FINAL PROJECT REPORT TEMPLATE

TITTLE :- SportSpecs: Unraveling Athletic Prowess With Advanced Transfer Learning For Sports.

1. INDRODUCTION :-

1.1. Project overview:

The SportSpecs project aims to leverage advanced transfer learning techniques to classify images of various sports activities. In the realm of sports analysis and digital transfoemations, accurate identification of sports activities from images is crucial. This project provides a solutions by developing a high-accuracy deep learning model capable of recognizing and categorizing sports activities such as cricket, wrestling, tennis etc.The final production is a web application developed using Flask, which allows for real-time image classification.

1.2. Obejectives

- Develop a deep learning model using transfer learning: This invovles fine-tuning pre-trained models to recognize specific sports activities.
- Train the modal on a diverse dataset: The dataset comprises images from seven sports classes, ensuring robust model training.
- Achieve real-time classifications: The model should be capable of making instant predictions.
- Deploy as web application: Using Flask, the model will be accessible for practical use.

2. Project Initialization and Planning Phase

2.1. Define Problem Statement

Sports activity classifications from images has wide applications, from enchancing sports analytics to improving user experiences in sports-related applications. However, this task poses challenges due to the variablitiy in images, such as different angles, backgrounds, and lighting conditions. The primary problem is to develop a model that can accurately classify these images despites such variations.

2.2. Project Proposal

To address this challenge, the project proposes using transfer learning, which utlizies pre-trained models on large datasets to adapt to specific tasks. Transfer learning is efficient as it reduces training time and enhances accuracy. The project will implement this technique to classify images into one of seven sports categories.

2.3. Initial Project Planing

- Timeline: Detailed scehdule outlining each phase of the project, from data collection to final deployment.

- Task Allocation: Distribution of responsibilities among team members.

- Milestones: Key deliverables such as the completion of data preprocessing, intial modal training, model tuning, and web application deployment.

3. Data Collection and Preprocessing Phase

3.1. Data Collection Plan and Raw Data resources Identified

The dataset includes labeled images from seven sports classes: cricket, wrestling, tennis, badminton etc. The images were sources from publicly available datasets and sports image repositories. The collection plan ensured a balanced numcer of imafesfor each class, providing a robust training set.

3.2. Data Quality Report

Data quality will be assessed by:

- Removing duplicates: Ensuring no repeated images to prevent bias.
- Handling missing values: Verifying and correcting any missing labels.
- Unifromly: Standardizing image formats and resolutions.

3.3. Data Preprocessing

- Resizing: All images resized to 224,224,3 pixels to match the input size of the chosen pre-trained model.
- Normalization: Pixel values scaled to the range [0,1]
- Data Augumentation: Technoques such as rotation, flipping, and scaling were applied to increase the dataset's variability and prevent overfitting.

4.Model Development Phase

4.1. Modal Selection Report

Several pe-trained models were considered, including VGG16, VGG19. Each model's performance is evaluated based on the accuracy training time, and computational efficiency. VGG16 was selected due to its superior performance in previous image classification tasks and its balance between accuracy and computational requirements.

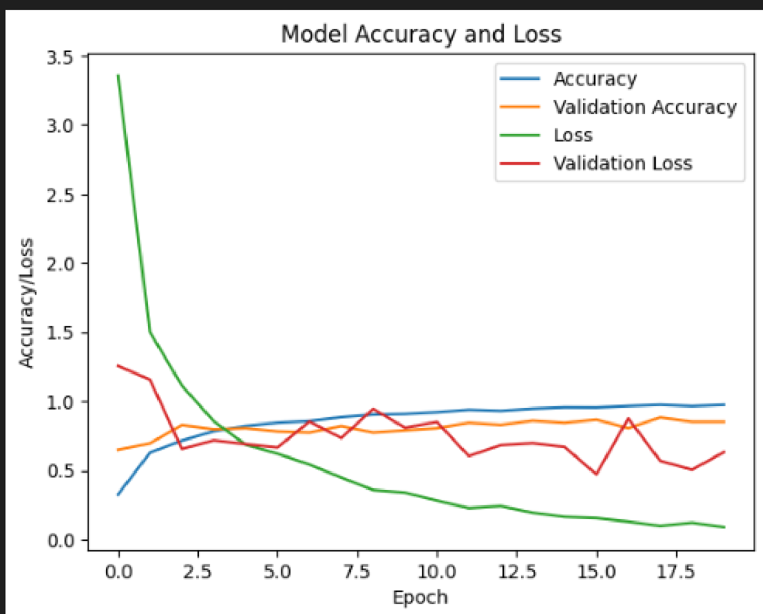
4.2. Initial Modal Training Code, Model Validation, and Evaluation Report

Model 1:- (VGG16)

```
import sys
r = vgg16.fit_generator(
    training_set,
    validation_data=test_set,
    epochs=20,
    steps_per_epoch=len(training_set)//3,
    validation_steps=len(test_set)//3
)
[20]
```

```
<ipython-input-20-66704c7fd1aa>:2: UserWarning: `Model.fit_generator` is deprecated and will be removed in a future version. Please use `Model.fit`, which supports generators.
  r = vgg16.fit_generator(
Epoch 1/20
70/70 [==============================] - 135s 1s/step - loss: 3.3539 - accuracy: 0.3250 - val_loss: 1.2559 - val_accuracy: 0.6484
Epoch 2/20
70/70 [==============================] - 95s 1s/step - loss: 1.5005 - accuracy: 0.6279 - val_loss: 1.1559 - val_accuracy: 0.6953
Epoch 3/20
70/70 [==============================] - 95s 1s/step - loss: 1.1133 - accuracy: 0.7152 - val_loss: 0.6544 - val_accuracy: 0.8281
Epoch 4/20
70/70 [==============================] - 128s 2s/step - loss: 0.8555 - accuracy: 0.7829 - val_loss: 0.7171 - val_accuracy: 0.7969
Epoch 5/20
70/70 [==============================] - 95s 1s/step - loss: 0.6860 - accuracy: 0.8203 - val_loss: 0.6902 - val_accuracy: 0.8047
Epoch 6/20
70/70 [==============================] - 95s 1s/step - loss: 0.6202 - accuracy: 0.8446 - val_loss: 0.6656 - val_accuracy: 0.7812
Epoch 7/20
70/70 [==============================] - 97s 1s/step - loss: 0.5421 - accuracy: 0.8569 - val_loss: 0.8528 - val_accuracy: 0.7734
Epoch 8/20
70/70 [==============================] - 95s 1s/step - loss: 0.4477 - accuracy: 0.8848 - val_loss: 0.7339 - val_accuracy: 0.8203
Epoch 9/20
70/70 [==============================] - 95s 1s/step - loss: 0.3577 - accuracy: 0.9038 - val_loss: 0.9447 - val_accuracy: 0.7734
Epoch 10/20
70/70 [==============================] - 95s 1s/step - loss: 0.3387 - accuracy: 0.9082 - val_loss: 0.8080 - val_accuracy: 0.7891
Epoch 11/20
70/70 [==============================] - 95s 1s/step - loss: 0.2807 - accuracy: 0.9205 - val_loss: 0.8500 - val_accuracy: 0.8047
Epoch 12/20
70/70 [==============================] - 95s 1s/step - loss: 0.2259 - accuracy: 0.9380 - val_loss: 0.6030 - val_accuracy: 0.8438
Epoch 13/20
...
Epoch 19/20
70/70 [==============================] - 96s 1s/step - loss: 0.1207 - accuracy: 0.9645 - val_loss: 0.5043 - val_accuracy: 0.8516
Epoch 20/20
70/70 [==============================] - 95s 1s/step - loss: 0.0888 - accuracy: 0.9738 - val_loss: 0.6316 - val_accuracy: 0.8516
```

```python
import matplotlib.pyplot as plt

# Plotting accuracy
plt.plot(r.history["accuracy"])
plt.plot(r.history['val_accuracy'])

# Plotting loss
plt.plot(r.history['loss'])
plt.plot(r.history['val_loss'])

# Adding title and labels
plt.title("Model Accuracy and Loss")
plt.ylabel("Accuracy/Loss")
plt.xlabel("Epoch")

# Adding legend
plt.legend(["Accuracy", "Validation Accuracy", "Loss", "Validation Loss"])

# Displaying plot
plt.show()
```




```python
vgg16.save("project1.h5")
```

[23]

Python

```
/usr/local/lib/python3.10/dist-packages/keras/src/engine/training.py:3103: UserWarning: You are saving your model as an HDF5 file via `model.save()`. This file format is considered leg
  saving_api.save_model(
```

```python
#import load_model class for loading h5 file
from tensorflow.keras.models import load_model
#import image class to process the images
from tensorflow.keras.preprocessing import image
from tensorflow.keras.applications.inception_v3 import preprocess_input
import numpy as np
```

[25]

```python
#load saved vgg 16 model file
model=load_model("project1.h5")
```

[26]

```python
# test accuracy
print('Test Score',model.evaluate(test_set))
```

[27]

```
8/8 [==============================] - 26s 2s/step - loss: 0.6175 - accuracy: 0.8500
Test Score [0.6175491809844971, 0.8500000238418579]
```

```python
# train accuracy
print('Train Score',model.evaluate(training_set))
```

[28]

```
211/211 [==============================] - 199s 941ms/step - loss: 0.0676 - accuracy: 0.9819
Train Score [0.06758040934801102, 0.9819152355194092]
```

```python
img=image.load_img("/content/test/sky surfing/4.jpg", target_size=(224,224))
#convert image to array format
x=image.img_to_array(img)
import numpy as np
x=np.expand_dims(x,axis=0)
img_data=preprocess_input(x)
output=np.argmax(model.predict(img_data), axis=1)
index=['air hockey', 'ampute football', 'archery', 'arm wrestling', 'axe throwing',
    'balance beam', 'barell racing', 'baseball', 'basketball', 'baton twirling',
    'bike polo', 'billiards', 'bmx', 'bobsled', 'bowling', 'boxing', 'bull riding',
    'bungee jumping', 'canoe slamon', 'cheerleading', 'chuckwagon racing', 'cricket',
    'croquet', 'curling', 'disc golf', 'fencing', 'field hockey', 'figure skating men',
    'figure skating pairs', 'figure skating women', 'fly fishing', 'football',
    'formula 1 racing', 'frisbee', 'gaga', 'giant slalom', 'golf', 'hammer throw',
    'hang gliding', 'harness racing', 'high jump', 'hockey', 'horse jumping',
    'horse racing', 'horseshoe pitching', 'hurdles', 'hydroplane racing', 'ice climbing',
    'ice yachting', 'jai alai', 'javelin', 'jousting', 'judo', 'lacrosse', 'log rolling',
    'luge', 'motorcycle racing', 'mushing', 'nascar racing', 'olympic wrestling',
    'parallel bar', 'pole climbing', 'pole dancing', 'pole vault', 'polo', 'pommel horse',
    'rings', 'rock climbing', 'roller derby', 'rollerblade racing', 'rowing', 'rugby',
    'sailboat racing', 'shot put', 'shuffleboard', 'sidecar racing', 'ski jumping',
    'sky surfing', 'skydiving', 'snow boarding', 'snowmobile racing', 'speed skating',
    'steer wrestling', 'sumo wrestling', 'surfing', 'swimming', 'table tennis', 'tennis',
    'track bicycle', 'trapeze', 'tug of war', 'ultimate', 'uneven bars', 'volleyball',
    'water cycling', 'water polo', 'weightlifting', 'wheelchair basketball',
    'wheelchair racing', 'wingsuit flying']
result = str(index[output[0]])
result
```

[39]

```
1/1 [==============================] - 0s 19ms/step
'sky surfing'
```

Model 2:- (VGG19)

```
import sys
r = vgg19.fit_generator(
    training_set,
    validation_data=test_set,
    epochs=20,
    steps_per_epoch=len(training_set)//3,
    validation_steps=len(test_set)//3
)
```

[23]

```
<ipython-input-23-a33db2704ae1>:2: UserWarning: `Model.fit_generator` is deprecated and will be removed in a future version. Please use `Model.fit`, which supports generators.
  r = vgg19.fit_generator(
Epoch 1/20
70/70 [==============================] - 136s 1s/step - loss: 3.8137 - accuracy: 0.2828 - val_loss: 1.7766 - val_accuracy: 0.5859
Epoch 2/20
70/70 [==============================] - 98s 1s/step - loss: 1.7551 - accuracy: 0.5824 - val_loss: 1.2456 - val_accuracy: 0.6562
Epoch 3/20
70/70 [==============================] - 130s 2s/step - loss: 1.2835 - accuracy: 0.6791 - val_loss: 1.2765 - val_accuracy: 0.6719
Epoch 4/20
70/70 [==============================] - 98s 1s/step - loss: 0.9734 - accuracy: 0.7484 - val_loss: 1.1409 - val_accuracy: 0.6719
Epoch 5/20
70/70 [==============================] - 98s 1s/step - loss: 0.7942 - accuracy: 0.7980 - val_loss: 0.7637 - val_accuracy: 0.7500
Epoch 6/20
70/70 [==============================] - 98s 1s/step - loss: 0.6965 - accuracy: 0.8125 - val_loss: 0.9722 - val_accuracy: 0.7344
Epoch 7/20
70/70 [==============================] - 97s 1s/step - loss: 0.6761 - accuracy: 0.8254 - val_loss: 0.9852 - val_accuracy: 0.7500
Epoch 8/20
70/70 [==============================] - 98s 1s/step - loss: 0.5491 - accuracy: 0.8556 - val_loss: 0.8887 - val_accuracy: 0.7656
Epoch 9/20
70/70 [==============================] - 97s 1s/step - loss: 0.5386 - accuracy: 0.8550 - val_loss: 0.7471 - val_accuracy: 0.8203
Epoch 10/20
70/70 [==============================] - 98s 1s/step - loss: 0.4497 - accuracy: 0.8767 - val_loss: 0.6678 - val_accuracy: 0.7969
Epoch 11/20
70/70 [==============================] - 98s 1s/step - loss: 0.3739 - accuracy: 0.8913 - val_loss: 1.0400 - val_accuracy: 0.7812
Epoch 12/20
70/70 [==============================] - 98s 1s/step - loss: 0.3241 - accuracy: 0.9096 - val_loss: 0.4723 - val_accuracy: 0.9062
Epoch 13/20
...
Epoch 19/20
70/70 [==============================] - 98s 1s/step - loss: 0.1747 - accuracy: 0.9496 - val_loss: 0.7033 - val_accuracy: 0.8047
Epoch 20/20
70/70 [==============================] - 98s 1s/step - loss: 0.1597 - accuracy: 0.9569 - val_loss: 0.8032 - val_accuracy: 0.7500
```

```
vgg19.save("project_vgg19.h5")
```

[25] Python

```
/usr/local/lib/python3.10/dist-packages/keras/src/engine/training.py:3103: UserWarning: You are saving your model as an HDF5 file via `model.save()`. This file format is considered leg
  saving_api.save_model(
```

```python
import matplotlib.pyplot as plt

# Plotting accuracy
plt.plot(r.history["accuracy"])
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# Plotting loss
plt.plot(r.history['loss'])
plt.plot(r.history['val_loss'])

# Adding title and labels
plt.title("Model Accuracy and Loss")
plt.ylabel("Accuracy/Loss")
plt.xlabel("Epoch")

# Adding legend
plt.legend(["Accuracy", "Validation Accuracy", "Loss", "Validation Loss"])

# Displaying plot
plt.show()
```
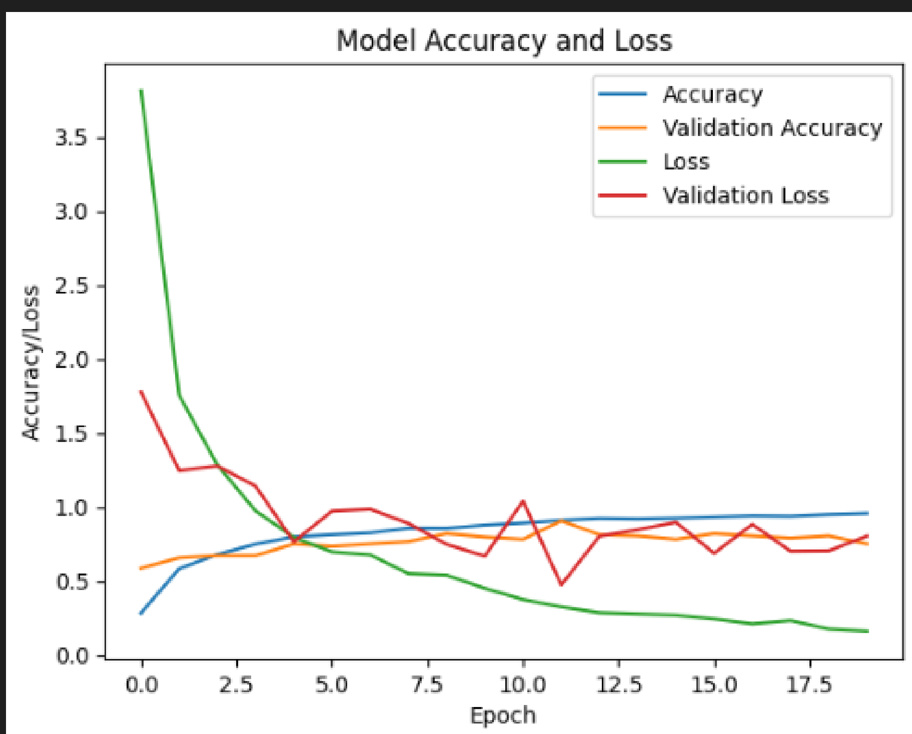

[24]



5. Model Optimization and Tuning Phase

5.1. Tuning Documentation

For VGG16:-

Learning Rate: 0.0001, Batch_Size: 64, target_size: (224, 224);Epochs: 20, Optimizer: Adam (Learning rate affects how quickly the model adapts to the problem. Batch size determines the number of samples processed before the model is updated. Epochs define the number of complete passes through the training dataset. Adam optimizer is used for its efficiency and low memory requirements.)

```
from tensorflow.keras.layers import Dense, Flatten, Input
from tensorflow.keras.models import Model
from tensorflow.keras.preprocessing import image
from tensorflow.keras.preprocessing.image import ImageDataGenerator, load_img
from tensorflow.keras.applications.vgg16 import VGG16, preprocess_input
from glob import glob
import numpy as np
import matplotlib.pyplot as plt
```
[8]

```
#import image datagenerator library
from tensorflow.keras.preprocessing.image import ImageDataGenerator
```
[9]

```python
train_datagen = ImageDataGenerator(
    rescale=1./255,
    shear_range=0.2,
    zoom_range=[0.99, 1.01],
    brightness_range=[0.8, 1.2],
    horizontal_flip=True,
    data_format="channels_last",
    fill_mode='nearest'
)

test_datagen = ImageDataGenerator(rescale=1./255)
```
[10]

```python
training_set = train_datagen.flow_from_directory(
    '/content/train',
    target_size=(224, 224),
    batch_size=64,
    class_mode='categorical'
)

test_set = test_datagen.flow_from_directory(
    '/content/test',
    target_size=(224, 224),
    batch_size=64,
    class_mode='categorical'
)
```
[11]

```
Found 13492 images belonging to 100 classes.
Found 500 images belonging to 100 classes.
```

VGG16

```python
from tensorflow.keras.applications.vgg16 import VGG16
from tensorflow.keras.layers import Dense,Flatten
from tensorflow.keras.models import Model
```
[12]

```python
vgg = VGG16(weights='imagenet', include_top=False, input_shape=(224, 224, 3))
```
[13]

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/vgg16/vgg16_weights_tf_dim_ordering_tf_kernels_notop.h5
58889256/58889256 [==============================] - 0s 0us/step
```

```python
vgg.summary()
```
[14]

```
Model: "vgg16"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 224, 224, 3)]     0

 block1_conv1 (Conv2D)       (None, 224, 224, 64)      1792

 block1_conv2 (Conv2D)       (None, 224, 224, 64)      36928

 block1_pool (MaxPooling2D)  (None, 112, 112, 64)      0

 block2_conv1 (Conv2D)       (None, 112, 112, 128)     73856

 block2_conv2 (Conv2D)       (None, 112, 112, 128)     147584

 block2_pool (MaxPooling2D)  (None, 56, 56, 128)       0

 block3_conv1 (Conv2D)       (None, 56, 56, 256)       295168

 block3_conv2 (Conv2D)       (None, 56, 56, 256)       590080

 block3_conv3 (Conv2D)       (None, 56, 56, 256)       590080

 block3_pool (MaxPooling2D)  (None, 28, 28, 256)       0
...
Total params: 14714688 (56.13 MB)
Trainable params: 14714688 (56.13 MB)
Non-trainable params: 0 (0.00 Byte)
```

```
for layer in vgg.layers:
    print(layer)
```

[15]

```
<keras.src.engine.input_layer.InputLayer object at 0x7c1f7599f280>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f759e32e0>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f759e3a60>
<keras.src.layers.pooling.max_pooling2d.MaxPooling2D object at 0x7c1f759e1240>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f759e3b80>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f759e0df0>
<keras.src.layers.pooling.max_pooling2d.MaxPooling2D object at 0x7c1f759f4250>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f759f5c30>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f759f6470>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f759f7010>
<keras.src.layers.pooling.max_pooling2d.MaxPooling2D object at 0x7c1f746a41f0>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f759f5810>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f746a4c40>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f746a53c0>
<keras.src.layers.pooling.max_pooling2d.MaxPooling2D object at 0x7c1f746a6c50>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f746a74c0>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f746a6a70>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f746a7fa0>
<keras.src.layers.pooling.max_pooling2d.MaxPooling2D object at 0x7c1f746bd090>
```

```
for layer in vgg.layers:
    layer.trainable = False
```

[16]

```
x = Flatten()(vgg.output)
output = Dense(100,activation='softmax')(x)
vgg16 = Model(vgg.input,output)
```

[17]

```
[18]
vgg16.summary()
```

```
Model: "model"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 224, 224, 3)]     0

 block1_conv1 (Conv2D)       (None, 224, 224, 64)      1792

 block1_conv2 (Conv2D)       (None, 224, 224, 64)      36928

 block1_pool (MaxPooling2D)  (None, 112, 112, 64)      0

 block2_conv1 (Conv2D)       (None, 112, 112, 128)     73856

 block2_conv2 (Conv2D)       (None, 112, 112, 128)     147584

 block2_pool (MaxPooling2D)  (None, 56, 56, 128)       0

 block3_conv1 (Conv2D)       (None, 56, 56, 256)       295168

 block3_conv2 (Conv2D)       (None, 56, 56, 256)       590080

 block3_conv3 (Conv2D)       (None, 56, 56, 256)       590080

 block3_pool (MaxPooling2D)  (None, 28, 28, 256)       0
...
Total params: 17223588 (65.70 MB)
Trainable params: 2508900 (9.57 MB)
Non-trainable params: 14714688 (56.13 MB)
_________________________________________________________________
```

Output is truncated. View as a scrollable element or open in a text editor. Adjust cell output settings...

```
[19]
vgg16.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['accuracy'],run_eagerly=True)
```

```
[20]
import sys
r = vgg16.fit_generator(
    training_set,
    validation_data=test_set,
    epochs=20,
    steps_per_epoch=len(training_set)//3,
    validation_steps=len(test_set)//3
)
```

```
<ipython-input-20-66704c7fd1aa>:2: UserWarning: `Model.fit_generator` is deprecated and will be removed in a future version. Please use `Model.fit`, which supports generators.
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70/70 [==============================] - 95s 1s/step - loss: 0.6860 - accuracy: 0.8203 - val_loss: 0.6902 - val_accuracy: 0.8047
Epoch 6/20
70/70 [==============================] - 95s 1s/step - loss: 0.6202 - accuracy: 0.8446 - val_loss: 0.6656 - val_accuracy: 0.7812
Epoch 7/20
70/70 [==============================] - 97s 1s/step - loss: 0.5421 - accuracy: 0.8569 - val_loss: 0.8528 - val_accuracy: 0.7734
Epoch 8/20
70/70 [==============================] - 95s 1s/step - loss: 0.4477 - accuracy: 0.8848 - val_loss: 0.7339 - val_accuracy: 0.8203
Epoch 9/20
70/70 [==============================] - 95s 1s/step - loss: 0.3577 - accuracy: 0.9038 - val_loss: 0.9447 - val_accuracy: 0.7734
Epoch 10/20
70/70 [==============================] - 95s 1s/step - loss: 0.3387 - accuracy: 0.9082 - val_loss: 0.8080 - val_accuracy: 0.7891
Epoch 11/20
70/70 [==============================] - 95s 1s/step - loss: 0.2807 - accuracy: 0.9205 - val_loss: 0.8500 - val_accuracy: 0.8047
Epoch 12/20
70/70 [==============================] - 95s 1s/step - loss: 0.2259 - accuracy: 0.9380 - val_loss: 0.6030 - val_accuracy: 0.8438
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...
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Epoch 20/20
70/70 [==============================] - 95s 1s/step - loss: 0.0888 - accuracy: 0.9738 - val_loss: 0.6316 - val_accuracy: 0.8516
```

Output is truncated. View as a scrollable element or open in a text editor. Adjust cell output settings...

```python
import matplotlib.pyplot as plt

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plt.plot(r.history["accuracy"])
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# Plotting loss
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# Adding title and labels
plt.title("Model Accuracy and Loss")
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# Adding legend
plt.legend(["Accuracy", "Validation Accuracy", "Loss", "Validation Loss"])

# Displaying plot
plt.show()
```
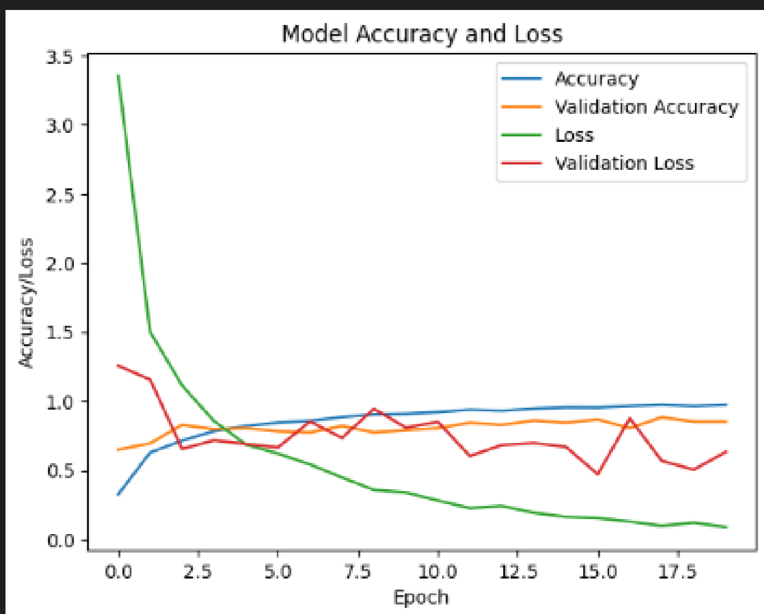

[22]




```python
vgg16.save("project1.h5")
```

[23]

```
/usr/local/lib/python3.10/dist-packages/keras/src/engine/training.py:3103: UserWarning: You are saving your model
  saving_api.save_model(
```

5.2. Final Modal Selection Justification

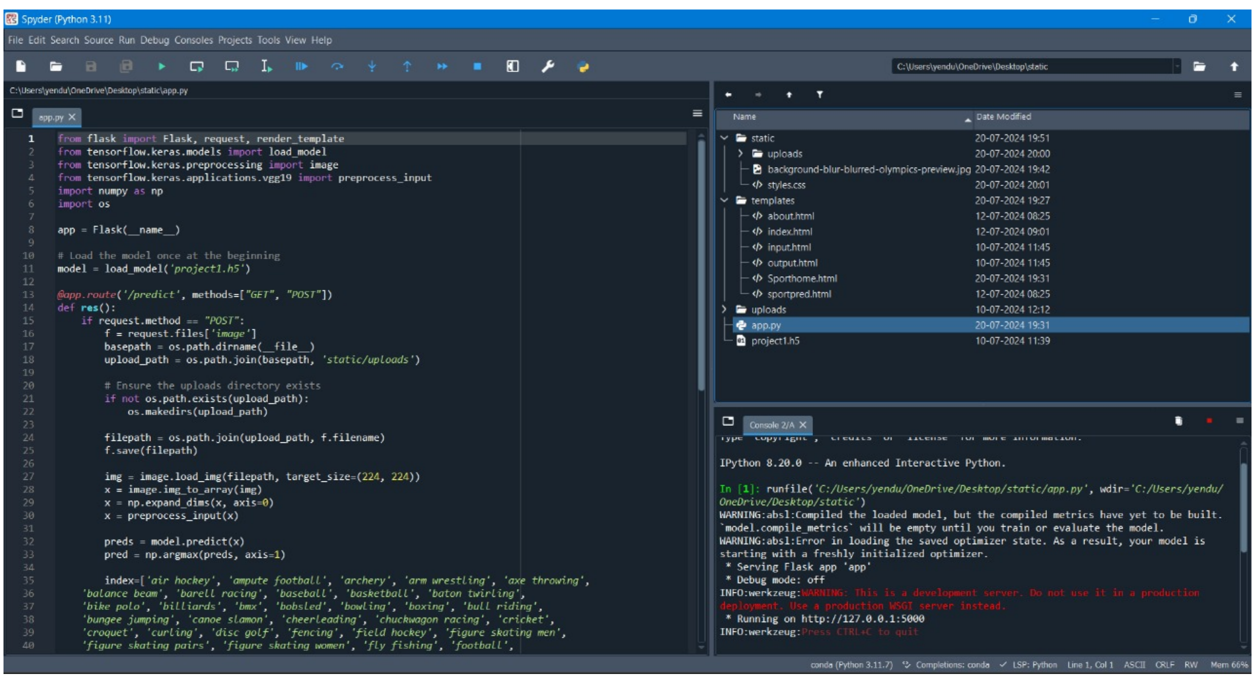
The final modal is VGG16 it is demonstrated significant improvements in performance metrics after tuning. The chosen hyperparameters were:

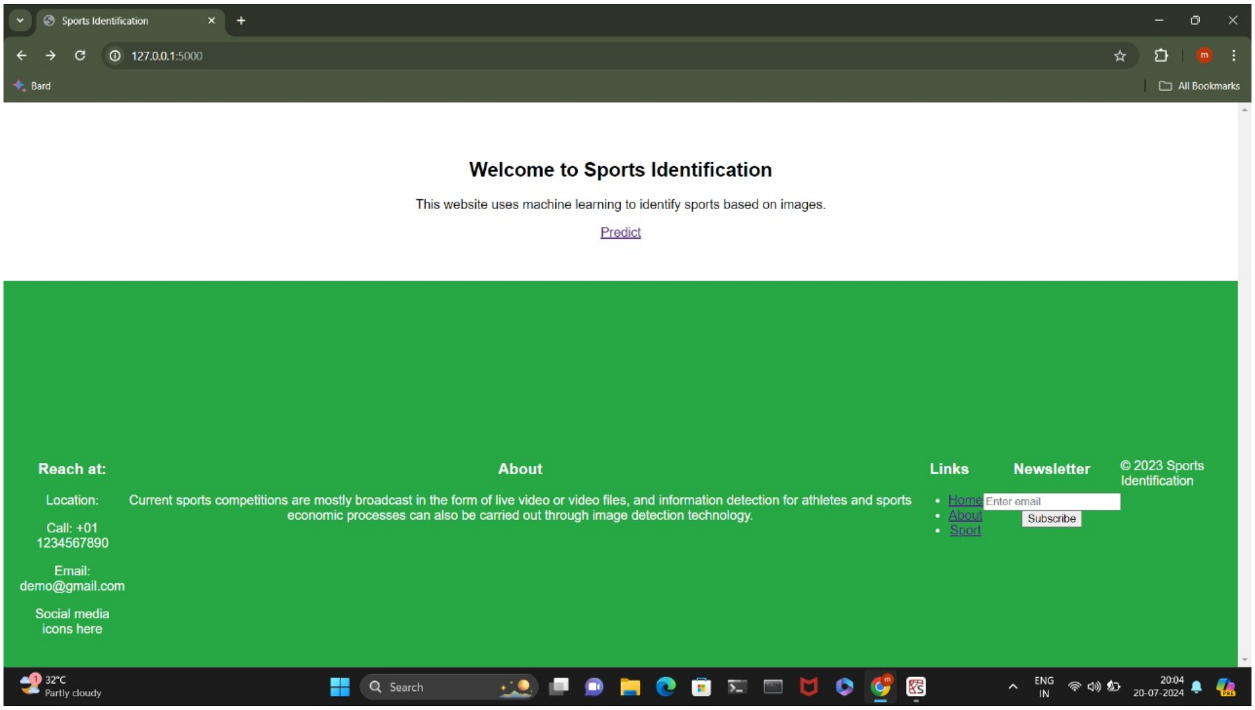
- Learning Rate: 0.0001
- Batch Size: 64
- Additional Dense Layer: Added for better feature extraction

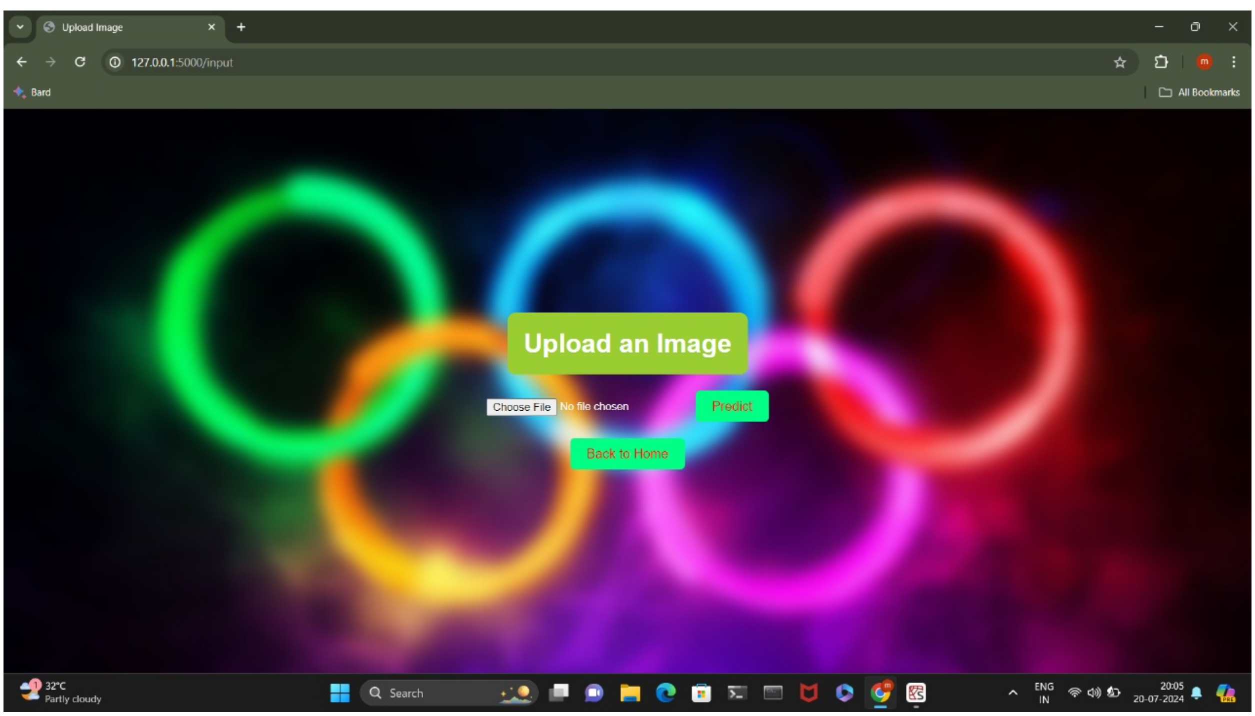
The final model showed improved accuracy and reduced overfitting compard to teh initial model.

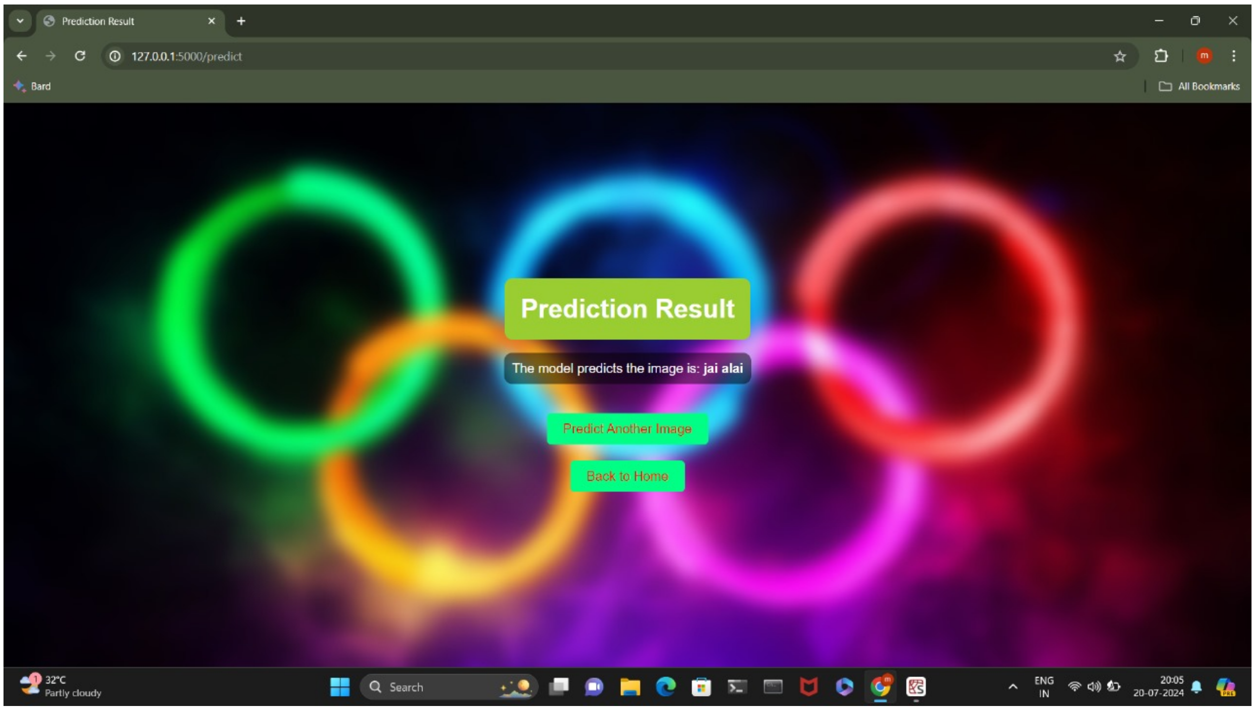
6. Results :-

6.1. Output Screenshots




Sports Identification
127.0.0.1:5000
Welcome to Sports Identification
This website uses machine learning to identify sports based on images.
Predict
Reach at:
Location:
Call: +01 1234567890
Email: demo@gmail.com
Social media icons here
About
Current sports competitions are mostly broadcast in the form of live video or video files, and information detection for athletes and sports economic processes can also be carried out through image detection technology.
Links
Home
About
Sport
Newsletter
Enter email
Subscribe
© 2023 Sports Identification


Upload Image
127.0.0.1:5000/input
Upload an Image
Choose File
No file chosen
Predict
Back to Home



7. Advantages & Disadvantages :-

Advantages :--

- High Accuracy: Leveraging transfer learning significantly improved the model's accuracy
- Efficiency: Reduced training time compared to training from scratch.

- Real-Time Classification: The modal provides instant predicitons, suitable for real-time applications.

- Scalability: The Flask web application can be easily scaled to handle more users.

Disadvantages :--

- Depending on data Quality: The model's performance is highly dependent on the quality of the dataset

- Computationally intensive: Requries significant computational resources during training.

8. Conclusion

The SportSpecs project successfully developed a high-accuracy deep learning sports activity classification. The model, integrated into a flask web application, met all the project objectives, providing real-time classification with high accuracy. This project demonstration the effectiveness of transfer learning in practical applications and paves the way for future enhancements.

9. Future Scope

potential improvements and extensions of the project include :-

- Dataset Expansion**:** Including more sports classes to enhance the model's versatility.
- Enhanced User Interface: Improving the web application's UI for better user experience.
- Video Classification: Extending the model to classify sports activities in videos, providing more dynamic analysis.
- Mobile Application: Developing a mobile version of the application for wider accessibility.

10. Appendix

10.1 Source codes :-

For model Building and Data Prepocessing :--

```
from tensorflow.keras.layers import Dense, Flatten, Input
from tensorflow.keras.models import Model
from tensorflow.keras.preprocessing import image
from tensorflow.keras.preprocessing.image import ImageDataGenerator, load_img
from tensorflow.keras.applications.vgg16 import VGG16, preprocess_input
from glob import glob
import numpy as np
import matplotlib.pyplot as plt
```
[8]

```
#import image datagenerator library
from tensorflow.keras.preprocessing.image import ImageDataGenerator
```
[9]

```
train_datagen = ImageDataGenerator(
    rescale=1./255,
    shear_range=0.2,
    zoom_range=[0.99, 1.01],
    brightness_range=[0.8, 1.2],
    horizontal_flip=True,
    data_format="channels_last",
    fill_mode='nearest'
)

test_datagen = ImageDataGenerator(rescale=1./255)
```
[10]

```
training_set = train_datagen.flow_from_directory(
    '/content/train',
    target_size=(224, 224),
    batch_size=64,
    class_mode='categorical'
)

test_set = test_datagen.flow_from_directory(
    '/content/test',
    target_size=(224, 224),
    batch_size=64,
    class_mode='categorical'
)
```
[11]

```
Found 13492 images belonging to 100 classes.
Found 500 images belonging to 100 classes.
```

VGG16

```
from tensorflow.keras.applications.vgg16 import VGG16
from tensorflow.keras.layers import Dense,Flatten
from tensorflow.keras.models import Model
```

[12]

```
vgg = VGG16(weights='imagenet', include_top=False, input_shape=(224, 224, 3))
```

[13]

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/vgg16/vgg16_weights_tf_dim_ordering_tf_kernels_notop.h5
58889256/58889256 [==============================] - 0s 0us/step
```

```
vgg.summary()
```

[14]

```
Model: "vgg16"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 224, 224, 3)]     0

 block1_conv1 (Conv2D)       (None, 224, 224, 64)      1792

 block1_conv2 (Conv2D)       (None, 224, 224, 64)      36928

 block1_pool (MaxPooling2D)  (None, 112, 112, 64)      0

 block2_conv1 (Conv2D)       (None, 112, 112, 128)     73856

 block2_conv2 (Conv2D)       (None, 112, 112, 128)     147584

 block2_pool (MaxPooling2D)  (None, 56, 56, 128)       0

 block3_conv1 (Conv2D)       (None, 56, 56, 256)       295168

 block3_conv2 (Conv2D)       (None, 56, 56, 256)       590080

 block3_conv3 (Conv2D)       (None, 56, 56, 256)       590080

 block3_pool (MaxPooling2D)  (None, 28, 28, 256)       0
...
Total params: 14714688 (56.13 MB)
Trainable params: 14714688 (56.13 MB)
Non-trainable params: 0 (0.00 Byte)
```

```
for layer in vgg.layers:
    print(layer)
```

[15]

```
<keras.src.engine.input_layer.InputLayer object at 0x7c1f7599f280>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f759e32e0>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f759e3a60>
<keras.src.layers.pooling.max_pooling2d.MaxPooling2D object at 0x7c1f759e1240>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f759e3b80>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f759e0df0>
<keras.src.layers.pooling.max_pooling2d.MaxPooling2D object at 0x7c1f759f4250>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f759f5c30>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f759f6470>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f759f7010>
<keras.src.layers.pooling.max_pooling2d.MaxPooling2D object at 0x7c1f746a41f0>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f759f5810>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f746a4c40>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f746a53c0>
<keras.src.layers.pooling.max_pooling2d.MaxPooling2D object at 0x7c1f746a6c50>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f746a74c0>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f746a6a70>
<keras.src.layers.convolutional.conv2d.Conv2D object at 0x7c1f746a7fa0>
<keras.src.layers.pooling.max_pooling2d.MaxPooling2D object at 0x7c1f746bd090>
```

```
for layer in vgg.layers:
    layer.trainable = False
```

[16]

```
x = Flatten()(vgg.output)
output = Dense(100,activation='softmax')(x)
vgg16 = Model(vgg.input,output)
```

[17]

```
vgg16.summary()
```

[18]

```
Model: "model"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 224, 224, 3)]     0

 block1_conv1 (Conv2D)       (None, 224, 224, 64)      1792

 block1_conv2 (Conv2D)       (None, 224, 224, 64)      36928

 block1_pool (MaxPooling2D)  (None, 112, 112, 64)      0

 block2_conv1 (Conv2D)       (None, 112, 112, 128)     73856

 block2_conv2 (Conv2D)       (None, 112, 112, 128)     147584

 block2_pool (MaxPooling2D)  (None, 56, 56, 128)       0

 block3_conv1 (Conv2D)       (None, 56, 56, 256)       295168

 block3_conv2 (Conv2D)       (None, 56, 56, 256)       590080

 block3_conv3 (Conv2D)       (None, 56, 56, 256)       590080

 block3_pool (MaxPooling2D)  (None, 28, 28, 256)       0
...
Total params: 17223588 (65.70 MB)
Trainable params: 2508900 (9.57 MB)
Non-trainable params: 14714688 (56.13 MB)
_________________________________________________________________
```

Output is truncated. View as a scrollable element or open in a text editor. Adjust cell output settings...

```
vgg16.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['accuracy'],run_eagerly=True)
```

[19]

For model training :--

```
import sys
r = vgg16.fit_generator(
    training_set,
    validation_data=test_set,
    epochs=20,
    steps_per_epoch=len(training_set)//3,
    validation_steps=len(test_set)//3
)
```

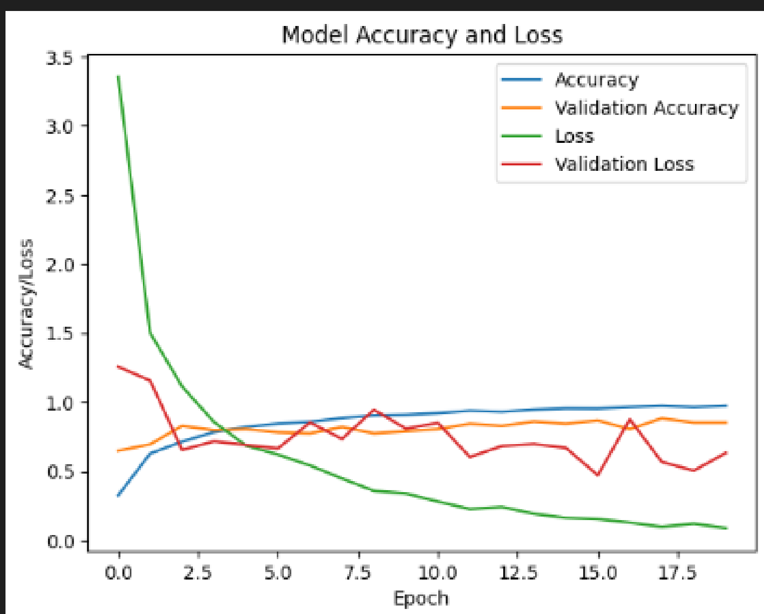
[20]

```
<ipython-input-20-66704c7fd1aa>:2: UserWarning: `Model.fit_generator` is deprecated and will be removed in a future version. Please use `Model.fit`, which supports generators.
  r = vgg16.fit_generator(
Epoch 1/20
70/70 [==============================] - 135s 1s/step - loss: 3.3539 - accuracy: 0.3250 - val_loss: 1.2559 - val_accuracy: 0.6484
Epoch 2/20
70/70 [==============================] - 95s 1s/step - loss: 1.5005 - accuracy: 0.6279 - val_loss: 1.1559 - val_accuracy: 0.6953
Epoch 3/20
70/70 [==============================] - 95s 1s/step - loss: 1.1133 - accuracy: 0.7152 - val_loss: 0.6544 - val_accuracy: 0.8281
Epoch 4/20
70/70 [==============================] - 128s 2s/step - loss: 0.8555 - accuracy: 0.7829 - val_loss: 0.7171 - val_accuracy: 0.7969
Epoch 5/20
70/70 [==============================] - 95s 1s/step - loss: 0.6860 - accuracy: 0.8203 - val_loss: 0.6902 - val_accuracy: 0.8047
Epoch 6/20
70/70 [==============================] - 95s 1s/step - loss: 0.6202 - accuracy: 0.8446 - val_loss: 0.6656 - val_accuracy: 0.7812
Epoch 7/20
70/70 [==============================] - 97s 1s/step - loss: 0.5421 - accuracy: 0.8569 - val_loss: 0.8528 - val_accuracy: 0.7734
Epoch 8/20
70/70 [==============================] - 95s 1s/step - loss: 0.4477 - accuracy: 0.8848 - val_loss: 0.7339 - val_accuracy: 0.8203
Epoch 9/20
70/70 [==============================] - 95s 1s/step - loss: 0.3577 - accuracy: 0.9038 - val_loss: 0.9447 - val_accuracy: 0.7734
Epoch 10/20
70/70 [==============================] - 95s 1s/step - loss: 0.3387 - accuracy: 0.9082 - val_loss: 0.8080 - val_accuracy: 0.7891
Epoch 11/20
70/70 [==============================] - 95s 1s/step - loss: 0.2807 - accuracy: 0.9205 - val_loss: 0.8500 - val_accuracy: 0.8047
Epoch 12/20
70/70 [==============================] - 95s 1s/step - loss: 0.2259 - accuracy: 0.9380 - val_loss: 0.6030 - val_accuracy: 0.8438
Epoch 13/20
...
Epoch 19/20
70/70 [==============================] - 96s 1s/step - loss: 0.1207 - accuracy: 0.9645 - val_loss: 0.5043 - val_accuracy: 0.8516
Epoch 20/20
70/70 [==============================] - 95s 1s/step - loss: 0.0888 - accuracy: 0.9738 - val_loss: 0.6316 - val_accuracy: 0.8516
```

Output is truncated. View as a scrollable element or open in a text editor. Adjust cell output settings...

```
import matplotlib.pyplot as plt

# Plotting accuracy
plt.plot(r.history["accuracy"])
plt.plot(r.history['val_accuracy'])

# Plotting loss
plt.plot(r.history['loss'])
plt.plot(r.history['val_loss'])

# Adding title and labels
plt.title("Model Accuracy and Loss")
plt.ylabel("Accuracy/Loss")
plt.xlabel("Epoch")

# Adding legend
plt.legend(["Accuracy", "Validation Accuracy", "Loss", "Validation Loss"])

# Displaying plot
plt.show()
```

[22]

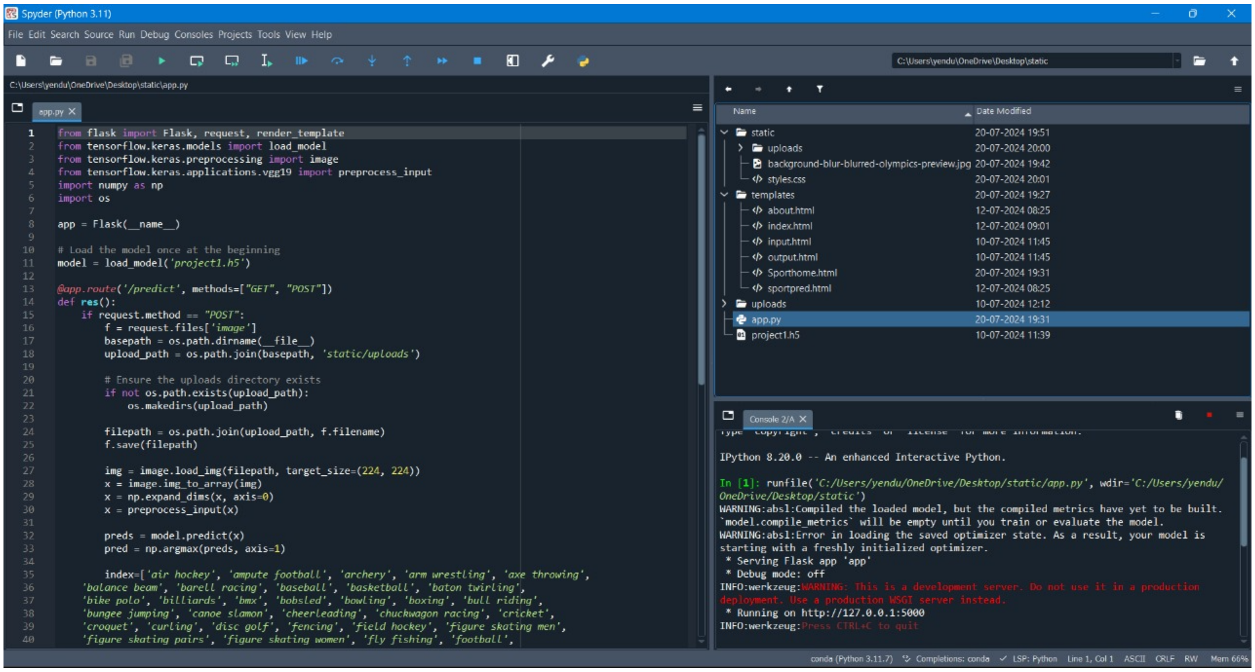



```
vgg16.save("project1.h5")
```

[23]

```
/usr/local/lib/python3.10/dist-packages/keras/src/engine/training.py:3103: UserWarning: You are saving your model a
  saving_api.save_model(
```

For Flask Implementation :-



10.2 Github & Project Demo Link

1.Github Link :- https://github.com/Yashwanth-Yenduri/SportSpecs-Unraveling-Athletic-Prowess-With-Advanced-Transfer-Learning-For-Sports.git

2.Project Demo Link's :-

Youtube Video Link :- https://youtu.be/Kari-AGtbQI
Google Drive Link :- https://drive.google.com/file/d/1Iuz7pMtbYiLYAyyB2teJhHK2oc0t3c5Z/view?usp=drive_link