+ Code + Text

```
!pip install -q git+https://github.com/huggingface/transformers
```

```
  Installing build dependencies ... done
  Getting requirements to build wheel ... done
  Preparing metadata (pyproject.toml) ... done
```

```
!curl -L "https://app.roboflow.com/ds/[GqRnfdLze9mzBCO6Y4Ps]" > roboflow.zip; unzip roboflow.zip; rm roboflow.zip
```

```
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100    27  100    27    0     0    128      0 --:--:-- --:--:-- --:--:--   128
Archive:  roboflow.zip
  End-of-central-directory signature not found.  Either this file is not
  a zipfile, or it constitutes one disk of a multi-part archive.  In the
  latter case the central directory and zipfile comment will be found on
  the last disk(s) of this archive.
unzip:  cannot find zipfile directory in one of roboflow.zip or
        roboflow.zip.zip, and cannot find roboflow.zip.ZIP, period.
```

```
!pip install roboflow

from roboflow import Roboflow
rf = Roboflow(api_key="GqRnfdLze9mzBCO6Y4Ps")
project = rf.workspace("rmk-engineering-college").project("tumor-vit")
dataset = project.version(1).download("folder")
```

```
Requirement already satisfied: roboflow in /usr/local/lib/python3.10/dist-packages (1.1.0)
Requirement already satisfied: certifi==2022.12.7 in /usr/local/lib/python3.10/dist-packages (from roboflow) (2022.12.7)
Requirement already satisfied: chardet==4.0.0 in /usr/local/lib/python3.10/dist-packages (from roboflow) (4.0.0)
Requirement already satisfied: cycler==0.10.0 in /usr/local/lib/python3.10/dist-packages (from roboflow) (0.10.0)
Requirement already satisfied: idna==2.10 in /usr/local/lib/python3.10/dist-packages (from roboflow) (2.10)
Requirement already satisfied: kiwisolver>=1.3.1 in /usr/local/lib/python3.10/dist-packages (from roboflow) (1.4.4)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.10/dist-packages (from roboflow) (3.7.1)
Requirement already satisfied: numpy>=1.18.5 in /usr/local/lib/python3.10/dist-packages (from roboflow) (1.22.4)
Requirement already satisfied: opencv-python>=4.1.2 in /usr/local/lib/python3.10/dist-packages (from roboflow) (4.7.0.72)
Requirement already satisfied: Pillow>=7.1.2 in /usr/local/lib/python3.10/dist-packages (from roboflow) (8.4.0)
Requirement already satisfied: pyparsing==2.4.7 in /usr/local/lib/python3.10/dist-packages (from roboflow) (2.4.7)
Requirement already satisfied: python-dateutil in /usr/local/lib/python3.10/dist-packages (from roboflow) (2.8.2)
Requirement already satisfied: python-dotenv in /usr/local/lib/python3.10/dist-packages (from roboflow) (1.0.0)
Requirement already satisfied: requests in /usr/local/lib/python3.10/dist-packages (from roboflow) (2.27.1)
Requirement already satisfied: six in /usr/local/lib/python3.10/dist-packages (from roboflow) (1.16.0)
Requirement already satisfied: supervision in /usr/local/lib/python3.10/dist-packages (from roboflow) (0.11.1)
Requirement already satisfied: urllib3>=1.26.6 in /usr/local/lib/python3.10/dist-packages (from roboflow) (1.26.16)
Requirement already satisfied: wget in /usr/local/lib/python3.10/dist-packages (from roboflow) (3.2)
Requirement already satisfied: tqdm>=4.41.0 in /usr/local/lib/python3.10/dist-packages (from roboflow) (4.65.0)
Requirement already satisfied: PyYAML>=5.3.1 in /usr/local/lib/python3.10/dist-packages (from roboflow) (6.0)
Requirement already satisfied: requests-toolbelt in /usr/local/lib/python3.10/dist-packages (from roboflow) (1.0.0)
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib->roboflow) (1.1.0)
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib->roboflow) (4.40.0)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib->roboflow) (23.1)
Requirement already satisfied: charset-normalizer~=2.0.0 in /usr/local/lib/python3.10/dist-packages (from requests->roboflow) (2.0.
loading Roboflow workspace...
loading Roboflow project...
Downloading Dataset Version Zip in tumor-ViT-1 to folder: 100% [21405884 / 21405884] bytes
Extracting Dataset Version Zip to tumor-ViT-1 in folder:: 100%|██████████| 2908/2908 [00:00<00:00, 3320.36it/s]
```

```
import torchvision
from torchvision.transforms import ToTensor

train_ds = torchvision.datasets.ImageFolder('/content/tumor-ViT-1/train', transform=ToTensor())
valid_ds = torchvision.datasets.ImageFolder('/content/tumor-ViT-1/valid', transform=ToTensor())
test_ds = torchvision.datasets.ImageFolder('/content/tumor-ViT-1/test', transform=ToTensor())


from transformers import ViTModel
from transformers.modeling_outputs import SequenceClassifierOutput
import torch.nn as nn
import torch.nn.functional as F

class ViTForImageClassification(nn.Module):
    def __init__(self, num_labels=3):
        super(ViTForImageClassification, self).__init__()
        self.vit = ViTModel.from_pretrained('google/vit-base-patch16-224-in21k')
        self.dropout = nn.Dropout(0.1)
        self.classifier = nn.Linear(self.vit.config.hidden_size, num_labels)
        self.num_labels = num_labels

    def forward(self, pixel_values, labels):
        outputs = self.vit(pixel_values=pixel_values)
```

```
          output = self.dropout(outputs.last_hidden_state[:,0])
          logits = self.classifier(output)

          loss = None
          if labels is not None:
            loss_fct = nn.CrossEntropyLoss()
            loss = loss_fct(logits.view(-1, self.num_labels), labels.view(-1))
          if loss is not None:
            return logits, loss.item()
          else:
            return logits, None


EPOCHS = 3
BATCH_SIZE = 10
LEARNING_RATE = 2e-5


from transformers import ViTFeatureExtractor
import torch.nn as nn
import torch
# Define Model
model = ViTForImageClassification(len(train_ds.classes))
# Feature Extractor
feature_extractor = ViTFeatureExtractor.from_pretrained('google/vit-base-patch16-224-in21k')
# Adam Optimizer
optimizer = torch.optim.Adam(model.parameters(), lr=LEARNING_RATE)
# Cross Entropy Loss
loss_func = nn.CrossEntropyLoss()
# Use GPU if available
device = torch.device('cuda' if torch.cuda.is_available() else 'cpu')
if torch.cuda.is_available():
    model.cuda()
```

```
Downloading (…)lve/main/config.json: 100%  502/502 [00:00<00:00, 23.3kB/s]
Downloading pytorch_model.bin: 100%  346M/346M [00:03<00:00, 84.8MB/s]
Downloading (…)rocessor_config.json: 100%  160/160 [00:00<00:00, 5.24kB/s]
The class ViTFeatureExtractor is deprecated and will be removed in version 5 of Transformers. Please use ViTImageProcessor instead.
```

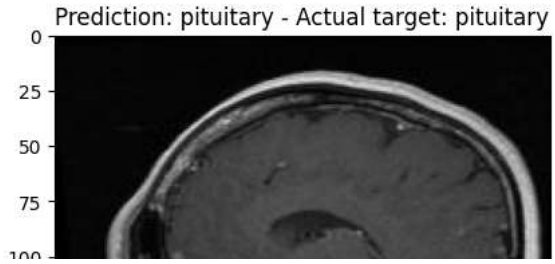
```
import torch.utils.data as data
from torch.autograd import Variable
import numpy as np

print("Number of train samples: ", len(train_ds))
print("Number of test samples: ", len(test_ds))
print("Detected Classes are: ", train_ds.class_to_idx)

train_loader = data.DataLoader(train_ds, batch_size=BATCH_SIZE, shuffle=True,  num_workers=4)
test_loader  = data.DataLoader(test_ds, batch_size=BATCH_SIZE, shuffle=True, num_workers=4)

# Train the model
for epoch in range(EPOCHS):
  for step, (x, y) in enumerate(train_loader):
    # Change input array into list with each batch being one element
    x = np.split(np.squeeze(np.array(x)), BATCH_SIZE)
    # Remove unecessary dimension
    for index, array in enumerate(x):
      x[index] = np.squeeze(array)
    # Apply feature extractor, stack back into 1 tensor and then convert to tensor
    x = torch.tensor(np.stack(feature_extractor(x)['pixel_values'], axis=0))
    # Send to GPU if available
    x, y  = x.to(device), y.to(device)
    b_x = Variable(x)   # batch x (image)
    b_y = Variable(y)   # batch y (target)
    # Feed through model
    output, loss = model(b_x, None)
    # Calculate loss
    if loss is None:
      loss = loss_func(output, b_y)
      optimizer.zero_grad()
      loss.backward()
      optimizer.step()

    if step % 50 == 0:
      # Get the next batch for testing purposes
      test = next(iter(test_loader))
      test_x = test[0]
      # Reshape and get feature matrices as needed
      test_x = np.split(np.squeeze(np.array(test_x)), BATCH_SIZE)
      for index, array in enumerate(test_x):
```

```
    test_x[index] = np.squeeze(array)
  test_x = torch.tensor(np.stack(feature_extractor(test_x)['pixel_values'], axis=0))
  # Send to appropirate computing device
  test_x = test_x.to(device)
  test_y = test[1].to(device)
  # Get output (+ respective class) and compare to target
  test_output, loss = model(test_x, test_y)
  test_output = test_output.argmax(1)
  # Calculate Accuracy
  accuracy = (test_output == test_y).sum().item() / BATCH_SIZE
  print('Epoch: ', epoch, '| train loss: %.4f' % loss, '| test accuracy: %.2f' % accuracy)
```

```
Number of train samples:  2300
Number of test samples:  350
Detected Classes are:  {'glioma': 0, 'meningioma': 1, 'notumor': 2, 'pituitary': 3}
This DataLoader will create 4 worker processes in total. Our suggested max number of worker in current system is 2, which is smalle
Epoch:  0 | train loss: 1.4159 | test accuracy: 0.10
Epoch:  0 | train loss: 1.3497 | test accuracy: 0.20
Epoch:  0 | train loss: 1.3774 | test accuracy: 0.40
Epoch:  0 | train loss: 1.3818 | test accuracy: 0.30
Epoch:  0 | train loss: 1.3927 | test accuracy: 0.00
Epoch:  1 | train loss: 1.3881 | test accuracy: 0.30
Epoch:  1 | train loss: 1.4104 | test accuracy: 0.00
Epoch:  1 | train loss: 1.4370 | test accuracy: 0.00
Epoch:  1 | train loss: 1.3937 | test accuracy: 0.30
Epoch:  1 | train loss: 1.3987 | test accuracy: 0.20
Epoch:  2 | train loss: 1.3948 | test accuracy: 0.10
Epoch:  2 | train loss: 1.3916 | test accuracy: 0.20
Epoch:  2 | train loss: 1.4005 | test accuracy: 0.10
Epoch:  2 | train loss: 1.3808 | test accuracy: 0.30
Epoch:  2 | train loss: 1.3918 | test accuracy: 0.20
```

```
import matplotlib.pyplot as plt
import numpy as np

EVAL_BATCH = 1
eval_loader  = data.DataLoader(valid_ds, batch_size=EVAL_BATCH, shuffle=True, num_workers=4)
# Disable grad
with torch.no_grad():

  inputs, target = next(iter(eval_loader))
  # Reshape and get feature matrices as needed
  print(inputs.shape)
  inputs = inputs[0].permute(1, 2, 0)
  # Save original Input
  originalInput = inputs
  for index, array in enumerate(inputs):
    inputs[index] = np.squeeze(array)
  inputs = torch.tensor(np.stack(feature_extractor(inputs)['pixel_values'], axis=0))

  # Send to appropriate computing device
  inputs = inputs.to(device)
  target = target.to(device)

  # Generate prediction
  prediction, loss = model(inputs, target)

  # Predicted class value using argmax
  predicted_class = np.argmax(prediction.cpu())
  value_predicted = list(valid_ds.class_to_idx.keys())[list(valid_ds.class_to_idx.values()).index(predicted_class)]
  value_target = list(valid_ds.class_to_idx.keys())[list(valid_ds.class_to_idx.values()).index(target)]

  # Show result
  plt.imshow(originalInput)
  plt.xlim(224,0)
  plt.ylim(224,0)
  plt.title(f'Prediction: {value_predicted} - Actual target: {value_target}')
  plt.show()
```

```
torch.Size([1, 3, 224, 224])
```




```
torch.save(model, '/content/ViTmodel1.pt')
```

```
torch.save(model, '/home/ViTmodelsaved.pt')
```

```
MODEL_PATH = '/content/ViTmodel1.pt'
model = torch.load(MODEL_PATH)
model.eval()
```

```
ViTForImageClassification(
  (vit): ViTModel(
    (embeddings): ViTEmbeddings(
      (patch_embeddings): ViTPatchEmbeddings(
        (projection): Conv2d(3, 768, kernel_size=(16, 16), stride=(16, 16))
      )
      (dropout): Dropout(p=0.0, inplace=False)
    )
    (encoder): ViTEncoder(
      (layer): ModuleList(
        (0-11): 12 x ViTLayer(
          (attention): ViTAttention(
            (attention): ViTSelfAttention(
              (query): Linear(in_features=768, out_features=768, bias=True)
              (key): Linear(in_features=768, out_features=768, bias=True)
              (value): Linear(in_features=768, out_features=768, bias=True)
              (dropout): Dropout(p=0.0, inplace=False)
            )
            (output): ViTSelfOutput(
              (dense): Linear(in_features=768, out_features=768, bias=True)
              (dropout): Dropout(p=0.0, inplace=False)
            )
          )
          (intermediate): ViTIntermediate(
            (dense): Linear(in_features=768, out_features=3072, bias=True)
            (intermediate_act_fn): GELUActivation()
          )
          (output): ViTOutput(
            (dense): Linear(in_features=3072, out_features=768, bias=True)
            (dropout): Dropout(p=0.0, inplace=False)
          )
          (layernorm_before): LayerNorm((768,), eps=1e-12, elementwise_affine=True)
          (layernorm_after): LayerNorm((768,), eps=1e-12, elementwise_affine=True)
        )
      )
    )
    (layernorm): LayerNorm((768,), eps=1e-12, elementwise_affine=True)
    (pooler): ViTPooler(
      (dense): Linear(in_features=768, out_features=768, bias=True)
      (activation): Tanh()
    )
  )
  (dropout): Dropout(p=0.1, inplace=False)
  (classifier): Linear(in_features=768, out_features=4, bias=True)
)
```

```
from PIL import Image
image_path = '/Hirnmetastase_MRT-T1_KM.jpg'
image = Image.open(image_path)
```

```
import torch
from torchvision import transforms
from PIL import Image
import matplotlib.pyplot as plt

# Load and preprocess the image

preprocess = transforms.Compose([
    transforms.Resize((224, 224)),
    transforms.ToTensor(),
    transforms.Normalize(mean=[0.485, 0.456, 0.406], std=[0.229, 0.224, 0.225])
])
```

```
input_image = preprocess(image).unsqueeze(0)

# Send the input image to the appropriate device
device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
input_image = input_image.to(device)

# Disable grad
with torch.no_grad():
    # Generate prediction
    logits, _ = model(input_image,labels=None)

# Convert prediction to class label
predicted_class_index = torch.argmax(logits, dim=1).item()
predicted_class_label = list(valid_ds.class_to_idx.keys())[predicted_class_index]

# Show result
print(predicted_class_label)
plt.imshow(image)
plt.title(f'Prediction: {predicted_class_label}')
plt.show()
```