PyTorch Hook

Underrated Tool for Debugging and Modifying Deep Learning Model Blindly

Rian Adam Rajagede – PyCon ID 2023

Code available:

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Website: https://structilmy.com

Konteks

Mau apa? Sharing pengalaman pakai PyTorch hook setahun terakhir

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Semoga tetap ada hikmah yang bisa dipetik ya :)

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Agenda

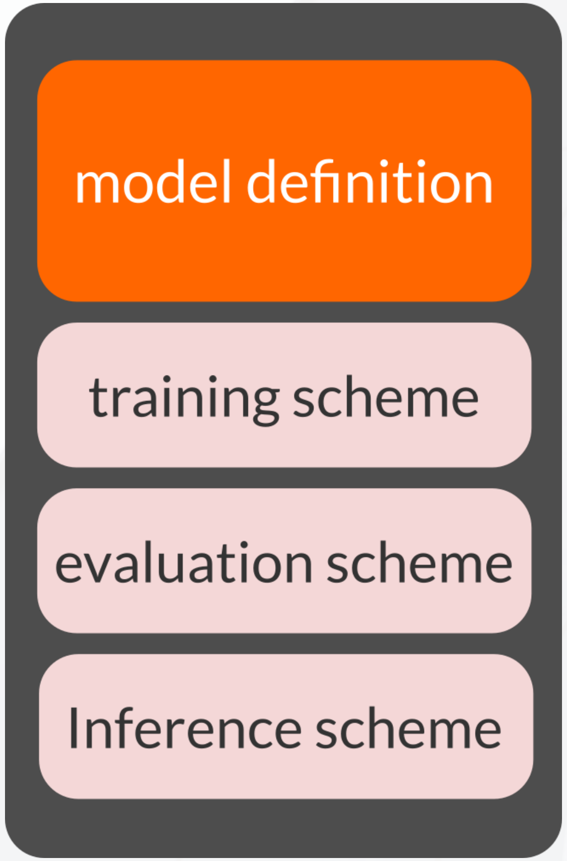
- **Sekilas PyTorch**
- **Mengulik model "blindly"**
- **PyTorch hook & studi kasus**

A Glimpse of PyTorch

Deep learning framework dari Meta.ai
Sekarang bagian dari Linux Foundation

Struktur

Secara umum, struktur kode PyTorch sama seperti Tensorflow/Keras*:



model definition

training scheme

evaluation scheme

Inference scheme

*tapi lebih banyak yang harus ditulis

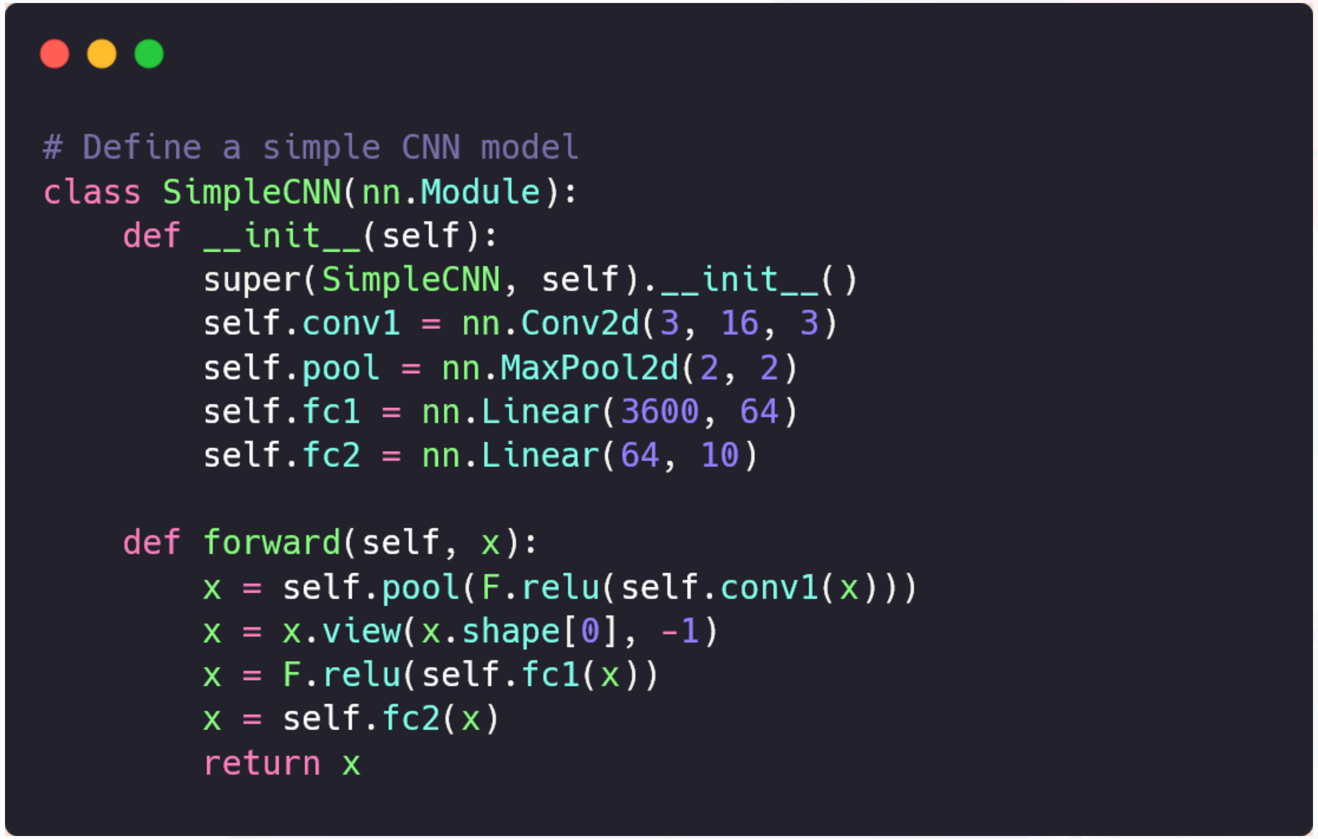
Mendefinisikan Model

- model definition
- training scheme
- evaluation scheme
- Inference scheme

Buat class model

Definisikan layer-layer

Definisikan forward propagation



```
# Define a simple CNN model
class SimpleCNN(nn.Module):
    def __init__(self):
        super(SimpleCNN, self).__init__()
        self.conv1 = nn.Conv2d(3, 16, 3)
        self.pool = nn.MaxPool2d(2, 2)
        self.fc1 = nn.Linear(3600, 64)
        self.fc2 = nn.Linear(64, 10)

    def forward(self, x):
        x = self.pool(F.relu(self.conv1(x)))
        x = x.view(x.shape[0], -1)
        x = F.relu(self.fc1(x))
        x = self.fc2(x)
        return x
```

Training Scheme

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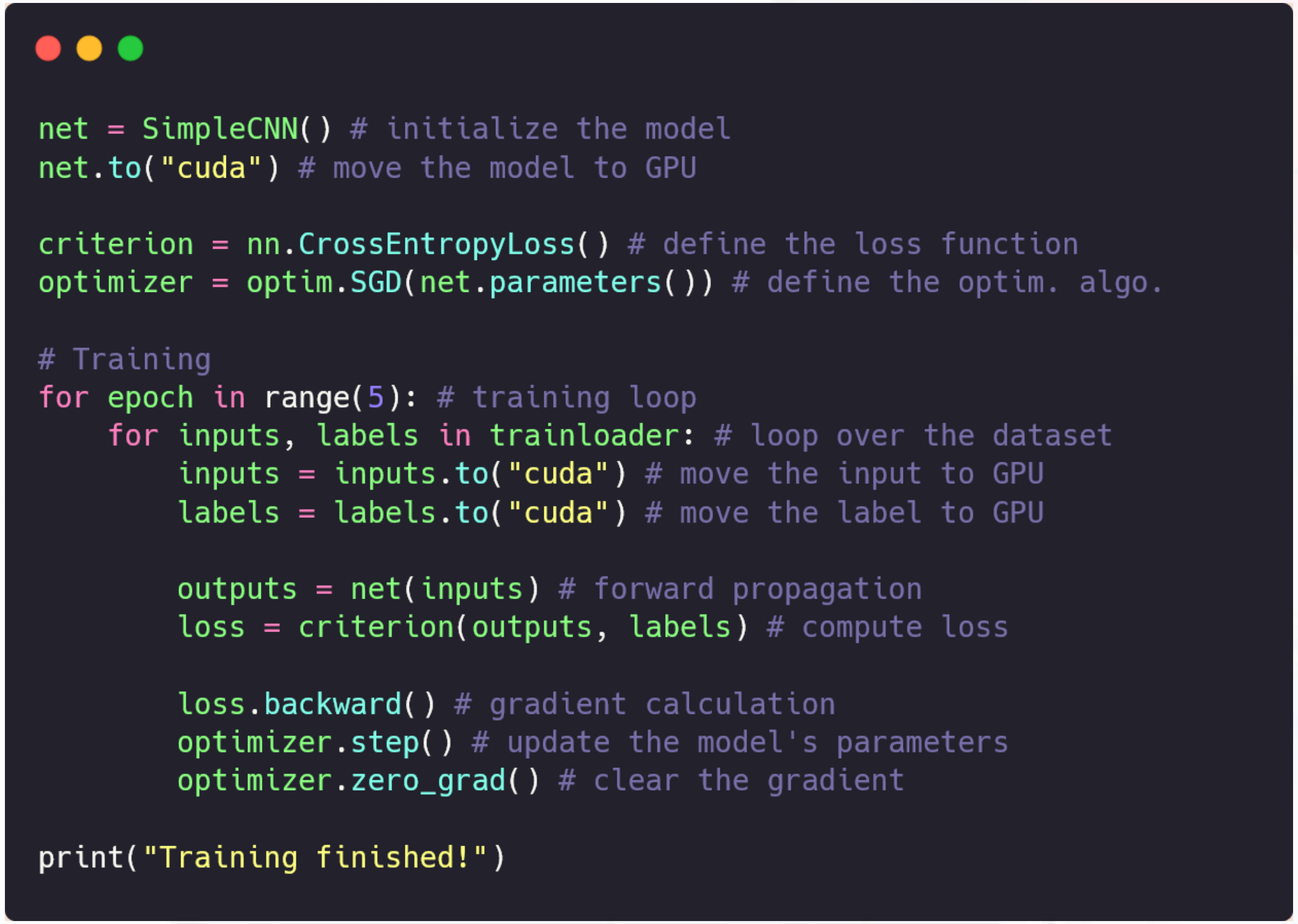
Initialize model,
optimizer,
loss function

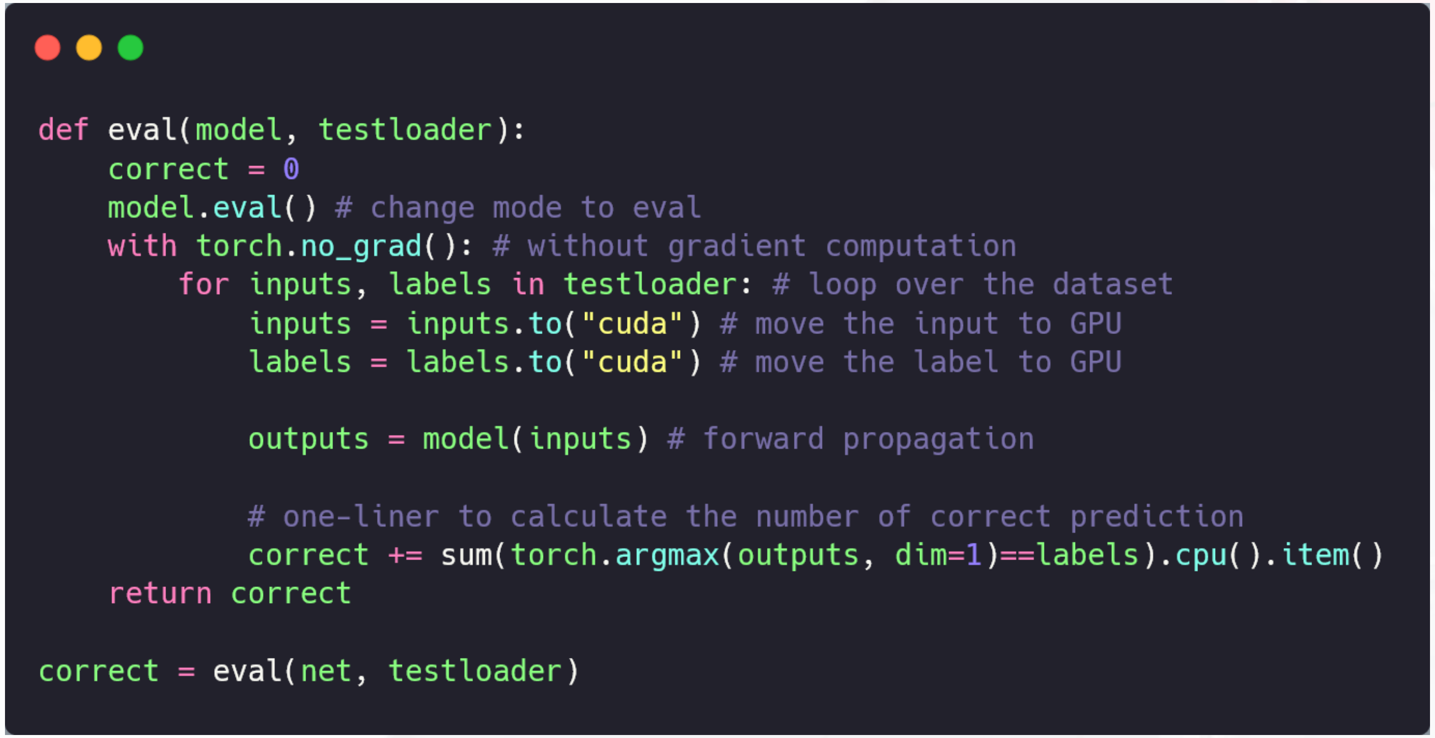
Training loop



```
net = SimpleCNN() # initialize the model
net.to("cuda") # move the model to GPU

criterion = nn.CrossEntropyLoss() # define the loss function
optimizer = optim.SGD(net.parameters()) # define the optim. algo.

# Training
for epoch in range(5): # training loop
    for inputs, labels in trainloader: # loop over the dataset
        inputs = inputs.to("cuda") # move the input to GPU
        labels = labels.to("cuda") # move the label to GPU

        outputs = net(inputs) # forward propagation
        loss = criterion(outputs, labels) # compute loss

        loss.backward() # gradient calculation
        optimizer.step() # update the model's parameters
        optimizer.zero_grad() # clear the gradient

print("Training finished!")
```

Evaluation Scheme

Sama seperti training, hanya saja tanpa sintaks-sintaks yang berhubungan dengan backward propagation / optimization



```python
def eval(model, testloader):
    correct = 0
    model.eval() # change mode to eval
    with torch.no_grad(): # without gradient computation
        for inputs, labels in testloader: # loop over the dataset
            inputs = inputs.to("cuda") # move the input to GPU
            labels = labels.to("cuda") # move the label to GPU

            outputs = model(inputs) # forward propagation

            # one-liner to calculate the number of correct prediction
            correct += sum(torch.argmax(outputs, dim=1)==labels).cpu().item()
    return correct

correct = eval(net, testloader)
```

Biasanya dibuat dalam bentuk fungsi biar enak kalau perlu panggil lagi

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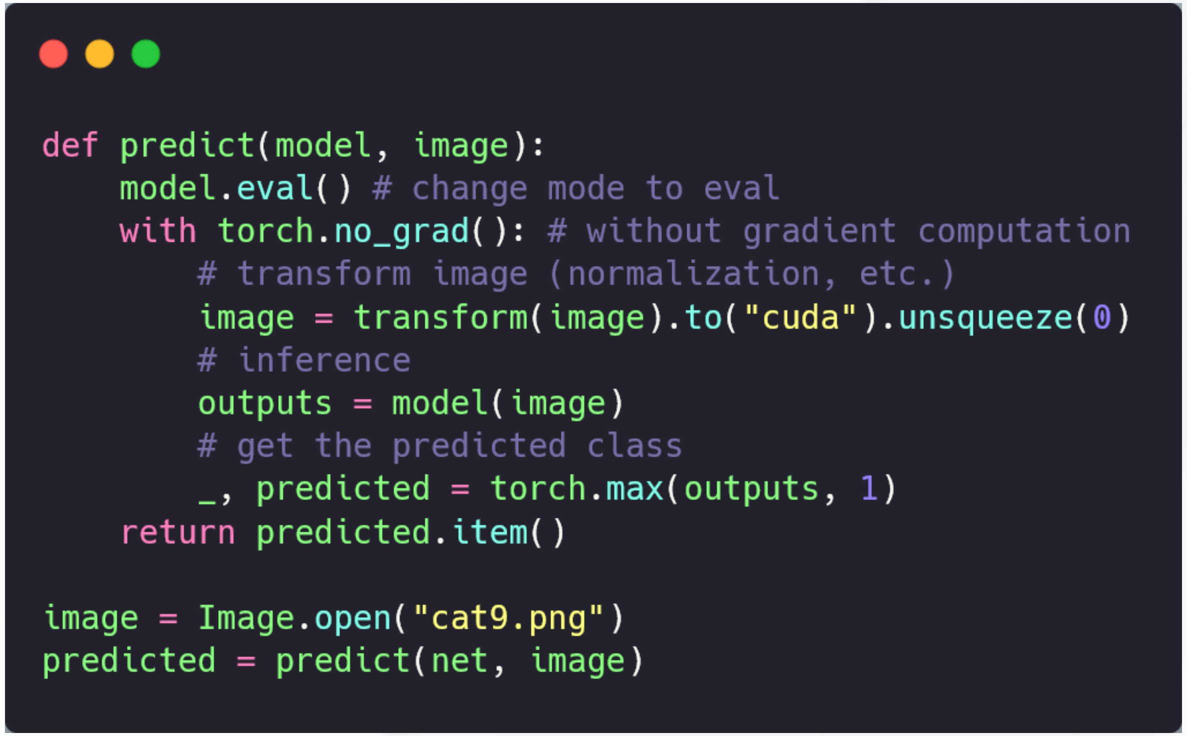
Inference Scheme

Sama seperti evaluasi, tapi hanya dari satu gambar raw



```python
def predict(model, image):
    model.eval() # change mode to eval
    with torch.no_grad(): # without gradient computation
        # transform image (normalization, etc.)
        image = transform(image).to("cuda").unsqueeze(0)
        # inference
        outputs = model(image)
        # get the predicted class
        _, predicted = torch.max(outputs, 1)
    return predicted.item()

image = Image.open("cat9.png")
predicted = predict(net, image)
```

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Mengulik Model “Blindly”

Karena model semakin kompleks

Mendefinisikan Model

Karena model semakin kompleks, bagian mendefinisikan model dan juga proses training jadi semakin kompleks

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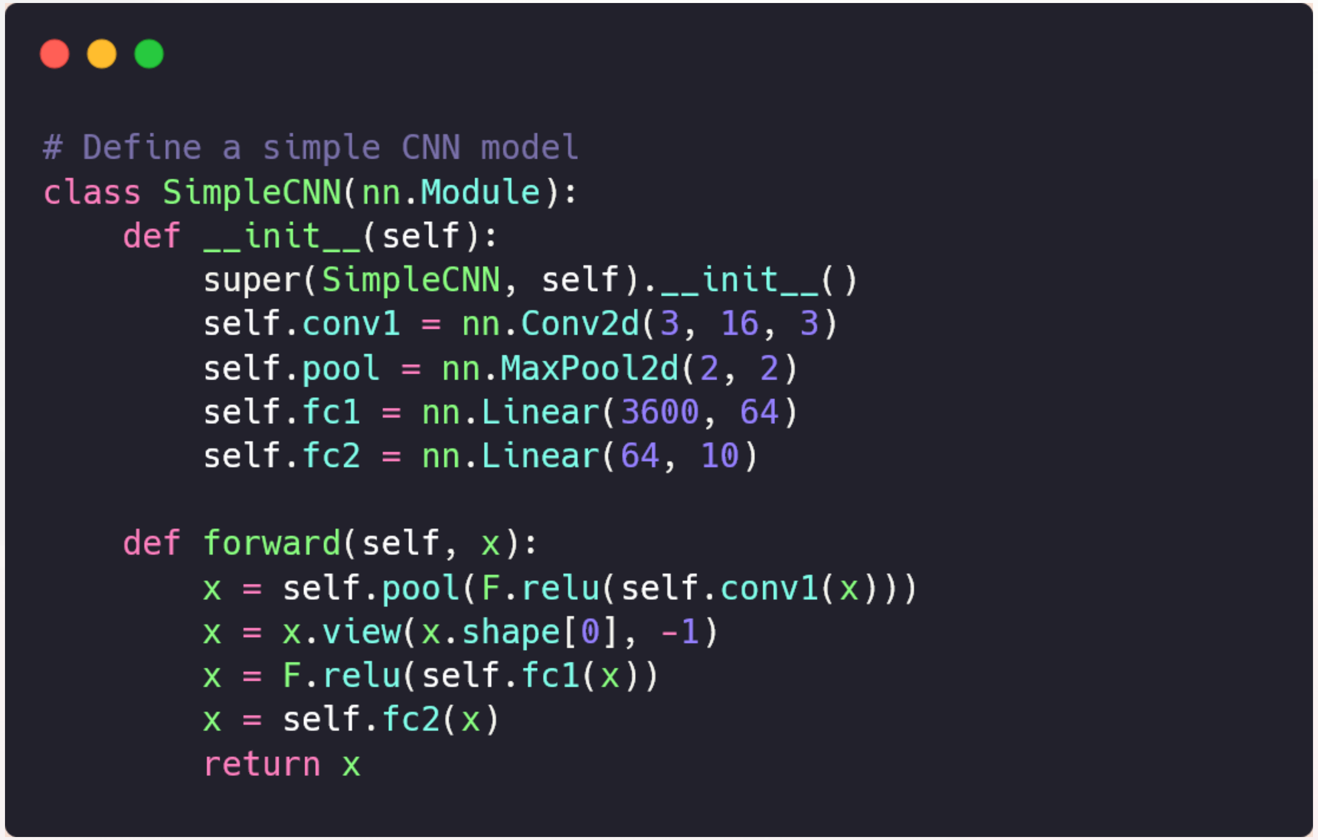
Buat class model

Definisikan layer-layer

Definisikan forward propagation



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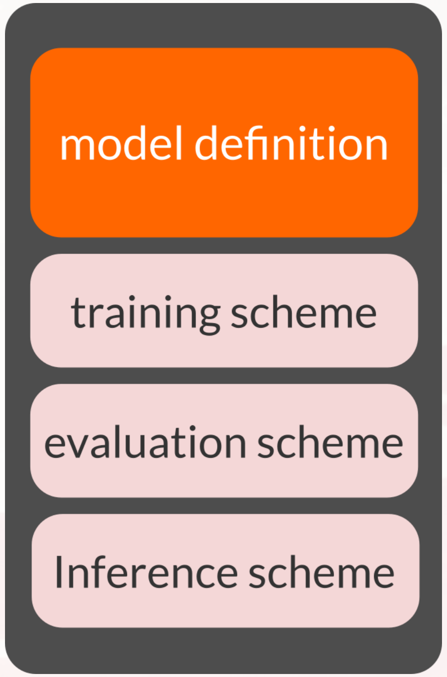
Mendefinisikan Model



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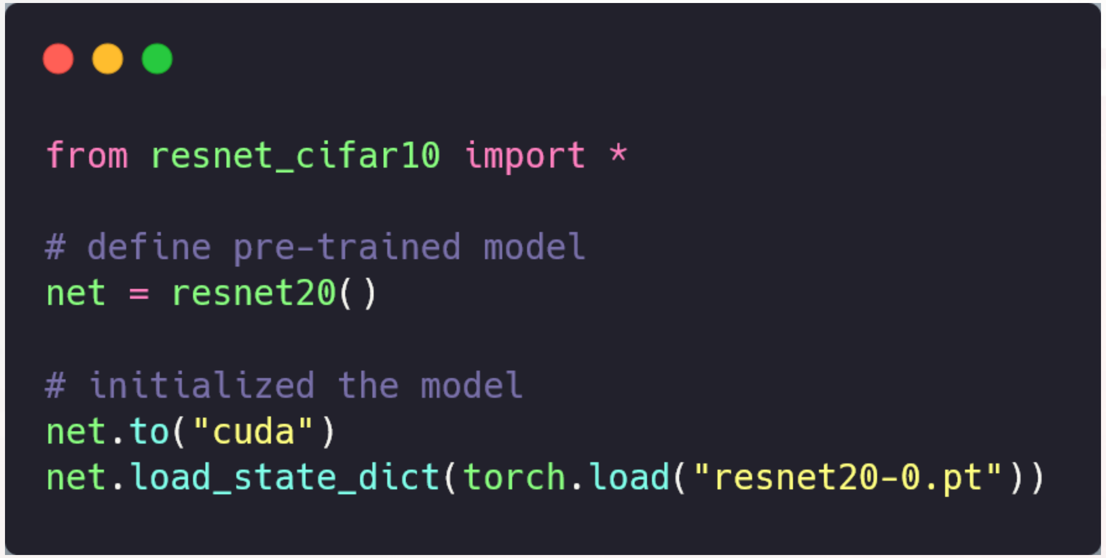
Solusi: Download model yang sudah jadi (pre-trained model)
- simple
- kualitas sudah bagus



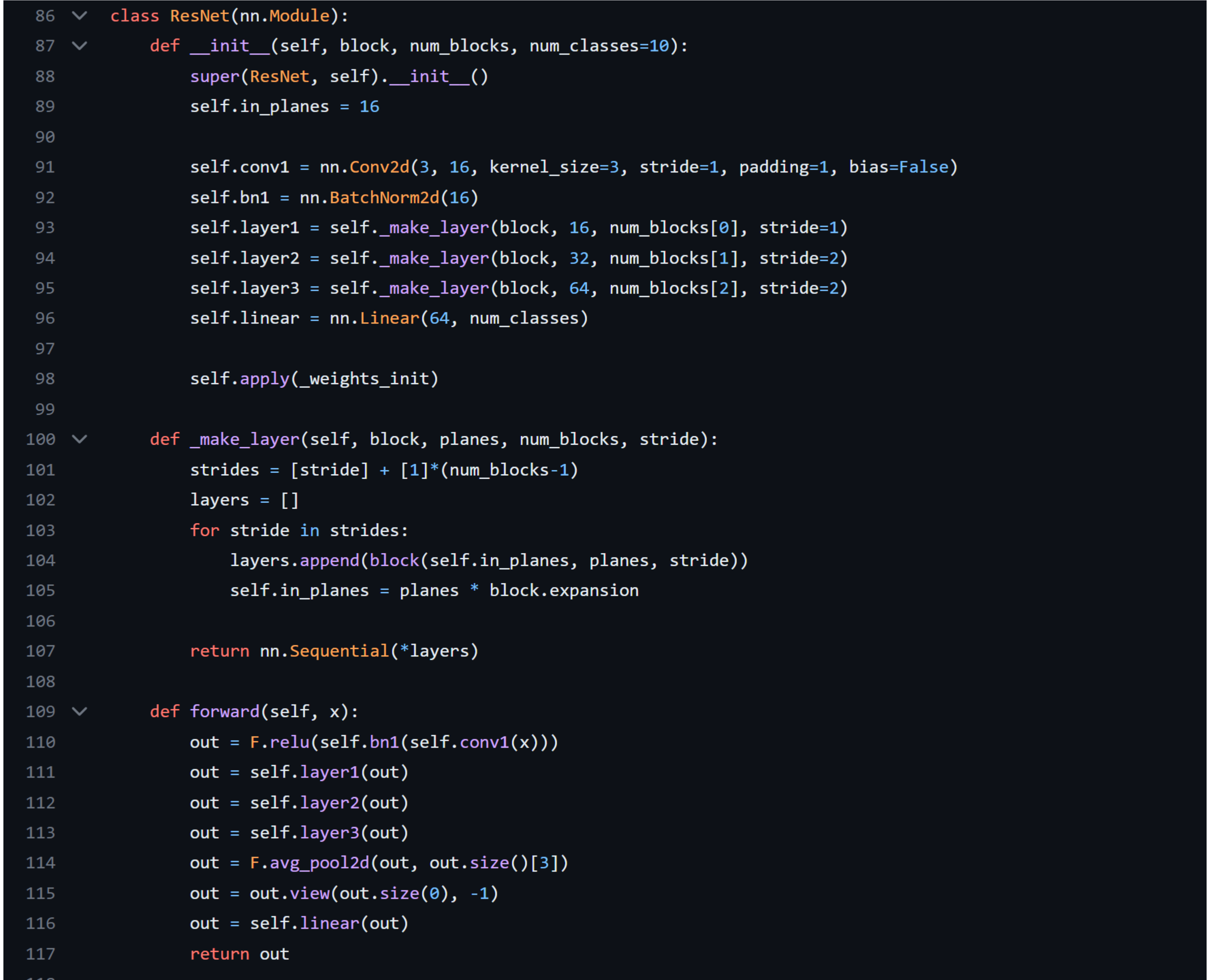
```
from resnet_cifar10 import *

# define pre-trained model
net = resnet20()

# initialized the model
net.to("cuda")
net.load_state_dict(torch.load("resnet20-0.pt"))
```

Model ResNet20 bisa didownload di
https://github.com/akamaster/pytorch_resnet_cifar10

Sekilas dibalik `resnet20()`



```python
class ResNet(nn.Module):
    def __init__(self, block, num_blocks, num_classes=10):
        super(ResNet, self).__init__()
        self.in_planes = 16

        self.conv1 = nn.Conv2d(3, 16, kernel_size=3, stride=1, padding=1, bias=False)
        self.bn1 = nn.BatchNorm2d(16)
        self.layer1 = self._make_layer(block, 16, num_blocks[0], stride=1)
        self.layer2 = self._make_layer(block, 32, num_blocks[1], stride=2)
        self.layer3 = self._make_layer(block, 64, num_blocks[2], stride=2)
        self.linear = nn.Linear(64, num_classes)

        self.apply(_weights_init)

    def _make_layer(self, block, planes, num_blocks, stride):
        strides = [stride] + [1]*(num_blocks-1)
        layers = []
        for stride in strides:
            layers.append(block(self.in_planes, planes, stride))
            self.in_planes = planes * block.expansion

        return nn.Sequential(*layers)

    def forward(self, x):
        out = F.relu(self.bn1(self.conv1(x)))
        out = self.layer1(out)
        out = self.layer2(out)
        out = self.layer3(out)
        out = F.avg_pool2d(out, out.size()[3])
        out = out.view(out.size(0), -1)
        out = self.linear(out)
        return out
```

Gimana kalau kita perlu memodifikasi pre-trained model?

https://imgflip.co

Buat model sendiri tapi panjang ngodingnya
Pakai model orang tapi susah pahamnya
JAKE-CLARK.TUMBLR
imgflip.com

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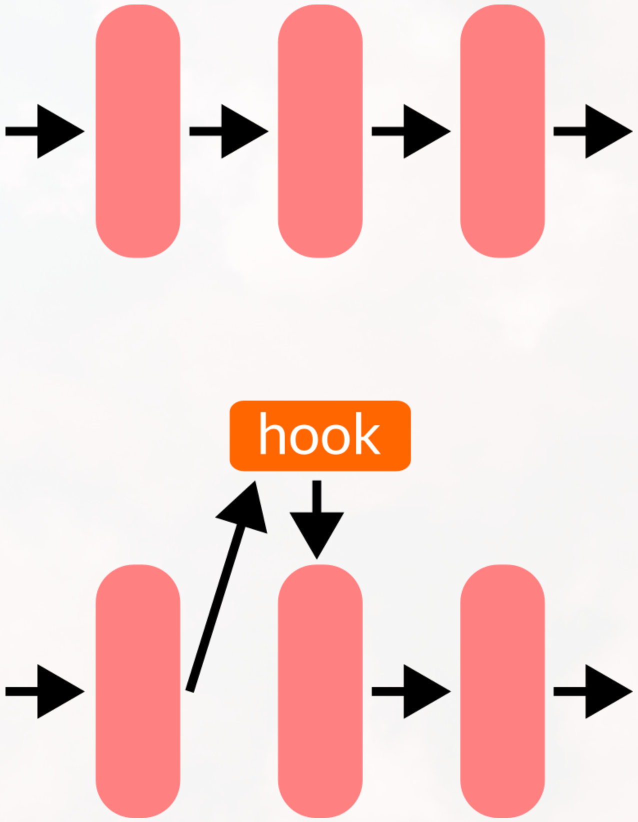
***Disclaimer:**
Memodifikasi di sini bisa jadi beda-beda tergantung kebutuhan. Solusi yang kita bahas bisa jadi tidak cocok

Introducing PyTorch Hook

Karena model semakin kompleks

PyTorch Hook

PyTorch Hook memungkinkan kita **untuk menaruh fungsi** di tengah-tengah model (di suatu modul).



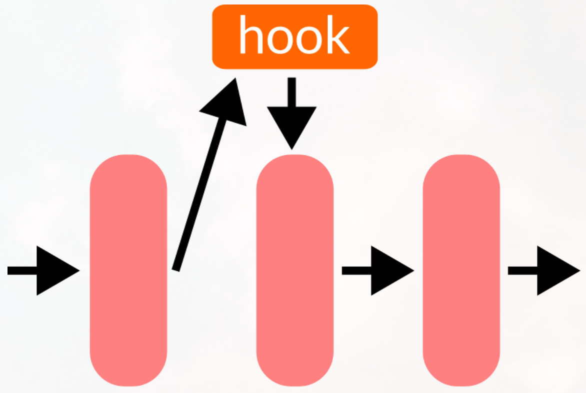
PyTorch Hook

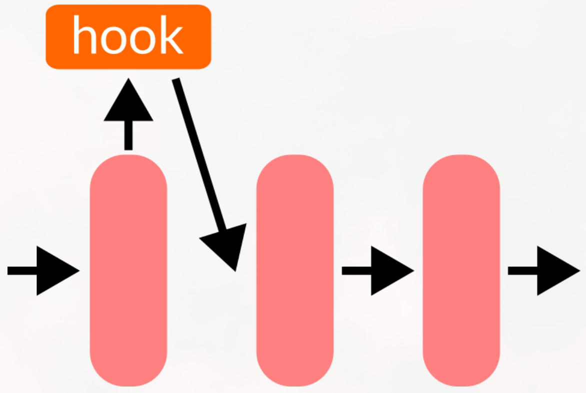
Saat ini ada 3 skema yang tersedia:

- **forward hook** : fungsi dijalankan setelah modul running

- **forward pre hook** : fungsi dijalankan sebelum modul running

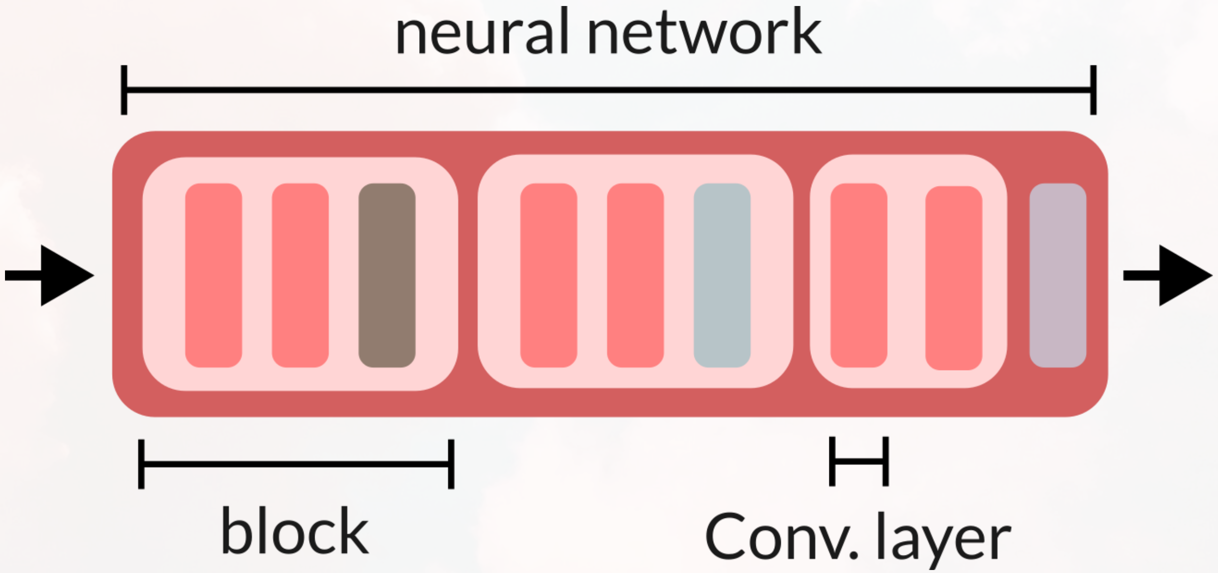
- **backward hook** : fungsi dijalankan saat proses backward propagation





“Modul” apa, *toh*?

Model Neural Network di PyTorch dibangun dari sekumpulan modul



PyTorch hook bisa dikaitkan di modul manapun

TKP

https:/ d-2023

https://github.com/rianrajagede/pyconid-2023

Thank You!

PyTorch Hook

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Code available: