Title  Recurrent Neural Network
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Description  
Implementation of a Recurrent Neural Network architectures in native R, including Long Short-Term Memory (Hochreiter and Schmidhuber, <doi:10.1162/neco.1997.9.8.1735>), Gated Recurrent Unit (Chung et al., <arXiv:1412.3555>) and vanilla RNN.
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**Description**

backpropagate the error in a model object of type gru

**Usage**

```
backprop_gru(model, a, c, j, ...)
```

**Arguments**

- **model**: the output model object
- **a**: the input of this learning batch
- **c**: the output of this learning batch
- **j**: the indexes of the sample in the current batch
- ... argument to be passed to method

**Value**

the updated model
**backprop_lstm**

**Description**
backpropagate the error in a model object of type rlstm

**Usage**
backprop_lstm(model, a, c, j, ...)

**Arguments**
- **model** the output model object
- **a** the input of this learning batch
- **c** the output of this learning batch
- **j** the indexes of the sample in the current batch
- ... argument to be passed to method

**Value**
the updated model

**backprop_r**

**Description**
backpropagate the error in a model object

**Usage**
backprop_r(model, a, c, j, ...)

**Arguments**
- **model** the output model object
- **a** the input of this learning batch
- **c** the output of this learning batch
- **j** the indexes of the sample in the current batch
- ... argument to be passed to method

**Value**
the updated model
backprop_rnn

Description
backpropagate the error in a model object of type rnn

Usage
backprop_rnn(model, a, c, j, ...)

Arguments
- model: the output model object
- a: the input of this learning batch
- c: the output of this learning batch
- j: the indexes of the sample in the current batch
- ...: argument to be passed to method

Value
the updated model

bin2int

Description
Binary to Integer

Usage
bin2int(binary)
b2i(binary)

Arguments
- binary: input binary

Value
integer representation

Functions
- b2i: individual Binary to Integer
clean_lstm

Description
clean the model for lighter output

Usage
clean_lstm(model)

Arguments
model the output model object

Value
the updated model

clean_r

Description
Initialize the weight parameters

Usage
clean_r(model)

Arguments
model the output model object

Value
the updated model
**clean_rnn**

Description

clean the model for lighter output

Usage

clean_rnn(model)

Arguments

model the output model object

Value

the updated model

---

**epoch_annealing**

Description

Apply the learning rate decay to the learning rate, called in epoch_model_function

Usage

ePOCH_annealing(model)

Arguments

model the output model object

Value

the updated model
**epoch_print**

**Description**
Print the error and learning rate at each epoch of the train, called in epoch_function

**Usage**
epoch_print(model)

**Arguments**
- model: the output model object

**Value**
- nothing

**init_gru**

**Description**
Initialize the weight parameter for a gru

**Usage**
init_gru(model)

**Arguments**
- model: the output model object

**Value**
- the updated model
init_lstm

Description
Initialize the weight parameter for a lstm

Usage
init_lstm(model)

Arguments
model the output model object

Value
the updated model

init_r

Description
Initialize the weight parameters

Usage
init_r(model)

Arguments
model the output model object

Value
the updated model
**init_rnn**

**Description**

Initialize the weight parameter for a rnn

**Usage**

`init_rnn(model)`

**Arguments**

- `model`: the output model object

**Value**

the updated model

---

**int2bin**

*Integer to Binary*

**Description**

Integer to Binary

**Usage**

`int2bin(integer, length = 8)`

`i2b(integer, length = 8)`

**Arguments**

- `integer`: input integer
- `length`: binary representation length

**Value**

binary representation

**Functions**

- `i2b`: individual Integer to Binary
**loss_L1**  
*L1 loss*

**Description**  
Apply the learning rate to the weight update, vocabulary to verify !!

**Usage**  
loss_L1(model)

**Arguments**  
- **model**  
  the output model object

**Value**  
the updated model

**predictr**  
*Recurrent Neural Network*

**Description**  
predict the output of a RNN model

**Usage**  
predictr(model, X, hidden = FALSE, real_output = T, ...)

**Arguments**  
- **model**  
  output of the trainr function  
- **X**  
  array of input values, dim 1: samples, dim 2: time, dim 3: variables (could be 1 or more, if a matrix, will be coerce to array)  
- **hidden**  
  should the function output the hidden units states  
- **real_output**  
  option used when the function in called inside trainr, do not drop factor for 2 dimension array output and other actions. Let it to TRUE, the default, to let the function take care of the data.  
- **...**  
  arguments to pass on to sigmoid function

**Value**  
array or matrix of predicted values
Examples

```r
## Not run:

# create training numbers
X1 <- sample(0:127, 10000, replace=TRUE)
X2 <- sample(0:127, 10000, replace=TRUE)

# create training response numbers
Y <- X1 + X2

# convert to binary
X1 <- int2bin(X1)
X2 <- int2bin(X2)
Y <- int2bin(Y)

# Create 3d array: dim 1: samples; dim 2: time; dim 3: variables.
X <- array( c(X1, X2), dim=c(dim(X1), 2) )

# train the model
model <- trainr(Y=Y[,dim(Y)[2]:1],
                 X=X[,dim(X)[2]:1],
                 learningrate = 1,
                 hidden_dim = 16)

# create test inputs
A1 <- int2bin( sample(0:127, 7000, replace=TRUE) )
A2 <- int2bin( sample(0:127, 7000, replace=TRUE) )

# create 3d array: dim 1: samples; dim 2: time; dim 3: variables
A <- array( c(A1, A2), dim=c(dim(A1), 2) )

# predict
B <- predictr(model,
              A[,dim(A)[2]:1])
B = B[,dim(B)[2]:1]

# convert back to integers
A1 <- bin2int(A1)
A2 <- bin2int(A2)
B <- bin2int(B)

# inspect the differences
table( B-(A1+A2) )

# plot the difference
hist( B-(A1+A2) )

## End(Not run)
```

**predict_gru**

gru prediction function
**Description**

predict the output of a gru model

**Usage**

```
predict_gru(model, X, hidden = FALSE, real_output = T, ...)
```

**Arguments**

- **model**: output of the trainr function
- **X**: array of input values, dim 1: samples, dim 2: time, dim 3: variables (could be 1 or more, if a matrix, will be coerced to array)
- **hidden**: should the function output the hidden units states
- **real_output**: option used when the function is called inside trainr, do not drop factor for 2 dimension array output
- **...**: arguments to pass on to sigmoid function

**Value**

array or matrix of predicted values

---

**Description**

predict the output of a lstm model

**Usage**

```
predict_lstm(model, X, hidden = FALSE, real_output = T, ...)
```

**Arguments**

- **model**: output of the trainr function
- **X**: array of input values, dim 1: samples, dim 2: time, dim 3: variables (could be 1 or more, if a matrix, will be coerced to array)
- **hidden**: should the function output the hidden units states
- **real_output**: option used when the function is called inside trainr, do not drop factor for 2 dimension array output
- **...**: arguments to pass on to sigmoid function

**Value**

array or matrix of predicted values
Description

predict the output of a RNN model

Usage

predict_rnn(model, X, hidden = FALSE, real_output = T, ...)

Arguments

model output of the trainr function
X array of input values, dim 1: samples, dim 2: time, dim 3: variables (could be 1 or more, if a matrix, will be coerce to array)
hidden should the function output the hidden units states
real_output option used when the function in called inside trainr, do not drop factor for 2 dimension array output
... arguments to pass on to sigmoid function

Value

array or matrix of predicted values

Description

A Recurrent Neural Network in native R, transforms numbers to binaries before adding bit by bit, teaching itself how to carry.

Author(s)

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References

http://qua.st/rnn

See Also

trainr for training a model and predictr for using a model to make predictions. http://qua.st/rnn
run.finance_demo  Demo app on finance data

Description
Function to launch the finance_demo app

Usage
run.finance_demo(port = NULL)

Arguments
port if not NULL will deploy on the local network on this port, just look for the IP of the host and go for example on 192.168.1.20:port to access the app from anywhere in the network

Author(s)
Dimitri Fichou

Examples
## Not run:
run.finance_demo()

## End(Not run)

run.rnn_demo  Demo app

Description
Function to launch the rnn_demo app

Usage
run.rnn_demo(port = NULL)

Arguments
port if not NULL will deploy on the local network on this port, just look for the IP of the host and go for example on 192.168.1.20:port to access the app from anywhere in the network
Author(s)

Dimitri Fichou

Examples

```r
# Not run:
run.rnn_demo()

# End(Not run)
```

---

trainr  

**Recurrent Neural Network**

Description

Trains a Recurrent Neural Network.

Usage

```r
trainr(Y, X, model = NULL, learningrate, learningrate_decay = 1,
momentum = 0, hidden_dim = c(10), network_type = "rnn",
numepochs = 1, sigmoid = c("logistic", "Gompertz", "tanh"),
use_bias = F, batch_size = 1, seq_to_seq_unsync = F,
update_rule = "sgd", epoch_function = c(epoch_print,
epoch_annealing), loss_function = loss_l1, ...)
```

Arguments

- **Y**
  array of output values, dim 1: samples (must be equal to dim 1 of X), dim 2:
  time (must be equal to dim 2 of X), dim 3: variables (could be 1 or more, if a
  matrix, will be coerce to array)
- **X**
  array of input values, dim 1: samples, dim 2: time, dim 3: variables (could be 1 or more, if a matrix, will be coerce to array)
- **model**
  a model trained before, used for retraining purpose.
- **learningrate**
  learning rate to be applied for weight iteration
- **learningrate_decay**
  coefficient to apply to the learning rate at each epoch, via the epoch_annealing function
- **momentum**
  coefficient of the last weight iteration to keep for faster learning
- **hidden_dim**
  dimension(s) of hidden layer(s)
- **network_type**
  type of network, could be rnn, gru or lstm. gru and lstm are experimental.
- **numepochs**
  number of iteration, i.e. number of time the whole dataset is presented to the network
- **sigmoid**
  method to be passed to the sigmoid function
use_bias: should the network use bias

batch_size: batch size: number of samples used at each weight iteration, only 1 supported for the moment

seq_to_seq_unsync: if TRUE, the network will be trained to backpropagate only the second half of the output error. If many to one is the target, just make Y have a time dim of 1. The X and Y data are modify at first to fit a classic learning, error are set to 0 during back propagation, input for the second part is also set to 0.

update_rule: rule to update the weight, "sgd", the default, is stochastic gradient descent, other available options are "adagrad" (experimentale, do not learn yet)

epoch_function: vector of functions to applied at each epoch loop. Use it to intereact with the objects inside the list model or to print and plot at each epoch. Should return the model.

loss_function: loss function, applied in each sample loop, vocabulary to verify.

... Arguments to be passed to methods, to be used in user defined functions

Value

a model to be used by the predictr function

Examples

```r
## Not run:
# create training numbers
X1 = sample(0:127, 10000, replace=TRUE)
X2 = sample(0:127, 10000, replace=TRUE)

# create training response numbers
Y <- X1 + X2

# convert to binary
X1 <- int2bin(X1, length=8)
X2 <- int2bin(X2, length=8)
Y <- int2bin(Y, length=8)

# create 3d array: dim 1: samples; dim 2: time; dim 3: variables
X <- array( c(X1,X2), dim=c(dim(X1),2) )

# train the model
model <- trainr(Y=Y,
  X=X,
  learningrate = 1,
  hidden_dim = 16 )

## End(Not run)
```
update_adagrad

Description
Apply the update with adagrad, not working yet

Usage
update_adagrad(model)

Arguments
model the output model object

Value
the updated model

update_r

Description
Apply the update

Usage
update_r(model)

Arguments
model the output model object

Value
the updated model
update_sgd

Description

Apply the update with stochastic gradient descent

Usage

update_sgd(model)

Arguments

model the output model object

Value

the updated model
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