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# **inferno Documentation**

*Release 0.1.7*

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Inferno is a little library providing utilities and convenience functions/classes around PyTorch. It's a work-in-progress, but the first stable release (0.2) is underway!

- Free software: Apache Software License 2.0
- Documentation: <https://pytorch-inferno.readthedocs.io> (Work in progress).

## 1.1 Features

### Current features include:

- a basic `Trainer` class to encapsulate the training boilerplate (iteration/epoch loops, validation and check-point creation),
- a graph API for building models with complex architectures, powered by `networkx`.
- easy data-parallelism over multiple GPUs,
- a submodule for `torch.nn.Module`-level parameter initialization,
- a submodule for data preprocessing / transforms,
- support for Tensorboard (best with atleast `tensorflow-cpu` installed)
- a callback API to enable flexible interaction with the trainer,
- various utility layers with more underway,
- a submodule for volumetric datasets, and more!

```
import torch.nn as nn
from inferno.io.box.cifar import get_cifar10_loaders
from inferno.trainers.basic import Trainer
from inferno.trainers.callbacks.logging.tensorboard import TensorboardLogger
from inferno.extensions.layers.convolutional import ConvELU2D
```

```

from inferno.extensions.layers.reshape import Flatten

# Fill these in:
LOG_DIRECTORY = '...'
SAVE_DIRECTORY = '...'
DATASET_DIRECTORY = '...'
DOWNLOAD_CIFAR = True
USE_CUDA = True

# Build torch model
model = nn.Sequential(
    ConvELU2D(in_channels=3, out_channels=256, kernel_size=3),
    nn.MaxPool2d(kernel_size=2, stride=2),
    ConvELU2D(in_channels=256, out_channels=256, kernel_size=3),
    nn.MaxPool2d(kernel_size=2, stride=2),
    ConvELU2D(in_channels=256, out_channels=256, kernel_size=3),
    nn.MaxPool2d(kernel_size=2, stride=2),
    Flatten(),
    nn.Linear(in_features=(256 * 4 * 4), out_features=10),
    nn.Softmax()
)

# Load loaders
train_loader, validate_loader = get_cifar10_loaders(DATASET_DIRECTORY,
                                                    download=DOWNLOAD_CIFAR)

# Build trainer
trainer = Trainer(model) \
    .build_criterion('CrossEntropyLoss') \
    .build_metric('CategoricalError') \
    .build_optimizer('Adam') \
    .validate_every((2, 'epochs')) \
    .save_every((5, 'epochs')) \
    .save_to_directory(SAVE_DIRECTORY) \
    .set_max_num_epochs(10) \
    .build_logger(TensorboardLogger(log_scalars_every=(1, 'iteration'),
                                    log_images_every='never'),
                 log_directory=LOG_DIRECTORY)

# Bind loaders
trainer \
    .bind_loader('train', train_loader) \
    .bind_loader('validate', validate_loader)

if USE_CUDA:
    trainer.cuda()

# Go!
trainer.fit()

```

To visualize the training progress, navigate to *LOG\_DIRECTORY* and fire up tensorboard with

```
$ tensorboard --logdir=${PWD} --port=6007
```

and navigate to *localhost:6007* with your browser.



## 1.2 Future Features:

### Planned features include:

- a class to encapsulate Hogwild! training over multiple GPUs,
- minimal shape inference with a dry-run,
- proper packaging and documentation,
- cutting-edge fresh-off-the-press implementations of what the future has in store. :)

## 1.3 Credits

All contributors are listed [here](#).

This packag was partially generated with [Cookiecutter](#) and the [audreyr/cookiecutter-pypackage](#) project template + lots of work by Thorsten.



## 2.1 Install on Linux and OSX

### 2.1.1 Developers

First, make sure you have Pytorch installed.

Then, clone this repository with:

```
$ git clone https://github.com/nasimrahaman/inferno.git
```

Next, install the dependencies.

```
$ cd inferno  
$ pip install -r requirements.txt
```

### 2.1.2 If you use python from the shell:

Finally, add *inferno* to your *PYTHONPATH* with:

```
source add2path.sh
```

### 2.1.3 If you use PyCharm:

Refer to this [QA](#) about setting up paths with Pycharm.



---

## Installation via PyPi / pip / setup.py(Experimental)

---

You need to install pytorch via pip before installing inferno. Follow the [pytorch installation guide](#).

### 3.1 Stable release

To install inferno, run this command in your terminal:

```
$ pip install inferno-pytorch
```

This is the preferred method to install inferno, as it will always install the most recent stable release.

If you don't have pip installed, this [Python installation guide](#) can guide you through the process.

### 3.2 From sources

First, make sure [you have Pytorch installed](#). The sources for inferno can be downloaded from the [Github repo](#). You can either clone the public repository:

```
$ git clone git://github.com/nasimrahan/inferno
```

Or download the [tarball](#):

```
$ curl -OL https://github.com/nasimrahan/inferno/tarball/master
```

Once you have a copy of the source, you can install it with:

```
$ python setup.py install
```



Inferno is a utility library built around [PyTorch](<http://pytorch.org/>), designed to help you train and even build complex pytorch models. And in this tutorial, we'll see how! If you're new to PyTorch, I highly recommended you work through the [Pytorch tutorials](<http://pytorch.org/tutorials/>) first.

## 4.1 Building a PyTorch Model

Inferno's training machinery works with just about any valid [Pytorch module](<http://pytorch.org/docs/master/nn.html#torch.nn.Module>). However, to make things even easier, we also provide pre-configured layers that work out-of-the-box. Let's use them to build a convolutional neural network for Cifar-10.

```
import torch.nn as nn
from inferno.extensions.layers.convolutional import ConvELU2D
from inferno.extensions.layers.reshape import Flatten
```

*ConvELU2D* is a 2-dimensional convolutional layer with orthogonal weight initialization and [ELU](<http://pytorch.org/docs/master/nn.html#torch.nn.ELU>) activation. *Flatten* reshapes the 4 dimensional activation tensor to a matrix. Let's use the *Sequential* container to chain together a bunch of convolutional and pooling layers, followed by a linear and softmax layer.

```
model = nn.Sequential(
    ConvELU2D(in_channels=3, out_channels=256, kernel_size=3),
    nn.MaxPool2d(kernel_size=2, stride=2),
    ConvELU2D(in_channels=256, out_channels=256, kernel_size=3),
    nn.MaxPool2d(kernel_size=2, stride=2),
    ConvELU2D(in_channels=256, out_channels=256, kernel_size=3),
    nn.MaxPool2d(kernel_size=2, stride=2),
    Flatten(),
    nn.Linear(in_features=(256 * 4 * 4), out_features=10),
    nn.Softmax()
)
```

Models this size don't win competitions anymore, but it'll do for our purpose.

## 4.1.1 Data Logistics

With our model built, it's time to worry about the data generators. Or is it?

```
from inferno.io.box.cifar import get_cifar10_loaders
train_loader, validate_loader = get_cifar10_loaders('path/to/cifar10',
                                                    download=True,
                                                    train_batch_size=128,
                                                    test_batch_size=100)
```

CIFAR-10 works out-of-the-*box* (pun very much intended) with all the fancy data-augmentation and normalization. Of course, it's perfectly fine if you have your own [*DataLoader*](<http://pytorch.org/docs/master/data.html#torch.utils.data.DataLoader>).

## 4.2 Preparing the Trainer

With our model and data loaders good to go, it's finally time to build the trainer. To start, let's initialize one.

```
from inferno.trainers.basic import Trainer

trainer = Trainer(model)
# Tell trainer about the data loaders
trainer.bind_loader('train', train_loader).bind_loader('validate', validate_loader)
```

Now to the things we could do with it.

### 4.2.1 Setting up Checkpointing

When training a model for days, it's usually a good idea to store the current training state to disk every once in a while. To set this up, we tell *trainer* where to store these *checkpoints* and how often.

```
trainer.save_to_directory('path/to/save/directory').save_every((25, 'epochs'))
```

So we're saving once every 25 epochs. But what if an epoch takes forever, and you don't wish to wait that long?

```
trainer.save_every((1000, 'iterations'))
```

In this setting, you're saving once every 1000 iterations (= batches). But we might also want to create a checkpoint when the validation score is the best. Easy as 1, 2,

```
trainer.save_at_best_validation_score()
```

Remember that a checkpoint contains the entire training state, and not just the model. Everything is included in the checkpoint file, including optimizer, criterion, and callbacks but not the data loaders.

### 4.2.2 Setting up Validation

Let's say you wish to validate once every 2 epochs.

```
trainer.validate_every((2, 'epochs'))
```

To be able to validate, you'll need to specify a validation metric.



```
trainer.build_metric('CategoricalError')
```

Inferno looks for a metric `'CategoricalError'` in `inferno.extensions.metrics`. To specify your own metric, subclass `inferno.extensions.metrics.base.Metric` and implement the `forward` method. With that done, you could:

```
trainer.build_metric(MyMetric)
```

or

```
trainer.build_metric(MyMetric, **my_metric_kwargs)
```

Note that the metric applies to `'torch.Tensor's`, and not on `'torch.autograd.Variable's`. Also, a metric might be way too expensive to evaluate every training iteration without slowing down the training. If this is the case and you'd like to evaluate the metric every (say) 10 *training* iterations:

```
trainer.evaluate_metric_every((10, 'iterations'))
```

However, while validating, the metric is evaluated once every iteration.

### 4.2.3 Setting up the Criterion and Optimizer

With that out of the way, let's set up a training criterion and an optimizer.

```
# set up the criterion
trainer.build_criterion('CrossEntropyLoss')
```

The *trainer* looks for a `'CrossEntropyLoss'` in `torch.nn`, which it finds. But any of the following would have worked:

```
trainer.build_criterion(nn.CrossEntropyLoss)
```

or

```
trainer.build_criterion(nn.CrossEntropyLoss())
```

What this means is that if you have your own loss criterion that has the same API as any of the criteria found in `torch.nn`, you should be fine by just plugging it in.

The same holds for the optimizer:

```
trainer.build_optimizer('Adam', weight_decay=0.0005)
```

Like for criteria, the *trainer* looks for a `'Adam'` in `torch.optim` (among other places), and initializes it with *model's* parameters. Any keywords you might use for `torch.optim.Adam`, you could pass them to the `build_optimizer` method.

Or alternatively, you could use:

```
from torch.optim import Adam
trainer.build_optimizer(Adam, weight_decay=0.0005)
```

If you implemented your own optimizer (by subclassing `torch.optim.Optimizer`), you should be able to use it instead of *Adam*. Alternatively, if you already have an optimizer *instance*, you could do:

```
optimizer = MyOptimizer(model.parameters(), **optimizer_kwargs)
trainer.build_optimizer(optimizer)
```

## 4.2.4 Setting up Training Duration

You probably don't want to train forever, in which case you must specify:

```
trainer.set_max_num_epochs(100)
```

or

```
trainer.set_max_num_iterations(10000)
```

If you like to train indefinitely (or until you're happy with the results), use:

```
trainer.set_max_num_iterations('inf')
```

In this case, you'll need to interrupt the training manually with a *KeyboardInterrupt*.

## 4.2.5 Setting up Callbacks

Callbacks are pretty handy when it comes to interacting with the *Trainer*. More precisely: *Trainer* defines a number of events as 'triggers' for callbacks. Currently, these are:

```
BEGIN_OF_FIT,  
END_OF_FIT,  
BEGIN_OF_TRAINING_RUN,  
END_OF_TRAINING_RUN,  
BEGIN_OF_EPOCH,  
END_OF_EPOCH,  
BEGIN_OF_TRAINING_ITERATION,  
END_OF_TRAINING_ITERATION,  
BEGIN_OF_VALIDATION_RUN,  
END_OF_VALIDATION_RUN,  
BEGIN_OF_VALIDATION_ITERATION,  
END_OF_VALIDATION_ITERATION,  
BEGIN_OF_SAVE,  
END_OF_SAVE
```

As an example, let's build a simple callback to interrupt the training on NaNs. We check at the end of every training iteration whether the training loss is NaN, and accordingly raise a *RuntimeError*.

```
import numpy as np  
from inferno.trainers.callbacks.base import Callback  
  
class NaNDetector(Callback):  
    def end_of_training_iteration(self, **_):  
        # The callback object has the trainer as an attribute.  
        # The trainer populates its 'states' with torch tensors (NOT VARIABLES!)  
        training_loss = self.trainer.get_state('training_loss')  
        # Extract float from torch tensor  
        training_loss = training_loss[0]  
        if np.isnan(training_loss):  
            raise RuntimeError("NaNs detected!")
```

With the callback defined, all we need to do is register it with the trainer:

```
trainer.register_callback(NaNDetector())
```

So the next time you get *RuntimeError*: "NaNs detected!", you know the drill.

## 4.2.6 Using Tensorboard

Inferno supports logging scalars and images to Tensorboard out-of-the-box, though this requires you have at least [tensorflow-cpu](https://github.com/tensorflow/tensorflow) installed. Let's say you want to log scalars every iteration and images every 20 iterations:

```
from inferno.trainers.callbacks.logging.tensorboard import TensorboardLogger

trainer.build_logger(TensorboardLogger(log_scalars_every=(1, 'iteration'),
                                       log_images_every=(20, 'iterations')),
                    log_directory='/path/to/log/directory')
```

After you've started training, use a bash shell to fire up tensorboard with:

```
$ tensorboard --logdir=/path/to/log/directory --port=6007
```

and navigate to `localhost:6007` with your favorite browser.

Fine print: missing the `log_images_every` keyword argument to `TensorboardLogger` will result in images being logged every iteration. If you don't have a fast hard drive, this might actually slow down the training. To not log images, just use `log_images_every='never'`.

## 4.2.7 Using GPUs

To use just one GPU:

```
trainer.cuda()
```

For multi-GPU data-parallel training, simply pass `trainer.cuda` a list of devices:

```
trainer.cuda(devices=[0, 1, 2, 3])
```

**\_\_Pro-tip\_\_**: Say you only want to use GPUs 0, 3, 5 and 7 (your colleagues might love you for this). Before running your training script, simply:

```
$ export CUDA_VISIBLE_DEVICES=0,3,5,7
$ python train.py
```

This maps device 0 to 0, 3 to 1, 5 to 2 and 7 to 3.

## 4.2.8 One more thing

Once you have everything configured, use

```
trainer.fit()
```

to commence training! This last step is kinda important. :wink:

## 4.3 Cherries:

### 4.3.1 Building Complex Models with the Graph API

Work in Progress:

### 4.3.2 Parameter Initialization

Work in Progress:

### 4.3.3 Support

Work in Progress:

## CHAPTER 5

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### Inferno Examples Gallery

---



Contributions are welcome, and they are greatly appreciated! Every little bit helps, and credit will always be given. You can contribute in many ways:

## 6.1 Types of Contributions

### 6.1.1 Report Bugs

Report bugs at <https://github.com/nasimrahaman/inferno/issues>.

If you are reporting a bug, please include:

- Your operating system name and version.
- Any details about your local setup that might be helpful in troubleshooting.
- Detailed steps to reproduce the bug.

### 6.1.2 Fix Bugs

Look through the GitHub issues for bugs. Anything tagged with “bug” and “help wanted” is open to whoever wants to implement it.

### 6.1.3 Implement Features

Look through the GitHub issues for features. Anything tagged with “enhancement” and “help wanted” is open to whoever wants to implement it.

## 6.1.4 Write Documentation

inferno could always use more documentation, whether as part of the official inferno docs, in docstrings, or even on the web in blog posts, articles, and such.

## 6.1.5 Submit Feedback

The best way to send feedback is to file an issue at <https://github.com/nasimrahaman/inferno/issues>.

If you are proposing a feature:

- Explain in detail how it would work.
- Keep the scope as narrow as possible, to make it easier to implement.
- Remember that this is a volunteer-driven project, and that contributions are welcome :)

## 6.2 Get Started!

Ready to contribute? Here's how to set up *inferno* for local development.

1. Fork the *inferno* repo on GitHub.
2. Clone your fork locally:

```
$ git clone git@github.com:your_name_here/inferno.git
```

3. Install your local copy into a virtualenv. Assuming you have virtualenvwrapper installed, this is how you set up your fork for local development:

```
$ mkvirtualenv inferno
$ cd inferno/
$ python setup.py develop
```

4. Create a branch for local development:

```
$ git checkout -b name-of-your-bugfix-or-feature
```

Now you can make your changes locally.

5. When you're done making changes, check that your changes pass flake8 and the tests, including testing other Python versions with tox:

```
$ flake8 inferno tests
$ python setup.py test or py.test
$ tox
```

To get flake8 and tox, just pip install them into your virtualenv.

6. Commit your changes and push your branch to GitHub:

```
$ git add .
$ git commit -m "Your detailed description of your changes."
$ git push origin name-of-your-bugfix-or-feature
```

7. Submit a pull request through the GitHub website.



## 6.3 Pull Request Guidelines

Before you submit a pull request, check that it meets these guidelines:

1. The pull request should include tests.
2. If the pull request adds functionality, the docs should be updated. Put your new functionality into a function with a docstring, and add the feature to the list in README.rst.
3. The pull request should work for Python 3.5 and 3.6. Check [https://travis-ci.org/nasimrahaman/inferno/pull\\_requests](https://travis-ci.org/nasimrahaman/inferno/pull_requests) and make sure that the tests pass for all supported Python versions.

## 6.4 Tips

To run a subset of tests:

```
$ python -m unittest tests.test_inferno
```



## 7.1 inferno package

### 7.1.1 Subpackages

#### 7.1.1.1 inferno.extensions package

##### Subpackages

##### inferno.extensions.containers package

##### Submodules

##### inferno.extensions.containers.graph module

```
class inferno.extensions.containers.graph.NNGraph (data=None, **attr)
```

```
    Bases: networkx.classes.digraph.DiGraph
```

```
    A NetworkX DiGraph, except that node and edge ordering matters.
```

```
    ATTRIBUTES_TO_NOT_COPY = {'payload'}
```

```
    adjlist_dict_factory  
        alias of OrderedDict
```

```
    copy (**init_kwargs)
```

```
    node_dict_factory  
        alias of OrderedDict
```

```
class inferno.extensions.containers.graph.Graph (graph=None)
```

```
    Bases: torch.nn.modules.module.Module
```

A graph structure to build networks with complex architectures. The resulting graph model can be used like any other `torch.nn.Module`. The graph structure used behind the scenes is a `networkx.DiGraph`. This internal graph is exposed by the `apply_on_graph` method, which can be used with any NetworkX function (e.g. for plotting with matplotlib or GraphViz).

## Examples

The naive inception module (without the max-pooling for simplicity) with ELU-layers of 64 units can be built as following, (assuming 64 input channels):

```
>>> from inferno.extensions.layers.reshape import Concatenate
>>> from inferno.extensions.layers.convolutional import ConvELU2D
>>> import torch
>>> from torch.autograd import Variable
>>> # Build the model
>>> inception_module = Graph()
>>> inception_module.add_input_node('input')
>>> inception_module.add_node('conv1x1', ConvELU2D(64, 64, 3), previous='input')
>>> inception_module.add_node('conv3x3', ConvELU2D(64, 64, 3), previous='input')
>>> inception_module.add_node('conv5x5', ConvELU2D(64, 64, 3), previous='input')
>>> inception_module.add_node('cat', Concatenate(),
>>>                             previous=['conv1x1', 'conv3x3', 'conv5x5'])
>>> inception_module.add_output_node('output', 'cat')
>>> # Build dummy variable
>>> input = Variable(torch.rand(1, 64, 100, 100))
>>> # Get output
>>> output = inception_module(input)
```

### `add_edge` (*from\_node*, *to\_node*)

Add an edge between two nodes.

#### Parameters

- **from\_node** (*str*) – Name of the source node.
- **to\_node** (*str*) – Name of the target node.

**Returns** self

**Return type** *Graph*

**Raises** `AssertionError` – if either of the two nodes is not in the graph, or if the edge is not ‘legal’.

### `add_input_node` (*name*)

Add an input to the graph. The order in which input nodes are added is the order in which the forward method accepts its inputs.

**Parameters** **name** (*str*) – Name of the input node.

**Returns** self

**Return type** *Graph*

### `add_node` (*name*, *module*, *previous=None*)

Add a node to the graph.

#### Parameters

- **name** (*str*) – Name of the node. Nodes are identified by their names.
- **module** (*torch.nn.Module*) – Torch module for this node.

- **previous** (*str or list of str*) – (List of) name(s) of the previous node(s).

**Returns** self

**Return type** *Graph*

**add\_output\_node** (*name, previous=None*)

Add an output to the graph. The order in which output nodes are added is the order in which the forward method returns its outputs.

**Parameters** **name** (*str*) – Name of the output node.

**Returns** self

**Return type** *Graph*

**apply\_on\_graph** (*function, \*args, \*\*kwargs*)

Applies a *function* on the internal graph.

**assert\_graph\_is\_valid** ()

Asserts that the graph is valid.

**clear\_payloads** (*graph=None*)

**forward** (*\*inputs*)

**forward\_through\_node** (*name, input=None*)

**get\_module\_for\_nodes** (*names*)

Gets the *torch.nn.Module* object for nodes corresponding to *names*.

**Parameters** **names** (*str or list of str*) – Names of the nodes to fetch the modules of.

**Returns** Module or a list of modules corresponding to *names*.

**Return type** list or *torch.nn.Module*

**get\_parameters\_for\_nodes** (*names, named=False*)

Get parameters of all nodes listed in *names*.

**graph**

**graph\_is\_valid**

Checks if the graph is valid.

**input\_nodes**

Gets a list of input nodes. The order is relevant and is the same as that in which the forward method accepts its inputs.

**Returns** A list of names (*str*) of the input nodes.

**Return type** list

**is\_node\_in\_graph** (*name*)

Checks whether a node is in the graph.

**Parameters** **name** (*str*) – Name of the node.

**Returns**

**Return type** bool

**is\_sink\_node** (*name*)

Checks whether a given node (by name) is a sink node. A sink node has no outgoing edges.

**Parameters** **name** (*str*) – Name of the node.

**Returns**

**Return type** bool

**Raises** `AssertionError` – if node is not found in the graph.

**is\_source\_node** (*name*)

Checks whether a given node (by name) is a source node. A source node has no incoming edges.

**Parameters** **name** (*str*) – Name of the node.

**Returns**

**Return type** bool

**Raises** `AssertionError` – if node is not found in the graph.

**output\_nodes**

Gets a list of output nodes. The order is relevant and is the same as that in which the forward method returns its outputs.

**Returns** A list of names (*str*) of the output nodes.

**Return type** list

**to\_device** (*names, target\_device, device\_ordinal=None, async=False*)

Transfer nodes in the network to a specified device.

## inferno.extensions.containers.sequential module

**class** inferno.extensions.containers.sequential.**Sequential1** (*\*args*)

Bases: `torch.nn.modules.container.Sequential`

Like `torch.nn.Sequential`, but with a few extra methods.

**class** inferno.extensions.containers.sequential.**Sequential2** (*\*args*)

Bases: `inferno.extensions.containers.sequential.Sequential1`

Another sequential container. Identical to `torch.nn.Sequential`, except that modules may return multiple outputs and accept multiple inputs.

**forward** (*\*input*)

## Module contents

### inferno.extensions.criteria package

#### Submodules

### inferno.extensions.criteria.core module

**class** inferno.extensions.criteria.core.**Criteria** (*\*criteria*)

Bases: `torch.nn.modules.module.Module`

Aggregate multiple criteria to one.

**forward** (*prediction, target*)

**class** inferno.extensions.criteria.core.**As2DCriterion** (*criterion*)

Bases: `torch.nn.modules.module.Module`

Makes a given criterion applicable on (N, C, H, W) prediction and (N, H, W) target tensors, if they're applicable to (N, C) prediction and (N,) target tensors .

**forward** (*prediction, target*)

## inferno.extensions.criteria.set\_similarity\_measures module

```
class inferno.extensions.criteria.set_similarity_measures.SorensenDiceLoss (weight=None,
                                                                    chan-
                                                                    nel-
                                                                    wise=True,
                                                                    eps=1e-
                                                                    06)
```

Bases: torch.nn.modules.module.Module

Computes a loss scalar, which when minimized maximizes the Sorensen-Dice similarity between the input and the target. For both inputs and targets it must be the case that *input\_or\_target.size(1) = num\_channels*.

**forward** (*input, target*)

## Module contents

### inferno.extensions.initializers package

#### Submodules

### inferno.extensions.initializers.base module

```
class inferno.extensions.initializers.base.Initializer
```

Bases: object

Base class for all initializers.

```
VALID_LAYERS = {'Conv2d', 'Conv1d', 'ConvTranspose1d', 'Conv3d', 'Linear', 'Embedding'
```

```
call_on_bias (tensor)
```

```
call_on_tensor (tensor)
```

```
call_on_weight (tensor)
```

```
classmethod initializes_bias ()
```

```
classmethod initializes_weight ()
```

```
class inferno.extensions.initializers.base.Initialization (weight_initializer=None,
                                                            bias_initializer=None)
```

Bases: *inferno.extensions.initializers.base.Initializer*

```
call_on_bias (tensor)
```

```
call_on_weight (tensor)
```

```
class inferno.extensions.initializers.base.WeightInitFunction (init_function,
                                                                *init_function_args,
                                                                **init_function_kwargs)
```

Bases: *inferno.extensions.initializers.base.Initializer*

```
call_on_weight (tensor)
```

```
class inferno.extensions.initializers.base.BiasInitFunction (init_function,
                                                         *init_function_args,
                                                         **init_function_kwargs)
```

Bases: *inferno.extensions.initializers.base.Initializer*

**call\_on\_bias** (*tensor*)

```
class inferno.extensions.initializers.base.TensorInitFunction (init_function,
                                                                *init_function_args,
                                                                **init_function_kwargs)
```

Bases: *inferno.extensions.initializers.base.Initializer*

**call\_on\_tensor** (*tensor*)

## inferno.extensions.initializers.presets module

```
class inferno.extensions.initializers.presets.Constant (constant)
```

Bases: *inferno.extensions.initializers.base.Initializer*

Initialize with a constant.

**call\_on\_tensor** (*tensor*)

```
class inferno.extensions.initializers.presets.NormalWeights (mean=0.0,
                                                             stddev=1.0,
                                                             sqrt_gain_over_fan_in=None)
```

Bases: *inferno.extensions.initializers.base.Initializer*

Initialize weights with random numbers drawn from the normal distribution at *mean* and *stddev*.

**call\_on\_weight** (*tensor*)

**compute\_fan\_in** (*tensor*)

```
class inferno.extensions.initializers.presets.SELUWeightsZeroBias
```

Bases: *inferno.extensions.initializers.base.Initialization*

```
class inferno.extensions.initializers.presets.ELUWeightsZeroBias
```

Bases: *inferno.extensions.initializers.base.Initialization*

```
class inferno.extensions.initializers.presets.OrthogonalWeightsZeroBias (orthogonal_gain=1.0)
```

Bases: *inferno.extensions.initializers.base.Initialization*

```
class inferno.extensions.initializers.presets.KaimingNormalWeightsZeroBias (relu_leakage=0)
```

Bases: *inferno.extensions.initializers.base.Initialization*

## Module contents

### inferno.extensions.layers package

#### Submodules

### inferno.extensions.layers.activations module

```
class inferno.extensions.layers.activations.SELU
```

Bases: *torch.nn.modules.module.Module*

**forward** (*input*)



`static selu(x)`

## inferno.extensions.layers.convolutional module

**class** inferno.extensions.layers.convolutional.**ConvActivation**(*in\_channels*,  
*out\_channels*, *kernel\_size*, *dim*, *activation*, *stride=1*,  
*dilation=1*,  
*groups=None*,  
*depthwise=False*,  
*bias=True*, *deconv=False*, *initialization=None*)

Bases: torch.nn.modules.module.Module

Convolutional layer with ‘SAME’ padding followed by an activation.

**forward**(*input*)

**get\_padding**(*kernel\_size*, *dilation*)

**class** inferno.extensions.layers.convolutional.**ConvELU2D**(*in\_channels*, *out\_channels*,  
*kernel\_size*)

Bases: *inferno.extensions.layers.convolutional.ConvActivation*

2D Convolutional layer with ‘SAME’ padding, ELU and orthogonal weight initialization.

**class** inferno.extensions.layers.convolutional.**ConvELU3D**(*in\_channels*, *out\_channels*,  
*kernel\_size*)

Bases: *inferno.extensions.layers.convolutional.ConvActivation*

3D Convolutional layer with ‘SAME’ padding, ELU and orthogonal weight initialization.

**class** inferno.extensions.layers.convolutional.**ConvSigmoid2D**(*in\_channels*,  
*out\_channels*,  
*kernel\_size*)

Bases: *inferno.extensions.layers.convolutional.ConvActivation*

2D Convolutional layer with ‘SAME’ padding, Sigmoid and orthogonal weight initialization.

**class** inferno.extensions.layers.convolutional.**ConvSigmoid3D**(*in\_channels*,  
*out\_channels*,  
*kernel\_size*)

Bases: *inferno.extensions.layers.convolutional.ConvActivation*

3D Convolutional layer with ‘SAME’ padding, Sigmoid and orthogonal weight initialization.

**class** inferno.extensions.layers.convolutional.**DeconvELU2D**(*in\_channels*,  
*out\_channels*, *kernel\_size=2*)

Bases: *inferno.extensions.layers.convolutional.ConvActivation*

2D deconvolutional layer with ELU and orthogonal weight initialization.

**class** inferno.extensions.layers.convolutional.**DeconvELU3D**(*in\_channels*,  
*out\_channels*, *kernel\_size=2*)

Bases: *inferno.extensions.layers.convolutional.ConvActivation*

3D deconvolutional layer with ELU and orthogonal weight initialization.

```
class inferno.extensions.layers.convolutional.StridedConvELU2D (in_channels,
                                                                out_channels,
                                                                kernel_size,
                                                                stride=2)
```

Bases: *inferno.extensions.layers.convolutional.ConvActivation*

2D strided convolutional layer with ‘SAME’ padding, ELU and orthogonal weight initialization.

```
class inferno.extensions.layers.convolutional.StridedConvELU3D (in_channels,
                                                                out_channels,
                                                                kernel_size,
                                                                stride=2)
```

Bases: *inferno.extensions.layers.convolutional.ConvActivation*

2D strided convolutional layer with ‘SAME’ padding, ELU and orthogonal weight initialization.

```
class inferno.extensions.layers.convolutional.DilatedConvELU2D (in_channels,
                                                                out_channels,
                                                                kernel_size,
                                                                dilation=2)
```

Bases: *inferno.extensions.layers.convolutional.ConvActivation*

2D dilated convolutional layer with ‘SAME’ padding, ELU and orthogonal weight initialization.

```
class inferno.extensions.layers.convolutional.DilatedConvELU3D (in_channels,
                                                                out_channels,
                                                                kernel_size,
                                                                dilation=2)
```

Bases: *inferno.extensions.layers.convolutional.ConvActivation*

3D dilated convolutional layer with ‘SAME’ padding, ELU and orthogonal weight initialization.

```
class inferno.extensions.layers.convolutional.Conv2D (in_channels, out_channels, kernel_size, dilation=1, activation=None)
```

Bases: *inferno.extensions.layers.convolutional.ConvActivation*

2D convolutional layer with same padding and orthogonal weight initialization. By default, this layer does not apply an activation function.

```
class inferno.extensions.layers.convolutional.Conv3D (in_channels, out_channels, kernel_size, dilation=1, activation=None)
```

Bases: *inferno.extensions.layers.convolutional.ConvActivation*

3D convolutional layer with same padding and orthogonal weight initialization. By default, this layer does not apply an activation function.

```
class inferno.extensions.layers.convolutional.BNReLUConv2D (in_channels,
                                                            out_channels, kernel_size)
```

Bases: *inferno.extensions.layers.convolutional.ConvActivation*

2D BN-ReLU-Conv layer with ‘SAME’ padding and He weight initialization.

**forward** (*input*)

```
class inferno.extensions.layers.convolutional.BNReLUConv3D (in_channels,
                                                            out_channels, kernel_size)
```

Bases: *inferno.extensions.layers.convolutional.ConvActivation*

3D BN-ReLU-Conv layer with ‘SAME’ padding and He weight initialization.

**forward** (*input*)

```

class inferno.extensions.layers.convolutional.BNReLUDepthwiseConv2D (in_channels,
                                                                    out_channels,
                                                                    ker-
                                                                    nel_size)

    Bases: inferno.extensions.layers.convolutional.ConvActivation

    2D BN-ReLU-Conv layer with ‘SAME’ padding, He weight initialization and depthwise convolution. Note that
    depthwise convolutions require in_channels == out_channels.

    forward (input)

class inferno.extensions.layers.convolutional.ConvSELU2D (in_channels,
                                                            out_channels,      ker-
                                                            nel_size)

    Bases: inferno.extensions.layers.convolutional.ConvActivation

    2D Convolutional layer with SELU activation and the appropriate weight initialization.

class inferno.extensions.layers.convolutional.ConvSELU3D (in_channels,
                                                            out_channels,      ker-
                                                            nel_size)

    Bases: inferno.extensions.layers.convolutional.ConvActivation

    3D Convolutional layer with SELU activation and the appropriate weight initialization.

```

### inferno.extensions.layers.device module

```

class inferno.extensions.layers.device.DeviceTransfer (target_device,      de-
                                                         vice_ordinal=None,
                                                         async=False)

    Bases: torch.nn.modules.module.Module

    Layer to transfer variables to a specified device.

    forward (*inputs)

class inferno.extensions.layers.device.OnDevice (module,      target_device,      de-
                                                         vice_ordinal=None, async=False)

    Bases: torch.nn.modules.module.Module

    Moves a module to a device. The advantage of using this over torch.nn.Module.cuda is that the inputs are
    transferred to the same device as the module, enabling easy model parallelism.

    forward (*inputs)

    transfer_module (module)

```

### inferno.extensions.layers.reshape module

```

class inferno.extensions.layers.reshape.View (as_shape)
    Bases: torch.nn.modules.module.Module

    forward (input)

    validate_as_shape (as_shape)

class inferno.extensions.layers.reshape.AsMatrix
    Bases: inferno.extensions.layers.reshape.View

class inferno.extensions.layers.reshape.Flatten
    Bases: inferno.extensions.layers.reshape.View

```

```

class inferno.extensions.layers.reshape.As3D (channel_as_z=False,
                                             num_channels_or_num_z_slices=1)
    Bases: torch.nn.modules.module.Module

    forward (input)

class inferno.extensions.layers.reshape.As2D (z_as_channel=True)
    Bases: torch.nn.modules.module.Module

    forward (input)

class inferno.extensions.layers.reshape.Concatenate (dim=1)
    Bases: torch.nn.modules.module.Module

    Concatenate input tensors along a specified dimension.

    forward (*inputs)

class inferno.extensions.layers.reshape.Cat (dim=1)
    Bases: inferno.extensions.layers.reshape.Concatenate

    An alias for Concatenate. Hey, everyone knows who Cat is.

class inferno.extensions.layers.reshape.ResizeAndConcatenate (target_size,
                                                             pool_mode='average')
    Bases: torch.nn.modules.module.Module

    Resize input tensors spatially (to a specified target size) before concatenating them along the channel dimension.
    The downsampling mode can be specified ('average' or 'max'), but the upsampling is always 'nearest'.

    POOL_MODE_MAPPING = {'avg': 'avg', 'max': 'max', 'average': 'avg', 'mean': 'avg'}

    forward (*inputs)

class inferno.extensions.layers.reshape.PoolCat (target_size, pool_mode='average')
    Bases: inferno.extensions.layers.reshape.ResizeAndConcatenate

    Alias for ResizeAndConcatenate, just to annoy snarky web developers.

class inferno.extensions.layers.reshape.Sum
    Bases: torch.nn.modules.module.Module

    Sum all inputs.

    forward (*inputs)

class inferno.extensions.layers.reshape.SplitChannels (channel_index)
    Bases: torch.nn.modules.module.Module

    Split input at a given index along the channel axis.

    forward (input)

```

## Module contents

### inferno.extensions.metrics package

#### Submodules

#### inferno.extensions.metrics.arand module

**class** inferno.extensions.metrics.arand.**ArandError**  
 Bases: *inferno.extensions.metrics.arand.ArandScore*  
 Arand Error = 1 - <arand score>  
**forward** (*prediction, target*)

**class** inferno.extensions.metrics.arand.**ArandScore**  
 Bases: *inferno.extensions.metrics.base.Metric*  
 Arand Score, as defined in [1].

#### References

[1]: <http://journal.frontiersin.org/article/10.3389/fnana.2015.00142/full#h3>

**forward** (*prediction, target*)

inferno.extensions.metrics.arand.**adapted\_rand** (*seg, gt*)

**Compute Adapted Rand error as defined by the SNEMI3D contest [1]** Formula is given as 1 - the maximal F-score of the Rand index (excluding the zero component of the original labels). Adapted from the SNEMI3D MATLAB script, hence the strange style.

**seg** [np.ndarray] the segmentation to score, where each value is the label at that point

**gt** [np.ndarray, same shape as seg] the groundtruth to score against, where each value is a label

**are** [float] The adapted Rand error; equal to  $1 -$

$\frac{2pr}{p+r}$ ,

where  $p$  and  $r$  are the precision and recall described below.

**prec** [float, optional] The adapted Rand precision.

**rec** [float, optional] The adapted Rand recall.

[1]: <http://brainiac2.mit.edu/SNEMI3D/evaluation>

#### inferno.extensions.metrics.base module

**class** inferno.extensions.metrics.base.**Metric**  
 Bases: object  
**forward** (*\*args, \*\*kwargs*)

## inferno.extensions.metrics.categorical module

**class** inferno.extensions.metrics.categorical.**CategoricalError** (*aggregation\_mode='mean'*)  
 Bases: *inferno.extensions.metrics.base.Metric*

Categorical error.

**forward** (*prediction, target*)

**class** inferno.extensions.metrics.categorical.**IOU** (*ignore\_class=None, sharpen\_prediction=False, eps=1e-06*)  
 Bases: *inferno.extensions.metrics.base.Metric*

Intersection over Union.

**forward** (*prediction, target*)

**class** inferno.extensions.metrics.categorical.**NegativeIOU** (*ignore\_class=None, sharpen\_prediction=False, eps=1e-06*)  
 Bases: *inferno.extensions.metrics.categorical.IOU*

**forward** (*prediction, target*)

## Module contents

### inferno.extensions.optimizers package

#### Submodules

### inferno.extensions.optimizers.adam module

**class** inferno.extensions.optimizers.adam.**Adam** (*params, lr=0.001, betas=(0.9, 0.999), eps=1e-08, lambda\_l1=0, weight\_decay=0, \*\*kwargs*)

Bases: *torch.optim.optimizer.Optimizer*

Implements Adam algorithm with the option of adding a L1 penalty.

It has been proposed in [Adam: A Method for Stochastic Optimization](#).

#### Parameters

- **params** (*iterable*) – iterable of parameters to optimize or dicts defining parameter groups
- **lr** (*float, optional*) – learning rate (default: 1e-3)
- **betas** (*Tuple[float, float], optional*) – coefficients used for computing running averages of gradient and its square (default: (0.9, 0.999))
- **eps** (*float, optional*) – term added to the denominator to improve numerical stability (default: 1e-8)
- **weight\_decay** (*float, optional*) – weight decay (L2 penalty) (default: 0)

**step** (*closure=None*)

Performs a single optimization step.

**Parameters** `closure` (*callable, optional*) – A closure that reevaluates the model and returns the loss.

### inferno.extensions.optimizers.annealed\_adam module

```
class inferno.extensions.optimizers.annealed_adam.AnnealedAdam(params,
                                                             lr=0.001,
                                                             betas=(0.9,
                                                             0.999),
                                                             eps=1e-08,
                                                             lambda_l1=0,
                                                             weight_decay=0,
                                                             lr_decay=1.0)
```

Bases: `inferno.extensions.optimizers.adam.Adam`

Implements Adam algorithm with learning rate annealing and optional L1 penalty.

It has been proposed in [Adam: A Method for Stochastic Optimization](#).

#### Parameters

- **params** (*iterable*) – iterable of parameters to optimize or dicts defining parameter groups
- **lr** (*float, optional*) – learning rate (default: 1e-3)
- **betas** (*Tuple[float, float], optional*) – coefficients used for computing running averages of gradient and its square (default: (0.9, 0.999))
- **eps** (*float, optional*) – term added to the denominator to improve numerical stability (default: 1e-8)
- **lambda\_l1** (*float, optional*) – L1 penalty (default: 0)
- **weight\_decay** (*float, optional*) – L2 penalty (weight decay) (default: 0)
- **lr\_decay** (*float, optional*) – decay learning rate by this factor after every step (default: 1.)

**step** (*closure=None*)

Performs a single optimization step.

**Parameters** `closure` (*callable, optional*) – A closure that reevaluates the model and returns the loss.

## Module contents

## Module contents

### 7.1.1.2 inferno.io package

#### Subpackages

#### inferno.io.box package

#### Submodules

#### inferno.io.box.camvid module

```
class inferno.io.box.camvid.CamVid(root, split='train', image_transform=None, label_transform=None, joint_transform=None, download=False, loader=<function default_loader>)
    Bases: torch.utils.data.dataset.Dataset
    CLASSES = ['Sky', 'Building', 'Column-Pole', 'Road', 'Sidewalk', 'Tree', 'Sign-Symbol']
    CLASS_WEIGHTS = [0.58872014284134, 0.51052379608154, 2.6966278553009, 0.45021694898605]
    MEAN = [0.41189489566336, 0.4251328133025, 0.4326707089857]
    SPLIT_NAME_MAPPING = {'train': 'train', 'validate': 'val', 'test': 'test', 'validation': 'val'}
    STD = [0.27413549931506, 0.28506257482912, 0.28284674400252]
    download()

inferno.io.box.camvid.get_camvid_loaders(root_directory, image_shape=(360, 480), labels_as_onehot=False, train_batch_size=1, validate_batch_size=1, test_batch_size=1, num_workers=2)

inferno.io.box.camvid.label_to_long_tensor(pic)
inferno.io.box.camvid.label_to_pil_image(label)
inferno.io.box.camvid.make_dataset(dir)
```

#### inferno.io.box.cifar module

```
inferno.io.box.cifar.get_cifar100_loaders(root_directory, train_batch_size=128, test_batch_size=100, download=False, augment=False, validation_dataset_size=None)

inferno.io.box.cifar.get_cifar10_loaders(root_directory, train_batch_size=128, test_batch_size=256, download=False, augment=False, validation_dataset_size=None)
```



## inferno.io.box.cityscapes module

```
class inferno.io.box.cityscapes.Cityscapes (root_folder, split='train',
                                             read_from_zip_archive=True, image_transform=None, label_transform=None,
                                             joint_transform=None)
```

Bases: torch.utils.data.dataset.Dataset

```
BLACKLIST = ['leftImg8bit/train_extra/troisdorf/troisdorf_000000_000073_leftImg8bit.png']
```

```
CLASSES = {0: 'unlabeled', 1: 'ego vehicle', 2: 'rectification border', 3: 'out of image'}
MEAN = [0.28689554, 0.32513303, 0.28389177]
```

```
SPLIT_NAME_MAPPING = {'train': 'train', 'validate': 'val', 'test': 'test', 'validation': 'val'}
```

```
STD = [0.18696375, 0.19017339, 0.18720214]
```

```
download()
```

```
get_image_and_label_roots()
```

```
inferno.io.box.cityscapes.extract_image (path, image_path)
```

```
inferno.io.box.cityscapes.get_cityscapes_loaders (root_directory, image_shape=(1024, 2048), labels_as_onehot=False,
                                                    include_coarse_dataset=False, read_from_zip_archive=True,
                                                    train_batch_size=1, validate_batch_size=1, num_workers=2)
```

```
inferno.io.box.cityscapes.get_filelist (path)
inferno.io.box.cityscapes.get_matching_labelimage_file (f, groundtruth)
inferno.io.box.cityscapes.make_dataset (path, split)
inferno.io.box.cityscapes.make_transforms (image_shape, labels_as_onehot)
```

```
inferno.io.box.cityscapes.get_filelist (path)
```

```
inferno.io.box.cityscapes.get_matching_labelimage_file (f, groundtruth)
```

```
inferno.io.box.cityscapes.make_dataset (path, split)
```

```
inferno.io.box.cityscapes.make_transforms (image_shape, labels_as_onehot)
```

## Module contents

Things that work out of the box. ;)

## inferno.io.core package

### Submodules

#### inferno.io.core.base module

```
class inferno.io.core.base.IndexSpec (index=None, base_sequence_at_index=None)
    Bases: object
```

Class to wrap any extra index information a *Dataset* object might want to send back. This could be useful in (say) inference, where we would wish to (asynchronously) know more about the current input.

```
class inferno.io.core.base.SyncableDataset
    Bases: torch.utils.data.dataset.Dataset
```

`sync_with (dataset)`

### inferno.io.core.concatenate module

`class inferno.io.core.concatenate.Concatenate (*datasets, transforms=None)`

Bases: `torch.utils.data.dataset.Dataset`

Concatenates multiple datasets to one. This class does not implement synchronization primitives.

`map_index (index)`

### inferno.io.core.data\_utils module

`inferno.io.core.data_utils.defines_base_sequence (dataset)`

`inferno.io.core.data_utils.implements_sync_primitives (dataset)`

### inferno.io.core.zip module

`class inferno.io.core.zip.Zip (*datasets, sync=False, transforms=None)`

Bases: `inferno.io.core.base.SyncableDataset`

Zip two or more datasets to one dataset. If the datasets implement synchronization primitives, they are all synchronized with the first dataset.

`sync_datasets ()`

`sync_with (dataset)`

`class inferno.io.core.zip.ZipReject (*datasets, sync=False, transforms=None, rejection_dataset_indices, rejection_criterion)`

Bases: `inferno.io.core.zip.Zip`

Extends `Zip` by the functionality of rejecting samples that don't fulfill a specified rejection criterion.

`fetch_from_rejection_datasets (index)`

## Module contents

### inferno.io.transform package

#### Submodules

### inferno.io.transform.base module

`class inferno.io.transform.base.Compose (*transforms)`

Bases: `object`

Composes multiple callables (including but not limited to `Transform` objects).

`add (transform)`

`remove (name)`

`class inferno.io.transform.base.DTypeMapping`

Bases: `object`

```
DTYPE_MAPPING = {'int64': 'int64', 'half': 'float16', 'byte': 'uint8', 'uint8': 'u
```

```
class inferno.io.transform.base.Transform(apply_to=None)
```

Bases: object

Base class for a Transform. The argument *apply\_to* (list) specifies the indices of the tensors this transform will be applied to.

The following methods are recognized (in order of descending priority):

- *batch\_function*: Applies to all tensors in a batch simultaneously
- *tensor\_function*: Applies to just `__one__` tensor at a time.
- *volume\_function*: For 3D volumes, applies to just `__one__` volume at a time.
- *image\_function*: For 2D or 3D volumes, applies to just `__one__` image at a time.

For example, if both *volume\_function* and *image\_function* are defined, this means that only the former will be called. If the inputs are therefore not 5D batch-tensors of 3D volumes, a *NotImplementedError* is raised.

```
build_random_variables(**kwargs)
```

```
clear_random_variables()
```

```
get_random_variable(key, default=None, build=True, **random_variable_building_kwargs)
```

```
set_random_variable(key, value)
```

## inferno.io.transform.generic module

```
class inferno.io.transform.generic.AsTorchBatch(dimensionality,
                                                add_channel_axis_if_necessary=True,
                                                **super_kwargs)
```

Bases: *inferno.io.transform.base.Transform*

Converts a given numpy array to a torch batch tensor.

The result is a torch tensor `__without__` the leading batch axis. For example, if the input is an image of shape  $(100, 100)$ , the output is a batch of shape  $(1, 100, 100)$ . The collate function will add the leading batch axis to obtain a tensor of shape  $(N, 1, 100, 100)$ , where  $N$  is the batch-size.

```
tensor_function(tensor)
```

```
class inferno.io.transform.generic.Cast(dtype='float', **super_kwargs)
```

Bases: *inferno.io.transform.base.Transform*, *inferno.io.transform.base.DTypeMapping*

Casts inputs to a specified datatype.

```
tensor_function(tensor)
```

```
class inferno.io.transform.generic.Label2OneHot(num_classes, dtype='float', **super_kwargs)
```

Bases: *inferno.io.transform.base.Transform*, *inferno.io.transform.base.DTypeMapping*

Convert integer labels to one-hot vectors for arbitrary dimensional data.

```
tensor_function(tensor)
```

```
class inferno.io.transform.generic.Normalize(eps=0.0001, mean=None, std=None, **super_kwargs)
```

Bases: *inferno.io.transform.base.Transform*

Normalizes input to zero mean unit variance.

**tensor\_function** (*tensor*)

**class** inferno.io.transform.generic.**NormalizeRange** (*normalize\_by=255.0,* *\*\*super\_kwargs*)

Bases: *inferno.io.transform.base.Transform*

Normalizes input by a constant.

**tensor\_function** (*tensor*)

**class** inferno.io.transform.generic.**Project** (*projection,* *\*\*super\_kwargs*)

Bases: *inferno.io.transform.base.Transform*

Given a projection mapping (i.e. a dict) and an input tensor, this transform replaces all values in the tensor that equal a key in the mapping with the value corresponding to the key.

**tensor\_function** (*tensor*)

### inferno.io.transform.image module

**class** inferno.io.transform.image.**AdditiveGaussianNoise** (*sigma,* *\*\*super\_kwargs*)

Bases: *inferno.io.transform.base.Transform*

Add gaussian noise to the input.

**build\_random\_variables** (*\*\*kwargs*)

**image\_function** (*image*)

**class** inferno.io.transform.image.**BinaryDilation** (*num\_iterations=1,* *morphology\_kwargs=None,* *\*\*super\_kwargs*)

Bases: *inferno.io.transform.image.BinaryMorphology*

Apply a binary dilation operation on an image.

**class** inferno.io.transform.image.**BinaryErosion** (*num\_iterations=1,* *morphology\_kwargs=None,* *\*\*super\_kwargs*)

Bases: *inferno.io.transform.image.BinaryMorphology*

Apply a binary erosion operation on an image.

**class** inferno.io.transform.image.**BinaryMorphology** (*mode,* *num\_iterations=1,* *morphology\_kwargs=None,* *\*\*super\_kwargs*)

Bases: *inferno.io.transform.base.Transform*

Apply a binary morphology operation on an image. Supported operations are dilation and erosion.

**image\_function** (*image*)

**class** inferno.io.transform.image.**CenterCrop** (*size,* *\*\*super\_kwargs*)

Bases: *inferno.io.transform.base.Transform*

Crop patch of size *size* from the center of the image

**image\_function** (*image*)

**class** inferno.io.transform.image.**ElasticTransform** (*alpha,* *sigma,* *order=1,* *invert=False,* *\*\*super\_kwargs*)

Bases: *inferno.io.transform.base.Transform*

Random Elastic Transformation.

```
NATIVE_DTYPES = {'float64', 'float32'}
```

```
PREFERRED_DTYPE = 'float32'
```

```
build_random_variables (**kwargs)
```

```
cast (image)
```

```
image_function (image)
```

```
uncast (image)
```

```
class inferno.io.transform.image.PILImage2NumPyArray (apply_to=None)
```

Bases: *inferno.io.transform.base.Transform*

Convert a PIL Image object to a numpy array.

For images with multiple channels (say RGB), the channel axis is moved to front. Therefore, a (100, 100, 3) RGB image becomes an array of shape (3, 100, 100).

```
tensor_function (tensor)
```

```
class inferno.io.transform.image.RandomCrop (output_image_shape, **super_kwargs)
```

Bases: *inferno.io.transform.base.Transform*

Crop input to a given size.

This is similar to `torchvision.transforms.RandomCrop`, except that it operates on numpy arrays instead of PIL images. If you do have a PIL image and wish to use this transform, consider applying *PILImage2NumPyArray* first.

**Warning:** If *output\_image\_shape* is larger than the image itself, the image is not cropped (along the relevant dimensions).

```
build_random_variables (height_leeway, width_leeway)
```

```
clear_random_variables ()
```

```
image_function (image)
```

```
class inferno.io.transform.image.RandomFlip (allow_lr_flips=True, allow_ud_flips=True,
                                             **super_kwargs)
```

Bases: *inferno.io.transform.base.Transform*

Random left-right or up-down flips.

```
build_random_variables (**kwargs)
```

```
image_function (image)
```

```
class inferno.io.transform.image.RandomGammaCorrection (gamma_between=(0.5, 2.0),
                                                         gain=1, **super_kwargs)
```

Bases: *inferno.io.transform.base.Transform*

Applies gamma correction [1] with a random gamma.

This transform uses *skimage.exposure.adjust\_gamma*, which requires the input be positive.

## References

[1] [https://en.wikipedia.org/wiki/Gamma\\_correction](https://en.wikipedia.org/wiki/Gamma_correction)

```
build_random_variables ()
```

`image_function (image)`

**class** `inferno.io.transform.image.RandomRotate (**super_kwargs)`

Bases: `inferno.io.transform.base.Transform`

Random 90-degree rotations.

`build_random_variables (**kwargs)`

`image_function (image)`

**class** `inferno.io.transform.image.RandomSizedCrop (ratio_between=None, height_ratio_between=None, width_ratio_between=None, pre-serve_aspect_ratio=False, relative_target_aspect_ratio=None, **super_kwargs)`

Bases: `inferno.io.transform.base.Transform`

Extract a randomly sized crop from the image.

The ratio of the sizes of the cropped and the original image can be limited within specified bounds along both axes. To resize back to a constant sized image, compose with *Scale*.

`build_random_variables (image_shape)`

`image_function (image)`

**class** `inferno.io.transform.image.RandomTranspose (**super_kwargs)`

Bases: `inferno.io.transform.base.Transform`

Random 2d transpose.

`build_random_variables (**kwargs)`

`image_function (image)`

**class** `inferno.io.transform.image.Scale (output_image_shape, interpolation_order=3, zoom_kwargs=None, **super_kwargs)`

Bases: `inferno.io.transform.base.Transform`

Scales an image to a given size with spline interpolation of requested order.

Unlike `torchvision.transforms.Scale`, this does not depend on PIL and therefore works with numpy arrays. If you do have a PIL image and wish to use this transform, consider applying *PILImage2NumPyArray* first.

**Warning:** This transform uses `scipy.ndimage.zoom` and requires `scipy >= 0.13.0` to work correctly.

`image_function (image)`

## inferno.io.transform.volume module

**class** `inferno.io.transform.volume.CentralSlice (apply_to=None)`

Bases: `inferno.io.transform.base.Transform`

`volume_function (volume)`

**class** `inferno.io.transform.volume.RandomFlip3D (**super_kwargs)`

Bases: `inferno.io.transform.base.Transform`

`build_random_variables (**kwargs)`

**volume\_function** (*volume*)

**class** inferno.io.transform.volume.**VolumeAsymmetricCrop** (*crop\_left*, *crop\_right*, **\*\*super\_kwargs**)

Bases: *inferno.io.transform.base.Transform*

Crop *crop\_left* from the left borders and *crop\_right* from the right borders

**volume\_function** (*volume*)

**class** inferno.io.transform.volume.**VolumeCenterCrop** (*size*, **\*\*super\_kwargs**)

Bases: *inferno.io.transform.base.Transform*

Crop patch of size *size* from the center of the volume

**volume\_function** (*volume*)

## Module contents

### inferno.io.volumetric package

#### Submodules

#### inferno.io.volumetric.volume module

**class** inferno.io.volumetric.volume.**HDF5VolumeLoader** (*path*, *path\_in\_h5\_dataset=None*,  
*data\_slice=None*, *transforms=None*, *name=None*,  
**\*\*slicing\_config**)

Bases: *inferno.io.volumetric.volume.VolumeLoader*

**class** inferno.io.volumetric.volume.**TIFVolumeLoader** (*path*, *data\_slice=None*, *transforms=None*,  
*name=None*, **\*\*slicing\_config**)

Bases: *inferno.io.volumetric.volume.VolumeLoader*

Loader for volumes stored in .tif files.

**class** inferno.io.volumetric.volume.**VolumeLoader** (*volume*, *window\_size*, *stride*, *down-sampling\_ratio=None*,  
*padding=None*, *padding\_mode='reflect'*, *transforms=None*, *return\_index\_spec=False*,  
*name=None*)

Bases: *inferno.io.core.base.SyncableDataset*

**clone** (*volume=None*, *transforms=None*, *name=None*)

**make\_sliding\_windows** ()

**pad\_volume** (*padding=None*)

#### inferno.io.volumetric.volumetric\_utils module

inferno.io.volumetric.volumetric\_utils.**parse\_data\_slice** (*data\_slice*)

Parse a dataslice as a list of slice objects.

```
inferno.io.volumetric.volumetric_utils.slidingwindowslices (shape, window_size,
                                                             strides, ds=1,
                                                             shuffle=True,
                                                             rngseed=None,
                                                             dataslice=None,
                                                             add_overhanging=True)
```

```
inferno.io.volumetric.volumetric_utils.slidingwindowslices_depr (shape, nhood-
                                                                    size, stride=1,
                                                                    ds=1, win-
                                                                    dow=None,
                                                                    ignorebor-
                                                                    der=True,
                                                                    shuffle=True,
                                                                    rngseed=None,
                                                                    start-
                                                                    mins=None,
                                                                    start-
                                                                    maxs=None,
                                                                    dataslice=None)
```

Returns a generator yielding (shuffled) sliding window slice objects. :type shape: int or list of int :param shape: Shape of the input data :type nhoodsize: int or list of int :param nhoodsize: Window size of the sliding window. :type stride: int or list of int :param stride: Stride of the sliding window. :type shuffle: bool :param shuffle: Whether to shuffle the iterator.

## Module contents

## Module contents

### 7.1.1.3 inferno.trainers package

#### Subpackages

#### inferno.trainers.callbacks package

#### Subpackages

#### inferno.trainers.callbacks.logging package

#### Submodules

#### inferno.trainers.callbacks.logging.base module

**class** inferno.trainers.callbacks.logging.base.**Logger** (*log\_directory=None*)

Bases: *inferno.trainers.callbacks.base.Callback*

A special callback for logging.

Loggers are special because they're required to be serializable, whereas other callbacks have no such guarantees. In this regard, they jointly handled by trainers and the callback engine.

**log\_directory**



`set_log_directory` (*log\_directory*)

## inferno.trainers.callbacks.logging.tensorboard module

**class** inferno.trainers.callbacks.logging.tensorboard.**TensorboardLogger** (*log\_directory=None, log\_scalars\_every=None, log\_images\_every=None, send\_image\_at\_batch\_indices=None, send\_image\_at\_channel\_indices=None, send\_volume\_at\_z\_indices=None*)

Bases: *inferno.trainers.callbacks.logging.base.Logger*

Class to enable logging of training progress to Tensorboard.

Currently supports logging scalars and images.

**end\_of\_training\_iteration** (\*\*\_)

**end\_of\_validation\_run** (\*\*\_)

**extract\_images\_from\_batch** (*batch*)

**get\_config** ()

**log\_histogram** (*tag, values, step, bins=1000*)

Logs the histogram of a list/vector of values.

**log\_image\_or\_volume\_batch** (*tag, batch, step=None*)

**log\_images** (*tag, images, step*)

Logs a list of images.

**log\_images\_every**

**log\_images\_now**

**log\_object** (*tag, object\_, allow\_scalar\_logging=True, allow\_image\_logging=True*)

**log\_scalar** (*tag, value, step*)

**tag** [basestring] Name of the scalar

**value** step : int

training iteration

**log\_scalars\_every**

**log\_scalars\_now**

**observe\_state** (*key, observe\_while='training'*)

**observe\_states** (*keys, observe\_while='training'*)

**writer**

## Module contents

inferno.trainers.callbacks.logging.**get\_logger** (*name*)

## Submodules

### inferno.trainers.callbacks.base module

**class** inferno.trainers.callbacks.base.Callback

Bases: object

Recommended (but not required) base class for callbacks.

**bind\_trainer** (*trainer*)

**debug\_print** (*message*)

**get\_config** ()

**classmethod** **get\_instances** ()

**classmethod** **register\_instance** (*instance*)

**set\_config** (*config\_dict*)

**toggle\_debug** ()

**trainer**

**unbind\_trainer** ()

**class** inferno.trainers.callbacks.base.CallbackEngine

Bases: object

Gathers and manages callbacks.

Callbacks are callables which are to be called by trainers when certain events ('triggers') occur. They could be any callable object, but if endowed with a *bind\_trainer* method, it's called when the callback is registered. It is recommended that callbacks (or their *\_\_call\_\_* methods) use the double-star syntax for keyword arguments.

**BEGIN\_OF\_EPOCH** = 'begin\_of\_epoch'

**BEGIN\_OF\_FIT** = 'begin\_of\_fit'

**BEGIN\_OF\_SAVE** = 'begin\_of\_save'

**BEGIN\_OF\_TRAINING\_ITERATION** = 'begin\_of\_training\_iteration'

**BEGIN\_OF\_TRAINING\_RUN** = 'begin\_of\_training\_run'

**BEGIN\_OF\_VALIDATION\_ITERATION** = 'begin\_of\_validation\_iteration'

**BEGIN\_OF\_VALIDATION\_RUN** = 'begin\_of\_validation\_run'

**END\_OF\_EPOCH** = 'end\_of\_epoch'

**END\_OF\_FIT** = 'end\_of\_fit'

**END\_OF\_SAVE** = 'end\_of\_save'

**END\_OF\_TRAINING\_ITERATION** = 'end\_of\_training\_iteration'

**END\_OF\_TRAINING\_RUN** = 'end\_of\_training\_run'

**END\_OF\_VALIDATION\_ITERATION** = 'end\_of\_validation\_iteration'

**END\_OF\_VALIDATION\_RUN** = 'end\_of\_validation\_run'

**TRIGGERS** = {'begin\_of\_epoch', 'end\_of\_validation\_run', 'end\_of\_validation\_iteration',

**bind\_trainer** (*trainer*)

```

call(trigger, **kwargs)
get_config()
rebind_trainer_to_all_callbacks()
register_callback(callback, trigger='auto', bind_trainer=True)
register_new_trigger(trigger_name)
set_config(config_dict)
trainer_is_bound
unbind_trainer()

```

## inferno.trainers.callbacks.essentials module

```

class inferno.trainers.callbacks.essentials.DumpHDF5Every(frequency,
                                                         to_directory, file-
                                                         name_template='dump.{mode}.epoch{epoch_co
                                                         force_dump=False,
                                                         dump_after_every_validation_run=False)

```

Bases: *inferno.trainers.callbacks.base.Callback*

Dumps intermediate training states to a HDF5 file.

```

add_to_dump_cache(key, value)
clear_dump_cache()
dump(mode)
dump_every
dump_now
dump_state(key, dump_while='training')
dump_states(keys, dump_while='training')
end_of_training_iteration(**_)
end_of_validation_run(**_)
get_file_path(mode)

```

```

class inferno.trainers.callbacks.essentials.NaNDetector

```

Bases: *inferno.trainers.callbacks.base.Callback*

```

end_of_training_iteration(**_)

```

```

class inferno.trainers.callbacks.essentials.ParameterEMA(momentum)

```

Bases: *inferno.trainers.callbacks.base.Callback*

Maintain a moving average of network parameters.

```

apply()
end_of_training_iteration(**_)
maintain()

```

```

class inferno.trainers.callbacks.essentials.PersistentSave(template='checkpoint.pytorch.epoch{epoch_co

```

Bases: *inferno.trainers.callbacks.base.Callback*

```

begin_of_save(**kwargs)

```

`end_of_save` (*save\_to\_directory*, \*\*\_)

**class** `inferno.trainers.callbacks.essentials.SaveAtBestValidationScore` (*smoothness=0*,  
*ver-*  
*bose=False*)

Bases: `inferno.trainers.callbacks.base.Callback`

Triggers a save at the best EMA (exponential moving average) validation score. The basic *Trainer* has built in support for saving at the best validation score, but this callback might eventually replace that functionality.

`end_of_validation_run` (\*\*\_)

## inferno.trainers.callbacks.scheduling module

**class** `inferno.trainers.callbacks.scheduling.AutoLR` (*factor*, *patience*, *re-*  
*quired\_minimum\_relative\_improvement=0*,  
*con-*  
*sider\_improvement\_with\_respect\_to='best'*,  
*cooldown\_duration=None*,  
*monitor='auto'*, *moni-*  
*tor\_momentum=0*, *mon-*  
*itor\_while='auto'*, *ex-*  
*clude\_param\_groups=None*,  
*verbose=False*)

Bases: `inferno.trainers.callbacks.scheduling._Scheduler`

Callback to decay or hike the learning rate automatically when a specified monitor stops improving.

The monitor should be decreasing, i.e. lower value -> better performance.

`cooldown_duration`

`decay` ()

`duration_since_last_decay`

`duration_since_last_improvement`

`end_of_training_iteration` (\*\*\_)

`end_of_validation_run` (\*\*\_)

`in_cooldown`

**static** `is_significantly_less_than` (*x*, *y*, *min\_relative\_delta*)

`maintain_monitor_moving_average` ()

`monitor_value_has_significantly_improved`

`out_of_patience`

`patience`

```
class inferno.trainers.callbacks.scheduling.AutoLRDecay (factor, patience, re-
    quired_minimum_relative_improvement=0, con-
    sider_improvement_with_respect_to='best',
    cooldown_duration=None,
    monitor='auto', monitor_momentum=0,
    monitor_while='auto', ex-
    clude_param_groups=None,
    verbose=False)
```

Bases: *inferno.trainers.callbacks.scheduling.AutoLR*

Callback to decay the learning rate automatically when a specified monitor stops improving.

The monitor should be decreasing, i.e. lower value -> better performance.

```
class inferno.trainers.callbacks.scheduling.DecaySpec (duration, factor)
```

Bases: object

A class to specify when to decay (or hike) LR and by what factor.

```
classmethod build_from (args)
```

```
match (iteration_count=None, epoch_count=None, when_equal_return=True)
```

```
new ()
```

```
class inferno.trainers.callbacks.scheduling.ManualLR (decay_specs,
    exclude_param_groups=None)
```

Bases: *inferno.trainers.callbacks.base.Callback*

```
decay (factor)
```

```
end_of_training_iteration (**_)
```

```
match ()
```

## Module contents

### Submodules

#### inferno.trainers.basic module

```
class inferno.trainers.basic.Trainer (model=None)
```

Bases: object

A basic trainer.

Given a torch model, this class encapsulates the training and validation loops, checkpoint creation, logging, CPU <-> GPU transfers and managing data-loaders.

In addition, this class interacts with the callback engine (found at *inferno.trainers.callbacks.base.CallbackEngine*), which manages callbacks at certain preset events.

### Notes

Logging is implemented as a special callback, in the sense that it's jointly managed by the this class and the callback engine. This is primarily because general callbacks are not intended to be serializable, but not being able to serialize the logger is a nuisance.

`DYNAMIC_STATES = {'learning_rate': 'current_learning_rate'}`

`INF_STRINGS = {'infty', 'infinity', 'inf'}`

`apply_model(*inputs)`

`apply_model_and_loss(inputs, target, backward=True)`

`bind_loader(name, loader, num_inputs=None, num_targets=1)`

Bind a data loader to the trainer.

**Parameters**

- **name** (`{'train', 'validate', 'test'}`) – Name of the loader, i.e. what it should be used for.
- **loader** (`torch.utils.data.DataLoader`) – DataLoader object.
- **num\_inputs** (`int`) – Number of input tensors from the *loader*.
- **num\_targets** (`int`) – Number of target tensors from the *loader*.

**Returns** `self`

**Return type** *Trainer*

**Raises**

- `KeyError` – if name is invalid.
- `TypeError` – if loader is not a `DataLoader` instance.

`bind_model(model)`

Binds a model to the trainer. Equivalent to setting model.

**Parameters** `model` (`torch.nn.Module`) – Model to bind.

**Returns** `self`.

**Return type** *Trainer*

`classmethod build(model=None, **trainer_config)`

Factory function to build the trainer.

`build_criterion(method, **kwargs)`

Builds the loss criterion for training.

**Parameters**

- **method** (`str` or `callable` or `torch.nn.Module`) – Name of the criterion when str, criterion class when callable, or a `torch.nn.Module` instance. If a name is provided, this method looks for the criterion in `torch.nn`.
- **kwargs** (`dict`) – Keyword arguments to the criterion class' constructor if applicable.

**Returns** `self`.

**Return type** *Trainer*

**Raises**

- `AssertionError` – if criterion is not found.
- `NotImplementedError` – if method is neither a str nor a callable.

`build_logger(logger=None, log_directory=None, **kwargs)`

Build the logger.

**Parameters**

- **logger** (*inferno.trainers.callbacks.logging.base.Logger or str or type*) – Must either be a Logger object or the name of a logger or the class of a logger.
- **log\_directory** (*str*) – Path to the directory where the log files are to be stored.
- **kwargs** (*dict*) – Keyword arguments to the logger class.

**Returns** self

**Return type** *Trainer*

**build\_metric** (*method, \*\*kwargs*)

Builds the metric for evaluation.

**Parameters**

- **method** (*callable or str*) – Name of the metric when string, metric class or a callable object when callable. If a name is provided, this method looks for the metric in *inferno.extensions.metrics*.
- **kwargs** (*dict*) – Keyword arguments to the metric class’ constructor, if applicable.

**Returns** self.

**Return type** *Trainer*

**Raises** AssertionError: if the metric is not found.

**build\_optimizer** (*method, param\_groups=None, \*\*kwargs*)

Builds the optimizer for training.

**Parameters**

- **method** (*str or callable or torch.optim.Optimizer*) – Name of the optimizer when str, handle to the optimizer class when callable, or a torch.optim.Optimizer instance. If a name is provided, this method looks for the optimizer in *torch.optim* module first and in *inferno.extensions.optimizers* second.
- **param\_groups** (*list of dict*) – Specifies the parameter group. Defaults to *model.parameters()* if None.
- **kwargs** (*dict*) – Keyword arguments to the optimizer.

**Returns** self.

**Return type** *Trainer*

**Raises**

- AssertionError – if optimizer is not found
- NotImplementedError – if method is not str or callable.

**callbacks**

Gets the callback engine.

**cast** (*objects*)

**cpu** ()

Train on the CPU.

**Returns** self

**Return type** *Trainer*

**criterion**

Gets the loss criterion.

**criterion\_is\_defined**

**cuda** (*devices=None, base\_device=None*)

Train on the GPU.

**Parameters**

- **devices** (*list*) – Specify the ordinals of the devices to use for dataparallel training.
- **base\_device** (*{'cpu', 'cuda'}*) – When using data-parallel training, specify where the result tensors are collected. If 'cuda', the results are collected in *devices[0]*.

**Returns** self

**Return type** *Trainer*

**current\_learning\_rate**

**dtype**

**epoch\_count**

**evaluate\_metric\_every** (*frequency*)

Set frequency of metric evaluation **\_\_during training\_\_** (and not during validation).

**Parameters** **frequency** (*inferno.utils.train\_utils.Frequency or str or tuple or list or int*) – Metric evaluation frequency. If str, it could be (say) '10 iterations' or '1 epoch'. If tuple (or list), it could be (10, 'iterations') or (1, 'epoch'). If int (say 10), it's interpreted as (10, 'iterations').

**Returns** self

**Return type** *Trainer*

**evaluate\_metric\_now**

**evaluating\_metric\_every**

**fetch\_next\_batch** (*from\_loader='train', restart\_exhausted\_generators=True, update\_batch\_count=True, update\_epoch\_count\_if\_generator\_exhausted=True*)

**fit** (*max\_num\_iterations=None, max\_num\_epochs=None*)

Fit model.

**Parameters**

- **max\_num\_iterations** (*int or float or str*) – (Optional) Maximum number of training iterations. Overrides the value set by *Trainer.set\_max\_num\_iterations*. If float, it should equal numpy.inf. If str, it should be one of {'inf', 'infinity', 'infty'}.
- **max\_num\_epochs** (*int or float or str*) – (Optional) Maximum number of training epochs. Overrides the value set by *Trainer.set\_max\_num\_epochs*. If float, it should equal numpy.inf. If str, it should be one of {'inf', 'infinity', 'infty'}.

**Returns** self

**Return type** *Trainer*

**get\_config** (*exclude\_loader=True*)

**get\_current\_learning\_rate** ()

Gets the current learning rate. :returns: List of learning rates if there are multiple parameter groups, or a float



if there's just one.

**Return type** list or float

**get\_loader\_specs** (*name*)

**get\_state** (*key*, *default=None*)

**is\_cuda** ()

Returns whether using GPU for training.

**iteration\_count**

**load** (*from\_directory=None*, *best=False*, *filename=None*)

Load the trainer from checkpoint.

**Parameters**

- **from\_directory** (*str*) – Path to the directory where the checkpoint is located. The filename should be 'checkpoint.pytorch' if *best=False*, or 'best\_checkpoint.pytorch' if *best=True*.
- **best** (*bool*) – Whether to load the best checkpoint. The filename in *from\_directory* should be 'best\_checkpoint.pytorch'.
- **filename** (*str*) – Overrides the default filename.

**Returns** self

**Return type** *Trainer*

**load\_** (*\*args*, *\*\*kwargs*)

**load\_model** (*from\_directory=None*, *filename=None*)

**log\_directory**

Gets the log directory.

**logger**

Gets the logger.

**metric**

Gets the evaluation metric.

**metric\_is\_defined**

Checks if the metric is defined.

**model**

Gets the model.

**model\_is\_defined**

**next\_epoch** ()

**next\_iteration** ()

**optimizer**

Gets the optimizer.

**optimizer\_is\_defined**

**print** (*message*)

**record\_validation\_results** (*validation\_loss*, *validation\_error*)

**register\_callback** (*callback*, *trigger='auto'*, *\*\*callback\_kwargs*)

Registers a callback with the internal callback engine.

**Parameters**

- **callback** (*type or callable*) – Callback to register.
- **trigger** (*str*) – Specify the event that triggers the callback. Leave at 'auto' to have the callback-engine figure out the triggers. See *inferno.training.callbacks.base.CallbackEngine* documentation for more on this.
- **callback\_kwargs** (*dict*) – If *callback* is a type, initialize an instance with these keywords to the `__init__` method.

**Returns** self.

**Return type** *Trainer*

**restart\_generators** (*of\_loader=None*)

**save** (*exclude\_loader=True*, *stash\_best\_checkpoint=True*)

**save\_at\_best\_validation\_score** (*yes=True*)

Sets whether to save when the validation score is the best seen.

**save\_directory**

**save\_every** (*frequency*, *to\_directory=None*, *checkpoint\_filename=None*, *best\_checkpoint\_filename=None*)

Set checkpoint creation frequency.

**Parameters**

- **frequency** (*inferno.utils.train\_utils.Frequency or tuple or str*) – Checkpoint creation frequency. Examples: '100 iterations' or '1 epochs'.
- **to\_directory** (*str*) – Directory where the checkpoints are to be created.
- **checkpoint\_filename** (*str*) – Name of the checkpoint file.
- **best\_checkpoint\_filename** (*str*) – Name of the best checkpoint file.

**Returns** self.

**Return type** *Trainer*

**save\_model** (*to\_directory=None*)

**save\_now**

**save\_to\_directory** (*to\_directory=None*, *checkpoint\_filename=None*, *best\_checkpoint\_filename=None*)

**saving\_every**

Gets the frequency at which checkpoints are made.

**set\_config** (*config\_dict*)

**set\_log\_directory** (*log\_directory*)

Set the directory where the log files are to be stored.

**Parameters** **log\_directory** (*str*) – Directory where the log files are to be stored.

**Returns** self

**Return type** *Trainer*

**set\_max\_num\_epochs** (*max\_num\_epochs*)

Set the maximum number of training epochs.

**Parameters** **max\_num\_epochs** (*int or float or str*) – Maximum number of training epochs. If float, it should equal `numpy.inf`. If str, it should be one of {'inf', 'infinity', 'infy'}.

**Returns** self

**Return type** *Trainer*

**set\_max\_num\_iterations** (*max\_num\_iterations*)

Set the maximum number of training iterations.

**Parameters** **max\_num\_iterations** (*int or float or str*) – Maximum number of training iterations. If float, it should equal `numpy.inf`. If str, it should be one of {'inf', 'infinity', 'infy'}.

**Returns** self

**Return type** *Trainer*

**set\_precision** (*dtype*)

Set training precision.

**Parameters** **dtype** ({'double', 'float', 'half'}) – Training precision.

**Returns** self

**Return type** *Trainer*

**split\_batch** (*batch, from\_loader*)

**stop\_fitting** (*max\_num\_iterations=None, max\_num\_epochs=None*)

**to\_device** (*objects*)

**train\_for** (*num\_iterations=None, break\_callback=None*)

**train\_loader**

**update\_state** (*key, value*)

**update\_state\_from\_model\_state\_hooks** ()

**validate\_every** (*frequency, for\_num\_iterations=None*)

Set validation frequency.

**Parameters**

- **frequency** (*inferno.utils.train\_utils.Frequency or str or tuple or list or int*) – Validation frequency. If str, it could be (say) '10 iterations' or '1 epoch'. If tuple (or list), it could be (10, 'iterations') or (1, 'epoch'). If int (say 10), it's interpreted as (10, 'iterations').
- **for\_num\_iterations** (*int*) – Number of iterations to validate for. If not set, the model is validated on the entire dataset (i.e. till the data loader is exhausted).

**Returns** self

**Return type** *Trainer*

**validate\_for** (*num\_iterations=None, loader\_name='validate'*)

Validate for a given number of validation (if *num\_iterations* is not *None*) or over the entire (validation) data set.

**Parameters**

- **num\_iterations** (*int*) – Number of iterations to validate for. To validate on the entire dataset, leave this as *None*.
- **loader\_name** (*str*) – Name of the data loader to use for validation. ‘validate’ is the obvious default.

**Returns** self.

**Return type** *Trainer*

**validate\_loader**

**validate\_now**

**validating\_every**

**verify\_batch** (*batch, from\_loader*)

**wrap\_batch** (*batch, from\_loader=None, requires\_grad=False, volatile=False*)

## Module contents

### 7.1.1.4 inferno.utils package

#### Submodules

#### inferno.utils.exceptions module

Exceptions and Error Handling

**exception** inferno.utils.exceptions.**ClassNotFoundError**  
Bases: LookupError

**exception** inferno.utils.exceptions.**DTypeError**  
Bases: TypeError

**exception** inferno.utils.exceptions.**DeviceError**  
Bases: ValueError

**exception** inferno.utils.exceptions.**FrequencyTypeError**  
Bases: TypeError

**exception** inferno.utils.exceptions.**FrequencyValueError**  
Bases: ValueError

**exception** inferno.utils.exceptions.**NotSetError**  
Bases: ValueError

**exception** inferno.utils.exceptions.**NotTorchModuleError**  
Bases: TypeError

**exception** inferno.utils.exceptions.**NotUnwrappableError**  
Bases: NotImplementedError

**exception** inferno.utils.exceptions.**ShapeError**  
Bases: ValueError

inferno.utils.exceptions.**assert\_**(*condition, message=*”, *exception\_type=<class 'Assertion-*  
*Error'>*)

Like assert, but with arbitrary exception types.

## inferno.utils.io\_utils module

`inferno.utils.io_utils.fromh5` (*path*, *datapath=None*, *dataslice=None*, *asnumpy=True*, *pretrain=None*)

Opens a hdf5 file at *path*, loads in the dataset at *datapath*, and returns dataset as a numpy array.

`inferno.utils.io_utils.print_tensor` (*tensor*, *prefix*, *directory*)

Prints a image or volume tensor to file as images.

`inferno.utils.io_utils.toh5` (*data*, *path*, *datapath='data'*, *compression=None*, *chunks=None*)

Write *data* to a HDF5 volume.

`inferno.utils.io_utils.yaml2dict` (*path*)

## inferno.utils.model\_utils module

**class** `inferno.utils.model_utils.ModelTester` (*input\_shape*, *expected\_output\_shape*)

Bases: `object`

**cuda** ()

**get\_input** ()

`inferno.utils.model_utils.is_model_cuda` (*model*)

## inferno.utils.python\_utils module

Utility functions with no external dependencies.

`inferno.utils.python_utils.as_tuple_of_len` (*x*, *len\_*)

**class** `inferno.utils.python_utils.delayed_keyboard_interrupt`

Bases: `object`

Delays SIGINT over critical code. Borrowed from: <https://stackoverflow.com/questions/842557/how-to-prevent-a-block-of-code-from-being-interrupted-by-keyboardinterrupt-in-py>

**handler** (*sig*, *frame*)

`inferno.utils.python_utils.from_iterable` (*x*)

`inferno.utils.python_utils.get_config_for_name` (*config*, *name*)

`inferno.utils.python_utils.has_callable_attr` (*object\_*, *name*)

`inferno.utils.python_utils.is_listlike` (*x*)

`inferno.utils.python_utils.is_maybe_list_of` (*check\_function*)

`inferno.utils.python_utils.robust_len` (*x*)

`inferno.utils.python_utils.to_iterable` (*x*)

## inferno.utils.test\_utils module

`inferno.utils.test_utils.generate_random_data` (*num\_samples*, *shape*, *num\_classes*, *hardness=0.3*, *dtype=None*)

Generate a random dataset with a given hardness and number of classes.

`inferno.utils.test_utils.generate_random_dataloader` (*num\_samples*, *shape*,  
*num\_classes*, *hardness=0.3*,  
*dtype=None*, *batch\_size=1*,  
*shuffle=False*, *num\_workers=0*,  
*pin\_memory=False*)

Generate a loader with a random dataset of given hardness and number of classes.

`inferno.utils.test_utils.generate_random_dataset` (*num\_samples*, *shape*, *num\_classes*,  
*hardness=0.3*, *dtype=None*)

Generate a random dataset with a given hardness and number of classes.

## inferno.utils.torch\_utils module

`inferno.utils.torch_utils.assert_same_size` (*tensor\_1*, *tensor\_2*)

`inferno.utils.torch_utils.flatten_samples` (*tensor\_or\_variable*)

Flattens a tensor or a variable such that the channel axis is first and the sample axis is second. The shapes are transformed as follows:

$(N, C, H, W) \rightarrow (C, N * H * W)$   $(N, C, D, H, W) \rightarrow (C, N * D * H * W)$   $(N, C) \rightarrow (C, N)$

The input must be atleast 2d.

`inferno.utils.torch_utils.is_image_or_volume_tensor` (*object\_*)

`inferno.utils.torch_utils.is_image_tensor` (*object\_*)

`inferno.utils.torch_utils.is_label_image_or_volume_tensor` (*object\_*)

`inferno.utils.torch_utils.is_label_image_tensor` (*object\_*)

`inferno.utils.torch_utils.is_label_tensor` (*object\_*)

`inferno.utils.torch_utils.is_label_volume_tensor` (*object\_*)

`inferno.utils.torch_utils.is_matrix_tensor` (*object\_*)

`inferno.utils.torch_utils.is_scalar_tensor` (*object\_*)

`inferno.utils.torch_utils.is_tensor` (*object\_*)

`inferno.utils.torch_utils.is_volume_tensor` (*object\_*)

`inferno.utils.torch_utils.unwrap` (*tensor\_or\_variable*, *to\_cpu=True*, *as\_numpy=False*)

`inferno.utils.torch_utils.where` (*condition*, *if\_true*, *if\_false*)

Torch equivalent of `numpy.where`.

### Parameters

- **condition** (*torch.ByteTensor* or *torch.cuda.ByteTensor* or *torch.autograd.Variable*) – Condition to check.
- **if\_true** (*torch.Tensor* or *torch.cuda.Tensor* or *torch.autograd.Variable*) – Output value if condition is true.
- **if\_false** (*torch.Tensor* or *torch.cuda.Tensor* or *torch.autograd.Variable*) – Output value if condition is false

### Returns

**Return type** `torch.Tensor`

### Raises

- AssertionError – if `if_true` and `if_false` are not both variables or both tensors.
- AssertionError – if `if_true` and `if_false` don't have the same datatype.

## inferno.utils.train\_utils module

Utilities for training.

**class** inferno.utils.train\_utils.**AverageMeter**

Bases: object

Computes and stores the average and current value. Taken from <https://github.com/pytorch/examples/blob/master/imagenet/main.py>

**reset** ()

**update** (*val, n=1*)

**class** inferno.utils.train\_utils.**CLUI**

Bases: object

Command Line User Interface

**class** inferno.utils.train\_utils.**Duration** (*value=None, units=None*)

Bases: *inferno.utils.train\_utils.Frequency*

Like frequency, but measures a duration.

**compare** (*iteration\_count=None, epoch\_count=None*)

**match** (*iteration\_count=None, epoch\_count=None, when\_equal\_return=False, \*\*\_*)

**class** inferno.utils.train\_utils.**Frequency** (*value=None, units=None*)

Bases: object

**UNIT\_PRIORITY** = 'iterations'

**VALID\_UNIT\_NAME\_MAPPING** = {'iterations': 'iterations', 'iteration': 'iterations', 'e'

**assert\_units\_consistent** (*units=None*)

**assert\_value\_consistent** (*value=None*)

**classmethod build\_from** (*args, priority='iterations'*)

**by\_epoch**

**by\_iteration**

**epoch** ()

**every** (*value*)

**classmethod from\_string** (*string*)

**is\_consistent**

**iteration** ()

**match** (*iteration\_count=None, epoch\_count=None, persistent=False, match\_zero=True*)

**units**

**value**

```
class inferno.utils.train_utils.MovingAverage (momentum=0)
```

Bases: object

Computes the moving average of a given float.

```
relative_change
```

```
reset ()
```

```
update (val)
```

```
class inferno.utils.train_utils.NoLogger (logdir=None)
```

Bases: object

```
log_value (*kwargs)
```

```
inferno.utils.train_utils.get_state (module, key, default=None)
```

Gets key from *module*'s state hooks.

```
inferno.utils.train_utils.set_state (module, key, value)
```

Writes *key-value* pair to *module*'s state hook.

## Module contents

### 7.1.2 Submodules

#### 7.1.3 inferno.inferno module

Main module.

#### 7.1.4 Module contents

Top-level package for inferno.



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### **9.1 0.1.0 (2017-08-24)**

- First early release on PyPI

### **9.2 0.1.1 (2017-08-24)**

- Version Increment

### **9.3 0.1.2 (2017-08-24)**

- Version Increment

### **9.4 0.1.3 (2017-08-24)**

- Updated Documentation

### **9.5 0.1.4 (2017-08-24)**

- travis auto-deployment on pypi

### **9.6 0.1.5 (2017-08-24)**

- travis changes to run unittest

## 9.7 0.1.6 (2017-08-24)

- travis missing packages for unittesting
- fixed inconsistent version numbers

## 9.8 0.1.7 (2017-08-25)

- setup.py critical bugfix in install procedure

## CHAPTER 10

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### Bibliography

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The bibliography:

Top-level package for inferno.



# CHAPTER 11

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