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# **pytorch-pfn-extras**

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**pytorch-pfn-extras** (PPE) is a collection of supplementary components to accelerate research and development in PyTorch.



## USER GUIDE

## 1.1 Trainer (technical preview)

### 1.1.1 Trainer and Evaluator

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**Note:** The Trainer/Evaluator APIs are currently under technical preview and may subject to change in the future versions.

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The Trainer and Evaluator provide the device-agnostic training framework for PyTorch. These APIs abstract the training process using different *runtimes*, *handlers*, and *logics*.

#### Concepts

- **Trainer** (`ppe.engine.create_trainer()`) abstracts the training loop, built on top of the `ExtensionsManager`.
- **Evaluator** (`ppe.engine.create_evaluator()`) abstracts the evaluation step and invoked from the Trainer (usually once in every epoch).
- **Runtime** (`ppe.runtime.BaseRuntime`) represents an environment used to execute models. Device-specific implementations will reside here. PPE provides the default Runtime that supports the PyTorch-native devices (`ppe.runtime.PyTorchRuntime`).
- **Handler** (`ppe.handler.Handler`) is a layer to support device-agnostic training. This is considered as a low-level API and in most cases users can just use the Handler provided by PPE.
- **Logic** (`ppe.handler.Logic`) is a set of callback functions that define the training logic (`optimizer.zero_grad()`, `forward`, `backward`, `optimizer.step()`). You can inherit the class and define your own training flow in case you need more complex training processes such as GAN.
- **Model** is a `torch.nn.Module` used for training and evaluation, whose inputs are dicts or keyword arguments and outputs of the `forward` pass is a dict.

Note that the default logic will perform `backward` in tensors returned by `model.forward` so you will need to perform the loss calculation inside the model itself.

## Trainer at a glance

```

import torch
import torch.nn.functional as F

import pytorch_pfn_extras as ppe

class MyModel(torch.nn.Module):
    def __init__(self):
        super().__init__()
        self.w = torch.nn.LazyLinear(1)

    def forward(self, *, x, target):
        y = self.w(x)
        loss = F.nll_loss(y, target)
        prefix = 'train' if self.training else 'val'
        ppe.reporting.report({f'{prefix}/loss': loss.item()})
        return {'loss': loss}

model = MyModel()
optim = torch.optim.SGD(model.parameters(), lr=0.01)

extensions = [
    ppe.training.extensions.LogReport(),
    ppe.training.extensions.ProgressBar(),
    ppe.training.extensions.PrintReport(
        ['epoch', 'iteration', 'train/loss', 'val/loss']),
]

device = 'cuda:0'  # or any other PyTorch devices ('cpu', etc.) or PPE runtime names
epochs = 10
trainer = ppe.engine.create_trainer(
    model,
    optim,
    epochs,
    evaluator=ppe.engine.create_evaluator(
        model,
        device=device,
        progress_bar=True,
    ),
    device=device,
    extensions=extensions,
)

# Move the model to the device. This is almost equivalent to
# `model.to(device)`, but supports PPE runtimes as well as the PyTorch's
# built-in devices.
ppe.to(model, device)

# Using dummy data to illustrate the minimal working example.
# Notice that dict keys match with the kwargs of the forward method.

```

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```

train_loader = torch.utils.data.DataLoader(
    [{'x': torch.rand(10, 64), 'target': torch.tensor([1])} for _ in range(1)],
    num_workers=8)
val_loader = torch.utils.data.DataLoader(
    [{'x': torch.rand(10, 64), 'target': torch.tensor([1])} for _ in range(1)],
    num_workers=8)

trainer.run(train_loader, val_loader)

```

## Snapshot

To obtain and save the trained model for later use you can use the *Snapshot* extension, or directly invoke *state\_dict* on the trainer itself.

## Handler

The `ppe.handler.Handler` object is used to help the trainer and evaluator objects in the *Logic* and *Runtime* manipulation. This class should ideally never be overridden by the user if the desired functionality can be achieved through subclassing `BaseLogic` or `BaseRuntime`.

The handler object's main responsibility is to inspect all the submodules of a module to obtain the runtimes they have associated, and then execute their callbacks accordingly. In addition, it drives the actual model execution by using the user provided Logic object and deals with asynchronous execution in runtimes that provide support for it.

## Runtime

By inheriting `ppe.runtime.BaseRuntime` and implementing your own runtime, you can use your non-standard devices with the training loop.

```

class MyRuntime(BaseRuntime):
    ...

# Register MyRuntime with device name "mydev"
ppe.runtime.runtime_registry.register('mydev', MyRuntime)

ppe.to(module_or_tensor, 'mydev')

```

See *Runtimes for Custom Devices* if you are interested in implementing your own runtime.

## 1.1.2 Logic for Custom Training and Evaluation

In the training and evaluation engines, `ppe.handler.BaseLogic` API is in charge of abstracting the algorithmic details of the training and evaluation loops.

Logic is an object that defines multiple callbacks used through the training and evaluation processes. With logic, we can implement training of complex models such as GANs.

Users wanting to define their own Logic for training can inherit from `ppe.handler.Logic` which implements the training and evaluation steps to train a single module.

Logic functions are not expected to be directly called by the user. They will be invoked by the Trainer and Evaluator engines.

### Default Logic (`ppe.handler.Logic`)

PPE provides a default logic that performs the forward/backward/optimizer loop for a single model. This logic allows using some torch features such as AMP autocast and GradScaler and performs the backward pass on the outputs specified by the config option `backward_outputs`.

### CodeBlock Logic (`ppe.handler.Logic`)

With the CodeBlock API, we provide a basic logic that uses it to perform the training of a single model. Similarly to the default logic AMP features are supported but by means of the Runtime. For more information check the codeblock documentation.

## 1.1.3 Runtimes for Custom Devices

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**Note:** This documentation is intended for those implementing the own device backend for PPE training framework. Most users can just skip this chapter.

---

The `ppe.runtime.BaseRuntime` API is in charge of abstracting the device details and performing the movement of data and modules to the corresponding device.

A runtime is an object that defines multiple callbacks used through the training, evaluation, and regular model calls. With runtimes, we can implement training in devices other than cpus or gpus with minimal changes to the user code.

Users wanting to override only a few callbacks can inherit from `ppe.runtime.PyTorchRuntime` which implements the basic functionality for cpu and gpu devices.

Runtimes must be registered by calling the `ppe.runtime.runtime_registry.register(device_name, runtime_class)` function for them to be discoverable.

### Use of `ppe.to` to transfer modules and batches to custom devices

If you have defined a new runtime for a custom device the `ppe.to` function allows moving a module or a tensor to the new device by invoking the `Runtime.move_tensor` and `Runtime.move_module` when needed.

The module will be tagged by adding a attribute named `_ppe_runtime` that holds the needed runtime. It is the responsibility of the user custom runtime to perform the actual movement to the device and apply all the transformations needed to a module so it can be correctly executed.

Usually, runtime writers will need to replace the given module forward function by a new one that performs the actual device execution.

```
class MyModule(torch.nn.Module):
    def __init__(self):
        super().__init__()
        self.layer = torch.nn.Linear(10, 10)

    def forward(x):
        return self.layer(x)

class MyMagicDeviceRuntime(ppe.runtime.BaseRuntime):
    def _device_forward(self, args):
        return run_batch_in_my_device(args)
```

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```

def move_module(self, module):
    # Registers a hook to initialize the module on the first batch
    # execution
    def hook(module, *args):
        module._ppe_runtime.initialize_module(module, args)

    self.hook = module.register_forward_pre_hook(hook)
    # Change the module forward to do the computation in the device
    module.forward = self._device_forward

def initialize_module(self, module, loader_or_batch, optimizer=None):
    create_the_module_in_my_device(module, loader_or_batch, optimizer)

# Register the runtime class
ppe.runtime.runtime_registry.register('my_device', MyMagicDeviceRuntime)

# Create a regular module
module = MyModule()
# Move the module to the device
ppe.to(module, device='my_device')

for x in my_dataloader:
    # The first iteration will create the module in the device
    # and the next ones will directly execute the module in the device instead
    # of executing the regular pytorch `forward` call.
    y = model(x)

```

Please note that this is an oversimplified description and that developing a runtime that is 100% compatible with PyTorch requires to wrap the substitute forward function with `torch.autograd.Function` among several other concerns such as `state_dict` manipulation to ensure correctness.

## Runtime Registry

When creating a new Runtime class for custom needs, they need to be registered in a global `runtime_registry` object as detailed above. This object is of the `_RuntimeRegistry` type and it maintains a map of strings and Runtime types. The keys are the devices passed to `ppe.to` and the types will be the type of the Runtime object that `ppe.to` will use to treat the module or tensor. Beware that users are not supposed to interact directly with this class, only with the `runtime_registry.register` to register new runtimes.

### 1.1.4 CodeBlocks for Abstracting Logic Steps

The `ppe.handler.CodeBlock` API provides a mean of abstracting the actions that are possible to be done in a model in a device agnostic way.

Currently there is support for two different actions using CodeBlock.

- **:function: `ppe.handler.update_parameters` <pytorch\_pfn\_extras.handler.update\_parameters>**  
takes a model, an optimizer and returns a CodeBlock object that performs the forward, backward and optimizer step at once.
- **:function: `ppe.handler.forward` <pytorch\_pfn\_extras.handler.forward>**

takes a model and returns a CodeBlock object that performs only the forward pass.

## Executing CodeBlocks

For executing CodeBlock objects we need to add an `:method:`ppe.runtime.BaseRuntime.execute`` `<pytorch_pfn_extras.runtime.BaseRuntime.execute>` to the corresponding Runtime class. This method takes a CodeBlock and uses the information in the object to execute the CodeBlock in the device. Note that the `:method:`ppe.runtime.PyTorchRuntime.execute`` `<pytorch_pfn_extras.runtime.PyTorchRuntime.execute>` method provides support for using PyTorch AMP with autocast or gradient scaling if needed.

Moreover, you can execute CodeBlock objects outside the training API.

```
ppe.to(model, "cuda:0")
cblock = ppe.handler.update_parameters(model, optimizer)
outs = cblock(input_batch)
```

The only requirement is that the associated model has been assigned a device using `ppe.to`.

## 1.2 Extensions

### 1.2.1 Extensions Manager

Extensions Manager provides an interface to extend your training loop, by integrating it into your manual training loop or Ignite.

#### Extensions

See the [API Reference](#) for the list of built-in extensions.

#### How to use

Create an ExtensionsManager object and then wrap the iteration of your training loop inside the manager. `run_iteration()` context manager.

An example follows:

```
import pytorch_pfn_extras as ppe
from pytorch_pfn_extras.training import extensions

import time
import math

max_epoch = 10
iters_per_epoch = 938

# manager.extend(...) also works
my_extensions = [extensions.LogReport(),
                  extensions.ProgressBar(),
                  extensions.PrintReport(['epoch', 'iteration', 'sin', 'cos'])]
```

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```

models = {}
optimizers = []
manager = ppe.training.ExtensionsManager(
    models, optimizers, max_epoch,
    extensions=my_extensions,
    iters_per_epoch=iters_per_epoch)

for epoch in range(max_epoch):
    for i in range(iters_per_epoch):
        with manager.run_iteration():
            ppe.reporting.report({
                'sin': math.sin(i * 2 * math.pi / iters_per_epoch),
                'cos': math.cos(i * 2 * math.pi / iters_per_epoch),
            })
            time.sleep(0.001)

```

In the examples folder there is a mnist using all the available extensions.

## Usage with Ignite

Ignite is supported by using the `IgniteExtensionsManager` with the trainer as the first argument.

The user needs to define an ignite event to report the appropriated metrics for the extensions to use them.

```

manager = ppe.training.IgniteExtensionsManager(
    trainer, models, optimizers, epochs,
    extensions=my_extensions)

@trainer.on(Events.ITERATION_COMPLETED)
def report_loss(engine):
    ppe.reporting.report({'train/loss': engine.state.output})

```

## Using Evaluators

### Regular PyTorch

In order to report the results of the evaluation so they can be accessed by other extensions, an `Evaluation` extension needs to be created with the argument `eval_func` set to a function that gets the current data and target batches as parameters and reports the needed metrics. [Example](#)

The test function looks has the following signature

```
def test(args, model, device, data, target):
```

and is invoked once per batch in the validation dataloader. It is important to report the current validation loss or accuracy in order to the log report to see it.

```

def test(args, model, device, data, target):
    ...
    # Final result will be average of averages of the same size
    test_loss += F.nll_loss(output, target, reduction='mean').item()

```

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```
ppe.reporting.report({'val/loss': test_loss})
pred = output.argmax(dim=1, keepdim=True)
correct += pred.eq(target.view_as(pred)).sum().item()
ppe.reporting.report({'val/acc': correct/len(data)})
```

## Ignite

Just use the `IgniteEvaluator` extension with the ignite created evaluator as the first parameter and you are ready to go. [Example](#) The metrics defined when creating the evaluator with `create_supervised_evaluator` will be automatically reported

```
create_supervised_evaluator(model, metrics={'acc': Accuracy(), 'loss': Loss(F.nll_loss)}
↪, device)
```

## Snapshots

It is possible to take snapshots by using the `snapshot` training extension just as in chainer.

Whenever the extension is triggered, it saves the status of the optimizer, model and extensions to the output folder in the same way as chainer. To load the snapshot and continue the training call `torch.load` and use the `ExtensionsManager.load_state_dict` [example](#) to resume the training. The snapshots can be used outside the `pytorch-pfn-extras` module just by accessing the models, or optimizers fields of the loaded state.

## Extensions execution order

The supported extensions honours the chainer priorities for execution. However, when using Ignite. Chainer extensions are executed after any user-defined ignite events. The idea is to use ignite events to report the metrics of the model, and after this, Chainer extensions will be executed in the chainer defined order.

If you want to execute an event-handler in between chainer extensions, create a Chainer-like extension and access the ignite engine on the `.engine` attribute of the manager object passed as a parameter when your extension is called.

### 1.2.2 Creating Extensions

It is possible to create an extension just by passing a function which receives the manager object as an argument to the manager extend call

```
def my_extension(manager):
    print('Epoch-Iteration: {}-{}'.format(manager.epoch, manager.iteration))

manager.extend(my_extension, trigger=(1, 'iteration'))
```

It is also possible to create extensions using the `ppe.training.extension.make_extension` decorator to add a specific trigger, default\_name, priority. In addition, initializer, finalizer and on\_error functions can be specified as well.

```
@ppe.training.extension.make_extension(finalizer=lambda: print('done'))
def my_extension(manager):
    print('Epoch-Iteration: {}-{}'.format(manager.epoch, manager.iteration))
```

Finally, it is possible to create an extension by subclassing the `ppe.training.extensions.Extension` class as shown below.

```
import pytorch_pfn_extras as ppe

class MyExtension(ppe.training.extension.Extension):
    def __init__(self, args):
        self.args = args

    def initialize(self, manager):
        """
        Automatically called before training. Optional.
        """
        pass

    def __call__(self, manager):
        """
        Called when the associated trigger is fired.
        """
        print('Epoch-Iteration: {}-{}'.format(manager.epoch, manager.iteration))

    def state_dict(self):
        """
        Used to serialize the state. Optional.
        """
        return {'args': self.args}

    def load_state_dict(self, state):
        """
        Used to deserialize the state. Optional.
        """
        self.args = state['args']
```

### 1.2.3 Reporting

`reporting.Reporter` is used to collect values that users want to watch. The reporter object holds a mapping from value names to the actually observed values. We call this mapping observations.

When a value is passed to the reporter, an object called observer can be optionally attached. In this case, the name of the observer is added as the prefix of the value name. The observer name should be registered beforehand.

```
import pytorch_pfn_extras as ppe

reporter = ppe.reporting.Reporter()
observer = object()
reporter.add_observer('my_observer', observer)
observation = {}

with reporter.scope(observation):
    reporter.report({'x': 1}, observer)

print(observation)
# outputs: {'my_observer/x': 1}
```

There is also a global API to add values:

```
import pytorch_pfn_extras as ppe

reporter = ppe.reporting.Reporter()
observer = object()
reporter.add_observer('my_observer', observer)

observation = {}
with reporter:
    with ppe.reporting.report_scope(observation):
        ppe.reporting.report({'x': 1}, observer)

print(observation)
# outputs: {'my_observer/x': 1}
```

The most important application of Reporter is to report observed values from different parts of the model in the training and validation procedures. ExtensionsManager objects hold their own Reporter object with the parameters of the target module registered as observers. report() can be used inside the modules to report the observed values (e.g., training loss, accuracy, activation statistics, etc.).

## 1.2.4 Distributed Snapshot

To take snapshots when using torch.distributed the only needed step is to provide the saver\_rank keyword argument to the regular snapshot extension.

```
# saver_rank is the MPI rank which will write the actual snapshot.
snapshot = extensions.snapshot(saver_rank=saver_rank)
```

To resume the training, snapshots are loaded in every worker by using the ExtensionsManager.load\_state\_dict method, or the extensions.snapshot autoload keyword argument.

## 1.3 Utilities

### 1.3.1 Lazy Modules

Lazy modules can automatically infer shapes of parameters based on the shape of the data given to the first forward invocation.

Following modules are provided:

- ppe.nn.LazyBatchNorm1d, ppe.nn.LazyBatchNorm2d, ppe.nn.LazyBatchNorm3d
  - Module that behaves as torch.nn.BatchNorm[123]d but num\_features can be set to None.
  - These modules are now included as a part of PyTorch 1.9 release (torch.nn.LazyBatchNormXd, pull-request).

The following modules are now considered deprecated as now included as a part of PyTorch 1.8 release:

- ppe.nn.LazyLinear
  - Module that behaves as torch.nn.Linear but in\_features can be set to None.
  - PyTorch-native implementation: (torch.nn.LazyLinear, pull-request)
- ppe.nn.LazyConv1d, ppe.nn.LazyConv2d, ppe.nn.LazyConv3d



- Module that behaves as `torch.nn.Conv[123]d` but `in_channels` can be set to `None`.
- PyTorch-native implementation: (`torch.nn.LazyConvXd`, `pull-request`)

Now that all lazy modules are merged to the upstream, we encourage you to migrate to PyTorch’s lazy modules. We will keep these implementations only for backward compatibility.

Note that you need to run a “dummy” forward to initialize lazy parameters. See the example below:

```
import torch
import torch.nn.functional as F

import pytorch_pfn_extras as ppe

class Net(torch.nn.Module):
    def __init__(self):
        super().__init__()
        self.conv1 = ppe.nn.LazyConv2d(None, 20, 5, 1)
        self.conv2 = ppe.nn.LazyConv2d(None, 50, 5, 1)
        self.fc1 = ppe.nn.LazyLinear(None, 500)
        self.fc2 = ppe.nn.LazyLinear(None, 10)

    def forward(self, x):
        x = F.relu(self.conv1(x))
        x = F.max_pool2d(x, 2, 2)
        x = F.relu(self.conv2(x))
        x = F.max_pool2d(x, 2, 2)
        x = x.flatten(start_dim=1)
        x = F.relu(self.fc1(x))
        x = self.fc2(x)
        return F.log_softmax(x, dim=1)

model = Net()

# Initialize lazy parameters.
dummy_input = ...
model(dummy_input)

# Pass parameters to the optimizer.
optimizer = torch.optim.SGD(
    model.parameters(), lr=args.lr, momentum=args.momentum)

# Run training loop.
# ...
```

You need to run a dummy forward before passing parameters to optimizers; otherwise optimizers cannot refer to lazily-initialized parameters. You will get a warning if you pass uninitialized lazy parameters to optimizers:

```
>>> model = ppe.nn.LazyLinear(None, 10)
>>> optimizer = torch.optim.SGD(model.parameters(), lr=0.1)
/.../pytorch-pfn-extras/pytorch_pfn_extras/nn/modules/lazy.py:127: UserWarning:
  Use of uninitialized lazy parameter in Optimizer has been detected.
  Maybe you forgot to run forward before passing `module.parameters()` to the
optimizer?
```

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- *Config*
  - *Basic*
  - *Substitution*
    - \* *Callable Substitution*
    - \* *Substitution by Path*
    - \* *Substitution by Attribute*
    - \* *Default Value by Path Substitution*
    - \* *Ignore Substitution*
    - \* *Lazy Evaluation*

### 1.3.2 Config

#### Basic

```
from pytorch_pfn_extras.config import Config
import yaml
pre_eval_config = yaml.load('''
foo:
  bar: 'bar_value'
  ls:
    - 'first'
    - key0: 'value0'
      key1: 'value1'
baz: 'baz_value'
''')
config = Config(pre_eval_config)
```

Accessing config values:

```
print(config['/foo/ls/0'])
# 'first'
print(config['/foo/ls/1/key0'])
# 'value0'
print(config['/foo/ls'])
# ['first', {'key0': 'value0', 'key1': 'value1'}]
print(config['/baz'])
# 'baz_value'
```

## Substitution

### Callable Substitution

You could replace a value as the return value of a callable.

- `types` is an additional input to `Config`. `types` is a mapping from a callable's name to the actual callable.
- A sub-dictionary containing the key `type` invokes callable substitution.

```
pre_eval_config = yaml.load('''
name:
  type: concat
  x0: 'First'
  x1: 'Last'
''')

types = {
  'concat': lambda x0, x1: x0 + ' ' + x1
}

config = Config(pre_eval_config, types)
# the value returned by
# concat(x0='First', x1='Last')
print(config['/name'])
# 'First Last'
```

### Nested

```
pre_eval_config = yaml.load('''
name:
  type: concat
  x0: 'First'
  x1:
    type: concat
    x0: 'Middle'
    x1: 'Last'
''')

types = {
  'concat': lambda x0, x1: x0 + ' ' + x1
}

config = Config(pre_eval_config, types)
print(config['/name'])
# First Middle Last
```

## Class

```
pre_eval_config = yaml.load('''
dataset:
  type: Dataset
  n_class: 10
''')

class Dataset(object):

    def __init__(self, n_class):
        self.n_class = n_class

types = {
    'Dataset': Dataset,
}

config = Config(pre_eval_config, types)
print(isinstance(config['/dataset'], Dataset))
# True
```

## Substitution by Path

### Absolute

@/absolute/path is replaced by the value at /absolute/path.

```
pre_eval_config = yaml.load('''
foo: 'FOO'
boo:
  baz: '@/foo'
''')
config = Config(pre_eval_config)
print(config['/boo/baz'])
# FOO
```

### Relative

Relative path is also possible using @relative/path.

```
pre_eval_config = yaml.load('''
foo: 'FOO'
boo:
  baz: '@../foo'
''')
config = Config(pre_eval_config)
print(config['/boo/baz'])
# FOO
```

## Substitution by Attribute

@/path/to/obj.attr\_name is replaced by:

1. Use substitution by path to get an object at /path/to/obj.
2. Replace the config value by getattr(obj, attr\_name), where obj is obtained at step 1.

```
pre_eval_config = yaml.load('''
dataset:
  type: Dataset
  n_class: 10
n_data: '@/dataset.n_data'
''')

class Dataset(object):

    def __init__(self, n_class):
        self.n_class = n_class
        self.n_data = 4

types = {
    'Dataset': Dataset,
}

config = Config(pre_eval_config, types)
print(config['/n_data'])
# 4
```

## Default Value by Path Substitution

customize\_type is a decorator that sets default argument values by path substitution.

```
from pytorch_pfn_extras.config import customize_type

pre_eval_config = yaml.load('''
dataset:
  type: Dataset
n_class: 5
''')

# If n_class is not passed, the value would be config['/n_class'].
# Both absolute and relative paths are allowed.
@customize_type(n_class='/n_class')
class Dataset(object):

    def __init__(self, n_class):
        self.n_class = n_class

types = {
    'Dataset': Dataset,
}
```

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```

config = Config(pre_eval_config, types)
print(config['/dataset'].n_class)
# 5

```

## Ignore Substitution

Access using `config['!/path']` instead of `config['/path']`.

```

pre_eval_config = yaml.load('''
name:
  type: concat
  x0: 'First'
  x1: 'Last'
''')

types = {
  'concat': lambda x0, x1: x0 + ' ' + x1
}

config = Config(pre_eval_config, types)
print(config['!/name'])
# {'type': 'concat', 'x0': 'First', 'x1': 'Last'}

```

## Lazy Evaluation

Callable substitution is lazily executed. This means that callables that are not dependent on the accessed value do not get executed.

```

pre_eval_config = yaml.load('''
foo:
  - type: f0
  - '@/bar'
bar:
  type: f1
baz:
  type: f2
''')

def f0():
    print('f0 called')
    return 'f0_return'

def f1():
    print('f1 called')
    return 'f1_return'

def f2():
    print('f2 called')
    return 'f2_return'

```

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```
types = {
    'f0': f0,
    'f1': f1,
    'f2': f2,
}

config = Config(pre_eval_config, types)
config['/foo'] # f2 does not get called
# f0 called
# f1 called
```

### 1.3.3 pytorch\_pfn\_extras.onnx

Extensions to `torch.onnx.export`.

#### Installation

```
pip3 install "pytorch-pfn-extras[onnx]"
```

Or

1. Install pytorch-pfn-extras normally
2. Install onnx with `pip install onnx==1.7.0`

#### API

##### `pytorch_pfn_extras.onnx.export_testcase`

Instead of specifying file name in `torch.onnx.export`, `pytorch_pfn_extra.onnx.export_testcase` specifies directory to output ONNX model and test case in/out.

```
import torch
import torch.nn as nn
model = nn.Sequential(nn.Linear(5, 10, bias=False))
x = torch.zeros((2, 5))

import pytorch_pfn_extras.onnx as tou
tou.export_testcase(model, x, '/path/to/output')
```

Directory structure with following will be generated to `/path/to/output`:

```
$ tree /path/to/output
/path/to/output
├── meta.json
├── model.onnx
└── test_data_set_0
    ├── input_0.pb
    └── output_0.pb
```

- This directory structure format is inspired by ONNX official test data set: (Example: [node](#)). PyTorch's ONNX tests use this format too. (Reference: [export\\_onnx\\_tests\\_generator.py](#))
  - There are scripts in [chainer-compiler/utlis](#) to run inference in major runtime with the directory structure. For example to inference with ONNXRuntime, run `$ python run_onnx_onnxruntime.py /path/to/output` to use `input_N.pb` as input and compare numerically with its output `output_N.pb` (N is the index of test case).
- By default `meta.json` is generated too to track git infos, date times, etc. Add `metadata=False` argument to suppress this.

### out\_grad option

If `out_grad=True` is specified gradient will be dumped too, which is useful for debugging backward. `gradient_N.pb` and `gradient_input_N.pb` would be dumped to test case directory with in/out data. `gradient_input_N.pb` is the initial value of backward, and it's default value is ones tensor with same shape of output. Use `out_grad` to specify custom initial value (`torch.Tensor` type) for it.

```
model = nn.Sequential(nn.Linear(5, 10, bias=False))
x = torch.zeros((2, 5))

import pytorch_pfn_extras.onnx as tou
tou.export_testcase(model, x, '/path/to/output', out_grad=True)
```

```
$ tree /path/to/output
/path/to/output
├── meta.json
├── model.onnx
└── test_data_set_0
    ├── gradient_0.pb
    ├── gradient_input_0.pb
    ├── input_0.pb
    └── output_0.pb
```

### model\_overwrite option

Use `model_overwrite` option to create multiple data set like following:

```
import pytorch_pfn_extras.onnx as tou
tou.export_testcase(model, x1, '/path/to/output')
tou.export_testcase(model, x2, '/path/to/output', model_overwrite=False)
```

Following is the generated test cases of the above. `test_data_set_0` is the input `x1` and is its output, `test_data_set_1` is the input `x2` and its output.

```
$ tree /path/to/output
├── meta.json
├── model.onnx
├── test_data_set_0
│   ├── input_0.pb
│   └── output_0.pb
└── test_data_set_1
```

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```
├─ input_0.pb
└─ output_0.pb
```

### strip\_large\_tensor\_data option

This option strips large tensor in dumped files which is useful to reduce file size in usage such as benchmarking. Not only model.onnx, in/out, gradient data would be affected too. `large_tensor_threshold` could be used to specify threshold of large tensor size.

```
import torchvision
model = torchvision.models.resnet50(pretrained=True)
x = torch.zeros((1, 3, 224, 224))

import pytorch_pfn_extras.onnx as tou
tou.export_testcase(model, x, '/path/to/output')
tou.export_testcase(model, x, '/path/to/output2', strip_large_tensor_data=True)
```

```
$ ls -lh /path/to/output/model.onnx
-rwxrwxrwx 1 user user 98M Jun 24 23:34 /path/to/output/model.onnx
$ ls -lh /path/to/output2/model.onnx
-rwxrwxrwx 1 user user 64K Jun 24 23:34 /path/to/output2/model.onnx
```

This feature could be called from CLI:

```
$ python -m pytorch_pfn_extras.onnx.strip_large_tensor resnet50.onnx --out_onnx_path_
↳ resnet50_slim.onnx
$ ls -lh
-rwxrwxrwx 1 user user 98M Jun 30 09:13 resnet50.onnx
-rwxrwxrwx 1 user user 64K Jun 30 09:16 resnet50_slim.onnx
```

See `$ python -m pytorch_pfn_extras.onnx.strip_large_tensor -h` for help

Notes:

If an ONNX runtime does not support no raw\_data tensor, `unstrip_tensor.py` will resolve. See `$ python -m pytorch_pfn_extras.onnx.unstrip_tensor -h` for help

### pytorch\_pfn\_extras.onnx.export

Function with same interface like `torch.onnx.export`. Unlike `torch.onnx.export`, you can use annotation feature (described below), `strip_large_tensor_data` options, or other `torch.onnx` extensions.

- `strip_large_tensor_data`: Same as `export_testcase`. Useful reducing file sizes.
- `return_output`: Returns output value of model execution. Note: Most output type would be `torch.Tensor`(not `onnx.TensorProto`)

```
model = nn.Sequential(nn.Linear(5, 10, bias=False))
x = torch.zeros((2, 5))

import io, onnx
bytesio = io.BytesIO()
```

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```
pytorch_pfn_extras.onnx.export(model, x, bytesio)
onnx_proto = onnx.load(io.BytesIO(bytesio.getvalue()))
```

## annotate

Feature to add custom ONNX attribute to specified `nn.Module`.

Notes:

- Annotated ONNX would be invalid ONNX format that doesn't pass check of `onnx.checker.check_model`.
- Only valid with `pytorch_pfn_extras.onnx.export_testcase` or `pytorch_pfn_extras.onnx.export`.
- **Only** the first ONNX node of modules like `nn.Linear`, `nn.GroupNorm`, etc. with multiple ONNX node would be annotated
  - For example `nn.Linear` with bias is split to `MatMul` -> `Add` graph. Only `MatMul` would be annotated. This is same in `apply_annotation` (described later) too.
- Use `apply_annotation` instead when the annotation target isn't `nn.Module`.

```
import pytorch_pfn_extras.onnx as tou

class Net(nn.Module):
    def __init__(self):
        super(Net, self).__init__()

        self.conv = nn.Conv2d(6, 9, 3)
        self.conv2 = nn.Conv2d(9, 12, 3)
        self.linear = nn.Linear(28, 20)
        self.linear2 = nn.Linear(20, 15)

    def forward(self, x):
        h = self.conv(x)
        with tou.annotate(key='value'):
            h = self.conv2(h)
            h = self.linear(h)
        h = self.linear2(h)
        return h

model = Net()
x = torch.randn((1, 6, 32, 32))
tou.export_testcase(model, x, '/path/to/output')
onnx_proto = onnx.load(os.path.join('/path/to/output', 'model.onnx'))
print(onnx.helper.printable_graph(onnx_proto.graph))
```

```
graph torch-jit-export (
  %input.1[FLOAT, 1x6x32x32]
) initializers (
  %17[FLOAT, 28x20]
  %18[FLOAT, 20x15]
  %conv.bias[FLOAT, 9]
```

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```

%conv.weight[FLOAT, 9x6x3x3]
%conv2.bias[FLOAT, 12]
%conv2.weight[FLOAT, 12x9x3x3]
%linear.bias[FLOAT, 20]
%linear2.bias[FLOAT, 15]
) {
    %9 = Conv[dilations = [1, 1], group = 1, kernel_shape = [3, 3], pads = [0, 0, 0, 0],
    ↪ strides = [1, 1]](%input.1, %conv.weight, %conv.bias)
    %10 = Conv[dilations = [1, 1], group = 1, kernel_shape = [3, 3], key = 'value', pads =
    ↪ [0, 0, 0, 0], strides = [1, 1]](%9, %conv2.weight, %conv2.bias)
    %12 = MatMul[key = 'value'](%10, %17)
    %13 = Add(%12, %linear.bias)
    %15 = MatMul(%13, %18)
    %16 = Add(%15, %linear2.bias)
    return %16
}

```

In above example %10 = Conv and %12 = MatMul has key='value' attribute annotated.

### apply\_annotation

This annotates function call instead of annotating it with with.

The annotate target is nn.Module, so torch.nn.functional couldn't be annotated

```

import torch.nn.functional as F
import pytorch_pfn_extras.onnx as tou

class Net(nn.Module):
    def __init__(self):
        super(Net, self).__init__()

        self.conv = nn.Conv2d(6, 9, 3)
        self.conv2 = nn.Conv2d(9, 12, 3)
        self.linear = nn.Linear(28, 20)
        self.linear2 = nn.Linear(20, 15)

    def forward(self, x):
        h = self.conv(x)
        with tou.annotate(key='value'):
            h = self.conv2(h)
            h = F.relu(h)
            h = self.linear(h)
        h = self.linear2(h)
        return h

model = Net()
x = torch.randn((1, 6, 32, 32))
tou.export_testcase(model, x, '/path/to/output')
onnx_proto = onnx.load(os.path.join('/path/to/output', 'model.onnx'))
print(onnx.helper.printable_graph(onnx_proto.graph))

```

```

graph torch-jit-export (
  %input.1[FLOAT, 1x6x32x32]
) initializers (
  %18[FLOAT, 28x20]
  %19[FLOAT, 20x15]
  %conv.bias[FLOAT, 9]
  %conv.weight[FLOAT, 9x6x3x3]
  %conv2.bias[FLOAT, 12]
  %conv2.weight[FLOAT, 12x9x3x3]
  %linear.bias[FLOAT, 20]
  %linear2.bias[FLOAT, 15]
) {
  %9 = Conv[dilations = [1, 1], group = 1, kernel_shape = [3, 3], pads = [0, 0, 0, 0],
→ strides = [1, 1]](%input.1, %conv.weight, %conv.bias)
  %10 = Conv[dilations = [1, 1], group = 1, kernel_shape = [3, 3], key = 'value', pads =
→ [0, 0, 0, 0], strides = [1, 1]](%9, %conv2.weight, %conv2.bias)
  %11 = Relu(%10)
  %13 = MatMul[key = 'value'](%11, %18)
  %14 = Add(%13, %linear.bias)
  %16 = MatMul(%14, %19)
  %17 = Add(%16, %linear2.bias)
  return %17
}

```

%10 = Conv and %13 = MatMul has key='value' attribute but %11 = Relu hasn't. By using apply\_annotation all node in the function is annotated.

```

import pytorch_pfn_extras.onnx as tou

class Net(nn.Module):
    def __init__(self):
        super(Net, self).__init__()

        self.conv = nn.Conv2d(6, 9, 3)
        self.conv2 = nn.Conv2d(9, 12, 3)
        self.linear = nn.Linear(28, 20)
        self.linear2 = nn.Linear(20, 15)

    def forward(self, x):
        h = self.conv(x)
        def _f(x):
            h = self.conv2(x)
            h = F.relu(h)
            h = self.linear(h)
            return h
        h = tou.apply_annotation(_f, h, key='value')
        h = self.linear2(h)
        return h

model = Net()
x = torch.randn((1, 6, 32, 32))
tou.export_testcase(model, x, '/path/to/output')
onnx_proto = onnx.load(os.path.join('/path/to/output', 'model.onnx'))

```

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```
print(onnx.helper.printable_graph(onnx_proto.graph))
```

```
graph torch-jit-export (
  %input.1[FLOAT, 1x6x32x32]
) initializers (
  %18[FLOAT, 28x20]
  %19[FLOAT, 20x15]
  %conv.bias[FLOAT, 9]
  %conv.weight[FLOAT, 9x6x3x3]
  %conv2.bias[FLOAT, 12]
  %conv2.weight[FLOAT, 12x9x3x3]
  %linear.bias[FLOAT, 20]
  %linear2.bias[FLOAT, 15]
) {
  %9 = Conv[dilations = [1, 1], group = 1, kernel_shape = [3, 3], pads = [0, 0, 0, 0],
  → strides = [1, 1]](%input.1, %conv.weight, %conv.bias)
  %10 = Conv[dilations = [1, 1], group = 1, kernel_shape = [3, 3], key = 'value', pads =
  → [0, 0, 0, 0], strides = [1, 1]](%9, %conv2.weight, %conv2.bias)
  %11 = Relu[key = 'value'](%10)
  %13 = MatMul[key = 'value'](%11, %18)
  %14 = Add(%13, %linear.bias)
  %16 = MatMul(%14, %19)
  %17 = Add(%16, %linear2.bias)
  return %17
}
```

Now %11 = Relu is annotated with key='value' attribute too.

### scoped\_anchor

This annotates scope's beginning and end of one or modules by adding Anchor node. Node would be named Anchor\_N\_start or Anchor\_N\_end (N is a index) and with op\_type Identity.

- Adding custom parameter would add ONNX attribute and this will generate invalid ONNX in checker.
- Use this with `pytorch_pfn_extras.onnx.export_testcase` or `pytorch_pfn_extras.onnx.export`.
- When scope has multiple input/output only first input/output will get Anchor node added.
- N of node name is the index of pair beginning/end Anchor node like `Anchor_0_start`, `Anchor_0_end`.

```
import pytorch_pfn_extras.onnx as tou

class Net(nn.Module):
    def __init__(self):
        super(Net, self).__init__()

        self.conv = nn.Conv2d(6, 9, 3)
        self.conv2 = nn.Conv2d(9, 12, 3)
        self.linear = nn.Linear(28, 20)
        self.linear2 = nn.Linear(20, 15)

    def forward(self, x):
```

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```

        h = self.conv(x)
        with tou.scoped_anchor(key='value'):
            h = self.conv2(h)
            h = self.linear(h)
        h = self.linear2(h)
        return h

    def forward(self, x):
        with annotate(key='value'):
            return self.add(x)

model = Net()
x = torch.randn((1, 6, 32, 32))
out_dir = tou.export_testcase(model, x, '/path/to/output')
onnx_proto = onnx.load(os.path.join('/path/to/output', 'model.onnx'))
print(onnx.helper.printable_graph(onnx_proto.graph))

```

```

graph torch-jit-export (
  %input.1[FLOAT, 1x6x32x32]
) initializers (
  %23[FLOAT, 28x20]
  %24[FLOAT, 20x15]
  %conv.bias[FLOAT, 9]
  %conv.weight[FLOAT, 9x6x3x3]
  %conv2.bias[FLOAT, 12]
  %conv2.weight[FLOAT, 12x9x3x3]
  %linear.bias[FLOAT, 20]
  %linear2.bias[FLOAT, 15]
) {
  %9 = Conv[dilations = [1, 1], group = 1, kernel_shape = [3, 3], pads = [0, 0, 0, 0],
→ strides = [1, 1]](%input.1, %conv.weight, %conv.bias)
  %11 = Identity[key = 'value'](%9)
  %12 = Conv[dilations = [1, 1], group = 1, kernel_shape = [3, 3], pads = [0, 0, 0, 0],
→ strides = [1, 1]](%11, %conv2.weight, %conv2.bias)
  %16 = MatMul(%12, %23)
  %17 = Add(%16, %linear.bias)
  %19 = Identity[key = 'value'](%17)
  %21 = MatMul(%19, %24)
  %22 = Add(%21, %linear2.bias)
  return %22
}

```

%11 = Identity (node name = Anchor\_0\_start) and %19 = Identity (node name = Anchor\_0\_end) is added. key='value' is added as ONNX attribute.

## non-nn.Module

The target of scope is only `nn.Module`. You can add adding sub `nn.Module` instead, if scope bound doesn't match `nn.Module`.

```
import pytorch_pfn_extras.onnx as tou

class Net(nn.Module):
    def __init__(self):
        super(Net, self).__init__()
        class _Net(nn.Module):
            def forward(self, x):
                return x + torch.ones((1,))
        self.add = _Net()

    def forward(self, x):
        with tou.scoped_anchor(key='value'):
            return self.add(x)

model = Net()
x = torch.randn((1, 6, 32, 32))
out_dir = tou.export_testcase(model, x, '/path/to/output')
onnx_proto = onnx.load(os.path.join('/path/to/output', 'model.onnx'))
print(onnx.helper.printable_graph(onnx_proto.graph))
```

```
graph torch-jit-export (
    %x.1[FLOAT, 1x6x32x32]
) {
    %2 = Identity[key = 'value'](%x.1)
    %3 = Constant[value = <Tensor>]()
    %4 = Add(%2, %3)
    %6 = Identity[key = 'value'](%4)
    return %6
}
```

Or you can use `anchor` (described below) instead.

## anchor (Future work)

Inserts `Anchor` node per each arbitrarily position of `nn.Module`. Node name would be `Anchor` and `op_type` would be `Identity`.

- Note: adding extra parameter would make extended ONNX format because it would be attribute.
- Please use it with `pytorch_pfn_extras.onnx.export_testcase` or `pytorch_pfn_extras.onnx.export`.

### 1.3.4 CUDA (CuPy Interoperability)

- `pytorch_pfn_extras.cuda.stream(stream)`
  - Context-manager that selects a given stream. This context manager also changes the CuPy's default stream if CuPy is available. When CuPy is not available, the functionality is the same as the PyTorch's counterpart, `torch.cuda.stream()`.
- `pytorch_pfn_extras.cuda.use_torch_mempool_in_cupy()`
  - Use PyTorch's memory pool in CuPy. If you want to use PyTorch's memory pool and non-default CUDA streams, streams must be created and managed using PyTorch (using `torch.cuda.Stream()` and `pytorch_pfn_extras.cuda.stream(stream)`). This feature requires CuPy v8.0+ and PyTorch v1.5+.
- `pytorch_pfn_extras.cuda.use_default_mempool_in_cupy()`
  - Use CuPy's default memory pool in CuPy.
- `pytorch_pfn_extras.from_ndarray(ndarray)`
  - Creates a Tensor from NumPy/CuPy ndarray.
- `pytorch_pfn_extras.as_ndarray(tensor)`
  - Creates a NumPy/CuPy ndarray from Tensor.
- `pytorch_pfn_extras.get_xp(tensor_device_or_ndarray)`
  - Returns numpy or cupy module for the given object.
- `pytorch_pfn_extras.as_numpy_dtype(torch_dtype)`
  - Returns NumPy dtype for the given torch dtype.
- `pytorch_pfn_extras.from_numpy_dtype(numpy_dtype)`
  - Returns torch dtype for the given NumPy dtype.



## API REFERENCE

- `genindex`

## 2.1 Training Loop

### 2.1.1 Trainer (technical preview)

|  |   |
|--|---|
| <code>engine.create_trainer(models, optimizers, ...)</code>  | Creates a trainer object.   |
| <code>engine.create_evaluator(models, *[, ...])</code>       | Creates an evaluator object.  |
| <code>handler.BaseLogic([options])</code>                    |   |
| <code>handler.Logic([model_name, options])</code>            |   |
| <code>handler.BaseHandler(logic, options, *args, ...)</code> |   |
| <code>handler.Handler(logic, entry_runtime, options)</code>  |   |
| <code>runtime.BaseRuntime(device_spec, options)</code>       | A base class for collections of device-specific callback functions.                   |
| <code>runtime.PyTorchRuntime(device_spec, options)</code>    | A collections of callback functions for the devices that PyTorch supports by default. |

#### `pytorch_pfn_extras.engine.create_trainer`

`pytorch_pfn_extras.engine.create_trainer(models, optimizers, max_epochs, *, extensions=None, out_dir='result', stop_trigger=None, writer=None, evaluator=None, device='cpu', logic=None, transform_model=<function default_transform_model>, handler_class=None, options=None, runtime_options=None, profile=None, **kwargs)`

Creates a trainer object.

#### Parameters

- **models** (`Union[torch.nn.modules.module.Module, Mapping[str, torch.nn.modules.module.Module]]`) – Map of string to Module or an actual Module.
- **optimizers** (`Union[torch.optim.optimizer.Optimizer, Mapping[str, torch.optim.optimizer.Optimizer]]`) – Map of string to Optimizer or an actual Optimizer.

- **max\_epochs** (*int*) – Number of epochs in the whole training loop. Ignored if *stop\_trigger* is passed as a kwarg.
- **extensions** (*Optional[Sequence[Union[extension.ExtensionLike, extension.ExtensionEntry]]]*) – List of extensions to be registered to the trainer.
- **out\_dir** (*str*) – Output directory (default: *result*).
- **stop\_trigger** (*trigger, optional*) – Trigger that can be consulted to determine whether training has concluded. The default is an interval trigger set to *max\_epochs*.
- **writer** (*Optional[writing.Writer]*) – Writer that can be used by extensions to write data to custom filesystems.
- **evaluator** (*Optional[Union[Evaluator, Tuple[Evaluator, TriggerLike], Mapping[str, Union[Evaluator, Tuple[Evaluator, TriggerLike]]]]]*) – Evaluator that is used in evaluation phase. If *None* is given, the evaluation is skipped. Evaluators can be created with *pytorch\_pfn\_extras.engine.create\_evaluator()*.
- **device** (*str or torch.device*) – Device name used for selecting a corresponding runtime class.
- **logic** (*Optional[pytorch\_pfn\_extras.handler.\_logic.BaseLogic]*) – A logic object. If *None* is given, an logic object is instantiated from the default logic class.
- **transform\_model** (*Callable[[str, torch.nn.modules.module.Module], torch.nn.modules.module.Module]*) – A function to transform a model structure, often used to unwrap the a module from DDP module.
- **handler\_class** (*Optional[Type[pytorch\_pfn\_extras.handler.\_handler.Handler]]*) – A handler class that instantiates a handler object. If *None* is given, *ppe.handler.Handler* is used as a default handler class.
- **options** (*Optional[Dict[str, Any]]*) – Options that are set to the handler and logic object. See the documentation of *ppe.handler.Handler* and *ppe.handler.Logic* for details.
- **runtime\_options** (*Optional[Mapping[str, Any]]*) – Options that are set to the runtime object. See the documentation of *ppe.runtime.PyTorchRuntime* for details.
- **profile** (*Optional[torch.profiler.profiler.profile]*) – A *torch.profiler.profile* object to collect the performance metrics.
- **kwargs** (*Any*) –

**Return type** Trainer

### **pytorch\_pfn\_extras.engine.create\_evaluator**

```
pytorch_pfn_extras.engine.create_evaluator(models, *, progress_bar=False, device='cpu',  
                                           metrics=None, logic=None, handler_class=None,  
                                           options=None, runtime_options=None, profile=None)
```

Creates an evaluator object. The return value of this function is expected to be fed to *ppe.engine.create\_trainer* as an argument.

#### **Parameters**

- **models** (*Union[torch.nn.modules.module.Module, Mapping[str, torch.nn.modules.module.Module]]*) – Map of string to *torch.nn.Module* or an actual *Module*. In most cases, this argument is the same as the *model* argument of *ppe.engine.create\_trainer*.
- **progress\_bar** (*bool*) – If *True*, a progress bar is enabled in evaluation.

- **device** (*str* or *torch.device*) – Device name used for selecting a corresponding runtime class.
- **metrics** (*list of metrics*) – List of metrics, which computes various quantities and update output for the reporting.
- **logic** (*Optional*[*pytorch\_pfn\_extras.handler.\_logic.Logic*]) – A logic object. If *None* is given, an logic object is instantiated from the default logic class.
- **handler\_class** (*Optional*[*Type*[*pytorch\_pfn\_extras.handler.\_handler.Handler*]]) – A handler class that instantiates a handler object. If *None* is given, *ppe.handler.Handler* is used as a default handler class.
- **options** (*Optional*[*Dict*[*str*, *Any*]]) – Options that are set to the handler and logic object. See the documentation of *ppe.handler.Handler* and *ppe.handler.Logic* for details.
- **runtime\_options** (*Optional*[*Mapping*[*str*, *Any*]]) – Options that are set to the runtime object. See the documentation of *ppe.handler.Handler* for details.
- **profile** (*Optional*[*torch.profiler.profiler.profile*]) – A *torch.profiler.profile* object to collect the performance metrics.

Return type *Evaluator*

## pytorch\_pfn\_extras.handler.BaseLogic

**class** `pytorch_pfn_extras.handler.BaseLogic`(*options=None*)

Parameters **options** (*Optional*[*Dict*[*str*, *Any*]]) –  
`__init__`(*options=None*)

Parameters **options** (*Optional*[*Dict*[*str*, *Any*]]) –

## Methods

|  |  |
|--|--|
| <code>__init__</code> ([options])                              |  |
| <code>consume_options</code> (options)                         | A method to update options of Logic.                     |
| <code>eval_step</code> (models, batch_idx, batch)              | A method for an evaluation step.                         |
| <code>train_epoch_begin</code> (models, epoch, loader)         | A method called when starting a new epoch of training.   |
| <code>train_epoch_end</code> (models, epoch)                   | A method called when completing an epoch of training.    |
| <code>train_step</code> (models, optimizers, batch_idx, batch) | A method invokes the models forward and backward passes. |
| <code>train_step_optimizers</code> (models, optimizers, ...)   | A method in charge of stepping the provided optimizers.  |
| <code>train_validation_begin</code> (models)                   | A method called when starting a validation.              |
| <code>train_validation_end</code> (models)                     | A method called when the validation completes.           |

**pytorch\_pfn\_extras.handler.Logic**

```
class pytorch_pfn_extras.handler.Logic(model_name='main', options=None)
```

**Parameters**

- **model\_name** (*str*) –
- **options** (*Optional[Dict[str, Any]]*) –

**Return type** None

**\_\_init\_\_**(*model\_name='main', options=None*)

A set of methods that defines the training logic.

**Parameters**

- **model\_name** (*str*) – Name of the model. Default is 'main'.
- **options** (*dict, optional*) – The configuration options.
  - **'backward\_outputs'** (*list of str*): A list of names of outputs that require computation of the gradient.
  - **'autocast'** (*bool*): If True, `torch.cuda.amp.autocast` is enabled. Default is False.
  - **'grad\_scaler'** (*torch.cuda.amp.GradScaler*): A gradient scaler that outputs are applied to.

**Return type** None

**Methods**

|   |   |
|---|---|
| <code>__init__([model_name, options])</code>                  | A set of methods that defines the training logic.       |
| <code>consume_options(options)</code>                         | A method to update options of Logic.                    |
| <code>eval_step(models, batch_idx, batch)</code>              | A method for an evaluation step.                        |
| <code>train_epoch_begin(models, epoch, loader)</code>         | A method called when starting a new epoch of training.  |
| <code>train_epoch_end(models, epoch)</code>                   | A method called when completing an epoch of training.   |
| <code>train_step(models, optimizers, batch_idx, batch)</code> | A method invokes the model forward and backward passes. |
| <code>train_step_optimizers(models, optimizers, ...)</code>   | A method in charge of stepping the provided optimizers. |
| <code>train_validation_begin(models)</code>                   | A method called when starting a validation.             |
| <code>train_validation_end(models)</code>                     | A method called when the validation completes.          |

**pytorch\_pfn\_extras.handler.BaseHandler**

**class** pytorch\_pfn\_extras.handler.**BaseHandler**(*logic, options, \*args, \*\*kwargs*)

**Parameters**

- **logic** (`pytorch_pfn_extras.handler._logic.BaseLogic`) –
- **options** (`Dict[str, Any]`) –
- **args** (`Any`) –
- **kwargs** (`Any`) –

**Return type** None

**\_\_init\_\_**(*logic, options, \*args, \*\*kwargs*)

Base class of Handler.

**Parameters**

- **logic** (`Logic`) – A logic.
- **options** (`Dict[str, Any]`) –
- **args** (`Any`) –
- **kwargs** (`Any`) –

**Return type** None

**Methods**

|   |  |
|---|--|
| <code>__init__(logic, options, *args, **kwargs)</code>        | Base class of Handler.                                     |
| <code>consume_options(options)</code>                         | A method to update options of Handler.                     |
| <code>eval_loop_begin(evaluator)</code>                       | A method called before each evaluation step.               |
| <code>eval_loop_end(evaluator)</code>                         | A method called after running all steps of the evaluation. |
| <code>eval_post_step(evaluator, batch_idx, batch, ...)</code> | A method called after each evaluation step.                |
| <code>eval_setup(evaluator, loader)</code>                    | A method called only once when starting a training run.    |
| <code>eval_step(evaluator, batch_idx, batch, ...)</code>      | Evaluation iteration.                                      |
| <code>train_cleanup(trainer)</code>                           | A method called only once when compleing a training run.   |
| <code>train_epoch_begin(trainer, loader)</code>               | A method called when starting a new epoch.                 |
| <code>train_epoch_end(trainer)</code>                         | A method called when finishing an epoch.                   |
| <code>train_post_step(trainer, batch_idx, batch, ...)</code>  | A method called after each training step.                  |
| <code>train_setup(trainer, loader)</code>                     | A method called only once when starting a training run.    |
| <code>train_step(trainer, batch_idx, batch, ...)</code>       | A training step.   |
| <code>train_validation_begin(trainer, evaluator)</code>       | A method called when starting a validation.                |
| <code>train_validation_end(trainer, evaluator)</code>         | A method called after validation.                          |

**pytorch\_pfn\_extras.handler.Handler**

```
class pytorch_pfn_extras.handler.Handler(logic, entry_runtime, options)
```

**Parameters**

- **logic** (`pytorch_pfn_extras.handler._logic.BaseLogic`) –
- **entry\_runtime** (`BaseRuntime`) –
- **options** (`Dict[str, Any]`) –

**Return type** None

```
__init__(logic, entry_runtime, options)
```

A set of callback functions to perform device-specific operations.

**Parameters**

- **logic** (`Logic`) – A logic.
- **entry\_runtime** (`BaseRuntime`) – A runtime object.
- **options** (`dict`) – The configuration options.
  - **'eval\_report\_keys'** (**list of str**): A list of names of outputs that are given as inputs of `reporting.report` after each evaluation step. Default is an empty list.
  - **'train\_report\_keys'** (**list of str**): A list of names of outputs that are given as inputs of `reporting.report` after each training step. Default is an empty list.

**Return type** None**Methods**

|   |  |
|---|--|
| <code>__init__(logic, entry_runtime, options)</code>          | A set of callback functions to perform device-specific operations. |
| <code>consume_options(options)</code>                         | A method to update options of Handler.                             |
| <code>eval_loop_begin(evaluator)</code>                       | A method called before each evaluation step.                       |
| <code>eval_loop_end(evaluator)</code>                         | A method called after running all steps of the evaluation.         |
| <code>eval_post_step(evaluator, batch_idx, batch, ...)</code> | A method called after each evaluation step.                        |
| <code>eval_setup(evaluator, loader)</code>                    | Called only once when starting a training run.                     |
| <code>eval_step(evaluator, batch_idx, batch, ...)</code>      | Evaluation iteration.  |
| <code>train_cleanup(trainer)</code>                           | A method called only once when completing a training run.          |
| <code>train_epoch_begin(trainer, loader)</code>               | A method called when starting a new epoch.                         |
| <code>train_epoch_end(trainer)</code>                         | A method called when finishing an epoch.                           |
| <code>train_post_step(trainer, batch_idx, batch, ...)</code>  | A method called after each training step.                          |
| <code>train_setup(trainer, loader)</code>                     | A method called only once when starting a training run.            |
| <code>train_step(trainer, batch_idx, batch, ...)</code>       | A training step.   |
| <code>train_validation_begin(trainer, evaluator)</code>       | A method called when starting a validation.                        |
| <code>train_validation_end(trainer, evaluator)</code>         | A method called after validation.                                  |

**pytorch\_pfn\_extras.runtime.BaseRuntime**

**class** pytorch\_pfn\_extras.runtime.**BaseRuntime**(*device\_spec, options*)

A base class for collections of device-specific callback functions.

The function attributes of this class will be called from `ppe.to` or `ppe.handler.Handler`.

`ppe.runtime.runtime_registry` stores the runtime classes and dispatches them by feeding the corresponding name string as an input.

**Parameters**

- **device\_spec** (*torch.device* or *str*) – The device that modules and tensors are transferred to.
- **options** (*dict*) – A configuration dictionary that can be used from runtime method.

**Return type** None

**\_\_init\_\_**(*device\_spec, options*)

**Parameters**

- **device\_spec** (*Union[str, torch.device]*) –
- **options** (*Dict[str, Any]*) –

**Return type** None

**Methods**

|   |   |
|---|---|
| <b>__init__</b> ( <i>device_spec, options</i> )           |   |
| <b>convert_batch</b> (args)                               | Transfers the given batch to the specific device.                     |
| <b>eval_post_step</b> (evaluator, module, batch_idx, ...) | The method called at the end of each evaluation.                      |
| <b>eval_pre_step</b> (evaluator, module, batch_idx, ...)  | The method called at the beginning of each evaluation.                |
| <b>execute</b> (code_block, batch)                        | Method called by the CodeBlocks API to do device dependent execution. |
| <b>initialize_module</b> (module, loader_or_batch[, ...]) | Initializes the module at the beginning of training or inference.     |
| <b>map</b> (func, iterable[, out_keys, device])           | Method called by the user to apply function to iterable efficiently.  |
| <b>move_module</b> (module)                               | Transfers the module to the specific device.                          |
| <b>move_tensor</b> (tensor)                               | Transfers the tensor to the specific device.                          |
| <b>trace</b> (event_name, arg)                            | Context manager for tracing PPE events in the custom device tools.    |
| <b>train_cleanup</b> (module)                             | A method called only once when compleing a training run.              |
| <b>train_epoch_begin</b> (module)                         | Preprocess of each epoch.   |
| <b>train_epoch_end</b> (module)                           | Completion of each epoch.   |
| <b>train_post_step</b> (trainer, module, batch_idx, ...)  | Postprocess of each step.   |
| <b>train_pre_step</b> (trainer, module, batch_idx, batch) | Preprocess of each step.  |
| <b>train_validation_begin</b> (module)                    | The method called before each evaluation.                             |

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Table 6 – continued from previous page

|   |  |
|---|--|
| <code>train_validation_end(module)</code> | The method called after each evaluation. |
|---|--|

## pytorch\_pfn\_extras.runtime.PyTorchRuntime

**class** `pytorch_pfn_extras.runtime.PyTorchRuntime(device_spec, options)`

A collections of callback functions for the devices that PyTorch supports by default.

### Parameters

- **device\_spec** (*torch.device* or *str*) – The device.
- **options** (*dict*, *optional*) – The configuration options.
  - **'autocast'** (*bool*): If True, `torch.cuda.amp.autocast` is enabled. Default is False.
  - **'grad\_scaler'** (*torch.cuda.amp.GradScaler*): A gradient scaler that outputs are applied to.

**Return type** `None`

`__init__(device_spec, options)`

### Parameters

- **device\_spec** (*Union[str, torch.device]*) –
- **options** (*Dict[str, Any]*) –

**Return type** `None`

### Methods

|  |   |
|--|---|
| <code>__init__(device_spec, options)</code>                    |   |
| <code>convert_batch(args)</code>                               | Transfers the given batch to the specific device.                     |
| <code>eval_post_step(evaluator, module, batch_idx, ...)</code> | The method called at the end of each evaluation.                      |
| <code>eval_pre_step(evaluator, module, batch_idx, ...)</code>  | The method called at the beginning of each evaluation.                |
| <code>execute(code_block, batch)</code>                        | Method called by the CodeBlocks API to do device dependent execution. |
| <code>initialize_module(module, loader_or_batch[, ...])</code> | Initializes the module at the beginning of training or inference.     |
| <code>map(func, iterable[, out_keys, device])</code>           | Method called by the user to apply function to iterable efficiently.  |
| <code>move_module(module)</code>                               | Transfers the module to the specific device.                          |
| <code>move_tensor(tensor)</code>                               | Transfers the tensor to the specific device.                          |
| <code>trace(event_name, arg)</code>                            | Context manager for tracing PPE events in the custom device tools.    |
| <code>train_cleanup(module)</code>                             | A method called only once when compleing a training run.              |
| <code>train_epoch_begin(module)</code>                         | Preprocess of each epoch.   |
| <code>train_epoch_end(module)</code>                           | Completion of each epoch.   |

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|  |   |
|--|---|
| <code>train_post_step(trainer, module, batch_idx, ...)</code>  | Postprocess of each step.                 |
| <code>train_pre_step(trainer, module, batch_idx, batch)</code> | Preprocess of each step.                  |
| <code>train_validation_begin(module)</code>                    | The method called before each evaluation. |
| <code>train_validation_end(module)</code>                      | The method called after each evaluation.  |

## 2.1.2 Extensions Manager

|   |  |
|---|--|
| <code>training.ExtensionsManager(models, ..., [...])</code> | Manages the extensions and the current status.                     |
| <code>training.IgniteExtensionsManager(engine, ...)</code>  | Manages extensions and the current status in Ignite training loop. |

### pytorch\_pfn\_extras.training.ExtensionsManager

```
class pytorch_pfn_extras.training.ExtensionsManager(models, optimizers, max_epochs, *,
                                                    iters_per_epoch, extensions=None,
                                                    out_dir='result', stop_trigger=None,
                                                    writer=None, transform_model=<function
                                                    ExtensionsManager.<lambda>>,
                                                    enable_profile=False)
```

Manages the extensions and the current status.

#### Parameters

- **models** (dict or `torch.nn.Module`) – Map of string to Module or an actual Module
- **optimizers** (dict or `torch.Optimizer`) – Map of string to Optimizer or an actual Optimizer.
- **max\_epochs** (`int`) – Number of epochs in the whole training loop. Ignored if `stop_trigger` is passed as a kwarg.
- **iters\_per\_epoch** (`int`) – Number of iterations in one epoch.
- **extensions** (`list` or `None`) – List of Extensions to be used.
- **out\_dir** (`str`) – Output directory (default: `result`).
- **stop\_trigger** (`trigger object`, optional) – to determine whether training has concluded. The default is an interval trigger set to `max_epochs`
- **writer** (`writing.Writer object`) – Writer that can be used by extensions to write data to custom filesystems.
- **enable\_profile** (`bool`) – Flag to enable/disable profiling of iterations. Default is `False`.
- **transform\_model** (`Callable[[str, torch.nn.modules.module.Module], torch.nn.modules.module.Module]`) –

**Return type** `None`

```
__init__(models, optimizers, max_epochs, *, iters_per_epoch, extensions=None, out_dir='result',
         stop_trigger=None, writer=None, transform_model=<function ExtensionsManager.<lambda>>,
         enable_profile=False)
```

#### Parameters

- **models** (*Union*[*torch.nn.modules.module.Module*, *Dict*[*str*, *torch.nn.modules.module.Module*]]) –
- **optimizers** (*Union*[*torch.optim.optimizer.Optimizer*, *Dict*[*str*, *torch.optim.optimizer.Optimizer*]]) –
- **max\_epochs** (*int*) –
- **iters\_per\_epoch** (*int*) –
- **extensions** (*Optional*[*Sequence*[*extension\_module.ExtensionLike*]]) –
- **out\_dir** (*str*) –
- **stop\_trigger** (*trigger\_module.TriggerLike*) –
- **writer** (*Optional*[*pytorch\_pfn\_extras.writing.\_writer\_base.Writer*]) –
- **transform\_model** (*Callable*[[*str*, *torch.nn.modules.module.Module*], *torch.nn.modules.module.Module*]) –
- **enable\_profile** (*bool*) –

**Return type** *None*

## Methods

---

`__init__(models, optimizers, max_epochs, *, ...)`

---

`extend(extension[, name, trigger, priority, ...])`      Registers an extension to the manager.

---

`finalize()`

---

`get_extension(name)`      Returns the extension of a given name.

---

`load_state_dict(to_load)`

---

`needs_model_state([iteration])`

---

`needs_state_this_iteration()`

---

`run_extensions()`

---

`run_iteration(*[, step_optimizers])`      Context manager to run an iteration.

---

`start_extensions()`

---

`state_dict()`

---

**Attributes**

|                    |
|--------------------|
| elapsed_time       |
| epoch              |
| epoch_detail       |
| is_before_training |
| iteration          |
| models             |
| optimizers         |
| out                |
| raw_models         |
| stop_trigger       |
| updater            |

**pytorch\_pfn\_extras.training.IgniteExtensionsManager**

**class** pytorch\_pfn\_extras.training.IgniteExtensionsManager(*engine, models, optimizers, max\_epochs, \*, extensions=None, out\_dir='result', writer=None, enable\_profile=False*)

Manages extensions and the current status in Ignite training loop.

**Parameters**

- **engine** (*ignite.engine.Engine*) – Ignite trainer engine
- **models** (*dict or torch.nn.Module*) – Map of string to Module or an actual Module
- **optimizers** (*dict or torch.Optimizer*) – Map of string to Optimizer or an actual Optimizer.
- **max\_epochs** (*int*) – Number of epochs in the whole training loop.
- **extensions** (*list or None*) – List of Extensions to be used.
- **out\_dir** (*str*) – Output directory (default: `result`).
- **writer** (*writing.Writer object*) – Writer that can be used by extensions to write data to custom filesystems.
- **enable\_profile** (*bool*) – Flag to enable/disable profiling of iterations. Default is *False*.

**Return type** None

**\_\_init\_\_** (*engine, models, optimizers, max\_epochs, \*, extensions=None, out\_dir='result', writer=None, enable\_profile=False*)

### Parameters

- **engine** (*ignite.engine.Engine*) –
- **models** (*Union[torch.nn.modules.module.Module, Mapping[str, torch.nn.modules.module.Module]]*) –
- **optimizers** (*Union[torch.optim.optimizer.Optimizer, Mapping[str, torch.optim.optimizer.Optimizer]]*) –
- **max\_epochs** (*int*) –
- **extensions** (*Optional[Sequence[extension\_module.ExtensionLike]]*) –
- **out\_dir** (*str*) –
- **writer** (*Optional[pytorch\_pfn\_extras.writing.\_writer\_base.Writer]*) –
- **enable\_profile** (*bool*) –

**Return type** `None`

### Methods

---

`__init__`(engine, models, optimizers, ..., ..., ...)

---

|   |  |
|---|--|
| <code>extend</code> (extension[, name, trigger, priority, ...]) | Registers an extension to the manager. |
|---|--|

---

|                                   |  |
|-----------------------------------|--|
| <code>get_extension</code> (name) | Returns the extension of a given name. |
|-----------------------------------|--|

---

`load_state_dict`(to\_load)

---

`needs_model_state`([iteration])

---

`needs_state_this_iteration`()

---

`run_extensions`()

---

`set_ignite_handlers`()

---

`start_extensions`()

---

`state_dict`()

---

### Attributes

---

`elapsed_time`

---

`epoch`

---

`epoch_detail`

---

`is_before_training`

---

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|              |
|--------------|
| iteration    |
| models       |
| optimizers   |
| out          |
| raw_models   |
| stop_trigger |
| updater      |

### 2.1.3 Extensions

|  |   |
|--|---|
| <code>training.extension.make_extension([trigger, ...])</code> | Decorator to make given function into an extension. |
| <code>training.extension.Extension()</code>                    | Base class of extensions.                           |
| <code>training.extension.ExtensionEntry(extension, *)</code>   | Extension and options.                              |

#### pytorch\_pfn\_extras.training.extension.make\_extension

`pytorch_pfn_extras.training.extension.make_extension(trigger=(1, 'iteration'), default_name=None, priority=100, finalizer=<function <lambda>>, initializer=<function <lambda>>, on_error=<function <lambda>>)`

Decorator to make given function into an extension.

This decorator just adds some attributes to a given function. The value of the attributes are given by the arguments of this decorator.

See [Extension](#) for details of extensions. Most of the default values of arguments also follow those for this class.

#### Parameters

- **trigger** (*TriggerLike*) – Default trigger of the extension.
- **default\_name** (*Optional[str]*) – Default name of the extension. The name of a given function is used by default.
- **priority** (*int*) – Default priority of the extension.
- **finalizer** (*ExtensionLike*) – Finalizer function of this extension. It is called at the end of the training loop.
- **initializer** (*ExtensionLike*) – Initializer function of this extension. It is called at the beginning of the training loop.
- **on\_error** (*Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol, Exception, types.TracebackType], None]*)

- Error handler callback function of this extension. It is called after an error is raised during the training loop.

**Return type** Callable[[ExtensionLike], ExtensionLike]

## pytorch\_pfn\_extras.training.extension.Extension

**class** pytorch\_pfn\_extras.training.extension.**Extension**

Base class of extensions.

An extension is a callable object that takes the manager object as the argument. It also provides some default configurations as its attributes, e.g. the default trigger and the default priority. This class provides a set of typical default values for these attributes.

There are three ways to define users' own extensions: inheriting this class, decorating closures by `make_extension()`, or using any callable including lambda functions as extensions. Decorator can slightly reduce the overhead and is much easier to use, while this class provides more flexibility (for example, it can have methods to configure the behavior). Using a lambda function allows one-line coding for simple purposes, but users have to specify the configurations as arguments to `ExtensionsManager.extend()`. For a callable not inheriting this class, the default configurations of this class are used unless the user explicitly specifies them in `ExtensionsManager.extend()` method.

**trigger**

Default value of trigger for this extension. It is set to (1, 'iteration') by default.

**Type** TriggerLike

**priority**

Default priority of the extension. It is set to PRIORITY\_READER by default.

**Type** int

**~Extension.name**

Name of the extension. It is set to None by default. This value will be overwritten when registering an extension to a manager. See `pytorch_pfn_extras.ExtensionsManager.extend()` for details.

**\_\_init\_\_()**

## Methods

---

|   |  |
|---|--|
| <code>__init__()</code>                 |  |
| <hr/>                                   |  |
| <code>finalize(manager)</code>          | Finalizes the extension.                                       |
| <code>initialize(manager)</code>        | Initializes up the manager state.                              |
| <hr/>                                   |  |
| <code>load_state_dict(to_load)</code>   |  |
| <hr/>                                   |  |
| <code>on_error(manager, exc, tb)</code> | Handles the error raised during training before final-ization. |
| <hr/>                                   |  |
| <code>state_dict()</code>               | Serializes the extension state.                                |
| <hr/>                                   |  |

### Attributes

|                                |                                |
|--------------------------------|--------------------------------|
| <code>default_name</code>      | Default name of the extension. |
| <code>is_async</code>          |                                |
| <code>name</code>              |                                |
| <code>needs_model_state</code> |                                |
| <code>priority</code>          |                                |
| <code>trigger</code>           |                                |

### pytorch\_pfn\_extras.training.extension.ExtensionEntry

```
class pytorch_pfn_extras.training.extension.ExtensionEntry(extension, *, name=None,
                                                           priority=None, trigger=None,
                                                           call_before_training=False)
```

Extension and options. When name, priority, or trigger is not specified, it is copied from the attributes of the given extension.

#### Parameters

- **extension** (*ExtensionLike*) – An extension.
- **name** (*Optional[str]*) – Name of extension.
- **priority** (*Optional[int]*) – Invocation priority of the extension.
- **trigger** (*Optional[TriggerLike]*) – Trigger object that determines when to invoke the extension.
- **call\_before\_training** (*bool*) – Flag to call extension before training.

**Return type** None

See also:

`pytorch_pfn_extras.training.ExtensionsManager.extend()`

`__init__(extension, *, name=None, priority=None, trigger=None, call_before_training=False)`

#### Parameters

- **extension** (*ExtensionLike*) –
- **name** (*Optional[str]*) –
- **priority** (*Optional[int]*) –
- **trigger** (*Optional[TriggerLike]*) –
- **call\_before\_training** (*bool*) –

**Return type** None

## Methods

|  |  |
|--|--|
| <code>__init__(extension, *[, name, priority, ...])</code>       |  |
| <code>load_state_dict(to_load)</code>                            |  |
| <code>state_dict()</code>  |  |
| <code>training.extensions.BestValue(key, compare)</code>         | Extension traces the best value of a specific key in the observation.    |
| <code>training.extensions.Evaluator(self, ...[, ...])</code>     | An extension to evaluate models on a validation set.                     |
| <code>training.extensions.LogReport([keys, ...])</code>          | An extension to output the accumulated results to a log file.            |
| <code>training.extensions.MaxValue(key[, trigger])</code>        | Extension traces the maximum value of a specific key in the observation. |
| <code>training.extensions.MicroAverage(...[, trigger])</code>    | Calculates micro-average ratio.  |
| <code>training.extensions.MinValue(key[, trigger])</code>        | Extension traces the maximum value of a specific key in the observation. |
| <code>training.extensions.observe_lr(optimizer[, ...])</code>    | Returns an extension to record the learning rate.                        |
| <code>training.extensions.observe_value(...)</code>              | Returns an extension to continuously record a value.                     |
| <code>training.extensions.ParameterStatistics(links)</code>      | An extension to report parameter statistics.                             |
| <code>training.extensions.PlotReport(y_keys[, ...])</code>       | An extension to output plots.  |
| <code>training.extensions.PrintReport([entries, ...])</code>     | An extension to print the accumulated results.                           |
| <code>training.extensions.ProgressBar([...])</code>              | An extension to print a progress bar and recent training status.         |
| <code>training.extensions.ProfileReport([...])</code>            | Writes the profile results to a file.                                    |
| <code>training.extensions.snapshot([savefun, ...])</code>        | Returns a trainer extension to take snapshots of the trainer.            |
| <code>training.extensions.Slack(channel[, msg, ...])</code>      | An extension to communicate with Slack.                                  |
| <code>training.extensions.SlackWebhook(url[, msg, ...])</code>   | An extension to communicate with Slack using Incoming Webhook.           |
| <code>training.extensions.VariableStatisticsPlot(targets)</code> | An extension to plot statistics for Tensors.                             |

## pytorch\_pfn\_extras.training.extensions.BestValue

**class** `pytorch_pfn_extras.training.extensions.BestValue(key, compare, trigger=(1, 'epoch'))`  
 Extension traces the best value of a specific key in the observation.

### Parameters

- **key** (*str*) – Key of value.
- **compare** (*callable*) – Compare function which takes current best value and new value and returns whether new value is better than current best.
- **trigger** (*TriggerLike*) – Trigger that decides the comparison interval between current best value and new value. This must be a tuple in the form of `<int>, 'epoch' or <int>`,



'iteration' which is passed to BestValueTrigger.

**Return type** None

`__init__(key, compare, trigger=(1, 'epoch'))`

#### Parameters

- **key** (*str*) –
- **compare** (*Callable[[float, float], bool]*) –
- **trigger** (*TriggerLike*) –

**Return type** None

#### Methods

|  |   |
|--|---|
| <code>__init__(key, compare[, trigger])</code> |   |
| <code>finalize(manager)</code>                 | Finalizes the extension.                                      |
| <code>initialize(manager)</code>               | Initializes up the manager state.                             |
| <code>load_state_dict(to_load)</code>          |   |
| <code>on_error(manager, exc, tb)</code>        | Handles the error raised during training before finalization. |
| <code>state_dict()</code>                      | Serializes the extension state.                               |

#### Attributes

|                                |  |
|--------------------------------|--|
| <code>best_epoch</code>        | Returns the epoch count that the current best value is observed.     |
| <code>best_iteration</code>    | Returns the iteration count that the current best value is observed. |
| <code>best_value</code>        | Returns the current best value.                                      |
| <code>default_name</code>      |  |
| <code>is_async</code>          |  |
| <code>name</code>              |  |
| <code>needs_model_state</code> |  |
| <code>priority</code>          |  |
| <code>trigger</code>           |  |

**pytorch\_pfn\_extras.training.extensions.Evaluator**

```
class pytorch_pfn_extras.training.extensions.Evaluator(self, iterator, target, eval_func=None, *,
                                                    progress_bar=False)
```

An extension to evaluate models on a validation set.

This extension evaluates the current models by a given evaluation function. It creates a **Reporter** object to store values observed in the evaluation function on each iteration. The report for all iterations are aggregated to **DictSummary**. The collected mean values are further reported to the reporter object of the manager, where the name of each observation is prefixed by the evaluator name. See **Reporter** for details in naming rules of the reports.

Evaluator has a structure to customize similar to that of **StandardUpdater**. The main differences are:

- There are no optimizers in an evaluator. Instead, it holds links to evaluate.
- An evaluation loop function is used instead of an update function.
- Preparation routine can be customized, which is called before each evaluation. It can be used, e.g., to initialize the state of stateful recurrent networks.

There are two ways to modify the evaluation behavior besides setting a custom evaluation function. One is by setting a custom evaluation loop via the `eval_func` argument. The other is by inheriting this class and overriding the `evaluate()` method. In latter case, users have to create and handle a reporter object manually. Users also have to copy the iterators before using them, in order to reuse them at the next time of evaluation. In both cases, the functions are called in testing mode

This extension is called at the end of each epoch by default.

**Parameters**

- **iterator** (*Union[torch.utils.data.data\_loader.DataLoader[Any], Dict[str, torch.utils.data.data\_loader.DataLoader[Any]]]*) – Dataset iterator for the validation dataset. It can also be a dictionary of iterators. If this is just an iterator, the iterator is registered by the name 'main'.
- **target** (*Union[torch.nn.modules.module.Module, Dict[str, torch.nn.modules.module.Module]]*) – torch.nn.Module object or a dictionary of links to evaluate. If this is just a layer object, the link is registered by the name 'main'.
- **eval\_func** (*Optional[Callable[[...], Any]]*) – Evaluation function called at each iteration. The target link to evaluate as a callable is used by default.
- **progress\_bar** – Boolean flag to show a progress bar while training, which is similar to **ProgressBar**. (default: False)
- **metrics** – List of callables that are called every batch to calculate metrics such as accuracy, roc\_auc or others. The signature of the callable is: *def metric\_fn(batch, output, last\_iteration)* (default: [])
- **eval\_hook** (*Optional[Callable[[Evaluator], None]]*) –
- **kwargs** (*Any*) –

**Return type** None

**Warning:** The argument `progress_bar` is experimental. The interface can change in the future.

**eval\_hook**

Function to prepare for each evaluation process.

**eval\_func**

Evaluation function called at each iteration.

**\_\_init\_\_**(*iterator*, *target*, *eval\_hook=None*, *eval\_func=None*, *\*\*kwargs*)

**Parameters**

- **iterator** (*Union[torch.utils.data.dataloader.DataLoader[Any], Dict[str, torch.utils.data.dataloader.DataLoader[Any]]]*) –
- **target** (*Union[torch.nn.modules.module.Module, Dict[str, torch.nn.modules.module.Module]]*) –
- **eval\_hook** (*Optional[Callable[[pytorch\_pfn\_extras.training.extensions.evaluator.Evaluator], None]]*) –
- **eval\_func** (*Optional[Callable[[...], Any]]*) –
- **kwargs** (*Any*) –

**Return type** None

**Methods**

|   |   |
|---|---|
| <code>__init__</code> ( <i>iterator</i> , <i>target</i> [, <i>eval_hook</i> , ...]) |   |
| <code>add_metric</code> ( <i>metric_fn</i> )  | Adds a custom metric to the evaluator.                        |
| <code>eval_func</code> (*args, **kwargs)  |   |
| <code>evaluate</code> ()  | Evaluates the model and returns a result dictionary.          |
| <code>finalize</code> ( <i>manager</i> )  | Finalizes the extension.                                      |
| <code>get_all_iterators</code> ()   | Returns a dictionary of all iterators.                        |
| <code>get_all_targets</code> ()   | Returns a dictionary of all target links.                     |
| <code>get_iterator</code> ( <i>name</i> )   | Returns the iterator of the given name.                       |
| <code>get_target</code> ( <i>name</i> )   | Returns the target link of the given name.                    |
| <code>initialize</code> ( <i>manager</i> )  | Initializes up the manager state.                             |
| <code>load_state_dict</code> ( <i>to_load</i> )                                     |   |
| <code>on_error</code> ( <i>manager</i> , <i>exc</i> , <i>tb</i> )                   | Handles the error raised during training before finalization. |
| <code>state_dict</code> ()  | Serializes the extension state.                               |

**Attributes**

|                                |
|--------------------------------|
| <code>default_name</code>      |
| <code>is_async</code>          |
| <code>name</code>              |
| <code>needs_model_state</code> |

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Table 21 – continued from previous page

|          |
|----------|
| priority |
| trigger  |

## pytorch\_pfn\_extras.training.extensions.LogReport

**class** `pytorch_pfn_extras.training.extensions.LogReport` (*keys=None, trigger=(1, 'epoch'), postprocess=None, filename=None, append=False, format=None, \*\*kwargs*)

An extension to output the accumulated results to a log file.

This extension accumulates the observations of the manager to `DictSummary` at a regular interval specified by a supplied trigger, and writes them into a log file in JSON format.

There are two triggers to handle this extension. One is the trigger to invoke this extension, which is used to handle the timing of accumulating the results. It is set to 1, 'iteration' by default. The other is the trigger to determine when to emit the result. When this trigger returns True, this extension appends the summary of accumulated values to the list of past summaries, and writes the list to the log file. Then, this extension makes a new fresh summary object which is used until the next time that the trigger fires.

It also adds some entries to each result dictionary.

- 'epoch' and 'iteration' are the epoch and iteration counts at the output, respectively.
- 'elapsed\_time' is the elapsed time in seconds since the training begins. The value is taken from `ExtensionsManager.elapsed_time`.

### Parameters

- **keys** (*iterable of strs*) – Keys of values to accumulate. If this is None, all the values are accumulated and output to the log file.
- **trigger** (*Optional[Union[pytorch\_pfn\_extras.training.\_trigger\_util.Trigger, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol], bool], Tuple[float, str]]]*) – Trigger that decides when to aggregate the result and output the values. This is distinct from the trigger of this extension itself. If it is a tuple in the form <int>, 'epoch' or <int>, 'iteration', it is passed to `IntervalTrigger`.
- **postprocess** (*Optional[Callable[[Mapping[str, Any]], None]]*) – Callback to postprocess the result dictionaries. Each result dictionary is passed to this callback on the output. This callback can modify the result dictionaries, which are used to output to the log file.
- **filename** (*str*) – Name of the log file under the output directory. It can be a format string: the last result dictionary is passed for the formatting. For example, users can use '{iteration}' to separate the log files for different iterations. (default: 'log')
- **append** (*bool, optional*) – If the file is JSON Lines or YAML, contents will be appended instead of rewriting the file every call.
- **format** (*str, optional*) – accepted values are 'json', 'json-lines' and 'yaml'.
- **writer** (*writer object, optional*) – must be callable. object to dump the log to. If specified, it needs to have a correct *savefun* defined. The writer can override the save location in the `pytorch_pfn_extras.training.ExtensionsManager` object

- **kwargs** (*Any*) –

---

**Note:** Enabling `append=True` reduces size of snapshots (and thus reduces the time needed to take snapshots). Note that extensions relying on the logs from past iterations may behave differently; for example, when resuming from a snapshot, `PrintReport` will not show logs of iterations already done.

---

```
__init__(keys=None, trigger=(1, 'epoch'), postprocess=None, filename=None, append=False,
         format=None, **kwargs)
```

### Parameters

- **keys** (*Optional[Iterable[str]]*) –
- **trigger** (*Optional[Union[pytorch\_pfn\_extras.training.\_trigger\_util.Trigger, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol], bool], Tuple[float, str]]]*) –
- **postprocess** (*Optional[Callable[[Mapping[str, Any]], None]]*) –
- **filename** (*Optional[str]*) –
- **append** (*bool*) –
- **format** (*Optional[str]*) –
- **kwargs** (*Any*) –

### Methods

---

|  |   |
|--|---|
| <code>__init__([keys, trigger, postprocess, ...])</code> |   |
| <code>finalize(manager)</code>                           | Finalizes the extension.                                      |
| <code>initialize(manager)</code>                         | Initializes up the manager state.                             |
| <code>load_state_dict(to_load)</code>                    |   |
| <code>on_error(manager, exc, tb)</code>                  | Handles the error raised during training before finalization. |
| <code>state_dict()</code>                                | Serializes the extension state.                               |
| <code>to_dataframe()</code>                              |   |

---

### Attributes

---

|                           |   |
|---------------------------|---|
| <code>default_name</code> | Default name of the extension.                |
| <code>is_async</code>     |   |
| <code>log</code>          | The current list of observation dictionaries. |
| <code>name</code>         |   |

---

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Table 23 – continued from previous page

|                   |
|-------------------|
| needs_model_state |
| priority          |
| trigger           |

**pytorch\_pfn\_extras.training.extensions.MaxValue**

**class** pytorch\_pfn\_extras.training.extensions.**MaxValue**(key, trigger=(1, 'epoch'))

Extension traces the maximum value of a specific key in the observation.

**Parameters**

- **key** (*str*) – Key of value.
- **trigger** (*TriggerLike*) – Trigger that decides the comparison interval between current maximum value and new value. This must be a tuple in the form of <int>, 'epoch' or <int>, 'iteration' which is passed to `BestValueTrigger`.

**\_\_init\_\_**(key, trigger=(1, 'epoch'))

**Parameters**

- **key** (*str*) –
- **trigger** (*TriggerLike*) –

**Methods**

|                                    |   |
|------------------------------------|---|
| <b>__init__</b> (key[, trigger])   |   |
| <b>finalize</b> (manager)          | Finalizes the extension.                                      |
| <b>initialize</b> (manager)        | Initializes up the manager state.                             |
| <b>load_state_dict</b> (to_load)   |   |
| <b>on_error</b> (manager, exc, tb) | Handles the error raised during training before finalization. |
| <b>state_dict</b> ()               | Serializes the extension state.                               |

**Attributes**

|                       |  |
|-----------------------|--|
| <b>best_epoch</b>     | Returns the epoch count that the current best value is observed.     |
| <b>best_iteration</b> | Returns the iteration count that the current best value is observed. |
| <b>best_value</b>     | Returns the current best value.                                      |
| <b>default_name</b>   |  |

continues on next page

Table 25 – continued from previous page

|                   |
|-------------------|
| is_async          |
| name              |
| needs_model_state |
| priority          |
| trigger           |

### pytorch\_pfn\_extras.training.extensions.MicroAverage

**class** pytorch\_pfn\_extras.training.extensions.**MicroAverage**(*numerator\_key*, *denominator\_key*, *result\_key*, *trigger*=(1, 'epoch'))

Calculates micro-average ratio.

Give  $N$  batches and values  $\{n_1, \dots, n_N\}$  and  $\{d_1, \dots, d_N\}$ , this extension calculates micro-average of these ratio defined as:

$$\frac{\sum_i^N n_i}{\sum_i^N d_i}.$$

A user usually uses the number of examples which a system correctly predict as  $n_i$  and the number of total examples in  $i$ -th batch as  $d_i$ . This value is called macro-average of precision.

Note that macro-average is defined as:

$$\frac{1}{N} \sum_i^N (n_i/d_i),$$

It is same to the micro-average when each mini-batch has the same  $d_i$ .

You need to report numerator value (the number of correct examples) and denominator value (the number of examples) in your model.

```
>>> class MyModel(torch.nn.Module):
...     def __call__(self, x, y):
...         loss = torch.nn.CrossEntropyLoss(x, y)
...         correct = (x.data.argmax(axis=1) == y.data).sum()
...         total = len(y.data)
...         reporting.report({'correct': correct, 'total': total}, self)
...         return loss
```

And then, make an extension with corresponding reporting keys and register it.

```
>>> ext = extensions.MicroAverage(
...     'main/correct', 'main/total', 'main/accuracy')
```

#### Parameters

- **numerator\_key** (*str*) – Key string of obserbation storing a numerator value.
- **denominator\_key** (*str*) – Key string of obserbation storing a denominator value.

- **result\_key** (*str*) – Key string of obserbation to store a result.
- **trigger** (*Optional[Union[pytorch\_pfn\_extras.training.\_trigger\_util.Trigger, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol], bool], Tuple[float, str]]]*) – Trigger that decides when to calculate average. This is distinct from the trigger of this extension itself. If it is a tuple in the form <int>, 'epoch' or <int>, 'iteration', it is passed to IntervalTrigger.

**Return type** None

`__init__(numerator_key, denominator_key, result_key, trigger=(1, 'epoch'))`

#### Parameters

- **numerator\_key** (*str*) –
- **denominator\_key** (*str*) –
- **result\_key** (*str*) –
- **trigger** (*Optional[Union[pytorch\_pfn\_extras.training.\_trigger\_util.Trigger, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol], bool], Tuple[float, str]]]*) –

**Return type** None

#### Methods

|  |   |
|--|---|
| <code>__init__(numerator_key, denominator_key, ...)</code> |   |
| <code>finalize(manager)</code>                             | Finalizes the extension.                                      |
| <code>initialize(manager)</code>                           | Initializes up the manager state.                             |
| <code>load_state_dict(to_load)</code>                      |   |
| <code>on_error(manager, exc, tb)</code>                    | Handles the error raised during training before finalization. |
| <code>state_dict()</code>                                  | Serializes the extension state.                               |

#### Attributes

|                                |                                |
|--------------------------------|--------------------------------|
| <code>default_name</code>      | Default name of the extension. |
| <code>is_async</code>          |                                |
| <code>name</code>              |                                |
| <code>needs_model_state</code> |                                |
| <code>priority</code>          |                                |

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trigger

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**pytorch\_pfn\_extras.training.extensions.MinValue****class** pytorch\_pfn\_extras.training.extensions.**MinValue**(key, trigger=(1, 'epoch'))

Extension traces the maximum value of a specific key in the observation.

**Parameters**

- **key** (*str*) – Key of value.
- **trigger** (*TriggerLike*) – Trigger that decides the comparison interval between current maximum value and new value. This must be a tuple in the form of <int>, 'epoch' or <int>, 'iteration' which is passed to `BestValueTrigger`.

`__init__(key, trigger=(1, 'epoch'))`**Parameters**

- **key** (*str*) –
- **trigger** (*TriggerLike*) –

**Methods**`__init__(key[, trigger])`

|                                |                          |
|--------------------------------|--------------------------|
| <code>finalize(manager)</code> | Finalizes the extension. |
|--------------------------------|--------------------------|

|                                  |                                   |
|----------------------------------|-----------------------------------|
| <code>initialize(manager)</code> | Initializes up the manager state. |
|----------------------------------|-----------------------------------|

|                                       |  |
|---------------------------------------|--|
| <code>load_state_dict(to_load)</code> |  |
|---------------------------------------|--|

|   |   |
|---|---|
| <code>on_error(manager, exc, tb)</code> | Handles the error raised during training before finalization. |
|---|---|

|                           |                                 |
|---------------------------|---------------------------------|
| <code>state_dict()</code> | Serializes the extension state. |
|---------------------------|---------------------------------|

**Attributes**

|                         |  |
|-------------------------|--|
| <code>best_epoch</code> | Returns the epoch count that the current best value is observed. |
|-------------------------|--|

|                             |  |
|-----------------------------|--|
| <code>best_iteration</code> | Returns the iteration count that the current best value is observed. |
|-----------------------------|--|

|                         |                                 |
|-------------------------|---------------------------------|
| <code>best_value</code> | Returns the current best value. |
|-------------------------|---------------------------------|

|                           |  |
|---------------------------|--|
| <code>default_name</code> |  |
|---------------------------|--|

|                       |  |
|-----------------------|--|
| <code>is_async</code> |  |
|-----------------------|--|

|                   |  |
|-------------------|--|
| <code>name</code> |  |
|-------------------|--|

---

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Table 29 – continued from previous page

|                   |
|-------------------|
| needs_model_state |
| priority          |
| trigger           |

### pytorch\_pfn\_extras.training.extensions.observe\_lr

`pytorch_pfn_extras.training.extensions.observe_lr(optimizer, param_group=0, observation_key='lr')`  
Returns an extension to record the learning rate.

#### Parameters

- **optimizer** (*Optimizer*) – Optimizer whose learning rate is recorded.
- **param\_group** (*int*) – Param group of the optimizer to observe
- **observation\_key** (*str*) – Key of observation to record.

**Returns** The extension function.

**Return type** Any

This extension is triggered each epoch by default. To change this, use the `trigger` argument with the `ExtensionsManager.extend()` method.

### pytorch\_pfn\_extras.training.extensions.observe\_value

`pytorch_pfn_extras.training.extensions.observe_value(observation_key, target_func)`  
Returns an extension to continuously record a value.

#### Parameters

- **observation\_key** (*str*) – Key of observation to record.
- **target\_func** (*function*) – Function that returns the value to record. It must take one argument: :class:`~pytorch\_pfn\_extras.training.ExtensionsManager` object.

**Returns** The extension function.

**Return type** Callable[[`pytorch_pfn_extras.training._manager_protocol.ExtensionsManagerProtocol`], None]

This extension is triggered each epoch by default. To change this, use the `trigger` argument with the `ExtensionsManager.extend()` method.

### pytorch\_pfn\_extras.training.extensions.ParameterStatistics

`class pytorch_pfn_extras.training.extensions.ParameterStatistics(links, statistics='default', report_params=True, report_grads=True, prefix=None, trigger=(1, 'epoch'), skip_nan_params=False)`

An extension to report parameter statistics.

Statistics are collected and reported for a given `Module` or an iterable of `Modules`. If a link contains child modules, the statistics are reported separately for each child.

Any function that takes a one-dimensional `torch.Tensor` and outputs a single or multiple real numbers can be registered to handle the collection of statistics, e.g. `numpy.ndarray.mean()`.

The keys of reported statistics follow the convention of link name followed by parameter name, attribute name and function name, e.g. `VGG16Layers/conv1_1/W/data/mean`. They are prepended with an optional prefix and appended with integer indices if the statistics generating function return multiple values.

### Parameters

- **links** (*instance or iterable of `~torch.nn.Module`*) – Module(s) containing the parameters to observe. The link is expected to have a `name` attribute which is used as a part of the report key.
- **statistics** (*dict or 'default'*) – Dictionary with function name to function mappings. The name is a string and is used as a part of the report key. The function is responsible for generating the statistics. If the special value `'default'` is specified, the default statistics functions will be used.
- **report\_params** (*bool*) – If True, report statistics for parameter values such as weights and biases.
- **report\_grads** (*bool*) – If True, report statistics for parameter gradients.
- **prefix** (*str*) – Optional prefix to prepend to the report keys.
- **trigger** (*Optional[Union[pytorch\_pfn\_extras.training.\_trigger\_util.Trigger, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol], bool], Tuple[float, str]]]*) – Trigger that decides when to aggregate the results and report the values.
- **skip\_nan\_params** (*bool*) – If True, statistics are not computed for parameters including NaNs and a single NaN value is immediately reported instead. Otherwise, this extension will simply try to compute the statistics without performing any checks for NaNs.

---

**Note:** The default statistic functions are as follows:

- `'mean' (xp.mean(x))`
  - `'std' (xp.std(x))`
  - `'min' (xp.min(x))`
  - `'max' (xp.max(x))`
  - `'zeros' (xp.count_nonzero(x == 0))`
  - `'percentile' (xp.percentile(x, (0.13, 2.28, 15.87, 50, 84.13, 97.72, 99.87)))`
- 

`__init__(links, statistics='default', report_params=True, report_grads=True, prefix=None, trigger=(1, 'epoch'), skip_nan_params=False)`

### Parameters

- **links** (*Any*) –
- **statistics** (*Any*) –
- **report\_params** (*bool*) –

- **report\_grads** (*bool*) –
- **prefix** (*Optional[str]*) –
- **trigger** (*Optional[Union[pytorch\_pfn\_extras.training.\_trigger\_util.Trigger, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol], bool], Tuple[float, str]]]*) –
- **skip\_nan\_params** (*bool*) –

## Methods

|  |   |
|--|---|
| <code>__init__(links[, statistics, report_params, ...])</code> |   |
| <code>finalize(manager)</code>                                 | Finalizes the extension.                                      |
| <code>initialize(manager)</code>                               | Initializes up the manager state.                             |
| <code>load_state_dict(to_load)</code>                          |   |
| <code>on_error(manager, exc, tb)</code>                        | Handles the error raised during training before finalization. |
| <code>register_statistics(name, function)</code>               | Register a function to compute a certain statistic.           |
| <code>state_dict()</code>                                      | Serializes the extension state.                               |

## Attributes

|                                  |
|----------------------------------|
| <code>default_name</code>        |
| <code>default_statistics</code>  |
| <code>is_async</code>            |
| <code>name</code>                |
| <code>needs_model_state</code>   |
| <code>priority</code>            |
| <code>report_key_template</code> |
| <code>trigger</code>             |

**pytorch\_pfn\_extras.training.extensions.PlotReport**

```
class pytorch_pfn_extras.training.extensions.PlotReport(y_keys, x_key='iteration', trigger=(1,
                                                    'epoch'), postprocess=None,
                                                    filename='plot.png', marker='x',
                                                    grid=True)
```

An extension to output plots.

This extension accumulates the observations of the manager to DictSummary at a regular interval specified by a supplied trigger, and plot a graph with using them.

There are two triggers to handle this extension. One is the trigger to invoke this extension, which is used to handle the timing of accumulating the results. It is set to 1, 'iteration' by default. The other is the trigger to determine when to emit the result. When this trigger returns True, this extension appends the summary of accumulated values to the list of past summaries, and writes the list to the log file. Then, this extension makes a new fresh summary object which is used until the next time that the trigger fires.

It also adds 'epoch' and 'iteration' entries to each result dictionary, which are the epoch and iteration counts at the output.

**Warning:** If your environment needs to specify a backend of matplotlib explicitly, please call `matplotlib.use` before calling `manager.run_iteration`. For example:

```
import matplotlib
matplotlib.use('Agg')

manager.extend(
    extensions.PlotReport(['main/loss', 'validation/main/loss'],
                          'epoch', filename='loss.png'))
with manager.run_iteration():
    pass
```

Then, once one of instances of this extension is called, `matplotlib.use` will have no effect.

For the details, please see here: [https://matplotlib.org/faq/usage\\_faq.html#what-is-a-backend](https://matplotlib.org/faq/usage_faq.html#what-is-a-backend)

**Parameters**

- **y\_keys** (*iterable of strs*) – Keys of values regarded as y. If this is None, nothing is output to the graph.
- **x\_key** (*str*) – Keys of values regarded as x. The default value is 'iteration'.
- **trigger** (*Optional[Union[pytorch\_pfn\_extras.training.\_trigger\_util.Trigger, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol], bool], Tuple[float, str]]]*) – Trigger that decides when to aggregate the result and output the values. This is distinct from the trigger of this extension itself. If it is a tuple in the form <int>, 'epoch' or <int>, 'iteration', it is passed to IntervalTrigger.
- **postprocess** (*Any*) – Callback to postprocess the result dictionaries. Figure object, Axes object, and all plot data are passed to this callback in this order. This callback can modify the figure.
- **filename** (*str*) – Name of the figure file under the output directory. It can be a format string. For historical reasons `file_name` is also accepted as an alias of this argument.

- **marker** (*str*) – The marker used to plot the graph. Default is 'x'. If None is given, it draws with no markers.
- **grid** (*bool*) – If True, set the axis grid on. The default value is True.
- **writer** (*writer object, optional*) – must be callable. object to dump the log to. If specified, it needs to have a correct *savefun* defined. The writer can override the save location in the `pytorch_pfn_extras.training.ExtensionsManager` object
- **kwargs** (*Any*) –

```
__init__(y_keys, x_key='iteration', trigger=(1, 'epoch'), postprocess=None, filename=None, marker='x',
        grid=True, **kwargs)
```

### Parameters

- **y\_keys** (*Union[Iterable[str], str]*) –
- **x\_key** (*str*) –
- **trigger** (*Optional[Union[pytorch\_pfn\_extras.training.\_trigger\_util.Trigger, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol], bool], Tuple[float, str]]]*) –
- **postprocess** (*Optional[Any]*) –
- **filename** (*Optional[str]*) –
- **marker** (*str*) –
- **grid** (*bool*) –
- **kwargs** (*Any*) –

### Methods

---

```
__init__(y_keys[, x_key, trigger, ...])
```

---

```
available()
```

---

|                                |                          |
|--------------------------------|--------------------------|
| <code>finalize(manager)</code> | Finalizes the extension. |
|--------------------------------|--------------------------|

---

|                                  |                                   |
|----------------------------------|-----------------------------------|
| <code>initialize(manager)</code> | Initializes up the manager state. |
|----------------------------------|-----------------------------------|

---

|                                       |  |
|---------------------------------------|--|
| <code>load_state_dict(to_load)</code> |  |
|---------------------------------------|--|

---

|   |  |
|---|--|
| <code>on_error(manager, exc, tb)</code> | Handles the error raised during training before final-ization. |
|---|--|

---

|                           |                                 |
|---------------------------|---------------------------------|
| <code>state_dict()</code> | Serializes the extension state. |
|---------------------------|---------------------------------|

---

**Attributes**

|                   |                                |
|-------------------|--------------------------------|
| default_name      | Default name of the extension. |
| is_async          |                                |
| name              |                                |
| needs_model_state |                                |
| priority          |                                |
| trigger           |                                |

**pytorch\_pfn\_extras.training.extensions.PrintReport**

```
class pytorch_pfn_extras.training.extensions.PrintReport(entries=None, log_report='LogReport',
                                                         out=<_io.TextIOWrapper
                                                         name='<stdout>' mode='w'
                                                         encoding='utf-8'>)
```

An extension to print the accumulated results.

This extension uses the log accumulated by a [LogReport](#) extension to print specified entries of the log in a human-readable format.

**Parameters**

- **entries** (*list of str or None*) – List of keys of observations to print. If *None* is passed, automatically infer keys from reported dict.
- **log\_report** (*str or LogReport*) – Log report to accumulate the observations. This is either the name of a LogReport extensions registered to the manager, or a LogReport instance to use internally.
- **out** (*IO[Any]*) – Stream to print the bar. Standard output is used by default.

**Return type** None

```
__init__(entries=None, log_report='LogReport', out=<_io.TextIOWrapper name='<stdout>' mode='w'
encoding='utf-8'>)
```

**Parameters**

- **entries** (*Optional[Sequence[str]]*) –
- **log\_report** (*Union[str, pytorch\_pfn\_extras.training.extensions.log\_report.LogReport]*) –
- **out** (*IO[Any]*) –

**Return type** None

## Methods

|   |   |
|---|---|
| <code>__init__([entries, log_report, out])</code> |   |
| <code>finalize(manager)</code>                    | Finalizes the extension.                                      |
| <code>get_log_report(manager)</code>              |   |
| <code>initialize(manager)</code>                  | Initializes up the manager state.                             |
| <code>load_state_dict(to_load)</code>             |   |
| <code>on_error(manager, exc, tb)</code>           | Handles the error raised during training before finalization. |
| <code>state_dict()</code>                         | Serializes the extension state.                               |

## Attributes

|                                |                                |
|--------------------------------|--------------------------------|
| <code>default_name</code>      | Default name of the extension. |
| <code>is_async</code>          |                                |
| <code>name</code>              |                                |
| <code>needs_model_state</code> |                                |
| <code>priority</code>          |                                |
| <code>trigger</code>           |                                |

## pytorch\_pfn\_extras.training.extensions.ProgressBar

```
class pytorch_pfn_extras.training.extensions.ProgressBar(training_length=None,
                                                         update_interval=100, bar_length=50,
                                                         out=<_io.TextIOWrapper
                                                         name='<stdout>' mode='w'
                                                         encoding='utf-8'>)
```

An extension to print a progress bar and recent training status.

This extension prints a progress bar at every call. It watches the current iteration and epoch to print the bar.

### Parameters

- **training\_length** (*tuple* or *None*) – Length of whole training. It consists of an integer and either 'epoch' or 'iteration'. If this value is omitted and the stop trigger of the manager is `IntervalTrigger`, this extension uses its attributes to determine the length of the training.
- **update\_interval** (*int*) – Number of iterations to skip printing the progress bar.
- **bar\_length** (*int*) – Length of the progress bar in characters.
- **out** (*Any*) – Stream to print the bar. Standard output is used by default.



```
__init__(training_length=None, update_interval=100, bar_length=50, out=<_io.TextIOWrapper
        name='<stdout>' mode='w' encoding='utf-8'>)
```

#### Parameters

- **training\_length** (*Optional*[*Any*]) –
- **update\_interval** (*int*) –
- **bar\_length** (*int*) –
- **out** (*Any*) –

#### Methods

|   |   |
|---|---|
| <code><b>__init__</b>([training_length, update_interval, ...])</code> |   |
| <code><b>finalize</b>(manager)</code>                                 | Finalizes the extension.                                      |
| <code><b>initialize</b>(manager)</code>                               | Initializes up the manager state.                             |
| <code><b>load_state_dict</b>(to_load)</code>                          |   |
| <code><b>on_error</b>(manager, exc, tb)</code>                        | Handles the error raised during training before finalization. |
| <code><b>state_dict</b>()</code>                                      | Serializes the extension state.                               |

#### Attributes

|                                |                                |
|--------------------------------|--------------------------------|
| <code>default_name</code>      | Default name of the extension. |
| <code>is_async</code>          |                                |
| <code>name</code>              |                                |
| <code>needs_model_state</code> |                                |
| <code>priority</code>          |                                |
| <code>trigger</code>           |                                |

### pytorch\_pfn\_extras.training.extensions.ProfileReport

```
class pytorch_pfn_extras.training.extensions.ProfileReport(store_keys=None, report_keys=None,
        trigger=(1, 'epoch'), filename=None,
        append=False, format=None,
        **kwargs)
```

Writes the profile results to a file.

Times are reported by using the `pytorch_pfn_extras.profiler.TimeSummary.report()` context manager.

#### Parameters

- **store\_keys** (*iterable of strs*) – Keys of values to write to the profiler report file.
- **report\_keys** (*iterable of strs*) – Keys of values that will be reported.
- **trigger** (*Optional[Union[pytorch\_pfn\_extras.training.\_trigger\_util.Trigger, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol], bool], Tuple[float, str]]]*) – Trigger that decides when to aggregate the result and output the values. This is distinct from the trigger of this extension itself. If it is a tuple in the form <int>, 'epoch' or <int>, 'iteration', it is passed to IntervalTrigger.
- **filename** (*str*) – Name of the log file under the output directory. It can be a format string: the last result dictionary is passed for the formatting. For example, users can use '{iteration}' to separate the log files for different iterations. If the log name is None, it does not output the log to any file.
- **append** (*bool, options1*) – If the file is JSON Lines or YAML, contents will be appended instead of rewriting the file every call.
- **format** (*str, optional*) – accepted values are 'json', 'json-lines' and 'yaml'.
- **writer** (*writer object, optional*) – must be callable. object to dump the log to. If specified, it needs to have a correct *savefun* defined. The writer can override the save location in the `pytorch_pfn_extras.training.ExtensionsManager` object
- **entries** (*list*) – list of str
- **kwargs** (*Any*) –

**Returns** header string templates (*str*): template string for print values.

**Return type** header (*str*)

```
__init__(store_keys=None, report_keys=None, trigger=(1, 'epoch'), filename=None, append=False,
         format=None, **kwargs)
```

#### Parameters

- **store\_keys** (*Optional[Iterable[str]]*) –
- **report\_keys** (*Optional[Iterable[str]]*) –
- **trigger** (*Optional[Union[pytorch\_pfn\_extras.training.\_trigger\_util.Trigger, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol], bool], Tuple[float, str]]]*) –
- **filename** (*Optional[str]*) –
- **append** (*bool*) –
- **format** (*Optional[str]*) –
- **kwargs** (*Any*) –

## Methods

|  |   |
|--|---|
| <code>__init__([store_keys, report_keys, trigger, ...])</code> |   |
| <code>finalize(manager)</code>                                 | Finalizes the extension.                                      |
| <code>initialize(manager)</code>                               | Initializes up the manager state.                             |
| <code>load_state_dict(to_load)</code>                          |   |
| <code>on_error(manager, exc, tb)</code>                        | Handles the error raised during training before finalization. |
| <code>state_dict()</code>                                      | Serializes the extension state.                               |

## Attributes

|                                |                                |
|--------------------------------|--------------------------------|
| <code>default_name</code>      | Default name of the extension. |
| <code>is_async</code>          |                                |
| <code>name</code>              |                                |
| <code>needs_model_state</code> |                                |
| <code>priority</code>          |                                |
| <code>trigger</code>           |                                |

## pytorch\_pfn\_extras.training.extensions.snapshot

`pytorch_pfn_extras.training.extensions.snapshot(savefun=None, filename='snapshot_iter_{.iteration}', *, target=None, condition=None, writer=None, snapshot_on_error=False, n_retains=-1, autoload=False, saver_rank=None)`

Returns a trainer extension to take snapshots of the trainer.

This extension serializes the manager object and saves it to the output directory. It is used to support resuming the training loop from the saved state.

This extension is called once per epoch by default. To take a snapshot at a different interval, a trigger object specifying the required interval can be passed along with this extension to the `extend()` method of the manager.

The default priority is -100, which is lower than that of most built-in extensions.

### Parameters

- **savefun** (*Optional*[*Any*]) – Function to save the manager. It takes two arguments: the output file path and the manager object. It is `torch.save()` by default. If `writer` is specified, this argument must be `None`.
- **filename** (*str*) – Name of the file into which the manager is serialized. It can be a format string, where the manager object is passed to the `str.format()` method.
- **target** (*Optional*[*Any*]) – Object to serialize. If it is not specified, it will be the manager object.

- **condition** (*Optional[Any]*) – Condition object. It must be a callable object that returns boolean without any arguments. If it returns `True`, the snapshot will be done. If not, it will be skipped. The default is a function that always returns `True`.
- **writer** (*Optional[pytorch\_pfn\_extras.writing.\_writer\_base.Writer]*) – Writer object. It must be a callable object. See below for the list of built-in writers. If `savefun` is other than `None`, this argument must be `None`. In that case, a `SimpleWriter` object instantiated with specified `savefun` argument will be used.
- **snapshot\_on\_error** (*bool*) – Whether to take a snapshot in case training loop has been failed.
- **n\_retains** (*int*) – Number of snapshot files to retain through the cleanup. Must be a positive integer for any cleanup to take place. Automatic deletion of old snapshots only works when the filename is string.
- **autoload** (*bool*) – With this enabled, the extension automatically finds the latest snapshot and loads the data to the target. Automatic loading only works when the filename is a string. It is assumed that snapshots are generated by `torch.save()`.
- **saver\_rank** (*int*) – If defined, the snapshot will be taken by only one rank when running in distributed mode and restored by all.

**Returns** Snapshot extension object.

**Return type** `pytorch_pfn_extras.training.extensions._snapshot._Snapshot`

---

### Using asynchronous writers

By specifying `writer` argument, writing operations can be made asynchronous, hiding I/O overhead of snapshots.

```
>>> from pytorch_pfn_extras.training import extensions
>>> from pytorch_pfn_extras import writing
>>> writer = writing.ProcessWriter()
>>> manager.extend(extensions.snapshot(writer=writer), trigger=(1, 'epoch'))
```

To change the format, you can pass a saving function as `savefun` argument of the writer.

```
>>> from pytorch_pfn_extras.training import extensions
>>> from pytorch_pfn_extras import writing
>>> writer = writing.ProcessWriter(
...     savefun=torch.save)
>>> manager.extend(extensions.snapshot(writer=writer), trigger=(1, 'epoch'))
```

---

This is the list of built-in snapshot writers.

- `pytorch_pfn_extras.writing.SimpleWriter`
- `pytorch_pfn_extras.writing.ThreadWriter`
- `pytorch_pfn_extras.writing.ProcessWriter`
- `pytorch_pfn_extras.writing.ThreadQueueWriter`
- `pytorch_pfn_extras.writing.ProcessQueueWriter`

See also:

- `pytorch_pfn_extras.training.extensions.snapshot_object()`

**pytorch\_pfn\_extras.training.extensions.Slack**

```
class pytorch_pfn_extras.training.extensions.Slack(channel, msg=None, *, start_msg='{default}',
                                                    end_msg='{default}', error_msg='{default}',
                                                    thread=True, filenames=None,
                                                    upload_trigger=None, context=None,
                                                    token=None)
```

An extension to communicate with Slack.

**Example**

```
>>> ppe.training.extensions.Slack(
...     channel="experiment-progress",
...     msg="Epoch #{manager.epoch}: loss = {val/loss}",
...     end_msg="{default} \n <@username> Check out the result!",
...     # Upload files at the end of the experiment.
...     filenames=["result/statistics.png"],
...     upload_trigger=(max_epoch, 'epoch'),
... )
```

This extension posts a message when:

- **start\_msg**: The training has started
- **msg**: The extension is triggered, usually at the end of each epoch
- **end\_msg**: The training has finished
- **error\_msg**: An exception has raised during the training

These messages can be specified as a format string, a callable that returns a string, or None to disable posting on that event.

When using a format string, the following variables are available for use:

- **manager**: an ExtensionsManager object
- **default**: the default message string
- **context**: an arbitrary object passed to this extension
- **error**: an Exception object (for **error\_msg** only)
- All reported values (**manager.observations**)

When using a callable, it should take (*ExtensionsManager, context*) or (*ExtensionsManager, Exception, context*) (for **error\_msg**) and return a string.

This extension can upload files along with the message when triggered. **filenames** can be a list of filenames (the same formatting rule as **msg** apply), or a callable taking (*ExtensionsManager, context*) and returning a list of filenames.

To use this extension, you must create a Slack app, then specify the token via an environment variable **SLACK\_BOT\_TOKEN** or **token** option.

**Parameters**

- **channel** (*str*) – The channel where messages and files will be sent. This can be a channel name or a channel ID.

- **msg** (*str*, *callable*, or *None*) – A message to be sent when triggered. It can be a string to be formatted using `.format` or a callable that returns a string.
- **start\_msg** (*str*, *callable*, or *None*) – A message to be sent at the beginning of the experiment.
- **end\_msg** (*str*, *callable*, or *None*) – A message to be sent at the completion of the experiment.
- **error\_msg** (*str*, *callable*, or *None*) – A message to be sent when an exception is raised during the experiment.
- **thread** (*bool*) – When True, subsequent messages will be posted as a thread of the original message. Default is True.
- **filenames** (*list of str or callable*) – A list of files that will be uploaded. These are string templates that can take values in the same way as `msg`, or a callable that returns a list of filenames.
- **upload\_trigger** (*trigger or None*) – Used to upload files at certain events. If not specified, files will be uploaded in every call.
- **context** (*Any*) – Any arbitrary user object you will need when generating a message.
- **token** (*str*) – Slack bot token. If *None*, the environment variable `SLACK_BOT_TOKEN` will be used. Optional, default is *None*.

**Return type** *None*

```
__init__(channel, msg=None, *, start_msg='{default}', end_msg='{default}', error_msg='{default}',  
         thread=True, filenames=None, upload_trigger=None, context=None, token=None)
```

#### Parameters

- **channel** (*str*) –
- **msg** (*Optional[Union[str, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol, Any], str]]]*) –
- **start\_msg** (*Optional[Union[str, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol, Any], str]]]*) –
- **end\_msg** (*Optional[Union[str, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol, Any], str]]]*) –
- **error\_msg** (*Optional[Union[str, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol, Any], Exception], str]]]*) –
- **thread** (*bool*) –
- **filenames** (*Optional[Union[Sequence[str], Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol, Any], Sequence[str]]]]*) –
- **upload\_trigger** (*Optional[Union[pytorch\_pfn\_extras.training.\_trigger\_util.Trigger, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol], bool], Tuple[float, str]]]*) –
- **context** (*Optional[Any]*) –

- **token** (*Optional[str]*) –

**Return type** None

## Methods

|  |   |
|--|---|
| <code>__init__(channel[, msg, start_msg, end_msg, ...])</code> |   |
| <code>default_end_msg(context)</code>                          |   |
| <code>default_error_msg(exc, context)</code>                   |   |
| <code>default_msg(context)</code>                              |   |
| <code>default_start_msg(context)</code>                        |   |
| <code>finalize(manager)</code>                                 | Finalizes the extension.                                      |
| <code>initialize(manager)</code>                               | Initializes up the manager state.                             |
| <code>load_state_dict(to_load)</code>                          |   |
| <code>on_error(manager, exc, tb)</code>                        | Handles the error raised during training before finalization. |
| <code>state_dict()</code>                                      | Serializes the extension state.                               |

## Attributes

|                                |                                |
|--------------------------------|--------------------------------|
| <code>default_name</code>      | Default name of the extension. |
| <code>is_async</code>          |                                |
| <code>name</code>              |                                |
| <code>needs_model_state</code> |                                |
| <code>priority</code>          |                                |
| <code>trigger</code>           |                                |

## pytorch\_pfn\_extras.training.extensions.SlackWebhook

```
class pytorch_pfn_extras.training.extensions.SlackWebhook(url, msg=None, *, start_msg='{default}',
                                                         end_msg='{default}',
                                                         error_msg='{default}', context=None)
```

An extension to communicate with Slack using Incoming Webhook.

## Example

```
>>> ppe.training.extensions.SlackWebhook(
...     url="https://hooks.slack.com/services/Txxxxx.....",
```

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```

...     msg="Epoch #{manager.epoch}: loss = {val/loss}",
...     end_msg="{default} \n <@username> Check out the result!",
... )

```

This extension posts a message when:

- **start\_msg**: The training has started
- **msg**: The extension is triggered, usually at the end of each epoch
- **end\_msg**: The training has finished
- **error\_msg**: An exception has raised during the training

These messages can be specified as a format string, a callable that returns a string, or None to disable posting on that event.

When using a format string, the following variables are available for use:

- **manager**: an `ExtensionsManager` object
- **default**: the default message string
- **context**: an arbitrary object passed to this extension
- **error**: an `Exception` object (for **error\_msg** only)
- All reported values (`manager.observations`)

When using a callable, it should take (*ExtensionsManager, context*) or (*ExtensionsManager, Exception, context*) (for **error\_msg**) and return a string.

#### Parameters

- **url** (*str*) – Incoming webhook URL to send messages.
- **msg** (*str, callable, or None*) – A message to be sent when triggered. It can be a string to be formatted using `.format` or a callable that returns a string.
- **start\_msg** (*str, callable, or None*) – A message to be sent at the beginning of the experiment.
- **end\_msg** (*str, callable, or None*) – A message to be sent at the completion of the experiment.
- **error\_msg** (*str, callable, or None*) – A message to be sent when an exception is raised during the experiment.
- **context** (*object*) – Any arbitrary user object you will need when generating a message.

**Return type** None

```

__init__(url, msg=None, *, start_msg='{default}', end_msg='{default}', error_msg='{default}',
         context=None)

```

#### Parameters

- **url** (*str*) –
- **msg** (*Optional[Union[str, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol, Any], str]]]*) –



- **start\_msg** (Optional[Union[str, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol, Any], str]]]) –
- **end\_msg** (Optional[Union[str, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol, Any], str]]]) –
- **error\_msg** (Optional[Union[str, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol, Any, Exception], str]]]) –
- **context** (Optional[Any]) –

**Return type** None

## Methods

|  |   |
|--|---|
| <code>__init__(url[, msg, start_msg, end_msg, ...])</code> |   |
| <code>default_end_msg(context)</code>                      |   |
| <code>default_error_msg(exc, context)</code>               |   |
| <code>default_msg(context)</code>                          |   |
| <code>default_start_msg(context)</code>                    |   |
| <code>finalize(manager)</code>                             | Finalizes the extension.                                      |
| <code>initialize(manager)</code>                           | Initializes up the manager state.                             |
| <code>load_state_dict(to_load)</code>                      |   |
| <code>on_error(manager, exc, tb)</code>                    | Handles the error raised during training before finalization. |
| <code>state_dict()</code>                                  | Serializes the extension state.                               |

## Attributes

|                                |                                |
|--------------------------------|--------------------------------|
| <code>default_name</code>      | Default name of the extension. |
| <code>is_async</code>          |                                |
| <code>name</code>              |                                |
| <code>needs_model_state</code> |                                |
| <code>priority</code>          |                                |
| <code>trigger</code>           |                                |

**pytorch\_pfn\_extras.training.extensions.VariableStatisticsPlot**

```
class pytorch_pfn_extras.training.extensions.VariableStatisticsPlot(targets,
                                                                    max_sample_size=1000,
                                                                    report_data=True,
                                                                    report_grad=True,
                                                                    plot_mean=True,
                                                                    plot_std=True,
                                                                    percentile_sigmas=(0, 0.13,
                                                                2.28, 15.87, 50, 84.13,
                                                                97.72, 99.87, 100),
                                                                    trigger=(1, 'epoch'),
                                                                    filename='statistics.png',
                                                                    figsize=None,
                                                                    marker=None, grid=True)
```

An extension to plot statistics for Tensors.

This extension collects statistics for a single `torch.Tensor`, a list of `torch.Tensors` or similarly a single or a list of `torch.nn.Modules` containing one or more `torch.Tensors`. In case multiple `torch.Tensors` are found, the means are computed. The collected statistics are plotted and saved as an image in the directory specified by the `Manager`.

Statistics include mean, standard deviation and percentiles.

This extension uses reservoir sampling to preserve memory, using a fixed size running sample. This means that collected items in the sample are discarded uniformly at random when the number of items becomes larger than the maximum sample size, but each item is expected to occur in the sample with equal probability.

:param targets (`torch.Tensor`: or list of either): Parameters for which statistics are collected. :param `torch.nn.Module`: or list of either): Parameters for which statistics are collected. :param `max_sample_size`: Maximum number of running samples. :type `max_sample_size`: `int` :param `report_data`: If `True`, data (e.g. weights) statistics are plotted. If

`False`, they are neither computed nor plotted.

**Parameters**

- **report\_grad** (*bool*) – If `True`, gradient statistics are plotted. If `False`, they are neither computed nor plotted.
- **plot\_mean** (*bool*) – If `True`, means are plotted. If `False`, they are neither computed nor plotted.
- **plot\_std** (*bool*) – If `True`, standard deviations are plotted. If `False`, they are neither computed nor plotted.
- **percentile\_sigmas** (*float or tuple of floats*) – Percentiles to plot in the range `[0, 100]`.
- **trigger** (*Optional[Union[pytorch\_pfn\_extras.training.\_trigger\_util.Trigger, Callable[[pytorch\_pfn\_extras.training.manager\_protocol.ExtensionsManagerProtocol], bool], Tuple[float, str]]]*) – Trigger that decides when to save the plots as an image. This is distinct from the trigger of this extension itself. If it is a tuple in the form `<int>, 'epoch'` or `<int>, 'iteration'`, it is passed to `IntervalTrigger`.
- **filename** (*str*) – Name of the output image file under the output directory. For historical reasons `file_name` is also accepted as an alias of this argument.

- **figsize** (*tuple of int*) – Matplotlib figsize argument that specifies the size of the output image.
- **marker** (*str*) – Matplotlib marker argument that specified the marker style of the plots.
- **grid** (*bool*) – Matplotlib grid argument that specifies whether grids are rendered in the plots or not.
- **writer** (*writer object, optional*) – must be callable. object to dump the log to. If specified, it needs to have a correct *savefun* defined. The writer can override the save location in the `pytorch_pfn_extras.training.ExtensionsManager` object
- **targets** (*Any*) –
- **max\_sample\_size** (*int*) –
- **report\_data** (*bool*) –
- **kwargs** (*Any*) –

```
__init__(targets, max_sample_size=1000, report_data=True, report_grad=True, plot_mean=True,
          plot_std=True, percentile_sigmas=(0, 0.13, 2.28, 15.87, 50, 84.13, 97.72, 99.87, 100), trigger=(1,
          'epoch'), filename=None, figsize=None, marker=None, grid=True, **kwargs)
```

#### Parameters

- **targets** (*Any*) –
- **max\_sample\_size** (*int*) –
- **report\_data** (*bool*) –
- **report\_grad** (*bool*) –
- **plot\_mean** (*bool*) –
- **plot\_std** (*bool*) –
- **percentile\_sigmas** (*Union[float, Tuple[float, ...]]*) –
- **trigger** (*Optional[Union[pytorch\_pfn\_extras.training.\_trigger\_util.Trigger, Callable[[pytorch\_pfn\_extras.training.\_manager\_protocol.ExtensionsManagerProtocol], bool], Tuple[float, str]]]*) –
- **filename** (*Optional[str]*) –
- **figsize** (*Optional[Tuple[int, ...]]*) –
- **marker** (*Optional[str]*) –
- **grid** (*bool*) –
- **kwargs** (*Any*) –

**Methods**

|  |   |
|--|---|
| <code>__init__(targets[, max_sample_size, ...])</code> |   |
| <code>available()</code>                               |   |
| <code>finalize(manager)</code>                         | Finalizes the extension.                                      |
| <code>initialize(manager)</code>                       | Initializes up the manager state.                             |
| <code>load_state_dict(to_load)</code>                  |   |
| <code>on_error(manager, exc, tb)</code>                | Handles the error raised during training before finalization. |
| <code>save_plot_using_module(plt, manager)</code>      |   |
| <code>state_dict()</code>                              | Serializes the extension state.                               |

**Attributes**

|                                |                                |
|--------------------------------|--------------------------------|
| <code>default_name</code>      | Default name of the extension. |
| <code>is_async</code>          |                                |
| <code>name</code>              |                                |
| <code>needs_model_state</code> |                                |
| <code>priority</code>          |                                |
| <code>trigger</code>           |                                |

**2.1.4 Triggers**

|  |  |
|--|--|
| <code>training.triggers.EarlyStoppingTrigger(self)</code>      | Trigger for Early Stopping                                     |
| <code>training.triggers.IntervalTrigger(period, unit)</code>   | Trigger based on a fixed interval.                             |
| <code>training.triggers.ManualScheduleTrigger(...)</code>      | Trigger invoked at specified point(s) of iterations or epochs. |
| <code>training.triggers.BestValueTrigger(key, compare)</code>  | Trigger invoked when specific value becomes best.              |
| <code>training.triggers.MaxValueTrigger(key[, trigger])</code> | Trigger invoked when specific value becomes maximum.           |
| <code>training.triggers.MinValueTrigger(key[, trigger])</code> | Trigger invoked when specific value becomes minimum.           |
| <code>training.triggers.OnceTrigger([call_on_resume])</code>   | Trigger based on the starting point of the iteration.          |
| <code>training.triggers.TimeTrigger(period)</code>             | Trigger based on a fixed time interval.                        |

**pytorch\_pfn\_extras.training.triggers.EarlyStoppingTrigger**

```
class pytorch_pfn_extras.training.triggers.EarlyStoppingTrigger(self, check_trigger=(1, 'epoch'),
                                                                monitor='main/loss',
                                                                patience=3, mode='auto',
                                                                verbose=False,
                                                                max_trigger=(100, 'epoch'))
```

Trigger for Early Stopping

This trigger works as follows. Within each *check interval* defined by the `check_trigger` argument, it monitors and accumulates the reported value at each iteration. At the end of each interval, it computes the mean of the accumulated values and compares it to the previous ones to maintain the *best* value. When it finds that the best value is not updated for some periods (defined by `patience`), this trigger fires.

**Parameters**

- **monitor** (*str*) – The metric you want to monitor
- **check\_trigger** (*TriggerLike*) – Trigger that decides the comparison interval between current best value and new value. This must be a tuple in the form of `<int>, 'epoch'` or `<int>, 'iteration'` which is passed to `IntervalTrigger`.
- **patience** (*int*) – Counts to let the trigger be patient. The trigger will not fire until the condition is met for successive `patience` checks.
- **mode** (*str*) – 'max', 'min', or 'auto'. It is used to determine how to compare the monitored values.
- **verbose** (*bool*) – Enable verbose output. If verbose is true, you can get more information
- **max\_trigger** (*Tuple[int, UnitLiteral]*) – Upper bound of the number of training loops

**Return type** None

```
__init__(check_trigger=(1, 'epoch'), monitor='main/loss', patience=3, mode='auto', verbose=False,
         max_trigger=(100, 'epoch'))
```

**Parameters**

- **check\_trigger** (*TriggerLike*) –
- **monitor** (*str*) –
- **patience** (*int*) –
- **mode** (*str*) –
- **verbose** (*bool*) –
- **max\_trigger** (*Tuple[int, UnitLiteral]*) –

**Return type** None

## Methods

---

`__init__([check_trigger, monitor, patience, ...])`

---

`get_training_length()`

---

`load_state_dict(state)`

---

|  |  |
|--|--|
| <code>may_fire(iteration, epoch_length)</code> | Flags if the trigger may fire at the current iteration |
| <code>state_dict()</code>                      |  |

---

## pytorch\_pfn\_extras.training.triggers.IntervalTrigger

**class** pytorch\_pfn\_extras.training.triggers.IntervalTrigger(*period, unit*)

Trigger based on a fixed interval.

This trigger accepts iterations divided by a given interval. There are two ways to specify the interval: per iterations and epochs. *Iteration* means the number of updates, while *epoch* means the number of sweeps over the training dataset. Fractional values are allowed if the interval is a number of epochs; the trigger uses the *iteration* and *epoch\_detail* attributes defined by the manager.

For the description of triggers see `get_trigger()`.

### Parameters

- **period** (*int or float*) – Length of the interval. Must be an integer if unit is 'iteration'.
- **unit** (*str*) – Unit of the length specified by period. It must be either 'iteration' or 'epoch'.

`__init__(period, unit)`

### Parameters

- **period** (*float*) –
- **unit** (*UnitLiteral*) –

## Methods

---

`__init__(period, unit)`

---

`get_training_length()`

---

`load_state_dict(state)`

---

|  |  |
|--|--|
| <code>may_fire(iteration, epoch_length)</code> | Flags if the trigger may fire at the current iteration |
| <code>state_dict()</code>                      |  |

---

**pytorch\_pfn\_extras.training.triggers.ManualScheduleTrigger**

**class** pytorch\_pfn\_extras.training.triggers.ManualScheduleTrigger(*points, unit*)

Trigger invoked at specified point(s) of iterations or epochs.

This trigger accepts iterations or epochs indicated by given point(s). There are two ways to specify the point(s): iteration and epoch. `iteration` means the number of updates, while `epoch` means the number of sweeps over the training dataset. Fractional values are allowed if the point is a number of epochs; the trigger uses the `iteration` and `epoch_detail` attributes defined by the manager.

**Parameters**

- **points** (*int, float, or list of int or float*) – time of the trigger. Must be an integer or list of integer if unit is 'iteration'.
- **unit** (*str*) – Unit of the time specified by points. It must be either 'iteration' or 'epoch'.

`__init__`(*points, unit*)

**Parameters**

- **points** (*Union[float, Sequence[float]]*) –
- **unit** (*UnitLiteral*) –

**Methods**


---

`__init__`(*points, unit*)

---

`load_state_dict`(*state*)

---

|  |  |
|--|--|
| <code>may_fire</code> ( <i>iteration, epoch_length</i> ) | Flags if the trigger may fire at the current iteration |
| <code>state_dict</code> ()                               |  |

---

**pytorch\_pfn\_extras.training.triggers.BestValueTrigger**

**class** pytorch\_pfn\_extras.training.triggers.BestValueTrigger(*key, compare, trigger=(1, 'epoch')*)

Trigger invoked when specific value becomes best.

**Parameters**

- **key** (*str*) – Key of value.
- **compare** (*callable*) – Compare function which takes current best value and new value and returns whether new value is better than current best.
- **trigger** (*TriggerLike*) – Trigger that decides the comparison interval between current best value and new value. This must be a tuple in the form of `<int>, 'epoch'` or `<int>, 'iteration'` which is passed to `IntervalTrigger`.

**Return type** None

`__init__`(*key, compare, trigger=(1, 'epoch')*)

**Parameters**

- **key** (*str*) –
- **compare** (*Callable*[[*float*, *float*], *bool*]) –
- **trigger** (*TriggerLike*) –

**Return type** None

### Methods

---

`__init__`(key, compare[, trigger])

---

`load_state_dict`(to\_load)

---

|   |  |
|---|--|
| <code>may_fire</code> (iteration, epoch_length) | Flags if the trigger may fire at the current iteration |
| <code>state_dict</code> ()                      |  |

---

## pytorch\_pfn\_extras.training.triggers.MaxValueTrigger

**class** pytorch\_pfn\_extras.training.triggers.**MaxValueTrigger**(key, trigger=(1, 'epoch'))

Trigger invoked when specific value becomes maximum.

For example you can use this trigger to take snapshot on the epoch the validation accuracy is maximum.

### Parameters

- **key** (*str*) – Key of value. The trigger fires when the value associated with this key becomes maximum.
- **trigger** (*TriggerLike*) – Trigger that decides the comparison interval between current best value and new value. This must be a tuple in the form of <int>, 'epoch' or <int>, 'iteration' which is passed to IntervalTrigger.

`__init__`(key, trigger=(1, 'epoch'))

### Parameters

- **key** (*str*) –
- **trigger** (*TriggerLike*) –

### Methods

---

`__init__`(key[, trigger])

---

`load_state_dict`(to\_load)

---

|   |  |
|---|--|
| <code>may_fire</code> (iteration, epoch_length) | Flags if the trigger may fire at the current iteration |
| <code>state_dict</code> ()                      |  |

---



**pytorch\_pfn\_extras.training.triggers.MinValueTrigger**

**class** pytorch\_pfn\_extras.training.triggers.MinValueTrigger(*key*, *trigger*=(1, 'epoch'))

Trigger invoked when specific value becomes minimum.

For example you can use this trigger to take snapshot on the epoch the validation loss is minimum.

**Parameters**

- **key** (*str*) – Key of value. The trigger fires when the value associated with this key becomes minimum.
- **trigger** (*TriggerLike*) – Trigger that decides the comparison interval between current best value and new value. This must be a tuple in the form of <int>, 'epoch' or <int>, 'iteration' which is passed to IntervalTrigger.

**\_\_init\_\_**(*key*, *trigger*=(1, 'epoch'))

**Parameters**

- **key** (*str*) –
- **trigger** (*TriggerLike*) –

**Methods**


---

**\_\_init\_\_**(*key*[, *trigger*])

---

**load\_state\_dict**(*to\_load*)

---

|  |  |
|--|--|
| <b>may_fire</b> ( <i>iteration</i> , <i>epoch_length</i> ) | Flags if the trigger may fire at the current iteration |
|--|--|

---

**state\_dict**()

---

**pytorch\_pfn\_extras.training.triggers.OnceTrigger**

**class** pytorch\_pfn\_extras.training.triggers.OnceTrigger(*call\_on\_resume*=False)

Trigger based on the starting point of the iteration.

This trigger accepts only once at starting point of the iteration. There are two ways to specify the starting point: only starting point in whole iteration or called again when training resumed.

**Parameters** **call\_on\_resume** (*bool*) – Whether the extension is called again or not when restored from a snapshot. It is set to False by default.

**Return type** None

**finished**

Flag that indicates whether or not this trigger will

**Type** bool

**fire in the future. This flag is used to determine if the extension should be initialized after resume.**

**\_\_init\_\_**(*call\_on\_resume*=False)

**Parameters** `call_on_resume` (*bool*) –

**Return type** `None`

### Methods

---

`__init__`(`call_on_resume`)

---

`load_state_dict`(`to_load`)

---

|  |  |
|--|--|
| <code>may_fire</code> ( <code>iteration</code> , <code>epoch_length</code> ) | Flags if the trigger may fire at the current iteration |
| <code>state_dict</code> ()   |  |

---

### Attributes

---

`finished`

---

## pytorch\_pfn\_extras.training.triggers.TimeTrigger

**class** `pytorch_pfn_extras.training.triggers.TimeTrigger`(*period*)

Trigger based on a fixed time interval.

This trigger accepts iterations with a given interval time.

**Parameters** `period` (*float*) – Interval time. It is given in seconds.

**Return type** `None`

`__init__`(*period*)

**Parameters** `period` (*float*) –

**Return type** `None`

### Methods

---

`__init__`(`period`)

---

`load_state_dict`(`to_load`)

---

|   |  |
|---|--|
| <code>may_fire</code> ( <code>iteration</code> , <code>epoch_len</code> ) | Flags if the trigger may fire at the current iteration |
| <code>state_dict</code> ()  |  |

---

## 2.1.5 Reporting

|   |   |
|---|---|
| <code>reporting.Reporter()</code>                 | Object to which observed values are reported.             |
| <code>reporting.report(values[, observer])</code> | Reports observed values with the current reporter object. |
| <code>reporting.report_scope(observation)</code>  | Returns a report scope with the current reporter.         |

### pytorch\_pfn\_extras.reporting.Reporter

**class** pytorch\_pfn\_extras.reporting.Reporter

Object to which observed values are reported.

Reporter is used to collect values that users want to watch. The reporter object holds a mapping from value names to the actually observed values. We call this mapping *observations*.

When a value is passed to the reporter, an object called *observer* can be optionally attached. In this case, the name of the observer is added as the prefix of the value name. The observer name should be registered beforehand.

See the following example:

```
>>> from pytorch_pfn_extras.reporting import Reporter, report, report_scope
>>>
>>> reporter = Reporter()
>>> observer = object() # it can be an arbitrary (reference) object
>>> reporter.add_observer('my_observer', observer)
>>> observation = {}
>>> with reporter.scope(observation):
...     reporter.report({'x': 1}, observer)
...
>>> observation
{'my_observer/x': 1}
```

There are also a global API to add values:

```
>>> reporter = Reporter()
>>> observation = {}
>>> with reporter:
...     with report_scope(observation):
...         report({'x': 1})
...
>>> observation
{'x': 1}
```

The most important application of Reporter is to report observed values from each link or chain in the training and validation procedures. and some extensions prepare their own Reporter object with the hierarchy of the target module registered as observers. We can use `report()` function inside any `nn.Module` to report the observed values (e.g., training loss, accuracy, activation statistics, etc.).

**Return type** None

**observation**

Dictionary of observed values.

**\_\_init\_\_()**

**Return type** None

## Methods

---

|   |   |
|---|---|
| <code>__init__()</code>                       |   |
| <code>add_observer(name, observer)</code>     | Registers an observer of values.                          |
| <code>add_observers(prefix, observers)</code> | Registers multiple observers at once.                     |
| <code>report(values[, observer])</code>       | Reports observed values.                                  |
| <code>scope(observation)</code>               | Creates a scope to report observed values to observation. |

---

## pytorch\_pfn\_extras.reporting.report

`pytorch_pfn_extras.reporting.report(values, observer=None)`

Reports observed values with the current reporter object.

Any reporter object can be set current by the `with` statement. This function calls the `Reporter.report()` method of the current reporter. If no reporter object is current, this function does nothing.

---

### Example

The most typical example is a use within `nn.Module`. Suppose that a module is registered to the current reporter as an observer (for example, the target module of the optimizer is automatically registered to the main reporter. We can report some values from the link as follows:

```
class MyRegressor:
    def __init__(self, predictor):
        super().__init__(predictor=predictor)

    def __call__(self, x, y):
        # This chain just computes the mean absolute and squared
        # errors between the prediction and y.
        pred = self.predictor(x)
        abs_error = F.sum(abs(pred - y)) / len(x)
        loss = F.mean_squared_error(pred, y)

        # Report the mean absolute and squared errors.
        reporter.report({
            'abs_error': abs_error,
            'squared_error': loss,
        }, self)

    return loss
```

If the module is named 'main' in the hierarchy these reported values are named 'main/abs\_error' and 'main/squared\_error'.

---

### Parameters

- **values** (*dict*) – Dictionary of observed values.
- **observer** (*Optional[torch.nn.modules.module.Module]*) – Observer object. Its object ID is used to retrieve the observer name, which is used as the prefix of the registration name of the observed value.

**Return type** None

### pytorch\_pfn\_extras.reporting.report\_scope

pytorch\_pfn\_extras.reporting.**report\_scope**(*observation*)

Returns a report scope with the current reporter.

This is equivalent to `get_current_reporter().scope(observation)`, except that it does not make the reporter current redundantly.

**Parameters** **observation** (*Dict[str, Union[torch.Tensor, numpy.ndarray, numpy.floating, float, Callable[[], float]]]*) –

**Return type** Generator[None, None, None]

## 2.1.6 Logging

---

*logging.get\_logger*(name)

Returns a child logger to be used by applications.

---

### pytorch\_pfn\_extras.logging.get\_logger

pytorch\_pfn\_extras.logging.**get\_logger**(*name*)

Returns a child logger to be used by applications.

**Parameters** **name** (*str*) – Name used to register and retrieve the logger object.

**Returns** A logging.Logger object used to log in the application code.

**Return type** logging.Logger

## 2.1.7 Profiler

---

*profiler.TimeSummary.report*(tag[, use\_cuda])

Context manager to automatically report execution times.

---

### pytorch\_pfn\_extras.profiler.TimeSummary.report

TimeSummary.**report**(*tag, use\_cuda=False*)

Context manager to automatically report execution times.

The start and completion times are obtained automatically, the user only needs to provide a tag to identify the value in the summary values.

**Parameters**

- **tag** (*str*) – A name to identify the section of code being profiled.
- **use\_cuda** (*bool*) – Indicates if GPU time should also be profiled.

**Return type** Generator[pytorch\_pfn\_extras.profiler.\_time\_summary.\_ReportNotification, None, None]

## 2.2 Distributed Training

|  |  |
|--|--|
| <code>nn.parallel.DistributedDataParallel(module)</code>       | Module for distributed data parallelism  |
| <code>distributed.initialize_ompi_environment(*[, ...])</code> | Initialize <i>torch.distributed</i> environments with values taken from OpenMPI. |

### 2.2.1 pytorch\_pfn\_extras.nn.parallel.DistributedDataParallel

```
class pytorch_pfn_extras.nn.parallel.DistributedDataParallel(module, broadcast_buffers=True,
                                                            negotiate_grads=True,
                                                            process_group=None,
                                                            reduce_function=None,
                                                            broadcast_function=None,
                                                            **kwargs)
```

Module for distributed data parallelism

This class synchronizes the gradients and the buffers after backward computations.

#### Parameters

- **module** (*torch.nn.modules.module.Module*) – torch.nn.Module object to be trained
- **broadcast\_buffers** (*bool*) – Boolean flag to broadcast buffers after backward computations. Broadcasting buffers may be helpful when the module includes BatchNormalization. However, it will degrade training throughput. (default: *True*)
- **negotiate\_grads** (*bool*) – Boolean flag to choose gradients to be sent before all-reduce. This flag is necessary when the computation graph of the module is dynamic. (default: *True*)
- **process\_group** (*Optional[torch.distributed.distributed\_c10d.ProcessGroup]*) – Process group used for broadcasting and reducing. (default: *torch.distributed.group.WORLD*)
- **reduce\_function** (*Optional[Callable[[Sequence[torch.Tensor], Optional[torch.distributed.distributed\_c10d.ProcessGroup]], None]]*) – All-reduce function
- **broadcast\_function** (*Optional[Callable[[Sequence[torch.Tensor], Optional[torch.distributed.distributed\_c10d.ProcessGroup]], None]]*) – Broadcast function
- **kwargs** (*Any*) –

**Return type** *None*

```
__init__(module, broadcast_buffers=True, negotiate_grads=True, process_group=None,
         reduce_function=None, broadcast_function=None, **kwargs)
```

This module receives keyword arguments for the compatibility with *torch.nn.parallel.DistributedDataParallel*. It shows a warning when setting the ignored arguments.

#### Parameters

- **module** (*torch.nn.modules.module.Module*) –
- **broadcast\_buffers** (*bool*) –
- **negotiate\_grads** (*bool*) –

- **process\_group** (Optional[torch.distributed.distributed\_c10d.ProcessGroup]) –
- **reduce\_function** (Optional[Callable[[Sequence[torch.Tensor], Optional[torch.distributed.distributed\_c10d.ProcessGroup]], None]]) –
- **broadcast\_function** (Optional[Callable[[Sequence[torch.Tensor], Optional[torch.distributed.distributed\_c10d.ProcessGroup]], None]]) –
- **kwargs** (Any) –

**Return type** None

## Methods

|   |  |
|---|--|
| <code>__init__(module[, broadcast_buffers, ...])</code> | This module receives keyword arguments for the compatibility with <i>torch.nn.parallel.DistributedDataParallel</i> . |
| <code>add_module(name, module)</code>                   | Adds a child module to the current module.   |
| <code>apply(fn)</code>                                  | Applies <i>fn</i> recursively to every submodule (as returned by <i>.children()</i> ) as well as self.               |
| <code>bfloat16()</code>                                 | Casts all floating point parameters and buffers to <i>bfloat16</i> datatype.   |
| <code>buffers([recurse])</code>                         | Returns an iterator over module buffers.   |
| <code>children()</code>                                 | Returns an iterator over immediate children modules.   |
| <code>cpu()</code>                                      | Moves all model parameters and buffers to the CPU.   |
| <code>cuda([device])</code>                             | Moves all model parameters and buffers to the GPU.   |
| <code>double()</code>                                   | Casts all floating point parameters and buffers to <i>double</i> datatype.   |
| <code>eval()</code>                                     | Sets the module in evaluation mode.  |
| <code>extra_repr()</code>                               | Set the extra representation of the module   |
| <code>float()</code>                                    | Casts all floating point parameters and buffers to <i>float</i> datatype.  |
| <code>forward(*args, **kwargs)</code>                   | Defines the computation performed at every call.   |
| <code>get_buffer(target)</code>                         | Returns the buffer given by <i>target</i> if it exists, otherwise throws an error.                                   |
| <code>get_extra_state()</code>                          | Returns any extra state to include in the module's <i>state_dict</i> .   |
| <code>get_parameter(target)</code>                      | Returns the parameter given by <i>target</i> if it exists, otherwise throws an error.                                |
| <code>get_submodule(target)</code>                      | Returns the submodule given by <i>target</i> if it exists, otherwise throws an error.                                |
| <code>half()</code>                                     | Casts all floating point parameters and buffers to <i>half</i> datatype.   |
| <code>ipu([device])</code>                              | Moves all model parameters and buffers to the IPU.   |
| <code>load_state_dict(state_dict[, strict])</code>      | Copies parameters and buffers from <i>state_dict</i> into this module and its descendants.                           |
| <code>modules()</code>                                  | Returns an iterator over all modules in the network.   |
| <code>named_buffers([prefix, recurse])</code>           | Returns an iterator over module buffers, yielding both the name of the buffer as well as the buffer itself.          |

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|  |  |
|--|--|
| <code>named_children()</code>                                | Returns an iterator over immediate children modules, yielding both the name of the module as well as the module itself.    |
| <code>named_modules([memo, prefix, remove_duplicate])</code> | Returns an iterator over all modules in the network, yielding both the name of the module as well as the module itself.    |
| <code>named_parameters([prefix, recurse])</code>             | Returns an iterator over module parameters, yielding both the name of the parameter as well as the parameter itself.       |
| <code>no_sync()</code>                                       | A context manager to disable synchronization after backward  |
| <code>parameters([recurse])</code>                           | Returns an iterator over module parameters.  |
| <code>register_backward_hook(hook)</code>                    | Registers a backward hook on the module.   |
| <code>register_buffer(name, tensor[, persistent])</code>     | Adds a buffer to the module.   |
| <code>register_comm_hook(hook)</code>                        | Registers a hook function.   |
| <code>register_forward_hook(hook)</code>                     | Registers a forward hook on the module.  |
| <code>register_forward_pre_hook(hook)</code>                 | Registers a forward pre-hook on the module.  |
| <code>register_full_backward_hook(hook)</code>               | Registers a backward hook on the module.   |
| <code>register_load_state_dict_post_hook(hook)</code>        | Registers a post hook to be run after module's <code>load_state_dict</code> is called.                                     |
| <code>register_module(name, module)</code>                   | Alias for <code>add_module()</code> .  |
| <code>register_parameter(name, param)</code>                 | Adds a parameter to the module.  |
| <code>requires_grad_([requires_grad])</code>                 | Change if autograd should record operations on parameters in this module.  |
| <code>set_extra_state(state)</code>                          | This function is called from <code>load_state_dict()</code> to handle any extra state found within the <i>state_dict</i> . |
| <code>share_memory()</code>                                  | See <code>torch.Tensor.share_memory_()</code>  |
| <code>state_dict()</code>                                    | Returns a dictionary containing references to the whole state of the module.   |
| <code>to(*args, **kwargs)</code>                             | Moves and/or casts the parameters and buffers.   |
| <code>to_empty(*, device)</code>                             | Moves the parameters and buffers to the specified device without copying storage.  |
| <code>train([mode])</code>                                   | Sets the module in training mode.  |
| <code>type(dst_type)</code>                                  | Casts all parameters and buffers to <code>dst_type</code> .  |
| <code>xpu([device])</code>                                   | Moves all model parameters and buffers to the XPU.   |
| <code>zero_grad([set_to_none])</code>                        | Sets gradients of all model parameters to zero.  |

### Attributes

|                            |  |
|----------------------------|--|
| <code>T_destination</code> | alias of <code>TypeVar('T_destination', bound=Mapping[str, torch.Tensor])</code> |
| <code>dump_patches</code>  |  |



## 2.2.2 pytorch\_pfn\_extras.distributed.initialize\_ompi\_environment

```
pytorch_pfn_extras.distributed.initialize_ompi_environment(*, backend='gloo', init_method='tcp',
                                                         world_size=1, rank=0, local_rank=0,
                                                         addr='localhost', port='1234')
```

Initialize *torch.distributed* environments with values taken from OpenMPI.

### Parameters

- **backend** (*str*) – The backend to be used, only "gloo" and "nccl" are supported. Defaults to "gloo".
- **init\_method** (*str*) – Initialization method used by torch, only "tcp" and "env" are supported. Defaults to "tcp".
- **world\_size** (*int*) – The total world size to be used in case it is not specified in MPI env vars. Defaults to 1.
- **rank** (*int*) – The process rank to be used in case it is not specified in MPI env vars. Defaults to 0.
- **local\_rank** (*int*) – The process local rank to be used in case it is not specified in MPI env vars. Defaults to 0.
- **addr** (*str*) – The address of the master process of *torch.distributed*. Defaults to "localhost".
- **port** (*str*) – The port of the master process of *torch.distributed*. Defaults to "1234".

**Return type** Tuple[int, int, int]

## 2.3 Check Pointing

---

*utils.checkpoint*

---

### 2.3.1 pytorch\_pfn\_extras.utils.checkpoint

#### Functions

---

`checkpoint(function, *args, **kwargs)`

---

## 2.4 Lazy Modules

|   |  |
|---|--|
| <code>nn.Ensure(*[, shape, dtype, broadcastable, ...])</code> | Module to check the shape of a tensor.         |
| <code>nn.ensure(tensor[, shape, dtype, ...])</code>           | Checks the shape and type of a tensor.         |
| <code>nn.LazyLinear(in_features, *args, **kwargs)</code>      | Linear module with lazy weight initialization. |
| <code>nn.LazyConv1d(in_channels, *args, **kwargs)</code>      | Conv1d module with lazy weight initialization. |
| <code>nn.LazyConv2d(in_channels, *args, **kwargs)</code>      | Conv2d module with lazy weight initialization. |

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|   |   |
|---|---|
| <code>nn.LazyConv3d</code> (in_channels, *args, **kwargs)       | Conv3d module with lazy weight initialization.      |
| <code>nn.LazyBatchNorm1d</code> (num_features, *args, **kwargs) | BatchNorm1d module with lazy weight initialization. |
| <code>nn.LazyBatchNorm2d</code> (num_features, *args, **kwargs) | BatchNorm2d module with lazy weight initialization. |
| <code>nn.LazyBatchNorm3d</code> (num_features, *args, **kwargs) | BatchNorm3d module with lazy weight initialization. |

### 2.4.1 pytorch\_pfn\_extras.nn.Ensure

**class** `pytorch_pfn_extras.nn.Ensure`(\* , shape=None, dtype=None, broadcastable=False, can\_cast=False)  
Module to check the shape of a tensor.

#### Parameters

- **shape** (*Optional[Tuple[Optional[int], ...]]*) – Tuple with the desired shape. If the input tensor shape is not compatible, *ValueError* will be raised. If *None* is set as a dimension value, that dimension will be ignored.
- **dtype** (*Optional[torch.dtype]*) – Checks if the *dtype* of the input tensor matches the provided one.
- **broadcastable** (*bool*) – Check if the shapes are compatible using broadcasting rules.
- **can\_cast** (*bool*) – Check if the input tensor can be casted to the provided type.

**\_\_init\_\_**(\* , shape=None, dtype=None, broadcastable=False, can\_cast=False)

Initializes internal Module state, shared by both `nn.Module` and `ScriptModule`.

#### Parameters

- **shape** (*Optional[Tuple[Optional[int], ...]]*) –
- **dtype** (*Optional[torch.dtype]*) –
- **broadcastable** (*bool*) –
- **can\_cast** (*bool*) –

#### Methods

|   |  |
|---|--|
| <code>__init__</code> (*[, shape, dtype, broadcastable, ...]) | Initializes internal Module state, shared by both <code>nn.Module</code> and <code>ScriptModule</code> .           |
| <code>add_module</code> (name, module)                        | Adds a child module to the current module.   |
| <code>apply</code> (fn)                                       | Applies <code>fn</code> recursively to every submodule (as returned by <code>.children()</code> ) as well as self. |
| <code>bfloat16</code> ()                                      | Casts all floating point parameters and buffers to <code>bfloat16</code> datatype.                                 |
| <code>buffers</code> ([recurse])                              | Returns an iterator over module buffers.   |
| <code>children</code> ()                                      | Returns an iterator over immediate children modules.   |
| <code>cpu</code> ()   | Moves all model parameters and buffers to the CPU.   |
| <code>cuda</code> ([device])                                  | Moves all model parameters and buffers to the GPU.   |
| <code>double</code> ()  | Casts all floating point parameters and buffers to <code>double</code> datatype.                                   |

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|  |  |
|--|--|
| <code>eval()</code>  | Sets the module in evaluation mode.  |
| <code>extra_repr()</code>                                    | Set the extra representation of the module   |
| <code>float()</code>   | Casts all floating point parameters and buffers to float datatype.   |
| <code>forward(input)</code>                                  | Defines the computation performed at every call.   |
| <code>get_buffer(target)</code>                              | Returns the buffer given by <code>target</code> if it exists, otherwise throws an error.   |
| <code>get_extra_state()</code>                               | Returns any extra state to include in the module's <code>state_dict</code> .   |
| <code>get_parameter(target)</code>                           | Returns the parameter given by <code>target</code> if it exists, otherwise throws an error.                                      |
| <code>get_submodule(target)</code>                           | Returns the submodule given by <code>target</code> if it exists, otherwise throws an error.                                      |
| <code>half()</code>  | Casts all floating point parameters and buffers to half datatype.  |
| <code>ipu([device])</code>                                   | Moves all model parameters and buffers to the IPU.   |
| <code>load_state_dict(state_dict[, strict])</code>           | Copies parameters and buffers from <code>state_dict</code> into this module and its descendants.                                 |
| <code>modules()</code>                                       | Returns an iterator over all modules in the network.   |
| <code>named_buffers([prefix, recurse])</code>                | Returns an iterator over module buffers, yielding both the name of the buffer as well as the buffer itself.                      |
| <code>named_children()</code>                                | Returns an iterator over immediate children modules, yielding both the name of the module as well as the module itself.          |
| <code>named_modules([memo, prefix, remove_duplicate])</code> | Returns an iterator over all modules in the network, yielding both the name of the module as well as the module itself.          |
| <code>named_parameters([prefix, recurse])</code>             | Returns an iterator over module parameters, yielding both the name of the parameter as well as the parameter itself.             |
| <code>parameters([recurse])</code>                           | Returns an iterator over module parameters.  |
| <code>register_backward_hook(hook)</code>                    | Registers a backward hook on the module.   |
| <code>register_buffer(name, tensor[, persistent])</code>     | Adds a buffer to the module.   |
| <code>register_forward_hook(hook)</code>                     | Registers a forward hook on the module.  |
| <code>register_forward_pre_hook(hook)</code>                 | Registers a forward pre-hook on the module.  |
| <code>register_full_backward_hook(hook)</code>               | Registers a backward hook on the module.   |
| <code>register_load_state_dict_post_hook(hook)</code>        | Registers a post hook to be run after module's <code>load_state_dict</code> is called.   |
| <code>register_module(name, module)</code>                   | Alias for <code>add_module()</code> .  |
| <code>register_parameter(name, param)</code>                 | Adds a parameter to the module.  |
| <code>requires_grad_([requires_grad])</code>                 | Change if autograd should record operations on parameters in this module.  |
| <code>set_extra_state(state)</code>                          | This function is called from <code>load_state_dict()</code> to handle any extra state found within the <code>state_dict</code> . |
| <code>share_memory()</code>                                  | See <code>torch.Tensor.share_memory_()</code>  |
| <code>state_dict(*args[, destination, prefix, ...])</code>   | Returns a dictionary containing references to the whole state of the module.   |
| <code>to(*args, **kwargs)</code>                             | Moves and/or casts the parameters and buffers.   |
| <code>to_empty(*, device)</code>                             | Moves the parameters and buffers to the specified device without copying storage.  |
| <code>train([mode])</code>                                   | Sets the module in training mode.  |

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|                                       |   |
|---------------------------------------|---|
| <code>type(dst_type)</code>           | Casts all parameters and buffers to <code>dst_type</code> . |
| <code>xpu([device])</code>            | Moves all model parameters and buffers to the XPU.          |
| <code>zero_grad([set_to_none])</code> | Sets gradients of all model parameters to zero.             |

**Attributes**

|                            |  |
|----------------------------|--|
| <code>T_destination</code> | alias of <code>TypeVar('T_destination', bound=Dict[str, Any])</code> |
| <code>dump_patches</code>  |  |

**2.4.2 pytorch\_pfn\_extras.nn.ensure**

`pytorch_pfn_extras.nn.ensure(tensor, shape=None, dtype=None, broadcastable=False, can_cast=False)`  
 Checks the shape and type of a tensor.

**Parameters**

- **shape** (*Optional[Tuple[Optional[int], ...]]*) – Tuple with the desired shape. If the input tensor shape is not compatible, *ValueError* will be raised. If *None* is set as a dimension value, that dimension will be ignored.
- **dtype** (*Optional[torch.dtype]*) – Checks if the *dtype* of the input tensor matches the provided one.
- **broadcastable** (*bool*) – Check if the shapes are compatible using broadcasting rules.
- **can\_cast** (*bool*) – Check if the input tensor can be casted to the provided type.
- **tensor** (*torch.Tensor*) –

**Return type** `None`

**2.4.3 pytorch\_pfn\_extras.nn.LazyLinear**

`class pytorch_pfn_extras.nn.LazyLinear(in_features, *args, **kwargs)`  
 Linear module with lazy weight initialization.

When `in_features` is `None`, it is determined at the first time of the forward step.

**Parameters**

- **in\_features** (*int*) –
- **args** (*Any*) –
- **kwargs** (*Any*) –

**Return type** `None`

`__init__(in_features, *args, **kwargs)`

Initializes internal Module state, shared by both `nn.Module` and `ScriptModule`.

**Parameters**

- **in\_features** (*Optional[int]*) –

- **args** (*Any*) –
- **kwargs** (*Any*) –

**Return type** None

## Methods

|  |   |
|--|---|
| <code>__init__(in_features, *args, **kwargs)</code>          | Initializes internal Module state, shared by both <code>nn.Module</code> and <code>ScriptModule</code> .                |
| <code>add_module(name, module)</code>                        | Adds a child module to the current module.  |
| <code>apply(fn)</code>                                       | Applies <code>fn</code> recursively to every submodule (as returned by <code>.children()</code> ) as well as self.      |
| <code>bfloat16()</code>                                      | Casts all floating point parameters and buffers to <code>bfloat16</code> datatype.                                      |
| <code>buffers([recurse])</code>                              | Returns an iterator over module buffers.  |
| <code>children()</code>                                      | Returns an iterator over immediate children modules.  |
| <code>cpu()</code>   | Moves all model parameters and buffers to the CPU.  |
| <code>cuda([device])</code>                                  | Moves all model parameters and buffers to the GPU.  |
| <code>double()</code>  | Casts all floating point parameters and buffers to <code>double</code> datatype.  |
| <code>eval()</code>  | Sets the module in evaluation mode.   |
| <code>extra_repr()</code>                                    | Set the extra representation of the module  |
| <code>float()</code>   | Casts all floating point parameters and buffers to <code>float</code> datatype.   |
| <code>forward(input)</code>                                  | Defines the computation performed at every call.  |
| <code>get_buffer(target)</code>                              | Returns the buffer given by <code>target</code> if it exists, otherwise throws an error.                                |
| <code>get_extra_state()</code>                               | Returns any extra state to include in the module's <code>state_dict</code> .  |
| <code>get_parameter(target)</code>                           | Returns the parameter given by <code>target</code> if it exists, otherwise throws an error.                             |
| <code>get_submodule(target)</code>                           | Returns the submodule given by <code>target</code> if it exists, otherwise throws an error.                             |
| <code>half()</code>  | Casts all floating point parameters and buffers to <code>half</code> datatype.  |
| <code>ipu([device])</code>                                   | Moves all model parameters and buffers to the IPU.  |
| <code>load_state_dict(state_dict[, strict])</code>           | Copies parameters and buffers from <code>state_dict</code> into this module and its descendants.                        |
| <code>modules()</code>                                       | Returns an iterator over all modules in the network.  |
| <code>named_buffers([prefix, recurse])</code>                | Returns an iterator over module buffers, yielding both the name of the buffer as well as the buffer itself.             |
| <code>named_children()</code>                                | Returns an iterator over immediate children modules, yielding both the name of the module as well as the module itself. |
| <code>named_modules([memo, prefix, remove_duplicate])</code> | Returns an iterator over all modules in the network, yielding both the name of the module as well as the module itself. |
| <code>named_parameters([prefix, recurse])</code>             | Returns an iterator over module parameters, yielding both the name of the parameter as well as the parameter itself.    |
| <code>parameters([recurse])</code>                           | Returns an iterator over module parameters.   |

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|  |  |
|--|--|
| <code>register_backward_hook(hook)</code>                | Registers a backward hook on the module.   |
| <code>register_buffer(name, tensor[, persistent])</code> | Adds a buffer to the module.   |
| <code>register_forward_hook(hook)</code>                 | Registers a forward hook on the module.  |
| <code>register_forward_pre_hook(hook)</code>             | Registers a forward pre-hook on the module.  |
| <code>register_full_backward_hook(hook)</code>           | Registers a backward hook on the module.   |
| <code>register_load_state_dict_post_hook(hook)</code>    | Registers a post hook to be run after module's <code>load_state_dict</code> is called.                                     |
| <code>register_module(name, module)</code>               | Alias for <code>add_module()</code> .  |
| <code>register_parameter(name, param)</code>             | Adds a parameter to the module.  |
| <code>requires_grad_([requires_grad])</code>             | Change if autograd should record operations on parameters in this module.  |
| <code>reset_parameters()</code>                          |  |
| <code>set_extra_state(state)</code>                      | This function is called from <code>load_state_dict()</code> to handle any extra state found within the <i>state_dict</i> . |
| <code>share_memory()</code>                              | See <code>torch.Tensor.share_memory_()</code>  |
| <code>state_dict(*args, **kwargs)</code>                 | Returns a dictionary containing a whole state of the module.   |
| <code>to(*args, **kwargs)</code>                         | Moves and/or casts the parameters and buffers.   |
| <code>to_empty(*, device)</code>                         | Moves the parameters and buffers to the specified device without copying storage.  |
| <code>train([mode])</code>                               | Sets the module in training mode.  |
| <code>type(dst_type)</code>                              | Casts all parameters and buffers to <i>dst_type</i> .  |
| <code>xpu([device])</code>                               | Moves all model parameters and buffers to the XPU.   |
| <code>zero_grad([set_to_none])</code>                    | Sets gradients of all model parameters to zero.  |

### Attributes

|   |  |
|---|--|
| <code>T_destination</code>              | alias of <code>TypeVar('T_destination', bound=Dict[str, Any])</code> |
| <code>dump_patches</code>               |  |
| <code>lazy_buffer_names</code>          |  |
| <code>lazy_parameter_names</code>       |  |
| <code>lazy_parameters_determined</code> | Returns if all lazy parameters are determined.                       |

## 2.4.4 pytorch\_pfn\_extras.nn.LazyConv1d

**class** `pytorch_pfn_extras.nn.LazyConv1d(in_channels, *args, **kwargs)`

Conv1d module with lazy weight initialization.

When `in_channels` is `None`, it is determined at the first time of the forward step.

### Parameters

- `in_channels` (*int*) –
- `args` (*Any*) –
- `kwargs` (*Any*) –

**Return type** None

**\_\_init\_\_**(*in\_channels*, \*args, \*\*kwargs)

Initializes internal Module state, shared by both nn.Module and ScriptModule.

**Parameters**

- **self** (*Any*) –
- **in\_channels** (*Optional[int]*) –
- **args** (*Any*) –
- **kwargs** (*Any*) –

**Return type** None

**Methods**

|   |  |
|---|--|
| <code>__init__(in_channels, *args, **kwargs)</code> | Initializes internal Module state, shared by both nn.Module and ScriptModule.                                      |
| <code>add_module(name, module)</code>               | Adds a child module to the current module.   |
| <code>apply(fn)</code>                              | Applies <code>fn</code> recursively to every submodule (as returned by <code>.children()</code> ) as well as self. |
| <code>bfloat16()</code>                             | Casts all floating point parameters and buffers to <code>bfloat16</code> datatype.                                 |
| <code>buffers([recurse])</code>                     | Returns an iterator over module buffers.   |
| <code>children()</code>                             | Returns an iterator over immediate children modules.   |
| <code>cpu()</code>                                  | Moves all model parameters and buffers to the CPU.   |
| <code>cuda([device])</code>                         | Moves all model parameters and buffers to the GPU.   |
| <code>double()</code>                               | Casts all floating point parameters and buffers to <code>double</code> datatype.                                   |
| <code>eval()</code>                                 | Sets the module in evaluation mode.  |
| <code>extra_repr()</code>                           | Set the extra representation of the module   |
| <code>float()</code>                                | Casts all floating point parameters and buffers to <code>float</code> datatype.                                    |
| <code>forward(input)</code>                         | Defines the computation performed at every call.   |
| <code>get_buffer(target)</code>                     | Returns the buffer given by <code>target</code> if it exists, otherwise throws an error.                           |
| <code>get_extra_state()</code>                      | Returns any extra state to include in the module's <code>state_dict</code> .                                       |
| <code>get_parameter(target)</code>                  | Returns the parameter given by <code>target</code> if it exists, otherwise throws an error.                        |
| <code>get_submodule(target)</code>                  | Returns the submodule given by <code>target</code> if it exists, otherwise throws an error.                        |
| <code>half()</code>                                 | Casts all floating point parameters and buffers to <code>half</code> datatype.                                     |
| <code>ipu([device])</code>                          | Moves all model parameters and buffers to the IPU.   |
| <code>load_state_dict(state_dict[, strict])</code>  | Copies parameters and buffers from <code>state_dict</code> into this module and its descendants.                   |
| <code>modules()</code>                              | Returns an iterator over all modules in the network.   |
| <code>named_buffers([prefix, recurse])</code>       | Returns an iterator over module buffers, yielding both the name of the buffer as well as the buffer itself.        |

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|  |  |
|--|--|
| <code>named_children()</code>                                | Returns an iterator over immediate children modules, yielding both the name of the module as well as the module itself.    |
| <code>named_modules([memo, prefix, remove_duplicate])</code> | Returns an iterator over all modules in the network, yielding both the name of the module as well as the module itself.    |
| <code>named_parameters([prefix, recurse])</code>             | Returns an iterator over module parameters, yielding both the name of the parameter as well as the parameter itself.       |
| <code>parameters([recurse])</code>                           | Returns an iterator over module parameters.  |
| <code>register_backward_hook(hook)</code>                    | Registers a backward hook on the module.   |
| <code>register_buffer(name, tensor[, persistent])</code>     | Adds a buffer to the module.   |
| <code>register_forward_hook(hook)</code>                     | Registers a forward hook on the module.  |
| <code>register_forward_pre_hook(hook)</code>                 | Registers a forward pre-hook on the module.  |
| <code>register_full_backward_hook(hook)</code>               | Registers a backward hook on the module.   |
| <code>register_load_state_dict_post_hook(hook)</code>        | Registers a post hook to be run after module's <code>load_state_dict</code> is called.                                     |
| <code>register_module(name, module)</code>                   | Alias for <code>add_module()</code> .  |
| <code>register_parameter(name, param)</code>                 | Adds a parameter to the module.  |
| <code>requires_grad_([requires_grad])</code>                 | Change if autograd should record operations on parameters in this module.  |
| <code>reset_parameters()</code>                              |  |
| <code>set_extra_state(state)</code>                          | This function is called from <code>load_state_dict()</code> to handle any extra state found within the <i>state_dict</i> . |
| <code>share_memory()</code>                                  | See <code>torch.Tensor.share_memory_()</code>  |
| <code>state_dict(*args, **kwargs)</code>                     | Returns a dictionary containing a whole state of the module.   |
| <code>to(*args, **kwargs)</code>                             | Moves and/or casts the parameters and buffers.   |
| <code>to_empty(*, device)</code>                             | Moves the parameters and buffers to the specified device without copying storage.  |
| <code>train([mode])</code>                                   | Sets the module in training mode.  |
| <code>type(dst_type)</code>                                  | Casts all parameters and buffers to <code>dst_type</code> .  |
| <code>xpu([device])</code>                                   | Moves all model parameters and buffers to the XPU.   |
| <code>zero_grad([set_to_none])</code>                        | Sets gradients of all model parameters to zero.  |

### Attributes

|   |  |
|---|--|
| <code>T_destination</code>              | alias of <code>TypeVar('T_destination', bound=Dict[str, Any])</code> |
| <code>dump_patches</code>               |  |
| <code>lazy_buffer_names</code>          |  |
| <code>lazy_parameter_names</code>       |  |
| <code>lazy_parameters_determined</code> | Returns if all lazy parameters are determined.                       |



## 2.4.5 pytorch\_pfn\_extras.nn.LazyConv2d

**class** pytorch\_pfn\_extras.nn.LazyConv2d(*in\_channels*, \**args*, \*\**kwargs*)

Conv2d module with lazy weight initialization.

When *in\_channels* is None, it is determined at the first time of the forward step.

### Parameters

- **in\_channels** (*int*) –
- **args** (*Any*) –
- **kwargs** (*Any*) –

**Return type** None

**\_\_init\_\_**(*in\_channels*, \**args*, \*\**kwargs*)

Initializes internal Module state, shared by both nn.Module and ScriptModule.

### Parameters

- **self** (*Any*) –
- **in\_channels** (*Optional[int]*) –
- **args** (*Any*) –
- **kwargs** (*Any*) –

**Return type** None

### Methods

|   |  |
|---|--|
| <code>__init__(in_channels, *args, **kwargs)</code> | Initializes internal Module state, shared by both nn.Module and ScriptModule.                                      |
| <code>add_module(name, module)</code>               | Adds a child module to the current module.   |
| <code>apply(fn)</code>                              | Applies <code>fn</code> recursively to every submodule (as returned by <code>.children()</code> ) as well as self. |
| <code>bfloat16()</code>                             | Casts all floating point parameters and buffers to <code>bfloat16</code> datatype.                                 |
| <code>buffers([recurse])</code>                     | Returns an iterator over module buffers.   |
| <code>children()</code>                             | Returns an iterator over immediate children modules.   |
| <code>cpu()</code>                                  | Moves all model parameters and buffers to the CPU.   |
| <code>cuda([device])</code>                         | Moves all model parameters and buffers to the GPU.   |
| <code>double()</code>                               | Casts all floating point parameters and buffers to <code>double</code> datatype.                                   |
| <code>eval()</code>                                 | Sets the module in evaluation mode.  |
| <code>extra_repr()</code>                           | Set the extra representation of the module   |
| <code>float()</code>                                | Casts all floating point parameters and buffers to <code>float</code> datatype.                                    |
| <code>forward(input)</code>                         | Defines the computation performed at every call.   |
| <code>get_buffer(target)</code>                     | Returns the buffer given by <code>target</code> if it exists, otherwise throws an error.                           |
| <code>get_extra_state()</code>                      | Returns any extra state to include in the module's <code>state_dict</code> .                                       |

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|  |  |
|--|--|
| <code>get_parameter(target)</code>                           | Returns the parameter given by <code>target</code> if it exists, otherwise throws an error.                                      |
| <code>get_submodule(target)</code>                           | Returns the submodule given by <code>target</code> if it exists, otherwise throws an error.                                      |
| <code>half()</code>  | Casts all floating point parameters and buffers to <code>half</code> datatype.   |
| <code>ipu([device])</code>                                   | Moves all model parameters and buffers to the IPU.   |
| <code>load_state_dict(state_dict[, strict])</code>           | Copies parameters and buffers from <code>state_dict</code> into this module and its descendants.                                 |
| <code>modules()</code>                                       | Returns an iterator over all modules in the network.   |
| <code>named_buffers([prefix, recurse])</code>                | Returns an iterator over module buffers, yielding both the name of the buffer as well as the buffer itself.                      |
| <code>named_children()</code>                                | Returns an iterator over immediate children modules, yielding both the name of the module as well as the module itself.          |
| <code>named_modules([memo, prefix, remove_duplicate])</code> | Returns an iterator over all modules in the network, yielding both the name of the module as well as the module itself.          |
| <code>named_parameters([prefix, recurse])</code>             | Returns an iterator over module parameters, yielding both the name of the parameter as well as the parameter itself.             |
| <code>parameters([recurse])</code>                           | Returns an iterator over module parameters.  |
| <code>register_backward_hook(hook)</code>                    | Registers a backward hook on the module.   |
| <code>register_buffer(name, tensor[, persistent])</code>     | Adds a buffer to the module.   |
| <code>register_forward_hook(hook)</code>                     | Registers a forward hook on the module.  |
| <code>register_forward_pre_hook(hook)</code>                 | Registers a forward pre-hook on the module.  |
| <code>register_full_backward_hook(hook)</code>               | Registers a backward hook on the module.   |
| <code>register_load_state_dict_post_hook(hook)</code>        | Registers a post hook to be run after module's <code>load_state_dict</code> is called.   |
| <code>register_module(name, module)</code>                   | Alias for <code>add_module()</code> .  |
| <code>register_parameter(name, param)</code>                 | Adds a parameter to the module.  |
| <code>requires_grad_([requires_grad])</code>                 | Change if autograd should record operations on parameters in this module.  |
| <code>reset_parameters()</code>                              |  |
| <code>set_extra_state(state)</code>                          | This function is called from <code>load_state_dict()</code> to handle any extra state found within the <code>state_dict</code> . |
| <code>share_memory()</code>                                  | See <code>torch.Tensor.share_memory_()</code>  |
| <code>state_dict(*args, **kwargs)</code>                     | Returns a dictionary containing a whole state of the module.   |
| <code>to(*args, **kwargs)</code>                             | Moves and/or casts the parameters and buffers.   |
| <code>to_empty(*, device)</code>                             | Moves the parameters and buffers to the specified device without copying storage.  |
| <code>train([mode])</code>                                   | Sets the module in training mode.  |
| <code>type(dst_type)</code>                                  | Casts all parameters and buffers to <code>dst_type</code> .  |
| <code>xpu([device])</code>                                   | Moves all model parameters and buffers to the XPU.   |
| <code>zero_grad([set_to_none])</code>                        | Sets gradients of all model parameters to zero.  |

**Attributes**

|   |  |
|---|--|
| <code>T_destination</code>              | alias of <code>TypeVar('T_destination', bound=Dict[str, Any])</code> |
| <code>dump_patches</code>               |  |
| <code>lazy_buffer_names</code>          |  |
| <code>lazy_parameter_names</code>       |  |
| <code>lazy_parameters_determined</code> | Returns if all lazy parameters are determined.                       |

**2.4.6 pytorch\_pfn\_extras.nn.LazyConv3d**

**class** `pytorch_pfn_extras.nn.LazyConv3d(in_channels, *args, **kwargs)`

Conv3d module with lazy weight initialization.

When `in_channels` is `None`, it is determined at the first time of the forward step.

**Parameters**

- `in_channels` (*int*) –
- `args` (*Any*) –
- `kwargs` (*Any*) –

**Return type** `None`

**\_\_init\_\_**(*in\_channels*, \**args*, \*\**kwargs*)

Initializes internal Module state, shared by both `nn.Module` and `ScriptModule`.

**Parameters**

- `self` (*Any*) –
- `in_channels` (*Optional[int]*) –
- `args` (*Any*) –
- `kwargs` (*Any*) –

**Return type** `None`

**Methods**

|   |  |
|---|--|
| <b>__init__</b> ( <i>in_channels</i> , * <i>args</i> , ** <i>kwargs</i> ) | Initializes internal Module state, shared by both <code>nn.Module</code> and <code>ScriptModule</code> .           |
| <code>add_module(name, module)</code>                                     | Adds a child module to the current module.   |
| <code>apply(fn)</code>  | Applies <code>fn</code> recursively to every submodule (as returned by <code>.children()</code> ) as well as self. |
| <code>bfloat16()</code>   | Casts all floating point parameters and buffers to <code>bfloat16</code> datatype.                                 |
| <code>buffers([recurse])</code>   | Returns an iterator over module buffers.   |
| <code>children()</code>   | Returns an iterator over immediate children modules.   |

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|  |  |
|--|--|
| <code>cpu()</code>   | Moves all model parameters and buffers to the CPU.   |
| <code>cuda([device])</code>                                  | Moves all model parameters and buffers to the GPU.   |
| <code>double()</code>  | Casts all floating point parameters and buffers to <code>double</code> datatype.   |
| <code>eval()</code>  | Sets the module in evaluation mode.  |
| <code>extra_repr()</code>                                    | Set the extra representation of the module   |
| <code>float()</code>   | Casts all floating point parameters and buffers to <code>float</code> datatype.  |
| <code>forward(input)</code>                                  | Defines the computation performed at every call.   |
| <code>get_buffer(target)</code>                              | Returns the buffer given by <code>target</code> if it exists, otherwise throws an error.   |
| <code>get_extra_state()</code>                               | Returns any extra state to include in the module's <code>state_dict</code> .   |
| <code>get_parameter(target)</code>                           | Returns the parameter given by <code>target</code> if it exists, otherwise throws an error.                                      |
| <code>get_submodule(target)</code>                           | Returns the submodule given by <code>target</code> if it exists, otherwise throws an error.                                      |
| <code>half()</code>  | Casts all floating point parameters and buffers to <code>half</code> datatype.   |
| <code>ipu([device])</code>                                   | Moves all model parameters and buffers to the IPU.   |
| <code>load_state_dict(state_dict[, strict])</code>           | Copies parameters and buffers from <code>state_dict</code> into this module and its descendants.                                 |
| <code>modules()</code>                                       | Returns an iterator over all modules in the network.   |
| <code>named_buffers([prefix, recurse])</code>                | Returns an iterator over module buffers, yielding both the name of the buffer as well as the buffer itself.                      |
| <code>named_children()</code>                                | Returns an iterator over immediate children modules, yielding both the name of the module as well as the module itself.          |
| <code>named_modules([memo, prefix, remove_duplicate])</code> | Returns an iterator over all modules in the network, yielding both the name of the module as well as the module itself.          |
| <code>named_parameters([prefix, recurse])</code>             | Returns an iterator over module parameters, yielding both the name of the parameter as well as the parameter itself.             |
| <code>parameters([recurse])</code>                           | Returns an iterator over module parameters.  |
| <code>register_backward_hook(hook)</code>                    | Registers a backward hook on the module.   |
| <code>register_buffer(name, tensor[, persistent])</code>     | Adds a buffer to the module.   |
| <code>register_forward_hook(hook)</code>                     | Registers a forward hook on the module.  |
| <code>register_forward_pre_hook(hook)</code>                 | Registers a forward pre-hook on the module.  |
| <code>register_full_backward_hook(hook)</code>               | Registers a backward hook on the module.   |
| <code>register_load_state_dict_post_hook(hook)</code>        | Registers a post hook to be run after module's <code>load_state_dict</code> is called.   |
| <code>register_module(name, module)</code>                   | Alias for <code>add_module()</code> .  |
| <code>register_parameter(name, param)</code>                 | Adds a parameter to the module.  |
| <code>requires_grad_([requires_grad])</code>                 | Change if autograd should record operations on parameters in this module.  |
| <code>reset_parameters()</code>                              |  |
| <code>set_extra_state(state)</code>                          | This function is called from <code>load_state_dict()</code> to handle any extra state found within the <code>state_dict</code> . |
| <code>share_memory()</code>                                  | See <code>torch.Tensor.share_memory_()</code>  |

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|  |   |
|--|---|
| <code>state_dict(*args, **kwargs)</code> | Returns a dictionary containing a whole state of the module.                      |
| <code>to(*args, **kwargs)</code>         | Moves and/or casts the parameters and buffers.                                    |
| <code>to_empty(*, device)</code>         | Moves the parameters and buffers to the specified device without copying storage. |
| <code>train([mode])</code>               | Sets the module in training mode.   |
| <code>type(dst_type)</code>              | Casts all parameters and buffers to <code>dst_type</code> .                       |
| <code>xpu([device])</code>               | Moves all model parameters and buffers to the XPU.                                |
| <code>zero_grad([set_to_none])</code>    | Sets gradients of all model parameters to zero.                                   |

**Attributes**

|   |  |
|---|--|
| <code>T_destination</code>              | alias of <code>TypeVar('T_destination', bound=Dict[str, Any])</code> |
| <code>dump_patches</code>               |  |
| <code>lazy_buffer_names</code>          |  |
| <code>lazy_parameter_names</code>       |  |
| <code>lazy_parameters_determined</code> | Returns if all lazy parameters are determined.                       |

**2.4.7 pytorch\_pfn\_extras.nn.LazyBatchNorm1d**

**class** `pytorch_pfn_extras.nn.LazyBatchNorm1d(num_features, *args, **kwargs)`

BatchNorm1d module with lazy weight initialization.

When `num_features` is `None`, it is determined at the first time of the forward step.

**Parameters**

- **num\_features** (*int*) –
- **args** (*Any*) –
- **kwargs** (*Any*) –

**Return type** `None`

**\_\_init\_\_** (`num_features, *args, **kwargs`)

Initializes internal Module state, shared by both `nn.Module` and `ScriptModule`.

**Parameters**

- **num\_features** (*Optional[int]*) –
- **args** (*Any*) –
- **kwargs** (*Any*) –

**Return type** `None`

## Methods

|  |   |
|--|---|
| <code>__init__(num_features, *args, **kwargs)</code>         | Initializes internal Module state, shared by both <code>nn.Module</code> and <code>ScriptModule</code> .                |
| <code>add_module(name, module)</code>                        | Adds a child module to the current module.  |
| <code>apply(fn)</code>                                       | Applies <code>fn</code> recursively to every submodule (as returned by <code>.children()</code> ) as well as self.      |
| <code>bfloat16()</code>                                      | Casts all floating point parameters and buffers to <code>bfloat16</code> datatype.                                      |
| <code>buffers([recurse])</code>                              | Returns an iterator over module buffers.  |
| <code>children()</code>                                      | Returns an iterator over immediate children modules.  |
| <code>cpu()</code>   | Moves all model parameters and buffers to the CPU.  |
| <code>cuda([device])</code>                                  | Moves all model parameters and buffers to the GPU.  |
| <code>double()</code>  | Casts all floating point parameters and buffers to <code>double</code> datatype.  |
| <code>eval()</code>  | Sets the module in evaluation mode.   |
| <code>extra_repr()</code>                                    | Set the extra representation of the module  |
| <code>float()</code>   | Casts all floating point parameters and buffers to <code>float</code> datatype.   |
| <code>forward(input)</code>                                  | Defines the computation performed at every call.  |
| <code>get_buffer(target)</code>                              | Returns the buffer given by <code>target</code> if it exists, otherwise throws an error.                                |
| <code>get_extra_state()</code>                               | Returns any extra state to include in the module's <code>state_dict</code> .  |
| <code>get_parameter(target)</code>                           | Returns the parameter given by <code>target</code> if it exists, otherwise throws an error.                             |
| <code>get_submodule(target)</code>                           | Returns the submodule given by <code>target</code> if it exists, otherwise throws an error.                             |
| <code>half()</code>  | Casts all floating point parameters and buffers to <code>half</code> datatype.  |
| <code>ipu([device])</code>                                   | Moves all model parameters and buffers to the IPU.  |
| <code>load_state_dict(state_dict[, strict])</code>           | Copies parameters and buffers from <code>state_dict</code> into this module and its descendants.                        |
| <code>modules()</code>                                       | Returns an iterator over all modules in the network.  |
| <code>named_buffers([prefix, recurse])</code>                | Returns an iterator over module buffers, yielding both the name of the buffer as well as the buffer itself.             |
| <code>named_children()</code>                                | Returns an iterator over immediate children modules, yielding both the name of the module as well as the module itself. |
| <code>named_modules([memo, prefix, remove_duplicate])</code> | Returns an iterator over all modules in the network, yielding both the name of the module as well as the module itself. |
| <code>named_parameters([prefix, recurse])</code>             | Returns an iterator over module parameters, yielding both the name of the parameter as well as the parameter itself.    |
| <code>parameters([recurse])</code>                           | Returns an iterator over module parameters.   |
| <code>register_backward_hook(hook)</code>                    | Registers a backward hook on the module.  |
| <code>register_buffer(name, tensor[, persistent])</code>     | Adds a buffer to the module.  |
| <code>register_forward_hook(hook)</code>                     | Registers a forward hook on the module.   |
| <code>register_forward_pre_hook(hook)</code>                 | Registers a forward pre-hook on the module.   |
| <code>register_full_backward_hook(hook)</code>               | Registers a backward hook on the module.  |

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|   |  |
|---|--|
| <code>register_load_state_dict_post_hook(hook)</code> | Registers a post hook to be run after module's <code>load_state_dict</code> is called.   |
| <code>register_module(name, module)</code>            | Alias for <code>add_module()</code> .  |
| <code>register_parameter(name, param)</code>          | Adds a parameter to the module.  |
| <code>requires_grad_([requires_grad])</code>          | Change if autograd should record operations on parameters in this module.  |
| <code>reset_parameters()</code>                       |  |
| <code>reset_running_stats()</code>                    |  |
| <code>set_extra_state(state)</code>                   | This function is called from <code>load_state_dict()</code> to handle any extra state found within the <code>state_dict</code> . |
| <code>share_memory()</code>                           | See <code>torch.Tensor.share_memory_()</code>  |
| <code>state_dict(*args, **kwargs)</code>              | Returns a dictionary containing a whole state of the module.   |
| <code>to(*args, **kwargs)</code>                      | Moves and/or casts the parameters and buffers.   |
| <code>to_empty(*, device)</code>                      | Moves the parameters and buffers to the specified device without copying storage.  |
| <code>train([mode])</code>                            | Sets the module in training mode.  |
| <code>type(dst_type)</code>                           | Casts all parameters and buffers to <code>dst_type</code> .  |
| <code>xpu([device])</code>                            | Moves all model parameters and buffers to the XPU.   |
| <code>zero_grad([set_to_none])</code>                 | Sets gradients of all model parameters to zero.  |

### Attributes

|   |  |
|---|--|
| <code>T_destination</code>              | alias of <code>TypeVar('T_destination', bound=Dict[str, Any])</code> |
| <code>dump_patches</code>               |  |
| <code>lazy_buffer_names</code>          |  |
| <code>lazy_parameter_names</code>       |  |
| <code>lazy_parameters_determined</code> | Returns if all lazy parameters are determined.                       |

## 2.4.8 pytorch\_pfn\_extras.nn.LazyBatchNorm2d

**class** `pytorch_pfn_extras.nn.LazyBatchNorm2d(num_features, *args, **kwargs)`

BatchNorm2d module with lazy weight initialization.

When `num_features` is `None`, it is determined at the first time of the forward step.

### Parameters

- **num\_features** (*int*) –
- **args** (*Any*) –
- **kwargs** (*Any*) –

**Return type** `None`

**\_\_init\_\_**(*num\_features*, \*args, \*\*kwargs)

Initializes internal Module state, shared by both nn.Module and ScriptModule.

#### Parameters

- **num\_features** (*Optional[int]*) –
- **args** (*Any*) –
- **kwargs** (*Any*) –

**Return type** None

#### Methods

|  |   |
|--|---|
| <code>__init__(num_features, *args, **kwargs)</code> | Initializes internal Module state, shared by both nn.Module and ScriptModule.   |
| <code>add_module(name, module)</code>                | Adds a child module to the current module.  |
| <code>apply(fn)</code>                               | Applies <code>fn</code> recursively to every submodule (as returned by <code>.children()</code> ) as well as self.      |
| <code>bfloat16()</code>                              | Casts all floating point parameters and buffers to <code>bfloat16</code> datatype.                                      |
| <code>buffers([recurse])</code>                      | Returns an iterator over module buffers.  |
| <code>children()</code>                              | Returns an iterator over immediate children modules.  |
| <code>cpu()</code>                                   | Moves all model parameters and buffers to the CPU.  |
| <code>cuda([device])</code>                          | Moves all model parameters and buffers to the GPU.  |
| <code>double()</code>                                | Casts all floating point parameters and buffers to <code>double</code> datatype.  |
| <code>eval()</code>                                  | Sets the module in evaluation mode.   |
| <code>extra_repr()</code>                            | Set the extra representation of the module  |
| <code>float()</code>                                 | Casts all floating point parameters and buffers to <code>float</code> datatype.   |
| <code>forward(input)</code>                          | Defines the computation performed at every call.  |
| <code>get_buffer(target)</code>                      | Returns the buffer given by <code>target</code> if it exists, otherwise throws an error.                                |
| <code>get_extra_state()</code>                       | Returns any extra state to include in the module's <code>state_dict</code> .  |
| <code>get_parameter(target)</code>                   | Returns the parameter given by <code>target</code> if it exists, otherwise throws an error.                             |
| <code>get_submodule(target)</code>                   | Returns the submodule given by <code>target</code> if it exists, otherwise throws an error.                             |
| <code>half()</code>                                  | Casts all floating point parameters and buffers to <code>half</code> datatype.  |
| <code>ipu([device])</code>                           | Moves all model parameters and buffers to the IPU.  |
| <code>load_state_dict(state_dict[, strict])</code>   | Copies parameters and buffers from <code>state_dict</code> into this module and its descendants.                        |
| <code>modules()</code>                               | Returns an iterator over all modules in the network.  |
| <code>named_buffers([prefix, recurse])</code>        | Returns an iterator over module buffers, yielding both the name of the buffer as well as the buffer itself.             |
| <code>named_children()</code>                        | Returns an iterator over immediate children modules, yielding both the name of the module as well as the module itself. |

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|  |  |
|--|--|
| <code>named_modules([memo, prefix, remove_duplicate])</code> | Returns an iterator over all modules in the network, yielding both the name of the module as well as the module itself.    |
| <code>named_parameters([prefix, recurse])</code>             | Returns an iterator over module parameters, yielding both the name of the parameter as well as the parameter itself.       |
| <code>parameters([recurse])</code>                           | Returns an iterator over module parameters.  |
| <code>register_backward_hook(hook)</code>                    | Registers a backward hook on the module.   |
| <code>register_buffer(name, tensor[, persistent])</code>     | Adds a buffer to the module.   |
| <code>register_forward_hook(hook)</code>                     | Registers a forward hook on the module.  |
| <code>register_forward_pre_hook(hook)</code>                 | Registers a forward pre-hook on the module.  |
| <code>register_full_backward_hook(hook)</code>               | Registers a backward hook on the module.   |
| <code>register_load_state_dict_post_hook(hook)</code>        | Registers a post hook to be run after module's <code>load_state_dict</code> is called.                                     |
| <code>register_module(name, module)</code>                   | Alias for <code>add_module()</code> .  |
| <code>register_parameter(name, param)</code>                 | Adds a parameter to the module.  |
| <code>requires_grad_([requires_grad])</code>                 | Change if autograd should record operations on parameters in this module.  |
| <code>reset_parameters()</code>                              |  |
| <code>reset_running_stats()</code>                           |  |
| <code>set_extra_state(state)</code>                          | This function is called from <code>load_state_dict()</code> to handle any extra state found within the <i>state_dict</i> . |
| <code>share_memory()</code>                                  | See <code>torch.Tensor.share_memory_()</code>  |
| <code>state_dict(*args, **kwargs)</code>                     | Returns a dictionary containing a whole state of the module.   |
| <code>to(*args, **kwargs)</code>                             | Moves and/or casts the parameters and buffers.   |
| <code>to_empty(*, device)</code>                             | Moves the parameters and buffers to the specified device without copying storage.  |
| <code>train([mode])</code>                                   | Sets the module in training mode.  |
| <code>type(dst_type)</code>                                  | Casts all parameters and buffers to <i>dst_type</i> .  |
| <code>xpu([device])</code>                                   | Moves all model parameters and buffers to the XPU.   |
| <code>zero_grad([set_to_none])</code>                        | Sets gradients of all model parameters to zero.  |

### Attributes

|   |  |
|---|--|
| <code>T_destination</code>              | alias of <code>TypeVar('T_destination', bound=Dict[str, Any])</code> |
| <code>dump_patches</code>               |  |
| <code>lazy_buffer_names</code>          |  |
| <code>lazy_parameter_names</code>       |  |
| <code>lazy_parameters_determined</code> | Returns if all lazy parameters are determined.                       |

## 2.4.9 pytorch\_pfn\_extras.nn.LazyBatchNorm3d

**class** pytorch\_pfn\_extras.nn.LazyBatchNorm3d(*num\_features*, \*args, \*\*kwargs)  
BatchNorm3d module with lazy weight initialization.

When *num\_features* is None, it is determined at the first time of the forward step.

### Parameters

- **num\_features** (*int*) –
- **args** (*Any*) –
- **kwargs** (*Any*) –

**Return type** None

**\_\_init\_\_**(*num\_features*, \*args, \*\*kwargs)

Initializes internal Module state, shared by both nn.Module and ScriptModule.

### Parameters

- **num\_features** (*Optional[int]*) –
- **args** (*Any*) –
- **kwargs** (*Any*) –

**Return type** None

### Methods

|  |  |
|--|--|
| <b>__init__</b> ( <i>num_features</i> , *args, **kwargs) | Initializes internal Module state, shared by both nn.Module and ScriptModule.                          |
| <b>add_module</b> (name, module)                         | Adds a child module to the current module.   |
| <b>apply</b> (fn)  | Applies <i>fn</i> recursively to every submodule (as returned by <i>.children()</i> ) as well as self. |
| <b>bfloat16</b> ()                                       | Casts all floating point parameters and buffers to bfloat16 datatype.                                  |
| <b>buffers</b> ([recurse])                               | Returns an iterator over module buffers.   |
| <b>children</b> ()                                       | Returns an iterator over immediate children modules.   |
| <b>cpu</b> ()  | Moves all model parameters and buffers to the CPU.   |
| <b>cuda</b> ([device])                                   | Moves all model parameters and buffers to the GPU.   |
| <b>double</b> ()   | Casts all floating point parameters and buffers to double datatype.                                    |
| <b>eval</b> ()   | Sets the module in evaluation mode.  |
| <b>extra_repr</b> ()                                     | Set the extra representation of the module   |
| <b>float</b> ()  | Casts all floating point parameters and buffers to float datatype.                                     |
| <b>forward</b> (input)                                   | Defines the computation performed at every call.   |
| <b>get_buffer</b> (target)                               | Returns the buffer given by <i>target</i> if it exists, otherwise throws an error.                     |
| <b>get_extra_state</b> ()                                | Returns any extra state to include in the module's state_dict.   |
| <b>get_parameter</b> (target)                            | Returns the parameter given by <i>target</i> if it exists, otherwise throws an error.                  |

continues on next page

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|  |  |
|--|--|
| <code>get_submodule(target)</code>                           | Returns the submodule given by <code>target</code> if it exists, otherwise throws an error.                                      |
| <code>half()</code>  | Casts all floating point parameters and buffers to <code>half</code> datatype.   |
| <code>ipu([device])</code>                                   | Moves all model parameters and buffers to the IPU.   |
| <code>load_state_dict(state_dict[, strict])</code>           | Copies parameters and buffers from <code>state_dict</code> into this module and its descendants.                                 |
| <code>modules()</code>                                       | Returns an iterator over all modules in the network.   |
| <code>named_buffers([prefix, recurse])</code>                | Returns an iterator over module buffers, yielding both the name of the buffer as well as the buffer itself.                      |
| <code>named_children()</code>                                | Returns an iterator over immediate children modules, yielding both the name of the module as well as the module itself.          |
| <code>named_modules([memo, prefix, remove_duplicate])</code> | Returns an iterator over all modules in the network, yielding both the name of the module as well as the module itself.          |
| <code>named_parameters([prefix, recurse])</code>             | Returns an iterator over module parameters, yielding both the name of the parameter as well as the parameter itself.             |
| <code>parameters([recurse])</code>                           | Returns an iterator over module parameters.  |
| <code>register_backward_hook(hook)</code>                    | Registers a backward hook on the module.   |
| <code>register_buffer(name, tensor[, persistent])</code>     | Adds a buffer to the module.   |
| <code>register_forward_hook(hook)</code>                     | Registers a forward hook on the module.  |
| <code>register_forward_pre_hook(hook)</code>                 | Registers a forward pre-hook on the module.  |
| <code>register_full_backward_hook(hook)</code>               | Registers a backward hook on the module.   |
| <code>register_load_state_dict_post_hook(hook)</code>        | Registers a post hook to be run after module's <code>load_state_dict</code> is called.   |
| <code>register_module(name, module)</code>                   | Alias for <code>add_module()</code> .  |
| <code>register_parameter(name, param)</code>                 | Adds a parameter to the module.  |
| <code>requires_grad_([requires_grad])</code>                 | Change if autograd should record operations on parameters in this module.  |
| <code>reset_parameters()</code>                              |  |
| <code>reset_running_stats()</code>                           |  |
| <code>set_extra_state(state)</code>                          | This function is called from <code>load_state_dict()</code> to handle any extra state found within the <code>state_dict</code> . |
| <code>share_memory()</code>                                  | See <code>torch.Tensor.share_memory_()</code>  |
| <code>state_dict(*args, **kwargs)</code>                     | Returns a dictionary containing a whole state of the module.   |
| <code>to(*args, **kwargs)</code>                             | Moves and/or casts the parameters and buffers.   |
| <code>to_empty(*, device)</code>                             | Moves the parameters and buffers to the specified device without copying storage.  |
| <code>train([mode])</code>                                   | Sets the module in training mode.  |
| <code>type(dst_type)</code>                                  | Casts all parameters and buffers to <code>dst_type</code> .  |
| <code>xpu([device])</code>                                   | Moves all model parameters and buffers to the XPU.   |
| <code>zero_grad([set_to_none])</code>                        | Sets gradients of all model parameters to zero.  |

**Attributes**

|   |  |
|---|--|
| <code>T_destination</code>              | alias of <code>TypeVar('T_destination', bound=Dict[str, Any])</code> |
| <code>dump_patches</code>               |  |
| <code>lazy_buffer_names</code>          |  |
| <code>lazy_parameter_names</code>       |  |
| <code>lazy_parameters_determined</code> | Returns if all lazy parameters are determined.                       |

## 2.5 ONNX

### 2.5.1 Export

|  |   |
|--|---|
| <code>onnx.export(model, args, f[, return_output, ...])</code> | Export model into ONNX Graph.                                 |
| <code>onnx.export_testcase(model, args, out_dir, *)</code>     | Export model and I/O tensors of the model in protobuf format. |

#### `pytorch_pfn_extras.onnx.export`

`pytorch_pfn_extras.onnx.export(model, args, f, return_output=False, strip_large_tensor_data=False, large_tensor_threshold=100, **kwargs)`

Export model into ONNX Graph.

**Parameters**

- **f** (*IO*) – A file-like object or a string file path to be written to this file.
- **return\_output** (*bool*) – If True, return output values come from the model.
- **strip\_large\_tensor\_data** (*bool*) – If True, this function will strip data of large tensors to reduce ONNX file size for benchmarking
- **large\_tensor\_threshold** (*int*) – If number of elements of tensor is larger than this value, the tensor is stripped when `strip_large_tensor_data` is True
- **model** (`torch.nn.modules.module.Module`) –
- **args** (`Sequence[Any]`) –
- **kwargs** (*Any*) –

**Return type** `Any`

**Warning:** This function is not thread safe.

## pytorch\_pfn\_extras.onnx.export\_testcase

```
pytorch_pfn_extras.onnx.export_testcase(model, args, out_dir, *, output_grad=False, metadata=True,
                                         model_overwrite=True, strip_large_tensor_data=False,
                                         large_tensor_threshold=100, return_output=False,
                                         user_meta=None, export_torch_script=False,
                                         export_torch_trace=False, **kwargs)
```

Export model and I/O tensors of the model in protobuf format.

### Parameters

- **output\_grad** (*bool* or *Tensor*) – If True, this function will output model’s gradient with names ‘gradient\_%.pb’. If set Tensor, use it as gradient *input*. The gradient inputs are output as ‘gradient\_input\_%.pb’ along with gradient.
- **metadata** (*bool*) – If True, output meta information taken from git log.
- **model\_overwrite** (*bool*) – If False and model.onnx has already existed, only export input/output data as another test dataset.
- **strip\_large\_tensor\_data** (*bool*) – If True, this function will strip data of large tensors to reduce ONNX file size for benchmarking
- **large\_tensor\_threshold** (*int*) – If number of elements of tensor is larger than this value, the tensor is stripped when *strip\_large\_tensor\_data* is True
- **return\_output** (*bool*) – If True, return output values come from the model.
- **export\_torch\_script** (*bool*) – Output model\_script.pt using torch.jit.script
- **export\_torch\_trace** (*bool*) – Output model\_trace.pt using torch.jit.trace
- **model** (*Union[torch.nn.modules.module.Module, torch.jit.\_script.ScriptModule]*) –
- **args** (*Any*) –
- **out\_dir** (*str*) –
- **user\_meta** (*Optional[Mapping[str, Any]]*) –
- **kwargs** (*Any*) –

**Return type** Any

**Warning:** This function is not thread safe.

## 2.5.2 Annotation

|  |   |
|--|---|
| <code>onnx.annotate(**attrs)</code>                            | Annotation parameters to the target function.                 |
| <code>onnx.apply_annotation(fn, *args, **attrs)</code>         | Annotation applicer to the target function                    |
| <code>onnx.scoped_anchor(**attrs)</code>                       | Add anchor node to the scoped modules                         |
| <code>onnx.export(model, args, f[, return_output, ...])</code> | Export model into ONNX Graph.                                 |
| <code>onnx.export_testcase(model, args, out_dir, *)</code>     | Export model and I/O tensors of the model in protobuf format. |

### pytorch\_pfn\_extras.onnx.annotate

`pytorch_pfn_extras.onnx.annotate(**attrs)`

Annotation parameters to the target function.

Usage:

```
>>> class Net(nn.Module):
...     def __init__(self):
...         super(Net, self).__init__()
...         self.conv = nn.Conv2d(1, 6, 3)
...         self.conv2 = nn.Conv2d(6, 12, 3)
...     def forward(self, x):
...         with pytorch_pfn_extras.onnx.annotate(key='value'):
...             h = self.conv(x)
...             h = self.conv2(h)
...         return h
```

Use this annotate function under with statement, then the first Conv operator will be emit with customized attributes. Customized attributes are invalid for ONNX format, so pay attention that some ONNX runtimes cannot run the output ONNX graph.

This annotation is enabled with either `pytorch_pfn_extras.onnx.export_testcase` or `pytorch_pfn_extras.onnx.export`.

**Parameters** `attrs` (*dict*) – annotation parameters

**Return type** `AbstractContextManager[None]`

### pytorch\_pfn\_extras.onnx.apply\_annotation

`pytorch_pfn_extras.onnx.apply_annotation(fn, *args, **attrs)`

Annotation applier to the target function

Usage:

```
>>> class Net(nn.Module):
...     def __init__(self):
...         super(Net, self).__init__()
...         self.conv = nn.Conv2d(1, 6, 3)
...         self.conv2 = nn.Conv2d(6, 12, 3)
...     def forward(self, x):
...         def _conv(x):
...             h = self.conv(x)
...             return torch.relu(h)
...         h = pytorch_pfn_extras.onnx.apply_annotation(
...             _conv, key='value')
...         h = self.conv2(h)
...         return h
```

Annotate into all operators emitted from the target function even if included not `nn.Module` function. On the above code, the first Conv and ReLu operator will be emit with customized attributes. Customized attributes are invalid for ONNX format, so pay attention that some ONNX runtimes cannot run the output ONNX graph.

This applier is enabled with either `pytorch_pfn_extras.onnx.export_testcase` or `pytorch_pfn_extras.onnx.export`.

**Parameters**

- **fn** (*func*) – the target function to be annotated, args is used for this function. Cannot pass kwargs for the function.
- **args** (*tuple*) – arguments for the target function
- **attrs** (*dict*) – annotation paramters

**Return type** Any**pytorch\_pfn\_extras.onnx.scoped\_anchor****pytorch\_pfn\_extras.onnx.scoped\_anchor**(\*\**attrs*)

Add anchor node to the scoped modules

Usage:

```
>>> class Net(nn.Module):
...     def __init__(self):
...         super(Net, self).__init__()
...         self.conv = nn.Conv2d(1, 6, 3)
...         self.conv2 = nn.Conv2d(6, 12, 3)
...     def forward(self, x):
...         with pytorch_pfn_extras.onnx.scoped_anchor(key='value'):
...             h = self.conv(x)
...             h = self.conv2(h)
...         return h
```

Use this scoped anchoring under with statement, then dummy Identity nodes are added before/after the first Conv operator with customized attributes.

This anchoring is triggered by `nn.Module` applying function, cannot use this with `torch.*` functions.

This annotation is enabled with either `pytorch_pfn_extras.onnx.export_testcase` or `pytorch_pfn_extras.onnx.export`.

**Parameters** **attrs** (*dict*) – annotation parameters**Return type** AbstractContextManager[None]

## 2.6 Datasets

|   |   |
|---|---|
| <code>dataset.SharedDataset(sm_size[, cache_type])</code> | Dataset that caches the load samples in shared memory |
| <code>dataset.TabularDataset(*args, **kws)</code>         | An abstract class that represents tabular dataset.    |
| <code>dataset.ItemNotFoundException</code>                |   |

## 2.6.1 pytorch\_pfn\_extras.dataset.SharedDataset

**class** pytorch\_pfn\_extras.dataset.SharedDataset(sm\_size, cache\_type=<class 'pytorch\_pfn\_extras.dataset.shared\_dataset.InfiniteCache'>)

Dataset that caches the load samples in shared memory

Args

**\_\_init\_\_**(sm\_size, cache\_type=<class 'pytorch\_pfn\_extras.dataset.shared\_dataset.InfiniteCache'>)

### Methods

---

**\_\_init\_\_**(sm\_size[, cache\_type])

---

**cache\_item**(idx, x)

---

**is\_cached**(idx)

---

## 2.6.2 pytorch\_pfn\_extras.dataset.TabularDataset

**class** pytorch\_pfn\_extras.dataset.TabularDataset(\*args, \*\*kws)

An abstract class that represents tabular dataset.

This class represents a tabular dataset. In a tabular dataset, all examples have the same number of elements. For example, all examples of the dataset below have three elements (a[i], b[i], and c[i]).

|   | a    | b    | c    |
|---|------|------|------|
| 0 | a[0] | b[0] | c[0] |
| 1 | a[1] | b[1] | c[1] |
| 2 | a[2] | b[2] | c[2] |
| 3 | a[3] | b[3] | c[3] |

Since an example can be represented by both tuple and dict ((a[i], b[i], c[i]) and {'a': a[i], 'b': b[i], 'c': c[i]}), this class uses `mode` to indicate which representation will be used. If there is only one column, an example also can be represented by a value (a[i]). In this case, `mode` is `None`.

An inheritance should implement `__len__()`, `keys`, `mode` and `get_examples()`.

```
>>> import numpy as np
>>>
>>> from pytorch_pfn_extras import dataset
>>>
>>> class MyDataset(dataset.TabularDataset):
...     def __len__(self):
...         return 4
...
...     @property
...     def keys(self):
...         return ('a', 'b', 'c')
...
... 
```

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```

...     @property
...     def mode(self):
...         return tuple
...
...     def get_examples(self, indices, key_indices):
...         data = np.arange(12).reshape((4, 3))
...         if indices is not None:
...             data = data[indices]
...         if key_indices is not None:
...             data = data[:, list(key_indices)]
...         return tuple(data.transpose())
...
>>> dataset = MyDataset()
>>> len(dataset)
4
>>> dataset.keys
('a', 'b', 'c')
>>> dataset.astuple()[0]
(0, 1, 2)
>>> sorted(dataset.asdict()[0].items())
[('a', 0), ('b', 1), ('c', 2)]
>>>
>>> view = dataset.slice[[3, 2], ('c', 0)]
>>> len(view)
2
>>> view.keys
('c', 'a')
>>> view.astuple()[1]
(8, 6)
>>> sorted(view.asdict()[1].items())
[('a', 6), ('c', 8)]

```

`__init__()`

## Methods

|   |  |
|---|--|
| <code>__init__()</code>                             |  |
| <code>asdict()</code>                               | Return a view with dict mode.                      |
| <code>astuple()</code>                              | Return a view with tuple mode.                     |
| <code>concat(*datasets)</code>                      | Stack datasets along rows.                         |
| <code>convert(data)</code>                          | Convert fetched data.                              |
| <code>fetch()</code>                                | Fetch data.  |
| <code>get_example(i)</code>                         |  |
| <code>get_examples(indices, key_indices)</code>     |  |
| <code>join(*datasets)</code>                        | Stack datasets along columns.                      |
| <code>transform(keys, transform)</code>             | Apply a transform to each example.                 |
| <code>transform_batch(keys, transform_batch)</code> | Apply a transform to examples.                     |
| <code>with_converter(converter)</code>              | Override the behaviour of <code>convert()</code> . |

### Attributes

|       |                         |
|-------|-------------------------|
| keys  | Names of columns.       |
| mode  | Mode of representation. |
| slice | Get a slice of dataset. |

## 2.6.3 pytorch\_pfn\_extras.dataset.ItemNotFoundException

**exception** `pytorch_pfn_extras.dataset.ItemNotFoundException`

## 2.7 Config

---

`config.Config`(*config*[, *types*])

---

### 2.7.1 pytorch\_pfn\_extras.config.Config

**class** `pytorch_pfn_extras.config.Config`(*config*, *types=None*)

#### Parameters

- **config** (*Any*) –
- **types** (*Optional*[*Mapping*[*str*, *Callable*[[...], *Any*]]]) –

**Return type** `None`

`__init__`(*config*, *types=None*)

#### Parameters

- **config** (*Any*) –
- **types** (*Optional*[*Mapping*[*str*, *Callable*[[...], *Any*]]]) –

**Return type** `None`

#### Methods

---

`__init__`(*config*[, *types*])

---

`load_path`(*path*, \*[, *loader*, *types*])

---

`update_via_args`(*args*)

---

---

`config_types.optuna_types(trial)`


---

`config_types.load_path_with_optuna_types(...)`


---

## 2.7.2 pytorch\_pfn\_extras.config\_types.optuna\_types

`pytorch_pfn_extras.config_types.optuna_types(trial)`

**Parameters** `trial` (`optuna.trial.Trial`) –

**Return type** `Dict[str, Any]`

## 2.7.3 pytorch\_pfn\_extras.config\_types.load\_path\_with\_optuna\_types

`pytorch_pfn_extras.config_types.load_path_with_optuna_types(path, trial, loader=None, types=None)`

**Parameters**

- `path` (`str`) –
- `trial` (`optuna.trial.Trial`) –
- `loader` (`Optional[Callable[[str], Any]]`) –
- `types` (`Optional[Dict[str, Callable[[...], Any]]]`) –

**Return type** `pytorch_pfn_extras.config.Config`

## 2.8 NumPy/CuPy Compatibility

|  |   |
|--|---|
| <code>from_ndarray(ndarray)</code>         | Creates a <code>torch.Tensor</code> from a <code>numpy.ndarray</code> or <code>cupy.ndarray</code> .                    |
| <code>as_ndarray(tensor)</code>            | Creates a <code>numpy.ndarray</code> or <code>cupy.ndarray</code> from <code>torch.Tensor</code> .                      |
| <code>get_xp(obj)</code>                   | Returns a module of ndarray implementation ( <code>numpy</code> or <code>cupy</code> ) for the given <code>obj</code> . |
| <code>as_numpy_dtype(torch_dtype)</code>   | Returns NumPy dtype for the given PyTorch dtype.  |
| <code>from_numpy_dtype(numpy_dtype)</code> | Returns PyTorch dtype for the given NumPy dtype.  |

### 2.8.1 pytorch\_pfn\_extras.from\_ndarray

`pytorch_pfn_extras.from_ndarray(ndarray)`

Creates a `torch.Tensor` from a `numpy.ndarray` or `cupy.ndarray`.

Unlike `torch.from_numpy`, this method may make a copy when needed, e.g. when the given `ndarray` contains the negative strides which is not supported by PyTorch.

**Parameters** `ndarray` (*Any*) –

**Return type** `torch.Tensor`

### 2.8.2 pytorch\_pfn\_extras.as\_ndarray

`pytorch_pfn_extras.as_ndarray(tensor)`

Creates a `numpy.ndarray` or `cupy.ndarray` from `torch.Tensor`.

This method returns a tensor as a NumPy or CuPy ndarray depending on where the given `tensor` resides in. The `tensor` and the returned `ndarray` share the same underlying storage. Changes to the tensor will be reflected in the `ndarray` and vice versa. Note that changes made to `ndarray` cannot be tracked in the computational graph.

**Parameters** `tensor` (`torch.Tensor`) –

**Return type** *Any*

### 2.8.3 pytorch\_pfn\_extras.get\_xp

`pytorch_pfn_extras.get_xp(obj)`

Returns a module of ndarray implementation (`numpy` or `cupy`) for the given `obj`.

The `obj` can be `torch.Tensor`, `torch.device` or NumPy/CuPy ndarray.

**Parameters** `obj` (`Union[Any, torch.Tensor]`) –

**Return type** *Any*

### 2.8.4 pytorch\_pfn\_extras.as\_numpy\_dtype

`pytorch_pfn_extras.as_numpy_dtype(torch_dtype)`

Returns NumPy dtype for the given PyTorch dtype.

**Parameters** `torch_dtype` (`torch.dtype`) – PyTorch's dtype object.

**Returns** NumPy type object.

**Return type** *Any*

### 2.8.5 pytorch\_pfn\_extras.from\_numpy\_dtype

`pytorch_pfn_extras.from_numpy_dtype(numpy_dtype)`

Returns PyTorch dtype for the given NumPy dtype.

**Parameters** `numpy_dtype` (*Any*) – NumPy’s dtype object.

**Returns** PyTorch type object.

**Return type** `torch.dtype`

|   |  |
|---|--|
| <code>cuda.stream(stream)</code>                | Context-manager that selects a given stream. |
| <code>cuda.use_torch_mempool_in_cupy()</code>   | Use the PyTorch memory pool in CuPy.         |
| <code>cuda.use_default_mempool_in_cupy()</code> | Use the default memory pool in CuPy.         |

### 2.8.6 pytorch\_pfn\_extras.cuda.stream

`pytorch_pfn_extras.cuda.stream(stream)`

Context-manager that selects a given stream.

This context manager also changes the CuPy’s default stream if CuPy is available. When CuPy is not available, the functionality is the same as the PyTorch’s counterpart, `torch.cuda.stream()`.

**Parameters** `stream` (*Optional*[`torch.cuda.streams.Stream`]) –

**Return type** `Generator[None, None, None]`

### 2.8.7 pytorch\_pfn\_extras.cuda.use\_torch\_mempool\_in\_cupy

`pytorch_pfn_extras.cuda.use_torch_mempool_in_cupy()`

Use the PyTorch memory pool in CuPy.

If you want to use PyTorch’s memory pool and non-default CUDA streams, streams must be created and managed using PyTorch (using `torch.cuda.Stream()` and `pytorch_pfn_extras.cuda.stream(stream)`).

**Return type** `None`

### 2.8.8 pytorch\_pfn\_extras.cuda.use\_default\_mempool\_in\_cupy

`pytorch_pfn_extras.cuda.use_default_mempool_in_cupy()`

Use the default memory pool in CuPy.

**Return type** `None`



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