Logo Detection Using PyTorch

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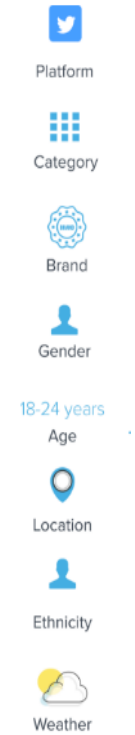
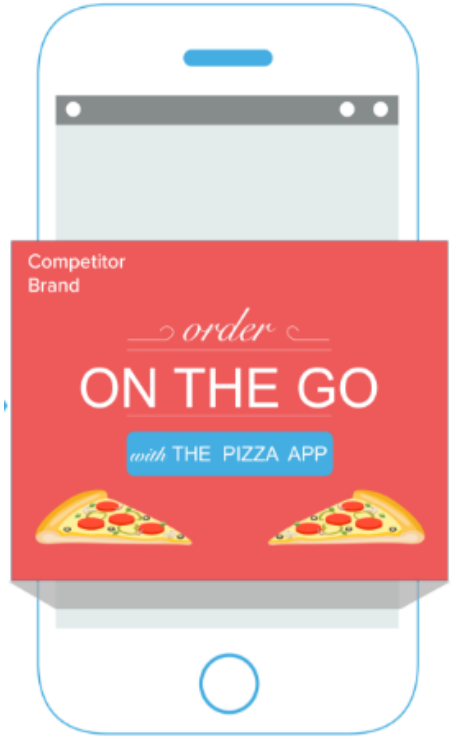
Ad Tech

Social Medias

Analyze



Target

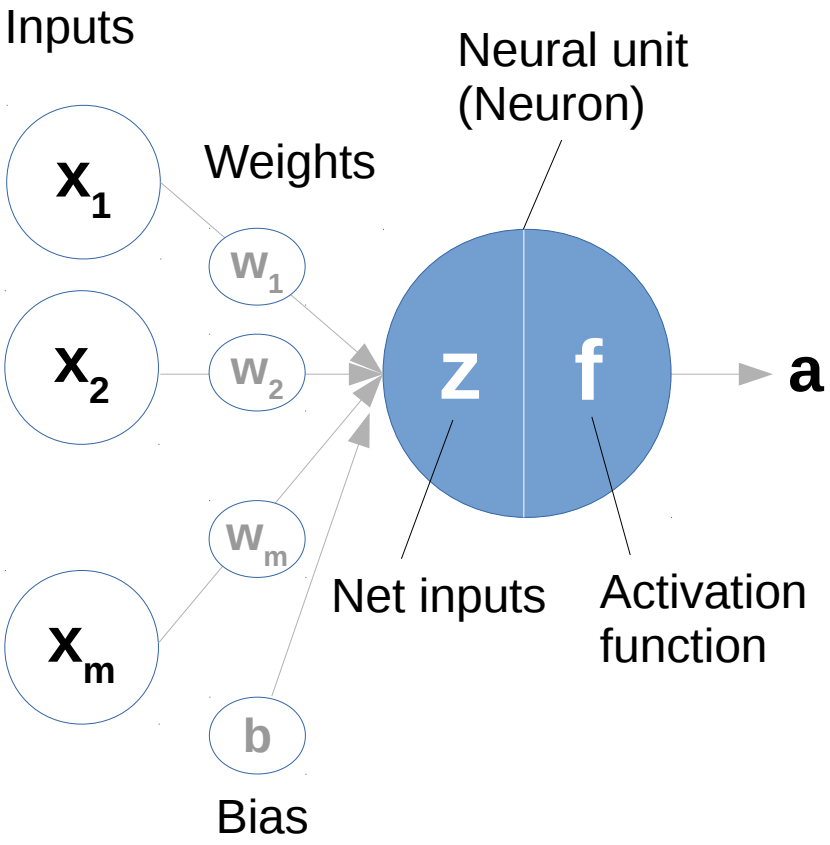


Source: https://cluep.com/

Deep Learning

1. **Create the Network**
2. **Train the Network**
3. **Deploy the Network**

Single-Layer Neural Network

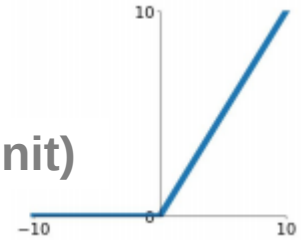


$$z = w_1x_1 + w_2x_2 + \ldots + w_mx_m + b$$

$$f = \max(0, z)$$

ReLU

(Rectified Linear Unit)



$$a = f(z)$$

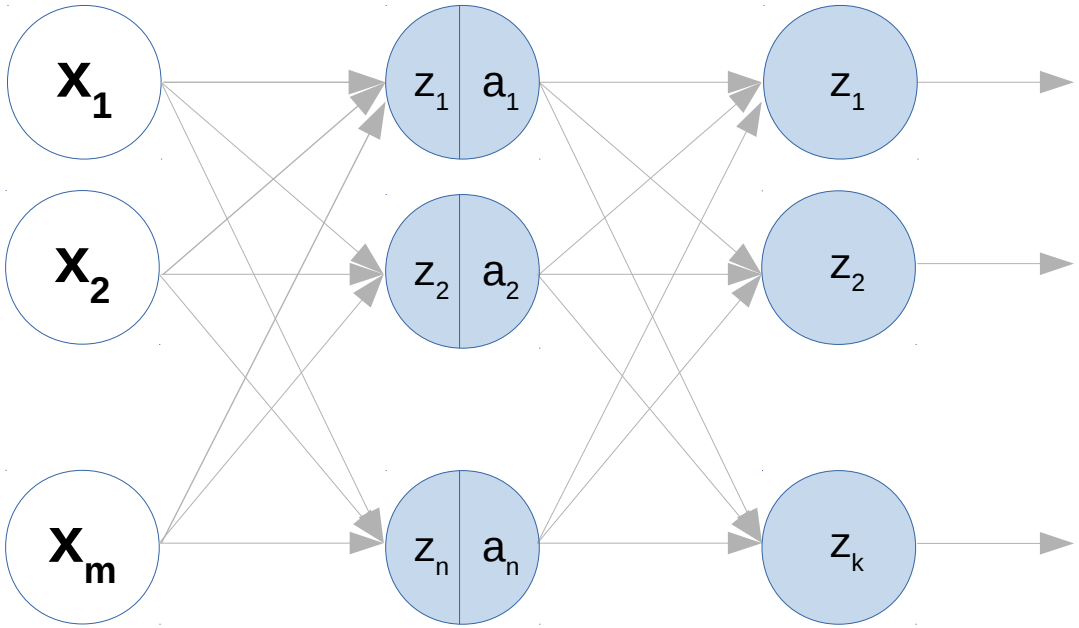
ReLU image: http://cs231n.stanford.edu/slides/2018/cs231n_2018_lecture06.pdf

Fully Connected Network

Input layer with *m* input units

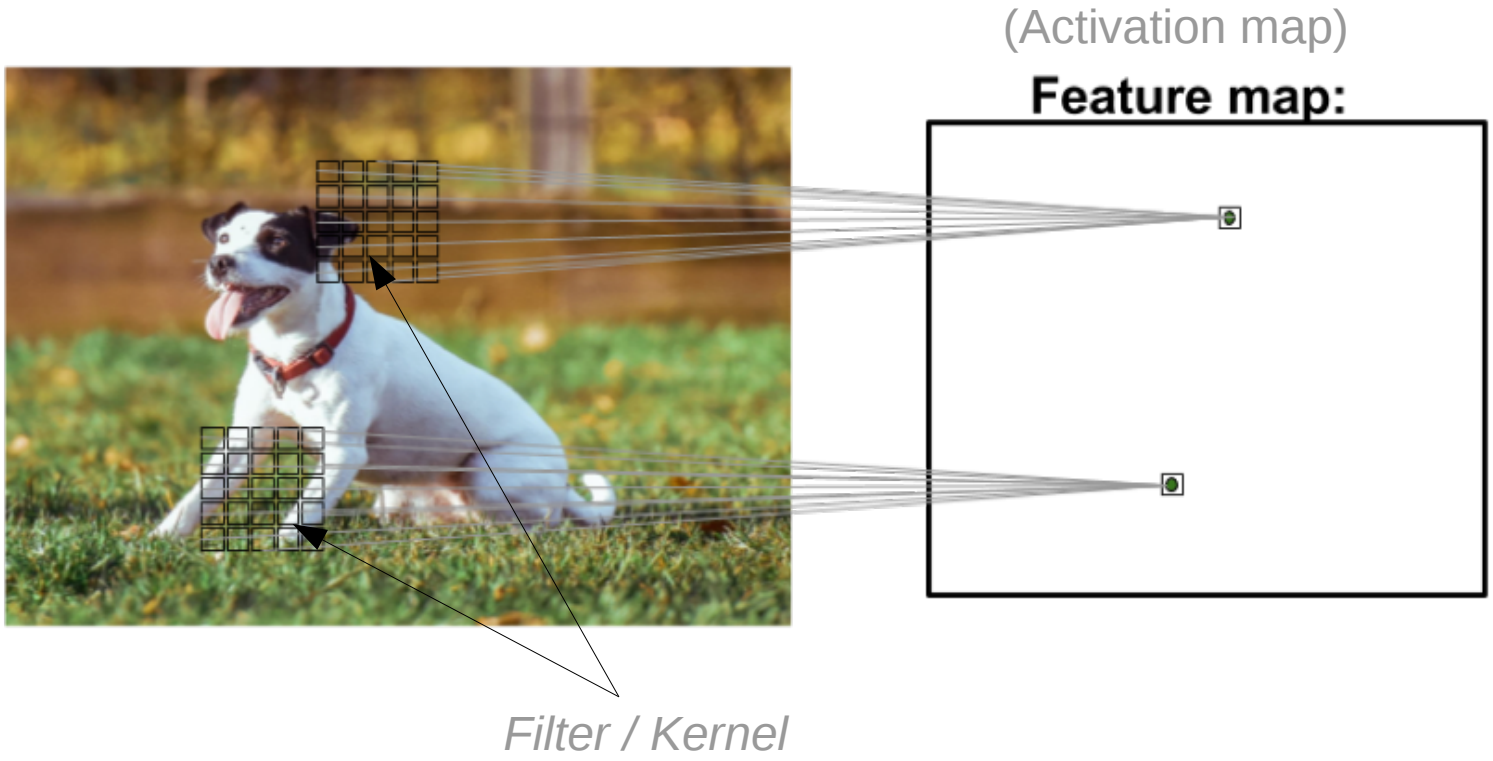
Hidden layer with *n* neural units

Output layer with *k* neural units

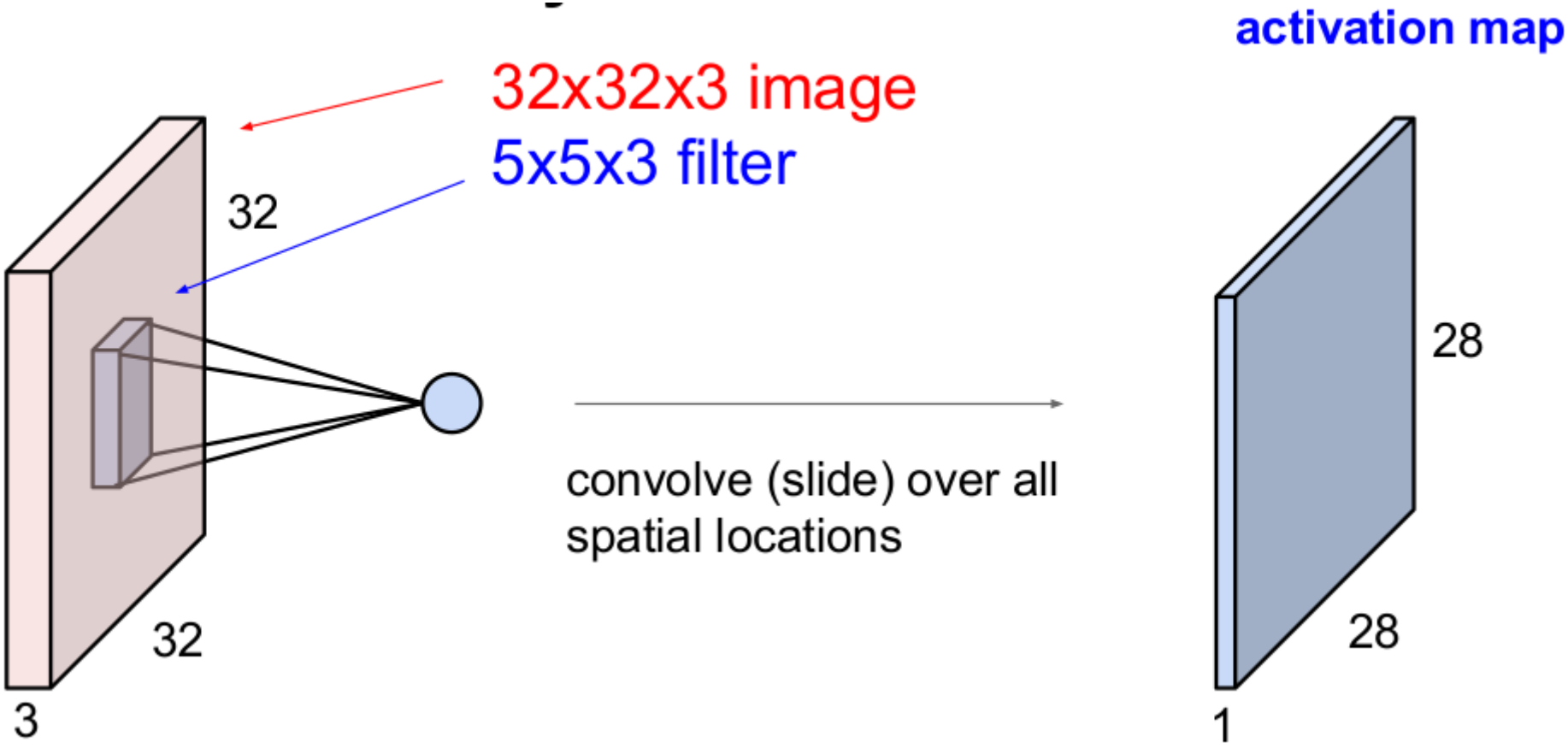


Convolutional Neural Networks (CNN)

It is an important tool for object recognition.



Convolutional Layer



Source: http://cs231n.stanford.edu/slides/2018/cs231n_2018_lecture06.pdf

Dot Product

INPUT
5 x 5 x 1

1	2	0	1	1
1	1	1	1	1
0	0	2	1	1
2	2	0	0	1
2	1	1	2	0

Filter
3 x 3 x 1
Stride = 1, Padding = 0

-1	1	0
-1	-1	0
1	0	0

weights

1

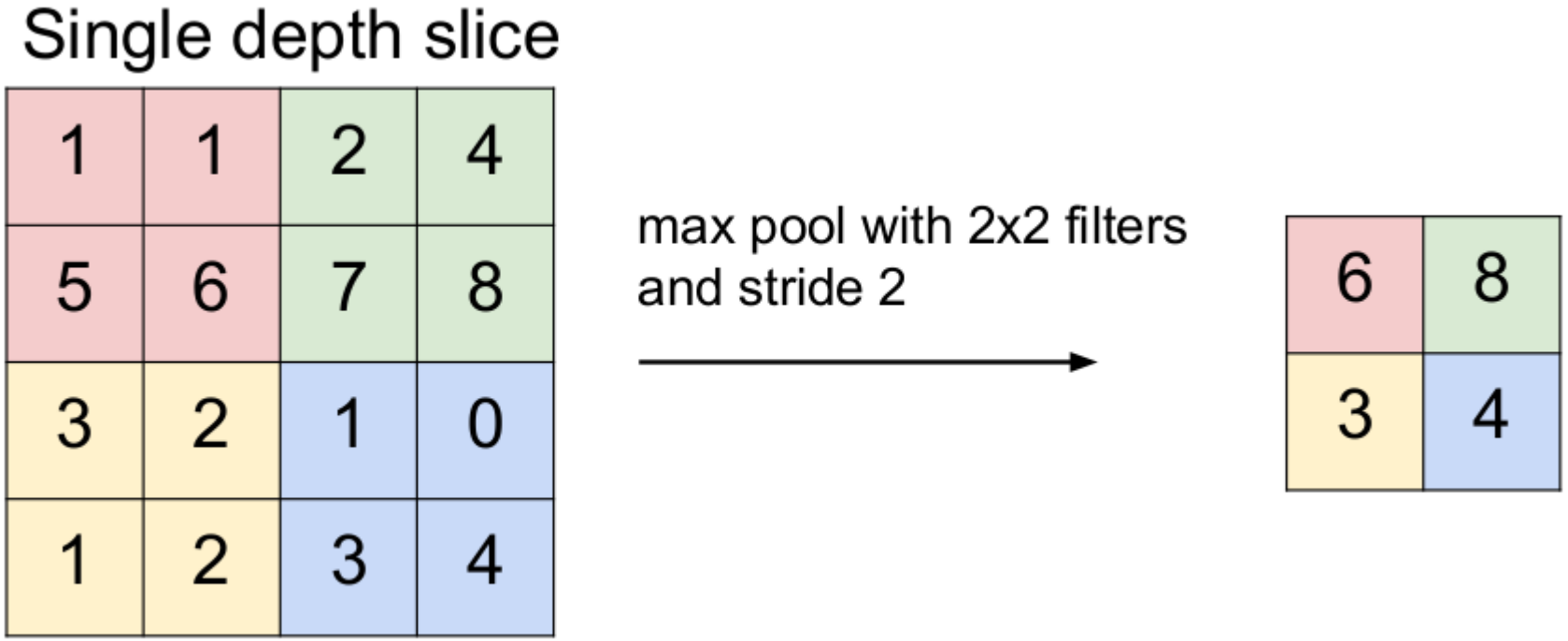
bias

OUTPUT
3 x 3 x 1
(Activation Map)

0	-3	2
3	1	-2
-1	2	1

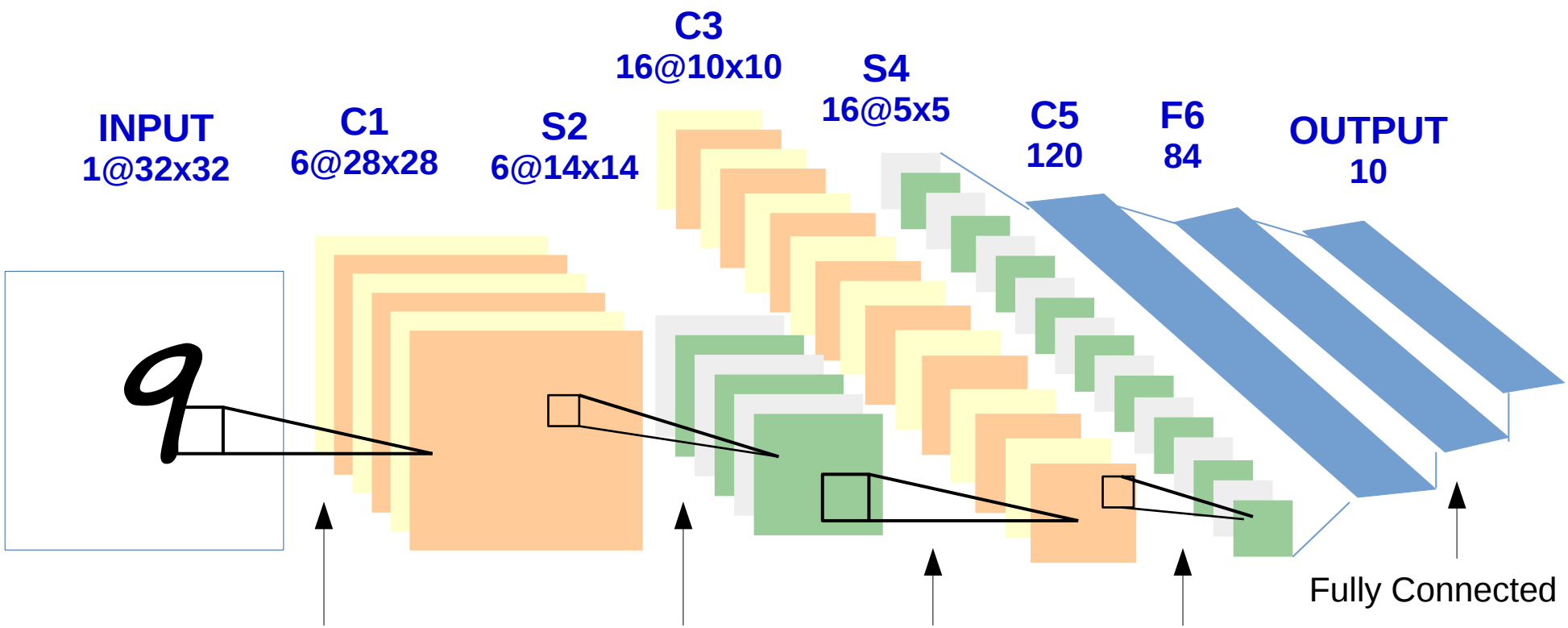
(1 * -1) + (2 * 1) + (0 * 0) + (1 * -1) + (1 * -1) + (2 * 0) + (2 * 1) + (0 * 0) +((1 * 0) + 1 = 3

Max Pooling



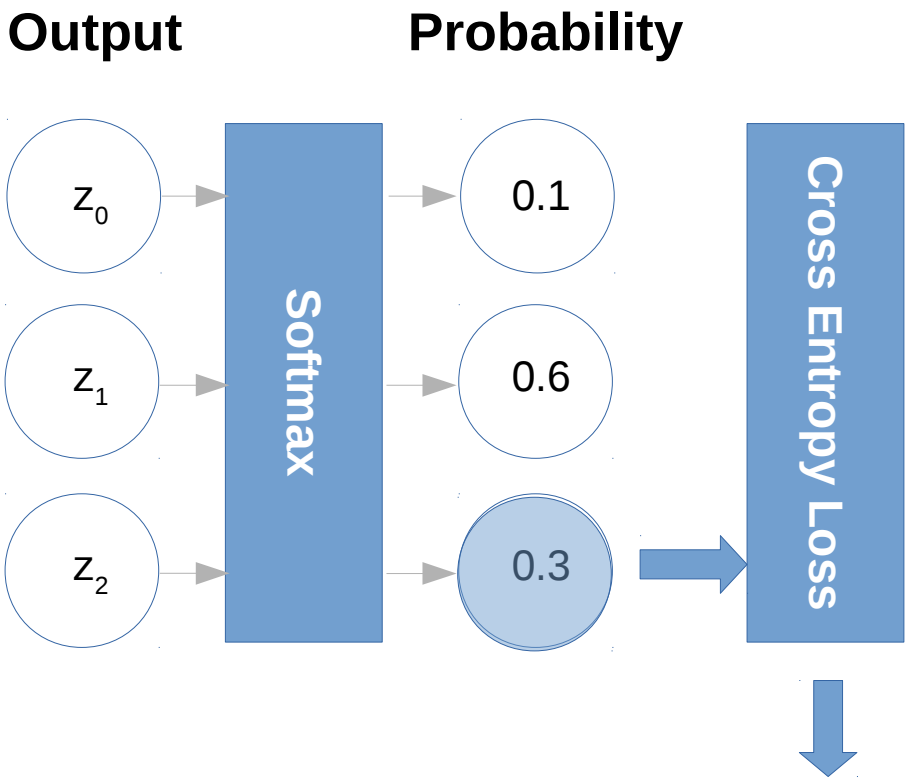
Source: http://cs231n.github.io/convolutional-networks/

LeNet-5



Source: LeCun, Yann, et al. "Gradient-based learning applied to document recognition." Proceedings of the IEEE 86.11 (1998): 2278-2324.

Loss Function



L_i = -log(0.3) = 0.523

Softmax

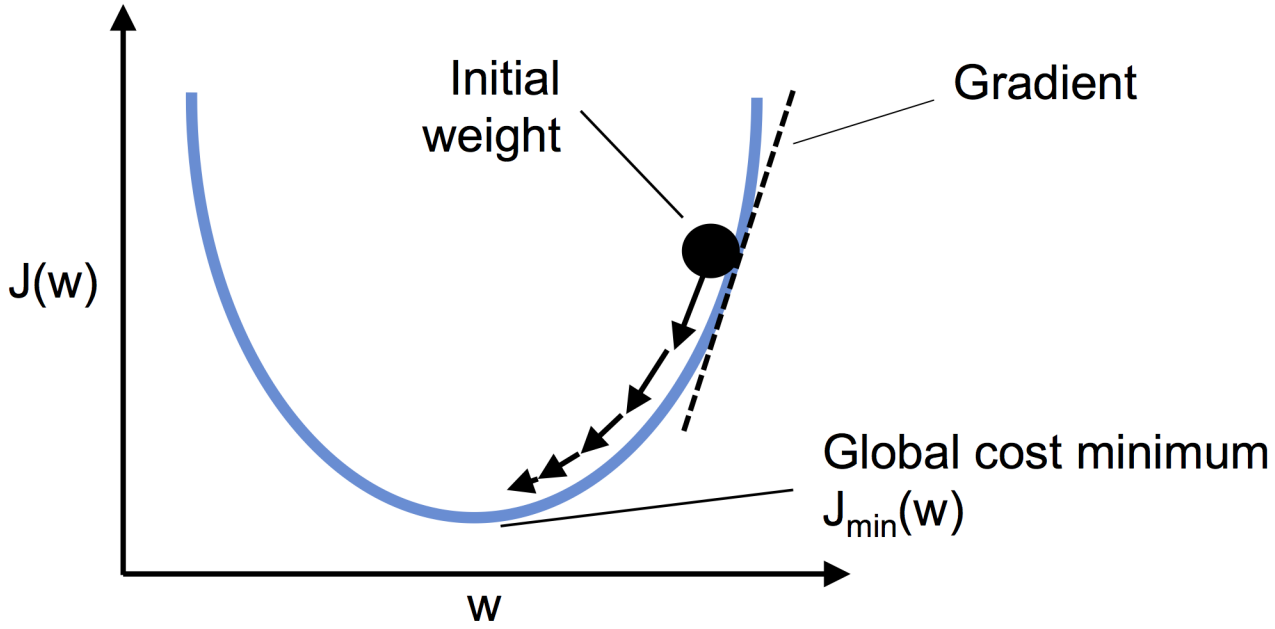
$$P(Y = k|X = x_i) = \frac{e^{s_k}}{\sum_j e^{s_j}}$$

Cross Entropy Loss

$$L_i = -\log\left(\frac{e^{sy_i}}{\sum_j e^{s_j}}\right)$$

Gradient Descent

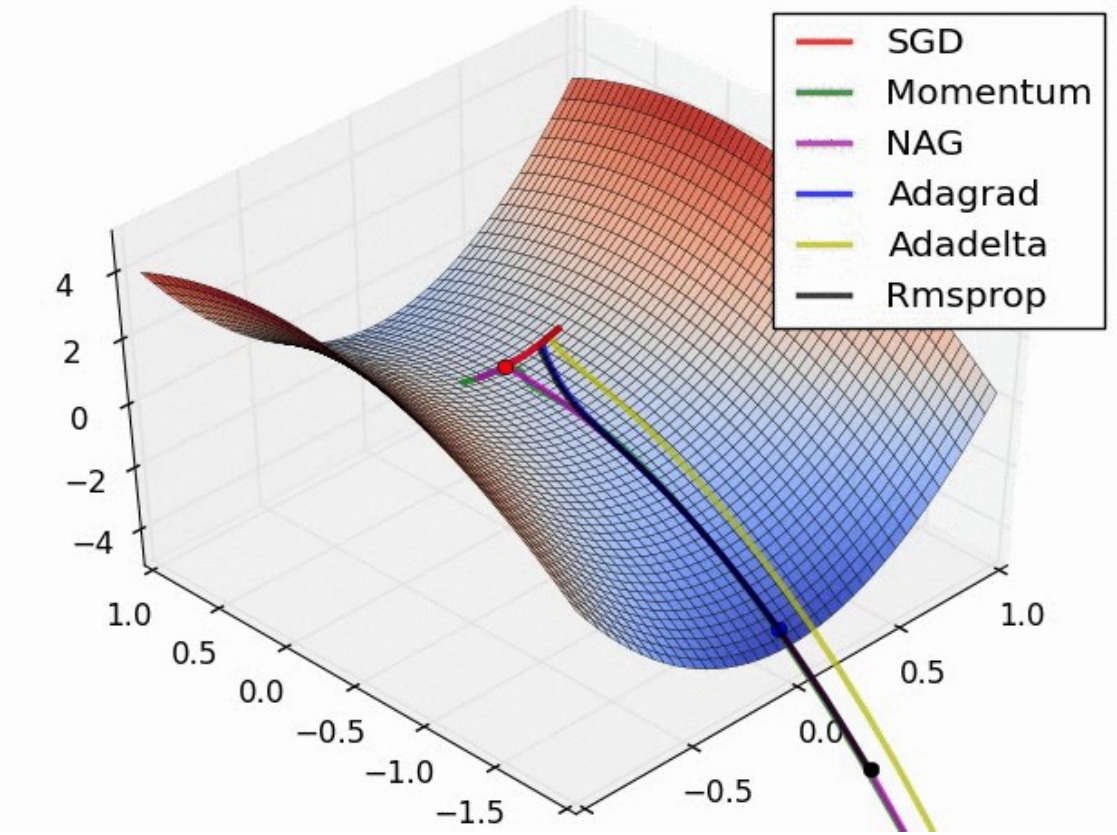
An algorithm used to optimize the network



Update weights : w += - learning_rate * gradient

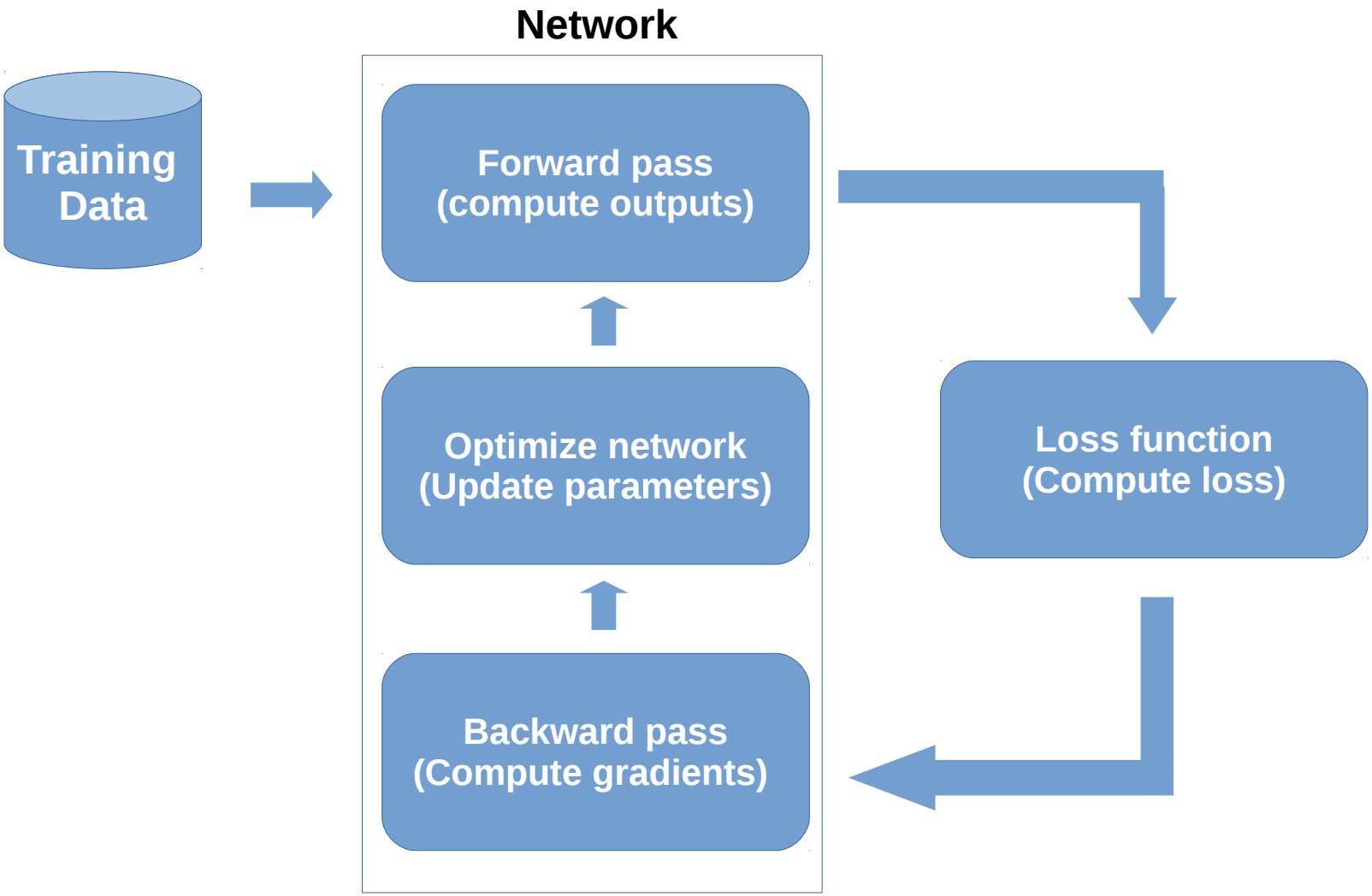
Optimizers

Algorithms used to optimize the network



Source: http://cs231n.github.io/neural-networks-3/

Network Training Loop

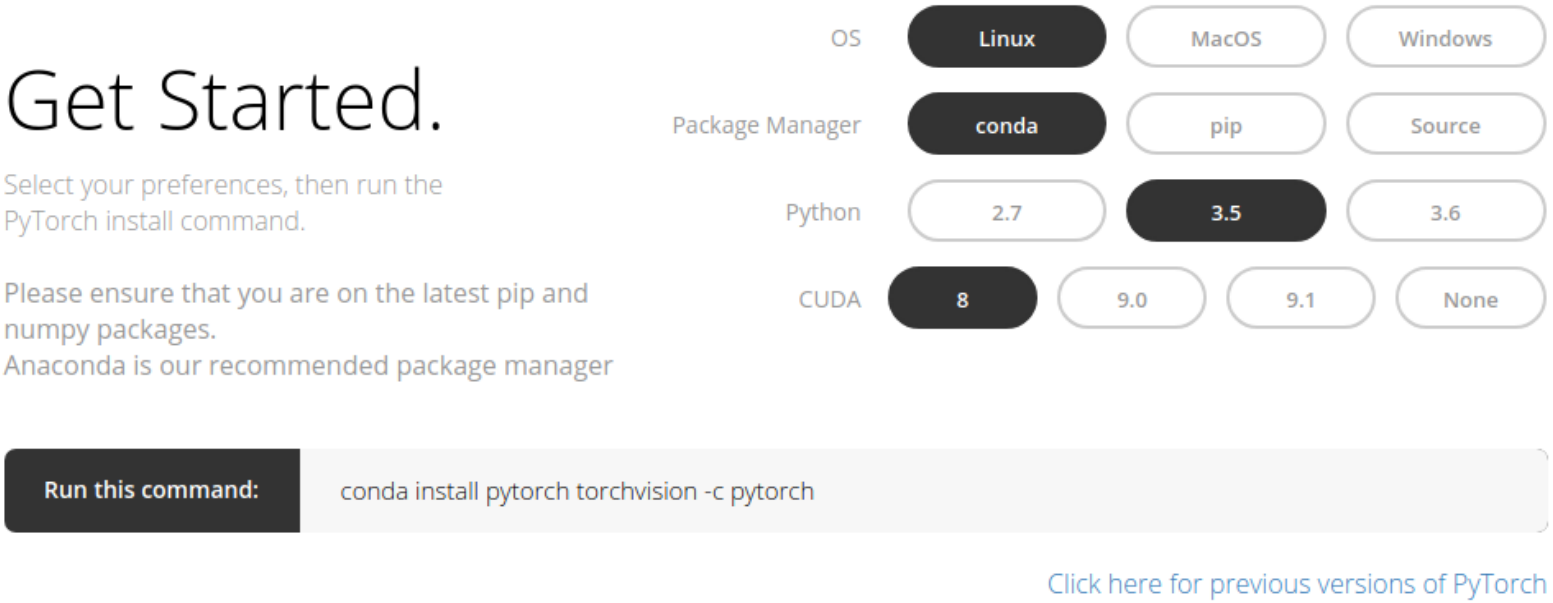


Deep Learning Framework

PyTorch

- **Deep learning framework**
- **Autograd**
- **Tools to create and train deep learning easily and efficiently**
- **GPU support**

pytorch.org


Get Started.
Select your preferences, then run the PyTorch install command.
Please ensure that you are on the latest pip and numpy packages.
Anaconda is our recommended package manager
OS
Linux
MacOS
Windows
Package Manager
conda
pip
Source
Python
2.7
3.5
3.6
CUDA
8
9.0
9.1
None
Run this command:
conda install pytorch torchvision -c pytorch
Click here for previous versions of PyTorch

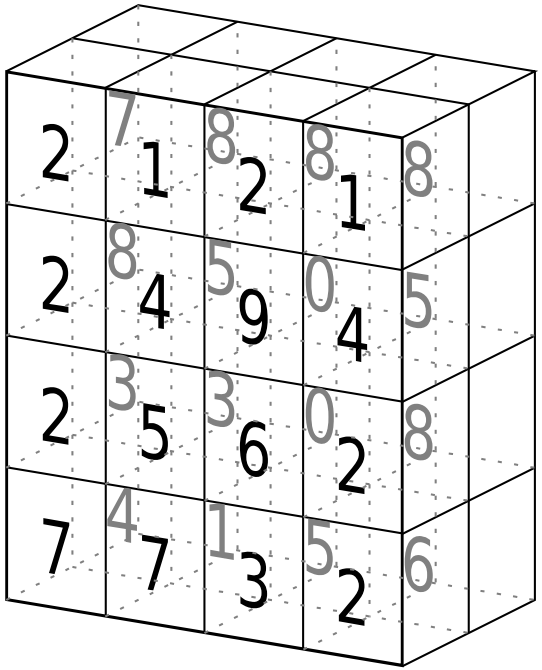
Tensors

't'
'e'
'n'
's'
'o'
'r'

tensor of dimensions [6]
(vector of dimension 6)

3	1	4	1
5	9	2	6
5	3	5	8
9	7	9	3
2	3	8	4
6	2	6	4

tensor of dimensions [6,4]
(matrix 6 by 4)



tensor of dimensions [4,4,2]

Logo Detection Using PyTorch

Project Pipeline

1. **Get the data.**
2. **Prepare data for network.**
3. **Create network.**
4. **Train network.**
5. **Evaluate.**

1. Get the Data

- Flickrlogos-32
- 32 Different logo brands from Flickr

  Adidas, Aldi, Apple, Becks, BMW, Carlsberg, Chimay, Coca-Cola, Corona, DHL, Erdinger, Esso, Fedex, Ferrari, Ford, Foster's, Google, Guiness, Heineken, HP, Milka, Nvidia, Paulaner, Pepsi, Ritter Sport, Shell, Singha, Starbucks, Stella Artois, Texaco, Tsingtao and UPS.
- Training logo set 320 images
- Validation logo set 960 images
- Test set 3,960 images
- No-logo set 3,000 images

http://www.multimedia-computing.de/flickrlogos *(see dowload on page)*

1. Get the Data

- Load FlickrLogos-32_dataset_v2.zip and unzip

```
import urllib.request
import os
import zipfile
import shutil
from pathlib import Path

FLICKLOGOS_URL = '../FlickrLogos-32_dataset_v2.zip'
SOURCE_DIR = Path('FlickrLogos-v2')
DATA_DIR = Path('data')

def load_datasets(url, dst_dir):
    zip_file = url.split(sep='/')[-1]
    if not dst_dir.is_dir():
        if not zip_file.is_file():
            urllib.request.urlretrieve(url, zip_file)
        with zipfile.ZipFile(zip_file) as zip_ref:
            zip_ref.extractall()

load_datasets(FLICKLOGOS_URL, SOURCE_DIR)
```

2. Prepare Data for Network

- List image paths from text files and add half of no-logo paths to train and val paths

```
def list_image_paths(txt_relpath):
    with open(txt_relpath) as f:
        image_paths = f.read().splitlines()
    return image_paths

train_logo_relpaths = list_image_paths(SOURCE_DIR / 'trainset.relpaths.txt')
val_logo_relpaths = list_image_paths(SOURCE_DIR / 'valset-logosonly.relpaths.txt')
val_nologo_relpaths = list_image_paths(SOURCE_DIR / 'valset-nologos.relpaths.txt')
test_relpaths = list_image_paths(SOURCE_DIR / 'testset.relpaths.txt')


train_relpaths = train_logo_relpaths \
                 + val_nologo_relpaths[:int(len(val_nologo_relpaths) / 2)]
val_relpaths = val_logo_relpaths \
               + val_nologo_relpaths[int(len(val_nologo_relpaths) / 2):]
```

2. Prepare Data for Network

../adidas/2325670.jpg

../Dataset/Class/image.jpg
../train/adidas/2354545.jpg
../val/adidas/5553232.jpg
../test/adidas/7353256.jpg

```
SETS = ['train', 'val', 'test']
relpaths = [train_relpaths, val_relpaths, test_relpaths]
dataset_paths = dict(zip(SETS, relpaths))

def prepare_datasets(src_dir, dst_dir, keep_source=True):
    for dataset, paths in dataset_paths.items():
        num_files = 0
        for path in paths:
            num_files += 1
            src = src_dir / path
            dst = dst_dir / (path.replace('classes/jpg', dataset))
            dst.parent.mkdir(parents=True, exist_ok=True)
            shutil.copy2(src, dst)
        print(dataset, 'dataset:', str(num_files))
    if not keep_source: shutil.rmtree(src_dir)

prepare_datasets(SOURCE_DIR, DATA_DIR)
```

2. Prepare Data for Network

- Create data_transforms, datasets, and dataloaders.

```
import torch
import torchvision
from torchvision.transforms import transforms
from torch.utils.data import DataLoader

train_mean = np.array([0.44943, 0.4331 , 0.40244])
train_std = np.array([0.29053, 0.28417, 0.30194])

data_transforms = transforms.Compose([
    transforms.Resize((224, 224)),
    transforms.ToTensor(),
    transforms.Normalize(train_mean, train_std)
])

datasets = {i : torchvision.datasets.ImageFolder(DATA_DIR / i, data_transforms)
            for i in SETS}

bz = 32

dataloaders = {i : DataLoader(datasets[i], batch_size=bz,
               shuffle=(i == 'train'), num_workers=4) for i in SETS}
```

2. Prepare Data for Network

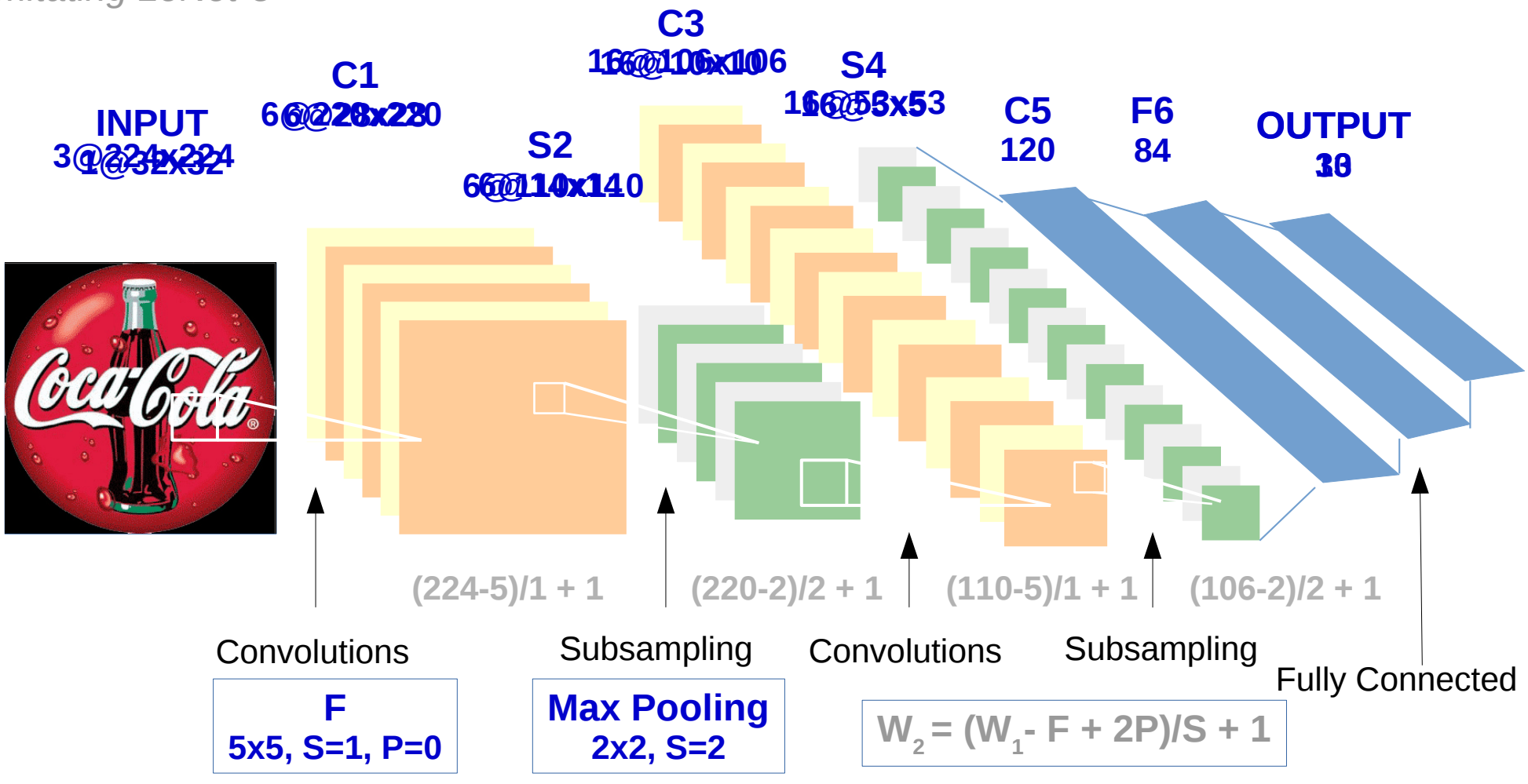
- Visualize datasets

```
import numpy as np
import matplotlib.pyplot as plt

def imshow(img):
    npimg = img.numpy().transpose((1, 2, 0))
    npimg = npimg * train_std + train_std    # denorm
    npimg = np.clip(npimg, 0, 1)
    plt.imshow(npimg)

imgs, labels = next(iter(dataloaders['train']))

img = torchvision.utils.make_grid(imgs[:4])
classes = datasets['train'].classes
print(', '.join(classes[i] for i in labels[:4]))
imshow(img)
```

```
guiness, no-logo, carlsberg, no-logo
```

3. Create Network

Imitating LeNet-5



Source: LeCun, Yann, et al. "Gradient-based learning applied to document recognition." Proceedings of the IEEE 86.11 (1998): 2278-2324.

3. Create Network

- Create network by subclass torch.nn.Module

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

class CNN(nn.Module):
    def __init__(self):
        super(CNN, self).__init__()
        self.conv1 = nn.Conv2d(3, 6, 5)
        self.pool = nn.MaxPool2d(2, 2)
        self.conv2 = nn.Conv2d(6, 16, 5)
        self.fc1 = nn.Linear(16 * 53 * 53, 120)
        self.fc2 = nn.Linear(120, 84)
        self.fc3 = nn.Linear(84, 33)

    def forward(self, x):
        x = self.pool(F.relu(self.conv1(x)))
        x = self.pool(F.relu(self.conv2(x)))
        x = x.view(-1, 16 * 53 * 53)
        x = F.relu(self.fc1(x))
        x = F.relu(self.fc2(x))
        x = self.fc3(x)
        return x
```

3. Create Network

- cnn

```
device = torch.device('cuda' if torch.cuda.is_available() else 'cpu')
cnn = CNN()
cnn = cnn.to(device)
```

```
Out[51]: CNN(
           (conv1): Conv2d(3, 6, kernel_size=(5, 5), stride=(1, 1))
           (pool): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
           (conv2): Conv2d(6, 16, kernel_size=(5, 5), stride=(1, 1))
           (fc1): Linear(in_features=44944, out_features=120, bias=True)
           (fc2): Linear(in_features=120, out_features=84, bias=True)
           (fc3): Linear(in_features=84, out_features=33, bias=True)
         )
```

4. Train Network

- Define loss function and optimizer

```
import torch.optim as optim

criterion = nn.CrossEntropyLoss()

optimizer = optim.SGD(cnn.parameters(), lr=0.001, momentum=0.9)
```

4. Train Network

- Create train and validate function

```
def train_val(model, criterion, optimizer, num_epochs=25):
    since = time.time()

    best_model_wts = copy.deepcopy(model.state_dict())
    best_acc = 0.0

    for epoch in range(num_epochs):
        print('Epoc {}/{}'.format(epoch, num_epochs - 1))
        print('-' * 10)
        for phase in ['train', 'val']:
            if phase == 'train':
                model.train()
            else:
                model.eval()
            running_loss = 0.0
            running_corrects = 0
            for inputs, labels in dataloaders[phase]:

                inputs, labels = inputs.to(device), labels.to(device)
```

Source: https://pytorch.org/tutorials/beginner/transfer_learning_tutorial.html

4. Train Network

- Create train and validate function

```
def train_val(model, criterion, optimizer, num_epochs=25):
                                    ...
            for inputs, labels in dataloaders[phase]:

                inputs, labels = inputs.to(device), labels.to(device)

                optimizer.zero_grad()

                with torch.set_grad_enabled(phase == 'train'):
                    # Forward pass
                    outputs = model(inputs)
                    _, preds = torch.max(outputs, 1)

                    # Compute loss
                    loss = criterion(outputs, labels)

                    # Compute gradients and update parameters if train
                    if phase == 'train':
                        loss.backward()
                        optimizer.step()
```

Source: https://pytorch.org/tutorials/beginner/transfer_learning_tutorial.html

4. Train Network

- Create train and validate function

```
def train_val(model, criterion, optimizer, num_epochs=25):
                                    ...

    time_elapsed = time.time() - since
    print('Training complete in {:.0f}m {:.0f}s'.format(
        time_elapsed // 60, time_elapsed % 60))
    print('Best Accuracy: {:.2f} %'.format(best_acc * 100))

    model.load_state_dict(best_model_wts)

    return model
```

Source: https://pytorch.org/tutorials/beginner/transfer_learning_tutorial.html

4. Train Network

- Train the network

```
model_cnn = train_val(cnn, criterion, optimizer)
```

```
Epoc 0/24
----------
Train Loss: 1.8010 Acc.: 75.71 %
Val Loss: 2.2365 Acc.: 60.98 %

Epoc 1/24
----------
Train Loss: 1.1586 Acc.: 82.42 %
Val Loss: 2.0667 Acc.: 60.98 %
 ...
Epoc 20/24
----------
Train Loss: 0.5419 Acc.: 86.98 %
Val Loss: 3.0452 Acc.: 61.87 %

 ...

Epoc 24/24
----------
Train Loss: 0.3455 Acc.: 92.14 %
Val Loss: 2.6079 Acc.: 57.72 %

Training complete in 11m 4s
Best Accuracy: 61.87 %
```

5. Evaluate

- Create test function to evaluate network on test set

```
def test(model):
    model.eval()
    running_corrects = 0
    with torch.no_grad():
        for inputs, labels in dataloaders['test']:
            inputs, labels = inputs.to(device), labels.to(device)
            outputs = model(inputs)
            _, preds = torch.max(outputs, 1)

            running_corrects += torch.sum(preds == labels).item()

    test_acc = running_corrects / len(datasets['test'])
    print('Test Acc.: {:.2f} %'.format(test_acc * 100))

test(model_cnn)
```

```
Test Acc.: 75.91 %
```

Transfer Learning

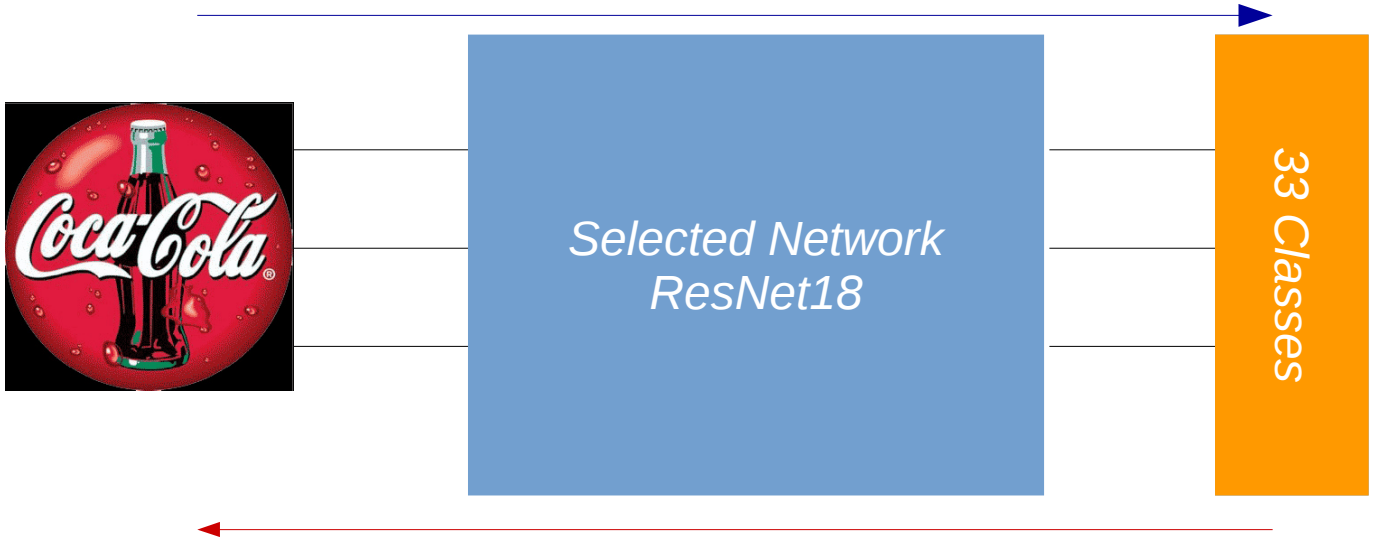
What’s Transfer Learning?

“Transfer learning is a machine learning technique where a model trained on one task is re-purposed on a second related task.”

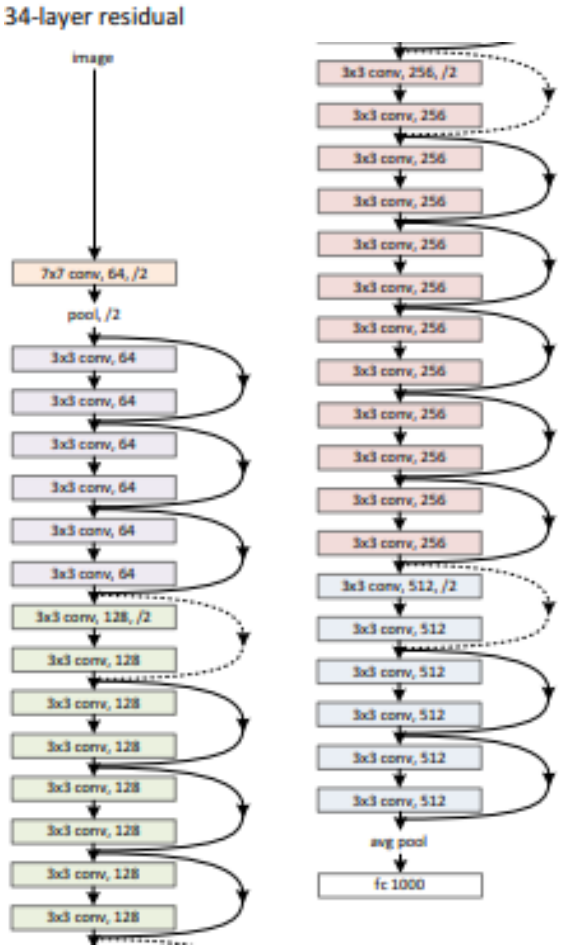
Source: https://machinelearningmastery.com/transfer-learning-for-deep-learning/

How?

1. **Select network.**
2. **Match input format.**
3. **Replace output layer.**
4. **Retrain network**



ResNet



layer name	output size	18-layer	34-layer	50-layer	101-layer	152-layer
conv1	112×112	7×7, 64, stride 2				
		3×3 max pool, stride 2				
conv2_x	56×56	[3×3, 64; 3×3, 64] ×2	[3×3, 64; 3×3, 64] ×3	[1×1, 64; 3×3, 64; 1×1, 256] ×3	[1×1, 64; 3×3, 64; 1×1, 256] ×3	[1×1, 64; 3×3, 64; 1×1, 256] ×3
conv3_x	28×28	[3×3, 128; 3×3, 128] ×2	[3×3, 128; 3×3, 128] ×4	[1×1, 128; 3×3, 128; 1×1, 512] ×4	[1×1, 128; 3×3, 128; 1×1, 512] ×4	[1×1, 128; 3×3, 128; 1×1, 512] ×8
conv4_x	14×14	[3×3, 256; 3×3, 256] ×2	[3×3, 256; 3×3, 256] ×6	[1×1, 256; 3×3, 256; 1×1, 1024] ×6	[1×1, 256; 3×3, 256; 1×1, 1024] ×23	[1×1, 256; 3×3, 256; 1×1, 1024] ×36
conv5_x	7×7	[3×3, 512; 3×3, 512] ×2	[3×3, 512; 3×3, 512] ×3	[1×1, 512; 3×3, 512; 1×1, 2048] ×3	[1×1, 512; 3×3, 512; 1×1, 2048] ×3	[1×1, 512; 3×3, 512; 1×1, 2048] ×3
	1×1	average pool, 1000-d fc, softmax				
FLOPs		1.8×10^9	3.6×10^9	3.8×10^9	7.6×10^9	11.3×10^9

Source: https://arxiv.org/pdf/1512.03385.pdf

Match Input Format

- Create matched transforms

```
train_mean = np.array([0.485, 0.456, 0.406])
train_std = np.array([0.229, 0.224, 0.225])
```

```
data_transforms = transforms.Compose([
    transforms.Resize((224, 224)),
    transforms.ToTensor(),
    transforms.Normalize(train_mean, train_std)])
```

```
datasets = {i : torchvision.datasets.ImageFolder(DATA_DIR / i, data_transforms)
             for i in SETS}

dataloaders = {i : DataLoader(datasets[i], batch_size=bz,
               shuffle=(i == 'train'), num_workers=4) for i in SETS}
```

Load Pretrained Network

- Load pretrained model. Define output layer (head).

```
model_ft = torchvision.models.resnet18(pretrained=True)
model_ft
```

```
Out[19]: ResNet(
           (conv1): Conv2d(3, 64, kernel_size=(7, 7), stride=(2, 2), padding=(3, 3), bias=False)
           (bn1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
           (relu): ReLU(inplace)
           (maxpool): MaxPool2d(kernel_size=3, stride=2, padding=1, dilation=1, ceil_mode=False)
           (layer1): Sequential(

         ...

             )
           )
           (avgpool): AvgPool2d(kernel_size=7, stride=1, padding=0)
           (fc): Linear(in_features=512, out_features=1000, bias=True)
         )
```

Replace Output Layer

- Replace output layer.

```
num_ftrs = model_ft.fc.in_features                    # 512
model_ft.fc = nn.Linear(num_ftrs, 33)
model_ft = model_ft.to(device)
criterion = nn.CrossEntropyLoss()
lr = 0.001
optimizer_ft = optim.SGD(model_ft.parameters(), lr=lr, momentum=0.9)
```

Train Network

- Fine tune the network

```
model_ft = train_val(model_ft, criterion, optimizer_ft)
```

```
Epoc 0/24
----------
Train Loss: 1.0930 Acc.: 78.35 %
Val Loss: 1.6996 Acc.: 61.38 %

Epoc 1/24
----------
Train Loss: 0.6551 Acc.: 83.30 %
Val Loss: 1.6968 Acc.: 61.87 %
...

Epoc 22/24
----------
Train Loss: 0.0142 Acc.: 100.00 %
Val Loss: 1.1601 Acc.: 75.69 %
...

Epoc 24/24
----------
Train Loss: 0.0132 Acc.: 99.95 %
Val Loss: 1.1957 Acc.: 75.65 %

Training complete in 13m 9s
Best Accuracy: 75.69 %
```

Evaluate

- Evaluate network on test set

```
test(model_ft)
```

```
Test Acc.: 85.58 %
```

Thank you

All materials:

https://github.com/nithiroj/pycon-thailand-2018

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