

PyTorch practice

Convolutional networks: VGG-Net

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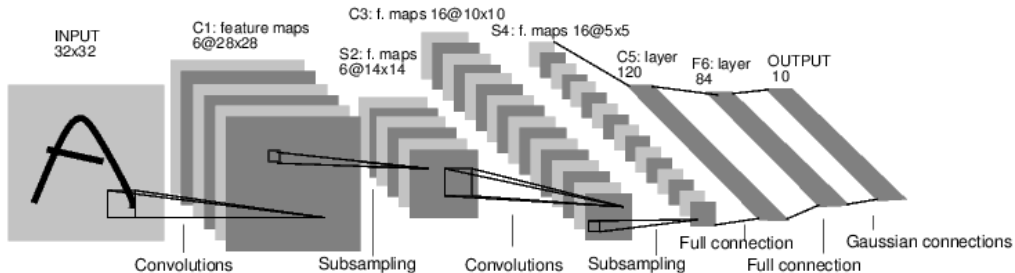
ConvNets: VGG-16

References

ConvNets: VGG-16

Neural networks can be constructed using the `torch.nn` package.

An `nn.Module` contains layers, and a method `forward(input)` that returns the output.



Let's define the `__init__()` method:

```
class Net(nn.Module):
```

```
    def __init__(self):
```

```
        pass
```

```
    def forward(self, x):
```

```
        pass
```

```
net = Net()
```

```
print(net)
```

```
def __init__(self):
```

```
    super(Net, self).__init__()
```

```
    # 1 input image channel
```

```
    # 6 output channels
```

```
    # 3x3 square convolution kernel
```

```
    self.conv1 = nn.Conv2d(1, 6, 3)
```

```
    self.conv2 = nn.Conv2d(6, 16, 3)
```

```
    # a linear operation:  $y = Wx + b$ 
```

```
    # 16 feature maps, with resolution 6 * 6
```

```
    self.fc1 = nn.Linear(16 * 6 * 6, 120)
```

```
    self.fc2 = nn.Linear(120, 84)
```

```
    self.fc3 = nn.Linear(84, 10)
```

Let's define the forward(x) method:

```
class Net(nn.Module):
```

```
    def __init__(self):  
        pass
```

```
    def forward(self, x):  
        pass
```

```
net = Net()
```

```
print(net)
```

```
# Let's define the entire network
```

```
def forward(self, x):
```

```
    # 3x3 2d convolution
```

```
    x = self.conv1(x) # 3x3 2d convolution
```

```
    x = F.relu(x) # RELU activation function
```

```
    x = F.max_pool2d(x, (2, 2)) # 2x2 max pooling
```

```
    x = F.max_pool2d(F.relu(self.conv2(x)), (2, 2))
```

```
    x = x.view(-1, 16 * 6 * 6)
```

```
    x = F.relu(self.fc1(x))
```

```
    x = F.relu(self.fc2(x))
```

```
    x = self.fc3(x)
```

```
    return x
```

Once the network has been defined, we are able to print it:

```
class Net(nn.Module):
```

```
    def __init__(self):
```

```
        self.conv1 = ...
```

```
        self.conv2 = ...
```

```
        ...
```

```
    def forward(self, x):
```

```
        x = ...
```

```
        x = ...
```

```
        return x
```

```
if __name__ == "__main__":
```

```
    net = Net()
```

```
    print(net)
```

```
Net(
```

```
  (conv1): Conv2d(1, 6, kernel_size=(3, 3), stride=(1, 1))
```

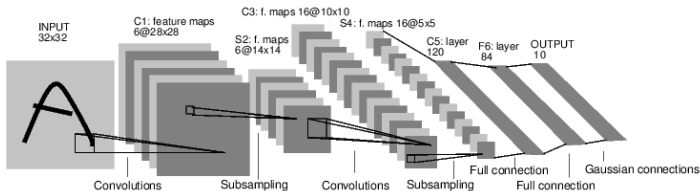
```
  (conv2): Conv2d(6, 16, kernel_size=(3, 3), stride=(1, 1))
```

```
  (fc1): Linear(in_features=576, out_features=120, bias=True)
```

```
  (fc2): Linear(in_features=120, out_features=84, bias=True)
```

```
  (fc3): Linear(in_features=84, out_features=10, bias=True)
```

```
)
```



Let's try a random 32x32 input. Note: expected input size of this net (LeNet) is 32x32.

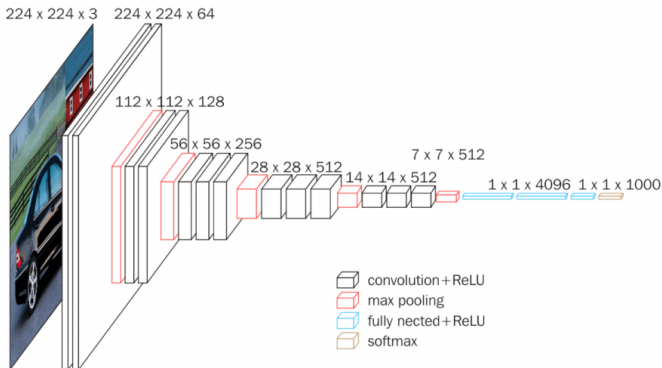
To use this net on MNIST dataset [3], please resize the images from the dataset to 32x32.

```
if __name__ == "__main__":  
    net = Net()  
    B = 1 # batch size  
    fin = 1 # one input channel (grayscale)  
    w, h = 32, 32  
    x = torch.randn(B, fin, w, h)  
    output = net(x)  
    print(output)
```

```
tensor([[ 0.0250,  0.0280, -0.0704,  
         -0.1894, -0.0126,  0.0648,  
         0.0774,  0.0855, -0.1219,  
        -0.0386]], grad_fn=<AddmmBackward>)
```

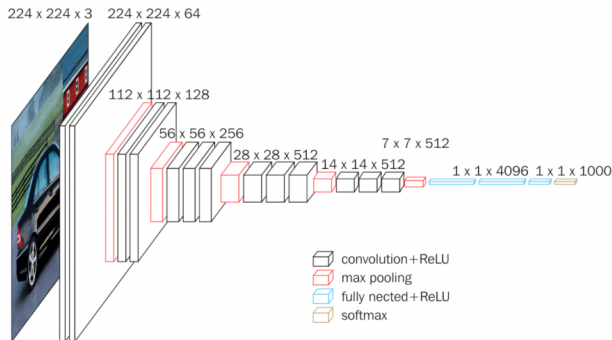

VGG16 [4] is a convolutional neural network model proposed in the paper “Very Deep Convolutional Networks for Large-Scale Image Recognition”.

The model achieves 92.7% top-5 test accuracy in ImageNet [1], which is a dataset of over 14 million images belonging to **1000 classes**.



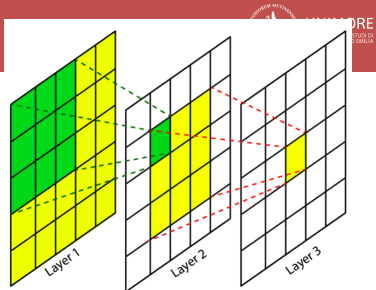
It makes the improvement over AlexNet [2] by replacing large kernel-sized filters (11 and 5 in the first and second convolutional layer, respectively) with multiple 3×3 kernel-sized filters one after another.

- conv. stride 1 – no loss of information
- Rectification (ReLU) non-linearity
- 5 max-pool layers (x2 reduction)
- no normalisation
- 3 fully-connected (FC) layers



Depth matters!

VGG-16

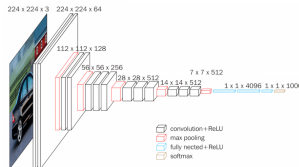


Let's code VGG-16!

- Main paper: <https://arxiv.org/pdf/1409.1556.pdf>
- Slides: http://www.robots.ox.ac.uk/~karen/pdf/ILSVRC_2014.pdf
- GitHub: <https://github.com/Abhisek-/VGG>

Useful Resources: <https://pytorch.org/docs/stable/nn.html>

- `nn.Sequential`
- `nn.Conv2d`
- `nn.ReLU`
- `nn.MaxPool2d`
- `nn.AdaptiveAvgPool2d`
- `nn.Linear`
- `nn.Dropout`
- `torch.flatten`



```
class VGG16(nn.Module):  
  
    def __init__(self):  
        pass  
  
    def forward(self, x):  
        pass  
  
net = VGG16()  
print(net)
```

Your Tasks Today

1. Code VGG16 in PyTorch
2. Make sure that it works on ImageNet-like input (i.e. $3 \times 224 \times 224$ tensors)
3. Optional: make it also work on CIFAR-like input ($3 \times 32 \times 32$ tensors)
4. Very optional: train it on the CIFAR-10 dataset

- [1] A. Krizhevsky, I. Sutskever, and G. E. Hinton.

Imagenet classification with deep convolutional neural networks.

In *Advances in neural information processing systems*, pages 1097–1105, 2012.

- [2] A. Krizhevsky, I. Sutskever, and G. E. Hinton.

Imagenet classification with deep convolutional neural networks.

In F. Pereira, C. J. C. Burges, L. Bottou, and K. Q. Weinberger, editors, *Advances in Neural Information Processing Systems 25*, pages 1097–1105. Curran Associates, Inc., 2012.

- [3] Y. LeCun.
The mnist database of handwritten digits.
<http://yann.lecun.com/exdb/mnist/>, 1998.
- [4] K. Simonyan and A. Zisserman.
Very deep convolutional networks for large-scale image recognition.
In International Conference on Learning Representations, 2015.
- [5] Y. B. P. H. Yann LeCun, Leon Bottou.
P. gradient-based learning applied to document recognition.
Proceedings of the IEEE 86, 1998.