```
!pip install tensorflow
!pip install matplotlib
!pip install ipywidgets
```

```
Requirement already satisfied: decorator in /usr/local/lib/python3.10/dist-packages (from ipython>=4.0.0->ipywidgets) (4.4.2)
Requirement already satisfied: pickleshare in /usr/local/lib/python3.10/dist-packages (from ipython>=4.0.0->ipywidgets) (0.7.5)
Requirement already satisfied: prompt-toolkit!=3.0.0,!=3.0.1,<3.1.0,>=2.0.0 in /usr/local/lib/python3.10/dist-packages (from ipython>=4.0.0->ipywidgets) (3.0.43)
Requirement already satisfied: pygments in /usr/local/lib/python3.10/dist-packages (from ipython>=4.0.0->ipywidgets) (2.16.1)
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Requirement already satisfied: matplotlib-inline in /usr/local/lib/python3.10/dist-packages (from ipython>=4.0.0->ipywidgets) (0.1.6)
Requirement already satisfied: pexpect>4.3 in /usr/local/lib/python3.10/dist-packages (from ipython>=4.0.0->ipywidgets) (4.9.0)
Requirement already satisfied: notebook>=4.4.1 in /usr/local/lib/python3.10/dist-packages (from widgetsnbextension~=3.6.0->ipywidgets) (6.5.5)
Requirement already satisfied: parso<0.9.0,>=0.8.3 in /usr/local/lib/python3.10/dist-packages (from jedi>=0.16->ipython>=4.0.0->ipywidgets) (0.8.3)
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Requirement already satisfied: pyzmq<25,>=17 in /usr/local/lib/python3.10/dist-packages (from notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets) (23.2.1)
Requirement already satisfied: argon2-cffi in /usr/local/lib/python3.10/dist-packages (from notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets) (23.1.0)
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Requirement already satisfied: platformdirs>=2.5 in /usr/local/lib/python3.10/dist-packages (from jupyter-core>=4.6.1->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets) (4.1.0)
Requirement already satisfied: jupyter-server>=1.8 in /usr/local/lib/python3.10/dist-packages (from nbclassic>=0.4.7->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets) (1.24.0)
Requirement already satisfied: notebook-shim>=0.2.3 in /usr/local/lib/python3.10/dist-packages (from nbclassic>=0.4.7->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets) (0.2.3)
Requirement already satisfied: lxml in /usr/local/lib/python3.10/dist-packages (from nbconvert>=5->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets) (4.9.4)
Requirement already satisfied: beautifulsoup4 in /usr/local/lib/python3.10/dist-packages (from nbconvert>=5->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets) (4.11.2)
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Requirement already satisfied: nbclient>=0.5.0 in /usr/local/lib/python3.10/dist-packages (from nbconvert>=5->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets) (0.9.0)
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Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-packages (from python-dateutil>=2.1->jupyter-client->ipykernel>=4.5.1->ipywidgets) (1.16.0)
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Requirement already satisfied: websocket-client in /usr/local/lib/python3.10/dist-packages (from jupyter-server>=1.8->nbclassic>=0.4.7->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipy
Requirement already satisfied: cffi>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from argon2-cffi-bindings->argon2-cffi->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets)
Requirement already satisfied: soupsieve>1.2 in /usr/local/lib/python3.10/dist-packages (from beautifulsoup4->nbconvert>=5->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets) (2.
Requirement already satisfied: webencodings in /usr/local/lib/python3.10/dist-packages (from bleach->nbconvert>=5->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets) (0.5.1)
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Requirement already satisfied: sniffio>=1.1 in /usr/local/lib/python3.10/dist-packages (from anyio<4,>=3.1.0->jupyter-server>=1.8->nbclassic>=0.4.7->notebook>=4.4.1->widgetsnbextensio
Requirement already satisfied: exceptiongroup in /usr/local/lib/python3.10/dist-packages (from anyio<4,>=3.1.0->jupyter-server>=1.8->nbclassic>=0.4.7->notebook>=4.4.1->widgetsnbextens
Requirement already satisfied: pycparser in /usr/local/lib/python3.10/dist-packages (from cffi>=1.0.1->argon2-cffi-bindings->argon2-cffi->notebook>=4.4.1->widgetsnbextension~=3.6.0->i
Installing collected packages: jedi
Successfully installed jedi-0.19.1
```

```python
# Import necessary libraries
from tensorflow.keras.applications.vgg16 import VGG16, preprocess_input, decode_predictions
from tensorflow.keras.preprocessing.image import load_img, img_to_array
from IPython.display import display
import numpy as np
import matplotlib.pyplot as plt
from PIL import Image, ImageFilter
import io
import ipywidgets as widgets
```

```python
widgets.__version__
```

```
'7.7.1'
```

Introduction

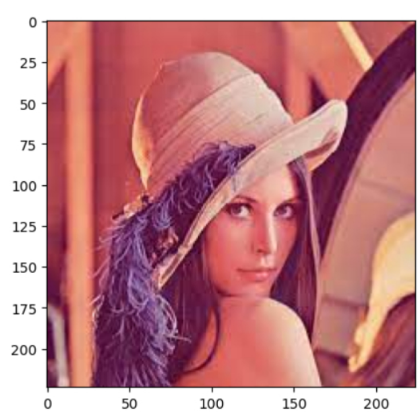
This lab is designed to introduce you to the basics of deep learning by interacting with a pre-built model. You'll understand the workflow of a deep learning project, including data preprocessing, model architecture, and making predictions. The goal is to familiarize yourself with the basics of deep learning without writing any code.

```python
# Load the VGG16 model
model = VGG16(weights='imagenet')

# Display the model architecture
model.summary()
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/vgg16/vgg16_weights_tf_dim_ordering_tf_kernels.h5
553467096/553467096 [==============================] - 8s 0us/step
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

 block4_conv1 (Conv2D)       (None, 28, 28, 512)       1180160

 block4_conv2 (Conv2D)       (None, 28, 28, 512)       2359808

 block4_conv3 (Conv2D)       (None, 28, 28, 512)       2359808

 block4_pool (MaxPooling2D)  (None, 14, 14, 512)       0

 block5_conv1 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_conv2 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_conv3 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_pool (MaxPooling2D)  (None, 7, 7, 512)         0

 flatten (Flatten)           (None, 25088)             0

 fc1 (Dense)                 (None, 4096)              102764544

 fc2 (Dense)                 (None, 4096)              16781312

 predictions (Dense)         (None, 1000)              4097000

=================================================================
Total params: 138357544 (527.79 MB)
Trainable params: 138357544 (527.79 MB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

```python
# Load and preprocess an image
def load_and_preprocess_image(image_path):
    # Load the image
    img = load_img(image_path, target_size=(224, 224))

    # Convert the image to a numpy array
    img_array = img_to_array(img)

    # Expand dimensions to fit the model input
    img_array = np.expand_dims(img_array, axis=0)

    # Preprocess the image
    img_array = preprocess_input(img_array)

    return img, img_array

# Load and preprocess a sample image
sample_image, processed_image = load_and_preprocess_image('/Lenna_picture.jpg')

# Display the sample image
plt.imshow(sample_image)
plt.show()
```



[ ]

```python
# Make predictions
predictions = model.predict(processed_image)

# Decode and print the predictions
decoded_predictions = decode_predictions(predictions, top=3)[0]
print(decoded_predictions)
```

```
1/1 [==============================] - 1s 1s/step
Downloading data from https://storage.googleapis.com/download.tensorflow.org/data/imagenet_class_index.json
35363/35363 [==============================] - 0s 0us/step
[('n02869837', 'bonnet', 0.35051045), ('n02892767', 'brassiere', 0.15976363), ('n04259630', 'sombrero', 0.07934212)]
```

```python
# Upload button to load images
upload = widgets.FileUpload()
display(upload)

# Button to make predictions
predict_button = widgets.Button(description="Make Prediction")
display(predict_button)

print(upload.value)

# Function to handle button click
def on_click(change):
    img_data = list(upload.value.values())[0]['content']
    img = Image.open(io.BytesIO(img_data))
    img = img.resize((224, 224))

    # Preprocess and predict
    img_array = img_to_array(img)
    img_array = np.expand_dims(img_array, axis=0)
    img_array = preprocess_input(img_array)
    predictions = model.predict(img_array)
    decoded_predictions = decode_predictions(predictions, top=3)[0]

    # Display predictions
    print(decoded_predictions)

predict_button.on_click(on_click)
```

Upload (1)

Make Prediction

```
{}
1/1 [==============================] - 1s 961ms/step
[('n02892767', 'brassiere', 0.24625528), ('n02869837', 'bonnet', 0.24349034), ('n03450230', 'gown', 0.05935052)]
```

Conclusion and Discussion

Reflect on the lab activities. Discuss how the pre-trained model was able to make predictions, the role of data preprocessing, and the impact of input modifications on the model's predictions.

This lab utilizes a pre-trained VGG16 Deep Learning model that has been trained on the ImageNet dataset. The first steps were installing the necessary libraries and importing the modules to be used from them. After this, the VGG16 model is loaded and the image data is preprocessed. The preprocessing step normalizes the image data so that it is compatible with the VGG16 model and the predictions made on it by the model will be more accurate if it more closely resembles the training data. This step can also include code to display the image to show that it is being loaded correctly. The model itself appears to be constructed from a series of convolutional and pooling layers with densly connected layers nearing the output. Convolutional neural networks such as this are commonly used for computer vision tasks due to their ability to use simple feature recognition to learn more complex features that can define various objects found in images. ImageNet, the dataset that this model was trained on, uses 224 X 224 sized images and I found that making the input image a different size than this negatively affected the predictions of the model. Additionally, using different images led to varying levels of prediction accuracy by the model.