

**Name:** Bala Guga Gopal S

**Batch:** R2

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**Experiment Name:** Final Review: Mini Project Report

**Experiment Description:** Indian Vehicle classification using CNN

## Indian Vehicle classification using CNN

In intelligent traffic management and transportation, vehicle classifiers play a significant role. It's tough to tell one vehicle type from another. The vehicle classification problem is fundamentally an image classification problem, and Convolutional Neural Networks are the ideal tool for the job because they require less image preprocessing than other approaches. Unlike classic machine learning algorithms, convolutional neural networks do not require handcrafted features for classification.

In This script two approach have used to solve the classification problem

1. By creating a model
2. By Using Transfer Learning

This script follows a basic machine learning workflow:

- \* Examine and understand data
- \* Build an input pipeline
- \* Build the model
- \* Train the model
- \* Test the model

The workspace for the script have been created using the google drive only for storing and saving the data and model.

### Workspace creation

In [ ]:

```
# importing google drive to create the work space
from google.colab import drive
drive.mount('/content/gdrive')
```

Drive already mounted at /content/gdrive; to attempt to forcibly remount, call drive.mount("/content/gdrive", force\_remount=True).

In [ ]:

```
# creating a working directory to load the dataset.
%cd '/content/gdrive/MyDrive/Neuralnetworks /MiniPro/Dataset'
```

/content/gdrive/MyDrive/Neuralnetworks /MiniPro/Dataset

### Dataset Loading

The dataset consists of Indian vehicle images for classification and object detection. It is observed that there is very little or no dataset available on these vehicles like autorickshaw, tempo, trucks, etc. The images have been taken in varied weather conditions in daylight, evening, and night. The dataset has a wide variety of variations of illumination, distances, viewpoints, etc. This dataset represents a very challenging set of images of vehicles of niche classes. This dataset can be used for image recognition and object detection for driver assistance systems, autonomous driving, etc.

## Vehicle Classes

Indian Auto  
Indian Truck  
Bus  
Truck  
Tempo Traveller  
Tractor  
Car  
Two Wheelers.. (etc)

## Dataset - [link](#)



In [ ]:

```
# Configure Working directory to for Kaggle Json image (important to download the dataset
from Kaggle to google drive via colab)
import os
os.environ['KAGGLE_CONFIG_DIR'] = "/content/gdrive/MyDrive/Neuralnetworks /MiniPro/Datase
t/kaggle"
```

In [ ]:

```
# Dataset API from Kaggle
!kaggle datasets download -d dataclusterlabs/indian-vehicle-dataset
```

In [ ]:

```
# Unzip the folders and to delete the .zip file.
!unzip \*.zip && rm *.zip
```

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Archive:  indian-vehicle-dataset.zip
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[illegible]

[illegible]

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inflating: Truck/Datacluster Truck (98).jpg
inflating: Truck/Datacluster Truck (99).jpg
```

## Import TensorFlow libraries and other Dependencies

**ImageDataGenerator** from keras is used to Load the data from the directory. Very useful in doing Image preprocessing. To load the images, Generate batches of tensor image data with real-time data augmentation. **ImageDataGenerator** can be used.

[ImageDataGenerator](#) - library link

In [ ]:

```
# Import tensorflow library and other dependencies
# Checking for GPU availability

import tensorflow as tf
import os
import numpy as np
from PIL import ImageFile
ImageFile.LOAD_TRUNCATED_IMAGES = True
from matplotlib import pyplot as plt
%matplotlib inline

if not os.path.isdir('models'):
    os.mkdir('models')

print('TensorFlow version:', tf.__version__)
print('Is using GPU?', tf.test.is_gpu_available())
```

TensorFlow version: 2.7.0  
Is using GPU? False

## Dataset preprocessing

In [ ]:

```
data_root = ("/content/gdrive/MyDrive/Neuralnetworks /MiniPro/Dataset")
```

In [ ]:

```
IMAGE_SHAPE = (224, 224) # (height, width) in no. of pixels
```

In [ ]:

```
TRAINING_DATA_DIR = str(data_root)
```

In [ ]:

```
datagen_kwargs = dict(rescale=1./255, validation_split=.20) #Splitting of Data
```

In [ ]:

```
# loading the dataset images form the directory and splitting between , training and Validations
valid_datagen = tf.keras.preprocessing.image.ImageDataGenerator(**datagen_kwargs)

valid_generator = valid_datagen.flow_from_directory(
    TRAINING_DATA_DIR,
    subset="validation",
    shuffle=True,
    target_size=IMAGE_SHAPE
)

train_datagen = tf.keras.preprocessing.image.ImageDataGenerator(**datagen_kwargs)

train_generator = train_datagen.flow_from_directory(
    TRAINING_DATA_DIR,
    subset="training",
    shuffle=True,
    target_size=IMAGE_SHAPE)
```

Found 146 images belonging to 6 classes.

Found 598 images belonging to 6 classes.

## Visualizing the data

**(32, 244, 244, 3)** means in one batch of images consist of 32 images and 244, 244 is height and width of images and 3 is RGB three colour channels.

**label\_batch shape is (32, 6)** means there are 32 labels and 6 because the labels are in one hot encoded format.

In [ ]:

```
# Iterating through the images and labels in train_generator

for image_batch, label_batch in train_generator:
    break
image_batch.shape, label_batch.shape
```

Out[ ]:

```
((32, 224, 224, 3), (32, 6))
```

In [ ]:

```
class_name = train_generator.class_indices
class_names = train_generator.classes
print(class_names)
print(class_name)
```

[illegible]

```
# dataset labels and Number of classes
dataset_labels = sorted(train_generator.class_indices.items(), key=lambda pair:pair[1])
dataset_labels = np.array([key.title() for key, value in dataset_labels])
print(dataset_labels)
```

In [ ]:

## Model creation

```
# model creation
def create_model(num_classes):
    model = tf.keras.Sequential([
        tf.keras.layers.Conv2D(filters=8, kernel_size=(3, 3), activation='relu',
                                input_shape=(224, 224, 3)),
        tf.keras.layers.MaxPooling2D(pool_size=(2, 2), strides=2),
        tf.keras.layers.Conv2D(filters=16, kernel_size=(3, 3), activation='relu'),
        tf.keras.layers.MaxPooling2D(pool_size=(2, 2), strides=2),
        tf.keras.layers.Conv2D(filters=32, kernel_size=(3, 3), activation='relu'),
        tf.keras.layers.MaxPooling2D(pool_size=(2, 2), strides=2),
        tf.keras.layers.Dropout(0.4),
        tf.keras.layers.Flatten(),
        tf.keras.layers.Dense(64, activation='relu'),
        tf.keras.layers.Dense(num_classes, activation='softmax')
    ])
    return model

model = create_model(num_classes=6)
```



For optimizer and Loss function, the `tf.keras.optimizers.Adam` optimizer and `tf.keras.losses.SparseCategoricalCrossentropy` loss function have been taken. To view training and validation accuracy for each training epoch, pass the metrics argument to `Model.compile`.

In [ ]:

```
model.compile(
    optimizer=tf.keras.optimizers.Adam(learning_rate=0.0001),
    loss=tf.keras.losses.CategoricalCrossentropy(from_logits=True),
    metrics=['accuracy']
)
model.summary() #Model summary ( all the layers of the network)
```

Model: "sequential\_5"

Layer (type)	Output Shape	Param #
=====		
conv2d_21 (Conv2D)	(None, 222, 222, 8)	224
max_pooling2d_15 (MaxPooling2D)	(None, 111, 111, 8)	0
conv2d_22 (Conv2D)	(None, 109, 109, 16)	1168
max_pooling2d_16 (MaxPooling2D)	(None, 54, 54, 16)	0
conv2d_23 (Conv2D)	(None, 52, 52, 32)	4640
max_pooling2d_17 (MaxPooling2D)	(None, 26, 26, 32)	0
dropout_7 (Dropout)	(None, 26, 26, 32)	0
flatten_5 (Flatten)	(None, 21632)	0
dense_8 (Dense)	(None, 64)	1384512
dense_9 (Dense)	(None, 6)	390
=====		
Total params: 1,390,934		
Trainable params: 1,390,934		
Non-trainable params: 0		
=====		

In [ ]:

```
# Training the model with 30 epoch
EPOCHS = 30
#BATCH_SIZE = 32
BATCH_SIZE = valid_generator.batch_size
print("BATCH_SIZE :", BATCH_SIZE)
steps_per_epoch = np.ceil(train_generator.samples/train_generator.batch_size)
val_steps_per_epoch = np.ceil(valid_generator.samples/valid_generator.batch_size)

history = model.fit(train_generator,
                    epochs=EPOCHS,
                    verbose=1,
                    steps_per_epoch = steps_per_epoch,
                    validation_data = valid_generator,
                    validation_steps= val_steps_per_epoch,
                    )
```

BATCH\_SIZE : 32  
Epoch 1/30  
19/19 [=====] - ETA: 0s - loss: 1.6342 - accuracy: 0.2458

/usr/local/lib/python3.7/dist-packages/tensorflow/python/util/dispatch.py:1096: UserWarning: "`categorical\_crossentropy` received `from\_logits=True`, but the `output` argument was produced by a sigmoid or softmax activation and thus does not represent logits. Was thi

```
s_intended?"  
    return dispatch_target(*args, **kwargs)
```

```
19/19 [=====] - 161s 9s/step - loss: 1.6342 - accuracy: 0.2458 -  
val_loss: 1.6260 - val_accuracy: 0.2123  
Epoch 2/30  
19/19 [=====] - 153s 8s/step - loss: 1.6034 - accuracy: 0.2358 -  
val_loss: 1.5863 - val_accuracy: 0.2740  
Epoch 3/30  
19/19 [=====] - 154s 8s/step - loss: 1.5557 - accuracy: 0.2960 -  
val_loss: 1.5816 - val_accuracy: 0.2740  
Epoch 4/30  
19/19 [=====] - 153s 8s/step - loss: 1.5192 - accuracy: 0.3344 -  
val_loss: 1.5744 - val_accuracy: 0.2808  
Epoch 5/30  
19/19 [=====] - 148s 8s/step - loss: 1.4826 - accuracy: 0.3779 -  
val_loss: 1.5578 - val_accuracy: 0.3288  
Epoch 6/30  
19/19 [=====] - 149s 8s/step - loss: 1.4349 - accuracy: 0.4348 -  
val_loss: 1.5575 - val_accuracy: 0.2808  
Epoch 7/30  
19/19 [=====] - 151s 8s/step - loss: 1.3953 - accuracy: 0.4415 -  
val_loss: 1.5542 - val_accuracy: 0.3288  
Epoch 8/30  
19/19 [=====] - 150s 8s/step - loss: 1.3457 - accuracy: 0.4983 -  
val_loss: 1.5815 - val_accuracy: 0.2603  
Epoch 9/30  
19/19 [=====] - 152s 8s/step - loss: 1.2821 - accuracy: 0.4933 -  
val_loss: 1.6105 - val_accuracy: 0.3630  
Epoch 10/30  
19/19 [=====] - 148s 8s/step - loss: 1.2273 - accuracy: 0.5368 -  
val_loss: 1.5809 - val_accuracy: 0.3151  
Epoch 11/30  
19/19 [=====] - 148s 8s/step - loss: 1.1980 - accuracy: 0.5535 -  
val_loss: 1.6113 - val_accuracy: 0.2877  
Epoch 12/30  
19/19 [=====] - 149s 8s/step - loss: 1.0976 - accuracy: 0.6120 -  
val_loss: 1.5427 - val_accuracy: 0.3219  
Epoch 13/30  
19/19 [=====] - 147s 8s/step - loss: 1.0235 - accuracy: 0.6906 -  
val_loss: 1.5663 - val_accuracy: 0.2808  
Epoch 14/30  
19/19 [=====] - 146s 8s/step - loss: 0.9522 - accuracy: 0.6973 -  
val_loss: 1.5831 - val_accuracy: 0.3493  
Epoch 15/30  
19/19 [=====] - 148s 8s/step - loss: 0.9177 - accuracy: 0.7090 -  
val_loss: 1.6033 - val_accuracy: 0.2534  
Epoch 16/30  
19/19 [=====] - 147s 8s/step - loss: 0.8611 - accuracy: 0.7358 -  
val_loss: 1.5829 - val_accuracy: 0.3493  
Epoch 17/30  
19/19 [=====] - 146s 8s/step - loss: 0.7801 - accuracy: 0.7943 -  
val_loss: 1.6059 - val_accuracy: 0.3356  
Epoch 18/30  
19/19 [=====] - 147s 8s/step - loss: 0.7384 - accuracy: 0.7977 -  
val_loss: 1.6165 - val_accuracy: 0.3219  
Epoch 19/30  
19/19 [=====] - 145s 8s/step - loss: 0.6797 - accuracy: 0.8311 -  
val_loss: 1.6604 - val_accuracy: 0.3630  
Epoch 20/30  
19/19 [=====] - 146s 8s/step - loss: 0.6254 - accuracy: 0.8478 -  
val_loss: 1.6923 - val_accuracy: 0.3288  
Epoch 21/30  
19/19 [=====] - 149s 8s/step - loss: 0.5834 - accuracy: 0.8462 -  
val_loss: 1.6979 - val_accuracy: 0.3219  
Epoch 22/30  
19/19 [=====] - 149s 8s/step - loss: 0.5612 - accuracy: 0.8562 -  
val_loss: 1.7216 - val_accuracy: 0.3562  
Epoch 23/30  
19/19 [=====] - 147s 8s/step - loss: 0.5058 - accuracy: 0.8545 -  
val_loss: 1.7494 - val_accuracy: 0.3699  
Epoch 24/30
```

```

19/19 [=====] - 150s 8s/step - loss: 0.4946 - accuracy: 0.8712 -
val_loss: 1.9422 - val_accuracy: 0.3973
Epoch 25/30
19/19 [=====] - 149s 8s/step - loss: 0.4981 - accuracy: 0.8612 -
val_loss: 1.7468 - val_accuracy: 0.3356
Epoch 26/30
19/19 [=====] - 149s 8s/step - loss: 0.4340 - accuracy: 0.8930 -
val_loss: 1.8158 - val_accuracy: 0.3562
Epoch 27/30
19/19 [=====] - 149s 8s/step - loss: 0.3958 - accuracy: 0.9080 -
val_loss: 1.8234 - val_accuracy: 0.3630
Epoch 28/30
19/19 [=====] - 147s 8s/step - loss: 0.3581 - accuracy: 0.9247 -
val_loss: 1.8116 - val_accuracy: 0.3493
Epoch 29/30
19/19 [=====] - 147s 8s/step - loss: 0.3329 - accuracy: 0.9381 -
val_loss: 1.8891 - val_accuracy: 0.3699
Epoch 30/30
19/19 [=====] - 147s 8s/step - loss: 0.3074 - accuracy: 0.9448 -
val_loss: 1.8572 - val_accuracy: 0.3630

```

In [ ]:

```

# plotting accuracy (for validation and training), loss (for validation and training)
acc = history.history['accuracy']
val_acc = history.history['val_accuracy']

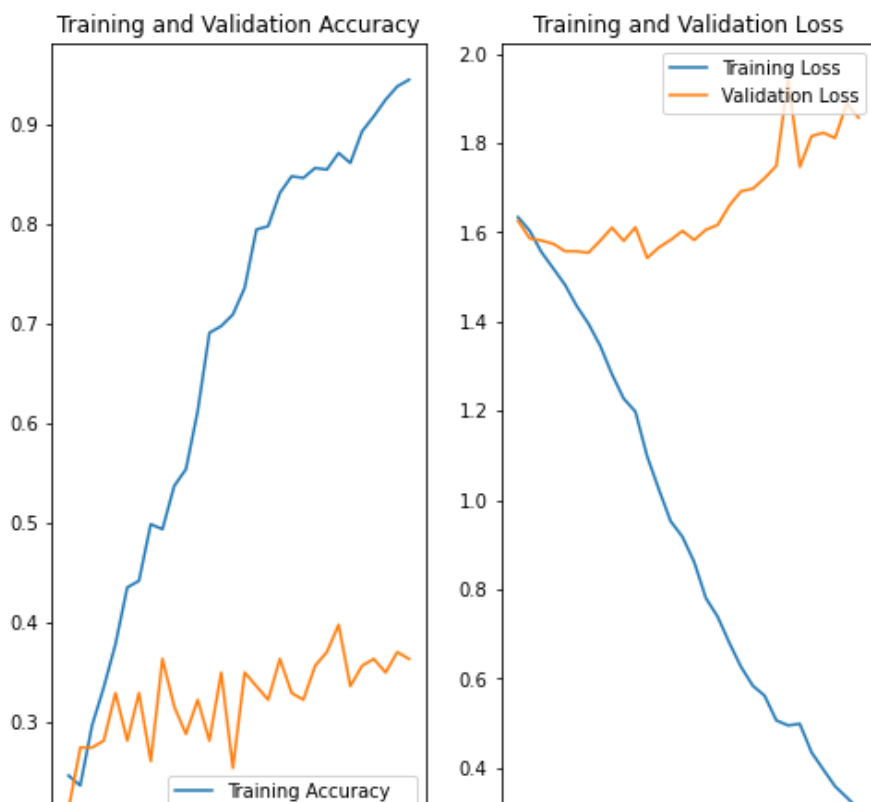
loss = history.history['loss']
val_loss = history.history['val_loss']

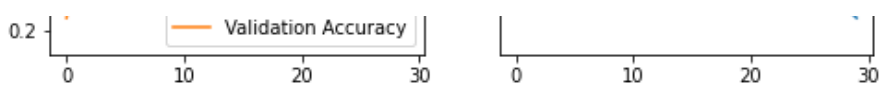
epochs_range = range(EPOCHS)

plt.figure(figsize=(8, 8))
plt.subplot(1, 2, 1)
plt.plot(epochs_range, acc, label='Training Accuracy')
plt.plot(epochs_range, val_acc, label='Validation Accuracy')
plt.legend(loc='lower right')
plt.title('Training and Validation Accuracy')

plt.subplot(1, 2, 2)
plt.plot(epochs_range, loss, label='Training Loss')
plt.plot(epochs_range, val_loss, label='Validation Loss')
plt.legend(loc='upper right')
plt.title('Training and Validation Loss')
plt.show()

```

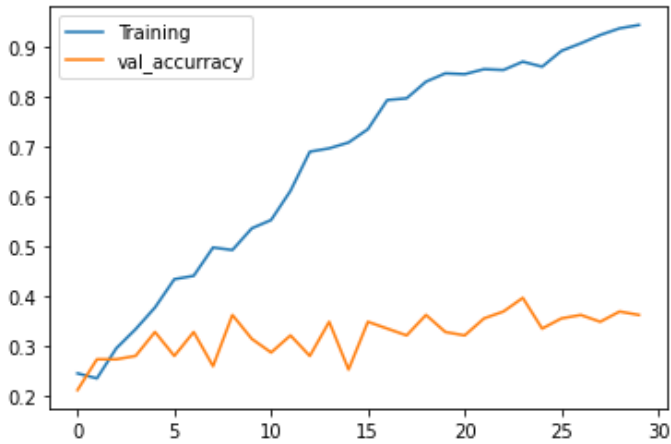




In [ ]:

```
accuracy = history.history['accuracy']
val_accuracy = history.history['val_accuracy']

plt.plot(range(len(accuracy)), accuracy, label='Training')
plt.plot(range(len(accuracy)), val_accuracy, label='val_accuracy')
plt.legend()
plt.show()
```



In [ ]:

```
# Model evaluation and Final accuracy of the model from validation dataset.

val_steps_per_epoch = np.ceil(valid_generator.samples/valid_generator.batch_size)
final_loss, final_accuracy = model.evaluate(valid_generator, steps = val_steps_per_epoch)
print("Final loss: {:.2f}".format(final_loss))
print("Final accuracy: {:.2f}%".format(final_accuracy * 100))

5/5 [=====] - 32s 6s/step - loss: 1.8572 - accuracy: 0.3630
Final loss: 1.86
Final accuracy: 36.30%
```

In [ ]:

```
#Model Prededction from Val_batch

val_image_batch, val_label_batch = next(iter(valid_generator))
true_label_ids = np.argmax(val_label_batch, axis=-1)
print("Validation batch shape:", val_image_batch.shape)

Validation batch shape: (32, 224, 224, 3)
```

In [ ]:

```
tf_model_predictions = model.predict(val_image_batch)
predicted_ids = np.argmax(tf_model_predictions, axis=-1)
predicted_labels = dataset_labels[predicted_ids]
```

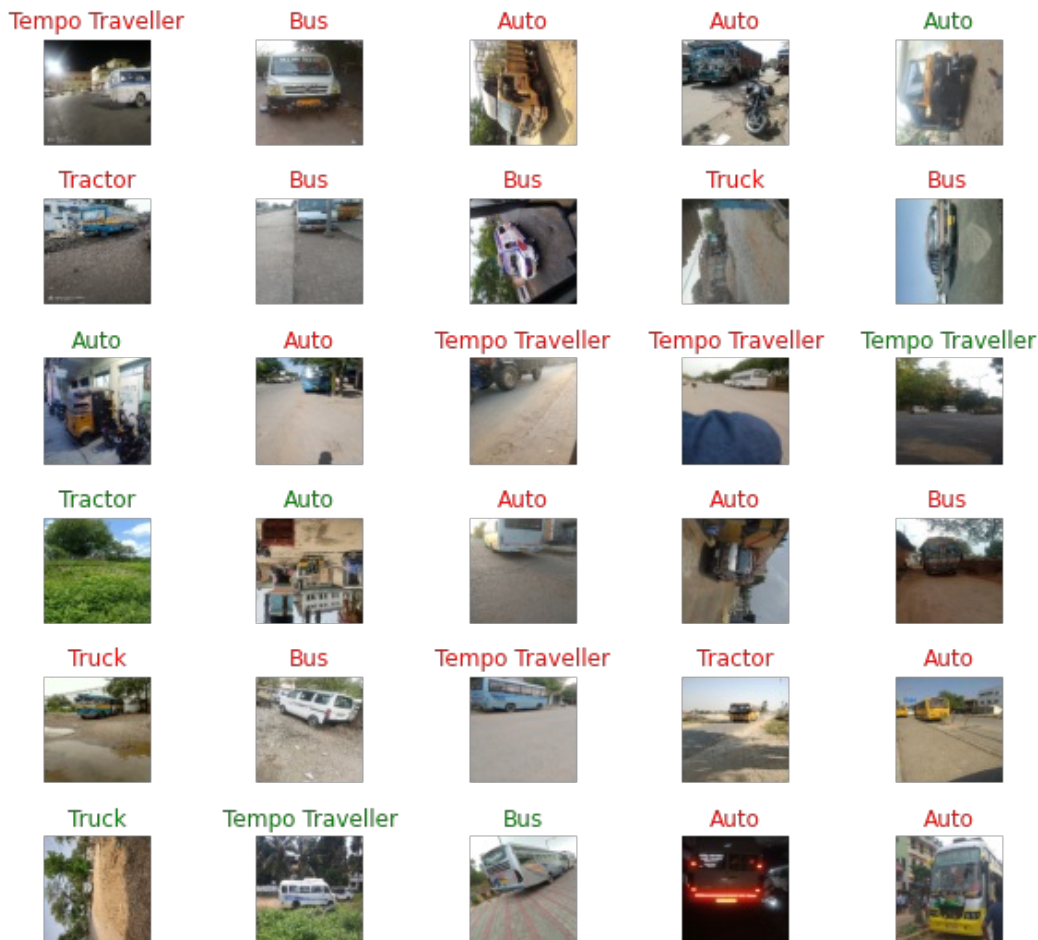
In [ ]:

```
print("Prediction results shape:", tf_model_predictions.shape)
plt.figure(figsize=(10,9))
plt.subplots_adjust(hspace=0.5)
for n in range((len(predicted_labels)-2)):
    plt.subplot(6,5,n+1)
    plt.imshow(val_image_batch[n])
    color = "green" if predicted_ids[n] == true_label_ids[n] else "red"
    plt.title(predicted_labels[n].title(), color=color)
    plt.axis('off')
_ = plt.suptitle("Model predictions (green: correct, red: incorrect)")
```

*#Green colour shows correctly predicted images and the red colour shows mismatch from the dataset class directory.*

Prediction results shape: (32, 6)

Model predictions (green: correct, red: incorrect)



In [ ]:

```
auto_url = "https://static3.bigstockphoto.com/5/4/9/large2/94577318.jpg"
auto_path = tf.keras.utils.get_file('Auto', origin=auto_url)

img = tf.keras.utils.load_img(
    auto_path, target_size=(224, 224)
)
```

```
img_array = tf.keras.utils.img_to_array(img)
img_array = tf.expand_dims(img_array, 0) # Create a batch
```

In [ ]:

```
predictions = model.predict(img_array)
score = tf.nn.softmax(predictions[0])

print(
    "This image most likely belongs to {} with a {:.2f} percent confidence."
    .format(class_names[np.argmax(score)], 100 * np.max(score))
)
```

This image most likely belongs to 0 with a 100.00 percent confidence.

## USING THE TRANSFERLEARNING

A pre-trained model is a saved network that was previously trained on a large dataset, typically on a large-scale image-classification task. You either use the pretrained model as is or use transfer learning to customize this model to a given task.

The intuition behind transfer learning for image classification is that if a model is trained on a large and general enough dataset, this model will effectively serve as a generic model of the visual world.

## TensorFlow hub to Load a pre-trained model

In [ ]:

```
!pip install tensorflow_hub
```

```
Requirement already satisfied: tensorflow_hub in /usr/local/lib/python3.7/dist-packages (0.12.0)
Requirement already satisfied: numpy>=1.12.0 in /usr/local/lib/python3.7/dist-packages (from tensorflow_hub) (1.19.5)
Requirement already satisfied: protobuf>=3.8.0 in /usr/local/lib/python3.7/dist-packages (from tensorflow_hub) (3.17.3)
Requirement already satisfied: six>=1.9 in /usr/local/lib/python3.7/dist-packages (from protobuf>=3.8.0->tensorflow_hub) (1.15.0)
```

In [ ]:

```
import tensorflow_hub as hub
```

The base model is from the MobileNet V2 model developed at Google. This is pre-trained on the ImageNet dataset, a large dataset consisting of 1.4M images and 1000 classes. ImageNet is a research training dataset with a wide variety of categories like jackfruit and syringe. This base of knowledge will help to classify different Vehicles.

In [ ]:

```
model = tf.keras.Sequential([
    hub.KerasLayer("https://tfhub.dev/google/tf2-preview/mobilenet_v2/feature_vector/4",
        output_shape=[1280],
        trainable=False),
    tf.keras.layers.Dropout(0.4),
    tf.keras.layers.Dense(train_generator.num_classes, activation='softmax')
])
model.build([None, 224, 224, 3])
```

In [ ]:

```
model.summary() #Model summary ( all the layers of the network)
```

Model: "sequential"

Layer (type)	Output Shape	Param #
keras_layer (KerasLayer)	(None, 1280)	2257984
dropout (Dropout)	(None, 1280)	0
dense (Dense)	(None, 6)	7686

```
=====  
Total params: 2,265,670  
Trainable params: 7,686  
Non-trainable params: 2,257,984  
=====
```

In [ ]:

```
#Model compiling
```

```
optimizer = tf.keras.optimizers.Adam(learning_rate=1e-3)
model.compile(
    optimizer=optimizer,
    loss='categorical_crossentropy',
    metrics=['acc'])
```

In [ ]:

### # Training the model with 20 epoch

```
steps_per_epoch = np.ceil(train_generator.samples/train_generator.batch_size)
val_steps_per_epoch = np.ceil(valid_generator.samples/valid_generator.batch_size)
hist = model.fit(
    train_generator,
    epochs=20,
    verbose=1,
    steps_per_epoch=steps_per_epoch,
    validation_data=valid_generator,
    validation_steps=val_steps_per_epoch).history
```

Epoch 1/20

19/19 [=====] - 356s 18s/step - loss: 1.9182 - acc: 0.2542 - val\_loss: 1.3682 - val\_acc: 0.3973

Epoch 2/20

19/19 [=====] - 121s 6s/step - loss: 1.5326 - acc: 0.3779 - val\_loss: 1.2050 - val\_acc: 0.5479

Epoch 3/20

19/19 [=====] - 117s 6s/step - loss: 1.3213 - acc: 0.4766 - val\_loss: 1.1059 - val\_acc: 0.5959

Epoch 4/20

19/19 [=====] - 117s 6s/step - loss: 1.2081 - acc: 0.5485 - val\_loss: 1.0351 - val\_acc: 0.6027

Epoch 5/20

19/19 [=====] - 117s 6s/step - loss: 1.0588 - acc: 0.5853 - val\_loss: 0.9876 - val\_acc: 0.6370

Epoch 6/20

19/19 [=====] - 117s 6s/step - loss: 0.9418 - acc: 0.6455 - val\_loss: 0.9654 - val\_acc: 0.6233

Epoch 7/20

19/19 [=====] - 119s 6s/step - loss: 0.9369 - acc: 0.6488 - val\_loss: 0.9421 - val\_acc: 0.6438

Epoch 8/20

19/19 [=====] - 118s 6s/step - loss: 0.8712 - acc: 0.6639 - val\_loss: 0.9095 - val\_acc: 0.6712

Epoch 9/20

19/19 [=====] - 116s 6s/step - loss: 0.8176 - acc: 0.6940 - val\_loss: 0.9086 - val\_acc: 0.6644

Epoch 10/20

19/19 [=====] - 117s 6s/step - loss: 0.7550 - acc: 0.7040 - val\_loss: 0.8911 - val\_acc: 0.6575

Epoch 11/20

19/19 [=====] - 116s 6s/step - loss: 0.7902 - acc: 0.6940 - val\_loss: 0.9155 - val\_acc: 0.6575

Epoch 12/20

19/19 [=====] - 117s 6s/step - loss: 0.7204 - acc: 0.7441 - val\_loss: 0.8930 - val\_acc: 0.6712

Epoch 13/20

19/19 [=====] - 117s 6s/step - loss: 0.6730 - acc: 0.7542 - val\_loss: 0.8804 - val\_acc: 0.6849

Epoch 14/20

19/19 [=====] - 117s 6s/step - loss: 0.6687 - acc: 0.7525 - val\_loss: 0.8556 - val\_acc: 0.6849

Epoch 15/20

19/19 [=====] - 117s 6s/step - loss: 0.6341 - acc: 0.7843 - val\_loss: 0.8764 - val\_acc: 0.6438

Epoch 16/20

19/19 [=====] - 117s 6s/step - loss: 0.6199 - acc: 0.7809 - val\_loss: 0.8919 - val\_acc: 0.6507

Epoch 17/20

19/19 [=====] - 116s 6s/step - loss: 0.5860 - acc: 0.7993 - val\_loss: 0.9039 - val\_acc: 0.7055

Epoch 18/20

19/19 [=====] - 116s 6s/step - loss: 0.6014 - acc: 0.7826 - val\_loss: 0.8712 - val\_acc: 0.7123

Epoch 19/20

19/19 [=====] - 116s 6s/step - loss: 0.5645 - acc: 0.8060 - val\_loss: 0.9109 - val\_acc: 0.6712

Epoch 20/20

19/19 [=====] - 116s 6s/step - loss: 0.5864 - acc: 0.7993 - val\_loss: 0.8865 - val\_acc: 0.6644

loss: 0.8965 - val\_acc: 0.6644

In [ ]:

```
# Model evaluation and Final accuracy of the model from validation dataset.

final_loss, final_accuracy = model.evaluate(valid_generator, steps = val_steps_per_epoch)
print("Final loss: {:.2f}".format(final_loss))
print("Final accuracy: {:.2f}%".format(final_accuracy * 100))
```

5/5 [=====] - 25s 5s/step - loss: 0.8965 - acc: 0.6644  
Final loss: 0.90  
Final accuracy: 66.44%

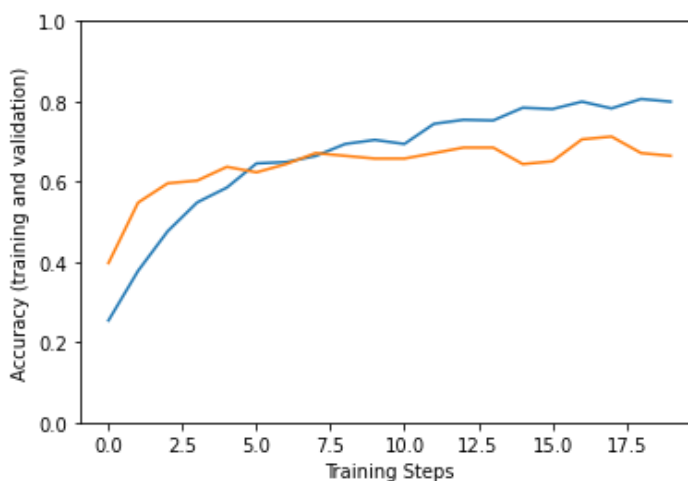
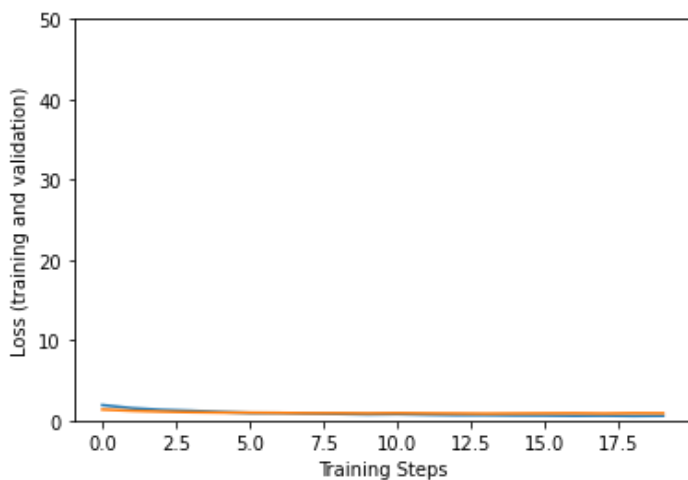
In [ ]:

```
# plotting accuracy (for validation and training), loss (for validation and training)

plt.figure()
plt.ylabel("Loss (training and validation)")
plt.xlabel("Training Steps")
plt.ylim([0, 50])
plt.plot(hist["loss"])
plt.plot(hist["val_loss"])
plt.figure()
plt.ylabel("Accuracy (training and validation)")
plt.xlabel("Training Steps")
plt.ylim([0, 1])
plt.plot(hist["acc"])
plt.plot(hist["val_acc"])
```

Out[ ]:

[<matplotlib.lines.Line2D at 0x7f10f6bce850>]



In [ ]:

```
# Save the model in the drive
```



```
VEHICLE_SAVED_MODEL = "/content/gdrive/MyDrive/Neuralnetworks /MiniPro/Dataset/models/saved_model"
model.save(VEHICLE_SAVED_MODEL)
```

```
INFO:tensorflow:Assets written to: /content/gdrive/MyDrive/Neuralnetworks /MiniPro/Dataset/models/saved_model/assets
```

```
INFO:tensorflow:Assets written to: /content/gdrive/MyDrive/Neuralnetworks /MiniPro/Dataset/models/saved_model/assets
```

```
In [ ]:
```

```
#Model Prededction from Val_batch
```

```
val_image_batch, val_label_batch = next(iter(valid_generator))
true_label_ids = np.argmax(val_label_batch, axis=-1)
print("Validation batch shape:", val_image_batch.shape)
```

```
Validation batch shape: (32, 224, 224, 3)
```

```
In [ ]:
```

```
predicted_ids = np.argmax(tf_model_predictions, axis=-1)
predicted_labels = dataset_labels[predicted_ids]
```

```
In [ ]:
```

```
tf_model_predictions = model.predict(val_image_batch)
print("Prediction results shape:", tf_model_predictions.shape)
plt.figure(figsize=(10,9))
plt.subplots_adjust(hspace=0.5)
for n in range((len(predicted_labels)-2)):
    plt.subplot(6,5,n+1)
    plt.imshow(val_image_batch[n])
    color = "green" if predicted_ids[n] == true_label_ids[n] else "red"
    plt.title(predicted_labels[n].title(), color=color)
    plt.axis('off')
_ = plt.suptitle("Model predictions (green: correct, red: incorrect)")
```

```
#Green colour shows correctly predicted images and the red colour shows mismatch from the dataset class directory.
```

```
Prediction results shape: (32, 6)
```

Model predictions (green: correct, red: incorrect)

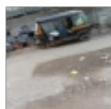
Tempo Traveller



Bus



Auto



Auto



Truck



Tempo Traveller



Auto



Truck



Tempo Traveller



Tempo Traveller



Bus



Truck



Truck



Tractor



Truck



Bus



Auto



Auto



Tempo Traveller



Tractor



Auto



Auto



Auto



Truck



Auto





## Reload and test the model

In [ ]:

```
# Load the saved model and test it with unseen data
load_save_model = tf.keras.models.load_model(VEHICLE_SAVED_MODEL)
load_save_model.summary()
```

Model: "sequential"

Layer (type)	Output Shape	Param #
keras_layer (KerasLayer)	(None, 1280)	2257984
dropout (Dropout)	(None, 1280)	0
dense (Dense)	(None, 6)	7686

```
=====
Total params: 2,265,670
Trainable params: 7,686
Non-trainable params: 2,257,984
=====
```

In [ ]:

```
# Accuracy on saved model

final_loss, final_accuracy = load_save_model.evaluate(valid_generator, steps = val_steps_
per_epoch)
print("Final loss: {:.2f}".format(final_loss))
print("Final accuracy: {:.2f}%".format(final_accuracy * 100))
```

```
5/5 [=====] - 25s 5s/step - loss: 0.8965 - acc: 0.6644
Final loss: 0.90
Final accuracy: 66.44%
```

In [ ]:

```
# Loading Image from the url

auto_url = "https://bizimages.withfloats.com/tile/5b61526a46c7460503709287.jpg"
auto_path = tf.keras.utils.get_file('Auto', origin=auto_url)

img = tf.keras.utils.load_img(
    auto_path, target_size=(224, 224)
)

img.show()

img_array = tf.keras.utils.img_to_array(img)
img_array = tf.expand_dims(img_array, 0) # Create a batch
```

In [ ]:

```
# making predictions

predictions = model.predict(img_array)
score = tf.nn.softmax(predictions[0])

print(
    "This image most likely belongs to {} with a {:.2f} percent confidence."
    .format(dataset_labels[np.argmax(score)], 100 * np.max(score))
)
```

```
)
```

This image most likely belongs to Truck with a 24.07 percent confidence.

```
In [ ]:
```

```
# Loading Image from the url
```

```
auto_url = "https://i.pinimg.com/564x/68/80/df/6880df8fae92d44bdf849b5eae41831e--modern-i  
ndia-hold-on.jpg"  
auto_path = tf.keras.utils.get_file('Auto', origin=auto_url)  
  
img = tf.keras.utils.load_img(  
    auto_path, target_size=(224, 224)  
)  
  
img_array = tf.keras.utils.img_to_array(img)  
img_array = tf.expand_dims(img_array, 0) # Create a batch
```

```
In [ ]:
```

```
# making predictions
```

```
predictions = model.predict(img_array)  
score = tf.nn.softmax(predictions[0])  
  
print(  
    "This image most likely belongs to {} with a {:.2f} percent confidence."  
    .format(dataset_labels[np.argmax(score)], 100 * np.max(score))  
)
```

This image most likely belongs to Truck with a 24.07 percent confidence.