Package ‘luz’

April 17, 2023

Title  Higher Level 'API' for 'torch'

Version  0.4.0

Description  A high level interface for 'torch' providing utilities to reduce the
the amount of code needed for common tasks, abstract away torch details and
make the same code work on both the 'CPU' and 'GPU'. It's flexible enough to
support expressing a large range of models. It's heavily inspired by 'fastai' by
Howard et al. (2020) <arXiv:2002.04688>, 'Keras' by Chollet et al. (2015) and

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        'callbacks-monitor-metrics.R' 'callbacks-profile.R'
        'callbacks-resume.R' 'callbacks-tfevents.R' 'context.R'
        'losses.R' 'lr-finder.R' 'metrics.R' 'metrics-auc.R'
        'module-plot.R' 'module-print.R' 'module.R' 'reexports.R'
        'serialization.R'

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**accelerator**

Create an accelerator

**Description**

Create an accelerator

**Usage**

```r
accelerator(
  device_placement = TRUE,
  cpu = FALSE,
  cuda_index = torch::cuda_current_device()
)
```

**Arguments**

- `device_placement` (logical) whether the accelerator object should handle device placement. Default: TRUE
- `cpu` (logical) whether the training procedure should run on the CPU.
- `cuda_index` (integer) index of the CUDA device to use if multiple GPUs are available. Default: the result of `torch::cuda_current_device()`.

**as_dataloader**

Creates a dataloader from its input

**Description**

`as_dataloader` is used internally by luz to convert input data and valid_data as passed to `fit.luz_module_generator()` to a `torch::dataloader`

**Usage**

```r
as_dataloader(x, ...)
```

```r
## S3 method for class 'dataset'
as_dataloader(x, ..., batch_size = 32)
```

```r
## S3 method for class 'list'
as_dataloader(x, ...)
```
## as_dataloader

```
## S3 method for class 'dataloader'
as_dataloader(x, ...)

## S3 method for class 'matrix'
as_dataloader(x, ...)

## S3 method for class 'numeric'
as_dataloader(x, ...)

## S3 method for class 'array'
as_dataloader(x, ...)

## S3 method for class 'torch_tensor'
as_dataloader(x, ...)
```

### Arguments

- **x**
  - the input object.
- **...**
  - Passed to `torch::dataloader()`.
- **batch_size**
  - (int, optional): how many samples per batch to load (default: 1).

### Details

`as_dataloader` methods should have sensible defaults for `batch_size`, parallel workers, etc.

It allows users to quickly experiment with `fit.luz_module_generator()` by not requiring to create a `torch::dataset` and a `torch::dataloader` in simple experiments.

### Methods (by class)

- `as_dataloader(dataset)`: Converts a `torch::dataset()` to a `torch::dataloader()`.
- `as_dataloader(list)`: Converts a list of tensors or arrays with the same size in the first dimension to a `torch::dataloader()`
- `as_dataloader(dataloader)`: Returns the same dataloader
- `as_dataloader(matrix)`: Converts the matrix to a dataloader
- `as_dataloader(numeric)`: Converts the numeric vector to a dataloader
- `as_dataloader(array)`: Converts the array to a dataloader
- `as_dataloader(torch_tensor)`: Converts the tensor to a dataloader

### Overridding

You can implement your own `as_dataloader` S3 method if you want your data structure to be automatically supported by luz’s `fit.luz_module_generator()`. The method must satisfy the following conditions:

- The method should return a `torch::dataloader()`.
- The only required argument is `x`. You have good default for all other arguments.
It’s better to avoid implementing `as_dataloader` methods for common S3 classes like `data.frames`. In this case, it’s better to assign a different class to the inputs and implement `as_dataloader` for it.

---

**context**

### Context object

**Description**

Context object storing information about the model training context. See also `ctx`.

**Public fields**

- `buffers` This is a list of buffers that callbacks can use to write temporary information into `ctx`.

**Active bindings**

- `records` stores information about values logged with `self$log`.
- `device` allows querying the current accelerator device.
- `callbacks` list of callbacks that will be called.
- `iter` current iteration
- `batch` the current batch data. a list with input data and targets.
- `input` a shortcut for `ctx$batch[[1]]`
- `target` a shortcut for `ctx$batch[[2]]`
- `min_epochs` the minimum number of epochs that the model will run on.
- `max_epochs` the maximum number of epochs that the model will run.
- `hparams` a list of hyperparameters that were used to initialize `ctx$model`.
- `opt_hparams` a list of hyperparameters used to initialize the `ctx$optimizers`.
- `train_data` a dataloader that is used for training the model.
- `valid_data` a dataloader using during model validation.
- `accelerator` an `accelerator()` used to move data, model and etc the the correct device.
- `optimizers` a named list of optimizers that will be used during model training.
- `verbose` bool wether the process is in verbose mode or not.
- `handlers` List of error handlers that can be used. See `rlang::try_fetch()` for more info.
- `epoch_handlers` List of error handlers that can be used. See `rlang::try_fetch()` for more info.
- `training` A bool indicating if the model is in training or validation mode.
- `model` The model being trained.
- `pred` Last predicted values.
- `opt` Current optimizer.
- `opt_name` Current optimizer name.
- `data` Current dataloader in use.
loss_fn  Loss function used to train the model
loss  Last computed loss values. detached from the graph.
loss_grad  Last computed loss value, not detached, so you can do additional tranformation.
epoch  Current epoch.
metrics  List of metrics that are tracked by the process.

Methods

Public methods:

• context$new()
• context$log()
• context$log_metric()
• context$get_log()
• context$get_metrics()
• context$get_metric()
• context$get_formatted_metrics()
• context$get_metrics_df()
• context$set_verbose()
• context$clean()
• context$call_callbacks()
• context$state_dict()
• context$unsafe_set_records()
• context$clone()

Method new(): Initializes the context object with minimal necessary information.

Usage:
context$new(verbos, accelerator, callbacks, training)

Arguments:
verbos  Whether the context should be in verbose mode or not.
accelerator  A luz accelerator() that configures device placement and others.
callbacks  A list of callbacks used by the model. See luz_callback().
training  A boolean that indicates if the context is in training mode or not.

Method log(): Allows logging arbitrary information in the ctx.

Usage:
context$log(what, set, value, index = NULL, append = TRUE)

Arguments:
what  (string) What you are logging.
set  (string) Usually 'train' or 'valid' indicating the set you want to lot to. But can be arbitrary info.
value  value to log
value  Arbitrary value to log.
index  Index that this value should be logged. If NULL the value is added to the end of list, otherwise the index is used.
append  If TRUE and a value in the corresponding index already exists, then value is appended to the current value. If FALSE value is overwritten in favor of the new value.

**Method log_metric():** Log a metric gen its name and value. Metric values are indexed by epoch.

*Usage:*  
```
context$log_metric(name, value)
```

*Arguments:*
- name  name of the metric
- value  value to log
- value  Arbitrary value to log.

**Method get_log():** Get a specific value from the log.

*Usage:*  
```
context$get_log(what, set, index = NULL)
```

*Arguments:*
- what  (string) What you are logging.
- set  (string) Usually 'train' or 'valid' indicating the set you want to log to. But can be arbitrary info.
- index  Index that this value should be logged. If NULL the value is added to the end of list, otherwise the index is used.

**Method get_metrics():** Get all metric given an epoch and set.

*Usage:*  
```
context$get_metrics(set, epoch = NULL)
```

*Arguments:*
- set  (string) Usually 'train' or 'valid' indicating the set you want to log to. But can be arbitrary info.
- epoch  The epoch you want to extract metrics from.

**Method get_metric():** Get the value of a metric given its name, epoch and set.

*Usage:*  
```
context$get_metric(name, set, epoch = NULL)
```

*Arguments:*
- name  name of the metric
- set  (string) Usually 'train' or 'valid' indicating the set you want to log to. But can be arbitrary info.
- epoch  The epoch you want to extract metrics from.

**Method get_formatted_metrics():** Get formatted metrics values

*Usage:*  
```
context$get_formatted_metrics(set, epoch = NULL)
```
Arguments:
set (string) Usually ‘train’ or ‘valid’ indicating the set you want to lot to. But can be arbitrary info.
epoch The epoch you want to extract metrics from.

Method get_metrics_df(): Get a data.frame containing all metrics.
Usage:
context$get_metrics_df()

Method set_verbose(): Allows setting the verbose attribute.
Usage:
context$set_verbose(verbose = NULL)
Arguments:
verbose boolean. If TRUE verbose mode is used. If FALSE non verbose. If NULL we use the result of interactive().

Method clean(): Removes unnecessary information from the context object.
Usage:
context$clean()

Method call_callbacks(): Call the selected callbacks. Where name is the callback types to call, eg ‘on_epoch_begin’.
Usage:
context$call_callbacks(name)
Arguments:
name name of the metric

Method state_dict(): Returns a list containing minimal information from the context. Used to create the returned values.
Usage:
context$state_dict()

Method unsafe_set_records(): Are you sure you know what you are doing?
Usage:
context$unsafe_set_records(records)
Arguments:
records New set of records to be set.

Method clone(): The objects of this class are cloneable with this method.
Usage:
context$clone(deep = FALSE)
Arguments:
deep Whether to make a deep clone.
Context attributes

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<td>verbose</td>
<td>The value (TRUE or FALSE) attributed to the verbose argument in fit.</td>
</tr>
<tr>
<td>accelerator</td>
<td>Accelerator object used to query the correct device to place models, data, etc. It assumes the value passed to the accelerator parameter in fit.</td>
</tr>
<tr>
<td>model</td>
<td>Initialized nn_module object that will be trained during the fit procedure.</td>
</tr>
<tr>
<td>optimizers</td>
<td>A named list of optimizers used during training.</td>
</tr>
<tr>
<td>data</td>
<td>The currently in-use dataloader. When training it's ctx$train_data, when doing validation its ctx$valid_data.</td>
</tr>
<tr>
<td>train_data</td>
<td>Dataloader passed to the data argument in fit. Modified to yield data in the selected device.</td>
</tr>
<tr>
<td>valid_data</td>
<td>Dataloader passed to the valid_data argument in fit. Modified to yield data in the selected device.</td>
</tr>
<tr>
<td>min_epochs</td>
<td>Minimum number of epochs the model will be trained for.</td>
</tr>
<tr>
<td>max_epochs</td>
<td>Maximum number of epochs the model will be trained for.</td>
</tr>
<tr>
<td>epoch</td>
<td>Current training epoch.</td>
</tr>
<tr>
<td>iter</td>
<td>Current training iteration. It’s reset every epoch and when going from training to validation.</td>
</tr>
<tr>
<td>training</td>
<td>Whether the model is in training or validation mode. See also help(&quot;luz_callback_train_valid&quot;)</td>
</tr>
<tr>
<td>callbacks</td>
<td>List of callbacks that will be called during the training procedure. It’s the union of the list passed to the call callbacks argument and the default callbacks.</td>
</tr>
<tr>
<td>step</td>
<td>Closure that will be used to do one step of the model. It’s used for both training and validation. Takes no arguments.</td>
</tr>
<tr>
<td>call_callbacks</td>
<td>Call callbacks by name. For example call_outputs(&quot;on_train_begin&quot;) will call all callbacks that provide methods for this point.</td>
</tr>
<tr>
<td>batch</td>
<td>Last batch obtained by the dataloader. A batch is a list() with 2 elements, one that is used as input and the other as target.</td>
</tr>
<tr>
<td>input</td>
<td>First element of the last batch obtained by the current dataloader.</td>
</tr>
<tr>
<td>target</td>
<td>Second element of the last batch obtained by the current dataloader.</td>
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<td>pred</td>
<td>Last predictions obtained by ctx$model$forward. Note: can be potentially modified by previously ran callbacks.</td>
</tr>
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<td>loss_fn</td>
<td>The active loss function that will be minimized during training.</td>
</tr>
<tr>
<td>loss</td>
<td>Last computed loss from the model. Note: this might not be available if you modified the training or validation step.</td>
</tr>
<tr>
<td>opt</td>
<td>Current optimizer, i.e. the optimizer that will be used to do the next step to update parameters.</td>
</tr>
<tr>
<td>opt_nm</td>
<td>Current optimizer name. By default it’s opt, but can change if your model uses more than one optimizer.</td>
</tr>
<tr>
<td>metrics</td>
<td>list() with current metric objects that are updated at every on_train_batch_end() or on_valid_batch_end().</td>
</tr>
<tr>
<td>records</td>
<td>list() recording metric values for training and validation for each epoch. See also help(&quot;luz_callback_records&quot;).</td>
</tr>
<tr>
<td>handlers</td>
<td>A named list() of handlers that is passed to rlang::with_handlers() during the training loop and can be potentially modified by previously ran callbacks.</td>
</tr>
<tr>
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<td>A named list of handlers that is used with rlang::with_handlers(). Those handlers are used inside the training loop.</td>
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evaluate

Evaluates a fitted model on a dataset

Description

Evaluates a fitted model on a dataset

Usage

evaluate(
  object,
  data,
  ...
, metrics = NULL,
  callbacks = list(),
  accelerator = NULL,
  verbose = NULL,
  dataloader_options = NULL
)

Arguments

- **object**: A fitted model to evaluate.
- **data**: (dataloader, dataset or list) A dataloader created with torch::dataloader() used for training the model, or a dataset created with torch::dataset() or a list. Dataloaders and datasets must return a list with at most 2 items. The first item will be used as input for the module and the second will be used as a target for the loss function.
- **...**: Currently unused.
- **metrics**: A list of luz metrics to be tracked during evaluation. If NULL (default) then the same metrics that were used during training are tracked.
- **callbacks**: (list, optional) A list of callbacks defined with luz_callback() that will be called during the training procedure. The callbacks luz_callback_metrics(), luz_callback_progress() and luz_callback_train_valid() are always added by default.
- **accelerator**: (accelerator, optional) An optional accelerator() object used to configure device placement of the components like nn_modules, optimizers and batches of data.
- **verbose**: (logical, optional) An optional boolean value indicating if the fitting procedure should emit output to the console during training. By default, it will produce output if interactive() is TRUE, otherwise it won’t print to the console.
Dataloader Options

Options used when creating a dataloader. See `torch::dataloader()` by default for the training data and `batch_size=32` by default. It will error if not `NULL` and `data` is already a dataloader.

Details

Once a model has been trained you might want to evaluate its performance on a different dataset. For that reason, luz provides the `evaluate` function that takes a fitted model and a dataset and computes the metrics attached to the model.

Evaluate returns a `luz_module_evaluation` object that you can query for metrics using the `get_metrics` function or simply `print` to see the results.

For example:

```r
evaluation <- fitted %>% evaluate(data = valid_dl)
metrics <- get_metrics(evaluation)
print(evaluation)
```

```
## A 'luz_module_evaluation'
## -- Results -----------------------------------------------
## loss: 1.5146
## mae: 1.0251
## mse: 1.5159
## rmse: 1.2312
```

See Also

Other training: `fit.luz_module_generator()`, `predict.luz_module_fitted()`, `setup()`

---

### fit.luz_module_generator

**Fit a nn_module**

**Description**

Fit a `nn_module`

**Usage**

```r
## S3 method for class 'luz_module_generator'
fit(
  object,
  data,
  epochs = 10,
  callbacks = NULL,
  valid_data = NULL,
  accelerator = NULL,
  ```
fit.luz_module_generator

```
verbose = NULL,
..., 
  dataloader_options = NULL
)

Arguments

object  An nn_module that has been setup.
data    (dataloader, dataset or list) A dataloader created with `torch::dataloader()` used for training the model, or a dataset created with `torch::dataset()` or a list. Dataloaders and datasets must return a list with at most 2 items. The first item will be used as input for the module and the second will be used as a target for the loss function.
ePOCHS  (int) The maximum number of epochs for training the model. If a single value is provided, this is taken to be the max_epochs and min_epochs is set to 0. If a vector of two numbers is provided, the first value is min_epochs and the second value is max_epochs. The minimum and maximum number of epochs are included in the context object as `ctx$min_epochs` and `ctx$max_epochs`, respectively.
callback defined with `luz_callback()` that will be called during the training procedure. The callbacks `luz_callback_metrics()`, `luz_callback_progress()` and `luz_callback_train_valid()` are always added by default.
valid_data (dataloader, dataset, list or scalar value; optional) A dataloader created with `torch::dataloader()` or a dataset created with `torch::dataset()` that will be used during the validation procedure. They must return a list with (input, target). If data is a torch dataset or a list, then you can also supply a numeric value between 0 and 1 - and in this case a random sample with size corresponding to that proportion from data will be used for validation.
accelerator (accelerator, optional) An optional `accelerator()` object used to configure device placement of the components like nn_modules, optimizers and batches of data.
verbose (logical, optional) An optional boolean value indicating if the fitting procedure should emit output to the console during training. By default, it will produce output if `interactive()` is TRUE, otherwise it won’t print to the console.
... Currently unused.
dataloader_options Options used when creating a dataloader. See `torch::dataloader()`. shuffle=TRUE by default for the training data and batch_size=32 by default. It will error if not NULL and data is already a dataloader.

Value

A fitted object that can be saved with `luz_save()` and can be printed with `print()` and plotted with `plot()`.
get_metrics

See Also

predict.luz_module_fitted() for how to create predictions. setup() to find out how to create modules that can be trained with fit.

Other training: evaluate().predict.luz_module_fitted(), setup()

---

get_metrics Get metrics from the object

Description

Get metrics from the object

Usage

get_metrics(object, ...)

## S3 method for class 'luz_module_fitted'
get_metrics(object, ...)

Arguments

object The object to query for metrics.
... Currently unused.

Value

A data.frame containing the metric values.

Methods (by class)

- get_metrics(luz_module_fitted): Extract metrics from a luz fitted model.

---

lr_finder Learning Rate Finder

Description

Learning Rate Finder
Usage

```
lr_finder(
    object,
    data,
    steps = 100,
    start_lr = 1e-07,
    end_lr = 0.1,
    log_spaced_intervals = TRUE,
    ...
    verbose = NULL
)
```

Arguments

- **object**: An `nn_module` that has been setup.
- **data**: A dataloader created with `torch::dataloader()` used for learning rate finding.
- **steps**: The number of steps to iterate over in the learning rate finder. Default: 100.
- **start_lr**: The smallest learning rate. Default: 1e-7.
- **end_lr**: The highest learning rate. Default: 1e-1.
- **log_spaced_intervals**: Whether to divide the range between start_lr and end_lr into log-spaced intervals (alternative: uniform intervals). Default: TRUE
- **...**: Other arguments passed to `fit`.
- **verbose**: Whether to show a progress bar during the process.

Value

A dataframe with two columns: learning rate and loss

Examples

```
if (torch::torch_is_installed()) {
  library(torch)
  ds <- torch::tensor_dataset(x = torch_randn(100, 10), y = torch_randn(100, 1))
  dl <- torch::dataloader(ds, batch_size = 32)
  model <- torch::nn_linear
  model <- model %>% setup(
    loss = torch::nn_mse_loss(),
    optimizer = torch::optim_adam
  ) %>%
    set_hparams(in_features = 10, out_features = 1)
  records <- lr_finder(model, dl, verbose = FALSE)
  plot(records)
}
```
Create a new callback

Usage

luz_callback(
    name = NULL,
    ..., 
    private = NULL,
    active = NULL,
    parent_env = parent.frame(),
    inherit = NULL
)

Arguments

name
name of the callback

... Public methods of the callback. The name of the methods is used to know how
they should be called. See the details section.

private An optional list of private members, which can be functions and non-functions.

active An optional list of active binding functions.

parent_env An environment to use as the parent of newly-created objects.

inherit A R6ClassGenerator object to inherit from; in other words, a superclass. This is
captured as an unevaluated expression which is evaluated in parent_env each
time an object is instantiated.

Details

Let’s implement a callback that prints ‘Iteration n’ (where n is the iteration number) for every batch
in the training set and ‘Done’ when an epoch is finished. For that task we use the luz_callback
function:

print_callback <- luz_callback(
    name = "print_callback",
    initialize = function(message) {
        self$message <- message
    },
    on_train_batch_end = function() {
        cat("Iteration ", ctx$iter, "\n")
    },
    on_epoch_end = function() {
        cat(self$message, "\n")
    })
luz_callback() takes named functions as arguments, where the name indicates the moment at which the callback should be called. For instance, on_train_batch_end() is called for every batch at the end of the training procedure, and on_epoch_end() is called at the end of every epoch.

The returned value of luz_callback() is a function that initializes an instance of the callback. Callbacks can have initialization parameters, like the name of a file where you want to log the results. In that case, you can pass an initialize method when creating the callback definition, and save these parameters to the self object. In the above example, the callback has a message parameter that is printed at the end of each epoch.

Once a callback is defined it can be passed to the fit function via the callbacks parameter:

```r
fitted <- net %>%
  setup(...) %>%
  fit(..., callbacks = list(
    print_callback(message = "Done!"))
)`
```

Callbacks can be called in many different positions of the training loop, including combinations of them. Here’s an overview of possible callback breakpoints:

Start Fit
- on_fit_begin
Start Epoch Loop
- on_epoch_begin
Start Train
- on_train_begin
Start Batch Loop
- on_train_batch_begin
  Start Default Training Step
  - on_train_batch_after_pred
  - on_train_batch_after_loss
  - on_train_batch_before_backward
  - on_train_batch_before_step
  - on_train_batch_after_step
End Default Training Step:
  - on_train_batch_end
End Batch Loop
- on_train_end
End Train
Start Valid
- on_valid_begin
Start Batch Loop
- on_valid_batch_begin
  Start Default Validation Step
  - on_valid_batch_after_pred
  - on_valid_batch_after_loss
```
End Default Validation Step
- on_valid_batch_end
End Batch Loop
- on_valid_end
End Valid
- on_epoch_end
End Epoch Loop
- on_fit_end
End Fit

Every step marked with on_* is a point in the training procedure that is available for callbacks to be called.

The other important part of callbacks is the ctx (context) object. See help("ctx") for details.

By default, callbacks are called in the same order as they were passed to fit (or predict or evaluate), but you can provide a weight attribute that will control the order in which it will be called. For example, if one callback has weight = 10 and another has weight = 1, then the first one is called after the second one. Callbacks that don’t specify a weight attribute are considered weight = 0. A few built-in callbacks in luz already provide a weight value. For example, the luz_callback_early_stopping has a weight of Inf, since in general we want to run it as the last thing in the loop.

Value

A luz_callback that can be passed to fit.luz_module_generator().

Prediction callbacks

You can also use callbacks when using predict(). In this case the supported callback methods are detailed above.

Start predict
- on_predict_begin
Start prediction loop
- on_predict_batch_begin
- on_predict_batch_end
End prediction loop
- on_predict_end
End predict

Evaluate callbacks

Callbacks can also be used with evaluate(), in this case, the callbacks that are used are equivalent to those of the validation loop when using fit():

Start Valid
- on_valid_begin
Start Batch Loop
- on_valid_batch_begin

End Predict
- on_predict_end
luz_callback_auto_resume

Resume training callback

Description
This callback allows you to resume training a model.

Usage
luz_callback_auto_resume(path = "./state.pt")

Arguments
path Path to save state files for the model.

Details
When using it, model weights, optimizer state are serialized at the end of each epoch. If something fails during training simply re-running the same script will restart the model training from the epoch right after the last epoch that was serialized.

Start Default Validation Step
- on_valid_batch_after_pred
- on_valid_batch_after_loss
End Default Validation Step
- on_valid_batch_end
End Batch Loop
- on_valid_end
End Valid

See Also

Examples
print_callback <- luz_callback(
  name = "print_callback",
  on_train_batch_end = function()
    cat("Iteration ", ctx$iter, "\n"),
  on_epoch_end = function()
    cat("Done!\n")
)

---

---

Description
This callback allows you to resume training a model.

Usage
luz_callback_auto_resume(path = "./state.pt")

Arguments
path Path to save state files for the model.

Details
When using it, model weights, optimizer state are serialized at the end of each epoch. If something fails during training simply re-running the same script will restart the model training from the epoch right after the last epoch that was serialized.
Customizing serialization

By default model, optimizer state and records are serialized. Callbacks can be used to customize serialization by implementing the `state_dict()` and `load_state_dict()` methods. If those methods are implemented, then `state_dict()` is called at the end of each epoch and `load_state_dict()` is called when the model is resumed.

**Note**

In general you will want to add this callback as the last in the callbacks list, this way, the serialized state is likely to contain all possible changes that other callbacks could have made at 'on_epoch_end'. The default weight attribute of this callback is Inf.

Read the checkpointing article in the pkgdown website for more information.

**See Also**


**Examples**

```r
if (torch::torch_is_installed()) {
library(torch)
library(luz)

x <- torch_randn(1000, 10)
y <- torch_randn(1000, 1)

model <- nn_linear %>%
  setup(optimizer = optim_sgd, loss = nnf_mse_loss) %>%
  set_hparams(in_features = 10, out_features = 1) %>%
  set_opt_hparams(lr = 0.01)

# simulate a failure in the middle of epoch 5 happening only once.
callback_stop <- luz_callback("interrupt",
  failed = FALSE,
  on_epoch_end = function() {
    if (ctx$epoch == 5 && !self$failed) {
      self$failed <- TRUE
      stop("Error on epoch 5")
    }
  })

path <- tempfile()
autoresume <- luz_callback_auto_resume(path = path)
interrupt <- callback_stop()
```

```
# try once and the model fails
try({
    results <- model %>% fit(
        list(x, y),
        callbacks = list(autoresume, interrupt),
        verbose = FALSE
    )
})

# model resumes and completes
results <- model %>% fit(
    list(x, y),
    callbacks = list(autoresume, interrupt),
    verbose = FALSE
)

get_metrics(results)

---

**luz_callback_csv_logger**

*CSV logger callback*

**Description**

Logs metrics obtained during training a file on disk. The file will have 1 line for each epoch/validation.

**Usage**

`luz_callback_csv_logger(path)`

**Arguments**

- **path** path to a file on disk.

**See Also**

Description

Stops training when a monitored metric stops improving

Usage

luz_callback_early_stopping(
    monitor = "valid_loss",
    min_delta = 0,
    patience = 0,
    mode = "min",
    baseline = NULL
)

Arguments

monitor A string in the format <set>_<metric> where <set> can be 'train' or 'valid' and <metric> can be the abbreviation of any metric that you are tracking during training. The metric name is case insensitive.
min_delta Minimum improvement to reset the patience counter.
patience Number of epochs without improving until stopping training.
mode Specifies the direction that is considered an improvement. By default 'min' is used. Can also be 'max' (higher is better) and 'zero' (closer to zero is better).
baseline An initial value that will be used as the best seen value in the beginning. Model will stop training if no better than baseline value is found in the first patience epochs.

Value

A luz_callback that does early stopping.

Note

This callback adds a on_early_stopping callback that can be used to call callbacks as soon as the model stops training.
If verbose=TRUE in fit.luz_module_generator() a message is printed when early stopping.

See Also

Examples

```r
cb <- luz_callback_early_stopping()
```

---

**luz_callback_gradient_clip**

*Gradient clipping callback*

**Description**

By adding the GradientClip callback, the gradient norm_type (default:2) norm is clipped to at most max_norm (default:1) using `torch::nn_utils_clip_grad_norm_()`, which can avoid loss divergence.

**Usage**

```r
luz_callback_gradient_clip(max_norm = 1, norm_type = 2)
```

**Arguments**

- `max_norm` (float or int): max norm of the gradients
- `norm_type` (float or int): type of the used p-norm. Can be Inf for infinity norm.

**References**

See FastAI documentation for the GradientClip callback.

---

**luz_callback_interrupt**

*Interrupt callback*

**Description**

Adds a handler that allows interrupting the training loop using `ctrl + C`. Also registers a `on_interrupt` breakpoint so users can register callbacks to be run on training loop interruption.

**Usage**

```r
luz_callback_interrupt()
```

**Value**

A `luz_callback`
**luz_callback_keep_best_model**

**Note**

In general you don’t need to use these callback by yourself because it’s always included by default in `fit.luz_module_generator()`.

**See Also**

Other luz callbacks: `luz_callback_auto_resume()`, `luz_callback_csv_logger()`, `luz_callback_early_stopping()`,
`luz_callback_keep_best_model()`, `luz_callback_lr_scheduler()`, `luz_callback_metrics()`,
`luz_callback_mixup()`, `luz_callback_model_checkpoint()`, `luz_callback_profile()`, `luz_callback_progress()`,
`luz_callback_resume_from_checkpoint()`, `luz_callback_train_valid()`, `luz_callback()`

**Examples**

```r
interrupt_callback <- luz_callback_interrupt()
```

---

**luz_callback_keep_best_model**

*Keep the best model*

**Description**

Each epoch, if there’s improvement in the monitored metric we serialize the model weights to a temp file. When training is done, we reload weights from the best model.

**Usage**

```r
luz_callback_keep_best_model(
  monitor = "valid_loss",
  mode = "min",
  min_delta = 0
)
```

**Arguments**

- **monitor**
  A string in the format `<set>_<metric>` where `<set>` can be ‘train’ or ‘valid’ and `<metric>` can be the abbreviation of any metric that you are tracking during training. The metric name is case insensitive.

- **mode**
  Specifies the direction that is considered an improvement. By default ‘min’ is used. Can also be ‘max’ (higher is better) and ‘zero’ (closer to zero is better).

- **min_delta**
  Minimum improvement to reset the patience counter.

**See Also**

Other luz callbacks: `luz_callback_auto_resume()`, `luz_callback_csv_logger()`, `luz_callback_early_stopping()`,
`luz_callback_interrupt()`, `luz_callback_lr_scheduler()`, `luz_callback_metrics()`, `luz_callback_mixup()`,
`luz_callback_model_checkpoint()`, `luz_callback_profile()`, `luz_callback_progress()`,
`luz_callback_resume_from_checkpoint()`, `luz_callback_train_valid()`, `luz_callback()`
**Examples**

cb <- luz_callback_keep_best_model()

---

**luz_callback_lr_scheduler**

*Learning rate scheduler callback*

**Description**

Initializes and runs `torch::lr_scheduler()`s.

**Usage**

```r
luz_callback_lr_scheduler(
  lr_scheduler,
  ..., 
  call_on = "on_epoch_end",
  opt_name = NULL
)
```

**Arguments**

- `lr_scheduler` A `torch::lr_scheduler()` that will be initialized with the optimizer and the ...
- `...` Additional arguments passed to `lr_scheduler` together with the optimizers.
- `call_on` The callback breakpoint that `scheduler$step()` is called. Default is 'on_epoch_end'. See `luz_callback()` for more information.
- `opt_name` name of the optimizer that will be affected by this callback. Should match the name given in `set_optimizers`. If your module has a single optimizer, `opt_name` is not used.

**Value**

A `luz_callback()` generator.

**See Also**


**Examples**

```r
if (torch::torch_is_installed()) {
  cb <- luz_callback_lr_scheduler(torch::lr_step, step_size = 30)
}
```
**luz_callback_metrics**  
**Metrics callback**

---

**Description**

Tracks metrics passed to `setup()` during training and validation.

**Usage**

```r
luz_callback_metrics()
```

**Details**

This callback takes care of 2 `ctx` attributes:

- `ctx$metrics`: stores the current metrics objects that are initialized once for epoch, and are further `update()`d and `compute()`d every batch. You will rarely need to work with these metrics.
- `ctx$records$metrics`: Stores metrics per training/validation and epoch. The structure is very similar to `ctx$losses`.

**Value**

A `luz_callback`

**Note**

In general you won’t need to explicitly use the metrics callback as it’s used by default in `fit.luz_module_generator()`.

**See Also**


---

**luz_callback_mixup**  
**Mixup callback**

---

**Description**

Implementation of 'mixup: Beyond Empirical Risk Minimization'. As of today, tested only for categorical data, where targets are expected to be integers, not one-hot encoded vectors. This callback is supposed to be used together with `nn_mixup_loss()`.
Usage

luz_callback_mixup(alpha = 0.4, ..., run_valid = FALSE, auto_loss = FALSE)

Arguments

alpha  parameter for the beta distribution used to sample mixing coefficients
...
run_valid  Should it run during validation
auto_loss  Should it automatically modify the loss function? This will wrap the loss function to create the mixup loss. If TRUE make sure that your loss function does not apply reductions. If run_valid=FALSE, then loss will be mean reduced during validation.

Details

Overall, we follow the fastai implementation described here. Namely,

- We work with a single dataloader only, randomly mixing two observations from the same batch.
- We linearly combine losses computed for both targets: loss(output, new_target) = weight * loss(output, target1) + (1-weight) * loss(output, target2)
- We draw different mixing coefficients for every pair.
- We replace weight with weight = max(weight, 1-weight) to avoid duplicates.

Value

A luz_callback

See Also

nn_mixup_loss(), nnf_mixup()


Examples

if (torch::torch_is_installed()) {
  mixup_callback <- luz_callback_mixup()
}
luz_callback_model_checkpoint

Checkpoints model weights

Description

This saves checkpoints of the model according to the specified metric and behavior.

Usage

luz_callback_model_checkpoint(
  path,
  monitor = "valid_loss",
  save_best_only = FALSE,
  mode = "min",
  min_delta = 0
)

Arguments

- **path**: Path to save the model on disk. The path is interpolated with glue, so you can use any attribute within the ctx by using '{ctx$epoch}'. Specially the epoch and monitor quantities are already in the environment. If the specified path is a path to a directory (ends with / or \), then models are saved with the name given by epoch-{epoch:02d}-{self$monitor}-{monitor:.3f}.pt. See more in the examples. You can use sprintf() to quickly format quantities, for example: '{epoch:02d}'.

- **monitor**: A string in the format <set>_<metric> where <set> can be 'train' or 'valid' and <metric> can be the abbreviation of any metric that you are tracking during training. The metric name is case insensitive.

- **save_best_only**: if TRUE models are only saved if they have an improvement over a previously saved model.

- **mode**: Specifies the direction that is considered an improvement. By default 'min' is used. Can also be 'max' (higher is better) and 'zero' (closer to zero is better).

- **min_delta**: Minimum difference to consider as improvement. Only used when save_best_only=TRUE.

Note

mode and min_delta are only used when save_best_only=TRUE. save_best_only will overwrite the saved models if the path parameter don't differentiate by epochs.

Read the checkpointer article in the pkgdown website for more information.
luz_callback_profile

See Also


Examples

luz_callback_model_checkpoint(path= "path/to/dir")
luz_callback_model_checkpoint(path= "path/to/dir/epoch-{epoch:02d}/model.pt")
luz_callback_model_checkpoint(path= "path/to/dir/epoch-{epoch:02d}/model-{monitor:.2f}.pt")

luz_callback_profile  Profile callback

Description

Computes the times for high-level operations in the training loops.

Usage

luz_callback_profile()

Details

Records are saved in ctx$records$profile. Times are stored as seconds. Data is stored in the following structure:

- **fit** time for the entire fit procedure.
- **epoch** times per epoch

Value

A luz_callback

Note

In general you don’t need to use these callback by yourself because it’s always included by default in fit.luz_module_generator().

See Also

luz_callback_progress

Examples

profile_callback <- luz_callback_profile()

Description

Responsible for printing progress during training.

Usage

luz_callback_progress()

Value

A luz_callback

Note

In general you don’t need to use these callback by yourself because it’s always included by default in \texttt{fit.luz\_module\_generator}().

Printing can be disabled by passing \texttt{verbose=FALSE} to \texttt{fit.luz\_module\_generator}().

See Also

Other luz callbacks: \texttt{luz\_callback\_auto\_resume()}, \texttt{luz\_callback\_csv\_logger()}, \texttt{luz\_callback\_early\_stopping()}, \texttt{luz\_callback\_interrupt()}, \texttt{luz\_callback\_keep\_best\_model()}, \texttt{luz\_callback\_lr\_scheduler()}, \texttt{luz\_callback\_metrics()}, \texttt{luz\_callback\_mixup()}, \texttt{luz\_callback\_model\_checkpoint()}, \texttt{luz\_callback\_profile()}, \texttt{luz\_callback\_resume\_from\_checkpoint()}, \texttt{luz\_callback\_train\_valid()}, \texttt{luz\_callback()}
Usage

```r
luz_callback_resume_from_checkpoint(
  path,
  ..., 
  restore_model_state = TRUE,
  restore_records = FALSE,
  restore_optimizer_state = FALSE,
  restore_callbacks_state = FALSE
)
```

Arguments

- `path`: Path to the checkpoint that you want to resume.
- `...`: currently unused.
- `restore_model_state`: Wether to restore the model state from the callback.
- `restore_records`: Wether to restore records from the checkpoint.
- `restore_optimizer_state`: Wether to restore the optimizer state from the checkpoint.
- `restore_callbacks_state`: Wether to restore the callbacks state from the checkpoint.

Note

Read the checkpointing article in the pkgdown website for more information.

See Also

- `luz_callback_model_checkpoint()`

---

**Description**

Logs metrics and other model information in the tfevents file format. Assuming tensorboard is installed, result can be visualized with

Usage

```r
luz_callback_tfevents(logdir = "logs", histograms = FALSE, ...)
```
Arguments

logdir A directory to where log will be written to.
histograms A boolean specifying if histograms of model weights should be logged. It can also be a character vector specifying the name of the parameters that should be logged (names are the same as names(model$parameters)).

... Currently not used. For future expansion.

Details

tensorboard --logdir=logs

Examples

if (torch::torch_is_installed()) {
  library(torch)
  x <- torch_randn(1000, 10)
  y <- torch_randn(1000, 1)

  model <- nn_linear %>%
    setup(loss = nnf_mse_loss, optimizer = optim_adam) %>%
    set_hparams(in_features = 10, out_features = 1) %>%
    set_opt_hparams(lr = 1e-4)
  tmp <- tempfile()

  model %>% fit(list(x, y), valid_data = 0.2, callbacks = list(
    luz_callback_tfevents(tmp, histograms = TRUE)
  ))
}

luz_callback_train_valid

Train-eval callback

Description

Switches important flags for training and evaluation modes.

Usage

luz_callback_train_valid()

Details

It takes care of the three ctx attributes:

- ctx$model: Responsible for calling ctx$model$train() and ctx$model$eval(), when appropriate.
- ctx$training: Sets this flag to TRUE when training and FALSE when in validation mode.
- ctx$loss: Resets the loss attribute to list() when finished training/ or validating.
Value

A luz_callback

Note

In general you won’t need to explicitly use the metrics callback as it’s used by default in `fit.luz_module_generator()`.

See Also


```
| luz_load                  | Load trained model |
```

Description

Loads a fitted model. See documentation in `luz_save()`.

Usage

```
luz_load(path)
```

Arguments

- path: path in file system so save the object.

See Also

Other luz_save: `luz_save()`

```
| luz_load_checkpoint       | Loads a checkpoint |
```

Description

Works with checkpoints created typically with `luz_callback_model_checkpoint()`.

Usage

```
luz_load_checkpoint(obj, path, ...)
```
### luz_load_model_weights

**Description**

This can be useful when you have saved model checkpoints during training and want to reload the best checkpoint in the end.

**Usage**

```r
luz_load_model_weights(obj, path, ...)
```

**Arguments**

- `obj` luz object to which we want to load the checkpoint.
- `path` Path of the checkpoint on disk.
- `...` unused. Is there to allow future extensions.

**Value**

Returns NULL invisibly.

### luz_save_model_weights

**Description**

This can be useful when you have saved model checkpoints during training and want to reload the best checkpoint in the end.

**Usage**

```r
luz_save_model_weights(obj, path)
```

**Arguments**

- `obj` luz object to which you want to copy the new weights.
- `path` path to saved model in disk.
- `...` other arguments passed to `torch_load()`.

**Value**

Returns NULL invisibly.

**Warning**

`luz_save_model_weights` operates in-place, i.e., modifies the model object to contain the new weights.
**luz_metric**  
*Creates a new luz metric*

**Description**

Creates a new luz metric

**Usage**

```r
luz_metric(
  name = NULL,
  ..., 
  private = NULL,
  active = NULL,
  parent_env = parent.frame(),
  inherit = NULL
)
```

**Arguments**

- `name`  
  string naming the new metric.
- `...`  
  named list of public methods. You should implement at least `initialize`, `update` and `compute`. See the details section for more information.
- `private`  
  An optional list of private members, which can be functions and non-functions.
- `active`  
  An optional list of active binding functions.
- `parent_env`  
  An environment to use as the parent of newly-created objects.
- `inherit`  
  A R6ClassGenerator object to inherit from; in other words, a superclass. This is captured as an unevaluated expression which is evaluated in `parent_env` each time an object is instantiated.

**Details**

In order to implement a new `luz_metric` we need to implement 3 methods:

- `initialize`: defines the metric initial state. This function is called for each epoch for both training and validation loops.
- `update`: updates the metric internal state. This function is called at every training and validation step with the predictions obtained by the model and the target values obtained from the dataloader.
- `compute`: uses the internal state to compute metric values. This function is called whenever we need to obtain the current metric value. Eg, it’s called every training step for metrics displayed in the progress bar, but only called once per epoch to record it’s value when the progress bar is not displayed.
Optionally, you can implement an `abbrev` field that gives the metric an abbreviation that will be used when displaying metric information in the console or tracking record. If no `abbrev` is passed, the class name will be used.

Let’s take a look at the implementation of `luz_metric_accuracy` so you can see how to implement a new one:

```r
luz_metric_accuracy <- luz_metric(
  # An abbreviation to be shown in progress bars, or
  abbrev = "Acc",
  # Initial setup for the metric. Metrics are initialized
  # every epoch, for both training and validation
  initialize = function() {
    self$correct <- 0
    self$total <- 0
  },
  # Run at every training or validation step and updates
  # the internal state. The update function takes 'preds'
  # and 'target' as parameters.
  update = function(preds, target) {
    pred <- torch::torch_argmax(preds, dim = 2)
    self$correct <- self$correct + (pred == target)$
      to(dtype = torch::torch_float())$
      sum()$
      item()
    self$total <- self$total + pred$numel()
  },
  # Use the internal state to query the metric value
  compute = function() {
    self$correct/self$total
  }
)
```

**Note:** It’s good practice that the `compute` metric returns regular R values instead of `torch` tensors and other parts of `luz` will expect that.

**Value**

Returns new `luz` metric.

**See Also**

Other `luz_metrics`: `luz_metric_accuracy()`, `luz_metric_binary_accuracy_with_logits()`, `luz_metric_binary_accuracy()`, `luz_metric_binary_auroc()`, `luz_metric_mae()`, `luz_metric_mse()`, `luz_metric_multiclass_auroc()`, `luz_metric_rmse()`

**Examples**

```r
luz_metric_accuracy <- luz_metric(
```
# An abbreviation to be shown in progress bars, or
# when printing progress
abbrev = "Acc",
# Initial setup for the metric. Metrics are initialized
# every epoch, for both training and validation
initialize = function() {
    self$correct <- 0
    self$total <- 0
},
# Run at every training or validation step and updates
# the internal state. The update function takes 'preds'
# and 'target' as parameters.
update = function(preds, target) {
    pred <- torch::torch_argmax(preds, dim = 2)
    self$correct <- self$correct + (pred == target)$
      to(dtype = torch::torch_float())$
        sum()$
        item()
    self$total <- self$total + pred$numel()
},
# Use the internal state to query the metric value
compute = function() {
    self$correct/self$total
}
)

luz_metric_accuracy  

Accuracy

Description
Computes accuracy for multi-class classification problems.

Usage
luz_metric_accuracy()

Details
This metric expects to take logits or probabilities at every update. It will then take the columnwise argmax and compare to the target.

Value
Returns new luz metric.
See Also

Other luz_metrics: `luz_metric_binary_accuracy_with_logits()`, `luz_metric_binary_accuracy()`, `luz_metric_binary_auroc()`, `luz_metric_mae()`, `luz_metric_mse()`, `luz_metric_multiclass_auroc()`, `luz_metric_rmse()`, `luz_metric()`

Examples

```r
if (torch::torch_is_installed()) {
  library(torch)
  metric <- luz_metric_accuracy()
  metric <- metric$new()
  metric$update(torch_randn(100, 10), torch::torch_randint(1, 10, size = 100))
  metric$compute()
}
```

---

`luz_metric_binary_accuracy`

*Binary accuracy*

Description

Computes the accuracy for binary classification problems where the model returns probabilities. Commonly used when the loss is `torch::nn_bce_loss()`.

Usage

`luz_metric_binary_accuracy(threshold = 0.5)`

Arguments

- **threshold**: value used to classify observations between 0 and 1.

Value

Returns new luz metric.

See Also

Other luz_metrics: `luz_metric_accuracy()`, `luz_metric_binary_accuracy_with_logits()`, `luz_metric_binary_auroc()`, `luz_metric_mae()`, `luz_metric_mse()`, `luz_metric_multiclass_auroc()`, `luz_metric_rmse()`, `luz_metric()`
Examples

if (torch::torch_is_installed()) {
  library(torch)
  metric <- luz_metric_binary_accuracy(threshold = 0.5)
  metric <- metric$new()
  metric$update(torch_rand(100), torch::torch_randint(0, 1, size = 100))
  metric$compute()
}

luz_metric_binary_accuracy_with_logits

Description

Computes accuracy for binary classification problems where the model return logits. Commonly used together with torch::nn_bce_with_logits_loss().

Usage

luz_metric_binary_accuracy_with_logits(threshold = 0.5)

Arguments

threshold value used to classify observations between 0 and 1.

Details

Probabilities are generated using torch::nnf_sigmoid() and threshold is used to classify between 0 or 1.

Value

Returns new luz metric.

See Also

Other luz_metrics: luz_metric_accuracy(), luz_metric_binary_accuracy(), luz_metric_binary_auroc(), luz_metric_mae(), luz_metric_mse(), luz_metric_multiclass_auroc(), luz_metric_rmse(), luz_metric()
Examples

```r
if (torch::torch_is_installed()) {
  library(torch)
  metric <- luz_metric_binary_accuracy_with_logits(threshold = 0.5)
  metric <- metric$new()
  metric$update(torch_randn(100), torch::torch_randint(0, 1, size = 100))
  metric$compute()
}
```

---

**luz_metric_binary_auroc**

*Computes the area under the ROC*

Description

To avoid storing all predictions and targets for an epoch we compute confusion matrices across a range of pre-established thresholds.

Usage

```r
luz_metric_binary_auroc(
  num_thresholds = 200,
  thresholds = NULL,
  from_logits = FALSE
)
```

Arguments

- `num_thresholds` Number of thresholds used to compute confusion matrices. In that case, thresholds are created by getting `num_thresholds` values linearly spaced in the unit interval.
- `thresholds` (optional) If threshold are passed, then those are used to compute the confusion matrices and `num_thresholds` is ignored.
- `from_logits` Boolean indicating if predictions are logits, in that case we use sigmoid to put them in the unit interval.

See Also

Other luz_metrics: `luz_metric_accuracy()`, `luz_metric_binary_accuracy_with_logits()`, `luz_metric_binary_accuracy()`, `luz_metric_mae()`, `luz_metric_mse()`, `luz_metric_multiclass_auroc()`, `luz_metric_rmse()`, `luz_metric()`
Examples

```r
if (torch::torch_is_installed()){
  library(torch)
  actual <- c(1, 1, 1, 0, 0, 0)
  predicted <- c(0.9, 0.8, 0.4, 0.5, 0.3, 0.2)

  y_true <- torch_tensor(actual)
  y_pred <- torch_tensor(predicted)

  m <- luz_metric_binary_auroc(thresholds = predicted)
  m <- m$new()

  m$update(y_pred[1:2], y_true[1:2])
  m$update(y_pred[3:4], y_true[3:4])
  m$update(y_pred[5:6], y_true[5:6])

  m$compute()
}
```

---

**luz_metric_mae**  
**Mean absolute error**

Description

Computes the mean absolute error.

Usage

```r
luz_metric_mae()
```

Value

Returns new luz metric.

See Also

Other luz_metrics:  
luz_metric_accuracy(), luz_metric_binary_accuracy_with_logits(), luz_metric_binary_auc(), luz_metric_mse(), luz_metric_multiclass_auc(), luz_metric_rmse(), luz_metric()  

Examples

```r
if (torch::torch_is_installed()) {
  library(torch)
  metric <- luz_metric_mae()
  metric <- metric$new()
  metric$update(torch_randn(100), torch_randn(100))
  metric$compute()
}
```
### luz_metric_mse

*Mean squared error*

**Description**

Computes the mean squared error

**Usage**

```r
luz_metric_mse()
```

**Value**

A `luz_metric` object.

**See Also**

Other `luz_metrics`: `luz_metric_accuracy()`, `luz_metric_binary_accuracy_with_logits()`, `luz_metric_binary_accuracy()`, `luz_metric_binary_auroc()`, `luz_metric_mae()`, `luz_metric_multiclass_auroc()`, `luz_metric_rmse()`, `luz_metric()`

---

### luz_metric_multiclass_auroc

*Computes the multi-class AUROC*

**Description**

The same definition as Keras is used by default. This is equivalent to the 'micro' method in SciKit Learn too. See docs.

**Usage**

```r
luz_metric_multiclass_auroc(
  num_thresholds = 200,
  thresholds = NULL,
  from_logits = FALSE,
  average = c("micro", "macro", "weighted", "none")
)
```
Arguments

num_thresholds Number of thresholds used to compute confusion matrices. In that case, thresholds are created by getting num_thresholds values linearly spaced in the unit interval.

thresholds (optional) If threshold are passed, then those are used to compute the confusion matrices and num_thresholds is ignored.

from_logits If TRUE then we call torch::nnf_softmax() in the predictions before computing the metric.

average The averaging method:

- 'micro': Stack all classes and computes the AUROC as if it was a binary classification problem.
- 'macro': Finds the AUROC for each class and computes their mean.
- 'weighted': Finds the AUROC for each class and computes their weighted mean pondering by the number of instances for each class.
- 'none': Returns the AUROC for each class in a list.

Details

Note that class imbalance can affect this metric unlike the AUC for binary classification. Currently the AUC is approximated using the 'interpolation' method described in Keras.

See Also

Other luz_metrics: luz_metric_accuracy(), luz_metric_binary_accuracy_with_logits(), luz_metric_binary_accuracy(), luz_metric_binary_auroc(), luz_metric_mae(), luz_metric_mse(), luz_metric_rmse(), luz_metric()

Examples

```r
if (torch::torch_is_installed()) {
library(torch)
actual <- c(1, 1, 1, 0, 0, 0) + 1L
predicted <- c(0.9, 0.8, 0.4, 0.5, 0.3, 0.2)
predicted <- cbind(1-predicted, predicted)
y_true <- torch_tensor(as.integer(actual))
y_pred <- torch_tensor(predicted)

m <- luz_metric_multiclass_auroc(thresholds = as.numeric(predicted),
                                  average = "micro")

m$update(y_pred[1:2,], y_true[1:2])

m$update(y_pred[3:4,], y_true[3:4])

m$update(y_pred[5:6,], y_true[5:6])

m$compute()
}
```
**luz_metric_rmse**

| luz_metric_rmse | Root mean squared error |

**Description**

Computes the root mean squared error.

**Usage**

luz_metric_rmse()

**Value**

Returns new luz metric.

**See Also**

Other luz_metrics: luz_metric_accuracy(), luz_metric_binary_accuracy_with_logits(), luz_metric_binary_accuracy(), luz_metric_binary_auroc(), luz_metric_mae(), luz_metric_mse(), luz_metric_multiclass_auroc(), luz_metric()

---

**luz_metric_set**

| luz_metric_set | Creates a metric set |

**Description**

A metric set can be used to specify metrics that are only evaluated during training, validation or both.

**Usage**

luz_metric_set(metrics = NULL, train_metrics = NULL, valid_metrics = NULL)

**Arguments**

- **metrics**
  
  A list of luz_metrics that are meant to be used in both training and validation.

- **train_metrics**
  
  A list of luz_metrics that are only used during training.

- **valid_metrics**
  
  A list of luz_metrics that are only used for validation.
### luz_save

**Saves luz objects to disk**

**Description**

Allows saving luz fitted models to the disk. Objects can be loaded back with `luz_load()`.

**Usage**

```r
luz_save(obj, path, ...)
```

**Arguments**

- `obj` an object of class 'luz_module_fitted' as returned by `fit.luz_module_generator()`.
- `path` path in file system so save the object.
- `...` currently unused.

**Warning**

The `ctx` is naively serialized. Ie, we only use `saveRDS()` to serialize it. Don’t expect `luz_save` to work correctly if you have unserializable objects in the `ctx` like `torch_tensor` and external pointers in general.

**Note**

Objects are saved as plain `.rds` files but `obj$model` is serialized with `torch_save` before saving it.

**See Also**

Other luz_save: `luz_load()`

### nnf_mixup

**Mixup logic**

**Description**

Logic underlying `luz_callback_mixup()`.

**Usage**

```r
nnf_mixup(x, y, weight)
```
**nn_mixup_loss**

**Arguments**

- `x` an input batch
- `y` a target batch
- `weight` weighting coefficient to be used by `torch_lerp()`

**Details**

Based on the passed-in input and target batches, as well as applicable mixing weights, we return new tensors intended to replace the current batch. The new input batch is a weighted linear combination of input batch items, while the new target batch bundles the original targets, as well as the mixing weights, in a nested list.

**Value**

A list of:

- `x`, the new, mixed-up input batch
- `y`, a list of:
  - `ys`, a list of:
    - `y1`, the original target `y`
    - `y2`, the mixed-in target `y`
  - `weight`, the mixing weights

**See Also**

`luz_callback_mixup()`

**Examples**

```r
if (torch::torch_is_installed()) {
  batch_x <- torch::torch_randn(c(10, 768))
  batch_y <- torch::torch_randn(10)
  weight <- torch::torch_tensor(rep(0.9, 10))$view(c(10, 1))
  nnf_mixup(batch_x, batch_y, weight)
}
```

---

**Description**

In the training phase, computes individual losses with regard to two targets, weights them item-wise, and averages the linear combinations to yield the mean batch loss. For validation and testing, defers to the passed-in loss.
Usage

nn_mixup_loss(loss)

Arguments

loss the underlying loss nn_module to call. It must support the reduction field. During training the attribute will be changed to 'none' so we get the loss for individual observations. See for example documentation for the reduction argument in torch::nn_cross_entropy_loss().

Details

It should be used together with luz_callback_mixup().

See Also

luz_callback_mixup()
setup  47

callbacks (list, optional) A list of callbacks defined with luz_callback() that will be
called during the training procedure. The callbacks luz_callback_metrics(),
luz_callback_progress() and luz_callback_train_valid() are always added
by default.

accelerator (accelerator, optional) An optional accelerator() object used to configure de-
vice placement of the components like nn_modules, optimizers and batches of
data.

verbose (logical, optional) An optional boolean value indicating if the fitting procedure
should emit output to the console during training. By default, it will produce
output if interactive() is TRUE, otherwise it won’t print to the console.

dataloader_options Options used when creating a dataloader. See torch::dataloader(). shuffle=TRUE
by default for the training data and batch_size=32 by default. It will error if
not NULL and data is already a dataloader.

See Also

Other training: evaluate(), fit.luz_module_generator(), setup()

setup Set’s up a nn_module to use with luz

Description

The setup function is used to set important attributes and method for nn_modules to be used with
luz.

Usage

setup(module, loss = NULL, optimizer = NULL, metrics = NULL, backward = NULL)

Arguments

module (nn_module) The nn_module that you want set up.

loss (function, optional) An optional function with the signature function(input, target).
It’s only requires if your nn_module doesn’t implement a method called loss.

optimizer (torch_optimizer, optional) A function with the signature function(parameters, ...)
that is used to initialize an optimizer given the model parameters.

metrics (list, optional) A list of metrics to be tracked during the training procedure.
Sometimes, you want some metrics to be evaluated only during training or vali-
dation, in this case you can pass a luz_metric_set() object to specify mmet-
rics used in each stage.

backward (function) A functions that takes the loss scalar values as it’s parameter. It must
call $backward() or torch::autograd_backward(). In general you don’t
need to set this parameter unless you need to customize how luz calls the backward(),
for example, if you need to add additional arguments to the backward call. Note
that this becomes a method of the nn_module thus can be used by your custom
step() if you override it.
Details

It makes sure the module have all the necessary ingredients in order to be fitted.

Value

A luz module that can be trained with \texttt{fit()}.

Note

It also adds a device active field that can be used to query the current module device within methods, with eg \texttt{self$device}. This is useful when \texttt{ctx()} is not available, eg, when calling methods from outside the luz wrappers. Users can override the default by implementing a device active method in the input module.

See Also

Other training: \texttt{evaluate()}, \texttt{fit.luz_module_generator()}, \texttt{predict.luz_module_fitted()}

---

\textbf{set_hparams} \hfill \textit{Set hyper-parameter of a module}

\begin{verbatim}
set_hparams(module, ...)
\end{verbatim}

Description

This function is used to define hyper-parameters before calling \texttt{fit} for \texttt{luz_modules}.

Usage

\texttt{set_hparams(module, ...)}

Arguments

\begin{itemize}
  \item \texttt{module} \hspace{1cm} An \texttt{nn_module} that has been \texttt{setup()}.
  \item \texttt{...} \hspace{1cm} The parameters set here will be used to initialize the \texttt{nn_module}, ie they are passed unchanged to the \texttt{initialize} method of the base \texttt{nn_module}.
\end{itemize}

Value

The same luz module

See Also

Other set_hparam: \texttt{set_opt_hparams()}
Description

This function is used to define hyper-parameters for the optimizer initialization method.

Usage

set_opt_hparams(module, ...)

Arguments

module An nn_module that has been setup().
...
The parameters passed here will be used to initialize the optimizers. For example, if your optimizer is optim_adam and you pass lr=0.1, then the optim_adam function is called with optim_adam(parameters, lr=0.1) when fitting the model.

Value

The same luz module

See Also

Other set_hparam: set_hparams()
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