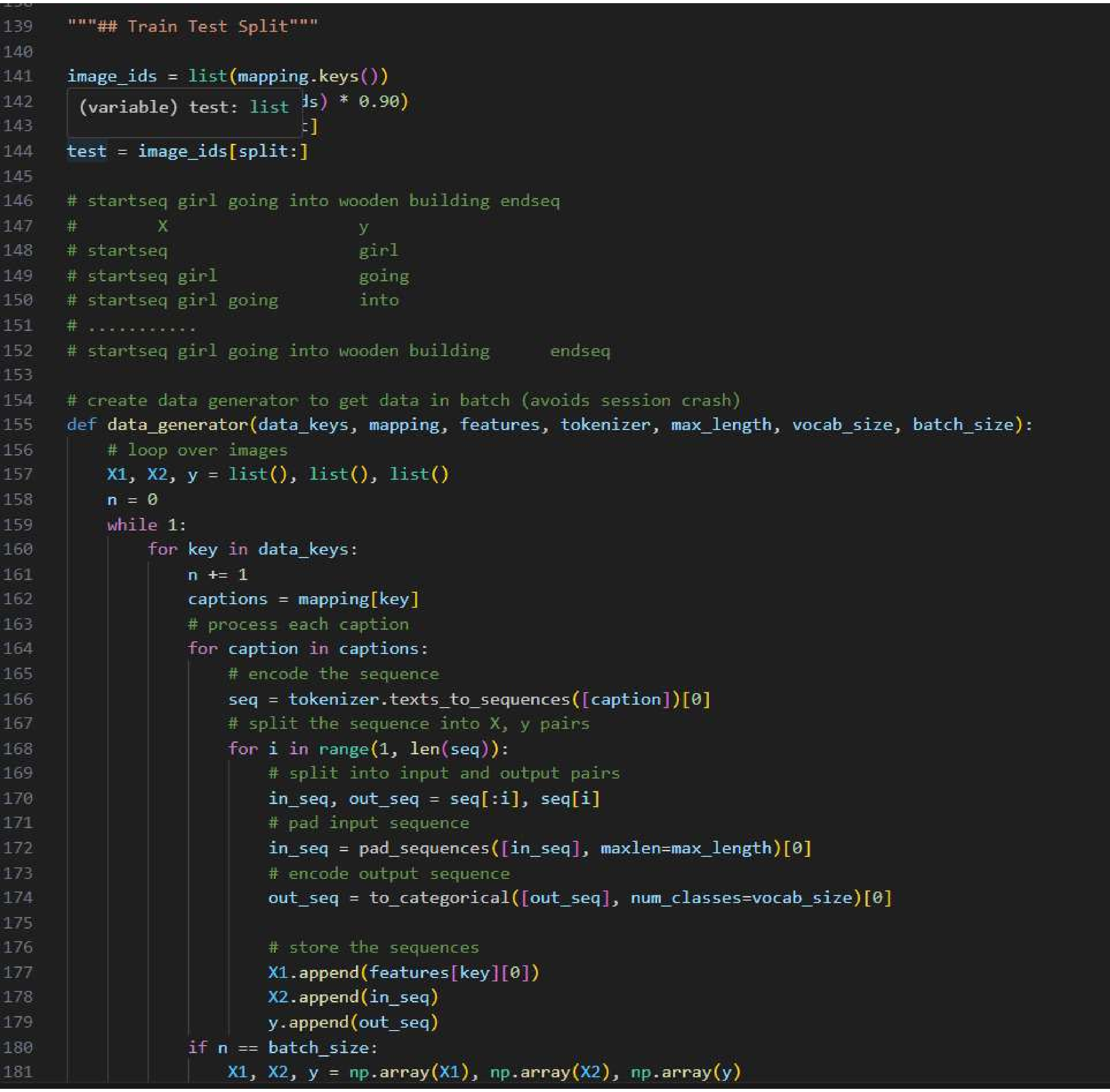
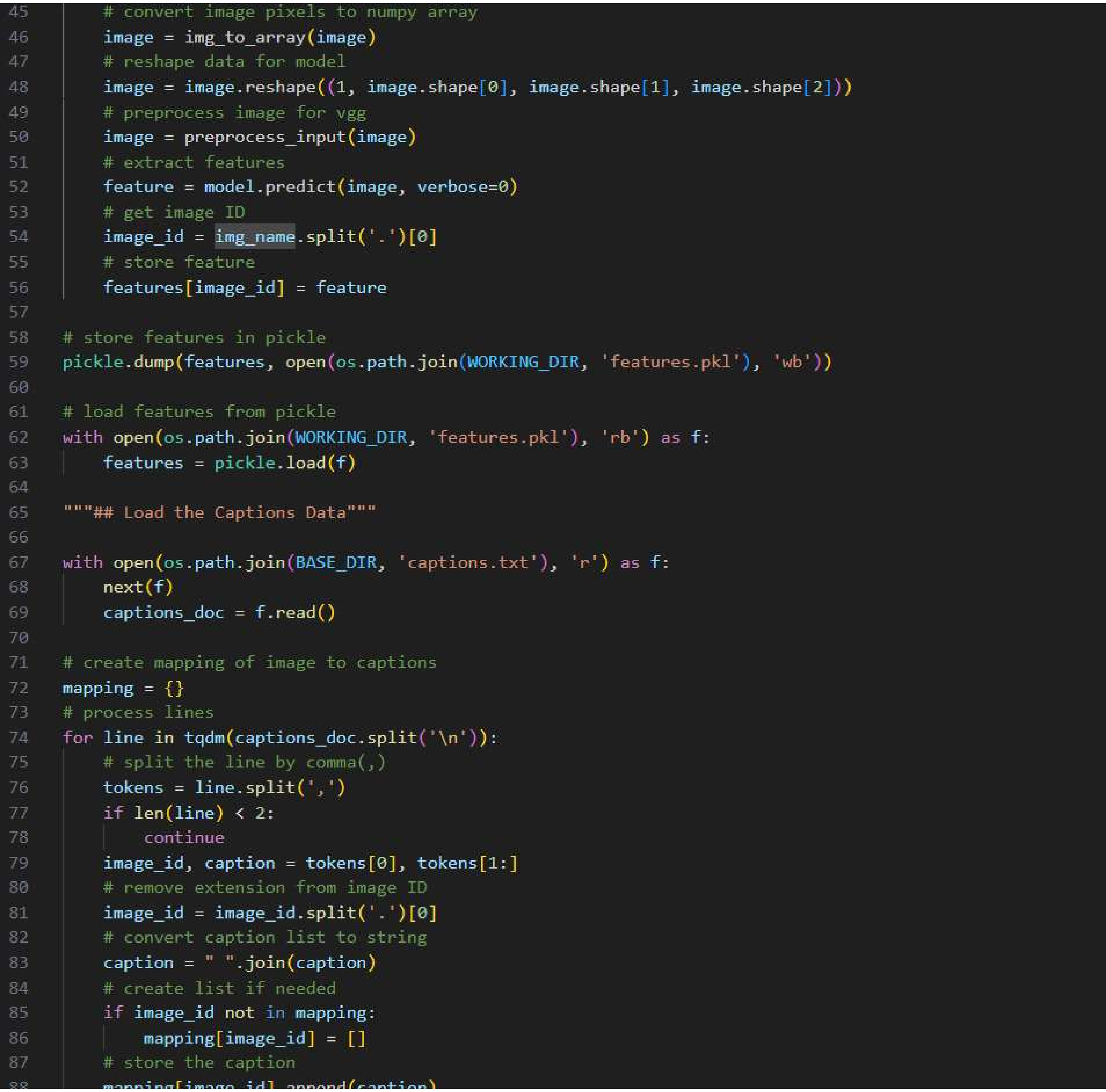
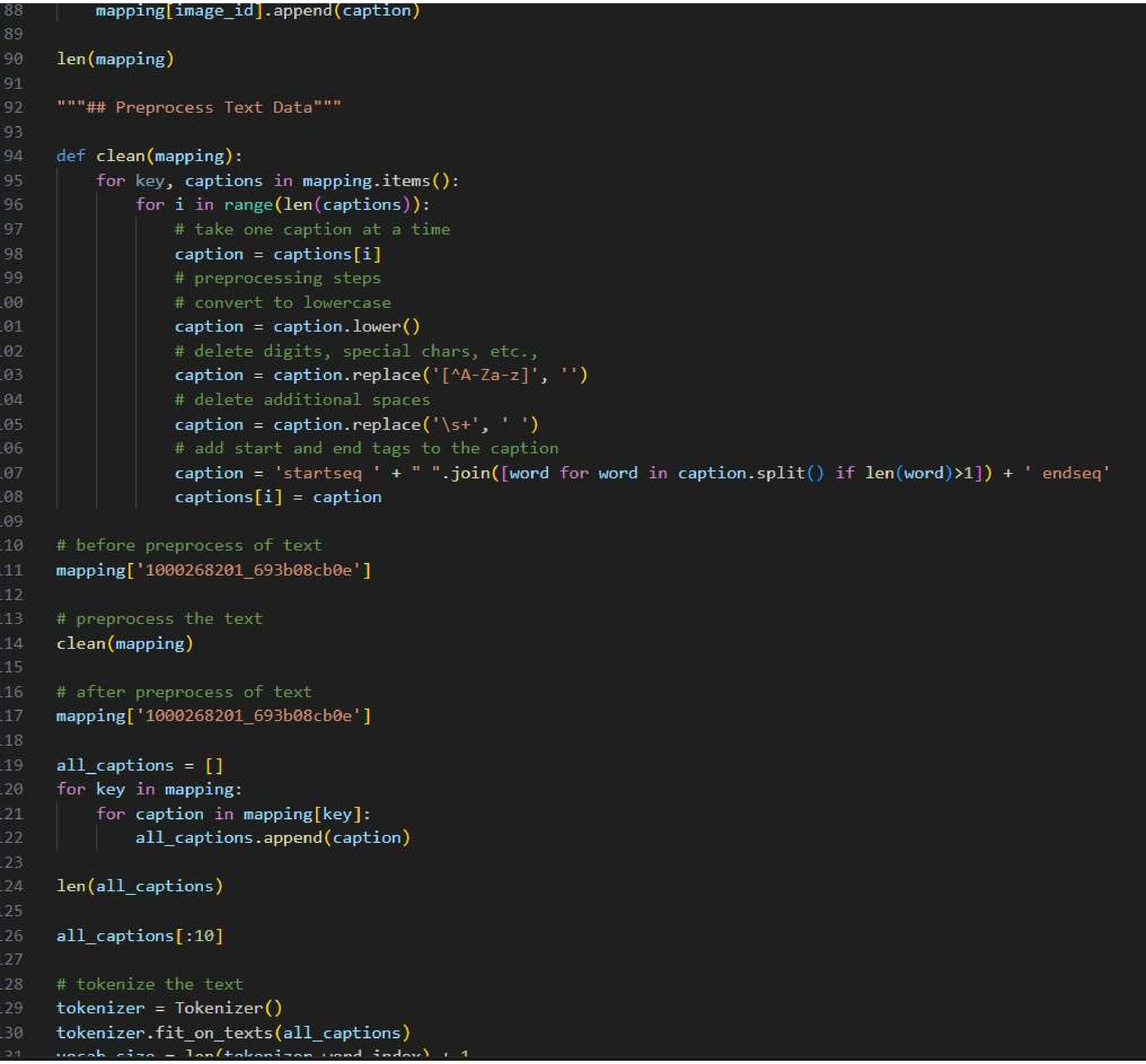


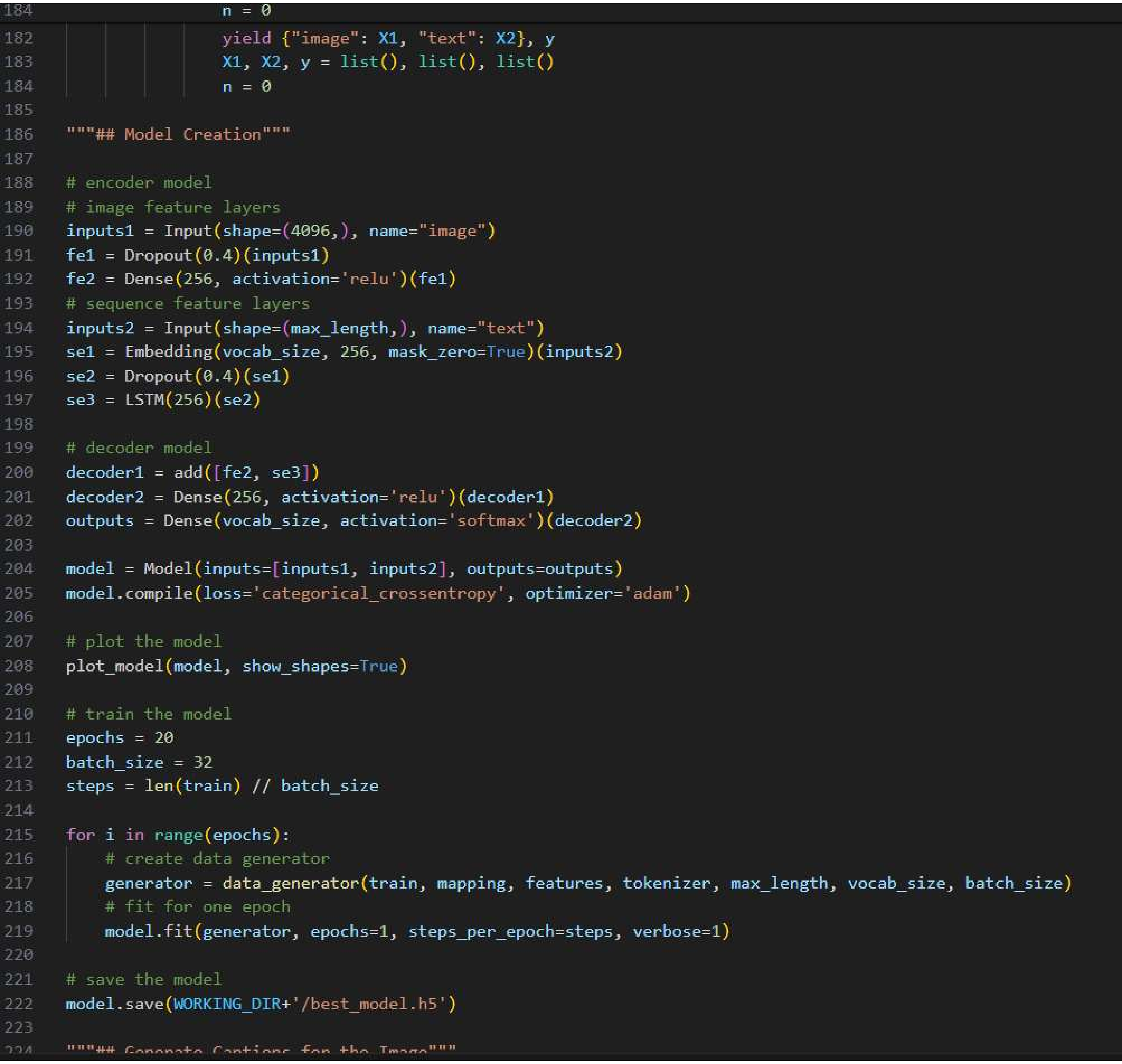
```
"""## Train Test Split"""

image_ids = list(mapping.keys())
                       ds) * 0.90)
                       :]
test = image_ids[split:]

# startseq girl going into wooden building endseq
#        X                   y
# startseq                   girl
# startseq girl              going
# startseq girl going        into
# ...........
# startseq girl going into wooden building       endseq

# create data generator to get data in batch (avoids session crash)
def data_generator(data_keys, mapping, features, tokenizer, max_length, vocab_size, batch_size):
    # loop over images
    X1, X2, y = list(), list(), list()
    n = 0
    while 1:
        for key in data_keys:
            n += 1
            captions = mapping[key]
            # process each caption
            for caption in captions:
                # encode the sequence
                seq = tokenizer.texts_to_sequences([caption])[0]
                # split the sequence into X, y pairs
                for i in range(1, len(seq)):
                    # split into input and output pairs
                    in_seq, out_seq = seq[:i], seq[i]
                    # pad input sequence
                    in_seq = pad_sequences([in_seq], maxlen=max_length)[0]
                    # encode output sequence
                    out_seq = to_categorical([out_seq], num_classes=vocab_size)[0]

                    # store the sequences
                    X1.append(features[key][0])
                    X2.append(in_seq)
                    y.append(out_seq)
            if n == batch_size:
                X1, X2, y = np.array(X1), np.array(X2), np.array(y)
```



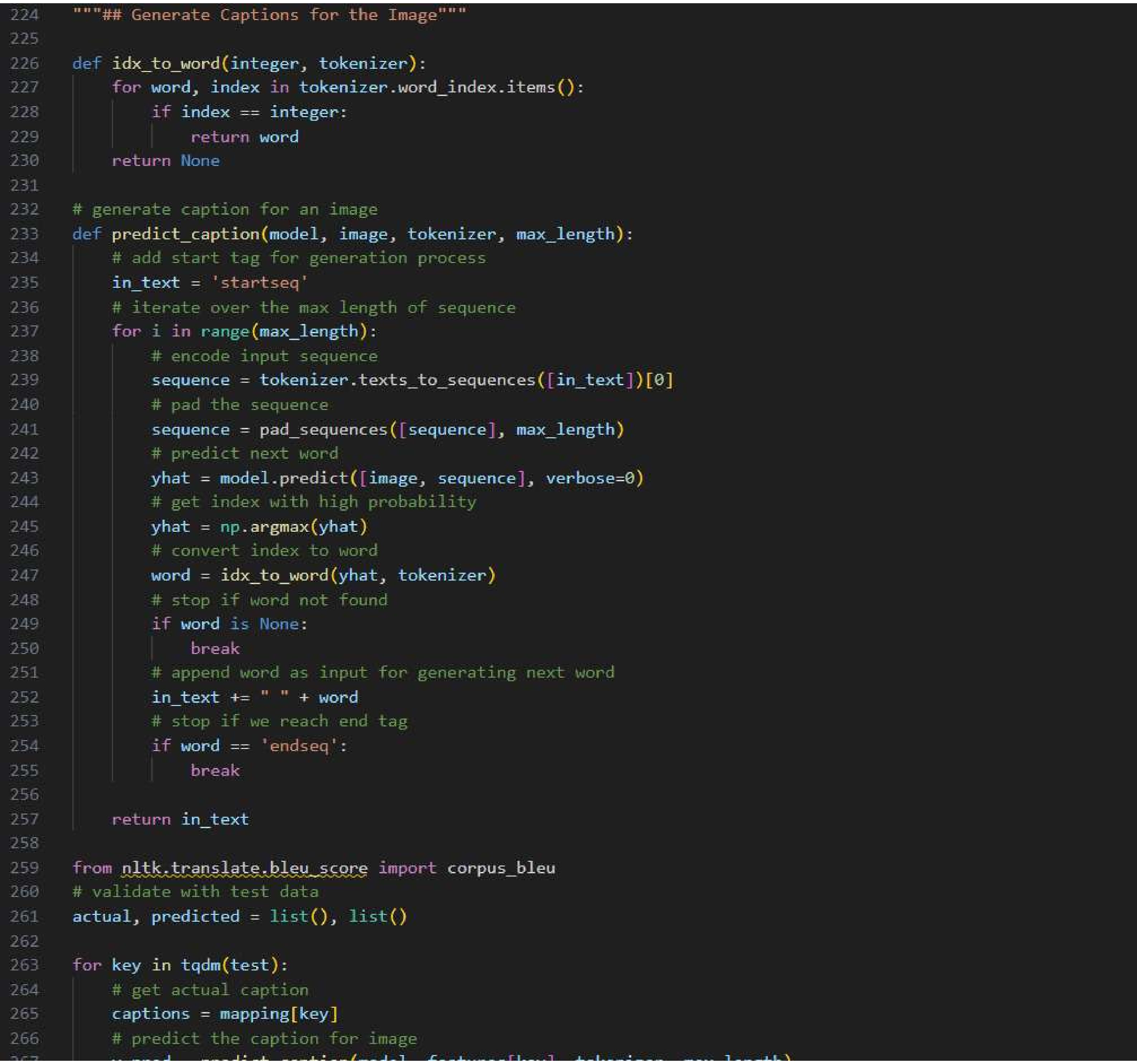
```
    # convert image pixels to numpy array
    image = img_to_array(image)
    # reshape data for model
    image = image.reshape((1, image.shape[0], image.shape[1], image.shape[2]))
    # preprocess image for vgg
    image = preprocess_input(image)
    # extract features
    feature = model.predict(image, verbose=0)
    # get image ID
    image_id = img_name.split('.')[0]
    # store feature
    features[image_id] = feature

# store features in pickle
pickle.dump(features, open(os.path.join(WORKING_DIR, 'features.pkl'), 'wb'))

# load features from pickle
with open(os.path.join(WORKING_DIR, 'features.pkl'), 'rb') as f:
    features = pickle.load(f)

"""## Load the Captions Data"""

with open(os.path.join(BASE_DIR, 'captions.txt'), 'r') as f:
    next(f)
    captions_doc = f.read()

# create mapping of image to captions
mapping = {}
# process lines
for line in tqdm(captions_doc.split('\n')):
    # split the line by comma(,)
    tokens = line.split(',')
    if len(line) < 2:
        continue
    image_id, caption = tokens[0], tokens[1:]
    # remove extension from image ID
    image_id = image_id.split('.')[0]
    # convert caption list to string
    caption = " ".join(caption)
    # create list if needed
    if image_id not in mapping:
        mapping[image_id] = []
    # store the caption
    mapping[image_id].append(caption)
```



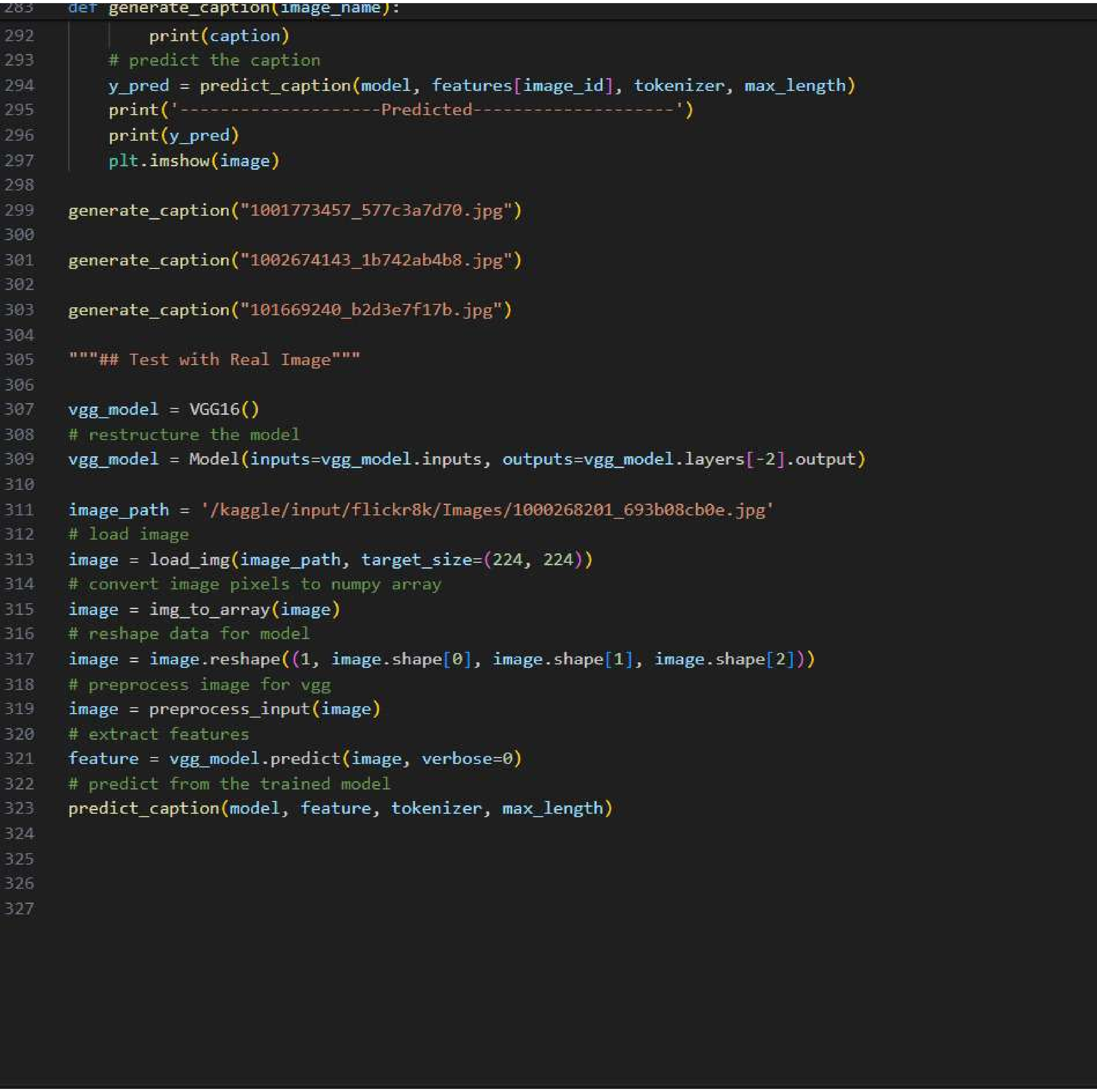
```
    mapping[image_id].append(caption)

len(mapping)

"""## Preprocess Text Data"""

def clean(mapping):
    for key, captions in mapping.items():
        for i in range(len(captions)):
            # take one caption at a time
            caption = captions[i]
            # preprocessing steps
            # convert to lowercase
            caption = caption.lower()
            # delete digits, special chars, etc.,
            caption = caption.replace('[^A-Za-z]', '')
            # delete additional spaces
            caption = caption.replace('\s+', ' ')
            # add start and end tags to the caption
            caption = 'startseq ' + " ".join([word for word in caption.split() if len(word)>1]) + ' endseq'
            captions[i] = caption

# before preprocess of text
mapping['1000268201_693b08cb0e']

# preprocess the text
clean(mapping)

# after preprocess of text
mapping['1000268201_693b08cb0e']

all_captions = []
for key in mapping:
    for caption in mapping[key]:
        all_captions.append(caption)

len(all_captions)

all_captions[:10]

# tokenize the text
tokenizer = Tokenizer()
tokenizer.fit_on_texts(all_captions)
vocab_size = len(tokenizer.word_index) + 1
```



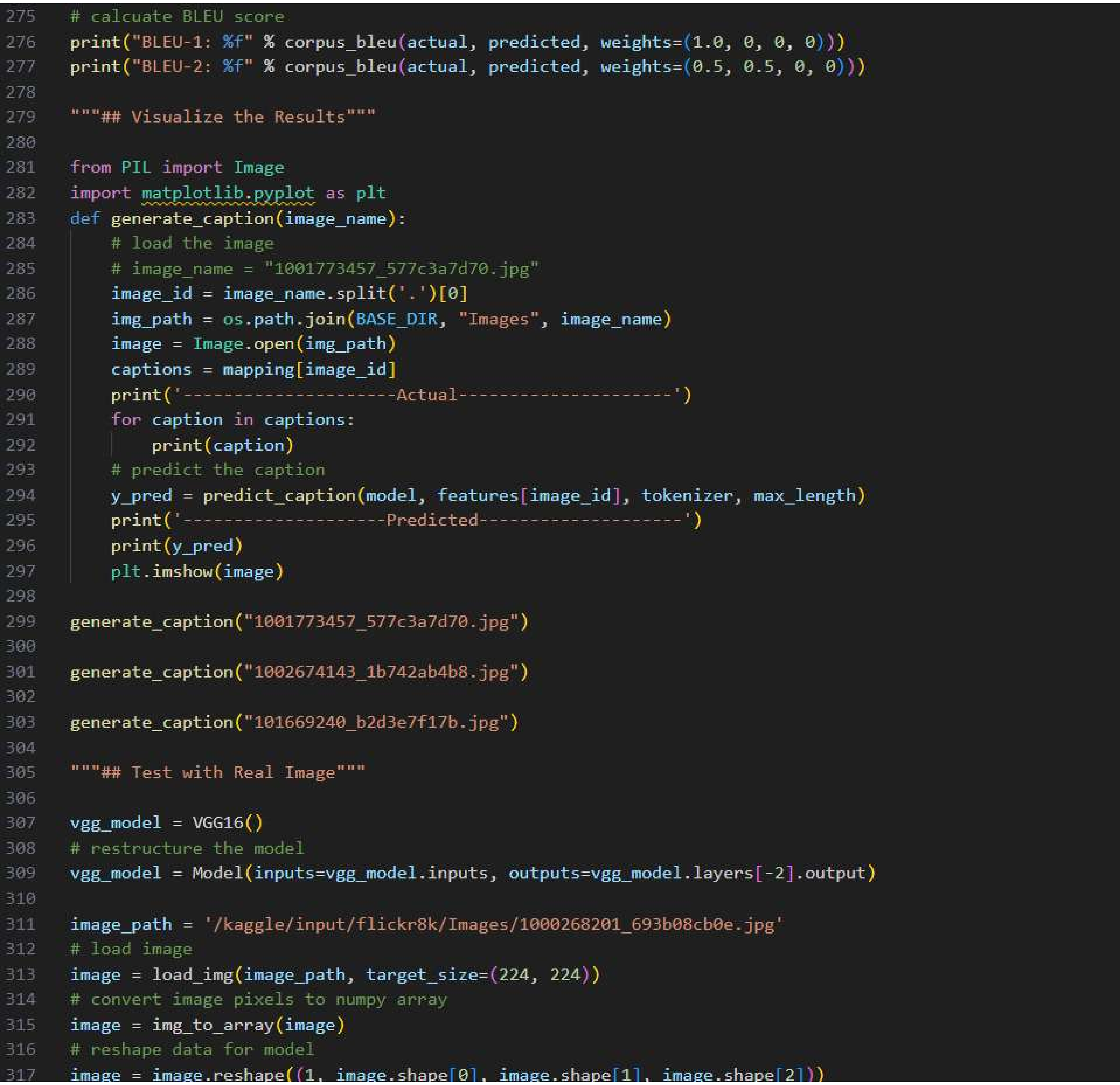
```
                n = 0
                yield {"image": X1, "text": X2}, y
                X1, X2, y = list(), list(), list()
                n = 0

"""## Model Creation"""

# encoder model
# image feature layers
inputs1 = Input(shape=(4096,), name="image")
fe1 = Dropout(0.4)(inputs1)
fe2 = Dense(256, activation='relu')(fe1)
# sequence feature layers
inputs2 = Input(shape=(max_length,), name="text")
se1 = Embedding(vocab_size, 256, mask_zero=True)(inputs2)
se2 = Dropout(0.4)(se1)
se3 = LSTM(256)(se2)

# decoder model
decoder1 = add([fe2, se3])
decoder2 = Dense(256, activation='relu')(decoder1)
outputs = Dense(vocab_size, activation='softmax')(decoder2)

model = Model(inputs=[inputs1, inputs2], outputs=outputs)
model.compile(loss='categorical_crossentropy', optimizer='adam')

# plot the model
plot_model(model, show_shapes=True)

# train the model
epochs = 20
batch_size = 32
steps = len(train) // batch_size

for i in range(epochs):
    # create data generator
    generator = data_generator(train, mapping, features, tokenizer, max_length, vocab_size, batch_size)
    # fit for one epoch
    model.fit(generator, epochs=1, steps_per_epoch=steps, verbose=1)

# save the model
model.save(WORKING_DIR+'/best_model.h5')

"""## Generate Captions for the Image"""
```



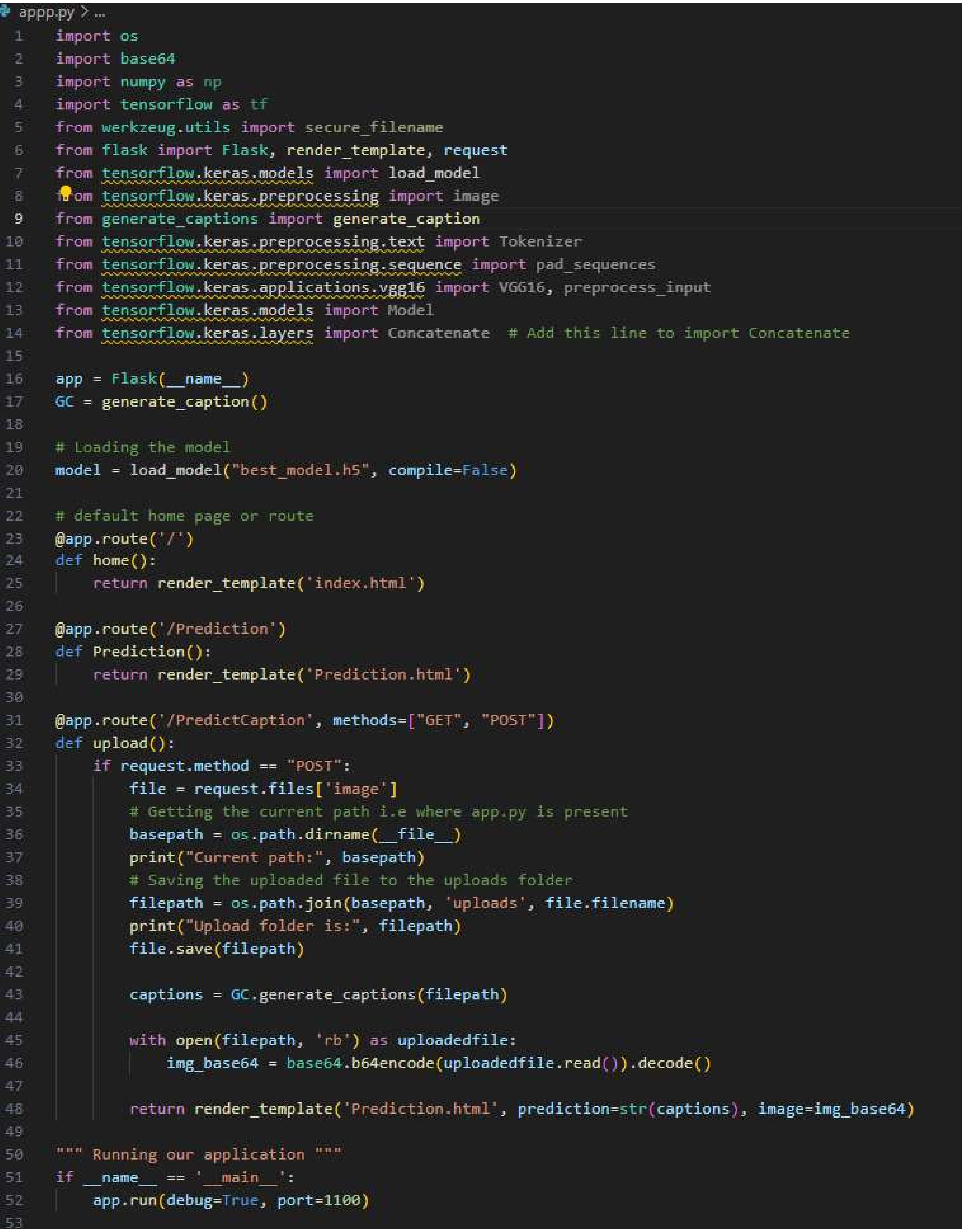
```python
"""## Generate Captions for the Image"""

def idx_to_word(integer, tokenizer):
    for word, index in tokenizer.word_index.items():
        if index == integer:
            return word
    return None

# generate caption for an image
def predict_caption(model, image, tokenizer, max_length):
    # add start tag for generation process
    in_text = 'startseq'
    # iterate over the max length of sequence
    for i in range(max_length):
        # encode input sequence
        sequence = tokenizer.texts_to_sequences([in_text])[0]
        # pad the sequence
        sequence = pad_sequences([sequence], max_length)
        # predict next word
        yhat = model.predict([image, sequence], verbose=0)
        # get index with high probability
        yhat = np.argmax(yhat)
        # convert index to word
        word = idx_to_word(yhat, tokenizer)
        # stop if word not found
        if word is None:
            break
        # append word as input for generating next word
        in_text += " " + word
        # stop if we reach end tag
        if word == 'endseq':
            break

    return in_text

from nltk.translate.bleu_score import corpus_bleu
# validate with test data
actual, predicted = list(), list()

for key in tqdm(test):
    # get actual caption
    captions = mapping[key]
    # predict the caption for image
```



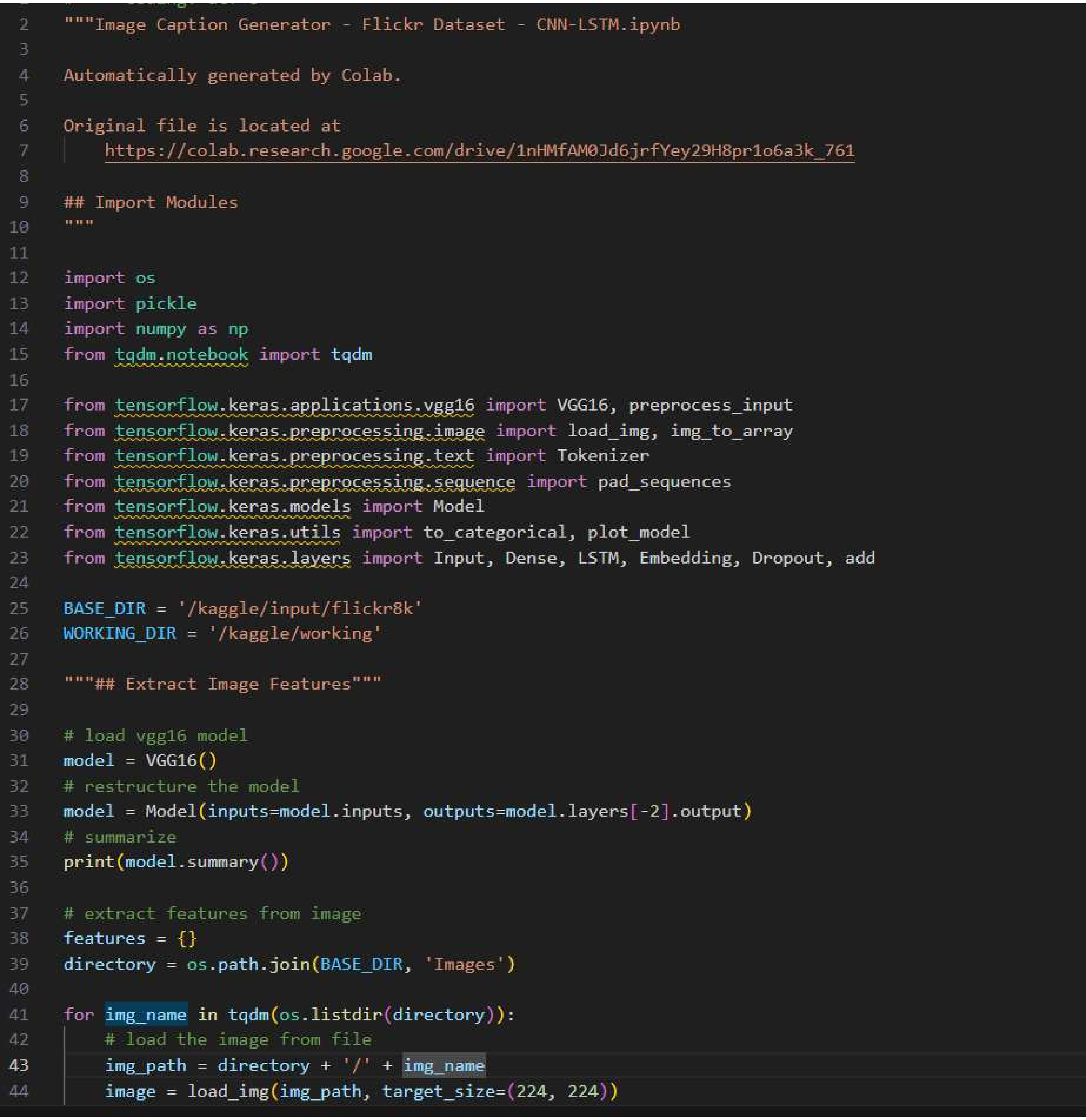
```
def generate_caption(image_name):
        print(caption)
    # predict the caption
    y_pred = predict_caption(model, features[image_id], tokenizer, max_length)
    print('--------------------Predicted--------------------')
    print(y_pred)
    plt.imshow(image)

generate_caption("1001773457_577c3a7d70.jpg")

generate_caption("1002674143_1b742ab4b8.jpg")

generate_caption("101669240_b2d3e7f17b.jpg")

"""## Test with Real Image"""

vgg_model = VGG16()
# restructure the model
vgg_model = Model(inputs=vgg_model.inputs, outputs=vgg_model.layers[-2].output)

image_path = '/kaggle/input/flickr8k/Images/1000268201_693b08cb0e.jpg'
# load image
image = load_img(image_path, target_size=(224, 224))
# convert image pixels to numpy array
image = img_to_array(image)
# reshape data for model
image = image.reshape((1, image.shape[0], image.shape[1], image.shape[2]))
# preprocess image for vgg
image = preprocess_input(image)
# extract features
feature = vgg_model.predict(image, verbose=0)
# predict from the trained model
predict_caption(model, feature, tokenizer, max_length)
```



```python
# calcuate BLEU score
print("BLEU-1: %f" % corpus_bleu(actual, predicted, weights=(1.0, 0, 0, 0)))
print("BLEU-2: %f" % corpus_bleu(actual, predicted, weights=(0.5, 0.5, 0, 0)))

"""## Visualize the Results"""

from PIL import Image
import matplotlib.pyplot as plt
def generate_caption(image_name):
    # load the image
    # image_name = "1001773457_577c3a7d70.jpg"
    image_id = image_name.split('.')[0]
    img_path = os.path.join(BASE_DIR, "Images", image_name)
    image = Image.open(img_path)
    captions = mapping[image_id]
    print('---------------------Actual---------------------')
    for caption in captions:
        print(caption)
    # predict the caption
    y_pred = predict_caption(model, features[image_id], tokenizer, max_length)
    print('--------------------Predicted--------------------')
    print(y_pred)
    plt.imshow(image)

generate_caption("1001773457_577c3a7d70.jpg")

generate_caption("1002674143_1b742ab4b8.jpg")

generate_caption("101669240_b2d3e7f17b.jpg")

"""## Test with Real Image"""

vgg_model = VGG16()
# restructure the model
vgg_model = Model(inputs=vgg_model.inputs, outputs=vgg_model.layers[-2].output)

image_path = '/kaggle/input/flickr8k/Images/1000268201_693b08cb0e.jpg'
# load image
image = load_img(image_path, target_size=(224, 224))
# convert image pixels to numpy array
image = img_to_array(image)
# reshape data for model
image = image.reshape((1, image.shape[0], image.shape[1], image.shape[2]))
```



```python
import os
import base64
import numpy as np
import tensorflow as tf
from werkzeug.utils import secure_filename
from flask import Flask, render_template, request
from tensorflow.keras.models import load_model
from tensorflow.keras.preprocessing import image
from generate_captions import generate_caption
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences
from tensorflow.keras.applications.vgg16 import VGG16, preprocess_input
from tensorflow.keras.models import Model
from tensorflow.keras.layers import Concatenate  # Add this line to import Concatenate

app = Flask(__name__)
GC = generate_caption()

# Loading the model
model = load_model("best_model.h5", compile=False)

# default home page or route
@app.route('/')
def home():
    return render_template('index.html')

@app.route('/Prediction')
def Prediction():
    return render_template('Prediction.html')

@app.route('/PredictCaption', methods=["GET", "POST"])
def upload():
    if request.method == "POST":
        file = request.files['image']
        # Getting the current path i.e where app.py is present
        basepath = os.path.dirname(__file__)
        print("Current path:", basepath)
        # Saving the uploaded file to the uploads folder
        filepath = os.path.join(basepath, 'uploads', file.filename)
        print("Upload folder is:", filepath)
        file.save(filepath)

        captions = GC.generate_captions(filepath)

        with open(filepath, 'rb') as uploadedfile:
            img_base64 = base64.b64encode(uploadedfile.read()).decode()

        return render_template('Prediction.html', prediction=str(captions), image=img_base64)

""" Running our application """
if __name__ == '__main__':
    app.run(debug=True, port=1100)

```



```python
"""Image Caption Generator - Flickr Dataset - CNN-LSTM.ipynb

Automatically generated by Colab.

Original file is located at
    https://colab.research.google.com/drive/1nHMfAM0Jd6jrfYey29H8pr1o6a3k_761

## Import Modules
"""

import os
import pickle
import numpy as np
from tqdm.notebook import tqdm

from tensorflow.keras.applications.vgg16 import VGG16, preprocess_input
from tensorflow.keras.preprocessing.image import load_img, img_to_array
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences
from tensorflow.keras.models import Model
from tensorflow.keras.utils import to_categorical, plot_model
from tensorflow.keras.layers import Input, Dense, LSTM, Embedding, Dropout, add

BASE_DIR = '/kaggle/input/flickr8k'
WORKING_DIR = '/kaggle/working'

"""## Extract Image Features"""

# load vgg16 model
model = VGG16()
# restructure the model
model = Model(inputs=model.inputs, outputs=model.layers[-2].output)
# summarize
print(model.summary())

# extract features from image
features = {}
directory = os.path.join(BASE_DIR, 'Images')

for img_name in tqdm(os.listdir(directory)):
    # load the image from file
    img_path = directory + '/' + img_name
    image = load_img(img_path, target_size=(224, 224))
```