ข้อ 1

```
[ ]
import git

git.Repo.clone_from('https://github.com/ardamavi/Sign-Language-Digits-Dataset.git', 'Sign-Language-Digits-Dataset')
```

```
<git.repo.base.Repo 'd:\\Python_For_ML\\Machine-Learning2658\\ALLLAB\\Lab7\\Sign-Language-Digits-Dataset\\.git'>
```

ข้อ 2

```
[ ]
from tensorflow.keras.preprocessing.image import ImageDataGenerator

datagen = ImageDataGenerator(rescale=1.0/255, validation_split=0.1)

train_gen = datagen.flow_from_directory(
    'Sign-Language-Digits-Dataset/Dataset',
    target_size=(100, 100),
    batch_size=32,
    class_mode='categorical',
    subset='training'
)

val_gen = datagen.flow_from_directory(
    'Sign-Language-Digits-Dataset/Dataset',
    target_size=(100, 100),
    batch_size=32,
    class_mode='categorical',
    subset='validation'
)
```

```
Found 1862 images belonging to 10 classes.
Found 200 images belonging to 10 classes.
```

ข้อ 3

```
[ ]
from tensorflow.keras.applications import VGG16
from tensorflow.keras.models import Model
from tensorflow.keras.layers import Dense, Dropout, GlobalAveragePooling2D
from tensorflow.keras.optimizers import SGD

base_vgg = VGG16(weights="imagenet", include_top=False, input_shape=(100, 100, 3))
for layer in base_vgg.layers:
    layer.trainable = False

print("Output shape ของ VGG16 base:", base_vgg.output_shape)
print("จำนวน trainable params ของ VGG16 base:", sum([w.count_params() for w in base_vgg.trainable_weights]))
base_vgg.summary()
```

```
Output shape ของ VGG16 base: (None, 3, 3, 512)
จำนวน trainable params ของ VGG16 base: 0
Model: "vgg16"
```

Layer (type)	Output Shape	Param #
input_layer_1 (InputLayer)	(None, 100, 100, 3)	0
block1_conv1 (Conv2D)	(None, 100, 100, 64)	1,792
block1_conv2 (Conv2D)	(None, 100, 100, 64)	36,928
block1_pool (MaxPooling2D)	(None, 50, 50, 64)	0
block2_conv1 (Conv2D)	(None, 50, 50, 128)	73,856
block2_conv2 (Conv2D)	(None, 50, 50, 128)	147,584
block2_pool (MaxPooling2D)	(None, 25, 25, 128)	0
block3_conv1 (Conv2D)	(None, 25, 25, 256)	295,168
block3_conv2 (Conv2D)	(None, 25, 25, 256)	590,080
block3_conv3 (Conv2D)	(None, 25, 25, 256)	590,080
block3_pool (MaxPooling2D)	(None, 12, 12, 256)	0
block4_conv1 (Conv2D)	(None, 12, 12, 512)	1,180,160
block4_conv2 (Conv2D)	(None, 12, 12, 512)	2,359,808
block4_conv3 (Conv2D)	(None, 12, 12, 512)	2,359,808
block4_pool (MaxPooling2D)	(None, 6, 6, 512)	0
block5_conv1 (Conv2D)	(None, 6, 6, 512)	2,359,808
block5_conv2 (Conv2D)	(None, 6, 6, 512)	2,359,808
block5_conv3 (Conv2D)	(None, 6, 6, 512)	2,359,808
block5_pool (MaxPooling2D)	(None, 3, 3, 512)	0

```
Total params: 14,714,688 (56.13 MB)
Trainable params: 0 (0.00 B)
Non-trainable params: 14,714,688 (56.13 MB)
```

ข้อ 4

```
x = GlobalAveragePooling2D()(base_vgg.output)
x = Dense(512, activation="relu")(x)
x = Dense(64, activation="relu")(x)
output = Dense(10, activation="softmax")(x)  # 10 classes

model_vgg = Model(inputs=base_vgg.input, outputs=output)

opt = SGD(learning_rate=0.0001)
model_vgg.compile(optimizer=opt, loss="categorical_crossentropy", metrics=["accuracy"])

model_vgg.summary()

history_vgg = model_vgg.fit(
    train_gen,
    epochs=50,
    validation_data=val_gen
)
```

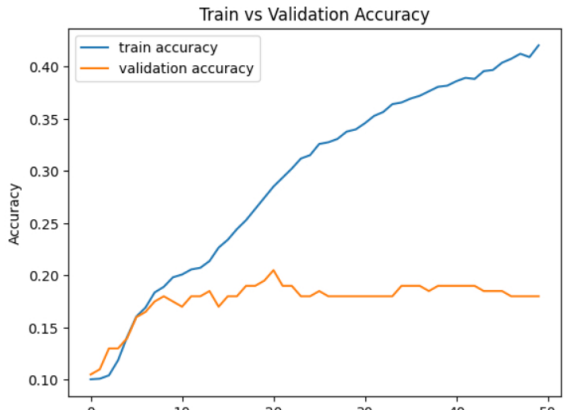
(GlobalAveragePooling2D)		
dense_3 (Dense)	(None, 512)	262,656
dense_4 (Dense)	(None, 64)	32,832
dense_5 (Dense)	(None, 10)	650

Total params: 15,010,826 (57.26 MB)
Trainable params: 296,138 (1.13 MB)
Non-trainable params: 14,714,688 (56.13 MB)

```
C:\Users\user\AppData\Roaming\Python\Python311\site-packages\keras\src\trainers\data_adapters\py_dataset_adapter.py:121: UserWarning: Your `PyDataset` class should call `super()._
  self._warn_if_super_not_called()
Epoch 1/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 49s 802ms/step - accuracy: 0.1044 - loss: 2.3517 - val_accuracy: 0.1050 - val_loss: 2.3528
Epoch 2/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 31s 528ms/step - accuracy: 0.1005 - loss: 2.3509 - val_accuracy: 0.1100 - val_loss: 2.3404
Epoch 3/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 32s 547ms/step - accuracy: 0.1113 - loss: 2.3301 - val_accuracy: 0.1300 - val_loss: 2.3299
Epoch 4/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 31s 527ms/step - accuracy: 0.1114 - loss: 2.3067 - val_accuracy: 0.1300 - val_loss: 2.3214
Epoch 5/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 31s 518ms/step - accuracy: 0.1400 - loss: 2.2977 - val_accuracy: 0.1400 - val_loss: 2.3142
Epoch 6/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 30s 507ms/step - accuracy: 0.1444 - loss: 2.3024 - val_accuracy: 0.1600 - val_loss: 2.3083
Epoch 7/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 31s 532ms/step - accuracy: 0.1648 - loss: 2.2905 - val_accuracy: 0.1650 - val_loss: 2.3034
Epoch 8/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 30s 500ms/step - accuracy: 0.1864 - loss: 2.2779 - val_accuracy: 0.1750 - val_loss: 2.2992
Epoch 9/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 31s 529ms/step - accuracy: 0.1983 - loss: 2.2644 - val_accuracy: 0.1800 - val_loss: 2.2957
Epoch 10/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 30s 511ms/step - accuracy: 0.1837 - loss: 2.2747 - val_accuracy: 0.1750 - val_loss: 2.2928
Epoch 11/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 31s 530ms/step - accuracy: 0.1971 - loss: 2.2665 - val_accuracy: 0.1700 - val_loss: 2.2903
Epoch 12/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 32s 547ms/step - accuracy: 0.1958 - loss: 2.2623 - val_accuracy: 0.1800 - val_loss: 2.2879
Epoch 13/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 30s 514ms/step - accuracy: 0.2032 - loss: 2.2575 - val_accuracy: 0.1800 - val_loss: 2.2859
Epoch 14/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 34s 571ms/step - accuracy: 0.2139 - loss: 2.2502 - val_accuracy: 0.1850 - val_loss: 2.2841
Epoch 15/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 30s 510ms/step - accuracy: 0.2087 - loss: 2.2528 - val_accuracy: 0.1700 - val_loss: 2.2822
Epoch 16/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 31s 527ms/step - accuracy: 0.2329 - loss: 2.2490 - val_accuracy: 0.1800 - val_loss: 2.2806
Epoch 17/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 34s 583ms/step - accuracy: 0.2411 - loss: 2.2422 - val_accuracy: 0.1800 - val_loss: 2.2794
Epoch 18/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 30s 510ms/step - accuracy: 0.2618 - loss: 2.2371 - val_accuracy: 0.1900 - val_loss: 2.2781
Epoch 19/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 30s 507ms/step - accuracy: 0.2565 - loss: 2.2395 - val_accuracy: 0.1900 - val_loss: 2.2769
Epoch 20/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 32s 545ms/step - accuracy: 0.2713 - loss: 2.2352 - val_accuracy: 0.1950 - val_loss: 2.2757
Epoch 21/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 31s 522ms/step - accuracy: 0.2924 - loss: 2.2340 - val_accuracy: 0.2050 - val_loss: 2.2746
Epoch 22/50
59/59 ━━━━━━━━━━━━━━━━━━━━ 33s 556ms/step - accuracy: 0.2824 - loss: 2.2286 - val_accuracy: 0.1900 - val_loss: 2.2737
Epoch 23/50
```

```
import matplotlib.pyplot as plt

plt.plot(history_vgg.history['accuracy'], label="train accuracy")
plt.plot(history_vgg.history['val_accuracy'], label="validation accuracy")
plt.xlabel("Epoch")
plt.ylabel("Accuracy")
plt.legend()
plt.title("Train vs Validation Accuracy")
plt.show()
```



0 10 20 30 40 50
Epoch

ข้อ 5

```
[ ]  model_vgg.save("sign_vgg.h5")
```

```
WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `keras.saving.save_model(model)`. This file format is considered legacy. We recommend using instead the
```