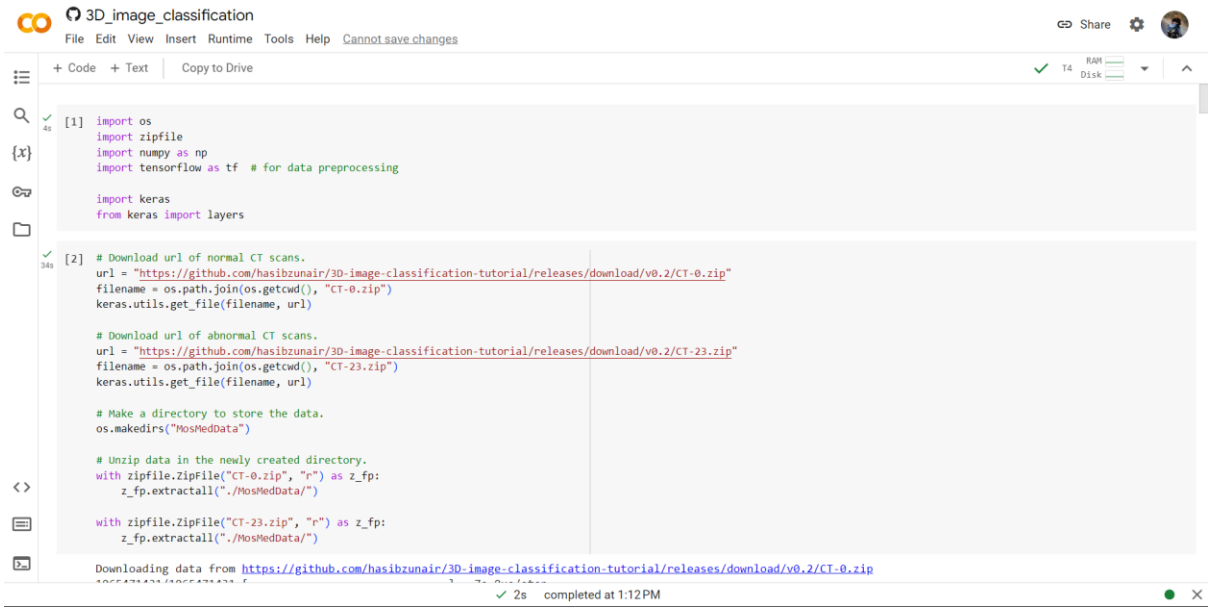
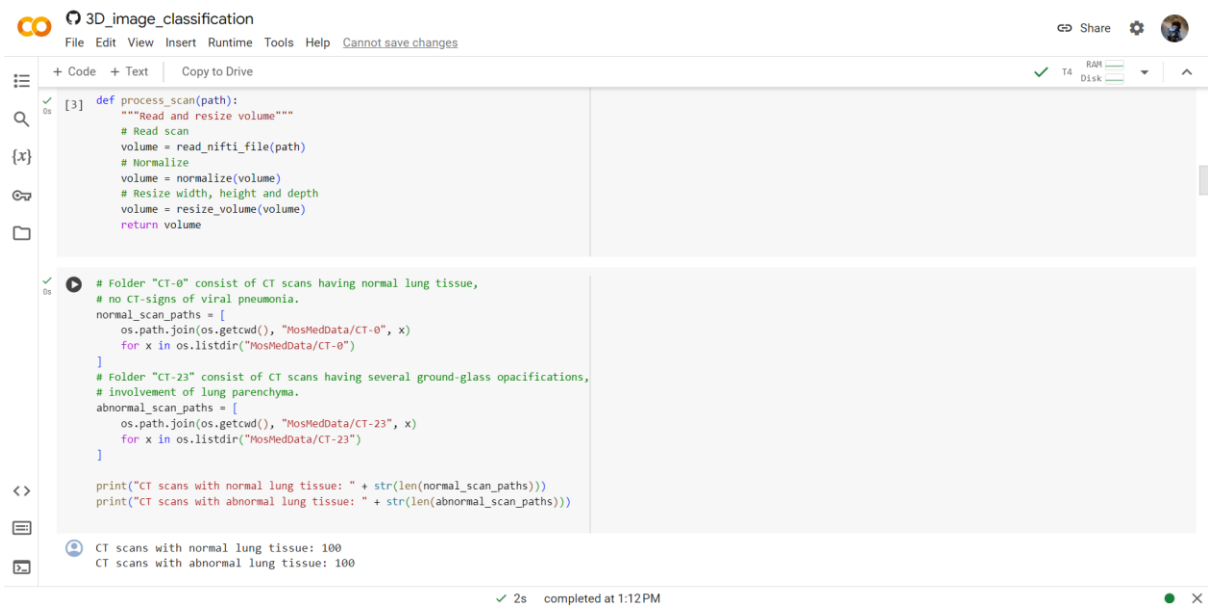
POST LAB DL – Sumit Sonar





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3D_image_classification

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```
[5] # Read and process the scans.
    # Each scan is resized across height, width, and depth and rescaled.
    abnormal_scans = np.array([process_scan(path) for path in abnormal_scan_paths])
    normal_scans = np.array([process_scan(path) for path in normal_scan_paths])

    # For the CT scans having presence of viral pneumonia
    # assign 1, for the normal ones assign 0.
    abnormal_labels = np.array([1 for _ in range(len(abnormal_scans))])
    normal_labels = np.array([0 for _ in range(len(normal_scans))])

    # Split data in the ratio 70-30 for training and validation.
    x_train = np.concatenate((abnormal_scans[:70], normal_scans[:70]), axis=0)
    y_train = np.concatenate((abnormal_labels[:70], normal_labels[:70]), axis=0)
    x_val = np.concatenate((abnormal_scans[70:], normal_scans[70:]), axis=0)
    y_val = np.concatenate((abnormal_labels[70:], normal_labels[70:]), axis=0)
    print(
        "Number of samples in train and validation are %d and %d."
        % (x_train.shape[0], x_val.shape[0])
    )
```

```
Number of samples in train and validation are 140 and 60.
```

```
[6] import random

    from scipy import ndimage


    def rotate(volume):
        """Rotate the volume by a few degrees"""

        def scipy_rotate(volume):
```

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```
[7] batch_size = 2
    # Augment the on the fly during training.
    train_dataset = (
        train_loader.shuffle(len(x_train))
        .map(train_preprocessing)
        .batch(batch_size)
        .prefetch(2)
    )
    # Only rescale.
    validation_dataset = (
        validation_loader.shuffle(len(x_val))
        .map(validation_preprocessing)
        .batch(batch_size)
        .prefetch(2)
    )
```

```
[8] import matplotlib.pyplot as plt

    data = train_dataset.take(1)
    images, labels = list(data)[0]
    images = images.numpy()
    image = images[0]
    print("Dimension of the CT scan is:", image.shape)
    plt.imshow(np.squeeze(image[:, :, 30]), cmap="gray")
```

```
Dimension of the CT scan is: (128, 128, 64, 1)
<matplotlib.image.AxesImage at 0x7c1758b24c70>
```

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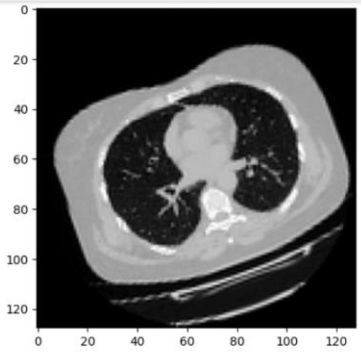


```
[9] def plot_slices(num_rows, num_columns, width, height, data):
        """Plot a montage of 20 CT slices"""
        data = np.rot90(np.array(data))
        data = np.transpose(data)
        data = np.reshape(data, (num_rows, num_columns, width, height))
        rows_data, columns_data = data.shape[0], data.shape[1]
        heights = [slc[0].shape[0] for slc in data]
```

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```
# Visualize montage of slices.
# 4 rows and 10 columns for 100 slices of the CT scan.
plot_slices(4, 10, 128, 128, image[:, :, :40])
```

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```
[10] def get_model(width=128, height=128, depth=64):
         """Build a 3D convolutional neural network model."""

         inputs = keras.Input((width, height, depth, 1))

         x = layers.Conv3D(filters=64, kernel_size=3, activation="relu")(inputs)
         x = layers.MaxPool3D(pool_size=2)(x)
         x = layers.BatchNormalization()(x)

         x = layers.Conv3D(filters=64, kernel_size=3, activation="relu")(x)
         x = layers.MaxPool3D(pool_size=2)(x)
         x = layers.BatchNormalization()(x)

         x = layers.Conv3D(filters=128, kernel_size=3, activation="relu")(x)
         x = layers.MaxPool3D(pool_size=2)(x)
         x = layers.BatchNormalization()(x)

         x = layers.Conv3D(filters=256, kernel_size=3, activation="relu")(x)
         x = layers.MaxPool3D(pool_size=2)(x)
         x = layers.BatchNormalization()(x)

         x = layers.GlobalAveragePooling3D()(x)
         x = layers.Dense(units=512, activation="relu")(x)
         x = layers.Dropout(0.3)(x)

         outputs = layers.Dense(units=1, activation="sigmoid")(x)

         # Define the model.
         model = keras.Model(inputs, outputs, name="3dcnn")
         return model
```

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```
[10] Total params: 1352897 (5.16 MB)
     Trainable params: 1351873 (5.16 MB)
     Non-trainable params: 1024 (4.00 KB)
```

Train model

```
[11] # Compile model.
     initial_learning_rate = 0.0001
     lr_schedule = keras.optimizers.schedules.ExponentialDecay(
         initial_learning_rate, decay_steps=100000, decay_rate=0.96, staircase=True
     )
     model.compile(
         loss="binary_crossentropy",
         optimizer=keras.optimizers.Adam(learning_rate=lr_schedule),
         metrics=["acc"],
         run_eagerly=True,
     )

     # Define callbacks.
     checkpoint_cb = keras.callbacks.ModelCheckpoint(
         "3d_image_classification.keras", save_best_only=True
     )
     early_stopping_cb = keras.callbacks.EarlyStopping(monitor="val_acc", patience=15)

     # Train the model, doing validation at the end of each epoch
     epochs = 100
     model.fit(
         train_dataset,
```

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```
[11] Epoch 1/100
WARNING:tensorflow:5 out of the last 5 calls to <function _BaseOptimizer._update_step_xla at 0x7c1751ec4b80> triggered tf.function retracing. Tracing is expensive a
WARNING:tensorflow:6 out of the last 6 calls to <function _BaseOptimizer._update_step_xla at 0x7c1751ec4b80> triggered tf.function retracing. Tracing is expensive a
70/70 - 42s - loss: 0.6578 - acc: 0.6571 - val_loss: 1.2279 - val_acc: 0.5000 - 42s/epoch - 595ms/step
Epoch 2/100
70/70 - 31s - loss: 0.6393 - acc: 0.6071 - val_loss: 2.2625 - val_acc: 0.5000 - 31s/epoch - 447ms/step
Epoch 3/100
70/70 - 31s - loss: 0.6534 - acc: 0.5929 - val_loss: 2.9793 - val_acc: 0.5000 - 31s/epoch - 449ms/step
Epoch 4/100
70/70 - 30s - loss: 0.6215 - acc: 0.7071 - val_loss: 3.0509 - val_acc: 0.5000 - 30s/epoch - 432ms/step
Epoch 5/100
70/70 - 29s - loss: 0.6490 - acc: 0.6571 - val_loss: 2.4660 - val_acc: 0.5000 - 29s/epoch - 420ms/step
Epoch 6/100
70/70 - 30s - loss: 0.6330 - acc: 0.6286 - val_loss: 1.9164 - val_acc: 0.5000 - 30s/epoch - 430ms/step
Epoch 7/100
70/70 - 29s - loss: 0.5965 - acc: 0.6929 - val_loss: 1.8847 - val_acc: 0.5000 - 29s/epoch - 419ms/step
Epoch 8/100
70/70 - 31s - loss: 0.6618 - acc: 0.5857 - val_loss: 0.9466 - val_acc: 0.5000 - 31s/epoch - 437ms/step
Epoch 9/100
70/70 - 30s - loss: 0.6102 - acc: 0.6714 - val_loss: 0.7172 - val_acc: 0.6000 - 30s/epoch - 432ms/step
Epoch 10/100
70/70 - 31s - loss: 0.5991 - acc: 0.6500 - val_loss: 0.6060 - val_acc: 0.6500 - 31s/epoch - 440ms/step
Epoch 11/100
70/70 - 30s - loss: 0.5790 - acc: 0.7000 - val_loss: 0.6044 - val_acc: 0.6500 - 30s/epoch - 429ms/step
Epoch 12/100
70/70 - 30s - loss: 0.5831 - acc: 0.7357 - val_loss: 0.9922 - val_acc: 0.5333 - 30s/epoch - 425ms/step
Epoch 13/100
70/70 - 29s - loss: 0.5783 - acc: 0.6929 - val_loss: 0.7319 - val_acc: 0.6500 - 29s/epoch - 415ms/step
Epoch 14/100
70/70 - 30s - loss: 0.6074 - acc: 0.6286 - val_loss: 1.4215 - val_acc: 0.5000 - 30s/epoch - 432ms/step
Epoch 15/100
70/70 - 29s - loss: 0.5655 - acc: 0.6714 - val_loss: 0.9379 - val_acc: 0.5167 - 29s/epoch - 415ms/step
```

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3D_image_classification

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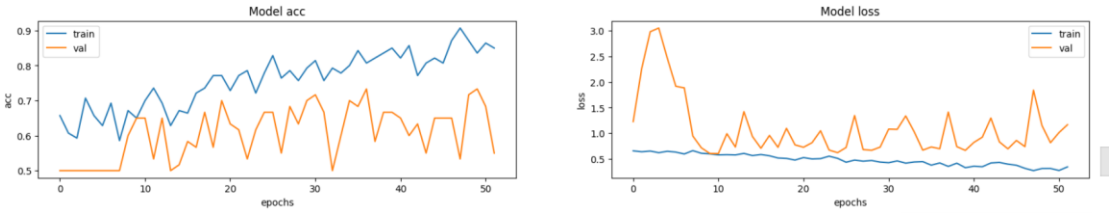
```
70/70 - 29s - loss: 0.2744 - acc: 0.8643 - val_loss: 1.0135 - val_acc: 0.6833 - 29s/epoch - 416ms/step
Epoch 52/100
70/70 - 29s - loss: 0.3454 - acc: 0.8500 - val_loss: 1.1675 - val_acc: 0.5500 - 29s/epoch - 414ms/step
<keras.src.callbacks.History at 0x7c1751f499c0>
```

```
[12] fig, ax = plt.subplots(1, 2, figsize=(20, 3))
ax = ax.ravel()

for i, metric in enumerate(["acc", "loss"]):
    ax[i].plot(model.history.history[metric])
    ax[i].plot(model.history.history["val_" + metric])
    ax[i].set_title("Model {}".format(metric))
    ax[i].set_xlabel("epochs")
    ax[i].set_ylabel(metric)
    ax[i].legend(["train", "val"])
```



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3D_image_classification

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```
# Load best weights.
model.load_weights("3d_image_classification.keras")
prediction = model.predict(np.expand_dims(x_val[0], axis=0))[0]
scores = [1 - prediction[0], prediction[0]]

class_names = ["normal", "abnormal"]
for score, name in zip(scores, class_names):
    print(
        "This model is %.2f percent confident that CT scan is %s"
        % ((100 * score), name)
    )
```

--NORMAL--

```
1/1 [==============================] - 1s 694ms/step
This model is 36.31 percent confident that CT scan is normal
This model is 63.69 percent confident that CT scan is abnormal
```