

Historical Structures Classification

Problem Statement

There are hundreds of years-old historical structures that preserve a country's and community's history for future generations and promote tourism opportunities.

To help the travel and tourism industries, it has been decided to use advanced machine learning techniques to monitor the condition of these historical structures and report to government agencies if any of them need maintenance.

Also, understanding customers (tourists) and their expectations is critical for effective marketing. A recommendation engine is an excellent way to supplement existing marketing outreach to prospects.

Part 1

XYZ Pvt. Ltd., a leading industry consulting firm, has been hired to help the cause by developing an intelligent and automated AI model using TensorFlow that can predict the category of a structure in an image.

1. Import Libraries

```
In [1]: import numpy as np
import tensorflow as tf
import pathlib
import matplotlib.pyplot as plt

import os
os.environ['TF_CPP_MIN_LOG_LEVEL'] = '3'
os.environ["GRPC_VERBOSITY"] = "ERROR"
# os.environ["GLOG_minLogLevel"] = "3"

# tf.get_logger().setLevel('ERROR')

from tensorflow import keras
from tensorflow.keras import layers
from tensorflow.keras.models import Model
```

```

2024-10-28 21:12:36.466216: E external/local_xla/xla/stream_executor/cuda/cuda_fft.c
c:485] Unable to register cuFFT factory: Attempting to register factory for plugin c
uFFT when one has already been registered
2024-10-28 21:12:36.525604: E external/local_xla/xla/stream_executor/cuda/cuda_dnn.c
c:8454] Unable to register cuDNN factory: Attempting to register factory for plugin
cuDNN when one has already been registered
2024-10-28 21:12:36.544077: E external/local_xla/xla/stream_executor/cuda/cuda_blas.
cc:1452] Unable to register cuBLAS factory: Attempting to register factory for plugi
n cuBLAS when one has already been registered
2024-10-28 21:12:36.598403: I tensorflow/core/platform/cpu_feature_guard.cc:210] Thi
s TensorFlow binary is optimized to use available CPU instructions in performance-cr
itical operations.
To enable the following instructions: AVX2 FMA, in other operations, rebuild TensorF
low with the appropriate compiler flags.
2024-10-28 21:12:38.547107: W tensorflow/compiler/tf2tensorrt/utils/py_utils.cc:38]
TF-TRT Warning: Could not find TensorRT

```

2. Import Datasets

```

In [2]: train_data_dir = pathlib.Path('./dataset_hist_structures/Structures_Dataset')
test_data_dir = pathlib.Path('./dataset_hist_structures/Dataset_test/Dataset_test_o

```

```

In [3]: batch_size = 10

train_ds = keras.utils.image_dataset_from_directory(
    train_data_dir,
    validation_split=0.2,
    subset="training",
    seed=123,
    batch_size=batch_size
)

val_ds = keras.utils.image_dataset_from_directory(
    train_data_dir,
    validation_split=0.2,
    subset="validation",
    seed=123,
    batch_size=batch_size
)

```

Found 10543 files belonging to 11 classes.
Using 8435 files for training.

```

WARNING: All log messages before absl::InitializeLog() is called are written to STDERR
I0000 00:00:1730175167.230536 56945 cuda_executor.cc:1001] could not open file to
read NUMA node: /sys/bus/pci/devices/0000:01:00.0/numa_node
Your kernel may have been built without NUMA support.
I0000 00:00:1730175167.431647 56945 cuda_executor.cc:1001] could not open file to
read NUMA node: /sys/bus/pci/devices/0000:01:00.0/numa_node
Your kernel may have been built without NUMA support.
I0000 00:00:1730175167.431736 56945 cuda_executor.cc:1001] could not open file to
read NUMA node: /sys/bus/pci/devices/0000:01:00.0/numa_node
Your kernel may have been built without NUMA support.
I0000 00:00:1730175167.435353 56945 cuda_executor.cc:1001] could not open file to
read NUMA node: /sys/bus/pci/devices/0000:01:00.0/numa_node
Your kernel may have been built without NUMA support.
I0000 00:00:1730175167.435592 56945 cuda_executor.cc:1001] could not open file to
read NUMA node: /sys/bus/pci/devices/0000:01:00.0/numa_node
Your kernel may have been built without NUMA support.
I0000 00:00:1730175167.435652 56945 cuda_executor.cc:1001] could not open file to
read NUMA node: /sys/bus/pci/devices/0000:01:00.0/numa_node
Your kernel may have been built without NUMA support.
I0000 00:00:1730175167.799024 56945 cuda_executor.cc:1001] could not open file to
read NUMA node: /sys/bus/pci/devices/0000:01:00.0/numa_node
Your kernel may have been built without NUMA support.
I0000 00:00:1730175167.799157 56945 cuda_executor.cc:1001] could not open file to
read NUMA node: /sys/bus/pci/devices/0000:01:00.0/numa_node
Your kernel may have been built without NUMA support.
2024-10-28 21:12:47.799180: I tensorflow/core/common_runtime/gpu/gpu_device.cc:2112]
Could not identify NUMA node of platform GPU id 0, defaulting to 0. Your kernel may
not have been built with NUMA support.
I0000 00:00:1730175167.799337 56945 cuda_executor.cc:1001] could not open file to
read NUMA node: /sys/bus/pci/devices/0000:01:00.0/numa_node
Your kernel may have been built without NUMA support.
2024-10-28 21:12:47.799419: I tensorflow/core/common_runtime/gpu/gpu_device.cc:2021]
Created device /job:localhost/replica:0/task:0/device:GPU:0 with 2249 MB memory: ->
device: 0, name: Quadro T1000, pci bus id: 0000:01:00.0, compute capability: 7.5
Found 10543 files belonging to 11 classes.
Using 2108 files for validation.

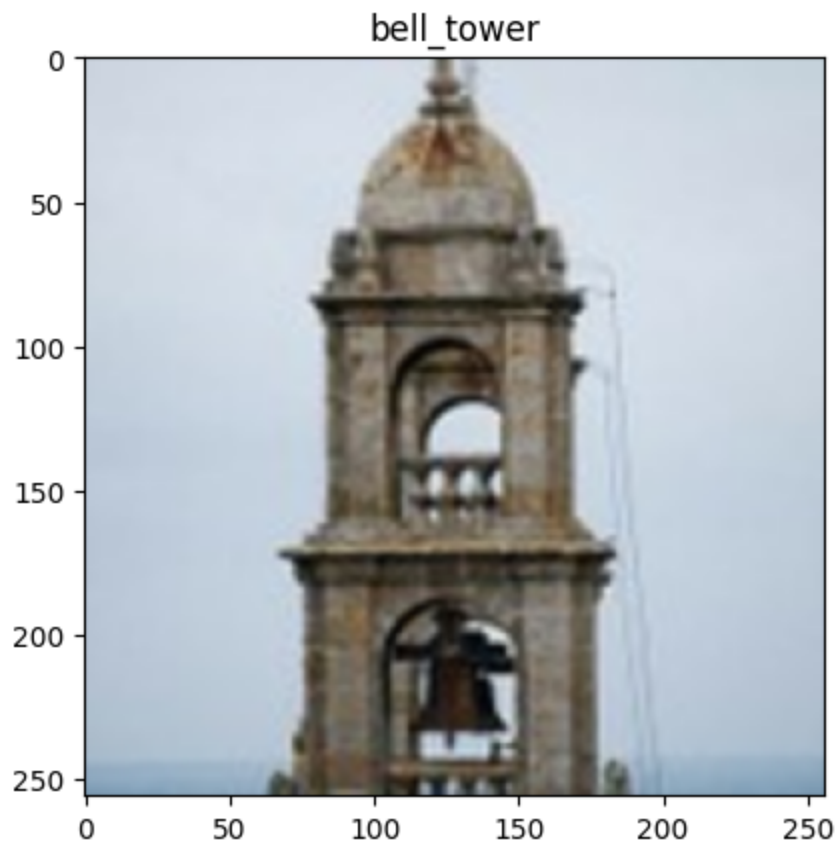
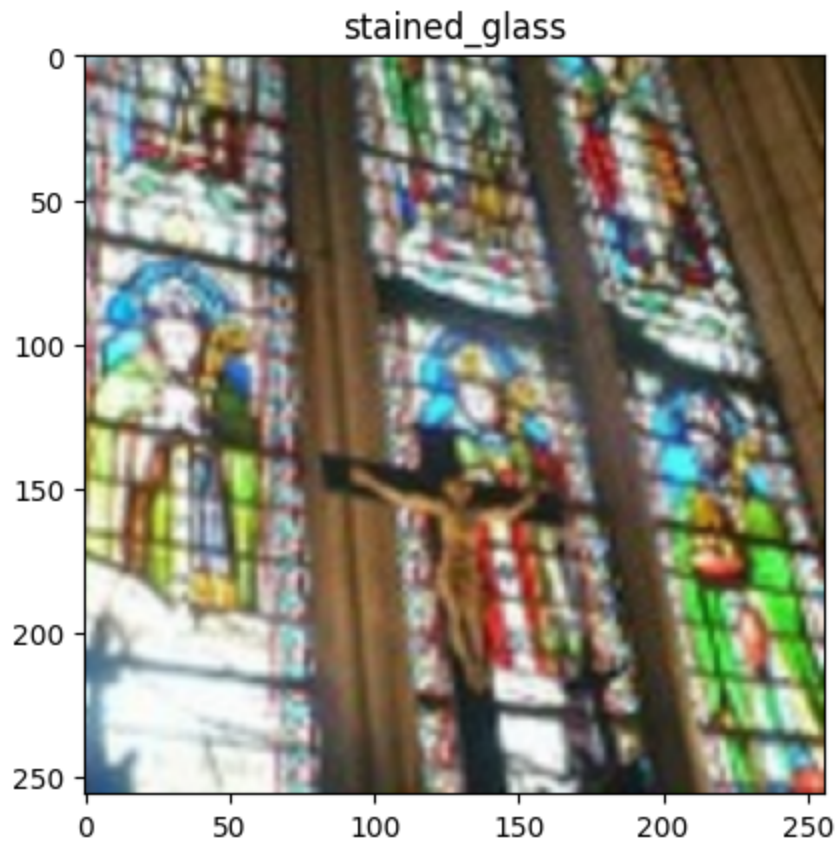
```

3. Plot Images from the Various Classes

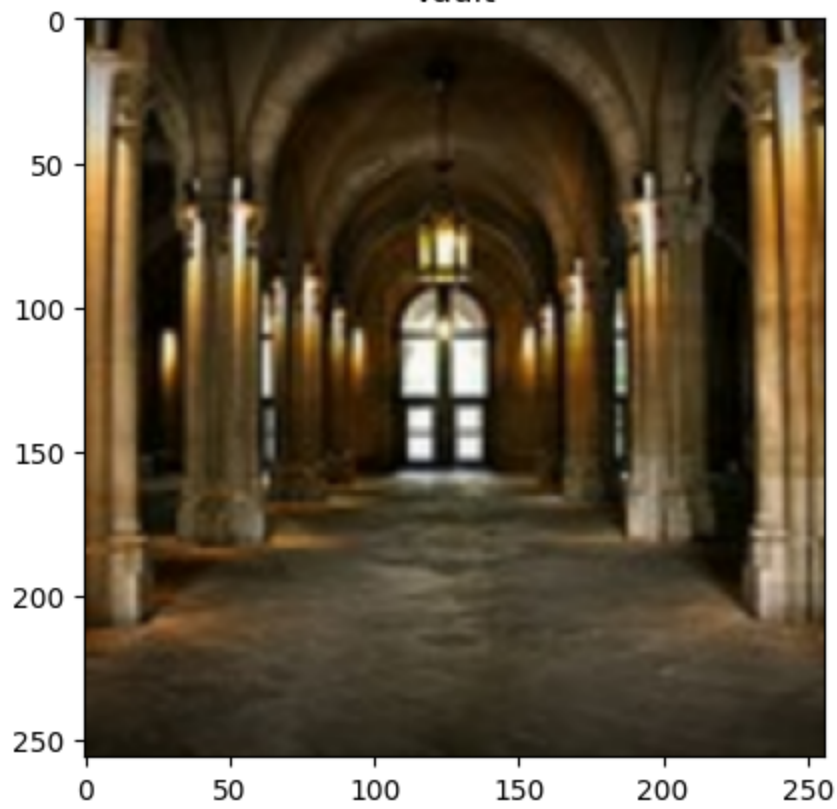
```

In [4]: class_names = train_ds.class_names
        for images, labels in train_ds.take(1):
            for i in range(batch_size):
                plt.imshow(images[i].numpy().astype("uint8"))
                plt.title(class_names[labels[i]])
                plt.show()

```

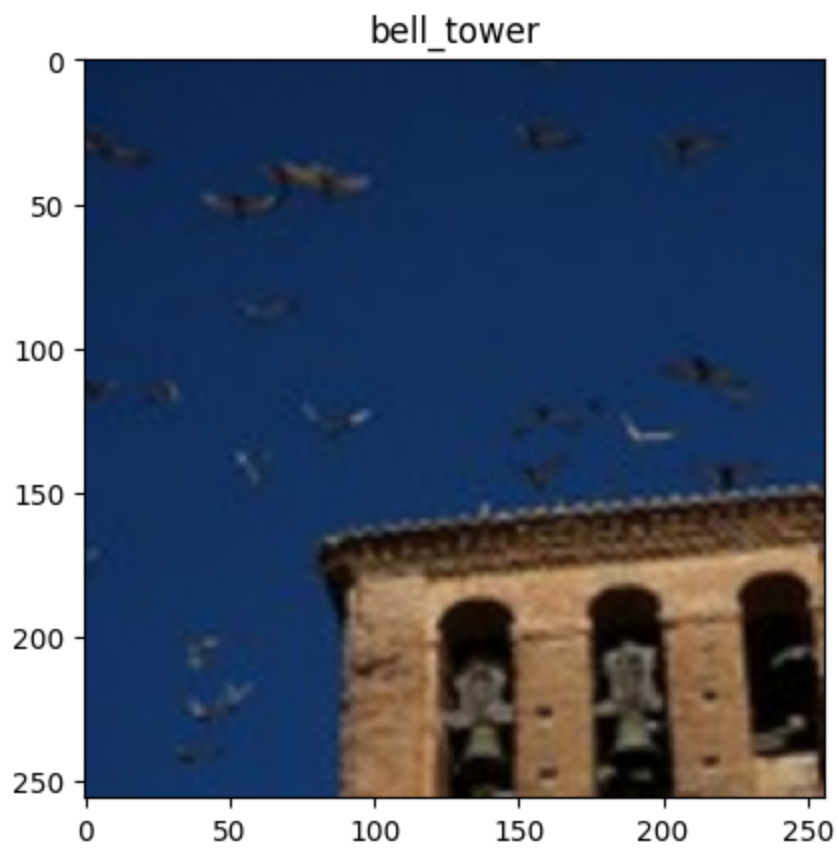
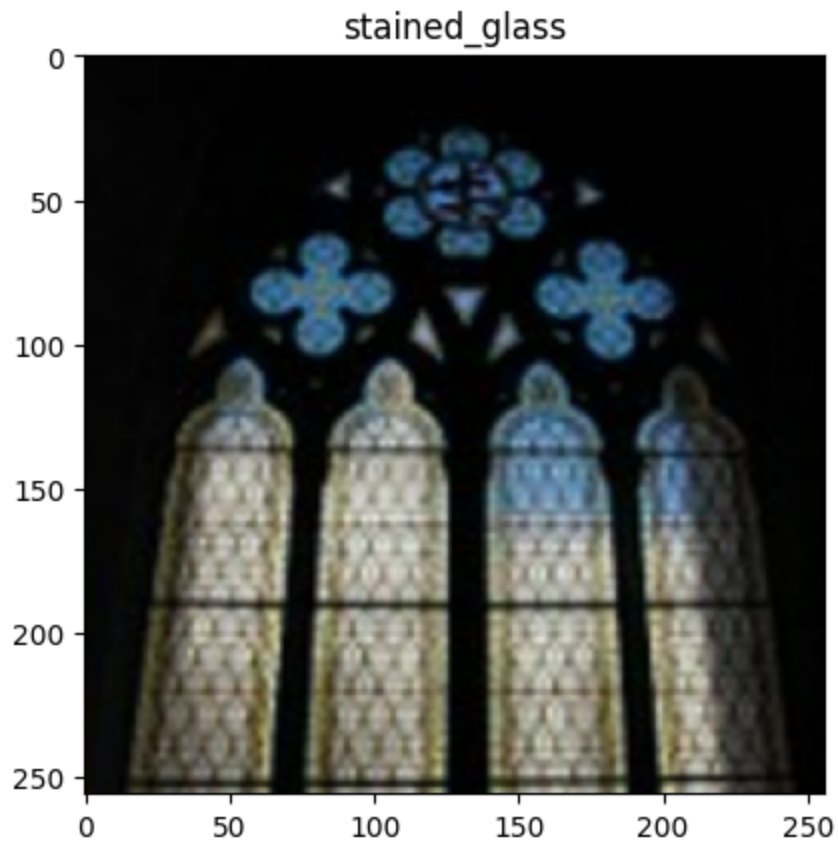


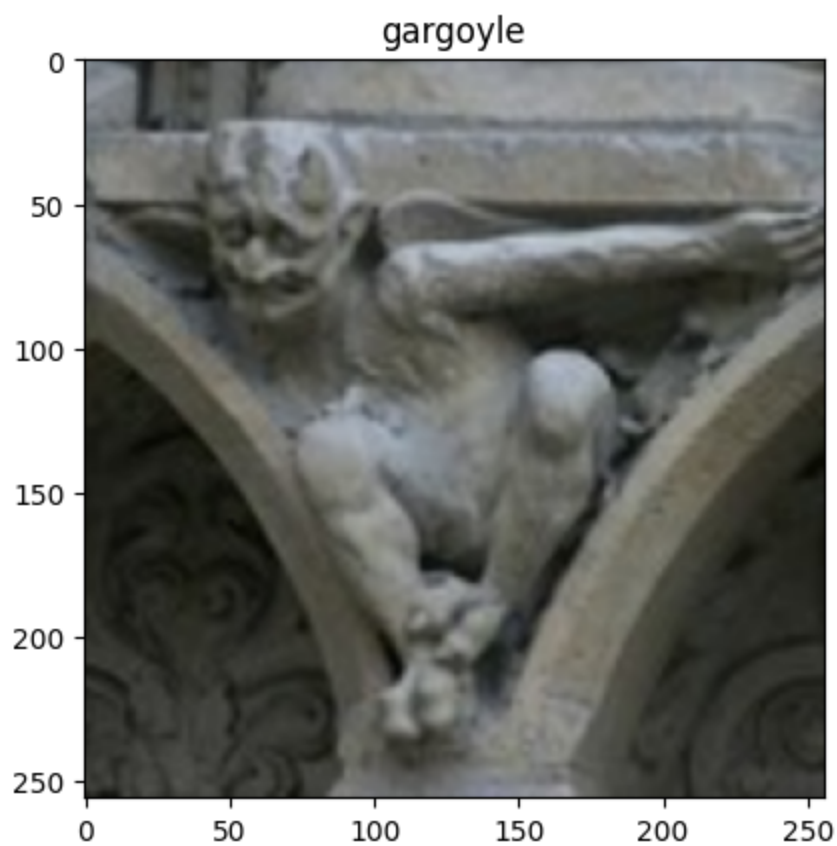
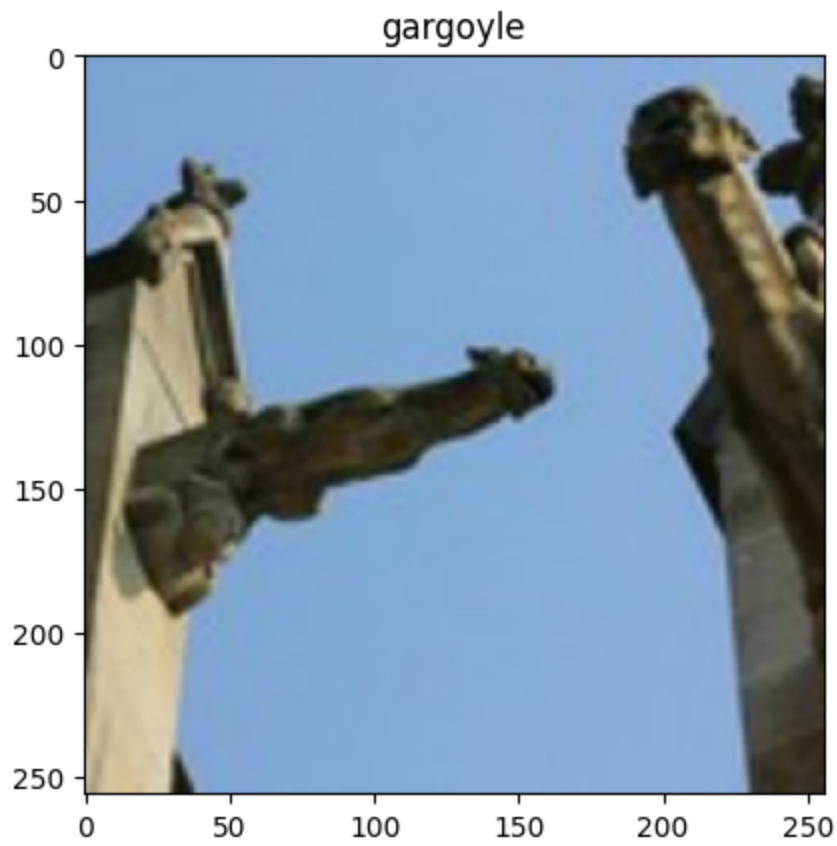
vault

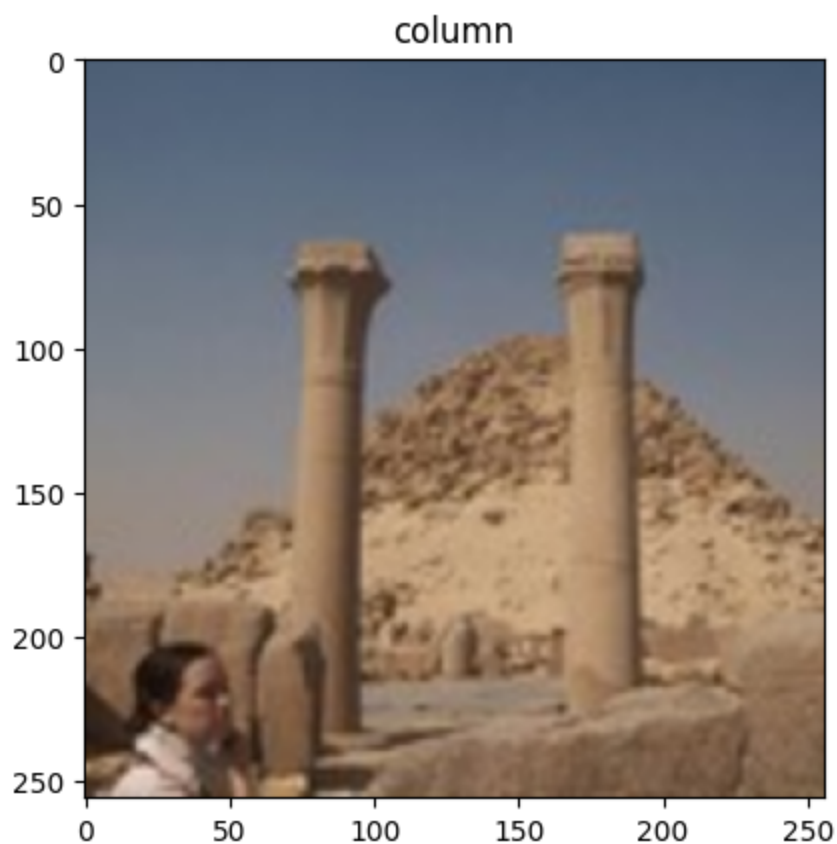
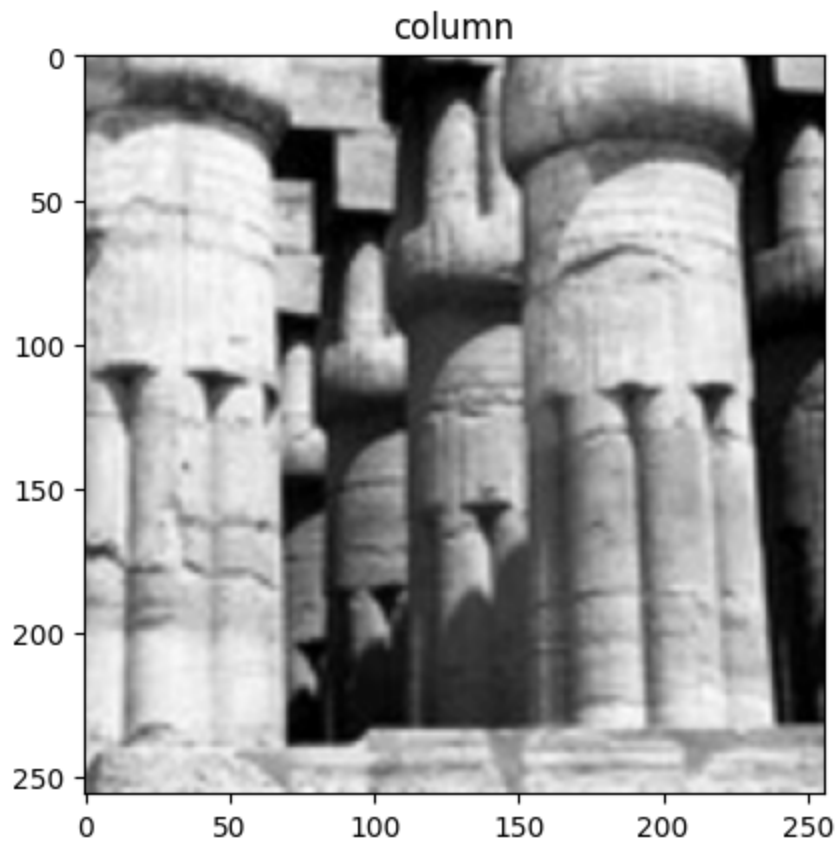


gargoyle









2024-10-28 20:51:32.581476: I tensorflow/core/framework/local_rendezvous.cc:404] Local rendezvous is aborting with status: OUT_OF_RANGE: End of sequence

4. Preprocess the Data for Use in the ML Model


```
In [4]: from tensorflow.keras.utils import to_categorical
```

```
def preprocess_labels(ds):  
    def _preprocess(image, label):  
        label = to_categorical(label, num_classes=11)  
        return image, label  
    return ds.map(_preprocess)  
  
train_ds = preprocess_labels(train_ds)  
val_ds = preprocess_labels(val_ds)
```

```
In [5]: normalization_layer = layers.Rescaling(1./255)
```

```
train_ds = train_ds.map(lambda x, y: (normalization_layer(x), y))  
val_ds = val_ds.map(lambda x, y: (normalization_layer(x), y))
```

5. Import and Customize a Pretrained CNN Model

```
In [6]: from tensorflow.keras.applications import VGG16
```

```
input_layer = layers.Input(shape=(256, 256, 3)) # Define the input shape  
base_model = VGG16(include_top=False, weights='imagenet', input_tensor=input_layer)  
base_model.trainable = False  
base_model_output = base_model.output  
flat = layers.Flatten()(base_model_output)  
dense1 = layers.Dense(128, activation='relu')(flat)  
dense2 = layers.Dense(128, activation='relu')(dense1)  
output = layers.Dense(11, activation='softmax')(dense2)
```

```
In [8]: model = Model(inputs=input_layer, outputs=output)  
model.summary()
```

Model: "functional"

Layer (type)	Output Shape	Par
input_layer (InputLayer)	(None, 256, 256, 3)	
block1_conv1 (Conv2D)	(None, 256, 256, 64)	1
block1_conv2 (Conv2D)	(None, 256, 256, 64)	36
block1_pool (MaxPooling2D)	(None, 128, 128, 64)	
block2_conv1 (Conv2D)	(None, 128, 128, 128)	73
block2_conv2 (Conv2D)	(None, 128, 128, 128)	147
block2_pool (MaxPooling2D)	(None, 64, 64, 128)	
block3_conv1 (Conv2D)	(None, 64, 64, 256)	295
block3_conv2 (Conv2D)	(None, 64, 64, 256)	590
block3_conv3 (Conv2D)	(None, 64, 64, 256)	590
block3_pool (MaxPooling2D)	(None, 32, 32, 256)	
block4_conv1 (Conv2D)	(None, 32, 32, 512)	1,180
block4_conv2 (Conv2D)	(None, 32, 32, 512)	2,359
block4_conv3 (Conv2D)	(None, 32, 32, 512)	2,359
block4_pool (MaxPooling2D)	(None, 16, 16, 512)	
block5_conv1 (Conv2D)	(None, 16, 16, 512)	2,359
block5_conv2 (Conv2D)	(None, 16, 16, 512)	2,359
block5_conv3 (Conv2D)	(None, 16, 16, 512)	2,359
block5_pool (MaxPooling2D)	(None, 8, 8, 512)	
flatten (Flatten)	(None, 32768)	
dense (Dense)	(None, 128)	4,194
dense_1 (Dense)	(None, 128)	16
dense_2 (Dense)	(None, 11)	1



Total params: 18,927,051 (72.20 MB)

Trainable params: 4,212,363 (16.07 MB)

Non-trainable params: 14,714,688 (56.13 MB)

6. Compile and Train the Model

```
In [9]: model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])
```

```
In [8]: callback = tf.keras.callbacks.EarlyStopping(monitor='val_accuracy', patience=3)
```

```
In [11]: history = model.fit(train_ds, validation_data=val_ds, epochs=30, callbacks=[callback])
```

Epoch 1/30

WARNING: All log messages before absl::InitializeLog() is called are written to STDERR

I0000 00:00:1730171102.733980 27458 service.cc:146] XLA service 0x7feac0004c00 initialized for platform CUDA (this does not guarantee that XLA will be used). Devices: I0000 00:00:1730171102.734281 27458 service.cc:154] StreamExecutor device (0): Quadro T1000, Compute Capability 7.5

2024-10-28 20:05:03.121735: I tensorflow/compiler/mlir/tensorflow/utils/dump_mlir_util.cc:268] disabling MLIR crash reproducer, set env var `MLIR_CRASH_REPRODUCER_DIRECTORY` to enable.

2024-10-28 20:05:03.659377: I external/local_xla/xla/stream_executor/cuda/cuda_dnn.cc:531] Loaded cuDNN version 8907

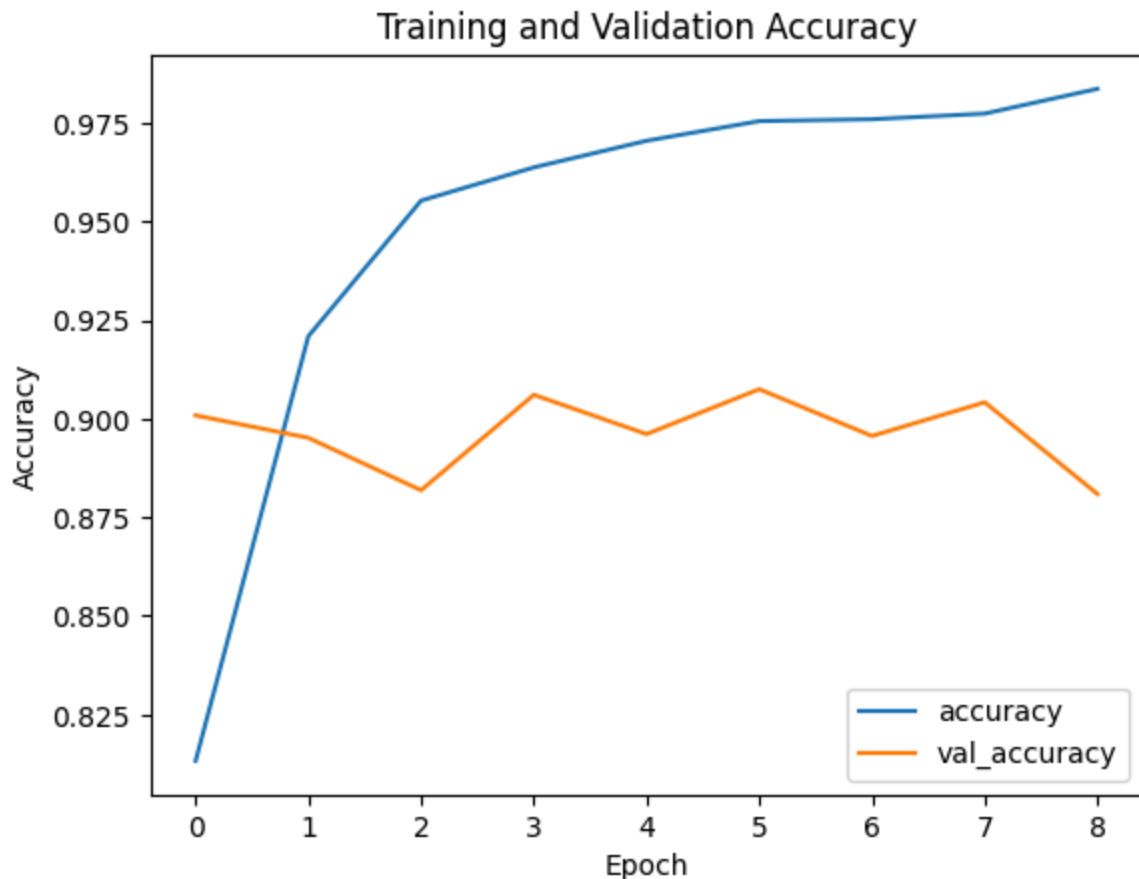
2024-10-28 20:05:09.086108: W external/local_tsl/tsl/framework/bfc_allocator.cc:291] Allocator (GPU_0_bfc) ran out of memory trying to allocate 4.36GiB with freed_by_count=0. The caller indicates that this is not a failure, but this may mean that there could be performance gains if more memory were available.

2024-10-28 20:05:11.534022: W external/local_tsl/tsl/framework/bfc_allocator.cc:291] Allocator (GPU_0_bfc) ran out of memory trying to allocate 8.71GiB with freed_by_count=0. The caller indicates that this is not a failure, but this may mean that there could be performance gains if more memory were available.

2024-10-28 20:05:12.868139: W external/local_tsl/tsl/framework/bfc_allocator.cc:291] Allocator (GPU_0_bfc) ran out of memory trying to allocate 4.24GiB with freed_by_count=0. The caller indicates that this is not a failure, but this may mean that there could be performance gains if more memory were available.

```
In [42]: plt.plot(history.history['accuracy'], label='accuracy')
plt.plot(history.history['val_accuracy'], label = 'val_accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend(loc='lower right')
plt.title('Training and Validation Accuracy')
```

```
Out[42]: Text(0.5, 1.0, 'Training and Validation Accuracy')
```



7. Train the model on augmented data

```
In [7]: new_input_layer = layers.Input(shape=(256, 256, 3)) # Define the input shape
augmentation1 = layers.RandomFlip("horizontal_and_vertical")(new_input_layer)
augmentation2 = layers.RandomRotation(0.2)(augmentation1)
base_model = VGG16(include_top=False, weights='imagenet', input_tensor=augmentation1)
base_model.trainable = False
base_model_output = base_model.output
flat = layers.Flatten()(base_model_output)
dense1 = layers.Dense(128, activation='relu')(flat)
dense2 = layers.Dense(128, activation='relu')(dense1)
new_output = layers.Dense(11, activation='softmax')(dense2)
```

```
In [8]: augmentation_model = Model(inputs=new_input_layer, outputs=new_output)
augmentation_model.compile(optimizer='adam', loss='categorical_crossentropy', metri
```

Due to repeated fluctuations in the validation accuracy during training sessions, the patience for the early stopping is set to 2.

```
In [9]: new_callback = tf.keras.callbacks.EarlyStopping(monitor='val_accuracy', patience=2)
```

```
In [10]: history2 = augmentation_model.fit(train_ds, validation_data=val_ds, epochs=30, call
```

Epoch 1/30

```
2024-10-28 21:13:21.772933: I external/local_xla/xla/stream_executor/cuda/cuda_dnn.c
c:531] Loaded cuDNN version 8907
W0000 00:00:1730175201.903808 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175201.983361 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.025408 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.065129 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.105224 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.143478 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.187601 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.196313 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.206872 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.216150 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.231520 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.243369 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.256871 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.269655 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.279477 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.300135 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.446168 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.477392 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.517944 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.556244 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.594809 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.637384 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.679962 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.723686 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.772223 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.820807 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.872842 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
```

```
W0000 00:00:1730175202.935298 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175202.991254 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.062587 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.149371 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.238798 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.346402 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.510740 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.527573 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.552468 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.572674 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.592873 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.613717 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.637045 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.659868 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.682832 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.710814 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.736451 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.762658 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.790240 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.835222 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.869204 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.919194 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175203.966259 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
2024-10-28 21:13:24.001003: W external/local_tsl/tsl/framework/bfc_allocator.cc:291]
Allocator (GPU_0_bfc) ran out of memory trying to allocate 4.36GiB with freed_by_cou
nt=0. The caller indicates that this is not a failure, but this may mean that there
could be performance gains if more memory were available.
W0000 00:00:1730175204.012367 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.059092 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.086460 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
```



```
W0000 00:00:1730175204.123506 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.161759 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.203459 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.240632 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.283259 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.326330 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.374475 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.422557 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.471454 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.521832 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.577705 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.641646 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.727908 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.816016 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.927948 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.962946 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.977886 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175204.997934 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.019790 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.041403 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.063911 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.087597 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.107544 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.134267 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.159615 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.186190 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.227557 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.254747 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
```

```
W0000 00:00:1730175205.288301 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.333632 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.380442 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
2024-10-28 21:13:25.427614: W external/local_tsl/tsl/framework/bfc_allocator.cc:291]
Allocator (GPU_0_bfc) ran out of memory trying to allocate 4.24GiB with freed_by_cou
nt=0. The caller indicates that this is not a failure, but this may mean that there
could be performance gains if more memory were available.
W0000 00:00:1730175205.438901 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.475709 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.502129 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.539159 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.576636 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.615431 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.655746 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.697947 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.740706 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.785642 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.859548 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.908551 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175205.956162 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.005804 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.070059 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.155219 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.242203 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.347739 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.402402 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.416636 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.437362 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.457678 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.478777 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
```

```
W0000 00:00:1730175206.500452 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.524045 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.546646 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.571171 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.642075 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.668834 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.694049 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.720702 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.753574 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.802809 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.850280 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
2024-10-28 21:13:26.895995: W external/local_tsl/tsl/framework/bfc_allocator.cc:291]
Allocator (GPU_0_bfc) ran out of memory trying to allocate 4.23GiB with freed_by_cou
nt=0. The caller indicates that this is not a failure, but this may mean that there
could be performance gains if more memory were available.
W0000 00:00:1730175206.925818 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.956235 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175206.982345 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175207.019886 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175207.057095 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175207.095127 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175207.137075 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175207.179732 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175207.223155 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175207.265576 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175207.398690 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175207.447966 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175207.497805 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175207.547393 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175207.610727 57129 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
```

```
W0000 00:00:1730175207.695614 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175207.786536 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175207.885249 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
2024-10-28 21:13:27.934699: W external/local_tsl/tsl/framework/bfc_allocator.cc:291] Allocator (GPU_0_bfc) ran out of memory trying to allocate 2.19GiB with freed_by_count=0. The caller indicates that this is not a failure, but this may mean that there could be performance gains if more memory were available.
W0000 00:00:1730175207.935020 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175207.943659 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175207.956427 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175207.969083 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175207.981112 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175207.994026 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175208.007774 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175208.021332 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175208.036215 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175208.052177 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175208.066202 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175208.081370 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175208.100007 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175208.150951 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175208.174615 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175208.200293 57129 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
843/844 ————— 0s 277ms/step - accuracy: 0.6202 - loss: 1.2456
```

```
W0000 00:00:1730175442.018428 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.024612 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.029217 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.033662 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.038612 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.045287 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.049736 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.055905 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.063014 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.069591 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.079325 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.086312 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.093948 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.101441 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.108490 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.126831 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.169177 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.186952 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.209342 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.230584 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.253656 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.292129 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.314951 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.339826 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.367017 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.393644 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.422918 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.450648 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
```



```
W0000 00:00:1730175442.489450 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.551243 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.596785 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.643556 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.699736 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.766220 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.780753 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.793318 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.806347 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.818995 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.831645 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.844898 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.857683 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.872895 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.887377 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.903515 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.920005 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.943540 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.961753 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175442.985396 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.010893 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.037068 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
2024-10-28 21:17:23.068484: W external/local_tsl/tsl/framework/bfc_allocator.cc:291]
Allocator (GPU_0_bfc) ran out of memory trying to allocate 4.20GiB with freed_by_cou
nt=0. The caller indicates that this is not a failure, but this may mean that there
could be performance gains if more memory were available.
W0000 00:00:1730175443.088101 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.106621 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.127668 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.148553 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
```



```
W0000 00:00:1730175443.170430 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.191201 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.214224 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.237772 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.264493 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.290460 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.316066 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.343496 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.380451 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.414221 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.459750 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.506733 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.557585 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.626103 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.636109 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.648421 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.660699 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.673512 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.684974 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.698197 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.711823 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.726239 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.741248 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.755697 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.770308 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.792176 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.811683 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.835906 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
```

```
W0000 00:00:1730175443.861011 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.886275 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
2024-10-28 21:17:23.926965: W external/local_tsl/tsl/framework/bfc_allocator.cc:291]
Allocator (GPU_0_bfc) ran out of memory trying to allocate 4.16GiB with freed_by_cou
nt=0. The caller indicates that this is not a failure, but this may mean that there
could be performance gains if more memory were available.
W0000 00:00:1730175443.950721 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.965768 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175443.988140 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.010915 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.032775 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.053405 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.077404 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.100720 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.127691 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.154031 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.179898 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.208113 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.239466 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.273791 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.320261 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.376934 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.427979 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.577144 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.591407 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.607657 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.623023 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.638547 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.654636 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.672413 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
```

```
W0000 00:00:1730175444.686700 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.702323 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.718294 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.734309 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.750439 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.767787 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.796769 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.830105 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.866552 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175444.901492 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
2024-10-28 21:17:24.971664: W external/local_tsl/tsl/framework/bfc_allocator.cc:291]
Allocator (GPU_0_bfc) ran out of memory trying to allocate 4.18GiB with freed_by_cou
nt=0. The caller indicates that this is not a failure, but this may mean that there
could be performance gains if more memory were available.
W0000 00:00:1730175444.997098 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.013427 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.034425 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.058862 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.085653 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.113071 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.136991 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.160891 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.187141 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.214459 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.238274 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.265425 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.295654 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.329491 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.374592 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.425511 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
```

```

W0000 00:00:1730175445.473036 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.648962 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.656524 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.665459 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.676602 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.685649 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.695689 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.704110 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.714524 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.725345 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.733143 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.741721 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.749768 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.759167 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.769828 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.784033 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
2024-10-28 21:17:25.798346: W external/local_tsl/tsl/framework/bfc_allocator.cc:291]
Allocator (GPU_0_bfc) ran out of memory trying to allocate 2.17GiB with freed_by_cou
nt=0. The caller indicates that this is not a failure, but this may mean that there
could be performance gains if more memory were available.
W0000 00:00:1730175445.798707 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175445.814741 57124 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
844/844 ————— 0s 282ms/step - accuracy: 0.6203 - loss: 1.2452

```

```
W0000 00:00:1730175499.608117 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.613140 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.618490 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.624128 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.628899 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.637248 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.642600 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.647923 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.656178 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.663728 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.671383 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.678955 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.688332 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.697696 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.706708 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.725405 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.758059 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.784208 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.814712 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.846402 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.886346 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.920738 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.956144 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175499.991356 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.030946 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.070138 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.113032 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.157944 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
```



```
W0000 00:00:1730175500.210493 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.267320 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.338274 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.410205 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.496155 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.601945 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.636290 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.660082 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.677254 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.694275 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.711722 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.730712 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.750137 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.770079 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.792993 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.814075 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.835954 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.858906 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.886287 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.918115 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.955282 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175500.993091 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
2024-10-28 21:18:21.033337: W external/local_tsl/tsl/framework/bfc_allocator.cc:291]
Allocator (GPU_0_bfc) ran out of memory trying to allocate 4.30GiB with freed_by_cou
nt=0. The caller indicates that this is not a failure, but this may mean that there
could be performance gains if more memory were available.
W0000 00:00:1730175501.046197 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.072925 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.110388 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.141301 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
```



```
W0000 00:00:1730175501.171798 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.204495 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.238231 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.272830 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.307676 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.346614 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.386662 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.425443 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.465855 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.517120 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.571630 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.641617 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.712540 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.802980 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.827149 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.845941 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.862828 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.880240 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.896999 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.915197 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.934334 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.954002 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.975353 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175501.996145 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.016993 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.039747 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.067296 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.107830 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
```

```
W0000 00:00:1730175502.143755 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.181145 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
2024-10-28 21:18:22.219569: W external/local_tsl/tsl/framework/bfc_allocator.cc:291]
Allocator (GPU_0_bfc) ran out of memory trying to allocate 4.21GiB with freed_by_cou
nt=0. The caller indicates that this is not a failure, but this may mean that there
could be performance gains if more memory were available.
W0000 00:00:1730175502.230204 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.264328 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.285624 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.315819 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.346970 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.378705 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.411323 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.446238 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.480613 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.516516 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.589538 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.627946 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.666849 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.707008 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.757998 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.827268 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.897530 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175502.980737 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.028155 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.040622 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.057468 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.074265 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.091636 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.109556 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
```

```
W0000 00:00:1730175503.128341 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.147074 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.166535 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.236778 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.257780 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.278626 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.300484 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.327958 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.363798 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.401871 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.448744 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.479099 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.499867 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.530832 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.561393 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.592639 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.625015 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.659429 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.693782 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.728981 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.860169 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.899043 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.938585 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175503.978498 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175504.029440 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175504.097377 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175504.169680 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
W0000 00:00:1730175504.249119 57127 gpu_timer.cc:114] Skipping the delay kernel, m
easurement accuracy will be reduced
```

```
W0000 00:00:1730175504.288777 57127 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175504.296165 57127 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175504.307163 57127 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175504.318952 57127 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175504.329076 57127 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175504.342186 57127 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175504.354703 57127 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175504.366894 57127 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175504.378100 57127 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175504.388713 57127 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175504.400096 57127 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175504.412344 57127 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175504.432981 57127 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175504.448965 57127 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175504.469977 57127 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
W0000 00:00:1730175504.492039 57127 gpu_timer.cc:114] Skipping the delay kernel, measurement accuracy will be reduced
```

```

844/844 ————— 308s 351ms/step - accuracy: 0.6204 - loss: 1.2448 - val
_accuracy: 0.8221 - val_loss: 0.5642
Epoch 2/30
Epoch 2/30
844/844 ————— 291s 344ms/step - accuracy: 0.7837 - loss: 0.6482 - val
_accuracy: 0.8397 - val_loss: 0.5251
Epoch 3/30
844/844 ————— 290s 344ms/step - accuracy: 0.8137 - loss: 0.5773 - val
_accuracy: 0.8145 - val_loss: 0.5889
Epoch 4/30
844/844 ————— 295s 350ms/step - accuracy: 0.8265 - loss: 0.5256 - val
_accuracy: 0.8454 - val_loss: 0.5205
Epoch 5/30
844/844 ————— 291s 344ms/step - accuracy: 0.8453 - loss: 0.4852 - val
_accuracy: 0.8506 - val_loss: 0.4907
Epoch 6/30
844/844 ————— 291s 344ms/step - accuracy: 0.8541 - loss: 0.4511 - val
_accuracy: 0.8615 - val_loss: 0.4671
Epoch 7/30
844/844 ————— 286s 339ms/step - accuracy: 0.8559 - loss: 0.4415 - val
_accuracy: 0.8700 - val_loss: 0.4083
Epoch 8/30
844/844 ————— 297s 352ms/step - accuracy: 0.8585 - loss: 0.4424 - val
_accuracy: 0.8572 - val_loss: 0.5058
Epoch 9/30
844/844 ————— 288s 342ms/step - accuracy: 0.8650 - loss: 0.4039 - val
_accuracy: 0.8662 - val_loss: 0.4813

```

```

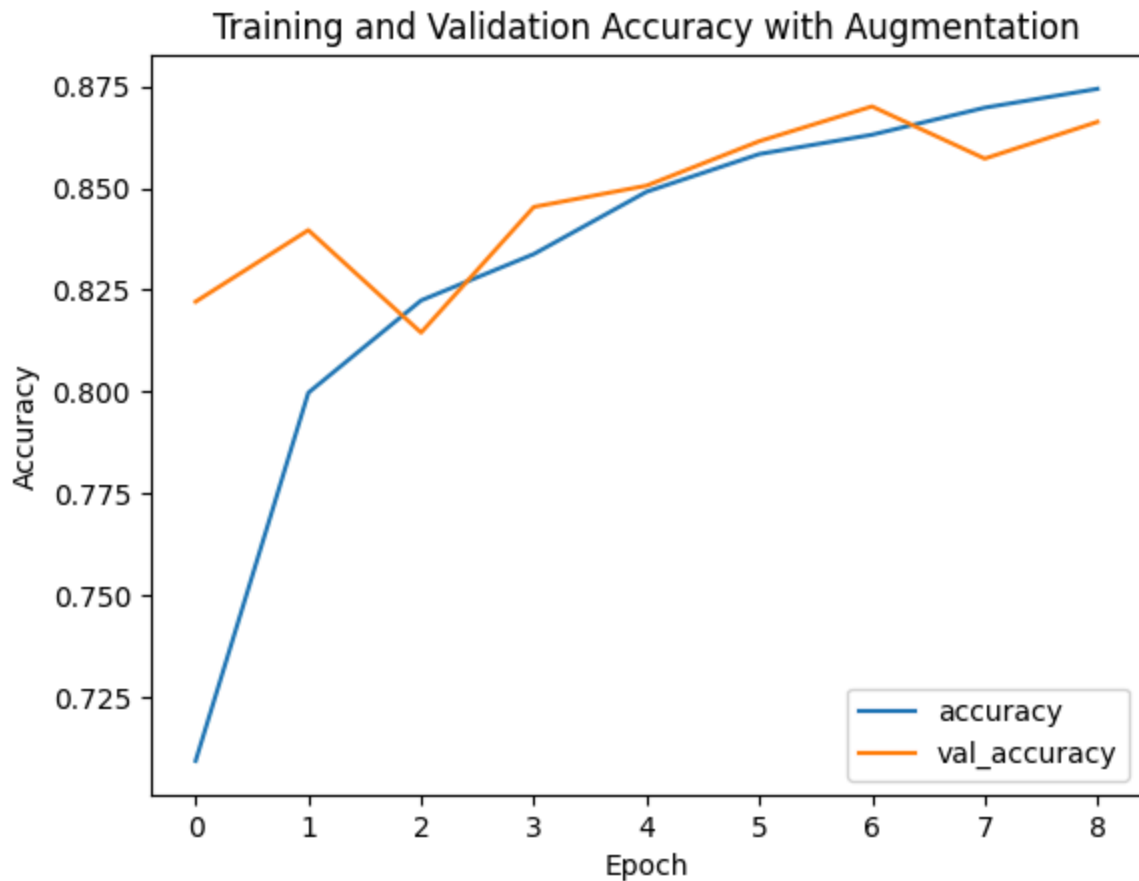
In [11]: plt.plot(history2.history['accuracy'], label='accuracy')
plt.plot(history2.history['val_accuracy'], label = 'val_accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend(loc='lower right')
plt.title('Training and Validation Accuracy with Augmentation')

```

```

Out[11]: Text(0.5, 1.0, 'Training and Validation Accuracy with Augmentation')

```



With augmentation, the training and validation accuracy are much more closely correlated. It approaches the same accuracy as the non-augmented validation accuracy fluctuated around. They also stop after the same number of epochs.

The non-augmented model is much more overtrained early on and remains so. The augmented model does not suffer from overtraining to a significant degree.

Without early stopping, it appears the augmented model is starting to overfit and would continue to do so.

Part 2

1. Import, Inspect and Clean the Datasets

```
In [13]: import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
```

```
In [14]: df_tourism = pd.read_excel('tourism_with_id.xlsx')
df_user = pd.read_csv('user.csv')
df_tourism_rating = pd.read_csv('tourism_rating.csv')
df_user.head()
```


Out[14]:

	User_Id	Location	Age
0	1	Semarang, Jawa Tengah	20
1	2	Bekasi, Jawa Barat	21
2	3	Cirebon, Jawa Barat	23
3	4	Bekasi, Jawa Barat	21
4	5	Lampung, Sumatera Selatan	20

In [15]: `df_user['Location'].unique()`

Out[15]: array(['Semarang, Jawa Tengah', 'Bekasi, Jawa Barat',
'Cirebon, Jawa Barat', 'Lampung, Sumatera Selatan',
'Jakarta Utara, DKI Jakarta', 'Jakarta Selatan, DKI Jakarta',
'Bandung, Jawa Barat', 'Surabaya, Jawa Timur', 'Yogyakarta, DIY',
'Bogor, Jawa Barat', 'Depok, Jawa Barat',
'Jakarta Pusat, DKI Jakarta', 'Jakarta Timur, DKI Jakarta',
'Subang, Jawa Barat', 'Jakarta Barat, DKI Jakarta',
'Palembang, Sumatera Selatan', 'Sragen, Jawa Tengah',
'Ponorogo, Jawa Timur', 'Klaten, Jawa Tengah', 'Solo, Jawa Tengah',
'Tangerang, Banten', 'Serang, Banten', 'Cilacap, Jawa Tengah',
'Kota Gede, DIY', 'Karawang, Jawa Barat', 'Purwakarat, Jawa Barat',
'Nganjuk, Jawa Timur', 'Madura, Jawa Timur'], dtype=object)

In [16]: `df_tourism['City'].unique()`

Out[16]: array(['Jakarta', 'Yogyakarta', 'Bandung', 'Semarang', 'Surabaya'],
dtype=object)

In [17]: `df_user.drop_duplicates(subset='User_Id', keep='first', inplace=True)`
`df_user = df_user.dropna()`
`df_user.info()`

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 300 entries, 0 to 299
Data columns (total 3 columns):
#   Column      Non-Null Count  Dtype
---  ---
0   User_Id     300 non-null    int64
1   Location    300 non-null    object
2   Age         300 non-null    int64
dtypes: int64(2), object(1)
memory usage: 7.2+ KB
```

In [18]: `df_tourism.info()`
`# df_tourism.drop_duplicates(subset='Tourism_Id', keep='first', inplace=True)`

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 437 entries, 0 to 436
Data columns (total 13 columns):
#   Column          Non-Null Count  Dtype
---  ---
0   Place_Id        437 non-null   int64
1   Place_Name      437 non-null   object
2   Description      437 non-null   object
3   Category        437 non-null   object
4   City            437 non-null   object
5   Price           437 non-null   int64
6   Rating          437 non-null   float64
7   Time_Minutes    205 non-null   float64
8   Coordinate      437 non-null   object
9   Lat             437 non-null   float64
10  Long            437 non-null   float64
11  Unnamed: 11     0 non-null     float64
12  Unnamed: 12     437 non-null   int64
dtypes: float64(5), int64(3), object(5)
memory usage: 44.5+ KB
```

```
In [19]: df_tourism = df_tourism.drop('Unnamed: 11', axis=1)
df_tourism = df_tourism.drop('Unnamed: 12', axis=1)
df_tourism['Time_Minutes'] = df_tourism['Time_Minutes'].fillna(df_tourism['Time_Min
```

```
In [20]: df_tourism_rating.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10000 entries, 0 to 9999
Data columns (total 3 columns):
#   Column          Non-Null Count  Dtype
---  ---
0   User_Id         10000 non-null  int64
1   Place_Id        10000 non-null  int64
2   Place_Ratings   10000 non-null  int64
dtypes: int64(3)
memory usage: 234.5 KB
```

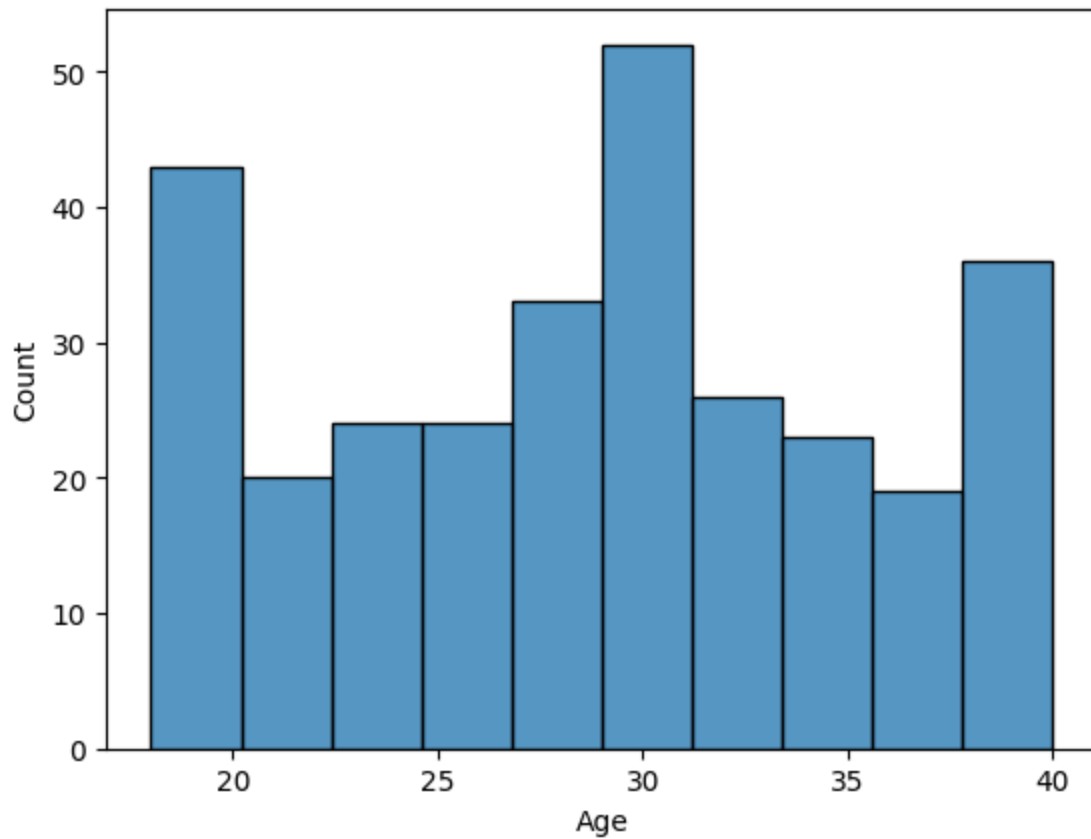
2. Examine the Data for Trends and Highlights

A. Explore the user group

A. Analyze the age distribution of the users

```
In [21]: sns.histplot(df_user['Age'])
```

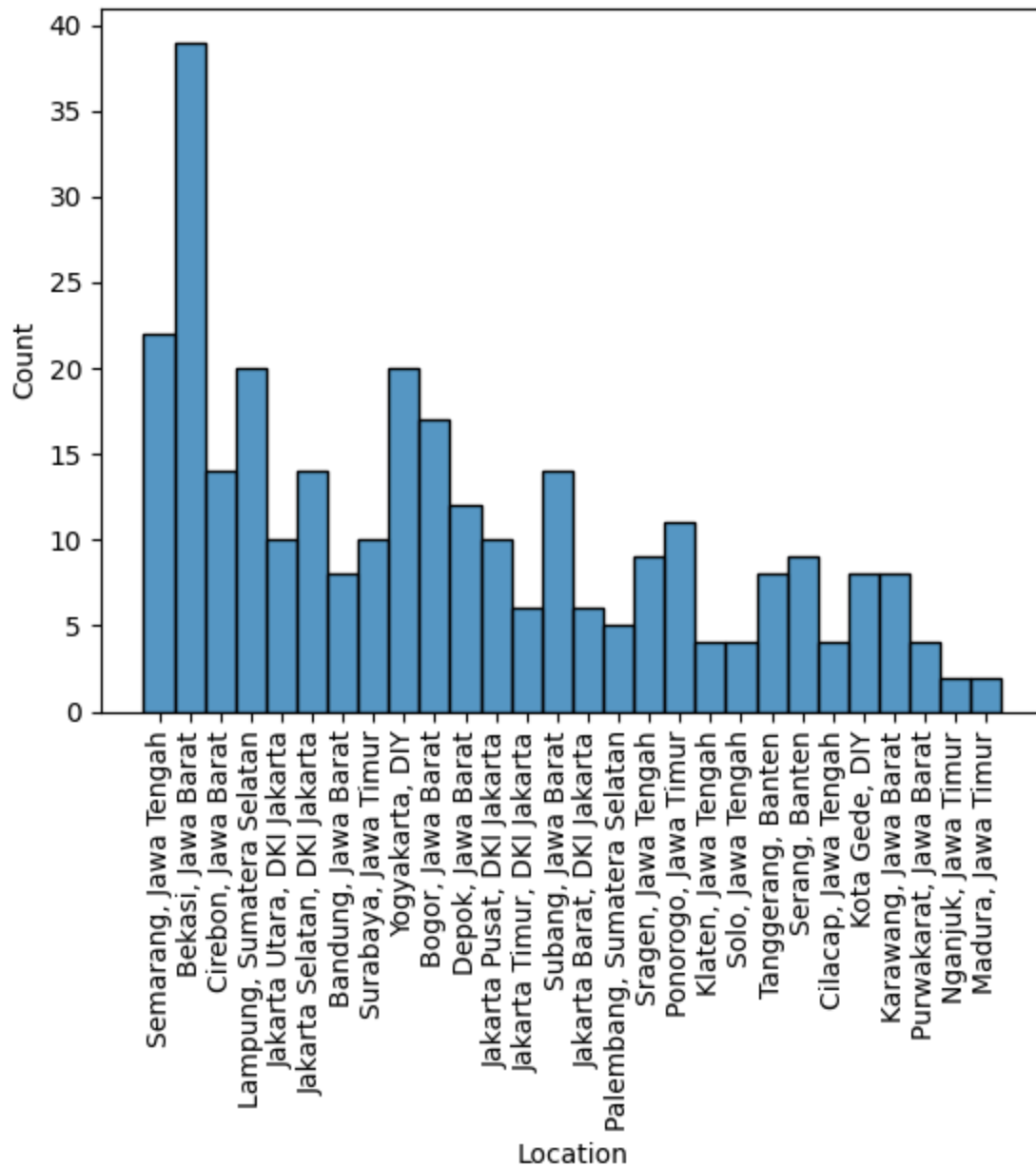
```
Out[21]: <Axes: xlabel='Age', ylabel='Count'>
```



B. Identiry where most of the users are coming from

```
In [22]: plt.xticks(rotation=90)
sns.histplot(df_user['Location'])
```

```
Out[22]: <Axes: xlabel='Location', ylabel='Count'>
```



3. Explore the locations and categories of the tourist spots

A. What are the different categories of tourist spots?

```
In [23]: df_tourism['Category'].value_counts()
```

```
Out[23]: Category
Taman Hiburan      135
Budaya              117
Cagar Alam          106
Bahari              47
Tempat Ibadah       17
Pusat Perbelanjaan  15
Name: count, dtype: int64
```

B. What kind of tourism is each location most famous or suitable for?

```
In [24]: grouped = df_tourism.groupby('City')['Category']
grouped.describe()
```

```
Out[24]:
```

	count	unique	top	freq
City				
Bandung	124	5	Cagar Alam	54
Jakarta	84	6	Budaya	32
Semarang	57	5	Cagar Alam	20
Surabaya	46	6	Taman Hiburan	18
Yogyakarta	126	5	Taman Hiburan	36

C. Which city would be best for a nature enthusiast to visit?

cagar alam = nature reserve taman hiburan = theme park budaya = culture tempat ibadah = place of worship Pusat Perbelanjaan = shopping center

Each city has a unique concentration of tourism locations. And each one has a different category as its most suitable.

A nature enthusiast would be best visiting Bandung. It has by far the highest concentration of nature reserves.

4. Create a combined data with places and their user ratings

```
In [25]: df_tourism_with_rating = df_tourism.merge(df_tourism_rating, on='Place_Id', how='in
df_tourism_with_rating.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10000 entries, 0 to 9999
Data columns (total 13 columns):
#   Column          Non-Null Count  Dtype
---  ---
0   Place_Id        10000 non-null  int64
1   Place_Name      10000 non-null  object
2   Description     10000 non-null  object
3   Category        10000 non-null  object
4   City            10000 non-null  object
5   Price           10000 non-null  int64
6   Rating          10000 non-null  float64
7   Time_Minutes    10000 non-null  float64
8   Coordinate      10000 non-null  object
9   Lat             10000 non-null  float64
10  Long            10000 non-null  float64
11  User_Id         10000 non-null  int64
12  Place_Ratings   10000 non-null  int64
dtypes: float64(4), int64(4), object(5)
memory usage: 1015.8+ KB
```

A. Use this to figure out the most loved spots by tourists.

```
In [26]: grouped = df_tourism_with_rating.groupby('Place_Name')['Rating'].agg('mean').sort_v
grouped
```

```
Out[26]: Place_Name
Desa Wisata Sungai Code Jogja Kota    5.0
Wisata Kuliner Pecenongan             5.0
Freedom Library                       5.0
Kauman Pakualaman Yogyakarta          5.0
Kebun Tanaman Obat Sari Alam          4.9
...
Desa Wisata Lembah Kalipancur         3.9
Curug Cipanas                       3.9
Tektona Waterpark                    3.8
Kampoeng Tulip                      3.8
Pantai Maron                         3.4
Name: Rating, Length: 437, dtype: float64
```

B. Which city has the most loved tourist spots?

```
In [27]: grouped = df_tourism_with_rating.groupby('City')['Rating'].agg('mean').sort_values(
grouped
```

```
Out[27]: City
Jakarta      4.491302
Yogyakarta   4.466040
Surabaya     4.454190
Bandung      4.426742
Semarang     4.369021
Name: Rating, dtype: float64
```

C. Which category of attraction are users liking the most?

```
In [28]: grouped = df_tourism_with_rating.groupby('Category')['Rating'].agg('mean').sort_val
grouped
```

```
Out[28]: Category
Tempat Ibadah      4.715844
Budaya             4.523034
Pusat Perbelanjaan 4.457662
Cagar Alam         4.404058
Taman Hiburan     4.401965
Bahari             4.369694
Name: Rating, dtype: float64
```

5. Build a recommender model for the system

Use the above data to develop a collaborative filtering model for the recommendation and use that to recommend other places to visit using the current tourist location (place name)

This presents a unique challenge with the data given. The user 'Location' column does not necessarily correspond to the tourism 'City' column. There are 5 unique cities and 28 unique user locations. I see two ways of handling this.

1. By region.

- Parse the user location and pick out the region.
- Associate one of the five major cities with each region.
- Recommend the user places from that city.

2. By lat/long.

- Get lat/long coordinates for each of the 28 unique User locations.
- Use those coordinates to recommend similar locations sorted by distance.

Recommending by region risks running into edge cases where a user may be on the edge of one region and closer to a neighboring region's major city and attractions.

Recommending by lat/long would be more arduous, but has the added benefit of similar lat/longs adding to the Pearson Correlation Coefficient during model building. As a result I'll be using this method.

I'll use the geopy library to extract lat/long from the location name.

```
In [29]: from sklearn.decomposition import TruncatedSVD
from geopy.geocoders import Nominatim
import numpy as np
```

A. Generate Location Data

Loop through all the unique location names and make sure we can get actual locations for each one.

```
In [30]: geolocator = Nominatim(user_agent="IndonesiaCoordinates")
locations = df_user['Location'].unique().tolist()

latitudes = []
longitudes = []

for location in locations:
    location_obj = geolocator.geocode(location)
    if location_obj:
        latitudes.append(location_obj.latitude)
        longitudes.append(location_obj.longitude)
    else:
        latitudes.append(None)
        longitudes.append(None)

print(latitudes)
```

```
[-6.9903988, -6.2349858, -6.7137044, -3.2069578, -6.136197, -6.28381815, -6.9215529,
-7.2459717, -7.8011998, -6.5962986, -6.40719, -6.18233995, -6.26289085, -6.49838875,
-6.161569, -2.9888243, -7.3924563, -7.97122665, -7.673189949999999, -7.5692489, -6.3
2990335, -6.032761, -7.46167105, None, -6.3021906, None, -7.600335, -7.0588909]
```

It seems some of the locations are returning none, because they're spelled incorrectly in the CSV. We will replace them with the correct spelling to be able to get actual location data.

```
In [31]: df_user['Location'] = df_user['Location'].str.replace("Purwakarat, Jawa Barat", "Pu
df_user['Location'] = df_user['Location'].str.replace("Kota Gede, DIY", "Kotagede,
```

We'll now rerun the loop to get a complete list of coordinates.

```
In [32]: latitudes = []
longitudes = []

for location in locations:
    location_obj = geolocator.geocode(location)
    if location_obj:
        latitudes.append(location_obj.latitude)
        longitudes.append(location_obj.longitude)
    else:
        latitudes.append(None)
        longitudes.append(None)

print(latitudes)
```

```
[-6.9903988, -6.2349858, -6.7137044, -3.2069578, -6.136197, -6.28381815, -6.9215529,
-7.2459717, -7.8011998, -6.5962986, -6.40719, -6.18233995, -6.26289085, -6.49838875,
-6.161569, -2.9888243, -7.3924563, -7.97122665, -7.673189949999999, -7.5692489, -6.3
2990335, -6.032761, -7.46167105, None, -6.3021906, None, -7.600335, -7.0588909]
```

Now we have actual location data for every unique place name.

Now we have 3 lists.

- Location Name
- Latitude
- Longitude

We can now create 2 new columns to go in our user dataframe. 1 for latitude, 1 for longitude. We'll create 2 dictionaries and map the lat/long to each unique value.

```
In [33]: location_lats = dict(zip(locations, latitudes))
location_longs = dict(zip(locations, longitudes))

df_user['User_Lat'] = df_user['Location'].map(location_lats)
df_user['User_Long'] = df_user['Location'].map(location_longs)

df_user.head()
```

Out[33]:

	User_Id	Location	Age	User_Lat	User_Long
0	1	Semarang, Jawa Tengah	20	-6.990399	110.422910
1	2	Bekasi, Jawa Barat	21	-6.234986	106.994544
2	3	Cirebon, Jawa Barat	23	-6.713704	108.560848
3	4	Bekasi, Jawa Barat	21	-6.234986	106.994544
4	5	Lampung, Sumatera Selatan	20	-3.206958	104.649490

B. Create and Prepare the Utility Matrix

We want to create a similarity matrix first using all available locations so the model has maximum data to work with.

```
In [34]: df_combined = df_user.merge(df_tourism_rating.merge(df_tourism, on='Place_Id'), on=
df_combined.head()
```

Out[34]:

	User_Id	Location	Age	User_Lat	User_Long	Place_Id	Place_Ratings	Place_Name
0	1	Semarang, Jawa Tengah	20	-6.990399	110.42291	179	3	Candi Ratu Boko
1	1	Semarang, Jawa Tengah	20	-6.990399	110.42291	344	2	Pantai Marina
2	1	Semarang, Jawa Tengah	20	-6.990399	110.42291	5	5	Atlantis Water Adventure
3	1	Semarang, Jawa Tengah	20	-6.990399	110.42291	373	3	Museum Kereta Ambarawa
4	1	Semarang, Jawa Tengah	20	-6.990399	110.42291	101	4	Kampung Wisata Sosro Menduran

```
In [35]: df_combined = df_combined.drop('Coordinate', axis=1)
df_combined.head()
```

Out[35]:

	User_Id	Location	Age	User_Lat	User_Long	Place_Id	Place_Ratings	Place_Name
0	1	Semarang, Jawa Tengah	20	-6.990399	110.42291	179	3	Candi Ratu Boko
1	1	Semarang, Jawa Tengah	20	-6.990399	110.42291	344	2	Pantai Marina
2	1	Semarang, Jawa Tengah	20	-6.990399	110.42291	5	5	Atlantis Water Adventure
3	1	Semarang, Jawa Tengah	20	-6.990399	110.42291	373	3	Museum Kereta Ambarawa
4	1	Semarang, Jawa Tengah	20	-6.990399	110.42291	101	4	Kampung Wisata Sosro Menduran

Using the combined matrix, we can build a crosstab matrix of users, place names, and ratings.

```
In [36]: rating_crosstab = df_combined.pivot_table(values='Place_Ratings', index='User_Id',
rating_crosstab.head())
```

Out[36]:

Place_Name	Air Mancur Menari	Air Terjun Kali Pancur	Air Terjun Kedung Pedut	Air Terjun Semirang	Air Terjun Sri Gethuk	Alive Museum Ancol	Alun Alun Selatan Yogyakarta	Alun- Alun Kota Bandung
User_Id								
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

5 rows × 437 columns

Now we'll transpose the matrix to use it in SVD.

```
In [37]: transposed_ratings = rating_crosstab.T
transposed_ratings.head()
```

```
Out[37]:
```

User_Id	1	2	3	4	5	6	7	8	9	10	...	291	292	293	294	295	2
Place_Name																	
Air Mancur Menari	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	
Air Terjun Kali Pancur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	3.0	
Air Terjun Kedung Pedut	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	
Air Terjun Semirang	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	
Air Terjun Sri Gethuk	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	

5 rows × 300 columns



C. Decompose the Utility matrix and Create the Similarity Matrix

Using the transposed matrix, we'll run a Single Value Decomposition on it to reduce the dimensionality.

```
In [38]: SVD = TruncatedSVD(n_components=10, random_state = 42)
resultant_matrix = SVD.fit_transform(transposed_ratings)
```

Using the decomposed matrix, we'll get a correlation matrix using the Pearson's R correlation coefficient.

```
In [39]: corr_matrix = np.corrcoef(resultant_matrix)
```

Now that we have a correlation for how similar each location is to every other location, we need to create a function to take a user id and do the following:

1. calculate a distance for every location from the user.
2. Sort the locations by distance and take the top X number of locations.
3. Take the user's highest rated location and get the similarity scores for the nearby locations.
4. Sort the locations by similarity and print the results.

D. Create the Recommendation Function

```

In [40]: def RecommendNearbyLocations(user_id, number_of_locations):
# Get user coordinates and a list of location coordinates to calculate distance
user_coords = df_user.loc[user_id, ['User_Lat', 'User_Long']].values
locations_coords = df_tourism[['Place_Name', 'Lat', 'Long']]

# Get the ID and place name of the user's top rated place
topRatedPlaceId = df_tourism_rating[df_tourism_rating['User_Id'] == user_id]
topRatedPlace = df_tourism[df_tourism['Place_Id'] == topRatedPlaceId]['Pla

# Calculate the distance from the user's location to each tourism location
df_tourism['distance'] = np.sqrt((locations_coords['Lat'] - user_coords[0])**2

# Get x number of the nearest locations dictated by number_of_locations
nearby_locations = df_tourism.nsmallest(number_of_locations, 'distance')['Place

# Get the column names in the rating_crosstab
place_names = rating_crosstab.columns.tolist()

# Get the column index of the top rated place and the nearby locations
place_index = place_names.index(topRatedPlace)

# Get the column indexes of the nearby locations
neaby_indexes = []
for location in nearby_locations:
    neaby_indexes.append(place_names.index(location))

# Get the column of the correlations to the user's top place
corr_top_place = corr_matrix[place_index]

# Get the correlations of nearby locations to that top place
nearby_correlations = []
for index in neaby_indexes:
    nearby_correlations.append(corr_top_place[index])

# Group the place names and their correlations together and sort by highest cor
correlated_locations = dict(zip(nearby_locations, nearby_correlations))
sorted_locations = sorted(correlated_locations.items(), key=lambda x: x[1], rev

# Print the sorted place names
for location in sorted_locations:
    print(location[0])

```

The function now returns nearby locations similar to one of the selected user's top rated destinations. Let's run it to see what we get out.

```

In [41]: RecommendNearbyLocations(20, 5)

```

```

Kampung Pelangi
Lawang Sewu
Pura Giri Natha
Taman Pandanaran
Indonesia Kaya Park

```