</td>
</tr>
<tr>
<td>method</td>
<td>type of scaling to perform, standard centers with mean and scales by sd(), robust centers with the median and scales by mad(constant=1), range maps to [0-1] interval</td>
</tr>
<tr>
<td>type</td>
<td>how should normalization be applied. global scales and centers matrix by one value, columnwise and rowwise normalize each column or row separately.</td>
</tr>
<tr>
<td>na.rm</td>
<td>logical value, ignore NA values or not.</td>
</tr>
</tbody>
</table>

Details

Scaling and centering quantities are stored as attributes.

Value

The possibly centered and scaled matrix. Scaling and centering quantities are stored as attributes.

Author(s)

Chad Hammerquist

Examples

```r
x = matrix(1:10, ncol = 2)
NormalizeMatrix(x)
```

---

**plot.TRMF**  
*Plot Latent Time Series for a TRMF Object*

Description

Plots all the time series in Xm from a trained TRMF object.

Usage

```r
# S3 method for class 'TRMF'
plot(x, ...)
```

Arguments

- `x` a trained TRMF object.
- `...` ignored.

Value

No return value, called for side effects.
predict.TRMF

Author(s)

Chad Hammerquist

See Also

create_TRMF, TRMF_columns, TRMF_trend

Examples

xm = poly(x = (-10:10)/10, degree=4)
fm = matrix(runif(40), 4, 10)
Am = xm%*%fm+rt(210,0,.2)

# create model
obj = create_TRMF(Am)
out = train(obj)
plot(out)

predict.TRMF

Predict method for TRMF model fit

Description

Predict values based on the TRMF fit

Usage

## S3 method for class 'TRMF'
predict(object, newdata=NULL, ...)

Arguments

object A trained TRMF object
newdata A list with slot Xm and possibly with slots cXreg and gXreg
... other arguments, ignored.

Details

If newdata is NULL, returns fitted model. If newdata doesn’t have the term Xm or if it has a different number of columns than the number of latent time series, it will throw an error. If the object also contains a global regression, gXreg must be present and appropriately sized. If the object also contains a column-wise regression, cXreg must be present and appropriately sized.

Value

Returns a matrix of predictions.
residuals.TRMF

Author(s)
Chad Hammerquist

See Also
create_TRMF, TRMF_columns, TRMF_trend, train.TRMF

Examples

xm = poly(x = (-10:10)/10, degree=4)
fM = matrix(runif(40), 4, 10)
Am = xm%*%fm+rnorm(210, 0, .2)

# create model
obj = create_TRMF(Am)
out = train(obj)
fitted(out)
newXm = 1:5
predict(out, newdata=list(Xm=newXm))

residuals.TRMF

Extract TRMF residuals

Description
A function to extract residuals from a trained TRMF object.

Usage

## S3 method for class 'TRMF'
residuals(object, ...)

Arguments

object a trained TRMF object.
...

Value
residuals extracted from TRMF object

Author(s)
Chad Hammerquist

See Also
create_TRMF, TRMF_columns, TRMF_trend
Examples

```r
xm = poly(x = (-10:10)/10, degree=4)
fm = matrix(runif(40), 4, 10)
Am = xm%*%fm+rnorm(210, 0, .2)

# create model
obj = create_TRMF(Am)
out = train(obj)
resid(out)
```

retrain

Retrain TRMF objects.

Description

Continue training on a pretrained TRMF object.

Usage

```r
retrain(obj, numit, fit_xm_first = TRUE)
```

Arguments

- `obj`: Pretrained TRMF object
- `numit`: Number of training iterations
- `fit_xm_first`: Fit the Xm factor first? This could be useful if modifications are made to one of the factors that we don’t want to be overwritten.

Details

This is basically the same function as `train()` but it doesn’t create any of the constraint matrices and doesn’t do any initialization.

Value

A trained TRMF object.

See Also

- `train.TRMF`
Examples

```r
# create test data
tm = 3*poly(x = (-20:20)/10, degree = 3)
sm = diffinv(rnorm(29,0,.1),lag=12,xi=(-5:6)/6)
xm = cbind(sm,tm)
fm = matrix(runif(40),4,10)
Am = xm%*%fm+rnorm(410,0,.1)

# create model
obj = create_TRMF(Am)
obj = TRMF_columns(obj,reg_type = "interval")
obj = TRMF_trend(obj,numTS=3,order=2)
obj = TRMF_seasonal(obj,numTS=1,freq=12,lambdaD=5)

# train
out = train(obj,numit=0) # intialize
plot(out)
new_out = retrain(out,numit=10)
plot(new_out)
```

---

**summary.TRMF**

Summarize TRMF

**Description**

summary method for class "TRMF"

**Usage**

```r
## S3 method for class 'TRMF'
summary(object, ...)
```

**Arguments**

- `object` TRMF object.
- `...` other arguments.

**Value**

NULL

**Author(s)**

Chad Hammerquist

**See Also**

`create_TRMF, TRMF_columns, TRMF_trend`
Examples

```r
xm = poly(x = (-10:10)/10, degree=4)
fm = matrix(runif(40), 4, 10)
Am = xm%*%fm+rnorm(210, 0, .2)

# create model
obj = create_TRMF(Am)
out = train(obj)
summary(obj)
summary(out)
```

Description

This function is the "engine" of the TRMF package. It takes a previously created TRMF object and fits it to the data using an alternating least squares algorithm.

Usage

```r
## S3 method for class 'TRMF'
train(x, numit = 10, ...)
```

Arguments

- `x` A TRMF object to be fit.
- `numit` Number of alternating least squares iterations
- `...` ignored

Details

If a coefficient model is not present in `object`, it adds a L2 regularization model. If no time series models have been added to `object`, it adds a simple model using `TRMF_simple`.

Value

`train` returns a fitted object of class "TRMF" that contains the data, all added models, matrix factorization and fitted model. The matrix factors `Xm`, `Fm` are stored in `object$Factors$Xm` and `object$Factors$Fm` respectively. Use `fitted` to get fitted model, use `resid` to get residuals, use `coef` to get coefficients (Fm matrix) and `components` to get Xm or Fm.

Author(s)

Chad Hammerquist
References


See Also

create_TRMF, TRMF_columns, TRMF_trend

Examples

```r
# create test data
xm = poly(x = (-10:10)/10, degree=4)
fm = matrix(rnorm(40),4,10)
Am = xm%*%fm+rnorm(210,0,.2)

# create model
obj = create_TRMF(Am)
out = train(obj)
plot(out)
```

TRMF_ar

Add an Auto-Regressive Regularization Model to a TRMF Object.

Description

Creates a regularization scheme that constrains latent time-series based on auto-regressive parameters and adds it to a TRMF object. In matrix optimization form, it adds the following term to the TRMF cost function: \( R(x) = \lambda_D^2 \|w(DX_s)\|^2 + \lambda_A^2 \|X_s\|^2 \) where \( X_s \) is sub-set of the \( Xm \) matrix controlled by this model and \( D \) is a matrix that corresponds to an auto-regressive model.

Usage

```r
TRMF_ar(obj,numTS = 1,AR,lambdaD=1,lambdaA=0.0001,weight=1)
```

Arguments

- **obj**: A TRMF object
- **numTS**: number of latent time series in this model
- **lambdaD**: regularization parameter for temporal constraint matrix
- **lambdaA**: regularization parameter to apply simple L2 regularization to this time series model
- **weight**: optional vector of weights to weight constraints, i.e. \( R(x) = \lambda_D^2 \|w(DX_s)\|^2 + \lambda_A^2 \|X_s\|^2 \)
- **AR**: vector of autoregressive parameters. No checks are performed
Details

Setting AR = c(1) gives a random walk model, same as TRMF_trend(..., order=1)

Value

Returns an updated object of class TRMF.

Author(s)

Chad Hammerquist

References


See Also

create_TRMF, TRMF_columns, TRMF_trend

Examples

```
# create test data
xm = matrix(rnorm(80),20,4)
fm = matrix(rnorm(40),4,10)+1
Am = xm%*%fm+rnorm(200,0,.1)

# create model
obj = create_TRMF(Am)
obj = TRMF_columns(obj,reg_type ="interval")
obj = TRMF_ar(obj,numTS=2,AR=c(0.5),lambdaD=4)
out = train(obj)
plot(out)
```
Usage

TRMF_columns(obj,
    reg_type = c("l2", "nnls", "constrain", "interval", "none"), lambda = 0.0001)
TRMF_coefficients(obj,
    reg_type = c("l2", "nnls", "constrain", "interval", "none"), lambda = 0.0001)

Arguments

obj            TRMF object created by create_TRMF()
reg_type       regularization type to apply when fitting TRMF model. l2 regularizes by simple sum of squares, nnls forces coefficients to be non-negative. constrain constrains coefficients to be non-negative and to sum to 1. interval constrains coefficients to the interval [0-1]
lambda         L2 regularization parameter used for all regularization types. If NULL, uses lambda set in create_TRMF().

Details

This function doesn’t do any computations, it just sets up regularization parameters for the coefficient matrix. This function should only be called once on a TRMF object. If called twice, it will overwrite previous model with a warning.

Value

Returns an updated object of class TRMF.

Author(s)

Chad Hammerquist

References


See Also

train.TRMF, create_TRMF, TRMF_trend

Examples

# create test data
xm = poly(x = (-10:10)/10, degree = 4)
fm = matrix(abs(rnorm(40)), 4, 10)
Am = xm%*%fm+rnorm(210, 0, .2)

# create model
obj = create_TRMF(Am)
obj = TRMF_columns(obj, reg_type = "nnls")
out = train(obj)
plot(out)

---

Add exponential smoothing regularization model to a TRMF object.

Description

Creates a regularization scheme that favors exponentially smoothed solutions and adds it to a TRMF object. In matrix optimization form, it adds the following term to the TRMF cost function: \( R(x) = \lambda_D D^T w (D X_s) ||X_s||^2 + \lambda_A A^T X_s ||X_s||^2 \) where \( X_s \) is sub-set of the \( X_m \) matrix controlled by this model and \( D \) is a matrix with weights from exponential smoothing.

Usage

```
TRMF_es(obj,numTS = 1,alpha=1,es_type=c("single","double"),
         lambdaD=1,lambdaA=0.0001,weight=1)
```

Arguments

- `obj`: A TRMF object
- `numTS`: number of latent time series in this model
- `lambdaD`: regularization parameter for temporal constraint matrix
- `lambdaA`: regularization parameter to apply simple L2 regularization to this time series model
- `weight`: optional vector of weights to weight constraint, i.e. \( R(x) = \lambda_D D^T w (D X_s) ||X_s||^2 \)
- `es_type`: type of exponential smoothing. "double" does Brown’s double exponential smoothing.
- `alpha`: exponential smoothing parameter, constrained to be in the interval [0,1]

Details

This creates a non-sparse constraint matrix which could slow training down for longer time series.

Value

Returns an updated object of class TRMF.

Author(s)

Chad Hammerquist
References

https://en.wikipedia.org/wiki/Exponential_smoothing

See Also

create_TRMF, TRMF_columns, TRMF_trend, TRMF_seasonal

Examples

# create test data
xm = cbind(cumsum(rnorm(20)), cumsum(rnorm(20)))
fm = matrix(runif(20), 2, 10)
Am = xm%*%fm+rnorm(200, 0, .2)

# create model
obj = create_TRMF(Am)
obj = TRMF_es(obj, numTS=2, alpha=0.5)
out = train(obj)
plot(out)

TRMF_regression

Add external regressors to TRMF object

Description

A function to add external regressors to a TRMF object.

Usage

TRMF_regression(obj, Xreg, type = c("global", "columnwise"))

Arguments

obj
TRMF object created by create_TRMF()

Xreg
Vector or matrix of external regressors. If type = "columnwise", Xreg can be a matrix or array, but the first two dimensions must match those of the data matrix.

type
how are the regressors added to the model. If type = "global" the matrix factorization includes all the regressors. If type = "columnwise" each column in the data matrix is regressed of the corresponding column of Xreg.
Details

The coefficients model for the regressors are subject to the same regularization as the rest of the matrix factorization. Only one columnwise and one global model should be used in the same model. Both types can be include in the same model though.

Value

Returns an updated object of class TRMF.

Author(s)

Chad Hammerquist

See Also

create_TRMF, TRMF_columns, TRMF_trend

Examples

```r
# ~ Global regression example ~
# create test data
bb = (-10:10)/10
xReg = 10*cos(bb*10)
xm = poly(x = bb, degree=3)
fm = matrix(rnorm(40),4,10)
Am = cbind(xReg,xm)%*%fm+rnorm(210,0,.2)

# creat model and fit
obj = create_TRMF(Am)
obj = TRMF_trend(obj,numTS=3,order=2)
obj = TRMF_regression(obj,Xreg=xReg,type="global")
out = train(obj)
plot(out)

# ~ columnwise regression example ~
# create test data
bb = (-10:10)/10
xm = poly(x = bb, degree=4)
fm = matrix(rnorm(84),4,21)
Am = xm%*%fm+rnorm(441,0,.2)

layers = array(0,dim=c(21,21,2))
layers[,1] = 2*cos(2*bb)%o%sin(4*bb)
layers[,2] = 2*sqrt(abs(bb%o%bb))
nAm = Am+layers[,1]+layers[,2]

# creat model and fit
obj = create_TRMF(nAm)
obj = TRMF_trend(obj,numTS=4,order=2)
obj = TRMF_regression(obj,Xreg=layers,type="columnwise")
out = train(obj)
plot(out)
```
TRMF_seasonal

Add seasonal regularization model to a TRMF object

Description

Creates a regularization scheme that favors seasonally varying solutions and adds it to a TRMF object. In matrix optimization form, it adds the following term to the TRMF cost function: \( R(x) = \lambda_D D^2 ||w(DX_s)||^2 + \lambda_A A^2 ||X_s||^2 \) where \( X_s \) is sub-set of the \( X_m \) matrix controlled by this model and \( D \) is a (with a lag of \( \text{freq} \)) finite difference matrix.

Usage

TRMF_seasonal(obj, numTS = 1, freq = 12, sumFirst = FALSE, lambdaD = 1, lambdaA = 0.0001, weight = 1)

Arguments

- **obj**: A TRMF object
- **numTS**: number of latent time series in this model
- **lambdaD**: regularization parameter for temporal constraint matrix
- **lambdaA**: regularization parameter to apply simple L2 regularization to this time series model
- **weight**: optional vector of weights to weight constraints, i.e. \( R(x) = \lambda_D D^2 ||w(DX_s)||^2 \)
- **freq**: The frequency of the seasonal time series model. Minimize the differences of \( \text{lag} = \text{freq} \)
- **sumFirst**: minimize the sum of first \( \text{freq} \) elements in time series

Details

TRMF_seasonal(freq=N) fits a lag N random walk. For monthly data, use freq=12, for quarterly data, freq=4. If sumFirst = TRUE, the sum of the first freq elements in the latent time series are also minimized. This can be used to help force the seasonal component to vary around a zero mean.

Value

Returns an updated object of class TRMF.

Author(s)

Chad Hammerquist

References

TRMF_simple

See Also

create_TRMF, TRMF_columns, TRMF_simple, TRMF_trend

Examples

# create test data
tm = 3*poly(x = (-20:20)/10, degree=3)
sm = diffinv(rnorm(29,0,.1),lag=12,xi=(-5:6)/6)
xm = cbind(sm,tm)
fm = matrix(runif(40),4,10)
Am = xm%*%fm+rnorm(410,0,.1)

# create model
obj = create_TRMF(Am)
obj = TRMF_columns(obj,reg_type ="interval")
obj = TRMF_trend(obj,numTS=3,order=2)
obj = TRMF_seasonal(obj,numTS=1,freq=12,lambdaD=5)
out = train(obj)
plot(out)

TRMF_simple

Add L2 regularization model to a TRMF object

Description

Creates an L2 regularization and adds it to a TRMF object. In matrix optimization form, it adds the following term to the TRMF cost function: $R(x) = \lambda A^2||w(X_s)||^2$ where $X_s$ is sub-set of the Xm matrix controlled by this model.

Usage

TRMF_simple(obj,numTS = 1,lambdaA=0.0001,weight=1)

Arguments

obj A TRMF object
numTS number of latent time series in this model
lambdaA regularization parameter to apply simple L2 regularization to this time series model
weight optional vector of weights to weight constraints, i.e. $R(x) = \lambda A^2||w*X||^2$

Details

This is called by train_TRMF if the TRMF object doesn’t have any time series models.
Value

Returns an updated object of class TRMF.

Author(s)

Chad Hammerquist

References


See Also

create_TRMF, TRMF_columns, TRMF_seasonal, TRMF_trend

Examples

```r
# create test data
xm = matrix(rnorm(160),40,4)
fm = matrix(runif(40),4,10)
Am = xm%*%fm+rnorm(400,0,.1)

# create model
obj = create_TRMF(Am)
obj = TRMF_simple(obj,numTS=4,lambdaA=0.1)
out = train(obj)
plot(out)
```

TRMF_trend

Add Trend Model to a TRMF Object

Description

Creates a regularization scheme that favors trend-like solutions and adds it to a TRMF object. In matrix optimization form, it adds the following term to the TRMF cost function: 
\[ R(x) = \lambda_D \|Dx\|^2 + \lambda_A \|Ax\|^2 \]
where \( X_s \) is sub-set of the Xm matrix controlled by this model and D is a finite difference matrix.

Usage

```
TRMF_trend(obj,numTS = 1,order = 1,lambdaD=1,lambdaA=0.0001,weight=1)
```
**Arguments**

- **obj**: A TRMF object
- **numTS**: number of latent time series in this model
- **order**: The order of derivative for finite difference constraint matrix. Fractionally and negative values allowed.
- **lambdaD**: regularization parameter for temporal constraint matrix
- **lambdaA**: regularization parameter to apply simple L2 regularization to this time series model
- **weight**: optional vector of weights to weight constraints, i.e. \( R(x) = \lambda_D^2 \|w*(D'*X)\|^2 \)

**Details**

An arbitrary number of time series models can be added. \( \text{TRMF}_\text{trend}(\text{order} = 1) \) fits a random walk. \( \text{TRMF}_\text{trend}(\text{order} = 2) \) fits a cubic smoothing spline. For a single time series, \( \text{TRMF}_\text{trend}(\text{order} = 2) \) is basically equivalent to the Hodge-Precht filter. A fractional value for order minimizes a squared fractional derivative. A negative value minimizes a (possibly fractional order) squared integral of time-series. Using a fractional or negative order for \( \text{TRMF}_\text{trend} \) or using \( \text{TRMF}\_\text{es} \) could drastically reduce the sparsity of constraint matrix and slow down training. Fractional or negative order has only been lightly tested, so use with care.

**Value**

Returns an updated object of class TRMF.

**Author(s)**

Chad Hammerquist

**References**


**See Also**

- `create_TRMF`, `TRMF_columns`, `TRMF_simple`, `TRMF_seasonal`

**Examples**

```r
# create test data
xm = poly(x = (-10:10)/10, degree=4)
fm = matrix(runif(40), 4, 10)
Am = xm%*%fm+rnorm(210, 0, .1)

# create model
obj = create_TRMF(Am)
obj = TRMF_columns(obj, reg_type = "interval")
```
```
obj = TRMF_trend(obj,numTS=4,order=2,lambdaD=2)
out = train(obj)
plot(out)

# more complex model
require(magrittr) # for pipes

obj = create_TRMF(Am)%>%
    TRMF_columns(reg_type ="interval")%>%
    TRMF_trend(numTS=2,order=1,lambdaD=4)%>%
    TRMF_trend(numTS=2,order=2,lambdaD=4)%>%
    TRMF_trend(numTS=1,order=1.5)

out = train(obj)
plot(out)
```
Index

class, 5, 13
coef, 13
coef.TRMF, 2
components, 13
components.TRMF, 3
create_TRMF, 2, 3, 4, 6, 7, 9, 10, 12, 14–16,
       18, 19, 21–23
fitted, 13
fitted.TRMF, 5
impute_TRMF, 6
NormalizeMatrix, 7
plot.TRMF, 8
predict.TRMF, 9
resid, 13
residuals.TRMF, 10
retrain, 11
summary.TRMF, 12
train.TRMF, 5, 7, 10, 11, 13, 16
TRMF_ar, 14
TRMF_coefficients(TRMF_columns), 15
TRMF_columns, 2, 3, 5, 6, 9, 10, 12, 14, 15, 15,
       18, 19, 21–23
TRMF_es, 17
TRMF_regression, 18
TRMF_seasonal, 18, 20, 22, 23
TRMF_simple, 13, 21, 21, 23
TRMF_trend, 2, 3, 5–7, 9, 10, 12, 14–16, 18,
       19, 21, 22, 22