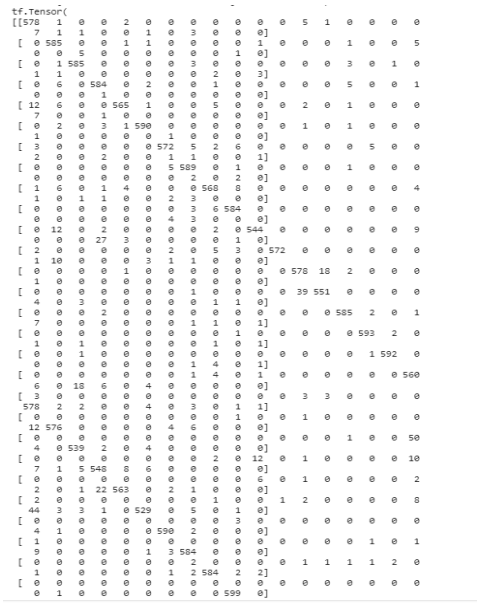
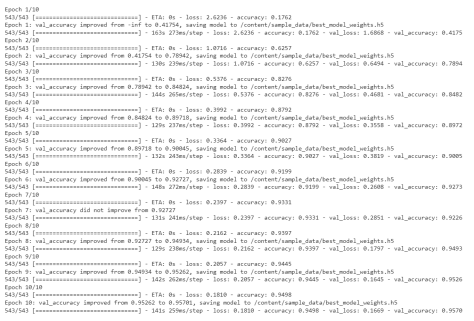
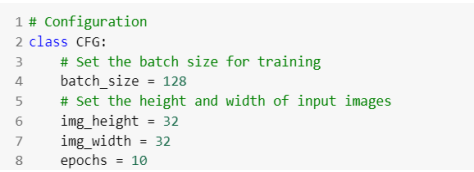
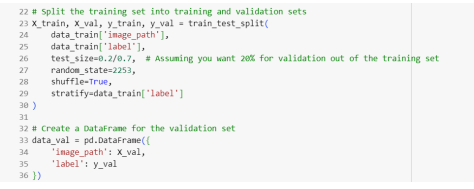
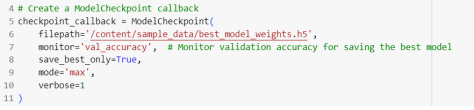
PERFORMANCE AND FINAL SUBMISSION PHRASE

Date	14 November 2023
Team ID	Team- 591769
Project Name	ASL - Alphabet image recognition
Maximum Marks	10 Marks

Model Performance Testing:

S.No.	Parameter	Values	Screenshot
1.	Metrics	**Classification Model:** VGG16 model **Confusion Matrix ,** **Classification Report &** **Accuracy Scores-** Training accuracy:- 94.98% Testing accuracy:- 96.26%	Confusion Matrix:-  Classification report:-

			136/136 [==============================] - 25s 181ms/step precision recall f1-score support A 0.95 0.95 0.95 600 B 0.94 0.96 0.95 600 C 1.00 0.97 0.98 600 D 0.99 0.98 0.98 600 E 0.98 0.94 0.96 600 F 0.99 0.97 0.98 600 G 0.99 0.95 0.97 600 H 0.97 0.98 0.97 600 I 0.97 0.96 0.96 600 J 0.97 0.97 0.97 600 K 0.94 0.91 0.93 600 L 1.00 0.96 0.98 600 M 0.93 0.93 0.93 600 N 0.94 0.95 0.94 600 O 0.97 0.99 0.98 600 P 0.98 0.98 0.98 600 Q 0.99 0.98 0.98 600 R 0.84 0.93 0.88 600 S 0.81 0.96 0.88 600 T 0.98 0.95 0.96 600 U 0.91 0.89 0.90 600 V 0.91 0.91 0.91 600 W 0.98 0.93 0.96 600 X 0.96 0.87 0.91 600 Y 0.97 0.97 0.97 600 Z 0.95 0.98 0.96 600 del 0.98 0.97 0.98 600 nothing 0.98 1.00 0.99 600 space 0.98 0.98 0.98 600 accuracy 0.95 17400 macro avg 0.96 0.95 0.95 17400 weighted avg 0.96 0.95 0.95 17400 Accuracy Score:-  
2.	Tune the Model	**<u>Hyperparameter Tuning:</u>** The model is tuned with following hyper parameters- Optimizer - Adam Learning rate - 0.0001 Loss - Categorical cross entropy Batch size - 128 EPOCHS - 10 **<u>Validation Method:</u>** The validation of the model is done through the validation data , which is set to 20% of training data. Data augmentation and callbacks are also used to validate performance. Accuracy is the validation parameter that we have monitored	Hyperparameter Tuning:-   Validation Method:-  

CONFUSION MATRIX:-

```
tf.Tensor(
[[578   1   0   0   2   0   0   0   0   0   0   0   5   1   0   0   0   0
    7   1   1   0   0   1   0   3   0   0   0]
 [  0 585   0   0   1   1   0   0   0   0   1   0   0   0   1   0   0   5
    0   0   5   0   0   0   0   0   0   1   0]
 [  0   1 585   0   0   0   0   3   0   0   0   0   0   0   3   0   1   0
    1   1   0   0   0   0   0   0   2   0   3]
 [  0   6   0 584   0   2   0   0   1   0   0   0   0   0   0   5   0   0   1
    0   0   0   1   0   0   0   0   0   0   0]
 [ 12   6   0   0 565   1   0   0   5   0   0   0   2   0   1   0   0   0
    7   0   0   1   0   0   0   0   0   0   0]
 [  0   2   0   3   1 590   0   0   0   0   0   0   1   0   1   0   0   0
    1   0   0   0   0   0   1   0   0   0   0]
 [  3   0   0   0   0   0 572   5   2   6   0   0   0   0   0   5   0   0
    2   0   0   2   0   0   1   1   0   0   1]
 [  0   0   0   0   0   0   5 589   0   1   0   0   0   0   1   0   0   0
    0   0   0   0   0   0   0   2   0   2   0]
 [  1   6   0   1   4   0   0   0 568   8   0   0   0   0   0   0   0   4
    1   0   1   1   0   0   2   3   0   0   0]
 [  0   0   0   0   0   0   0   3   6 584   0   0   0   0   0   0   0   0
    0   0   0   0   0   0   4   3   0   0   0]
 [  0  12   0   2   0   0   0   0   2   0 544   0   0   0   0   0   0   9
    0   0   0  27   3   0   0   0   0   1   0]
 [  2   0   0   0   0   0   2   0   5   3   0 572   0   0   0   0   0   0
    1  10   0   0   0   3   1   1   0   0   0]
 [  0   0   0   0   1   0   0   0   0   0   0   0 578  18   2   0   0   0
    1   0   0   0   0   0   0   0   0   0   0]
 [  0   0   0   0   0   0   0   1   0   0   0   0  39 551   0   0   0   0
    4   0   3   0   0   0   0   0   1   1   0]
 [  0   0   0   2   0   0   0   0   0   0   0   0   0   0 585   2   0   1
    7   0   0   0   0   0   0   1   1   0   1]
 [  0   0   0   0   0   0   0   0   0   1   0   0   0   0   0 593   2   0
    1   0   1   0   0   0   0   0   1   0   1]
 [  0   0   1   0   0   0   0   0   0   0   0   0   0   0   0   1 592   0
    0   0   0   0   0   0   0   1   4   0   1]
 [  0   0   0   0   0   0   0   1   4   0   1   0   0   0   0   0   0 560
    6   0  18   6   0   4   0   0   0   0   0]
 [  3   0   0   0   0   0   0   0   0   0   0   0   3   3   0   0   0   0
  578   2   2   0   0   4   0   3   0   1   1]
 [  0   0   0   0   0   0   0   0   0   1   0   0   1   0   0   0   0   0
   12 576   0   0   0   0   4   6   0   0   0]
 [  0   0   0   0   0   0   0   0   0   0   0   0   0   0   1   0   0  50
    4   0 539   2   0   4   0   0   0   0   0]
 [  0   0   0   0   0   0   0   0   2   0  12   0   1   0   0   0   0  10
    7   1   5 548   8   6   0   0   0   0   0]
 [  0   0   0   0   0   0   0   0   0   0   6   0   1   0   0   0   0   2
    2   0   1  22 563   0   2   1   0   0   0]
 [  2   0   0   0   0   0   0   0   1   0   0   1   2   0   0   0   0   8
   44   3   3   1   0 529   0   5   0   1   0]
 [  0   0   0   0   0   0   0   0   0   3   0   0   0   0   0   0   0   0
    4   1   0   0   0   0 590   2   0   0   0]
 [  1   0   0   0   0   0   0   0   0   0   0   0   0   0   0   1   0   1
    9   0   0   0   0   1   3 584   0   0   0]
 [  0   0   0   0   0   0   0   2   0   0   0   0   1   1   1   1   2   0
    1   0   0   0   0   0   1   2 584   2   2]
 [  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
    0   1   0   0   0   0   0   0   0 599   0]
```

CLASSIFICATION REPORT:-

```
136/136 [==============================] - 25s 181ms/step
              precision    recall  f1-score   support

           A       0.95      0.95      0.95       600
           B       0.94      0.96      0.95       600
           C       1.00      0.97      0.98       600
           D       0.99      0.98      0.98       600
           E       0.98      0.94      0.96       600
           F       0.99      0.97      0.98       600
           G       0.99      0.95      0.97       600
           H       0.97      0.98      0.97       600
           I       0.97      0.96      0.96       600
           J       0.97      0.97      0.97       600
           K       0.94      0.91      0.93       600
           L       1.00      0.96      0.98       600
           M       0.93      0.93      0.93       600
           N       0.94      0.95      0.94       600
           O       0.97      0.99      0.98       600
           P       0.98      0.98      0.98       600
           Q       0.99      0.98      0.98       600
           R       0.84      0.93      0.88       600
           S       0.81      0.96      0.88       600
           T       0.98      0.95      0.96       600
           U       0.91      0.89      0.90       600
           V       0.91      0.91      0.91       600
           W       0.98      0.93      0.96       600
           X       0.96      0.87      0.91       600
           Y       0.97      0.97      0.97       600
           Z       0.95      0.98      0.96       600
         del       0.98      0.97      0.98       600
     nothing       0.98      1.00      0.99       600
       space       0.98      0.98      0.98       600

    accuracy                           0.95     17400
   macro avg       0.96      0.95      0.95     17400
weighted avg       0.96      0.95      0.95     17400
```

ACCURACY SCORE:-

```
Epoch 1/10
543/543 [==============================] - ETA: 0s - loss: 2.6236 - accuracy: 0.1762
Epoch 1: val_accuracy improved from -inf to 0.41754, saving model to /content/sample_data/best_model_weights.h5
543/543 [==============================] - 163s 273ms/step - loss: 2.6236 - accuracy: 0.1762 - val_loss: 1.6868 - val_accuracy: 0.4175
Epoch 2/10
543/543 [==============================] - ETA: 0s - loss: 1.0716 - accuracy: 0.6257
Epoch 2: val_accuracy improved from 0.41754 to 0.78942, saving model to /content/sample_data/best_model_weights.h5
543/543 [==============================] - 130s 239ms/step - loss: 1.0716 - accuracy: 0.6257 - val_loss: 0.6494 - val_accuracy: 0.7894
Epoch 3/10
543/543 [==============================] - ETA: 0s - loss: 0.5376 - accuracy: 0.8276
Epoch 3: val_accuracy improved from 0.78942 to 0.84824, saving model to /content/sample_data/best_model_weights.h5
543/543 [==============================] - 144s 265ms/step - loss: 0.5376 - accuracy: 0.8276 - val_loss: 0.4681 - val_accuracy: 0.8482
Epoch 4/10
543/543 [==============================] - ETA: 0s - loss: 0.3992 - accuracy: 0.8792
Epoch 4: val_accuracy improved from 0.84824 to 0.89718, saving model to /content/sample_data/best_model_weights.h5
543/543 [==============================] - 129s 237ms/step - loss: 0.3992 - accuracy: 0.8792 - val_loss: 0.3558 - val_accuracy: 0.8972
Epoch 5/10
543/543 [==============================] - ETA: 0s - loss: 0.3364 - accuracy: 0.9027
Epoch 5: val_accuracy improved from 0.89718 to 0.90045, saving model to /content/sample_data/best_model_weights.h5
543/543 [==============================] - 132s 243ms/step - loss: 0.3364 - accuracy: 0.9027 - val_loss: 0.3819 - val_accuracy: 0.9005
Epoch 6/10
543/543 [==============================] - ETA: 0s - loss: 0.2839 - accuracy: 0.9199
Epoch 6: val_accuracy improved from 0.90045 to 0.92727, saving model to /content/sample_data/best_model_weights.h5
543/543 [==============================] - 148s 272ms/step - loss: 0.2839 - accuracy: 0.9199 - val_loss: 0.2608 - val_accuracy: 0.9273
Epoch 7/10
543/543 [==============================] - ETA: 0s - loss: 0.2397 - accuracy: 0.9331
Epoch 7: val_accuracy did not improve from 0.92727
543/543 [==============================] - 131s 241ms/step - loss: 0.2397 - accuracy: 0.9331 - val_loss: 0.2851 - val_accuracy: 0.9226
Epoch 8/10
543/543 [==============================] - ETA: 0s - loss: 0.2162 - accuracy: 0.9397
Epoch 8: val_accuracy improved from 0.92727 to 0.94934, saving model to /content/sample_data/best_model_weights.h5
543/543 [==============================] - 129s 238ms/step - loss: 0.2162 - accuracy: 0.9397 - val_loss: 0.1797 - val_accuracy: 0.9493
Epoch 9/10
543/543 [==============================] - ETA: 0s - loss: 0.2057 - accuracy: 0.9445
Epoch 9: val_accuracy improved from 0.94934 to 0.95262, saving model to /content/sample_data/best_model_weights.h5
543/543 [==============================] - 142s 262ms/step - loss: 0.2057 - accuracy: 0.9445 - val_loss: 0.1645 - val_accuracy: 0.9526
Epoch 10/10
543/543 [==============================] - ETA: 0s - loss: 0.1810 - accuracy: 0.9498
Epoch 10: val_accuracy improved from 0.95262 to 0.95701, saving model to /content/sample_data/best_model_weights.h5
543/543 [==============================] - 141s 259ms/step - loss: 0.1810 - accuracy: 0.9498 - val_loss: 0.1669 - val_accuracy: 0.9570
```

```
scores = model.evaluate(test_generator)
print("%s: %2f%%" % ("Evaluate Test Accuracy", scores[1]*100))
```

```
136/136 [==============================] - 25s 182ms/step - loss: 0.1469 - accuracy: 0.9626
Evaluate Test Accuracy: 96.264368%
```

HYPERPARAMETER TUNING:-

```
# Compile the model
model.compile(optimizer=Adam(lr=0.0001), loss='categorical_crossentropy', metrics=['accuracy'])

```

```
# Configuration
class CFG:
    # Set the batch size for training
    batch_size = 128
    # Set the height and width of input images
    img_height = 32
    img_width = 32
    epochs = 10
```

VALIDATION METHOD:-

```
# Split the training set into training and validation sets
X_train, X_val, y_train, y_val = train_test_split(
    data_train['image_path'],
    data_train['label'],
    test_size=0.2/0.7,  # Assuming you want 20% for validation out of the training set
    random_state=2253,
    shuffle=True,
    stratify=data_train['label']
)

# Create a DataFrame for the validation set
data_val = pd.DataFrame({
    'image_path': X_val,
    'label': y_val
})
```

```
# Create a ModelCheckpoint callback
checkpoint_callback = ModelCheckpoint(
    filepath='/content/sample_data/best_model_weights.h5',
    monitor='val_accuracy',  # Monitor validation accuracy for saving the best model
    save_best_only=True,
    mode='max',
    verbose=1
)
```