LibTopoART

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Class Documentation

5.1 LibTopoART.F2_output Class Reference

Class `F2_output` provides the output of a single TopoART module. It is a compressed version of the output vectors y and c.

Public Member Functions

- F2_output ()

  This constructor sets all instance variables of class `F2_output` to "undefined".

Public Attributes

- decimal bm_node_activation

  Instance variable `bm_node_activation` represents the activation of the best-matching node.
- long bm_node_ID

  Instance variable `bm_node_ID` represents the ID of the best-matching node.
- long bm_cluster_ID

  Instance variable `bm_cluster_ID` represents the cluster ID of the best-matching node.
- decimal bm_permanent_node_activation

  Instance variable `bm_permanent_node_activation` represents the activation of the best-matching permanent node.
- long bm_permanent_node_ID

  Instance variable `bm_permanent_node_ID` represents the ID of the best-matching permanent node.
- long bm_permanent_cluster_ID

  Instance variable `bm_permanent_cluster_ID` represents the cluster ID of the best-matching permanent node.

5.1.1 Detailed Description

Class `F2_output` provides the output of a single TopoART module. It is a compressed version of the output vectors y and c.

5.1.2 Constructor & Destructor Documentation

5.1.2.1 LibTopoART.F2_output.F2_output ( )

This constructor sets all instance variables of class `F2_output` to "undefined".

5.1.3 Member Data Documentation

5.1.3.1 long LibTopoART.F2_output.bm_cluster_ID

Instance variable `bm_cluster_ID` represents the cluster ID of the best-matching node.

5.1.3.2 decimal LibTopoART.F2_output.bm_node_activation

Instance variable `bm_node_activation` represents the activation of the best-matching node.

5.1.3.3 long LibTopoART.F2_output.bm_node_ID

Instance variable `bm_node_ID` represents the ID of the best-matching node.

5.1.3.4 long LibTopoART.F2_output.bm_permanent_cluster_ID

Instance variable `bm_permanent_cluster_ID` represents the cluster ID of the best-matching permanent node.

5.1.3.5 decimal LibTopoART.F2_output.bm_permanent_node_activation

Instance variable `bm_permanent_node_activation` represents the activation of the best-matching permanent node.

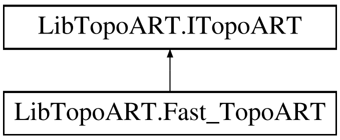
5.1.3.6 long LibTopoART.F2_output.bm_permanent_node_ID

Instance variable `bm_permanent_node_ID` represents the ID of the best-matching permanent node.

5.2 LibTopoART.Fast_TopoART Class Reference

Class `Fast_TopoART` provides an implementation of the TopoART neural network as proposed in "Tscherepanow, Marko (2010). TopoART: A topology learning hierarchical ART network. In Proceedings of the International Conference on Artificial Neural Networks, LNCS 6354 (pp. 157–167). Berlin, Germany: Springer."

Inheritance diagram for LibTopoART.Fast_TopoART:



Public Member Functions

- Fast_TopoART (long input_dimension, long module_number, decimal rho_a_value)

  This constructor initialises a TopoART network.
- Fast_TopoART (string path)

  This constructor loads a saved TopoART network.
- void ComputeClusterIDs ()

  This method computes the cluster IDs for all neurons.

- F2_output[] GetBMOutput (decimal[] input)

  This method finds the closest category for a given test input.
- void Learn (decimal[] input)

  This method performs a single training step.
- void SaveText (string path)

  This method saves the entire network as a text file.
- void Save (string path)

  This method saves the entire network as a binary file.

Static Public Attributes

- static readonly decimal file_format_version =0.09m

  Instance variable `file_format_version` represents the version of the file format used by class `Fast_TopoART`.
- static readonly string integer_base_type ="long"

  Instance variable `integer_base_type` provides a string containing the data type used for representing integer variables (IDs, parameters, counters, etc.) internally.
- static readonly string float_base_type ="long"

  Instance variable `float_base_type` provides a string containing the data type used for representing floating point variables (input, weights, etc.) internally.

Protected Attributes

- readonly long x_F0_dim

  Instance variable `x_F0_dim` represents the input dimension.
- readonly long[] x_F0

  Instance variable `x_F0` represents the current input vector.

Properties

- long[] NodeNum `[get]`

  Property `NodeNum` represents the number of TopoART nodes used by each module.
- long[] ClusterNum `[get]`

  Property `ClusterNum` represents the number of TopoART clusters found by each module.
- long ModuleNum `[get]`

  Property `ModuleNum` represents the number of TopoART modules used. (The original TopoART uses two modules.)
- long LearningSteps `[get]`

  Property `LearningSteps` represents the total number of performed learning steps.
- decimal Rho_a `[get]`

  Property `Rho_a` represents the vigilance parameter of the first TopoART module (TA a).
- decimal Beta_sbm `[get, set]`

  Property `Beta_sbm` represents the learning rate of the second best-matching nodes.
- long Tau `[get, set]`

  Property `Tau` represents the parameter tau required for the removal of nodes and edges.
- long Phi `[get, set]`

  Property `Phi` represents the parameter phi required for the removal of nodes and edges as well as for the propagation of input to subsequent TopoART modules.
- decimal Alpha `[get, set]`

  Property `Alpha` represents the choice parameter alpha.

5.2.1 Detailed Description

Class `Fast_TopoART` provides an implementation of the TopoART neural network as proposed in "Tscherepanow, Marko (2010). TopoART: A topology learning hierarchical ART network. In Proceedings of the International Conference on Artificial Neural Networks, LNCS 6354 (pp. 157–167). Berlin, Germany: Springer."

Internally, real-valued data are mapped to `long` variables. Therefore, computations are accelerated but less accurate. As a consequence, the results may differ slightly from class `TopoART`.

Class `Fast_TopoART` requires all input to lie in the interval [0,1].

5.2.2 Constructor & Destructor Documentation

5.2.2.1 LibTopoART.Fast_TopoART.Fast_TopoART (long *input_dimension,* long *module_number,* decimal *rho_a_value*)

This constructor initialises a TopoART network.

Parameters

input_dimension	The dimension of input vectors to be learnt.
module_number	The number of TopoART modules.
rho_a_value	The vigilance parameter of the first TopoART module (TA a).

5.2.2.2 LibTopoART.Fast_TopoART.Fast_TopoART (string *path*)

This constructor loads a saved TopoART network.

Parameters

path	The path of a binary TopoART file.

5.2.3 Member Function Documentation

5.2.3.1 void LibTopoART.Fast_TopoART.ComputeClusterIDs ( )

This method computes the cluster IDs for all neurons.

Implements LibTopoART.ITopoART.

5.2.3.2 F2_output [ ] LibTopoART.Fast_TopoART.GetBMOutput (decimal[ ] *input*)

This method finds the closest category for a given test input.

Parameters

input	The input vector.

Returns

An array of type `F2_output`. Each entry contains the ID of the best-matching node and the corresponding cluster ID for one TopoART module.

Implements LibTopoART.ITopoART.

5.2.3.3 void LibTopoART.Fast_TopoART.Learn (decimal[ ] *input*)

This method performs a single training step.

Parameters

input	The input vector to be learnt.

Implements LibTopoART.ITopoART.

5.2.3.4 void LibTopoART.Fast_TopoART.Save (string *path*)

This method saves the entire network as a binary file.

Parameters

path	A `string` representing the save file.

Implements LibTopoART.ITopoART.

5.2.3.5 void LibTopoART.Fast_TopoART.SaveText (string *path*)

This method saves the entire network as a text file.

Parameters

path	A `string` representing the save file.

Implements LibTopoART.ITopoART.

5.2.4 Member Data Documentation

5.2.4.1 readonly decimal LibTopoART.Fast_TopoART.file_format_version =0.09m [static]

Instance variable `file_format_version` represents the version of the file format used by class `Fast_TopoART`.

5.2.4.2 readonly string LibTopoART.Fast_TopoART.float_base_type ="long" [static]

Instance variable `float_base_type` provides a string containing the data type used for representing floating point variables (input, weights, etc.) internally.

5.2.4.3 readonly string LibTopoART.Fast_TopoART.integer_base_type ="long" [static]

Instance variable `integer_base_type` provides a string containing the data type used for representing integer variables (IDs, parameters, counters, etc.) internally.

5.2.4.4 readonly long [] LibTopoART.Fast_TopoART.x_F0 [protected]

Instance variable `x_F0` represents the current input vector.

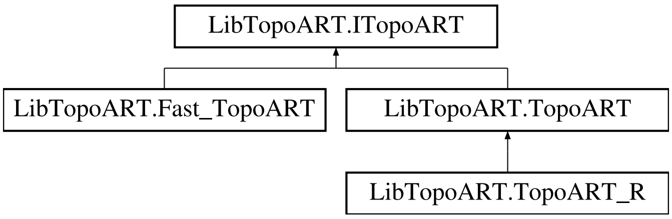
5.2.4.5 readonly long LibTopoART.Fast_TopoART.x_F0_dim [protected]

Instance variable `x_F0_dim` represents the input dimension.

5.3 LibTopoART.ITopoART Interface Reference

Interface summarising the basic TopoART functionality.

Inheritance diagram for LibTopoART.ITopoART:



Public Member Functions

- void ComputeClusterIDs ()

  This method computes the cluster IDs for all neurons.
- F2_output[] GetBMOutput (decimal[] input)

  This method finds the closest category for a given test input.
- void Learn (decimal[] input)

  This method performs a single training step.
- void SaveText (string path)

  This method saves the entire network as a text file.
- void Save (string path)

  This method saves the entire network as a binary file.

Properties

- long[] NodeNum `[get]`

  Property `NodeNum` represents the number of TopoART nodes used by each module.
- long[] ClusterNum `[get]`

  Property `ClusterNum` represents the number of TopoART clusters found by each module.
- long ModuleNum `[get]`

  Property `ModuleNum` represents the number of TopoART modules used. (The original TopoART uses two modules.)
- long LearningSteps `[get]`

  Property `LearningSteps` represents the total number of performed learning steps.
- decimal Beta_sbm `[get, set]`

  Property `Beta_sbm` represents the learning rate of the second best-matching nodes.
- decimal Rho_a `[get]`

  Property `Rho_a` represents the vigilance parameter of the first TopoART module (TA a).
- long Tau `[get, set]`

  Property `Tau` represents the parameter tau required for the removal of nodes and edges.
- long Phi `[get, set]`

  Property `Phi` represents the parameter phi required for the removal of nodes and edges as well as for the propagation of input to subsequent TopoART modules.
- decimal Alpha `[get, set]`

  Property `Alpha` represents the choice parameter alpha.

5.3.1 Detailed Description

Interface summarising the basic TopoART functionality.

5.3.2 Member Function Documentation

5.3.2.1 void LibTopoART.ITopoART.ComputeClusterIDs ( )

This method computes the cluster IDs for all neurons.

Implemented in LibTopoART.Fast_TopoART, and LibTopoART.TopoART.

5.3.2.2 F2_output [ ] LibTopoART.ITopoART.GetBMOutput (decimal[ ] *input*)

This method finds the closest category for a given test input.

Parameters

input	The input vector.

Returns

An array of type `F2_output`. Each entry contains the ID of the best-matching node and the corresponding cluster ID for one TopoART module.

Implemented in LibTopoART.Fast_TopoART, and LibTopoART.TopoART.

5.3.2.3 void LibTopoART.ITopoART.Learn (decimal[ ] *input*)

This method performs a single training step.

Parameters

input	The input vector to be learnt.

Implemented in LibTopoART.Fast_TopoART, and LibTopoART.TopoART.

5.3.2.4 void LibTopoART.ITopoART.Save (string *path*)

This method saves the entire network as a binary file.

Parameters

path	A `string` representing the save file.

Implemented in LibTopoART.Fast_TopoART, and LibTopoART.TopoART.

5.3.2.5 void LibTopoART.ITopoART.SaveText (string *path*)

This method saves the entire network as a text file.

Parameters

path	A `string` representing the save file.

Implemented in LibTopoART.Fast_TopoART, and LibTopoART.TopoART.

5.4 LibTopoART.LibTopoART_info Struct Reference

Struct `LibTopoART_info` provides some metainformation regarding the respective implementation of LibTopoART.

Static Public Attributes

- static readonly decimal version =0.44m

  Instance variable `version` *represents the version of LibTopoART.*
- static readonly string[] networks ={"TopoART (class TopoART, class Fast_TopoART)", "TopoART-R (class TopoART_R)"}

  Instance variable `networks` *provides a string array containing the networks implemented in the current version of LibTopoART.*

5.4.1 Detailed Description

Struct `LibTopoART_info` provides some metainformation regarding the respective implementation of LibTopoART.

5.4.2 Member Data Documentation

5.4.2.1 readonly string [] LibTopoART.LibTopoART_info.networks ={"TopoART (class TopoART, class Fast_TopoART)", "TopoART-R (class TopoART_R)"} `[static]`

Instance variable `networks` provides a string array containing the networks implemented in the current version of LibTopoART.

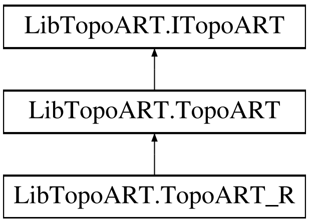
5.4.2.2 readonly decimal LibTopoART.LibTopoART_info.version =0.44m `[static]`

Instance variable `version` represents the version of LibTopoART.

5.5 LibTopoART.TopoART Class Reference

Class `TopoART` provides an implementation of the TopoART neural network as proposed in "Tscherepanow, Marko (2010). TopoART: A topology learning hierarchical ART network. In Proceedings of the International Conference on Artificial Neural Networks, LNCS 6354 (pp. 157–167). Berlin, Germany: Springer."

Inheritance diagram for LibTopoART.TopoART:



Public Member Functions

- TopoART (long input_dimension, long module_number, decimal rho_a_value)

  This constructor initialises a TopoART network.
- TopoART (string path)

  This constructor loads a saved TopoART network.
- void ComputeClusterIDs ()

  This method computes the cluster IDs for all neurons.
- F2_output[] GetBMOutput (decimal[] input)

This method finds the closest category for a given test input.

- void Learn (decimal[] input)

  This method performs a single training step.

- void SaveText (string path)

  This method saves the entire network as a text file.

- void Save (string path)

  This method saves the entire network as a binary file.

Static Public Attributes

- static readonly decimal file_format_version =0.09m

  Instance variable `file_format_version` represents the version of the file format used by class `TopoART`.

- static readonly string integer_base_type ="long"

  Instance variable `integer_base_type` provides a string containing the data type used for representing integer variables (IDs, parameters, counters, etc.) internally.

- static readonly string float_base_type ="decimal"

  Instance variable `float_base_type` provides a string containing the data type used for representing floating point variables (input, weights, etc.) internally.

Protected Attributes

- readonly long x_F0_dim

  Instance variable `x_F0_dim` represents the input dimension.

- readonly decimal[] x_F0

  Instance variable `x_F0` represents the current input vector.

Properties

- long[] NodeNum `[get]`

  Property `NodeNum` represents the number of TopoART nodes used by each module.

- long[] ClusterNum `[get]`

  Property `ClusterNum` represents the number of TopoART clusters found by each module.

- long ModuleNum `[get]`

  Property `ModuleNum` represents the number of TopoART modules used. (The original TopoART uses two modules.)

- long LearningSteps `[get]`

  Property `LearningSteps` represents the total number of performed learning steps.

- decimal Rho_a `[get]`

  Property `Rho_a` represents the vigilance parameter of the first TopoART module (TA a).

- decimal Beta_sbm `[get, set]`

  Property `Beta_sbm` represents the learning rate of the second best-matching nodes.

- long Tau `[get, set]`

  Property `Tau` represents the parameter tau required for the removal of nodes and edges.

- long Phi `[get, set]`

  Property `Phi` represents the parameter phi required for the removal of nodes and edges as well as for the propagation of input to subsequent TopoART modules.

- decimal Alpha `[get, set]`

  Property `Alpha` represents the choice parameter alpha.

5.5.1 Detailed Description

Class `TopoART` provides an implementation of the TopoART neural network as proposed in "Tscherepanow, Marko (2010). TopoART: A topology learning hierarchical ART network. In Proceedings of the International Conference on Artificial Neural Networks, LNCS 6354 (pp. 157–167). Berlin, Germany: Springer."

Internally, real-valued data are stored in `decimal` variables. Hence, computations are rather slow but very accurate.

Class `TopoART` requires all input to lie in the interval [0,1].

5.5.2 Constructor & Destructor Documentation

5.5.2.1 LibTopoART.TopoART.TopoART (long *input_dimension,* long *module_number,* decimal *rho_a_value*)

This constructor initialises a TopoART network.

Parameters

input_dimension	The dimension of input vectors to be learnt.
module_number	The number of TopoART modules.
rho_a_value	The vigilance parameter of the first TopoART module (TA a).

5.5.2.2 LibTopoART.TopoART.TopoART (string *path*)

This constructor loads a saved TopoART network.

Parameters

path	The path of a binary TopoART file.

5.5.3 Member Function Documentation

5.5.3.1 void LibTopoART.TopoART.ComputeClusterIDs ( )

This method computes the cluster IDs for all neurons.

Implements LibTopoART.ITopoART.

5.5.3.2 F2_output [ ] LibTopoART.TopoART.GetBMOutput (decimal[ ] *input*)

This method finds the closest category for a given test input.

Parameters

input	The input vector.

Returns

An array of type `F2_output`. Each entry contains the ID of the best-matching node and the corresponding cluster ID for one TopoART module.

Implements LibTopoART.ITopoART.

5.5.3.3 void LibTopoART.TopoART.Learn (decimal[ ] *input*)

This method performs a single training step.

Parameters

input	The input vector to be learnt.

Implements LibTopoART.ITopoART.

5.5.3.4 void LibTopoART.TopoART.Save (string *path*)

This method saves the entire network as a binary file.

Parameters

path	A `string` representing the save file.

Implements LibTopoART.ITopoART.

5.5.3.5 void LibTopoART.TopoART.SaveText (string *path*)

This method saves the entire network as a text file.

Parameters

path	A `string` representing the save file.

Implements LibTopoART.ITopoART.

5.5.4 Member Data Documentation

5.5.4.1 readonly decimal LibTopoART.TopoART.file_format_version =0.09m [static]

Instance variable `file_format_version` represents the version of the file format used by class `TopoART`.

5.5.4.2 readonly string LibTopoART.TopoART.float_base_type ="decimal" [static]

Instance variable `float_base_type` provides a string containing the data type used for representing floating point variables (input, weights, etc.) internally.

5.5.4.3 readonly string LibTopoART.TopoART.integer_base_type ="long" [static]

Instance variable `integer_base_type` provides a string containing the data type used for representing integer variables (IDs, parameters, counters, etc.) internally.

5.5.4.4 readonly decimal [] LibTopoART.TopoART.x_F0 [protected]

Instance variable `x_F0` represents the current input vector.

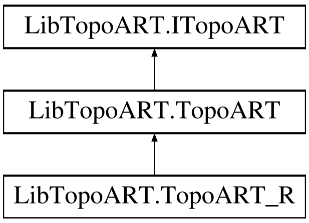
5.5.4.5 readonly long LibTopoART.TopoART.x_F0_dim [protected]

Instance variable `x_F0_dim` represents the input dimension.

5.6 LibTopoART.TopoART_R Class Reference

Class `TopoART_R` provides an implementation of the TopoART-R neural network as proposed in "Tscherepanow, Marko (2011). An Extended TopoART Network for the Stable On-Line Learning of Regression Functions. In Proceedings of the International Conference on Neural Information Processing, LNCS 7063 (pp. 562–571). Berlin, Germany: Springer.

Inheritance diagram for LibTopoART.TopoART_R:



Public Member Functions

- TopoART_R (long i_dimension, long d_dimension, long module_number, decimal rho_a_value)

  This constructor initialises a TopoART-R network.
- TopoART_R (string path)

  This constructor loads a saved TopoART-R network.
- void Learn (decimal[] i_vec, decimal[] d_vec)

  This method performs a single training step.
- TopoART_R_Prediction Predict (decimal[] i_vec, bool[] m_i_vec)

  This method predicts the dependent variables for a given set of independent variables. Unknown values of independent variables can be signified by setting the corresponding value of m_i_vec to true.

Static Public Attributes

- new static readonly decimal file_format_version =0.01m

  Instance variable `file_format_version` represents the version of the file format used by class `TopoART_R`.

Additional Inherited Members

5.6.1 Detailed Description

Class `TopoART_R` provides an implementation of the TopoART-R neural network as proposed in "Tscherepanow, Marko (2011). An Extended TopoART Network for the Stable On-Line Learning of Regression Functions. In Proceedings of the International Conference on Neural Information Processing, LNCS 7063 (pp. 562–571). Berlin, Germany: Springer.

Class `TopoART_R` requires all input and output to lie in the interval [0,1].

5.6.2 Constructor & Destructor Documentation

5.6.2.1 LibTopoART.TopoART_R.TopoART_R (long *i_dimension,* long *d_dimension,* long *module_number,* decimal *rho_a_value*)

This constructor initialises a TopoART-R network.

Parameters

i_dimension	The dimension of the input vector (independent variables) to be learnt.
d_dimension	The dimension of the output vector (dependent variables) to be learnt.
module_number	The number of TopoART-R modules.
rho_a_value	The vigilance parameter of the first TopoART-R module (TopoART-R a).

5.6.2.2 LibTopoART.TopoART_R.TopoART_R (string *path*)

This constructor loads a saved TopoART-R network.

Parameters

path	The path of a binary TopoART-R file.

5.6.3 Member Function Documentation

5.6.3.1 void LibTopoART.TopoART_R.Learn (decimal[ ] *i_vec*, decimal[ ] *d_vec*)

This method performs a single training step.

Parameters

i_vec	The input vector (independent variables) to be learnt.
d_vec	The output vector (dependent variables) corresponding to `i_vec`.

5.6.3.2 TopoART_R_Prediction LibTopoART.TopoART_R.Predict (decimal[ ] *i_vec*, bool[ ] *m_i_vec*)

This method predicts the dependent variables for a given set of independent variables. Unknown values of independent variables can be signified by setting the corresponding value of m_i_vec to true.

Parameters

i_vec	The input vector (independent variables).
m_i_vec	The mask vector corresponding to `i_vec`.

Returns

An object of type `TopoART_R_Prediction` containing the predicted values for the unknown independent variables and all dependent variables.

5.6.4 Member Data Documentation

5.6.4.1 new static readonly decimal LibTopoART.TopoART_R.file_format_version =0.01m `[static]`

Instance variable `file_format_version` represents the version of the file format used by class `TopoART_R`.

5.7 LibTopoART.TopoART_R_Prediction Class Reference

Class `F2_output` contains a prediction made by a TopoART-R network.

Public Member Functions

- TopoART_R_Prediction (decimal[ ] i_vec_prediction, decimal[ ] d_vec_prediction)

This constructor sets the instance variables `i_vec_prediction` and `d_vec_prediction` of class `TopoART_R_Prediction`.

- void PrintPredictions ()

  This method prints the predictions on the console.

Public Attributes

- readonly decimal[] i_vec_prediction

  Instance variable `i_vec_prediction` represents predictions for unknown independent variables.

- readonly decimal[] d_vec_prediction

  Instance variable `d_vec_prediction` provides the predictions for the dependent variables.

Static Public Attributes

- static readonly decimal NO_PREDICTION =-1.0m

  Instance variable `NO_PREDICTION` provides a default prediction to signify variables that are presented to the network; i.e., these variables are known and no prediction is computed for them.

5.7.1 Detailed Description

Class `F2_output` contains a prediction made by a TopoART-R network.

5.7.2 Constructor & Destructor Documentation

5.7.2.1 LibTopoART.TopoART_R_Prediction.TopoART_R_Prediction (decimal[] *i_vec_prediction,* decimal[] *d_vec_prediction*)

This constructor sets the instance variables `i_vec_prediction` and `d_vec_prediction` of class `TopoART_R_Prediction`.

5.7.3 Member Function Documentation

5.7.3.1 void LibTopoART.TopoART_R_Prediction.PrintPredictions ( )

This method prints the predictions on the console.

5.7.4 Member Data Documentation

5.7.4.1 readonly decimal [] LibTopoART.TopoART_R_Prediction.d_vec_prediction

Instance variable `d_vec_prediction` provides the predictions for the dependent variables.

5.7.4.2 readonly decimal [] LibTopoART.TopoART_R_Prediction.i_vec_prediction

Instance variable `i_vec_prediction` represents predictions for unknown independent variables.

5.7.4.3 readonly decimal LibTopoART.TopoART_R_Prediction.NO_PREDICTION =-1.0m `[static]`

Instance variable `NO_PREDICTION` provides a default prediction to signify variables that are presented to the network; i.e., these variables are known and no prediction is computed for them.

5.8 LibTopoART_samples.TopoART_R_sample1 Class Reference

Function approximation using TopoART-R.

5.8.1 Detailed Description

Function approximation using TopoART-R.

This sample train a TopoART-R network with 100 points sampled from a sine function. Then, sine values are predicted for 25 random values.

5.9 LibTopoART_samples.TopoART_sample1 Class Reference

Simple TopoART sample.

5.9.1 Detailed Description

Simple TopoART sample.

First, a datased comprised of 10 samples is learned by a TopoART network. Afterwards, the training samples are slightly modified by random values and used for predicting cluster labels.

5.10 LibTopoART_samples.TopoART_sample2 Class Reference

More complex TopoART sample.

5.10.1 Detailed Description

More complex TopoART sample.

Train TopoART with a two-dimensional dataset similar to the one used in "Marko Tscherepanow and Sören Riechers, 'An Incremental On-line Classifier for Imbalanced, Incomplete, and Noisy Data', European Conference on Artificial Intelligence (ECAI), Workshop on Active and Incremental Learning (AIL), pp. 18-23, 2012." This dataset comprises six clusters (each containing 15,000 samples) as well as 10,000 noise samples. These samples were mixed randomly.

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