PyTorch Lightning (PL)

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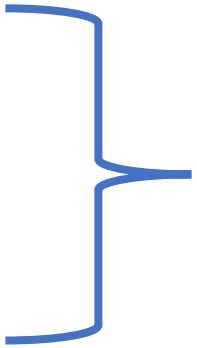
Decouple research code from engineering. – PL

Supervised Learning using PL

Experience

Task

Performance



PyTorch Lightning removes boiler plate code so we can focus on proper ETP

`PyTorch` vs `PyTorch Lightning`

`PyTorch`

Define train/val/test functions and `for` loops

Call optimizer/scheduler routines

Define dataset/dataloader class

Move model and data to/from device

Compute, accumulate & display performance metrics & losses

`PyTorch Lightning`

Installation

```
pip install pytorch-lightning
pip install torchmetrics

from pytorch_lightning import LightningModule, Trainer
from pytorch_lightning.loggers import WandbLogger
from torchmetrics.functional import accuracy
```

PyTorch → PL

Model, Data and Performance Measure Inside a `LightningModule (LM)`

An `LM` has a Model

```
class LitMNISTModel(LightningModule):
    def __init__(self, num_classes=10, lr=0.001, batch_size=32):
        super().__init__()
        self.save_hyperparameters()
        self.model = torchvision.models.resnet18(num_classes=num_classes)
        self.model.conv1 = torch.nn.Conv2d(1, 64, kernel_size=7,
                                           stride=2, padding=3, bias=False)
        self.loss = torch.nn.CrossEntropyLoss()

    def forward(self, x):
        return self.model(x)
```

```python
# this is called during fit()
def training_step(self, batch, batch_idx):
    x, y = batch
    y_hat = self.forward(x)
    loss = self.loss(y_hat, y)
    return {"loss": loss}

# calls to self.log() are recorded in wandb
def training_epoch_end(self, outputs):
    avg_loss = torch.stack([x["loss"] for x in outputs]).mean()
    self.log("train_loss", avg_loss, on_epoch=True)

# this is called at the end of an epoch
def test_step(self, batch, batch_idx):
    x, y = batch
    y_hat = self.forward(x)
    loss = self.loss(y_hat, y)
    acc = accuracy(y_hat, y) * 100.
    # we use y_hat to display predictions during callback
    return {"y_hat": y_hat, "test_loss": loss, "test_acc": acc}

# this is called at the end of all epochs
def test_epoch_end(self, outputs):
    avg_loss = torch.stack([x["test_loss"] for x in outputs]).mean()
    avg_acc = torch.stack([x["test_acc"] for x in outputs]).mean()
    self.log("test_loss", avg_loss, on_epoch=True, prog_bar=True)
    self.log("test_acc", avg_acc, on_epoch=True, prog_bar=True)
```

Train/Test Functions are `LM` methods

Automatically use right device
Automatic call to optimizer/scheduler
Easy logging of performance metrics

```python
def train_dataloader(self):
    return torch.utils.data.DataLoader(
        torchvision.datasets.MNIST(
            "./data", train=True, download=True,
            transform=torchvision.transforms.ToTensor()
        ),
        batch_size=self.hparams.batch_size,
        shuffle=True,
        num_workers=48,
        pin_memory=True,
    )

def test_dataloader(self):
    return torch.utils.data.DataLoader(
        torchvision.datasets.MNIST(
            "./data", train=False, download=True,
            transform=torchvision.transforms.ToTensor()
        ),
        batch_size=self.hparams.batch_size,
        shuffle=False,
        num_workers=48,
        pin_memory=True,
    )
```

Dataset/dataloader all in `LM`

`LightningDataModule` – Advanced data handling

```
class KWSDataModule(LightningDataModule):
    def __init__(self, path, batch_size=128, num_workers=0, n_fft=512,
                 n_mels=128, win_length=None, hop_length=256, class_dict={},
                 **kwargs):
        super().__init__(**kwargs)
        self.path = path
        self.batch_size = batch_size
        self.num_workers = num_workers
        self.n_fft = n_fft
        self.n_mels = n_mels
        self.win_length = win_length
        self.hop_length = hop_length
        self.class_dict = class_dict
```

`Trainer` for training/validator

```
# wandb is a great way to debug and visualize this model
wandb_logger = WandbLogger(project="pl-mnist")

trainer = Trainer(accelerator=args.accelerator,
                  devices=args.devices,
                  max_epochs=args.max_epochs,
                  logger=wandb_logger if not args.no_wandb else None,
                  callbacks=[WandbCallback() if not args.no_wandb else None])
trainer.fit(model)
trainer.test(model)

wandb.finish()
```

Code demo is next