

## Deep Neuronal Filter

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<b>1 Deep Neuronal Filter (DNF)</b>	<b>1</b>
<b>2 Class Index</b>	<b>3</b>
2.1 Class List	3
<b>3 Class Documentation</b>	<b>5</b>
3.1 DNF Class Reference	5
3.1.1 Detailed Description	5
3.1.2 Constructor & Destructor Documentation	6
3.1.2.1 DNF()	6
3.1.3 Member Function Documentation	6
3.1.3.1 filter()	6
3.1.3.2 getDelayedSignal()	7
3.1.3.3 getNet()	7
3.1.3.4 getOutput()	7
3.1.3.5 getRemover()	7
3.1.3.6 getSignalDelaySteps()	8
3.2 Layer Class Reference	8
3.2.1 Detailed Description	9
3.2.2 Constructor & Destructor Documentation	9
3.2.2.1 Layer()	9
3.2.3 Member Function Documentation	10
3.2.3.1 getGlobalError()	10
3.2.3.2 getGradient()	10
3.2.3.3 getInitWeight()	10
3.2.3.4 getNeuron()	11
3.2.3.5 getnNeurons()	11
3.2.3.6 getOutput()	11
3.2.3.7 getSumOutput()	12
3.2.3.8 getWeightChange()	12
3.2.3.9 getWeightDistance()	12
3.2.3.10 getWeights()	13
3.2.3.11 initLayer()	13
3.2.3.12 propInputs()	13
3.2.3.13 setError()	14
3.2.3.14 setInputs()	14
3.2.3.15 setlearningRate()	14
3.3 Net Class Reference	15
3.3.1 Detailed Description	16
3.3.2 Constructor & Destructor Documentation	16
3.3.2.1 Net()	16
3.3.3 Member Function Documentation	16
3.3.3.1 getGradient()	16

3.3.3.2	<a href="#">getLayer()</a>	17
3.3.3.3	<a href="#">getLayerWeightDistance()</a>	17
3.3.3.4	<a href="#">getnInputs()</a>	17
3.3.3.5	<a href="#">getnLayers()</a>	18
3.3.3.6	<a href="#">getnNeurons()</a>	18
3.3.3.7	<a href="#">getOutput()</a>	18
3.3.3.8	<a href="#">getSumOutput()</a>	18
3.3.3.9	<a href="#">getWeightDistance()</a>	19
3.3.3.10	<a href="#">getWeights()</a>	19
3.3.3.11	<a href="#">initNetwork()</a>	19
3.3.3.12	<a href="#">setError()</a>	21
3.3.3.13	<a href="#">setInputs()</a>	21
3.3.3.14	<a href="#">setLearningRate()</a>	21
3.4	<a href="#">Neuron Class Reference</a>	22
3.4.1	<a href="#">Detailed Description</a>	23
3.4.2	<a href="#">Constructor &amp; Destructor Documentation</a>	23
3.4.2.1	<a href="#">Neuron()</a>	23
3.4.3	<a href="#">Member Function Documentation</a>	24
3.4.3.1	<a href="#">calcOutput()</a>	24
3.4.3.2	<a href="#">doActivation()</a>	24
3.4.3.3	<a href="#">doActivationPrime()</a>	24
3.4.3.4	<a href="#">getError()</a>	26
3.4.3.5	<a href="#">getInitWeights()</a>	26
3.4.3.6	<a href="#">getMaxWeight()</a>	26
3.4.3.7	<a href="#">getMinWeight()</a>	27
3.4.3.8	<a href="#">getnInputs()</a>	27
3.4.3.9	<a href="#">getOutput()</a>	27
3.4.3.10	<a href="#">getSumOutput()</a>	27
3.4.3.11	<a href="#">getSumWeight()</a>	28
3.4.3.12	<a href="#">getWeightChange()</a>	28
3.4.3.13	<a href="#">getWeightDistance()</a>	28
3.4.3.14	<a href="#">getWeights()</a>	28
3.4.3.15	<a href="#">initNeuron()</a>	29
3.4.3.16	<a href="#">propInputs()</a>	29
3.4.3.17	<a href="#">setBackpropError()</a>	29
3.4.3.18	<a href="#">setError()</a>	30
3.4.3.19	<a href="#">setInput()</a>	30
3.4.3.20	<a href="#">setLearningRate()</a>	30
3.4.3.21	<a href="#">setWeight()</a>	31
<b>Index</b>		<b>33</b>

## Chapter 1

# Deep Neuronal Filter (DNF)

A noise reduction filter using deep networks in autoencoder configuration.

github: <https://github.com/berndporr/deepNeuronalFilter>



## Chapter 2

# Class Index

### 2.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

<a href="#">DNF</a>	Main Deep Neuronal Network main class . . . . .	5
<a href="#">Layer</a>	This is the class for creating layers that are contained inside the <a href="#">Net</a> class . . . . .	8
<a href="#">Net</a>	<a href="#">Net</a> is the main class used to set up a neural network used for closed-loop Deep Learning . . .	15
<a href="#">Neuron</a>	This is the class for creating neurons inside the <a href="#">Layer</a> class . . . . .	22





## Chapter 3

# Class Documentation

### 3.1 DNF Class Reference

Main Deep Neuronal Network main class.

```
#include <dnf.h>
```

#### Public Member Functions

- [DNF](#) (const int NLAYERS, const int numTaps, double fs, [Neuron::actMethod](#) am=Neuron::Act\_Tanh)  
*Constructor which sets up the delay lines, network layers and also calculates the number of neurons per layer so that the final layer always just has one neuron.*
- double [filter](#) (double signal, double noise)  
*Realtime sample by sample filtering operation.*
- [Net](#) & [getNet](#) () const  
*Returns a reference to the whole neural network.*
- const int [getSignalDelaySteps](#) () const  
*Returns the length of the delay line which delays the signal polluted with noise.*
- const double [getDelayedSignal](#) () const  
*Returns the delayed with noise polluted signal by the delay indicated by [getSignalDelaySteps\(\)](#).*
- const double [getRemover](#) () const  
*Returns the remover signal.*
- const double [getOutput](#) () const  
*Returns the output of the [DNF](#): the the noise free signal.*
- [~DNF](#) ()  
*Frees the memory used by the [DNF](#).*

#### 3.1.1 Detailed Description

Main Deep Neuronal Network main class.

It's designed to be as simple as possible with only a few parameters as possible.

### 3.1.2 Constructor & Destructor Documentation

#### 3.1.2.1 DNF()

```
DNF::DNF (
    const int NLAYERS,
    const int numTaps,
    double fs,
    Neuron::actMethod am = Neuron::Act_Tanh ) [inline]
```

Constructor which sets up the delay lines, network layers and also calculates the number of neurons per layer so that the final layer always just has one neuron.

##### Parameters

<i>NLAYERS</i>	Number of layers
<i>numTaps</i>	Number of taps for the delay line feeding into the 1st layer
<i>fs</i>	Sampling rate of the signals used in Hz.
<i>am</i>	The activation function for the neurons. Default is tanh.

### 3.1.3 Member Function Documentation

#### 3.1.3.1 filter()

```
double DNF::filter (
    double signal,
    double noise ) [inline]
```

Realtime sample by sample filtering operation.

##### Parameters

<i>signal</i>	The signal contaminated with noise. Should be less than one.
<i>noise</i>	The reference noise. Should be less than one.

##### Returns

The filtered signal where the noise has been removed by the [DNF](#).

### 3.1.3.2 getDelayedSignal()

```
const double DNF::getDelayedSignal ( ) const [inline]
```

Returns the delayed with noise polluted signal by the delay indicated by [getSignalDelaySteps\(\)](#).

#### Returns

The delayed noise polluted signal sample.

### 3.1.3.3 getNet()

```
Net& DNF::getNet ( ) const [inline]
```

Returns a reference to the whole neural network.

#### Returns

A reference to [Net](#).

### 3.1.3.4 getOutput()

```
const double DNF::getOutput ( ) const [inline]
```

Returns the output of the [DNF](#): the the noise free signal.

#### Returns

The current output of the [DNF](#) which is identical to [filter\(\)](#).

### 3.1.3.5 getRemover()

```
const double DNF::getRemover ( ) const [inline]
```

Returns the remover signal.

#### Returns

The current remover signal sample.

### 3.1.3.6 getSignalDelaySteps()

```
const int DNF::getSignalDelaySteps ( ) const [inline]
```

Returns the length of the delay line which delays the signal polluted with noise.

#### Returns

Number of delay steps in samples.

The documentation for this class was generated from the following file:

- dnf.h

## 3.2 Layer Class Reference

This is the class for creating layers that are contained inside the [Net](#) class.

```
#include <Layer.h>
```

### Public Types

- enum [whichGradient](#) { **exploding** = 0, **average** = 1, **vanishing** = 2 }
- Options for what gradient of a chosen error to monitor.*

### Public Member Functions

- [Layer](#) (int \_nNeurons, int \_nInputs, int \_subject, string \_trial)  
*Constructor for [Layer](#): it initialises the neurons internally.*
- [~Layer](#) ()  
*Destructor De-allocated any memory.*
- void [initLayer](#) (int \_layerIndex, [Neuron::weightInitMethod](#) \_wim, [Neuron::biasInitMethod](#) \_bim, [Neuron::actMethod](#) \_am)  
*Initialises each layer with specific methods for weight/bias initialisation and activation function of neurons.*
- void [setlearningRate](#) (double \_w\_learningRate, double \_b\_learningRate)  
*Sets the learning rate.*
- void [setInputs](#) (const double \*\_inputs, const double scale=1.0, const unsigned int offset=0, const int n=-1)  
*Sets the inputs to all neurons in the first hidden layer only.*
- void [propInputs](#) (int \_index, double \_value)  
*Sets the inputs to all neurons in the deeper layers (excluding the first hidden layer)*
- void [calcOutputs](#) ()  
*Demands that all neurons in this layer calculate their output.*
- void [setError](#) (double \_error)  
*Sets the error to be propagated backward at all neurons in the output layer only.*
- double [getGradient](#) ([whichGradient](#) \_whichGradient)  
*Allows for accessing the error that propagates backward in the network.*
- void [updateWeights](#) ()  
*Requests that all neurons perform one iteration of learning.*

- `Neuron * getNeuron (int _neuronIndex)`  
*Allows access to a specific neuron.*
- `int getnNeurons ()`  
*Reports the number of neurons in this layer.*
- `double getOutput (int _neuronIndex)`  
*Allows for accessing the activation of a specific neuron.*
- `double getSumOutput (int _neuronIndex)`  
*Allows for accessing the sum output of any specific neuron.*
- `double getWeights (int _neuronIndex, int _weightIndex)`  
*Allows for accessing any specific weights in the layer.*
- `double getWeightChange ()`  
*Accesses the total sum of weight changes of all the neurons in this layer.*
- `double getWeightDistance ()`  
*Performs squared root on the weight change.*
- `double getGlobalError (int _neuronIndex)`  
*Reports the global error that is assigned to a specific neuron in this layer.*
- `double getInitWeight (int _neuronIndex, int _weightIndex)`  
*Reports the initial value that was assigned to a specific weight at the initialisation of the network.*
- `void saveWeights ()`  
*Saves the temporal weight change of all weights in all neurons into files.*
- `void snapWeights (string prefix, string _trial, int _subject)`  
*Snaps the final distribution of weights in a specific layer, this is overwritten every time the function is called.*
- `void snapWeightsMatrixFormat (string prefix)`
- `void printLayer ()`  
*Prints on the console a full tree of this layer with the values of all weights and outputs for all neurons.*

### 3.2.1 Detailed Description

This is the class for creating layers that are contained inside the `Net` class.

The `Layer` instances in turn contain neurons.

### 3.2.2 Constructor & Destructor Documentation

#### 3.2.2.1 Layer()

```
Layer::Layer (
    int _nNeurons,
    int _nInputs,
    int _subject,
    string _trial )
```

Constructor for `Layer`: it initialises the neurons internally.

#### Parameters

<code>_nNeurons</code>	Total number of neurons in the layer
<code>_nInputs</code>	Total number of inputs to that layer

### 3.2.3 Member Function Documentation

#### 3.2.3.1 getGlobalError()

```
double Layer::getGlobalError (
    int _neuronIndex )
```

Reports the global error that is assigned to a specific neuron in this layer.

##### Parameters

<code>_neuronIndex</code>	the neuron index
---------------------------	------------------

##### Returns

the value of the global error

#### 3.2.3.2 getGradient()

```
double Layer::getGradient (
    whichGradient _whichGradient )
```

Allows for accessing the error that propagates backward in the network.

##### Parameters

<code>_neuronIndex</code>	The index from which the error is requested
---------------------------	---

##### Returns

Returns the error of the chosen neuron

#### 3.2.3.3 getInitWeight()

```
double Layer::getInitWeight (
    int _neuronIndex,
    int _weightIndex )
```

Reports the initial value that was assigned to a specific weight at the initialisatin of the network.

## Parameters

<code>_neuronIndex</code>	Index of the neuron containing the weight
<code>_weightIndex</code>	Index of the weight

## Returns

**3.2.3.4 getNeuron()**

```
Neuron* Layer::getNeuron (
    int _neuronIndex )
```

Allows access to a specific neuron.

## Parameters

<code>_neuronIndex</code>	The index of the neuron to access
---------------------------	-----------------------------------

## Returns

A pointer to that neuron

**3.2.3.5 getnNeurons()**

```
int Layer::getnNeurons ( )
```

Reports the number of neurons in this layer.

## Returns

The total number of neurons in this layer

**3.2.3.6 getOutput()**

```
double Layer::getOutput (
    int _neuronIndex )
```

Allows for accessing the activation of a specific neuron.

**Parameters**

<code>_neuronIndex</code>	The index of the neuron
---------------------------	-------------------------

**Returns**

the activation of that neuron

**3.2.3.7 getSumOutput()**

```
double Layer::getSumOutput (
    int _neuronIndex )
```

Allows for accessing the sum output of any specific neuron.

**Parameters**

<code>_neuronIndex</code>	The index of the neuron to access
---------------------------	-----------------------------------

**Returns**

Returns the wighted sum of the inputs to that neuron

**3.2.3.8 getWeightChange()**

```
double Layer::getWeightChange ( )
```

Accesses the total sum of weight changes of all the neurons in this layer.

**Returns**

sum of weight changes all neurons

**3.2.3.9 getWeightDistance()**

```
double Layer::getWeightDistance ( )
```

Performs squared root on the weight change.

**Returns**

The sqr of the weight changes



### 3.2.3.10 getWeights()

```
double Layer::getWeights (
    int _neuronIndex,
    int _weightIndex )
```

Allows for accessing any specific weights in the layer.

#### Parameters

<code>_neuronIndex</code>	The index of the neuron containing that weight
<code>_weightIndex</code>	The index of the input to which that weight is assigned

#### Returns

Returns the chosen weight

### 3.2.3.11 initLayer()

```
void Layer::initLayer (
    int _layerIndex,
    Neuron::weightInitMethod _wim,
    Neuron::biasInitMethod _bim,
    Neuron::actMethod _am )
```

Initialises each layer with specific methods for weight/bias initialisation and activation function of neurons.

#### Parameters

<code>_layerIndex</code>	The index that is assigned to this layer by the <a href="#">Net</a> class
<code>_wim</code>	weights initialisation method, see <a href="#">Neuron::weightInitMethod</a> for different options
<code>_bim</code>	biases initialisation method, see <a href="#">Neuron::biasInitMethod</a> for different options
<code>_am</code>	activation method, see <a href="#">Neuron::actMethod</a> for different options

### 3.2.3.12 propInputs()

```
void Layer::propInputs (
    int _index,
    double _value )
```

Sets the inputs to all neurons in the deeper layers (excluding the first hidden layer)

#### Parameters

<code>_index</code>	The index of the input
<code>_value</code>	The value of the input

### 3.2.3.13 setError()

```
void Layer::setError (
    double _error )
```

Sets the error to be propagated backward at all neurons in the output layer only.

#### Parameters

<code>_leadError</code>	the error to be propagated backward
-------------------------	-------------------------------------

### 3.2.3.14 setInputs()

```
void Layer::setInputs (
    const double * _inputs,
    const double scale = 1.0,
    const unsigned int offset = 0,
    const int n = -1 )
```

Sets the inputs to all neurons in the first hidden layer only.

#### Parameters

<code>_inputs</code>	A pointer to an array of inputs
----------------------	---------------------------------

### 3.2.3.15 setlearningRate()

```
void Layer::setlearningRate (
    double _w_learningRate,
    double _b_learningRate )
```

Sets the learning rate.

#### Parameters

<code>_learningRate</code>	Sets the learning rate for all neurons.
----------------------------	---

The documentation for this class was generated from the following file:

- Layer.h

## 3.3 Net Class Reference

**Net** is the main class used to set up a neural network used for closed-loop Deep Learning.

```
#include <Net.h>
```

### Public Member Functions

- **Net** (const int \_nLayers, const int \*const \_nNeurons, const int \_nInputs, const int \_subject, const string \_trial)  
*Constructor: The neural network that performs the learning.*
- **~Net** ()  
*Destructor De-allocated any memory.*
- void **initNetwork** (Neuron::weightInitMethod \_wim, Neuron::biasInitMethod \_bim, Neuron::actMethod \_am)  
*Dictates the initialisation of the weights and biases and determines the activation function of the neurons.*
- void **setLearningRate** (double \_w\_learningRate, double \_b\_learningRate)  
*Sets the learning rate.*
- void **setInputs** (const double \*\_inputs, const double scale=1.0, const unsigned int offset=0, const int n=-1)  
*Sets the inputs to the network in each iteration of learning, needs to be placed in an infinite loop.*
- void **propInputs** ()  
*It propagates the inputs forward through the network.*
- void **propErrorBackward** ()  
*Propagates the error backward.*
- void **setError** (double \_leadError)  
*Sets the error at the output layer to be propagated backward.*
- double **getGradient** (Layer::whichGradient \_whichGradient)  
*It provides a measure of how the magnitude of the error changes through the layers to alarm for vanishing or exploding gradients.*
- void **updateWeights** ()  
*Requests that all layers perform one iteration of learning.*
- Layer \* **getLayer** (int \_layerIndex)  
*Allows Net to access each layer.*
- double **getOutput** (int \_neuronIndex)  
*Allows the user to access the activation output of a specific neuron in the output layer only.*
- double **getSumOutput** (int \_neuronIndex)  
*Allows the user to access the weighted sum output of a specific neuron in output layer only.*
- int **getnLayers** ()  
*Inform on the total number of hidden layers (excluding the input layer)*
- int **getnInputs** ()  
*Inform on the total number of inputs to the network.*
- double **getWeightDistance** ()  
*Allows for monitoring the overall weight change of the network.*
- double **getLayerWeightDistance** (int \_layerIndex)  
*Allows for monitoring the weight change in a specific layer of the network.*
- double **getWeights** (int \_layerIndex, int \_neuronIndex, int \_weightIndex)  
*Grants access to a specific weight in the network.*
- int **getnNeurons** ()  
*Inform on the total number of neurons in the network.*
- void **saveWeights** ()  
*Saves the temporal changes of all weights in all neurons into files.*
- void **snapWeights** (string prefix, string \_trial, int \_subject)  
*Snaps the final distribution of all weights in a specific layer, this is overwritten every time the function is called.*
- void **snapWeightsMatrixFormat** (string prefix)
- void **printNetwork** ()  
*Prints on the console a full tree of the network with the values of all weights and outputs for all neurons.*

### 3.3.1 Detailed Description

[Net](#) is the main class used to set up a neural network used for closed-loop Deep Learning.

It initialises all the layers and the neurons internally.

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### 3.3.2 Constructor & Destructor Documentation

#### 3.3.2.1 Net()

```
Net::Net (
    const int _nLayers,
    const int *const _nNeurons,
    const int _nInputs,
    const int _subject,
    const string _trial )
```

Constructor: The neural network that performs the learning.

##### Parameters

<code>_nLayers</code>	Total number of hidden layers, excluding the input layer
<code>_nNeurons</code>	A pointer to an int array with number of neurons for all layers need to have the length of <code>_nLayers</code> .
<code>_nInputs</code>	Number of Inputs to the network

### 3.3.3 Member Function Documentation

#### 3.3.3.1 getGradient()

```
double Net::getGradient (
    Layer::whichGradient _whichGradient )
```

It provides a measure of how the magnitude of the error changes through the layers to alarm for vanishing or exploding gradients.

##### Parameters

<code>_whichError</code>	choose what error to monitor, for more information see <a href="#">Neuron::whichError</a>
<code>_whichGradient</code>	choose what gradient of the chosen error to monitor, for more information see <a href="#">Layer::whichGradient</a>

**Returns**

Returns the ratio of the chosen gradient in the last layer to the the first layer

**3.3.3.2 getLayer()**

```
Layer* Net::getLayer (
    int _layerIndex )
```

Allows [Net](#) to access each layer.

**Parameters**

<code>_layerIndex</code>	the index of the chosen layer
--------------------------	-------------------------------

**Returns**

A pointer to the chosen [Layer](#)

**3.3.3.3 getLayerWeightDistance()**

```
double Net::getLayerWeightDistance (
    int _layerIndex )
```

Allows for monitoring the weight change in a specific layer of the network.

**Parameters**

<code>_layerIndex</code>	The index of the chosen layer
--------------------------	-------------------------------

**Returns**

returns the Euclidean wight distance of neurons in the chosen layer from their initial value

**3.3.3.4 getnInputs()**

```
int Net::getnInputs ( )
```

Informs on the total number of inputs to the network.

**Returns**

Total number of inputs

### 3.3.3.5 getnLayers()

```
int Net::getnLayers ( )
```

Informs on the total number of hidden layers (excluding the input layer)

#### Returns

Total number of hidden layers in the network

### 3.3.3.6 getnNeurons()

```
int Net::getnNeurons ( )
```

Informs on the total number of neurons in the network.

#### Returns

The total number of neurons

### 3.3.3.7 getOutput()

```
double Net::getOutput (
    int _neuronIndex )
```

Allows the user to access the activation output of a specific neuron in the output layer only.

#### Parameters

<code>_neuronIndex</code>	The index of the chosen neuron
---------------------------	--------------------------------

#### Returns

The value at the output of the chosen neuron

### 3.3.3.8 getSumOutput()

```
double Net::getSumOutput (
    int _neuronIndex )
```

Allows the user to access the weighted sum output of a specific neuron in output layer only.

**Parameters**

<code>_neuronIndex</code>	The index of the chosen neuron
---------------------------	--------------------------------

**Returns**

The value at the sum output of the chosen neuron

**3.3.3.9 getWeightDistance()**

```
double Net::getWeightDistance ( )
```

Allows for monitoring the overall weight change of the network.

**Returns**

returns the Euclidean wight distance of all neurons in the network from their initial value

**3.3.3.10 getWeights()**

```
double Net::getWeights (
    int _layerIndex,
    int _neuronIndex,
    int _weightIndex )
```

Grants access to a specific weight in the network.

**Parameters**

<code>_layerIndex</code>	Index of the layer that contains the chosen weight
<code>_neuronIndex</code>	Index of the neuron in the chosen layer that contains the chosen weight
<code>_weightIndex</code>	Index of the input to which the chosen weight is assigned

**Returns**

returns the value of the chosen weight

**3.3.3.11 initNetwork()**

```
void Net::initNetwork (
    Neuron::weightInitMethod _wim,
```

```
Neuron::biasInitMethod _bim,  
Neuron::actMethod _am )
```

Dictates the initialisation of the weights and biases and determines the activation function of the neurons.



## Parameters

<code>_wim</code>	weights initialisation method, see <a href="#">Neuron::weightInitMethod</a> for different options
<code>_bim</code>	biases initialisation method, see <a href="#">Neuron::biasInitMethod</a> for different options
<code>_am</code>	activation method, see <a href="#">Neuron::actMethod</a> for different options

**3.3.3.12 setError()**

```
void Net::setError (
    double _leadError )
```

Sets the error at the output layer to be propagated backward.

## Parameters

<code>_leadError</code>	The closed-loop error for learning
-------------------------	------------------------------------

**3.3.3.13 setInputs()**

```
void Net::setInputs (
    const double * _inputs,
    const double scale = 1.0,
    const unsigned int offset = 0,
    const int n = -1 )
```

Sets the inputs to the network in each iteration of learning, needs to be placed in an infinite loop.

## Parameters

<code>_inputs</code>	A pointer to the array of inputs
----------------------	----------------------------------

**3.3.3.14 setLearningRate()**

```
void Net::setLearningRate (
    double _w_learningRate,
    double _b_learningRate )
```

Sets the learning rate.

## Parameters

<code>_learningRate</code>	Sets the learning rate for all layers and neurons.
----------------------------	--

The documentation for this class was generated from the following file:

- Net.h

## 3.4 Neuron Class Reference

This is the class for creating neurons inside the [Layer](#) class.

```
#include <Neuron.h>
```

### Public Types

- enum [biasInitMethod](#) { **B\_NONE** = 0, **B\_RANDOM** = 1 }  
*Options for method of initialising biases 0 for initialising all weights to zero 1 for initialising all weights to one 2 for initialising all weights to a random value between 0 and 1.*
- enum [weightInitMethod](#) {  
**W\_ZEROS** = 0, **W\_ONES** = 1, **W\_RANDOM** = 2, **W\_ONES\_NORM** = 3,  
**W\_RANDOM\_NORM** = 5 }  
*Options for method of initialising weights 0 for initialising all weights to zero 1 for initialising all weights to one 2 for initialising all weights to a random value between 0 and 1.*
- enum [actMethod](#) { **Act\_Sigmoid** = 1, **Act\_Tanh** = 2, **Act\_ReLU** = 3, **Act\_NONE** = 0 }  
*Options for activation functions of the neuron 0 for using the logistic function 1 for using the hyperbolic tan function 2 for unity function (no activation)*
- enum [whichError](#) { **onBackwardError** = 0, **onMidError** = 1, **onForwardError** = 2 }  
*Options for choosing an error to monitor the gradient of 0 for monitoring the error that propagates backward 1 for monitoring the error that propagates from the middle and bilaterally 2 for monitoring the error that propagates forward.*

### Public Member Functions

- [Neuron](#) (int \_nInputs)  
*Constructor for the [Neuron](#) class: it initialises a neuron with specific number fo inputs to that neuron.*
- [~Neuron](#) ()  
*Destructor De-allocated any memory.*
- void [initNeuron](#) (int \_neuronIndex, int \_layerIndex, [weightInitMethod](#) \_wim, [biasInitMethod](#) \_bim, [actMethod](#) \_am)  
*Initialises the neuron with the given methods for weight/bias initialisation and for activation function.*
- void [setLearningRate](#) (double \_learningRate, double \_b\_learningRate)  
*Sets the learning rate.*
- void [setInput](#) (int \_index, double \_value)  
*Sets the inputs to this neuron that is located in the first hidden layer.*
- void [propInputs](#) (int \_index, double \_value)  
*Sets the inputs to this neuron that can be located in any layer other than the first hidden layer.*
- int [calcOutput](#) (int \_layerHasReported)  
*Calculates the output of the neuron by performing a weighed sum of all inputs to this neuron and activating the sum.*
- void [setError](#) (double \_value)  
*Sets the error of the neuron in the first hidden layer that is to be propagated forward.*
- double [getError](#) ()  
*Allows accessing the error of this neuron.*
- void [updateWeights](#) ()

- Performs one iteration of learning, that is: it updates all the weights assigned to each input to this neuron.*
- double [doActivation](#) (const double sum) const  
*Performs the activation of the sum output of the neuron.*
- double [doActivationPrime](#) (const double input) const  
*Performs inverse activation on any input that is passed to this function.*
- void [setBackpropError](#) (const double upstreamDeltaErrorSum)  
*Sets the internal backprop error.*
- double [getOutput](#) ()  
*Requests the output of this neuron.*
- double [getSumOutput](#) ()  
*Requests the sum output of the neuron.*
- double [getWeights](#) (int \_inputIndex)  
*Requests a specific weight.*
- double [getInitWeights](#) (int \_inputIndex)  
*Requests a initial value of a specific weight.*
- double [getWeightChange](#) ()  
*Requests for overall change of all weights contained in this neuron.*
- double [getMaxWeight](#) ()  
*Requests for the maximum weights located in this neuron.*
- double [getMinWeight](#) ()  
*Requests for the minimum weights located in this neuron.*
- double [getSumWeight](#) ()  
*Requests for the total sum of weights located in this neuron.*
- double [getWeightDistance](#) ()  
*Requests the weight distance of all weights in this neuron.*
- int [getInputs](#) ()  
*Requests the total number of inputs to this neuron.*
- void [saveWeights](#) ()  
*Saves the temporal weight change of all weights in this neuron into a file.*
- void [printNeuron](#) ()  
*Prints on the console a full description of all weights, inputs and outputs for this neuron.*
- void [setWeight](#) (int \_index, double \_weight)  
*Sets the weights of the neuron.*

### 3.4.1 Detailed Description

This is the class for creating neurons inside the [Layer](#) class.

This is the building block class of the network.

### 3.4.2 Constructor & Destructor Documentation

#### 3.4.2.1 Neuron()

```
Neuron::Neuron (
    int _nInputs )
```

Constructor for the [Neuron](#) class: it initialises a neuron with specific number fo inputs to that neuron.

## Parameters

<code>_nInputs</code>	
-----------------------	--

### 3.4.3 Member Function Documentation

#### 3.4.3.1 calcOutput()

```
int Neuron::calcOutput (
    int _layerHasReported )
```

Calculates the output of the neuron by performing a weighed sum of all inputs to this neuron and activating the sum.

## Parameters

<code>_layerHasReported</code>	boolean variable to indicate whether or not any neuron in this layer has reported exploding output
--------------------------------	--

## Returns

Returns a boolean to report whether or not this neuron has exploding output

#### 3.4.3.2 doActivation()

```
double Neuron::doActivation (
    const double sum ) const [inline]
```

Performs the activation of the sum output of the neuron.

## Parameters

<code>_sum</code>	the weighted sum of all inputs
-------------------	--------------------------------

## Returns

activation of the sum

#### 3.4.3.3 doActivationPrime()

```
double Neuron::doActivationPrime (
    const double input ) const [inline]
```

Performs inverse activation on any input that is passed to this function.

**Parameters**

<code>_input</code>	the input value
---------------------	-----------------

**Returns**

the inverse activation of the input

**3.4.3.4 `getError()`**

```
double Neuron::getError ( )
```

Allows accessing the error of this neuron.

**Returns**

the value of the error

**3.4.3.5 `getInitWeights()`**

```
double Neuron::getInitWeights (
    int _inputIndex )
```

Requests a initial value of a specific weight.

**Parameters**

<code>_inputIndex</code>	index of the input to which the weight is assigned
--------------------------	--

**Returns**

teh initial value of the weight

**3.4.3.6 `getMaxWeight()`**

```
double Neuron::getMaxWeight ( ) [inline]
```

Requests for the maximum weights located in this neuron.

**Returns**

Returns the max weight

#### 3.4.3.7 getMinWeight()

```
double Neuron::getMinWeight ( ) [inline]
```

Requests for the minimum weights located in this neuron.

##### Returns

Returns the min weight

#### 3.4.3.8 getnInputs()

```
int Neuron::getnInputs ( )
```

Requests the total number of inputs to this neuron.

##### Returns

total number of inputs

#### 3.4.3.9 getOutput()

```
double Neuron::getOutput ( ) [inline]
```

Requests the output of this neuron.

##### Returns

the output of the neuron after activation

#### 3.4.3.10 getSumOutput()

```
double Neuron::getSumOutput ( ) [inline]
```

Requests the sum output of the neuron.

##### Returns

returns the sum output of the neuron before activation

#### 3.4.3.11 getSumWeight()

```
double Neuron::getSumWeight ( ) [inline]
```

Requests for the total sum of weights located in this neuron.

##### Returns

Returns the sum of weights

#### 3.4.3.12 getWeightChange()

```
double Neuron::getWeightChange ( )
```

Requests for overall change of all weights contained in this neuron.

##### Returns

the overal weight change

#### 3.4.3.13 getWeightDistance()

```
double Neuron::getWeightDistance ( )
```

Requests the weight distance of all weighs in this neuron.

##### Returns

returns the sqr of the total weight change in this neuron

#### 3.4.3.14 getWeights()

```
double Neuron::getWeights (
    int _inputIndex )
```

Requests a specific weight.

##### Parameters

<code>_inputIndex</code>	index of the input to which the chosen weight is assigned
--------------------------	---



**Returns**

Returns the chosen weight

**3.4.3.15 initNeuron()**

```
void Neuron::initNeuron (
    int _neuronIndex,
    int _layerIndex,
    weightInitMethod _wim,
    biasInitMethod _bim,
    actMethod _am )
```

Initialises the neuron with the given methods for weight/bias initialisation and for activation function.

It also specifies the index of the neuron and the index of the layer that contains this neuron.

**Parameters**

<code>_neuronIndex</code>	The index of this neuron
<code>_layerIndex</code>	The index of the layer that contains this neuron
<code>_wim</code>	The method of initialising the weights, refer to <code>weightInitMethod</code> for more information
<code>_bim</code>	The method of initialising the biases, refer to <code>biasInitMethod</code> for more information
<code>_am</code>	The function used for activation of neurons, refer to <code>actMethod</code> for more information

**3.4.3.16 propInputs()**

```
void Neuron::propInputs (
    int _index,
    double _value )
```

Sets the inputs to this neuron that can be located in any layer other than the first hidden layer.

**Parameters**

<code>_index</code>	index of the input
<code>_value</code>	value of the input

**3.4.3.17 setBackpropError()**

```
void Neuron::setBackpropError (
    const double upstreamDeltaErrorSum ) [inline]
```

Sets the internal backprop error.

## Parameters

<code>_input</code>	the input value
---------------------	-----------------

**3.4.3.18 setError()**

```
void Neuron::setError (
    double _value )
```

Sets the error of the neuron in the first hidden layer that is to be propagated forward.

## Parameters

<code>_value</code>	value of the error
---------------------	--------------------

**3.4.3.19 setInput()**

```
void Neuron::setInput (
    int _index,
    double _value )
```

Sets the inputs to this neuron that is located in the first hidden layer.

## Parameters

<code>_index</code>	Index of the input
<code>_value</code>	Value of the input

**3.4.3.20 setLearningRate()**

```
void Neuron::setLearningRate (
    double _learningRate,
    double _b_learningRate )
```

Sets the learning rate.

## Parameters

<code>_learningRate</code>	Sets the learning rate for this neuron.
----------------------------	---

#### 3.4.3.21 setWeight()

```
void Neuron::setWeight (
    int _index,
    double _weight ) [inline]
```

Sets the weights of the neuron.

##### Parameters

<i>_index</i>	index of the weight
<i>_weight</i>	value of the weight

The documentation for this class was generated from the following file:

- Neuron.h



# Index

calcOutput  
  Neuron, [24](#)

DNF, [5](#)  
  DNF, [6](#)  
  filter, [6](#)  
  getDelayedSignal, [6](#)  
  getNet, [7](#)  
  getOutput, [7](#)  
  getRemover, [7](#)  
  getSignalDelaySteps, [7](#)

doActivation  
  Neuron, [24](#)  
doActivationPrime  
  Neuron, [24](#)

filter  
  DNF, [6](#)

getDelayedSignal  
  DNF, [6](#)

getError  
  Neuron, [26](#)

getGlobalError  
  Layer, [10](#)

getGradient  
  Layer, [10](#)  
  Net, [16](#)

getInitWeight  
  Layer, [10](#)

getInitWeights  
  Neuron, [26](#)

getLayer  
  Net, [17](#)

getLayerWeightDistance  
  Net, [17](#)

getMaxWeight  
  Neuron, [26](#)

getMinWeight  
  Neuron, [26](#)

getNet  
  DNF, [7](#)

getNeuron  
  Layer, [11](#)

getnInputs  
  Net, [17](#)  
  Neuron, [27](#)

getnLayers  
  Net, [17](#)

getnNeurons

  Layer, [11](#)  
  Net, [18](#)

getOutput  
  DNF, [7](#)  
  Layer, [11](#)  
  Net, [18](#)  
  Neuron, [27](#)

getRemover  
  DNF, [7](#)

getSignalDelaySteps  
  DNF, [7](#)

getSumOutput  
  Layer, [12](#)  
  Net, [18](#)  
  Neuron, [27](#)

getSumWeight  
  Neuron, [27](#)

getWeightChange  
  Layer, [12](#)  
  Neuron, [28](#)

getWeightDistance  
  Layer, [12](#)  
  Net, [19](#)  
  Neuron, [28](#)

getWeights  
  Layer, [12](#)  
  Net, [19](#)  
  Neuron, [28](#)

initLayer  
  Layer, [13](#)

initNetwork  
  Net, [19](#)

initNeuron  
  Neuron, [29](#)

Layer, [8](#)  
  getGlobalError, [10](#)  
  getGradient, [10](#)  
  getInitWeight, [10](#)  
  getNeuron, [11](#)  
  getnNeurons, [11](#)  
  getOutput, [11](#)  
  getSumOutput, [12](#)  
  getWeightChange, [12](#)  
  getWeightDistance, [12](#)  
  getWeights, [12](#)  
  initLayer, [13](#)  
  Layer, [9](#)  
  propnInputs, [13](#)

- setError, [14](#)
- setInputs, [14](#)
- setlearningRate, [14](#)
- Net, [15](#)
  - getGradient, [16](#)
  - getLayer, [17](#)
  - getLayerWeightDistance, [17](#)
  - getnInputs, [17](#)
  - getnLayers, [17](#)
  - getnNeurons, [18](#)
  - getOutput, [18](#)
  - getSumOutput, [18](#)
  - getWeightDistance, [19](#)
  - getWeights, [19](#)
  - initNetwork, [19](#)
  - Net, [16](#)
  - setError, [21](#)
  - setInputs, [21](#)
  - setLearningRate, [21](#)
- Neuron, [22](#)
  - calcOutput, [24](#)
  - doActivation, [24](#)
  - doActivationPrime, [24](#)
  - getError, [26](#)
  - getInitWeights, [26](#)
  - getMaxWeight, [26](#)
  - getMinWeight, [26](#)
  - getnInputs, [27](#)
  - getOutput, [27](#)
  - getSumOutput, [27](#)
  - getSumWeight, [27](#)
  - getWeightChange, [28](#)
  - getWeightDistance, [28](#)
  - getWeights, [28](#)
  - initNeuron, [29](#)
  - Neuron, [23](#)
  - propInputs, [29](#)
  - setBackpropError, [29](#)
  - setError, [30](#)
  - setInput, [30](#)
  - setLearningRate, [30](#)
  - setWeight, [30](#)
- propInputs
  - Layer, [13](#)
  - Neuron, [29](#)
- setBackpropError
  - Neuron, [29](#)
- setError
  - Layer, [14](#)
  - Net, [21](#)
  - Neuron, [30](#)
- setInput
  - Neuron, [30](#)
- setInputs
  - Layer, [14](#)
  - Net, [21](#)
- setLearningRate
  - Net, [21](#)
  - Neuron, [30](#)
- setlearningRate
  - Layer, [14](#)
- setWeight
  - Neuron, [30](#)