Topic : Lecture 16 Transfer Learning

Follow the CRSIP-DM method

1. Step 1: Import library, import data
2. Step 2: Pre-processing (missing data, categorical type, normalization, format transform, data augmentation)
3. Step 3: Build ML Model
4. Step 4: Evaluate Model
5. Step 5: Deploy (Prediction)

Step 1: Load data (also import library)

```
!pip install torch torchvision
!pip install Pillow
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/
Requirement already satisfied: torch in /usr/local/lib/python3.7/dist-packages (1.11
Requirement already satisfied: torchvision in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: typing-extensions in /usr/local/lib/python3.7/dist-pa
Requirement already satisfied: numpy in /usr/local/lib/python3.7/dist-packages (from
Requirement already satisfied: requests in /usr/local/lib/python3.7/dist-packages (f
Requirement already satisfied: pillow!=8.3.*,>=5.3.0 in /usr/local/lib/python3.7/dis
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.7/dist-package
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.7/dist-p
Requirement already satisfied: chardet<4,>=3.0.2 in /usr/local/lib/python3.7/dist-pa
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in /usr/local
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/
Requirement already satisfied: Pillow in /usr/local/lib/python3.7/dist-packages (7.1
```

```
# import library
import torch
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from torch import nn
import torch.nn.functional as F
from torchvision import datasets, transforms, models

device = torch.device("cuda:0" if torch.cuda.is_available() else "cpu")
print(device)
```

```
cuda:0
```

```
# get data  (homework 4 要找一個github, 裡面有dataset的folder)
#!git clone https://github.com/jaddoescad/ants_and_bees.git
```

```
#!git clone https://github.com/chandrikadeb7/Face-Mask-Detection.git
!git clone https://github.com/laxmimerit/dog-cat-full-dataset.git
#!rm -rf ./Face-Mask-Detection/
# !rm -rf ./ants_and_bees/
#!rm -rf ./dog-cat-full-dataset/
```

```
fatal: destination path 'dog-cat-full-dataset' already exists and is not an empty di
```

```
!ls ./dog-cat-full-dataset/data/train
```

```
cats  dogs
```

Step 2: Pre-process X, Y

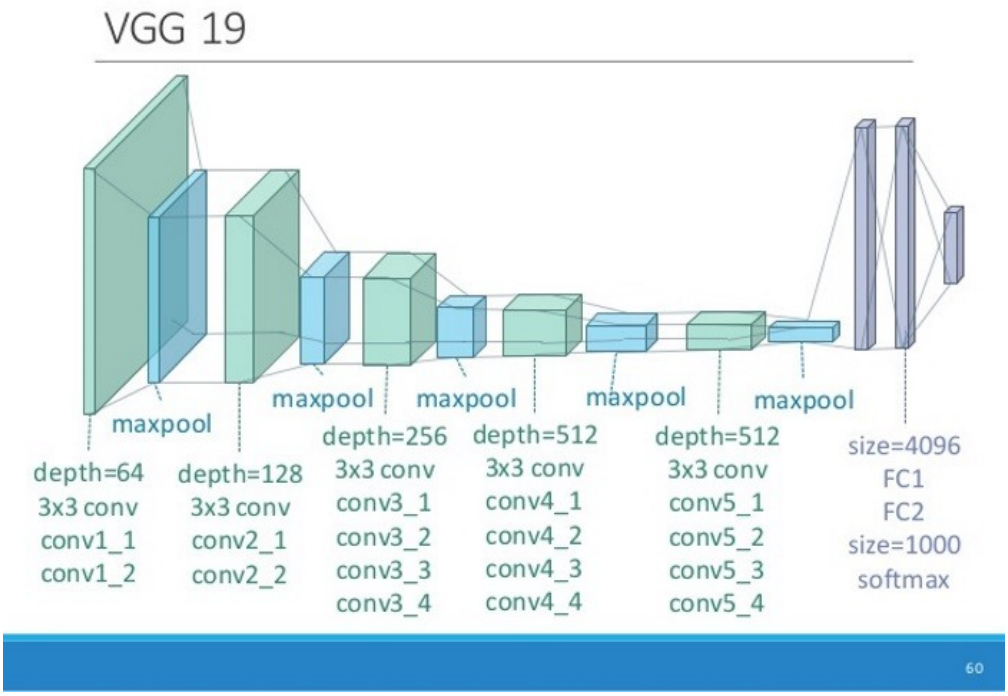
- format transform (轉換成numpy format)
- missing data (imputation)差補
- category data transform
- data augmentation
- normalization

```
transform_train = transforms.Compose([
          transforms.Resize((224,224)),
          transforms.RandomHorizontalFlip(),
          transforms.RandomAffine(0, shear=10, scale=(0.8,1.2)),
          transforms.ColorJitter(brightness=1, contrast=1, saturation=1),
          transforms.ToTensor(),
          transforms.Normalize((0.5, 0.5, 0.5), (0.5, 0.5, 0.5))
          ])


transform = transforms.Compose([transforms.Resize((224,224)),
transforms.ToTensor(),
transforms.Normalize((0.5, 0.5, 0.5), (0.5, 0.5, 0.5))
])

training_dataset = datasets.ImageFolder('dog-cat-full-dataset/data/train', transform=trans
validation_dataset = datasets.ImageFolder('dog-cat-full-dataset/data/train', transform=tra

training_loader = torch.utils.data.DataLoader(training_dataset, batch_size=20, shuffle=Tru
validation_loader = torch.utils.data.DataLoader(validation_dataset, batch_size = 20, shuff



print(len(training_dataset))
print(len(validation_dataset))
```

```
20000
20000
```

```
def im_convert(tensor):
  image = tensor.cpu().clone().detach().numpy()
  image = image.transpose(1, 2, 0)
  image = image * np.array((0.5, 0.5, 0.5)) + np.array((0.5, 0.5, 0.5))
  image = image.clip(0, 1)
  return image

# !ls ./Face-Mask-Detection/dataset/

classes=('cats','dogs')

dataiter = iter(training_loader)
images,labels = dataiter.next()
fig = plt.figure(figsize=(25, 4))

for idx in np.arange(20):
  ax = fig.add_subplot(2, 10, idx+1, xticks=[], yticks=[])
  plt.imshow(im_convert(images[idx]))
  ax.set_title(classes[labels[idx].item()])
```

Step 3: Build Model for training




```
model = models.vgg16(pretrained=True)
print(model)
```

```
VGG(
  (features): Sequential(
    (0): Conv2d(3, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (1): ReLU(inplace=True)
    (2): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (3): ReLU(inplace=True)
    (4): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
    (5): Conv2d(64, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (6): ReLU(inplace=True)
    (7): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (8): ReLU(inplace=True)
    (9): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
    (10): Conv2d(128, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (11): ReLU(inplace=True)
    (12): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (13): ReLU(inplace=True)
    (14): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (15): ReLU(inplace=True)
    (16): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
    (17): Conv2d(256, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (18): ReLU(inplace=True)
    (19): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (20): ReLU(inplace=True)
    (21): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (22): ReLU(inplace=True)
    (23): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
    (24): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (25): ReLU(inplace=True)
    (26): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (27): ReLU(inplace=True)
    (28): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
```

```
      (29): ReLU(inplace=True)
      (30): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
    )
    (avgpool): AdaptiveAvgPool2d(output_size=(7, 7))
    (classifier): Sequential(
      (0): Linear(in_features=25088, out_features=4096, bias=True)
      (1): ReLU(inplace=True)
      (2): Dropout(p=0.5, inplace=False)
      (3): Linear(in_features=4096, out_features=4096, bias=True)
      (4): ReLU(inplace=True)
      (5): Dropout(p=0.5, inplace=False)
      (6): Linear(in_features=4096, out_features=1000, bias=True)
    )
  )
```

```
# turn off gradient for all parameters in features extraction
for param in model.features.parameters():
  param.requires_grad = False

# modify last node from 1000 to 2
# import torch.nn as nn
n_inputs = model.classifier[6].in_features
last_layer = nn.Linear(n_inputs, len(classes))
model.classifier[6] = last_layer
model.to(device)
print(model)

print("output features=",model.classifier[6].out_features)
```

```
VGG(
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    (23): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
    (24): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (25): ReLU(inplace=True)
```

```
      (26): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
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    )
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      (1): ReLU(inplace=True)
      (2): Dropout(p=0.5, inplace=False)
      (3): Linear(in_features=4096, out_features=4096, bias=True)
      (4): ReLU(inplace=True)
      (5): Dropout(p=0.5, inplace=False)
      (6): Linear(in_features=4096, out_features=2, bias=True)
    )
  )
  output features= 2
```

Step 4 Training Model

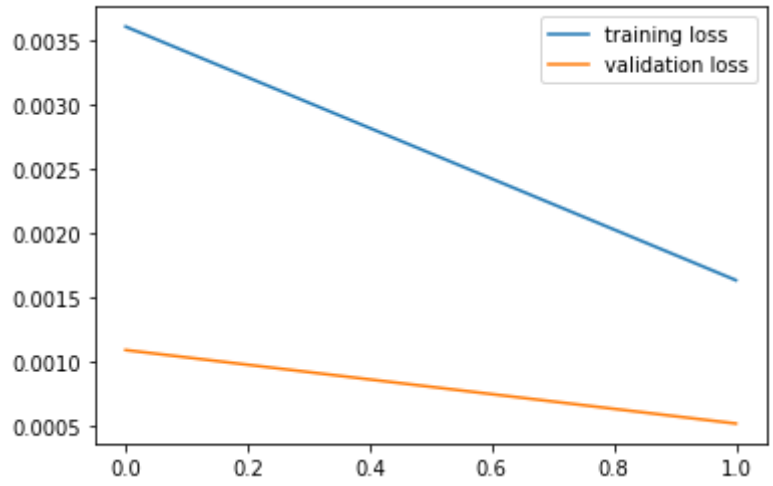
```
criterion = nn.CrossEntropyLoss()
optimizer = torch.optim.Adam(model.parameters(), lr = 0.0001)


epochs = 2
running_loss_history = []
running_corrects_history = []
val_running_loss_history = []
val_running_corrects_history = []

for e in range(epochs):

  running_loss = 0.0
  running_corrects = 0.0
  val_running_loss = 0.0
  val_running_corrects = 0.0

  for inputs,labels in training_loader:
    inputs = inputs.to(device)
    labels = labels.to(device)
    outputs = model(inputs)
    loss = criterion(outputs, labels)

    optimizer.zero_grad()
    loss.backward()
    optimizer.step()

    _, preds = torch.max(outputs, 1)
    running_loss += loss.item()
    running_corrects += torch.sum(preds == labels.data)

  else:
```

```
    with torch.no_grad():
      for val_inputs, val_labels in validation_loader:
        val_inputs = val_inputs.to(device)
        val_labels = val_labels.to(device)
        val_outputs = model(val_inputs)
        val_loss = criterion(val_outputs, val_labels)

        _, val_preds = torch.max(val_outputs, 1)
        val_running_loss += val_loss.item()
        val_running_corrects += torch.sum(val_preds == val_labels.data)

    epoch_loss = running_loss/len(training_loader.dataset)
    epoch_acc = running_corrects.float()/ len(training_loader.dataset)
    running_loss_history.append(epoch_loss)
    running_corrects_history.append(epoch_acc)

    val_epoch_loss = val_running_loss/len(validation_loader.dataset)
    val_epoch_acc = val_running_corrects.float()/ len(validation_loader.dataset)
    val_running_loss_history.append(val_epoch_loss)
    val_running_corrects_history.append(val_epoch_acc)
    print('epoch :', (e+1))
    print('training loss: {:.4f}, acc {:.4f} '.format(epoch_loss, epoch_acc.item()))
    print('validation loss: {:.4f}, validation acc {:.4f} '.format(val_epoch_loss, val_epo
```

```
 epoch : 1
 training loss: 0.0036, acc 0.9742
 validation loss: 0.0011, validation acc 0.9936
 epoch : 2
 training loss: 0.0016, acc 0.9886
 validation loss: 0.0005, validation acc 0.9966
```

```
plt.plot(running_loss_history, label='training loss')
plt.plot(val_running_loss_history, label='validation loss')
plt.legend()
```

```
 <matplotlib.legend.Legend at 0x7fdc7cd94f90>
```



Step 5 Testing

cats

dogs

```
!pip3 install pillow==4.0.0
```

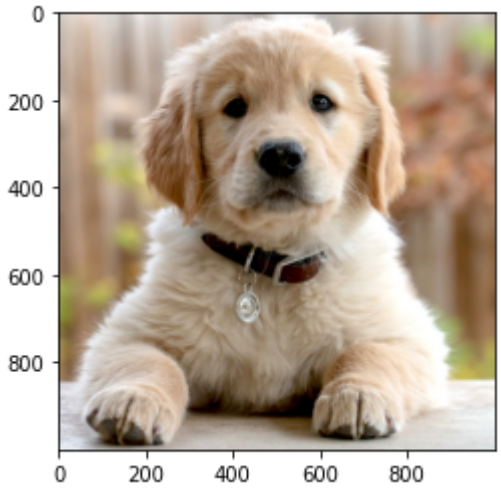
```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheel
Collecting pillow==4.0.0
  Downloading Pillow-4.0.0.tar.gz (11.1 MB)
     |████████████████████████████████| 11.1 MB 11.8 MB/s
Collecting olefile
```

```
import PIL.ImageOps
```

```
  Building wheels for collected packages: pillow, olefile
```

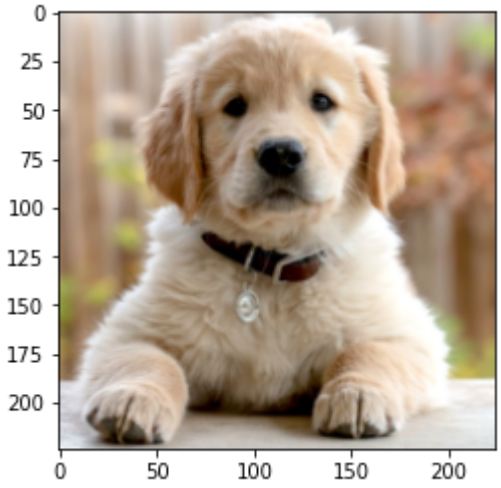
```
import requests
from PIL import Image

# url = 'http://media.rojaklah.com/wp-content/uploads/2017/09/19150232/1909bigstar1.jpg'
# url ='https://images.twgreatdaily.com/images/image/7fe/7feccfb21a05e5bd97bf2dab8e953cf7.
url='https://kb.rspca.org.au/wp-content/uploads/2018/11/golder-retriever-puppy.jpeg'
response = requests.get(url, stream = True)
img = Image.open(response.raw)
plt.imshow(img)
```

```
<matplotlib.image.AxesImage at 0x7fdd4647d890>
```




```
img = transform(img)
plt.imshow(im_convert(img))
```

```
<matplotlib.image.AxesImage at 0x7fdc7cbb4810>
```




```
image = img.to(device).unsqueeze(0)
output = model(image)
_, pred = torch.max(output, 1)
```

```
    _, pred = torch.max(output, 1)
    print(classes[pred.item()])
```

```
dogs
```

✓ 0s completed at 3:03 PM