Package ‘RSNNS’

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Description The Stuttgart Neural Network Simulator (SNNS) is a library containing many standard implementations of neural networks. This package wraps the SNNS functionality to make it available from within R. Using the RSNNS low-level interface, all of the algorithmic functionality and flexibility of SNNS can be accessed. Furthermore, the package contains a convenient high-level interface, so that the most common neural network topologies and learning algorithms integrate seamlessly into R.
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RSNNS-package

Getting started with the RSNNS package

Description

The Stuttgart Neural Network Simulator (SNNS) is a library containing many standard implementations of neural networks. This package wraps the SNNS functionality to make it available from within R.

Details

If you have problems using RSNNS, find a bug, or have suggestions, please contact the package maintainer by email, instead of writing to the general R lists or contacting the authors of the original SNNS software.

If you use the package, please cite the following work in your publications:

The package has a hierarchical architecture with three levels:
RSNNS-package

- RSNNS high-level api (rsnns)
- RSNNS low-level api (SnnsR)
- The api of our C++ port of SNNS (SnnsCLib)

Many demos for using both low-level and high-level api of the package are available. To get a list of them, type:

library(RSNNS)
demo()

It is a good idea to start with the demos of the high-level api (which is much more convenient to use). E.g., to access the iris classification demo type:

demo(iris)

or for the laser regression demo type:

demo(laser)

As the high-level api is already quite powerful and flexible, you’ll most probably normally end up using one of the functions: mlp, dlvq, rbf, rbfDDA, elman, jordan, som, art1, art2, artmap, or assoz, with some pre- and postprocessing. These S3 classes are all subclasses of rsnns.

You might also want to have a look at the original SNNS program and the SNNS User Manual 4.2, especially pp 67-87 for explications on all the parameters of the learning functions, and pp 145-215 for detailed (theoretical) explications of the methods and advice on their use. And, there is also the javaNNS, the successor of SNNS from the original authors. It makes the C core functionality available from a Java GUI.

Demos ending with "SnnsR" show the use of the low-level api. If you want to do special things with neural networks that are currently not implemented in the high-level api, you can see in this demos how to do it. Many demos are present both as high-level and low-level versions.

The low-level api consists mainly of the class SnnsR-class, which internally holds a pointer to a C++ object of the class SnnsCLib, i.e., an instance of the SNNS kernel. The class furthermore implements a calling mechanism for methods of the SnnsCLib object, so that they can be called conveniently using the "$"-operator. This calling mechanism also allows for transparent masking of methods or extending the kernel with new methods from within R. See $,SnnsR-method.

R-functions that are added by RSNNS to the kernel are documented in this manual under topics beginning with SnnsRobject$. Documentation of the original SNNS kernel user interface functions can be found in the SNNS User Manual 4.2 pp 290-314. A call to, e.g., the SNNS kernel function krui_getNoOfUnits(...) can be done with SnnsRobject$getNoOfUnits(...). However, a few functions were excluded from the wrapping for various reasons. For more details and other known issues see the file /inst/doc/KnownIssues.

Another nice tool is the NeuralNetTools package, that can be used to visualize and analyse the networks generated with RSNNS.

Most of the example data included in SNNS is also present in this package, see snnsData.

Additional information is also available at the project website:

http://sci2s.ugr.es/dicits/software/RSNNS
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References


General neural network literature:


Rumelhart, D. E.; Clelland, J. L. M. & Group, P. R. (1986), Parallel distributed processing :explo-

rations in the microstructure of cognition, Mit, Cambridge, MA etc..

Literature on the original SNNS software:


javaNNS, the successor of the original SNNS with a Java GUI: http://www.ra.cs.uni-tuebingen.de/software/JavaNNS


Other resources:

A function to plot networks from the mlp function: https://beckmw.wordpress.com/2013/11/14/visualizing-neural-networks-in-r-update/

See Also

mlp, dlvq, rbf, rbfDDA, elman, jordan, som, art1, art2, artmap, assoz
analyzeClassification  Converts continuous outputs to class labels

Description

This function converts the continuous outputs to binary outputs that can be used for classification. The two methods 402040, and winner-takes-all (WTA), are implemented as described in the SNNS User Manual 4.2.

Usage

analyzeClassification(y, method = "WTA", l = 0, h = 0)

Arguments

y  inputs
method  "WTA" or "402040"
l  lower bound, e.g. in 402040: l=0.4
h  upper bound, e.g. in 402040: h=0.6

Details

The following text is an edited citation from the SNNS User Manual 4.2 (pp 269):

402040 A pattern is recognized as classified correctly, if (i) the output of exactly one output unit is >= h (ii) the teaching output of this unit is the maximum teaching output (> 0) of the pattern (iii) the output of all other output units is <= l.

A pattern is recognized as classified incorrectly, if (i) and (iii) hold as above, but for (ii) holds that the teaching output is not the maximum teaching output of the pattern or there is no teaching output > 0.

A pattern is recognized as unclassified in all other cases.
The method derives its name from the commonly used default values l = 0.4, h = 0.6.

WTA A pattern is recognized as classified correctly, if (i) there is an output unit with the value greater than the output value of all other output units (this output value is supposed to be a) (ii) a > h (iii) the teaching output of this unit is the maximum teaching output of the pattern (> 0) (iv) the output of all other units is < a - l.

A pattern is recognized as classified incorrectly, if (i), (ii), and (iv) hold as above, but for (iii) holds that the teaching output of this unit is not the maximum teaching output of the pattern or there is no teaching output > 0.

A pattern is recognized as unclassified in all other cases.
Commonly used default values for this method are: l = 0.0, h = 0.0.

Value

the position of the winning unit (i.e., the winning class), or zero, if no classification was done.
References


See Also

encodeClassLabels

---

art1

Create and train an art1 network

Description

Adaptive resonance theory (ART) networks perform clustering by finding prototypes. They are mainly designed to solve the stability/plasticity dilemma (which is one of the central problems in neural networks) in the following way: new input patterns may generate new prototypes (plasticity), but patterns already present in the net (represented by their prototypes) are only altered by similar new patterns, not by others (stability). ART1 is for binary inputs only, if you have real-valued input, use art2 instead.

Usage

art1(x, ...)

## Default S3 method:
art1(x, dimX, dimY, f2Units = nrow(x), maxit = 100,
  initFunc = "ART1_Weights", initFuncParams = c(1, 1), learnFunc = "ART1",
  learnFuncParams = c(0.9, 0, 0), updateFunc = "ART1_Stable",
  updateFuncParams = c(0), shufflePatterns = TRUE, ...)

Arguments

x

a matrix with training inputs for the network

... additional function parameters (currently not used)

dimX x dimension of inputs and outputs

dimY y dimension of inputs and outputs

f2Units controls the number of clusters assumed to be present

maxit maximum of iterations to learn

initFunc the initialization function to use

initFuncParams the parameters for the initialization function

learnFunc the learning function to use

learnFuncParams the parameters for the learning function
updateFunc the update function to use
updateFuncParams the parameters for the update function
shufflePatterns should the patterns be shuffled?

Details

Learning in an ART network works as follows: A new input is intended to be classified according to the prototypes already present in the net. The similarity between the input and all prototypes is calculated. The most similar prototype is the winner. If the similarity between the input and the winner is high enough (defined by a vigilance parameter), the winner is adapted to make it more similar to the input. If similarity is not high enough, a new prototype is created. So, at most the winner is adapted, all other prototypes remain unchanged.

The architecture of an ART network is the following: ART is based on the more general concept of competitive learning. The networks have two fully connected layers (in both directions), the input/comparison layer and the recognition layer. They propagate activation back and forth (resonance). The units in the recognition layer have lateral inhibition, so that they show a winner-takes-all behaviour, i.e., the unit that has the highest activation inhibits activation of other units, so that after a few cycles its activation will converge to one, whereas the other units activations converge to zero. ART stabilizes this general learning mechanism by the presence of some special units. For details refer to the referenced literature.

The default initialization function, ART1_Weights, is the only one suitable for ART1 networks. It has two parameters, which are explained in the SNNS User Manual pp.189. A default of 1.0 for both is usually fine. The only learning function suitable for ART1 is ART1. Update functions are ART1_Stable and ART1_Synchronous. The difference between the two is that the first one updates until the network is in a stable state, and the latter one only performs one update step. Both the learning function and the update functions have one parameter, the vigilance parameter.

In its current implementation, the network has two-dimensional input. The matrix x contains all (one dimensional) input patterns. Internally, every one of these patterns is converted to a two-dimensional pattern using parameters dimX and dimY. The parameter f2Units controls the number of units in the recognition layer, and therewith the maximal amount of clusters that are assumed to be present in the input patterns.

A detailed description of the theory and the parameters is available from the SNNS documentation and the other referenced literature.

Value

an rsnns object. The fitted.values member of the object contains a list of two-dimensional activation patterns.

References


Zell, A. (1994), Simulation Neuronaler Netze, Addison-Wesley. (in German)

See Also

art2, artmap

Examples

```r
## Not run: demo(art1_letters)
## Not run: demo(art1_lettersSnnsR)

data(snnsData)
patterns <- snnsData$art1_letters.pat

inputMaps <- matrixToActMapList(patterns, nrow=7)
par(mfrow=c(3,3))
for (i in 1:9) plotActMap(inputMaps[[i]])

model <- art1(patterns, dimX=7, dimY=5)
encodeClassLabels(model$fitted.values)
```

---

**art2**

Create and train an art2 network

Description

ART2 is very similar to ART1, but for real-valued input. See art1 for more information. Opposed to the ART1 implementation, the ART2 implementation does not assume two-dimensional input.

Usage

```r
art2(x, ...)
```

## Default S3 method:
art2(x, f2Units = 5, maxit = 100,
    initFunc = "ART2_Weights", initFuncParams = c(0.9, 2),
    learnFunc = "ART2", learnFuncParams = c(0.98, 10, 10, 0.1, 0),
    updateFunc = "ART2_Stable", updateFuncParams = c(0.98, 10, 10, 0.1, 0),
    shufflePatterns = TRUE, ...)
```
Arguments

- **x**: a matrix with training inputs for the network
- Additional function parameters (currently not used)
- **f2Units**: controls the number of clusters assumed to be present
- **maxit**: maximum of iterations to learn
- **initFunc**: the initialization function to use
- **initFuncParams**: the parameters for the initialization function
- **learnFunc**: the learning function to use
- **learnFuncParams**: the parameters for the learning function
- **updateFunc**: the update function to use
- **updateFuncParams**: the parameters for the update function
- **shufflePatterns**: should the patterns be shuffled?

Details

As comparison of real-valued vectors is more difficult than comparison of binary vectors, the comparison layer is more complex in ART2, and actually consists of three layers. With a more complex comparison layer, also other parts of the network enhance their complexity. In SNNS, this enhanced complexity is reflected by the presence of more parameters in initialization-, learning-, and update function.

In analogy to the implementation of ART1, there are one initialization function, one learning function and two update functions suitable for ART2. The learning and update functions have five parameters, the initialization function has two parameters. For details see the SNNS User Manual, p. 67 and pp. 192.

Value

An `rsnn` object. The `fitted.values` member contains the activation patterns for all inputs.

References


Zell, A. (1994), Simulation Neuronaler Netze, Addison-Wesley. (in German)
artmap

See Also

art1, artmap

Examples

```r
## Not run: demo(art2_tetra)
## Not run: demo(art2_tetraSnnnsR)

data(snnnsData)
patterns <- snnnsData$art2_tetra_med.pat

model <- art2(patterns, f2Units=5, learnFuncParams=c(0.99, 20, 20, 0.1, 0),
              updateFuncParams=c(0.99, 20, 20, 0.1, 0))

model
testPatterns <- snnnsData$art2_tetra_high.pat
predictions <- predict(model, testPatterns)

## Not run: library(scatterplot3d)
## Not run: par(mfrow=c(2,2))
## Not run: scatterplot3d(patterns, pch=encodeClassLabels(model$fitted.values))
## Not run: scatterplot3d(testPatterns, pch=encodeClassLabels(predictions))
```

---

**artmap**

Create and train an artmap network

**Description**

An ARTMAP performs supervised learning. It consists of two coupled ART networks. In theory, these could be ART1, ART2, or others. However, in SNNS ARTMAP is implemented for ART1 only. So, this function is to be used with binary input. As explained in the description of art1, ART aims at solving the stability/plasticity dilemma. So the advantage of ARTMAP is that it is a supervised learning mechanism that guarantees stability.

**Usage**

```
artmap(x, ...)
```

## Default S3 method:
```
artmap(x, nInputsTrain, nInputsTargets, nUnitsRecLayerTrain, nUnitsRecLayerTargets, maxit = 1, nRowInputsTrain = 1, nRowInputsTargets = 1, nRowUnitsRecLayerTrain = 1, nRowUnitsRecLayerTargets = 1, initFunc = "ARTMAP_Weights", initFuncParams = c(1, 1, 1, 1, 0), learnFunc = "ARTMAP", learnFuncParams = c(0.8, 1, 1, 0, 0), updateFunc = "ARTMAP_Stable", updateFuncParams = c(0.8, 1, 1, 0, 0), shufflePatterns = TRUE, ...)
```
Arguments

\begin{itemize}
\item \texttt{x} \quad \text{a matrix with training inputs and targets for the network}
\item \ldots \quad \text{additional function parameters (currently not used)}
\item \texttt{nInputsTrain} \quad \text{the number of columns of the matrix that are training input}
\item \texttt{nInputsTargets} \quad \text{the number of columns that are target values}
\item \texttt{nUnitsRecLayerTrain} \quad \text{number of units in the recognition layer of the training data ART network}
\item \texttt{nUnitsRecLayerTargets} \quad \text{number of units in the recognition layer of the target data ART network}
\item \texttt{maxit} \quad \text{maximum of iterations to perform}
\item \texttt{nRowInputsTrain} \quad \text{number of rows the training input units are to be organized in (only for visualization purposes of the net in the original SNNS software)}
\item \texttt{nRowInputsTargets} \quad \text{same, but for the target value input units}
\item \texttt{nRowUnitsRecLayerTrain} \quad \text{same, but for the recognition layer of the training data ART network}
\item \texttt{nRowUnitsRecLayerTargets} \quad \text{same, but for the recognition layer of the target data ART network}
\item \texttt{initFunc} \quad \text{the initialization function to use}
\item \texttt{initFuncParams} \quad \text{the parameters for the initialization function}
\item \texttt{learnFunc} \quad \text{the learning function to use}
\item \texttt{learnFuncParams} \quad \text{the parameters for the learning function}
\item \texttt{updateFunc} \quad \text{the update function to use}
\item \texttt{updateFuncParams} \quad \text{the parameters for the update function}
\item \texttt{shufflePatterns} \quad \text{should the patterns be shuffled?}
\end{itemize}

Details

See also the details section of \texttt{art1}. The two ART1 networks are connected by a \textit{map field}. The input of the first ART1 network is the training input, the input of the second network are the target values, the teacher signals. The two networks are often called ART\textsubscript{a} and ART\textsubscript{b}, we call them here training data network and target data network.

In analogy to the ART1 and ART2 implementations, there are one initialization function, one learning function, and two update functions present that are suitable for ARTMAP. The parameters are basically as in ART1, but for two networks. The learning function and the update functions have 3 parameters, the vigilance parameters of the two ART1 networks and an additional vigilance parameter for inter ART reset control. The initialization function has four parameters, two for every ART1 network.

A detailed description of the theory and the parameters is available from the SNNS documentation and the other referenced literature.
assoz

Value

an rsnns object. The fitted.values member of the object contains a list of two-dimensional activation patterns.

References


Zell, A. (1994), Simulation Neuronaler Netze, Addison-Wesley. (in German)

See Also

art1, art2

Examples

## Not run: demo(artmap_letters)
## Not run: demo(artmap_lettersSnnsR)

data(snsData)
trainData <- snsData$artmap_train.pat
testData <- snsData$artmap_test.pat

model <- artmap(trainData, nInputsTrain=70, nInputsTargets=5,
               nUnitsRecLayerTrain=50, nUnitsRecLayerTargets=26)
model$fitted.values

predict(model, testData)

assoz

Create and train an (auto-)associative memory

Description

The autoassociative memory performs clustering by finding a prototype to the given input. The implementation assumes two-dimensional input and output (cf. art1).
Usage

assoz(x, ...)  

## Default S3 method:
assoz(x, dimX, dimY, maxit = 100,  
  initFunc = "RM_Random_Weights", initFuncParams = c(1, -1),  
  learnFunc = "RM_delta", learnFuncParams = c(0.01, 100, 0, 0, 0),  
  updateFunc = "Auto_Synchronous", updateFuncParams = c(50),  
  shufflePatterns = TRUE, ...)

Arguments

x
   a matrix with training inputs for the network

...  
   additional function parameters (currently not used)

dimX  
   x dimension of inputs and outputs

dimY  
   y dimension of inputs and outputs

maxit
   maximum of iterations to learn

initFunc
   the initialization function to use

initFuncParams
   the parameters for the initialization function

learnFunc
   the learning function to use

learnFuncParams
   the parameters for the learning function

updateFunc
   the update function to use

updateFuncParams
   the parameters for the update function

shufflePatterns
   should the patterns be shuffled?

Details

The default initialization and update functions are the only ones suitable for this kind of network. The update function takes one parameter, which is the number of iterations that will be performed. The default of 50 usually does not have to be modified. For learning, RM_delta and Hebbian functions can be used, though the first one usually performs better.

A more detailed description of the theory and the parameters is available from the SNNS documentation and the other referenced literature.

Value

an rsnns object. The fitted.values member contains the activation patterns for all inputs.
confusionMatrix

References


See Also

art1, art2

Examples

```r
## Not run: demo(asoz_letters)
## Not run: demo(asoz_lettersSnnsR)

data(snnsData)
patterns <- snnsData$art1_letters.pat

model <- asoz(patterns, dimX=7, dimY=5)

actMaps <- matrixToActMapList(model$fitted.values, nrow=7)

par(mfrow=c(3,3))
for (i in 1:9) plotActMap(actMaps[[i]])
```

---

confusionMatrix Computes a confusion matrix

Description

The confusion matrix shows how many times a pattern with the real class x was classified as class y. A perfect method should result in a diagonal matrix. All values not on the diagonal are errors of the method.

Usage

`confusionMatrix(targets, predictions)`

Arguments

targets the known, correct target values
predictions the corresponding predictions of a method for the targets
Details
If the class labels are not already encoded, they are encoded using `encodeClassLabels` (with default values).

Value
the confusion matrix

decodeClassLabels
*Decode class labels to a binary matrix*

Description
This method decodes class labels from a numerical or levels vector to a binary matrix, i.e., it converts the input vector to a binary matrix.

Usage
```r
decodeClassLabels(x, valTrue = 1, valFalse = 0)
```

Arguments
- `x` class label vector
- `valTrue` see Details paragraph
- `valFalse` see Details paragraph

Details
In the matrix, the value `valTrue` (e.g. 1) is present exactly in the column given by the value in the input vector, and the value `valFalse` (e.g. 0) in the other columns. The number of columns of the resulting matrix depends on the number of unique labels found in the vector. E.g. the input `c(1, 3, 2, 3)` will result in an output matrix with rows: 100 001 010 001

Value
a matrix containing the decoded class labels

Author(s)
The implementation is a slightly modified version of the function `class.ind` from the `nnet` package of Brian Ripley.

References
denormalizeData

Examples

decodeClassLabels(c(1,3,2,3))
decodeClassLabels(c("r","b","b","r","g","g"))

data(iris)
decodeClassLabels(iris[,5])

denormalizeData(x, normParams)

Arguments

x input data

normParams the parameters generated by an earlier call to normalizeData that will be used for reverting normalization

Details

The input matrix is column-wise denormalized using the parameters given by normParams. E.g., if normParams contains mean and sd for every column, the values are multiplied by sd and the mean is added

Value

column-wise denormalized input

See Also

normalizeData, getNormParameters

Examples

data(iris)
values <- normalizeData(iris[,1:4])
denormalizeData(values, getNormParameters(values))
Dynamic learning vector quantization (DLVQ) networks are similar to self-organizing maps (SOM, \texttt{som}). But they perform supervised learning and lack a neighborhood relationship between the prototypes.

### Usage

\begin{verbatim}
dlvq(x, ...)  
## Default S3 method:  
dlvq(x, y, initFunc = "DLVQ_Weights",  
    initFuncParams = c(1, -1), learnFunc = "Dynamic_LVQ",  
    learnFuncParams = c(0.03, 0.03, 10), updateFunc = "Dynamic_LVQ",  
    updateFuncParams = c(0), shufflePatterns = TRUE, ...)  
\end{verbatim}

### Arguments

- \texttt{x} a matrix with training inputs for the network
- \texttt{...} additional function parameters (currently not used)
- \texttt{y} the corresponding target values
- \texttt{initFunc} the initialization function to use
- \texttt{initFuncParams} the parameters for the initialization function
- \texttt{learnFunc} the learning function to use
- \texttt{learnFuncParams} the parameters for the learning function
- \texttt{updateFunc} the update function to use
- \texttt{updateFuncParams} the parameters for the update function
- \texttt{shufflePatterns} should the patterns be shuffled?

### Details

The input data has to be normalized in order to use DLVQ.

Learning in DLVQ: For each class, a mean vector (prototype) is calculated and stored in a (newly generated) hidden unit. Then, the net is used to classify every pattern by using the nearest prototype. If a pattern gets misclassified as class \( y \) instead of class \( x \), the prototype of class \( y \) is moved away from the pattern, and the prototype of class \( x \) is moved towards the pattern. This procedure is repeated iteratively until no more changes in classification take place. Then, new prototypes are introduced in the net per class as new hidden units, and initialized by the mean vector of misclassified patterns in that class.
Network architecture: The network only has one hidden layer, containing one unit for each prototype. The prototypes/hidden units are also called codebook vectors. Because SNNS generates the units automatically, and does not need their number to be specified in advance, the procedure is called dynamic LVQ in SNNS.

The default initialization, learning, and update functions are the only ones suitable for this kind of network. The three parameters of the learning function specify two learning rates (for the cases correctly/uncorrectly classified), and the number of cycles the net is trained before mean vectors are calculated.

A detailed description of the theory and the parameters is available, as always, from the SNNS documentation and the other referenced literature.

Value

an rsnns object. The fitted.values member contains the activation patterns for all inputs.

References

Zell, A. (1994), Simulation Neuronaler Netze, Addison-Wesley. (in German)

Examples

```r
## Not run: demo(dlvq_ziff)
## Not run: demo(dlvq_ziffRsnnsR)

data(snnspat)
dataset <- snnspat$dlvq_ziff_100.pat

inputs <- dataset[,inputColumns(dataset)]
outputs <- dataset[,outputColumns(dataset)]

model <- dlvq(inputs, outputs)

fitted(model) == outputs
mean(fitted(model) - outputs)
```

elman

Create and train an Elman network

Description

Elman networks are partially recurrent networks and similar to Jordan networks (function jordan). For details, see explanations there.
Usage

elman(x, ...)

## Default S3 method:
elman(x, y, size = c(5), maxit = 100,
initFunc = "JE_Weights", initFuncParams = c(1, -1, 0.3, 1, 0.5),
learnFunc = "JE_BP", learnFuncParams = c(0.2), updateFunc = "JE_Order",
updateFuncParams = c(0), shufflePatterns = FALSE, linOut = TRUE,
outContext = FALSE, inputsTest = NULL, targetsTest = NULL, ...)

Arguments

x a matrix with training inputs for the network

... additional function parameters (currently not used)

y the corresponding targets values

size number of units in the hidden layer(s)

maxit maximum of iterations to learn

initFunc the initialization function to use

initFuncParams the parameters for the initialization function

learnFunc the learning function to use

learnFuncParams the parameters for the learning function

updateFunc the update function to use

updateFuncParams the parameters for the update function

shufflePatterns should the patterns be shuffled?

linOut sets the activation function of the output units to linear or logistic

outContext if TRUE, the context units are also output units (untested)

inputsTest a matrix with inputs to test the network

targetsTest the corresponding targets for the test input

Details

Learning in Elman networks: Same as in Jordan networks (see jordan).

Network architecture: The difference between Elman and Jordan networks is that in an Elman network the context units get input not from the output units, but from the hidden units. Furthermore, there is no direct feedback in the context units. In an Elman net, the number of context units and hidden units has to be the same. The main advantage of Elman nets is that the number of context units is not directly determined by the output dimension (as in Jordan nets), but by the number of hidden units, which is more flexible, as it is easy to add/remove hidden units, but not output units.

A detailed description of the theory and the parameters is available, as always, from the SNNS documentation and the other referenced literature.
**Value**

an `rsnns` object.

**References**


Zell, A. (1994), Simulation Neuronaler Netze, Addison-Wesley. (in German)

**See Also**

`jordan`

**Examples**

```r
# Not run: demo(iris)
# Not run: demo(laser)
# Not run: demo(eight_elman)
# Not run: demo(eight_elmanSnnsR)

data(snnssData)
inputs <- snnssData$eight_016.pat[,inputColumns(snnssData$eight_016.pat)]
outputs <- snnssData$eight_016.pat[,outputColumns(snnssData$eight_016.pat)]

par(mfrow=c(1,2))

modelElman <- elman(inputs, outputs, size=8, learnFuncParams=c(0.1), maxit=1000)
modelElman
modelJordan <- jordan(inputs, outputs, size=8, learnFuncParams=c(0.1), maxit=1000)
modelJordan

plotIterativeError(modelElman)
plotIterativeError(modelJordan)

summary(modelElman)
summary(modelJordan)
```

---

**encodeClassLabels**

Encode a matrix of (decoded) class labels

**Description**

Applies `analyzeClassification` row-wise to a matrix.
Usage
encodeClassLabels(x, method = "WTA", l = 0, h = 0)

Arguments

- x: inputs
- method: see analyzeClassification
- l: idem
- h: idem

Value

A numeric vector, each number represents a different class. A zero means that no class was assigned to the pattern.

See Also

analyzeClassification

Examples

data(iris)
labels <- decodeClassLabels(iris[,5])
encodeClassLabels(labels)

exportToSnnsNetFile

Export the net to a file in the original SNNS file format

Usage
exportToSnnsNetFile(object, filename, netname = "RSNNS_untitled")

Arguments

- object: the rsnns object
- filename: path and filename to be written to
- netname: name that is given to the network in the file
extractNetInfo

Extract information from a network

Description

This function generates a list of data.frames containing the most important information that defines a network, in a format that is easy to use. To get the full definition in the original SNNS format, use summary.rsnns or exportToSnnsNetFile instead.

Usage

extractNetInfo(object)

Arguments

object the rsnns object

Details

Internally, a call to SnsrObject$extractNetInfo is done, and the results of this call are returned.

Value

a list containing information extracted from the network (see SnsrObject$extractNetInfo).

See Also

SnsrObject$extractNetInfo

getNormParameters

Get normalization parameters of the input data

Description

Get the normalization parameters that are appended by normalizeData as attributes to the input data.

Usage

getNormParameters(x)

Arguments

x input data
**getSnnsRDefine**

**Details**

This function is equivalent to calling `attr(x, "normParams")`.

**Value**

the parameters generated by an earlier call to `normalizeData`

**See Also**

`normalizeData`, `denormalizeData`

---

**getSnnsRDefine**  
*Get a define of the SNNS kernel*

**Description**

Get a define of the SNNS kernel from a defines-list. All defines-lists present can be shown with `RSNNS::SnnsDefines`.

**Usage**

`getSnnsRDefine(defList, defValue)`

**Arguments**

- `defList`  
  the defines-list from which to get the define from
- `defValue`  
  the value in the list

**Value**

a string with the name of the define

**See Also**

`resolveSnnsRDefine`

**Examples**

```r
getSnnsRDefine("topologicalUnitTypes",3)
getsnnsRDefine("errorCodes",-50)
```
getSnnsRFunctionTable  Get SnnsR function table

Description

Get the function table of available SNNS functions.

Usage

getSnnsRFunctionTable()

Value

a data.frame with columns:

<table>
<thead>
<tr>
<th>name</th>
<th>name of the function</th>
</tr>
</thead>
<tbody>
<tr>
<td>type</td>
<td>the type of the function (learning, init, update,...)</td>
</tr>
<tr>
<td>Cinparams</td>
<td>the number of input parameters of the function</td>
</tr>
<tr>
<td>Coutparams</td>
<td>the number of output parameters of the function</td>
</tr>
</tbody>
</table>

inputColumns  Get the columns that are inputs

Description

This function extracts all columns from a matrix whose column names begin with “in”. The example data of this package follows this naming convention.

Usage

inputColumns(patterns)

Arguments

patterns matrix or data.frame containing the patterns
Create and train a Jordan network

Description

Jordan networks are partially recurrent networks and similar to Elman networks (see `elman`). Partially recurrent networks are useful when working with time series data. I.e., when the output of the network not only should depend on the current pattern, but also on the patterns presented before.

Usage

```r
jordan(x, ...)  
```

## Default S3 method:
```r
jordan(x, y, size = c(5), maxit = 100,  
initFunc = "JE_Weights", initFuncParams = c(1, -1, 0.3, 1, 0.5),  
learnFunc = "JE_BP", learnFuncParams = c(0.2), updateFunc = "JE_Order",  
updateFuncParams = c(0), shufflePatterns = FALSE, linOut = TRUE,  
inputsTest = NULL, targetsTest = NULL, ...)
```

Arguments

- `x` a matrix with training inputs for the network
- `...` additional function parameters (currently not used)
- `y` the corresponding targets values
- `size` number of units in the hidden layer(s)
- `maxit` maximum of iterations to learn
- `initFunc` the initialization function to use
- `initFuncParams` the parameters for the initialization function
- `learnFunc` the learning function to use
- `learnFuncParams` the parameters for the learning function
- `updateFunc` the update function to use
- `updateFuncParams` the parameters for the update function
- `shufflePatterns` should the patterns be shuffled?
- `linOut` sets the activation function of the output units to linear or logistic
- `inputsTest` a matrix with inputs to test the network
- `targetsTest` the corresponding targets for the test input
Details

Learning on Jordan networks: Backpropagation algorithms for feed-forward networks can be adapted for their use with this type of networks. In SNNS, there exist adapted versions of several backpropagation-type algorithms for Jordan and Elman networks.

Network architecture: A Jordan network can be seen as a feed-forward network with additional context units in the input layer. These context units take input from themselves (direct feedback), and from the output units. The context units save the current state of the net. In a Jordan net, the number of context units and output units has to be the same.

Initialization of Jordan and Elman nets should be done with the default init function \texttt{je_weights}, which has five parameters. The first two parameters define an interval from which the forward connections are randomly chosen. The third parameter gives the self-excitation weights of the context units. The fourth parameter gives the weights of context units between them, and the fifth parameter gives the initial activation of context units.

Learning functions are \texttt{je_bp}, \texttt{je_bp_momentum}, \texttt{je_quickprop}, and \texttt{je_rprop}, which are all adapted versions of their standard-procedure counterparts. Update functions that can be used are \texttt{je_order} and \texttt{je_special}.

A detailed description of the theory and the parameters is available, as always, from the SNNS documentation and the other referenced literature.

Value

an \texttt{rsnns} object.

References


Zell, A. (1994), Simulation Neuronaler Netze, Addison-Wesley. (in German)

See Also

\texttt{elman}

Examples

```r
## Not run: demo(iris)
## Not run: demo(laser)
## Not run: demo(eight_elman)
## Not run: demo(eight_elmanSnsR)

data(snnssData)
inputs <- snnssData$laser_1000.pat[,inputColumns(snnssData$laser_1000.pat)]
outputs <- snnssData$laser_1000.pat[,outputColumns(snnssData$laser_1000.pat)]
```
matrixToActMapList

Convert matrix of activations to activation map list

Description
Organize a matrix containing 1d vectors of network activations as 2d maps.

Usage
matrixToActMapList(m, nrow = 0, ncol = 0)

Arguments
m
the matrix containing one activation pattern in every row
nrow
number of rows the resulting matrices will have
ncol
number of columns the resulting matrices will have

Details
The input to this function is a matrix containing in each row an activation pattern/output of a neural network. This function uses vectorToActMap to reorganize the matrix to a list of matrices, whereby each row of the input matrix is converted to a matrix in the output list.

Value
a list containing the activation map matrices
See Also

vectorToActMap plotActMap

---

**mlp**

Create and train a multi-layer perceptron (MLP)

### Description

This function creates a multilayer perceptron (MLP) and trains it. MLPs are fully connected feed-forward networks, and probably the most common network architecture in use. Training is usually performed by error backpropagation or a related procedure.

### Usage

```r
mlp(x, ...)
```

### Arguments

- `x` a matrix with training inputs for the network
- `...` additional function parameters (currently not used)
- `y` the corresponding targets values
- `size` number of units in the hidden layer(s)
- `maxit` maximum of iterations to learn
- `initFunc` the initialization function to use
- `initFuncParams` the parameters for the initialization function
- `learnFunc` the learning function to use
- `learnFuncParams` the parameters for the learning function
- `updateFunc` the update function to use
- `updateFuncParams` the parameters for the update function
- `hiddenActFunc` the activation function of all hidden units
- `shufflePatterns` should the patterns be shuffled?
linOut sets the activation function of the output units to linear or logistic
inputsTest a matrix with inputs to test the network
targetsTest the corresponding targets for the test input
pruneFunc the pruning function to use
pruneFuncParams the parameters for the pruning function. Unlike the other functions, these have
to be given in a named list. See the pruning demos for further explanation.

Details
There are a lot of different learning functions present in SNNS that can be used together with
this function, e.g., Std_Backpropagation, BackpropBatch, BackpropChunk, BackpropMomentum,
BackpropWeightDecay, Rprop, Quickprop, SCG (scaled conjugate gradient), ...
Std_Backpropagation, BackpropBatch, e.g., have two parameters, the learning rate and the max-
imum output difference. The learning rate is usually a value between 0.1 and 1. It specifies
the gradient descent step width. The maximum difference defines, how much difference between out-
put and target value is treated as zero error, and not backpropagated. This parameter is used to
prevent overtraining. For a complete list of the parameters of all the learning functions, see the
The defaults that are set for initialization and update functions usually don’t have to be changed.

Value
an rsnns object.

References
Rosenblatt, F. (1958), 'The perceptron: A probabilistic model for information storage and organi-
zation in the brain', Psychological Review 65(6), 386–408.
Rumelhart, D. E.; Clelland, J. L. M. & Group, P. R. (1986), Parallel distributed processing :explo-
rations in the microstructure of cognition, Mit, Cambridge, MA etc.
de/SNNS/
Zell, A. (1994), Simulation Neuronaler Netze, Addison-Wesley. (in German)

Examples

```r
## Not run: demo(iris)
## Not run: demo(laser)
## Not run: demo(encoderSnnsClib)

data(iris)

#shuffle the vector
iris <- iris[sample(1:nrow(iris),length(1:nrow(iris))),1:ncol(iris)]
```
normalizeData

Data normalization

Description
The input matrix is column-wise normalized.

Usage
normalizeData(x, type = "norm")

Arguments
- **x**: input data
- **type**: either type string specifying the type of normalization. Implemented are "0_1", "center", and "norm"
  - or attribute list of a former call to this method to apply e.g. normalization of the training data to the test data
normTrainingAndTestSet

Details

The parameter type specifies, how normalization takes place:

- **0_1** values are normalized to the [0,1]-interval. The minimum in the data is mapped to zero, the maximum to one.
- **center** the data is centered, i.e. the mean is subtracted
- **norm** the data is normalized to mean zero, variance one

Value

column-wise normalized input. The normalization parameters that were used for the normalization are present as attributes of the output. They can be obtained with getNormParameters.

See Also

denormalizedata, getNormParameters

Usage

normTrainingAndTestSet(x, dontNormTargets = TRUE, type = "norm")

Arguments

- **x** a list containing training and test data. Usually the output of splitForTrainingAndTest.
- **dontNormTargets** should the target values also be normalized?
- **type** type of the normalization. This parameter is passed to normalizeData.

Value

a named list with the same elements as splitForTrainingAndTest, but with normalized values. The normalization parameters are appended to each member of the list as attributes, as in normalizeData.
**outputColumns**

See Also

`splitForTrainingAndTest, normalizeData, denormalizeData, getNormParameters`

**Examples**

```r
data(iris)
# shuffle the vector
iris <- iris[sample(1:nrow(iris), length(1:nrow(iris))):1:ncol(iris)]

irisValues <- iris[,1:4]
irisTargets <- decodeClassLabels(iris[,5])

iris <- splitForTrainingAndTest(irisValues, irisTargets, ratio=0.15)
normTrainingAndTestSet(iris)
```

---

**Description**

This function extracts all columns from a matrix whose column names begin with "out". The example data of this package follows this naming convention.

**Usage**

```r
outputColumns(patterns)
```

**Arguments**

- `patterns` matrix or data.frame containing the patterns

---

**plotActMap**

Plot activation map

**Description**

Plot an activation map as a heatmap.

**Usage**

```r
plotActMap(x, ...)
```

**Arguments**

- `x` the input data matrix
- `...` parameters passed to `image`
plotRegressionError

See Also

vectorToActMap matrixToActMapList

plotIterativeError  Plot iterative errors of an rsnns object

Description

Plot the iterative training and test error of the net of this rsnns object.

Usage

plotIterativeError(object, ...)

Arguments

object  a rsnns object

...  parameters passed to plot

Details

Plots (if present) the class members IterativeFitError (as black line) and IterativeTestError (as red line).

plotRegressionError  Plot a regression error plot

Description

The plot shows target values on the x-axis and fitted/predicted values on the y-axis. The optimal fit would yield a line through zero with gradient one. This optimal line is shown in black color. A linear fit to the actual data is shown in red color.

Usage

plotRegressionError(targets, fits, ...)

Arguments

targets  the target values
fits  the values predicted/fitted by the model

...  parameters passed to plot
**plotROC**  

*Plot a ROC curve*

**Description**

This function plots a receiver operating characteristic (ROC) curve.

**Usage**

```r
plotROC(T, D, ...)
```

**Arguments**

- `T` predictions
- `D` targets
- `...` parameters passed to plot

**Author(s)**

Code is taken from R news Volume 4/1, June 2004.

**References**

R news Volume 4/1, June 2004

---

**predict.rsnns**  

*Generic predict function for rsnns object*

**Description**

Predict values using the given network.

**Usage**

```r
## S3 method for class 'rsnns'
predict(object, newdata, ...)
```

**Arguments**

- `object` the `rsnns` object
- `newdata` the new input data which is used for prediction
- `...` additional function parameters (currently not used)

**Value**

the predicted values
print.rsnns  
Generic print function for rsnns objects

Description
Print out some characteristics of an rsnns object.

Usage
```r
## S3 method for class 'rsnns'
print(x, ...)
```

Arguments
- `x` the rsnns object
- `...` additional function parameters (currently not used)

rbf  
Create and train a radial basis function (RBF) network

Description
The use of an RBF network is similar to that of an mlp. The idea of radial basis function networks comes from function interpolation theory. The RBF performs a linear combination of n basis functions that are radially symmetric around a center/prototype.

Usage
```r
rbf(x, ...)
```

## Default S3 method:
```r
rbf(x, y, size = c(5), maxit = 100, 
    initFunc = "RBF_Weights", initFuncParams = c(0, 1, 0, 0.02, 0.04), 
    learnFunc = "RadialBasisLearning", learnFuncParams = c(1e-05, 0, 1e-05, 
               0.1, 0.8), updateFunc = "Topological_Order", updateFuncParams = c(0), 
    shufflePatterns = TRUE, linOut = TRUE, inputsTest = NULL,
    targetsTest = NULL, ...)
```

Arguments
- `x` a matrix with training inputs for the network
- `...` additional function parameters (currently not used)
- `y` the corresponding targets values
- `size` number of units in the hidden layer(s)
maxit maximum of iterations to learn
initFunc the initialization function to use
initFuncParams the parameters for the initialization function
learnFunc the learning function to use
learnFuncParams the parameters for the learning function
updateFunc the update function to use
updateFuncParams the parameters for the update function
shufflePatterns should the patterns be shuffled?
linOut sets the activation function of the output units to linear or logistic
inputsTest a matrix with inputs to test the network
targetsTest the corresponding targets for the test input

Details

RBF networks are feed-forward networks with one hidden layer. Their activation is not sigmoid (as in MLP), but radially symmetric (often gaussian). Thereby, information is represented locally in the network (in contrast to MLP, where it is globally represented). Advantages of RBF networks in comparison to MLPs are mainly, that the networks are more interpretable, training ought to be easier and faster, and the network only activates in areas of the feature space where it was actually trained, and has therewith the possibility to indicate that it "just doesn't know".

Initialization of an RBF network can be difficult and require prior knowledge. Before use of this function, you might want to read pp 172-183 of the SNNS User Manual 4.2. The initialization is performed in the current implementation by a call to RBF_Weights_Kohonen(0,0,0,0,0) and a successive call to the given initFunc (usually RBF_Weights). If this initialization doesn’t fit your needs, you should use the RSNNS low-level interface to implement your own one. Have a look then at the demos/examples. Also, we note that depending on whether linear or logistic output is chosen, the initialization parameters have to be different (normally c(0,1,...) for linear and c(-4,4,...) for logistic output).

Value

an rsnns object.

References

Zell, A. (1994), Simulation Neuronaler Netze, Addison-Wesley. (in German)
Examples

```r
## Not run: demo(rbf_irisSnnsR)
## Not run: demo(rbf_sin)
## Not run: demo(rbf_sinSnnsR)

inputs <- as.matrix(seq(0, 10, 0.1))
outputs <- as.matrix(sin(inputs) + runif(nrow(inputs) * 0.2))
outputs <- normalizeData(outputs, "0_1")

model <- rbf(inputs, outputs, size=40, maxit=1000,
              initFuncParams=c(0, 1, 0, 0.01, 0.01),
              learnFuncParams=c(1e-8, 0, 1e-8, 0.1, 0.8), linOut=TRUE)

par(mfrow=c(2, 1))
plotIterativeError(model)
plot(inputs, outputs)
lines(inputs, fitted(model), col="green")
```

---

**rbfDDA**

Create and train an RBF network with the DDA algorithm

---

**Description**

Create and train an RBF network with the dynamic decay adjustment (DDA) algorithm. This type of network can only be used for classification. The training typically begins with an empty network, i.e., a network only consisting of input and output units, and adds new units successively. It is a lot easier to use than normal RBF, because it only requires two quite uncritical parameters.

**Usage**

```r
rbfDDA(x, ...)# Default S3 method:
rbfDDA(x, y, maxit = 1, initFunc = "Randomize_Weights",
       initFuncParams = c(-0.3, 0.3), learnFunc = "RBF-DDA",
       learnFuncParams = c(0.4, 0.2, 5), updateFunc = "Topological_Order",
       updateFuncParams = c(0), shufflePatterns = TRUE, linOut = FALSE, ...)
```

**Arguments**

- `x`: a matrix with training inputs for the network
- `...`: additional function parameters (currently not used)
- `y`: the corresponding targets values
- `maxit`: maximum of iterations to learn
- `initFunc`: the initialization function to use
- `initFuncParams`: the parameters for the initialization function
learnFunc the learning function to use
learnFuncParams the parameters for the learning function
updateFunc the update function to use
updateFuncParams the parameters for the update function
shufflePatterns should the patterns be shuffled?
linOut sets the activation function of the output units to linear or logistic

Details

The default functions do not have to be altered. The learning function RBF~DDA has three parameters: a positive threshold, and a negative threshold, that controls adding units to the network, and a parameter for display purposes in the original SNNS. This parameter has no effect in RSNNS. See p 74 of the original SNNS User Manual for details.

Value

an rsnns object.

References


Examples

```r
## Not run: demo(iris)
## Not run: demo(rbfDDA_spiralsSnnsR)

data(iris)
iris <- iris[sample(1:nrow(iris),length(1:nrow(iris))),ncol(iris)]
irisValues <- iris[,1:4]
irisTargets <- decodeClassLabels(iris[,5])
iris <- splitForTrainingAndTest(irisValues, irisTargets, ratio=0.15)
iris <- normTrainingAndTestSet(iris)

model <- rbfDDA(iris$inputsTrain, iris$targetsTrain)

summary(model)
plotIterativeError(model)
```
readPatFile  Load data from a pat file

Description

This function generates an SnnsR-class object, loads the given .pat file there as a pattern set and then extracts the patterns to a matrix, using SnnsRObject$extractPatterns.

Usage

readPatFile(filename)

Arguments

filename  the name of the .pat file

Value

a matrix containing the data loaded from the .pat file.

readResFile  Rudimentary parser for res files.

Description

This function contains a rudimentary parser for SNNS .res files. It is completely implemented in R and doesn’t make use of SNNS functionality.

Usage

readResFile(filename)

Arguments

filename  the name of the .res file

Value

a matrix containing the predicted values that were found in the .res file
resolveSnnsRDefine  Resolve a define of the SNNS kernel

Description

Resolve a define of the SNNS kernel using a defines-list. All defines-lists present can be shown with RSNNS:::SnnsDefines.

Usage

resolveSnnsRDefine(defList, def)

Arguments

defList  the defines-list from which to resolve the define from

def  the name of the define

Value

the value of the define

See Also

getSnnsRDefine

Examples

resolveSnnsRDefine("topologicalUnitTypes","UNIT_HIDDEN")

rsnnsObjectFactory  Object factory for generating rsnns objects

Description

The object factory generates an rsnns object and initializes its member variables with the values given as parameters. Furthermore, it generates an object of SnnsR-class. Later, this information is to be used to train the network.

Usage

rsnnsObjectFactory(subclass, nInputs, maxit, initFunc, initFuncParams, learnFunc, learnFuncParams, updateFunc, updateFuncParams, shufflePatterns = TRUE, computeIterativeError = TRUE, pruneFunc = NULL, pruneFuncParams = NULL)
Arguments

subclass the subclass of rsnns to generate (vector of strings)
nInputs the number of inputs the network will have
maxit maximum of iterations to learn
initFunc the initialization function to use
initFuncParams the parameters for the initialization function
learnFunc the learning function to use
learnFuncParams the parameters for the learning function
updateFunc the update function to use
updateFuncParams the parameters for the update function
shufflePatterns should the patterns be shuffled?
computeIterativeError should the error be computed in every iteration?
pruneFunc the pruning function to use
pruneFuncParams the parameters for the pruning function. Unlike the other functions, these have to be given in a named list. See the pruning demos for further explanation.

Details

The typical procedure implemented in rsnns subclasses is the following:

- generate the rsnns object with this object factory
- generate the network according to the architecture needed
- train the network (with train)

In every rsnns object, the iterative error is the summed squared error (SSE) of all patterns. If the SSE is computed on the test set, then it is weighted to take care of the different amount of patterns in the sets.

Value

a partly initialized rsnns object

See Also

mlp, dlvq, rbf, rbfDDA, elman, jordan, som, artI, art2, artmap, assoz
savePatFile  

**Save data to a pat file**

**Description**

This function generates an SnnsR-class object, loads the given data there as a pattern set and then uses the functionality of SNNS to save the data as a .pat file.

**Usage**

```r
savePatFile(inputs, targets, filename)
```

**Arguments**

- **inputs**  
  a matrix with input values
- **targets**  
  a matrix with target values
- **filename**  
  the name of the .pat file

---

**setSnnsRSeedValue**  

**DEPRECATED. Set the SnnsR seed value**

**Description**

DEPRECATED, now just calls R’s set.seed(), that should be used instead.

**Usage**

```r
setSnnsRSeedValue(seed)
```

**Arguments**

- **seed**  
  the seed to use. If 0, a seed based on the system time is generated.

---

**snnsData**  

**Example data of the package**

**Description**

This is data from the original SNNS examples directory ported to R and stored as one list. The function `readPatFile` was used to parse all pattern files (.pat) from the original SNNS examples directory. Due to limitations of that function, pattern files containing patterns with variable size were omitted.

**Examples**

```r
data(snnsData)
names(snnsData)
```
SnnsR-class  

The main class of the package

Description

An S4 class that is the main class of RSNNS. Each instance of this class contains a pointer to a C++ object of type SnnsCLib, i.e. an instance of the SNNS kernel.

Details

The only slot variables holds an environment with all member variables. Currently, there are two members (constructed by the object factory):

- **snnsCLibPointer**: A pointer to the corresponding C++ object
- **serialization**: a serialization of the C++ object, in SNNS .net format

The member variables are not directly present as slots but wrapped in an environment to allow for changing the serialization (by call by reference).

An object of this class is used internally by all the models in the package. The object is always accessible by `modelDsnnsObjectDNNN`

To make full use of the SNNS functionalities, you might want to use this class directly. Always use the object factory `SnnsRObjectFactory` to construct an object, and the calling mechanism `$` to call functions. Through the calling mechanism, many functions of SnnsCLib are present that are not documented here, but in the SNNS User Manual. So, if you choose to use the low-level interface, it is highly recommended to have a look at the demos and at the SNNS User Manual.

References


See Also

- `$`, `SnnsRObjectFactory`

Examples

```r
## Not run: demo(encoderSnnsCLib)
## Not run: demo(art1_lettersSnnsR)
## Not run: demo(art2_tetraSnnsR)
## Not run: demo(artmap_lettersSnnsR)
## Not run: demo(eight_elmanSnnsR)
## Not run: demo(rbf_irisSnnsR)
## Not run: demo(rbf_sinSnnsR)
## Not run: demo(rbfDDA_spiralsSnnsR)
## Not run: demo(som_cubeSnnsR)
```
#This is the demo eight_elmanSnsR
#Here, we train an Elman network
#and save a trained and an untrained version
to disk, as well as the used training data

basePath <- ("./")

data(snsnsData)

inputs <- snsnsData$eight_016.pat[,inputColumns(snsnsData$eight_016.pat)]
outputs <- snsnsData$eight_016.pat[,outputColumns(snsnsData$eight_016.pat)]

snnsObject <- SnsRObjectFactory()

snnsObject$setLearnFunc('JE_BP')
snnsObject$setUpdateFunc('JE_Order')
snnsObject$setUnitDefaults(1,0,1,0,1,'Act_Logistic','Out_Identity')

snnsObject$elman_createNet(c(2,8,2),c(1,1,1),FALSE)

patset <- snnsObject$createPatSet(inputs, outputs)
snnsObject$setCurrPatSet(patset$set_no)

snnsObject$initializeNet(c(1.0, -1.0, 0.3, 1.0, 0.5))
snnsObject$shufflePatterns(TRUE)

snnsObject$defTrainSubPat()

snnsObject$saveNet(paste(basePath,"eight_elmanSnsR_untrained.net",sep=""),
                   "eight_elmanSnsR_untrained")

parameters <- c(0.2, 0, 0, 0, 0)
maxit <- 1000

trends <- vector()
for(i in 1:maxit) {
    res <- snnsObject$learnAllPatterns(parameters)
    if(res[[1]] != 0) print(paste("Error at iteration ", i, ": ", res, sep=""))
    error[i] <- res[[2]]
}

trends[1:500]
plot(error, type="l")

snnsObject$saveNet(paste(basePath,"eight_elmanSnsR.net",sep=""),
                   "eight_elmanSnsR")

snnsObject$saveNewPatterns(paste(basePath,"eight_elmanSnsR.pat",sep=""),
                            patset$set_no)
Object factory to create a new object of type `SnnsR-class`.

Usage

`SnnsRObjFactory()`

Details

This function creates a new object of class `SnnsR-class`, initializes its only slot `variables` with a new environment, generates a new C++ object of class `SnnsCLib`, and an empty object serialization.

See Also

`$.SnnsR-class`

Examples

```r
mySnnsObject <- SnnsRObjFactory()
mySnnsObject$setLearnFunc('Quickprop')
mySnnsObject$setUpdateFunc('Topological_Order')
```

Enable calling of C++ functions as methods of `SnnsR-class` objects.

Usage

```r
## S4 method for signature 'SnnsR'
x$name
```

Arguments

- `x` object of class `SnnsR-class`
- `name` function to call
Details

This function makes methods of SnnsR__ and SnnsCLib__ accessible via "$". If no SnnsR__ method is present, then the according SnnsCLib__ method is called. This enables a very flexible method handling. To mask a method from SnnsCLib, e.g. to do some parameter checking or postprocessing, only a method with the same name, but beginning with SnnsR__ has to be present in R. See e.g. `SnnsRObject$initializeNet` for such an implementation.

Error handling is also done within the method caller. If the result of a function is a list with a member err, then SnnsCLib__error is called to use the SNNS kernel function to get the corresponding error message code and an R warning is thrown containing this message.

Furthermore, a serialization mechanism is implemented which all models present in the package use to be able to be saved and loaded by R’s normal save/load mechanism (as RData files). The completely trained object can be serialized with

```r
s <- snnsObject$serializeln("RSNNS_uuntitled")
```

```r
snnsObject@variables$serialization <- s$serialization
```

For the models implemented, this is done in `SnnsRObject$train`. If the S4 object is then saved and loaded, the calling mechanism will notice on the next use of a function that the pointer to the C++ SnnsCLib object is nil, and if a serialization is present, the object is restored from this serialization before the method is called.

---

**SnnsRObject$createNet**  
*Create a layered network*

### Description

This function creates a layered network in the given SnnsR object. This is an SnnsR low-level function. You may want to have a look at `SnnsR-class` to find out how to properly use it.

### Usage

```r
## S4 method for signature 'SnnsR'
createNet(unitsPerLayer, fullyConnectedFeedForward = TRUE, iNames = NULL, oNames = NULL)
```

### Arguments

- `unitsPerLayer`: a vector of integers that represents the number of units in each layer, including input and output layer
- `fullyConnectedFeedForward`: if TRUE, the network is fully connected as a feed-forward network. If FALSE, no connections are created
- `iNames`: names of input units
- `oNames`: names of output units

### See Also

`SnnsR-class`
Examples

```r
obj1 <- SnnSRObjec$tFactory()
obj1$createNet(c(2,2), FALSE)
obj1$getUnitDefinitions()

obj2 <- SnnSRObjec$tFactory()
obj2$createNet(c(8,5,5,2), TRUE)
obj2$getUnitDefinitions()
```

---

**SnnsRObject$createPatSet**

*Create a pattern set*

**Description**

SnnsR low-level function to create a pattern set in the SNNS kernel from the values given, so that they are available in the SNNS kernel for use.

**Usage**

```r
## S4 method for signature 'SnnsR'
createPatSet(inputs, targets)
```

**Arguments**

- **inputs** the input values
- **targets** the target values

**Value**

A list with elements `err` and `set_no`. The latter one identifies the pattern set within the SnnsR-class object.

---

**SnnsRObject$extractNetInfo**

*Get characteristics of the network.*

**Description**

The returned list has three members:

- **infoHeader** general information about the network
- **unitDefinitions** information about the units
- **fullWeightMatrix** weight matrix of the connections
Usage

## S4 method for signature 'SnnsR'
extractNetInfo()

Value

a list of data frames containing information extracted from the network.

---

SnsRObject$extractPatterns

*Extract the current pattern set to a matrix*

Description

SnsR low-level function that extracts all patterns of the current pattern set and returns them as a matrix. Columns are named with the prefix "in" or "out", respectively.

Usage

## S4 method for signature 'SnnsR'
extractPatterns()

Value

a matrix containing the patterns of the currently loaded pattern set.

---

SnsRObject$genericPredictCurrPatSet

*Predict values with a trained net*

Description

SnsR low-level function for generic prediction with a trained net.

Usage

## S4 method for signature 'SnnsR'
genericPredictCurrPatSet(units, updateFuncParams=c(0, 0))

Arguments

- **units**: the units that define the output
- **updateFuncParams**: the parameters for the update function (the function has to be already set)

Value

the predicted values
SnnsRObject$getAllHiddenUnits

Get all hidden units of the net

Description

SnnsR low-level function to get all units from the net with the ttype "UNIT_HIDDEN". This function calls SnnsRObject$getAllUnitsTTType with the parameter "UNIT_HIDDEN".

Usage

```r
## S4 method for signature 'SnnsR'
getAllHiddenUnits()
```

Value

a vector with integer numbers identifying the units.

See Also

SnnsRObject$getAllUnitsTTType

SnnsRObject$getAllInputUnits

Get all input units of the net

Description

SnnsR low-level function to get all units from the net with the ttype "UNIT_INPUT". This function calls SnnsRObject$getAllUnitsTTType with the parameter "UNIT_INPUT".

Usage

```r
## S4 method for signature 'SnnsR'
getAllInputUnits()
```

Value

a vector with integer numbers identifying the units.

See Also

SnnsRObject$getAllUnitsTTType
SnnsRObject$getAllOutputUnits

Get all output units of the net.

Description

SnnsR low-level function to get all units from the net with the type "UNIT_OUTPUT". This function calls SnnsRObject$getAllUnitsTTType with the parameter "UNIT_OUTPUT".

Usage

## S4 method for signature 'SnnsR'
getAllOutputUnits()

Value

a vector with integer numbers identifying the units.

See Also

SnnsRObject$getAllUnitsTTType

SnnsRObject$getAllUnits

Get all units present in the net.

Description

Get all units present in the net.

Usage

## S4 method for signature 'SnnsR'
getAllUnits()

Value

a vector with integer numbers identifying the units.
SnnsRObject$getCompleteWeightMatrix

Get the complete weight matrix.

Description

Get a weight matrix containing all weights of all neurons present in the net.

Usage

```r
## S4 method for signature 'SnnsR'
getCompleteWeightMatrix(setDimNames)
```

Arguments

- `setDimNames` indicates, whether names of units are extracted and set as row/col names in the weight matrix.

See Also

SnnsRObject$getAllOutputUnits, SnnsRObject$getAllInputUnits, SnnsRObject$getAllHiddenUnits
SnnsRObj$getInfoHeader

*Value*

the complete weight matrix

*Description*

Get an info header of the network.

*Usage*

```r
## S4 method for signature 'SnnsR'
getInfoHeader()
```

*Value*

a data frame containing some general characteristics of the network.

SnnsRObj$getSiteDefinitions

*Get the sites definitions of the network.*

*Description*

Get the sites definitions of the network.

*Usage*

```r
## S4 method for signature 'SnnsR'
getSiteDefinitions()
```

*Value*

a data frame containing information about all sites present in the network.
SnnsRObject$getUnitDefinitions

*Get the FType definitions of the network.*

**Description**

Get the FType definitions of the network.

**Usage**

```r
## S4 method for signature 'SnnsR'
gOfTypeDefinitions()
```

**Value**

a data frame containing information about FType units present in the network.

SnnsRObject$UnitDefinitions

*Get the unit definitions of the network.*

**Description**

Get the unit definitions of the network.

**Usage**

```r
## S4 method for signature 'SnnsR'
gUnitDefinitions()
```

**Value**

a data frame containing information about all units present in the network.
**SnnsRObject$getUnitsByName**

Find all units whose name begins with a given prefix.

**Description**

Find all units whose name begins with a given prefix.

**Usage**

```r
## S4 method for signature 'SnnsR'
getUnitsByName(prefix)
```

**Arguments**

- `prefix` a prefix that the names of the units to find have.

**Value**

a vector with integer numbers identifying the units.

---

**SnnsRObject$getWeightMatrix**

Get the weight matrix between two sets of units

**Description**

SnnsR low-level function to get the weight matrix between two sets of units.

**Usage**

```r
## S4 method for signature 'SnnsR'
getWeightMatrix(unitsSource, unitsTarget, setDimNames)
```

**Arguments**

- `unitsSource` a vector with numbers identifying the source units
- `unitsTarget` a vector with numbers identifying the target units
- `setDimNames` indicates, whether names of units are extracted and set as row/col names in the weight matrix

**Value**

the weight matrix between the two sets of neurons
See Also

SnnsRObject$getAllUnitsTTType

Description

This SnnsR low-level function masks the SNNS kernel function of the same name to allow for both giving the initialization function directly in the call or to use the one that is currently set.

Usage

```r
## S4 method for signature 'SnnsR'
initializeNet(parameterInArray, initFunc)
```

Arguments

- `parameterInArray`:
  - the parameters of the initialization function
- `initFunc`:
  - the name of the initialization function

Description

SnnsR low-level function to predict values with a trained net.

Usage

```r
## S4 method for signature 'SnnsR'
predictCurrPatSet(outputMethod="reg_class", updateFuncParams=c(0, 0))
```

Arguments

- `outputMethod`:
  - is passed to SnnsRObject$whereAreResults
- `updateFuncParams`:
  - parameters passed to the networks update function
Details

This function has to be used embedded in a step of loading and afterwards removing the patterns into the \texttt{SnnsR-class} object. As SNNS only supports 2 pattern sets in parallel, removing unneeded pattern sets is quite important.

Value

the predicted values

\texttt{SnnsRObject$resetRSNNS}

\textit{Reset the SnnsR object.}

Description

\texttt{SnnsR} low-level function to delete all pattern sets and delete the current net in the \texttt{SnnsR-class} object.

Usage

\begin{verbatim}
## S4 method for signature 'SnnsR'
resetRSNNS()
\end{verbatim}

\texttt{SnnsRObject$setTTTypeUnitsActFunc}

\textit{Set the activation function for all units of a certain \texttt{ttype}.}

Description

The function uses the function \texttt{SnnsRObject$getAllUnitsTTType} to find all units of a certain \texttt{ttype}, and sets the activation function of all these units to the given activation function.

Usage

\begin{verbatim}
## S4 method for signature 'SnnsR'
setTTTypeUnitsActFunc(ttype, act_func)
\end{verbatim}

Arguments

\begin{itemize}
  \item \texttt{ttype} \hspace{1cm} a string containing the \texttt{ttype}.
  \item \texttt{act_func} \hspace{1cm} the name of the activation function to set.
\end{itemize}

See Also

\texttt{SnnsRObject$getAllUnitsTTType}
Examples

```r
## Not run: SnnsRObject$setTTypeUnitsActFunc("UNIT_HIDDEN", "Act_Logistic")
```

---

**SnnsRObject$setUnitDefaults**

*Set the unit defaults*

**Description**

This SnnsR low-level function masks the SNNS kernel function of the same name to allow both for giving the parameters directly or as a vector. If the second parameter, bias, is missing, it is assumed that the first parameter should be interpreted as a vector containing all parameters.

**Usage**

```r
## S4 method for signature 'SnnsR'
setUnitDefaults(act, bias, st, subnet_no, layer_no, act_func, out_func)
```

**Arguments**

- **act**: same as SNNS kernel function
- **bias**: idem
- **st**: idem
- **subnet_no**: idem
- **layer_no**: idem
- **act_func**: idem
- **out_func**: idem

---

**SnnsRObject$somPredictComponentMaps**

*Calculate the som component maps*

**Description**

SnnsR low-level function to calculate the som component maps.

**Usage**

```r
## S4 method for signature 'SnnsR'
somPredictComponentMaps(updateFuncParams=c(0.0, 0.0, 1.0))
```
**Arguments**  
updateFuncParams  
parameters passed to the networks update function

**Value**  
a matrix containing all component maps as 1d vectors

**See Also**  
som

---

Get most of the relevant results from a SOM

**Description**  
SnnsR low-level function to get most of the relevant results from a SOM.

**Usage**  
```r  
## S4 method for signature 'SnnsR'  
somPredictCurrPatSetWinners(updateFuncParams=c(0.0, 0.0, 1.0),  
saveWinnersPerPattern=TRUE, targets=NULL)  
```

**Arguments**  
updateFuncParams  
parameters passed to the networks update function  
saveWinnersPerPattern  
should a list with the winners for every pattern be saved?  
targets  
optional target classes of the patterns

**Value**  
a list with three elements:  
- nWinnersPerUnit: For each unit, the amount of patterns where this unit won is given. So, this is a 1d vector representing the normal version of the som.  
- winnersPerPattern: a vector where for each pattern the number of the winning unit is given. This is an intermediary result that normally won’t be saved.  
- labeledUnits: a matrix which – if the targets parameter is given – contains for each unit (rows) and each class present in the targets (columns), the amount of patterns of the class where the unit has won. From the labeledUnits, the labeledMap can be computed, e.g. by voting of the class labels for the final label of the unit.
### SnnsRObject$train

*Train a network and test it in every training iteration*

**Description**

SnnsR low-level function to train a network and test it in every training iteration.

**Usage**

```r
## S4 method for signature 'Snns'
train(inputsTrain, targetsTrain=NULL,
      initFunc="Randomize_Weights", initFuncParams=c(1.0, -1.0),
      learnFunc="Std_Backpropagation", learnFuncParams=c(0.2, 0),
      updateFunc="Topological_Order", updateFuncParams=c(0.0),
      outputMethod="reg_class", maxit=100, shufflePatterns=TRUE,
      computeError=TRUE, inputsTest=NULL, targetsTest=NULL,
      pruneFunc=FALSE, pruneFuncParams=NULL)
```

---

### SnnsRObject$somPredictCurrPatSetWinnersSpanTree

*Get the spanning tree of the SOM*

**Description**

SnnsR low-level function to get the spanning tree of the SOM. This function calls directly the corresponding SNNS kernel function (the only one available for SOM). Advantage are faster computation, disadvantage is somewhat limited information in the output.

**Usage**

```r
## S4 method for signature 'Snns'
somPredictCurrPatSetWinnersSpanTree()
```

**Value**

the spanning tree, which is the som, showing for each unit a number identifying the last pattern for which this unit won. (We note that, also if there are more than one patterns, only the last one is saved)

**See Also**

- `som`

---

```r
SnnsRObject$somPredictCurrPatSetWinnersSpanTree
```
Arguments

- `inputsTrain` a matrix with inputs for the network
- `targetsTrain` the corresponding targets
- `initFunc` the initialization function to use
- `initFuncParams` the parameters for the initialization function
- `learnFunc` the learning function to use
- `learnFuncParams` the parameters for the learning function
- `updateFunc` the update function to use
- `updateFuncParams` the parameters for the update function
- `outputMethod` the output method of the net
- `maxit` maximum of iterations to learn
- `shufflePatterns` should the patterns be shuffled?
- `computeError` should the error be computed in every iteration?
- `inputsTest` a matrix with inputs to test the network
- `targetsTest` the corresponding targets for the test input
- `pruneFunc` the pruning function to use
- `pruneFuncParams` the parameters for the pruning function. Unlike the other functions, these have to be given in a named list. See the pruning demos for further explanation.

Value

a list containing:

- `fitValues` the fitted values, i.e. outputs of the training inputs
- `IterativeFitError` The SSE in every iteration/epoch on the training set
- `testValues` the predicted values, i.e. outputs of the test inputs
- `IterativeTestError` The SSE in every iteration/epoch on the test set
SnnsrObject$whereAreResults

Get a list of output units of a net

Description

Snnsr low-level function to get a list of output units of a net.

Usage

## S4 method for signature 'Snnsr'
whereAreResults(outputMethod="output")

Arguments

outputMethod a string defining the output method of the net. Possible values are: "art1", "art2", "artmap", "assoz", "som", "output".

Details

Depending on the network architecture, output is present in hidden units, in output units, etc. In some network types, the output units have a certain name prefix in SNNS. This function finds the output units according to certain network types. The type is specified by outputMethod. If the given outputMethod is unknown, the function defaults to "output".

Value

a list of numbers identifying the units

som

Create and train a self-organizing map (SOM)

Description

This function creates and trains a self-organizing map (SOM). SOMs are neural networks with one hidden layer. The network structure is similar to LVQ, but the method is unsupervised and uses a notion of neighborhood between the units. The general idea is that the map develops by itself a notion of similarity among the input and represents this as spatial nearness on the map. Every hidden unit represents a prototype. The goal of learning is to distribute the prototypes in the feature space such that the (probability density of the) input is represented well. SOMs are usually built with 1d, 2d quadratic, 2d hexagonal, or 3d neighborhood, so that they can be visualized straightforwardly. The SOM implemented in SNNS has a 2d quadratic neighborhood.
Usage

som(x, 
## Default S3 method:
som(x, mapX = 16, mapY = 16, maxit = 100,
  initFuncParams = c(1, -1), learnFuncParams = c(0.5, mapX/2, 0.8, 0.8,
  mapX), updateFuncParams = c(0, 0, 1), shufflePatterns = TRUE,
  calculateMap = TRUE, calculateActMaps = FALSE,
  calculateSpanningTree = FALSE, saveWinnersPerPattern = FALSE,
  targets = NULL, ...)}

Arguments

  x         a matrix with training inputs for the network
...        additional function parameters (currently not used)
mapX      the x dimension of the som
mapY      the y dimension of the som
maxit     maximum of iterations to learn
initFuncParams the parameters for the initialization function
learnFuncParams the parameters for the learning function
updateFuncParams the parameters for the update function
shufflePatterns should the patterns be shuffled?
calculateMap should the som be calculated?
calculateActMaps should the activation maps be calculated?
calculateSpanningTree should the SNNS kernel algorithm for generating a spanning tree be applied?
saveWinnersPerPattern should a list with the winners for every pattern be saved?
targets    optional target classes of the patterns

Details

As the computation of this function might be slow if many patterns are involved, much of its output is made switchable (see comments on return values).

Internally, this function uses the initialization function Kohonen_Weights_v3.2, the learning function Kohonen, and the update function Kohonen_Order of SNNS.
## Value

an `rsnns` object. Depending on which calculation flags are switched on, the som generates some special members:

- **map**
  - the som. For each unit, the amount of patterns where this unit won is given.

- **componentMaps**
  - a map for every input component, showing where in the map this component leads to high activation.

- **actMaps**
  - a list containing for each pattern its activation map, i.e. all unit activations. The actMaps are an intermediary result, from which all other results can be computed. This list can be very long, so normally it won’t be saved.

- **winnersPerPattern**
  - a vector where for each pattern the number of the winning unit is given. Also, an intermediary result that normally won’t be saved.

- **labeledUnits**
  - a matrix which – if the targets parameter is given – contains for each unit (rows) and each class present in the targets (columns), the amount of patterns of the class where the unit has won. From the labeledUnits, the labeledMap can be computed, e.g. by voting of the class labels for the final label of the unit.

- **labeledMap**
  - a labeled som that is computed from labeledUnits using `decodeClassLabels`.

- **spanningTree**
  - the result of the original SNNS function to calculate the map. For each unit, the last pattern where this unit won is present. As the other results are more informative, the spanning tree is only interesting, if the other functions are too slow or if the original SNNS implementation is needed.

## References


Zell, A. (1994), Simulation Neuronaler Netze, Addison-Wesley. (in German)

## Examples

```r
## Not run: demo(som_iris)
## Not run: demo(som_cubeSnnsR)

data(iris)
inputs <- normalizeData(iris[,1:4], "norm")

model <- som(inputs, mapX=16, mapY=16, maxit=500,
              calculateActMaps=TRUE, targets=iris[,5])

par(mfrow=c(3,3))
for(i in 1:ncol(inputs)) plotActMap(model$componentMaps[[i]],
                                   col=rev(topo.colors(12)))

plotActMap(model$map, col=rev(heat.colors(12)))
```
splitForTrainingAndTest

Function to split data into training and test set

Description
Split the input and target values to a training and a test set. Test set is taken from the end of the data. If the data is to be shuffled, this should be done before calling this function.

Usage
splitForTrainingAndTest(x, y, ratio = 0.15)

Arguments
x inputs
y targets
ratio ratio of training and test sets (default: 15% of the data is used for testing)

Value
a named list with the following elements:
inputsTrain a matrix containing the training inputs
targetsTrain a matrix containing the training targets
inputsTest a matrix containing the test inputs
targetsTest a matrix containing the test targets

Examples
data(iris)
#shuffle the vector
iris <- iris[sample(1:nrow(iris), length(1:nrow(iris))), 1:ncol(iris)]

irisValues <- iris[,1:4]
irisTargets <- decodeClassLabels(iris[,5])

splitForTrainingAndTest(irisValues, irisTargets, ratio=0.15)
summary.rsnnss  

Generic summary function for rsnns objects

Description

Prints out a summary of the network. The printed information can be either all information of
the network in the original SNNS file format, or the information given by extractNetInfo. This
behaviour is controlled with the parameter origSnnsFormat.

Usage

## S3 method for class 'rsnns'
summary(object, origSnnsFormat = TRUE, ...)

Arguments

- object: the rsnns object
- origSnnsFormat: show data in SNNS's original format in which networks are saved, or show
  output of extractNetInfo
- ...: additional function parameters (currently not used)

Value

Either the contents of the .net file that SNNS would generate from the object, as a string. Or the
output of extractNetInfo.

See Also

extractNetInfo

toNumericClassLabels  

Convert a vector (of class labels) to a numeric vector

Description

This function converts a vector (of class labels) to a numeric vector.

Usage

toNumericClassLabels(x)

Arguments

- x: inputs
Value

the vector converted to a numeric vector

Examples

data(iris)
toNumericClassLabels(iris[,5])

train

Internal generic train function for rsnns objects

Description

The function calls SnsRObject$train and saves the result in the current rsnns object. This function is used internally by the models (e.g. mlp) for training. Unless you are not about to implement a new model on the S3 layer you most probably don’t want to use this function.

Internal generic train function for rsnns objects.

Usage

train(object, ...)

## S3 method for class 'rsnns'
train(object, inputsTrain, targetsTrain = NULL,
inputsTest = NULL, targetsTest = NULL, serializeTrainedObject = TRUE,
...)

Arguments

object the rsnns object
... additional function parameters (currently not used)
inputsTrain training input
targetsTrain training targets
inputsTest test input
targetsTest test targets
serializeTrainedObject parameter passed to SnsRObject$train

Value

an rsnns object, to which the results of training have been added.
vectorToActMap  

**Convert a vector to an activation map**

**Description**
Organize network activation as 2d map.

**Usage**
```r
vectorToActMap(v, nrow = 0, ncol = 0)
```

**Arguments**
- `v`: the vector containing the activation pattern
- `nrow`: number of rows the resulting matrices will have
- `ncol`: number of columns the resulting matrices will have

**Details**
The input to this function is a vector containing in each row an activation pattern/output of a neural network. This function reorganizes the vector to a matrix. Normally, only the number of rows `nrow` will be used.

**Value**
a matrix containing the 2d reorganized input

**See Also**
- `matrixToActMapList`
- `plotActMap`

---

weightMatrix  

**Function to extract the weight matrix of an rsnns object**

**Description**
The function calls `SnnsRObject$getCompleteWeightMatrix` and returns its result. Function to extract the weight matrix of an rsnns object.

**Usage**
```r
weightMatrix(object, ...)
```

## S3 method for class 'rsnns'
weightMatrix(object, ...)

weightMatrix

Arguments

  object the rsnns object
  ... additional function parameters (currently not used)

Value

  a matrix with all weights from all neurons present in the net.
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