kurs

December 26, 2022

https://paperswithcode.com/dataset/oxford-102-flower

1 Oxford 102 Flower

oxford 102 flower , 102 ,
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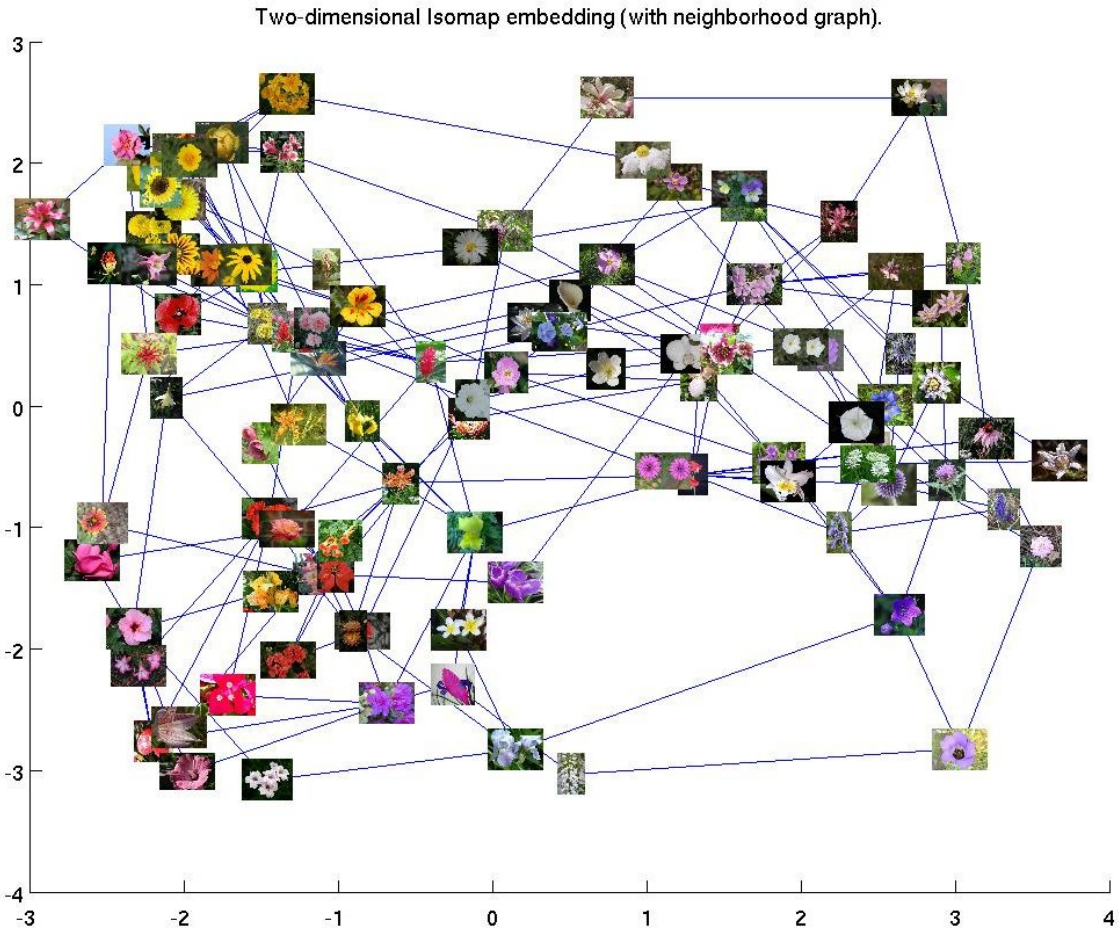
1.1


Two-dimensional Isomap embedding (with neighborhood graph).
3
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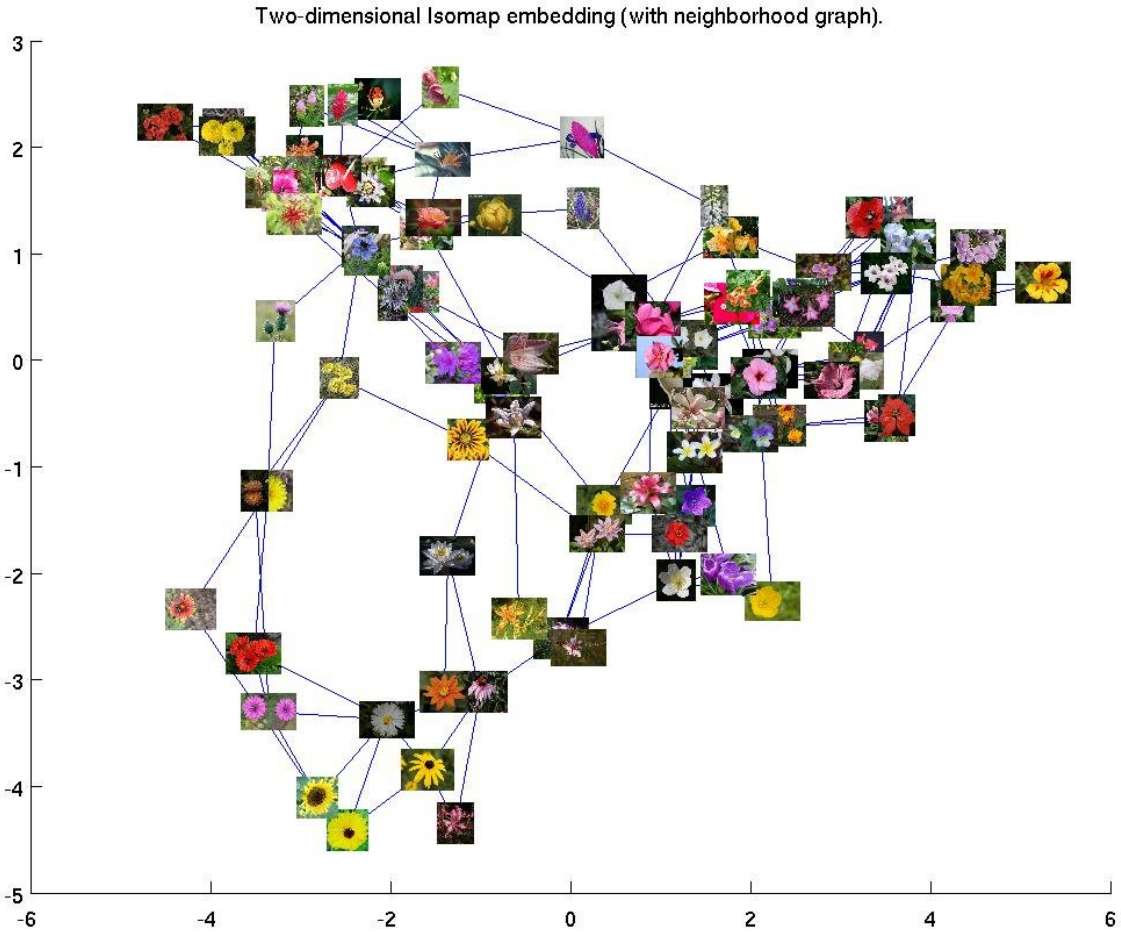

1.2

paperswithcode.com : - - -
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: - 102 (RGB) + -

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1.3

Big Transfer (BiT): General Visual Representation Learning (2019)

Big Transfer : , . ,
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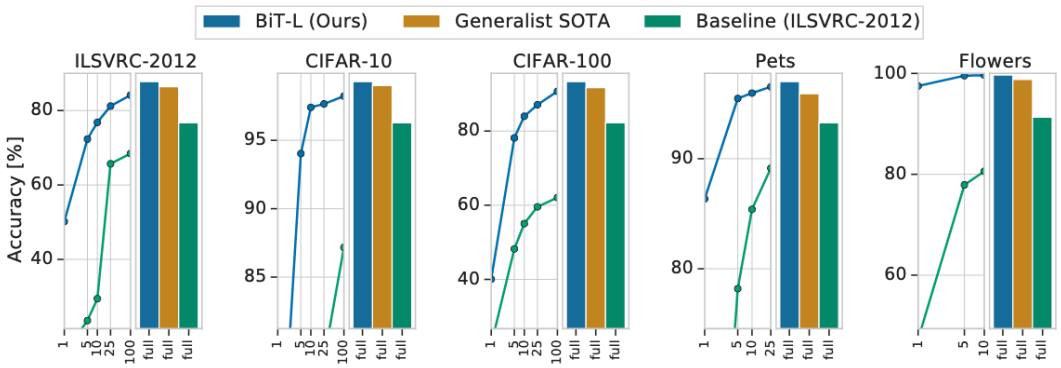
BiT-L, SOTA, ResNet-50 .



: - Upstream Pre-train - - Transfer to downstream tasks - -

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1.4

1.4.1

[167]:
```
import tensorflow as tf
import tensorflow_hub as hub

import time

from PIL import Image, ImageStat
import requests
from io import BytesIO

import matplotlib.pyplot as plt
import numpy as np

import glob, os
import pathlib

import plotly as xplt
import plotly.express as px
import plotly.graph_objects as go
import datetime
```

[98]:
```
tf_flowers_labels = ['dandelion', 'daisy', 'tulips', 'sunflowers', 'roses']
```

ResNet50

[3]:
```
model_url = "https://tfhub.dev/google/bit/m-r50x1/1"
module = hub.KerasLayer(model_url)
```

```
Metal device set to: Apple M1 Pro

2022-12-26 14:01:16.990700: I
tensorflow/core/common_runtime/pluggable_device/pluggable_device_factory.cc:305]
Could not identify NUMA node of platform GPU ID 0, defaulting to 0. Your kernel
may not have been built with NUMA support.
2022-12-26 14:01:16.990917: I
tensorflow/core/common_runtime/pluggable_device/pluggable_device_factory.cc:271]
Created TensorFlow device (/job:localhost/replica:0/task:0/device:GPU:0 with 0
MB memory) -> physical PluggableDevice (device: 0, name: METAL, pci bus id:
<undefined>)
```

[4]:
```
data_dir = tf.keras.utils.get_file(origin='https://storage.googleapis.com/
 ↪download.tensorflow.org/example_images/flower_photos.tgz',
                                   fname='flower_photos', untar=True)
data_dir = pathlib.Path(data_dir)
```

-

[176]:
```
from plotly.subplots import make_subplots
import plotly.graph_objects as go
from statistics import mean
import cv2

def plotdistribhw(imgs):
    df = {'width':[],'height':[]}
    for img in imgs:
        image = Image.open(img)
        df['width'].append(image.size[0])
        df['height'].append(image.size[1])
    fig = make_subplots(rows=1, cols=2)
    fig.add_trace(go.Histogram(x = df['width'], name = '              '),1,1)
    fig.add_trace(go.Histogram(x = df['height'], name = '              '),1,2)
    fig.update_layout(title_text='            ')
    fig.show()

def plotdistribcolor(imgs):
    df = {'R':[],'G':[],'B':[]}
    for img in imgs:
        image = Image.open(img)
        stat = ImageStat.Stat(image)
        df['R'].append(stat.mean[0])
        df['G'].append(stat.mean[1])
        df['B'].append(stat.mean[2])
```

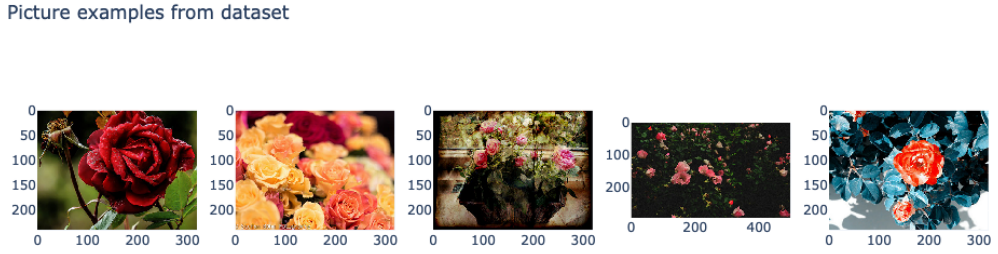
```
    fig = go.Figure()
    fig.add_trace(go.Histogram(x = df['R'], name = 'Red Channel'))
    fig.add_trace(go.Histogram(x = df['G'], name = 'Green Channel'))
    fig.add_trace(go.Histogram(x = df['B'], name = 'Blue Channel'))
    fig.update_layout(title_text='                    ')
    fig.show()

def datasetinfo(data_dir, tf_flowers_labels):
    imgs = glob.glob(f'{data_dir}/**/*.jpg', recursive=True)

    fig = make_subplots(rows=1, cols=5)
    for i, img in enumerate(imgs[55:60]):
        x = Image.open(img)
        fig.add_trace(go.Image(z=x), 1, i+1)
    fig.update_layout(
    height=300,
    title_text='Picture examples from dataset'
    )
    fig.show()

    print(f'            : {len(imgs)}\n          (         ):␣
 ↪{len(tf_flowers_labels)}')

    plotdistribhw(imgs)

    plotdistribcolor(imgs)
```

1.4.2

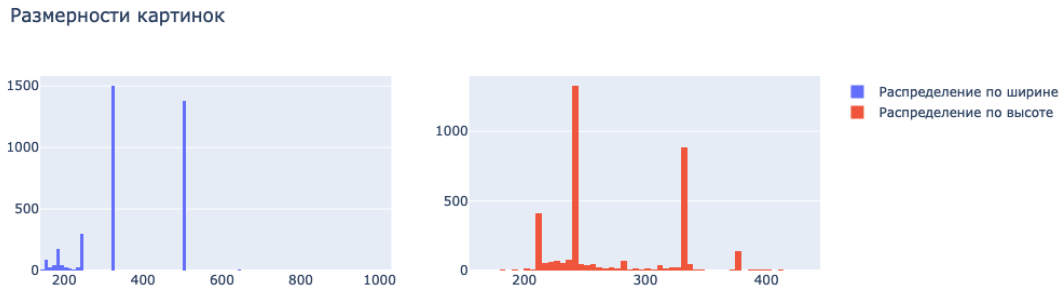
[71]:
```
print(data_dir)
```

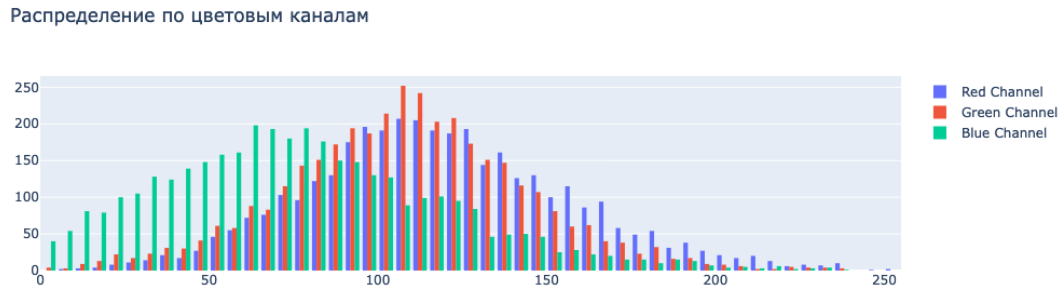
```
/Users/ivanskvortsov/.keras/datasets/flower_photos
```

[177]:
```
datasetinfo(data_dir, tf_flowers_labels)
```



: 3670
( ): 5





1.4.3 BiT-M R50x1

Feature extraction ResNet50-v2, ImageNet-21k
- 14 21.843 . 2048- , -
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: ResNet

ResNet50

[8]:
```
!wget https://storage.googleapis.com/bit_models/ilsvrc2012_wordnet_lemmas.txt

imagenet_int_to_str = {}

with open('ilsvrc2012_wordnet_lemmas.txt', 'r') as f:
  for i in range(1000):
```

```
    row = f.readline()
    row = row.rstrip()
    imagenet_int_to_str.update({i: row})
```

```
--2022-12-26 14:01:48--
https://storage.googleapis.com/bit_models/ilsvrc2012_wordnet_lemmas.txt
Resolving storage.googleapis.com (storage.googleapis.com)… 74.125.205.128,
64.233.165.128, 173.194.73.128, …
Connecting to storage.googleapis.com
(storage.googleapis.com)|74.125.205.128|:443… connected.
HTTP request sent, awaiting response… 200 OK
Length: 21675 (21K) [text/plain]
Saving to: ‘ilsvrc2012_wordnet_lemmas.txt.3’

ilsvrc2012_wordnet_ 100%[===================>]  21,17K  --.-KB/s    in 0,02s

2022-12-26 14:01:48 (1,04 MB/s) - ‘ilsvrc2012_wordnet_lemmas.txt.3’ saved
[21675/21675]
```

1.5

-

[9]:
```
IMG_HEIGHT = 224
IMG_WIDTH = 224

CLASS_NAMES = tf_flowers_labels  # from plotting helper functions above
NUM_CLASSES = len(CLASS_NAMES)
num_examples = len(list(data_dir.glob('*/*.jpg')))

def get_label(file_path):
  # convert the path to a list of path components
  parts = tf.strings.split(file_path, os.path.sep)
  # The second to last is the class-directory

  return tf.where(parts[-2] == CLASS_NAMES)[0][0]

def decode_img(img):
  # convert the compressed string to a 3D uint8 tensor
  img = tf.image.decode_jpeg(img, channels=3)
  return img

def process_path(file_path):
  label = get_label(file_path)
  # load the raw data from the file as a string
  img = tf.io.read_file(file_path)
  img = decode_img(img)
```

```
  features = {'image': img, 'label': label}
  return features

list_ds = tf.data.Dataset.list_files(str(data_dir/'*/*'))
ds = list_ds.map(process_path, num_parallel_calls=tf.data.experimental.AUTOTUNE)
```

[10]:
```
def preprocess_image(image):
  image = np.array(image)
  # reshape into shape [batch_size, height, width, num_channels]
  img_reshaped = tf.reshape(image, [1, image.shape[0], image.shape[1], image.
 ↪shape[2]])
  # Use `convert_image_dtype` to convert to floats in the [0,1] range.
  image = tf.image.convert_image_dtype(img_reshaped, tf.float32)
  return image

def load_image_from_url(url):
  """Returns an image with shape [1, height, width, num_channels]."""
  response = requests.get(url)
  image = Image.open(BytesIO(response.content))
  image = preprocess_image(image)
  return image
```

1.5.1

[11]:
```
# Show the MAX_PREDS highest scoring labels:
MAX_PREDS = 5
# Do not show labels with lower score than this:
MIN_SCORE = 0.8

def show_preds(logits, image, correct_flowers_label=None,␣
 ↪tf_flowers_logits=False):

  if len(logits.shape) > 1:
    logits = tf.reshape(logits, [-1])

  fig, axes = plt.subplots(1, 2, figsize=(7, 4), squeeze=False)

  ax1, ax2 = axes[0]

  ax1.axis('off')
  ax1.imshow(image)
  if correct_flowers_label is not None:
    ax1.set_title(tf_flowers_labels[correct_flowers_label])
  classes = []
  scores = []
```

```
  logits_max = np.max(logits)
  softmax_denominator = np.sum(np.exp(logits - logits_max))
  for index, j in enumerate(np.argsort(logits)[-MAX_PREDS::][::-1]):
    score = 1.0/(1.0 + np.exp(-logits[j]))
    if score < MIN_SCORE: break
    if not tf_flowers_logits:
      # predicting in imagenet label space
      classes.append(imagenet_int_to_str[j])
    else:
      # predicting in tf_flowers label space
      classes.append(tf_flowers_labels[j])
    scores.append(np.exp(logits[j] - logits_max)/softmax_denominator*100)

  ax2.barh(np.arange(len(scores)) + 0.1, scores)
  ax2.set_xlim(0, 100)
  ax2.set_yticks(np.arange(len(scores)))
  ax2.yaxis.set_ticks_position('right')
  ax2.set_yticklabels(classes, rotation=0, fontsize=14)
  ax2.invert_xaxis()
  ax2.invert_yaxis()
  ax2.set_xlabel('Prediction probabilities', fontsize=11)
```

[12]:
```
print(data_dir)
```

```
/Users/ivanskvortsov/.keras/datasets/flower_photos
```

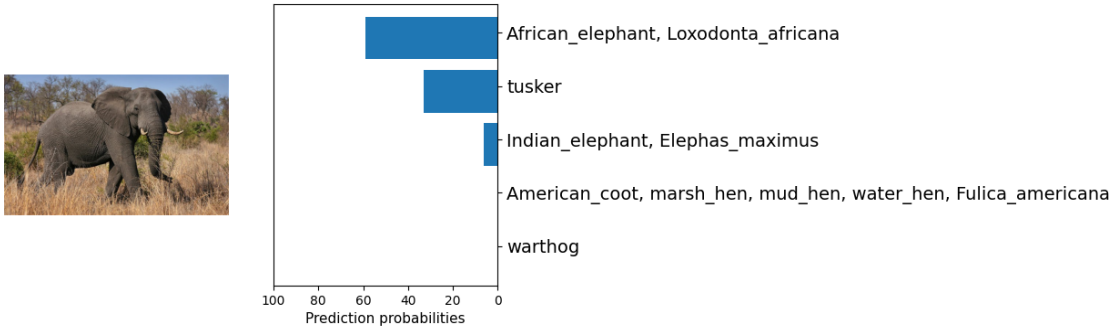
1.6 Showcase

[13]:
```
model_url = "https://tfhub.dev/google/bit/m-r50x1/ilsvrc2012_classification/1"
imagenet_module = hub.KerasLayer(model_url)
```

[16]:
```
# Load image (image provided is CC0 licensed)
img_url = "http://images6.fanpop.com/image/photos/34700000/
  ↪Grey-Elephant-colors-34712059-620-388.jpg"
image = load_image_from_url(img_url)

# Run model on image
logits = imagenet_module(image)

# Show image and predictions
show_preds(logits, image[0])
```



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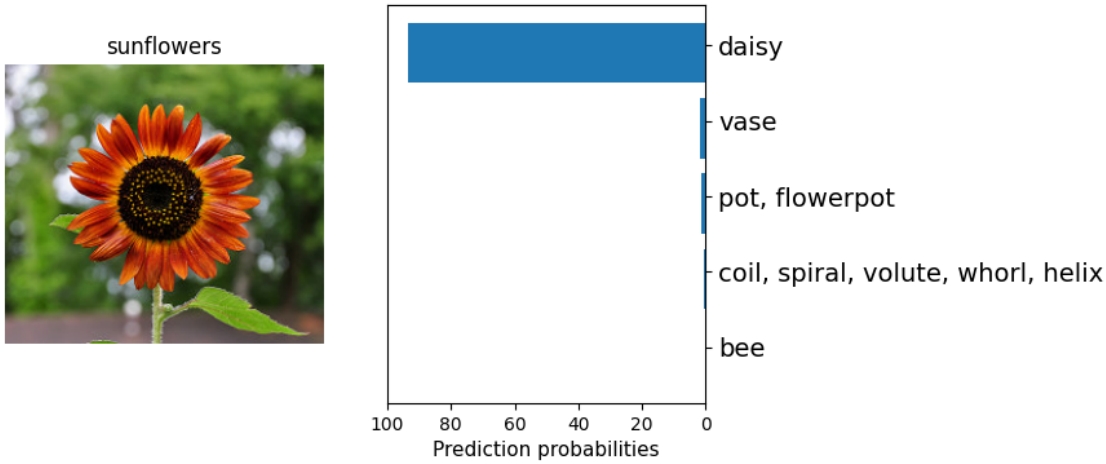
[17]:
```
train_split = 0.9
num_train = int(train_split * num_examples)
ds_train = ds.take(num_train)
ds_test = ds.skip(num_train)

DATASET_NUM_TRAIN_EXAMPLES = num_examples
```

[18]:
```
for features in ds_train.take(1):
  image = features['image']
  image = preprocess_image(image)

  # Run model on image
  logits = imagenet_module(image)

  # Show image and predictions
  show_preds(logits, image[0], correct_flowers_label=features['label'].numpy())
```

```
2022-12-26 14:02:57.453063: I
tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113]
Plugin optimizer for device_type GPU is enabled.
```



1.7 ( )

1.7.1

[19]:
```
# Add new head to the BiT model

class MyBiTModel(tf.keras.Model):
  """BiT with a new head."""

  def __init__(self, num_classes, module):
    super().__init__()

    self.num_classes = num_classes
    self.head = tf.keras.layers.Dense(num_classes, kernel_initializer='zeros')
    self.bit_model = module

  def call(self, images):
    # No need to cut head off since we are using feature extractor model
    bit_embedding = self.bit_model(images)
    return self.head(bit_embedding)

model = MyBiTModel(num_classes=NUM_CLASSES, module=module)
```

[20]:
```
IMAGE_SIZE = "=\u003C96x96 px" #@param ["=<96x96 px","> 96 x 96 px"]
DATASET_SIZE = "\u003C20k examples" #@param ["<20k examples", "20k-500k␣
 ↪examples", ">500k examples"]

if IMAGE_SIZE == "=<96x96 px":
  RESIZE_TO = 160
  CROP_TO = 128
else:
```

```
  RESIZE_TO = 512
  CROP_TO = 480

if DATASET_SIZE == "<20k examples":
  SCHEDULE_LENGTH = 500
  SCHEDULE_BOUNDARIES = [200, 300, 400]
elif DATASET_SIZE == "20k-500k examples":
  SCHEDULE_LENGTH = 10000
  SCHEDULE_BOUNDARIES = [3000, 6000, 9000]
else:
  SCHEDULE_LENGTH = 20000
  SCHEDULE_BOUNDARIES = [6000, 12000, 18000]
```

[21]:
```
# Preprocessing helper functions

# Create data pipelines for training and testing:
BATCH_SIZE = 512
SCHEDULE_LENGTH = SCHEDULE_LENGTH * 512 / BATCH_SIZE

STEPS_PER_EPOCH = 10

def cast_to_tuple(features):
  return (features['image'], features['label'])

def preprocess_train(features):
  # Apply random crops and horizontal flips for all tasks
  # except those for which cropping or flipping destroys the label semantics
  # (e.g. predict orientation of an object)
  features['image'] = tf.image.random_flip_left_right(features['image'])
  features['image'] = tf.image.resize(features['image'], [RESIZE_TO, RESIZE_TO])
  features['image'] = tf.image.random_crop(features['image'], [CROP_TO,␣
 ↪CROP_TO, 3])
  features['image'] = tf.cast(features['image'], tf.float32) / 255.0
  return features

def preprocess_test(features):
  features['image'] = tf.image.resize(features['image'], [RESIZE_TO, RESIZE_TO])
  features['image'] = tf.cast(features['image'], tf.float32) / 255.0
  return features

pipeline_train = (ds_train
                  .shuffle(10000)
                  .repeat(int(SCHEDULE_LENGTH * BATCH_SIZE /␣
 ↪DATASET_NUM_TRAIN_EXAMPLES * STEPS_PER_EPOCH) + 1 + 50)  # repeat␣
 ↪dataset_size / num_steps
                  .map(preprocess_train, num_parallel_calls=8)
                  .batch(BATCH_SIZE)
```

```
                  .map(cast_to_tuple)  # for keras model.fit
                  .prefetch(2))

pipeline_test = (ds_test.map(preprocess_test, num_parallel_calls=1)
                  .map(cast_to_tuple)  # for keras model.fit
                  .batch(BATCH_SIZE)
                  .prefetch(2))
```

[22]:
```
# Define optimiser and loss

lr = 0.003 * BATCH_SIZE / 512

# Decay learning rate by a factor of 10 at SCHEDULE_BOUNDARIES.
lr_schedule = tf.keras.optimizers.schedules.
 ↪PiecewiseConstantDecay(boundaries=SCHEDULE_BOUNDARIES,
                                                                values=[lr,␣
 ↪lr*0.1, lr*0.001, lr*0.0001])
optimizer = tf.keras.optimizers.SGD(learning_rate=lr_schedule, momentum=0.9)

loss_fn = tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True)
```

1.7.2

[27]:
```
%load_ext tensorboard
```

[32]:
```
# model.compile(optimizer=optimizer,
#               loss=loss_fn,
#               metrics=['accuracy'])

# log_dir = "./logs/fit/" + datetime.datetime.now().strftime("%Y%m%d-%H%M%S")
# tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=log_dir)#,␣
 ↪histogram_freq=1)

# # histogram_freq=1 -                (                  )

# # Fine-tune model
# history = model.fit(
#     pipeline_train,
#     batch_size=BATCH_SIZE,
#     steps_per_epoch=STEPS_PER_EPOCH,
#     epochs= 10,
#     validation_data=pipeline_test,
#     callbacks=[tensorboard_callback]
# )
```

```
Epoch 1/10
```

```
2022-12-26 14:40:56.799844: I
tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113]
Plugin optimizer for device_type GPU is enabled.

10/10 [==============================] - ETA: 0s - loss: 0.0626 - accuracy:
0.9812

2022-12-26 14:41:36.350812: I
tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113]
Plugin optimizer for device_type GPU is enabled.

WARNING:tensorflow:6 out of the last 6 calls to <function
Model.make_test_function.<locals>.test_function at 0x2e6ce8ee0> triggered
tf.function retracing. Tracing is expensive and the excessive number of tracings
could be due to (1) creating @tf.function repeatedly in a loop, (2) passing
tensors with different shapes, (3) passing Python objects instead of tensors.
For (1), please define your @tf.function outside of the loop. For (2),
@tf.function has reduce_retracing=True option that can avoid unnecessary
retracing. For (3), please refer to
https://www.tensorflow.org/guide/function#controlling_retracing and
https://www.tensorflow.org/api_docs/python/tf/function for  more details.

WARNING:tensorflow:6 out of the last 6 calls to <function
Model.make_test_function.<locals>.test_function at 0x2e6ce8ee0> triggered
tf.function retracing. Tracing is expensive and the excessive number of tracings
could be due to (1) creating @tf.function repeatedly in a loop, (2) passing
tensors with different shapes, (3) passing Python objects instead of tensors.
For (1), please define your @tf.function outside of the loop. For (2),
@tf.function has reduce_retracing=True option that can avoid unnecessary
retracing. For (3), please refer to
https://www.tensorflow.org/guide/function#controlling_retracing and
https://www.tensorflow.org/api_docs/python/tf/function for  more details.

10/10 [==============================] - 59s 5s/step - loss: 0.0626 - accuracy:
0.9812 - val_loss: 0.0389 - val_accuracy: 0.9891
Epoch 2/10
10/10 [==============================] - 25s 3s/step - loss: 0.0599 - accuracy:
0.9826 - val_loss: 0.0699 - val_accuracy: 0.9782
Epoch 3/10
10/10 [==============================] - 26s 3s/step - loss: 0.0542 - accuracy:
0.9822 - val_loss: 0.0503 - val_accuracy: 0.9891
Epoch 4/10
10/10 [==============================] - 24s 2s/step - loss: 0.0512 - accuracy:
0.9863 - val_loss: 0.0231 - val_accuracy: 0.9973
Epoch 5/10
10/10 [==============================] - 26s 3s/step - loss: 0.0441 - accuracy:
0.9852 - val_loss: 0.0296 - val_accuracy: 0.9864
Epoch 6/10
10/10 [==============================] - 23s 2s/step - loss: 0.0424 - accuracy:
0.9863 - val_loss: 0.0431 - val_accuracy: 0.9837
```

```
Epoch 7/10
10/10 [==============================] - 24s 2s/step - loss: 0.0371 - accuracy:
0.9873 - val_loss: 0.0158 - val_accuracy: 1.0000
Epoch 8/10
10/10 [==============================] - 26s 3s/step - loss: 0.0369 - accuracy:
0.9904 - val_loss: 0.0278 - val_accuracy: 0.9946
Epoch 9/10
10/10 [==============================] - 23s 2s/step - loss: 0.0391 - accuracy:
0.9875 - val_loss: 0.0458 - val_accuracy: 0.9864
Epoch 10/10
10/10 [==============================] - 22s 2s/step - loss: 0.0317 - accuracy:
0.9906 - val_loss: 0.0469 - val_accuracy: 0.9864
```

[33]:
```
%tensorboard --logdir logs/fit
```

```
<IPython.core.display.HTML object>
```

[36]:
```
# #Save fine-tuned model as SavedModel
# export_module_dir = './tmp/my_saved_bit_model/'
# tf.saved_model.save(model, export_module_dir)
```

```
INFO:tensorflow:Assets written to: ./tmp/my_saved_bit_model/assets

INFO:tensorflow:Assets written to: ./tmp/my_saved_bit_model/assets
```

1.7.3 showcase

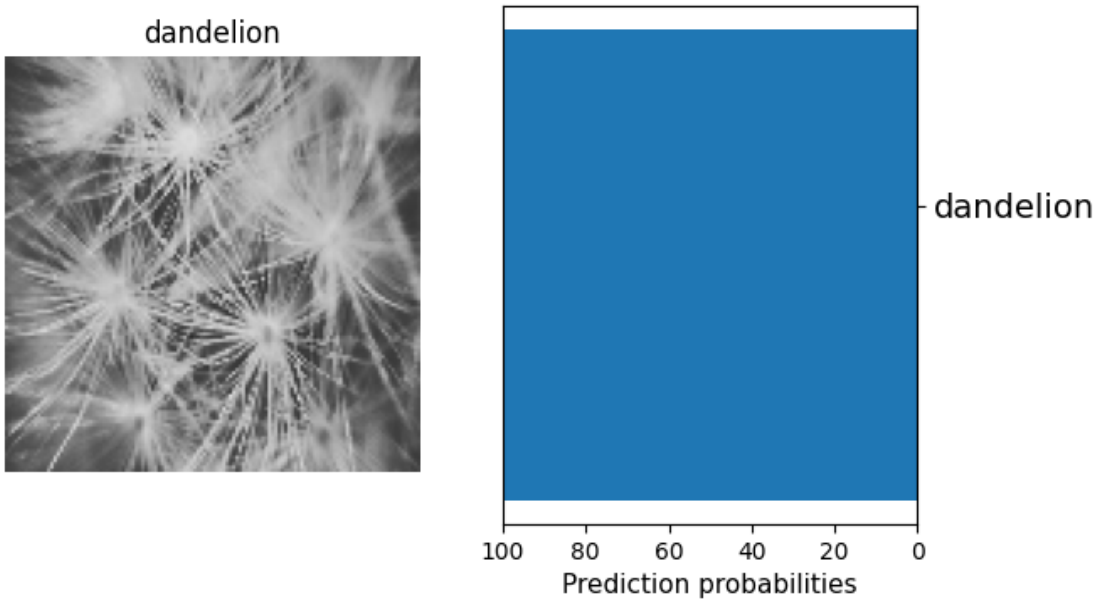
[37]:
```
saved_module = hub.KerasLayer(export_module_dir, trainable=True)
```

```
2022-12-26 14:49:02.825135: W
tensorflow/core/common_runtime/graph_constructor.cc:805] Node
're_lu_48/PartitionedCall' has 1 outputs but the _output_shapes attribute
specifies shapes for 2 outputs. Output shapes may be inaccurate.
2022-12-26 14:49:02.825908: W
tensorflow/core/common_runtime/graph_constructor.cc:805] Node
'global_average_pooling2d/PartitionedCall' has 1 outputs but the _output_shapes
attribute specifies shapes for 4 outputs. Output shapes may be inaccurate.
```

[38]:
```
for features in ds_train.take(1):
  image = features['image']
  image = preprocess_image(image)
  image = tf.image.resize(image, [CROP_TO, CROP_TO])

  # Run model on image
  logits = saved_module(image)

  # Show image and predictions
```

```
  show_preds(logits, image[0], correct_flowers_label=features['label'].numpy(),␣
↪tf_flowers_logits=True)
```

```
2022-12-26 14:49:07.590225: I
tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113]
Plugin optimizer for device_type GPU is enabled.
```



1.8 Preprocessing ESRGAN

Enhanced Super Resolution GAN

- .

1.8.1 -

[180]:
```
def preprocess_image(image_path):
  """ Loads image from path and preprocesses to make it model ready
      Args:
        image_path: Path to the image file
  """
  hr_image = tf.image.decode_image(tf.io.read_file(image_path))
  # If PNG, remove the alpha channel. The model only supports
  # images with 3 color channels.
  if hr_image.shape[-1] == 4:
    hr_image = hr_image[...,:-1]
  hr_size = (tf.convert_to_tensor(hr_image.shape[:-1]) // 4) * 4
  hr_image = tf.image.crop_to_bounding_box(hr_image, 0, 0, hr_size[0],␣
↪hr_size[1])
```

```
  hr_image = tf.cast(hr_image, tf.float32)
  return tf.expand_dims(hr_image, 0)

def save_image(image, filename):
  """
    Saves unscaled Tensor Images.
    Args:
      image: 3D image tensor. [height, width, channels]
      filename: Name of the file to save.
  """
  if not isinstance(image, Image.Image):
    image = tf.clip_by_value(image, 0, 255)
    image = Image.fromarray(tf.cast(image, tf.uint8).numpy())
  image.save("%s.jpg" % filename)
  print("Saved as %s.jpg" % filename)


def plot_image(image, title=""):
  """
    Plots images from image tensors.
    Args:
      image: 3D image tensor. [height, width, channels].
      title: Title to display in the plot.
  """
  image = np.asarray(image)
  image = tf.clip_by_value(image, 0, 255)
  image = Image.fromarray(tf.cast(image, tf.uint8).numpy())
  plt.imshow(image)
  plt.axis("off")
  plt.title(title)
```

1.8.2 ESRGAN

[181]:
```
ESR_SAVED_MODEL_PATH = "https://tfhub.dev/captain-pool/esrgan-tf2/1"
IMAGE_PATH="image.jpg"
```

ESRGAN tfhub

[182]:
```
hr_image = preprocess_image(IMAGE_PATH)
plot_image(tf.squeeze(hr_image), title="Original Image")
save_image(tf.squeeze(hr_image), filename="Original Image")
```

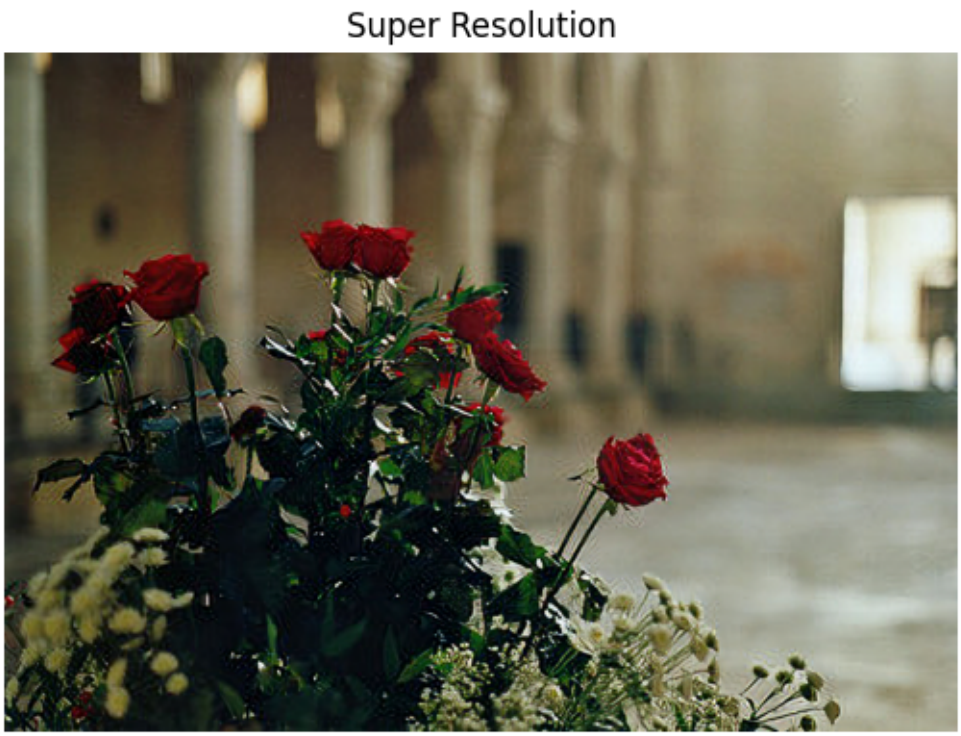
```
Saved as Original Image.jpg
```

[183]:
```
model = hub.load(ESR_SAVED_MODEL_PATH)
```

ESRGAN, .

[185]:
```
start = time.time()
fake_image = model(hr_image)
fake_image = tf.squeeze(fake_image)
print("Time Taken: %f" % (time.time() - start))
plot_image(tf.squeeze(fake_image), title="Super Resolution")
save_image(tf.squeeze(fake_image), filename="Super Resolution")
```

```
Time Taken: 0.193167
Saved as Super Resolution.jpg
```



1.9

oxford102. ResNet50, ESRGAN, TensorBoard. Plotly.

[186]:
```
!export PATH=/Library/TeX/texbin:$PATH
```

[ ]:
```

```