

Pokemon Classification

This is a simple notebook to classify Pokemon using transfer learning on mobilenet v3 model. Earlier, we used transfers learning on mobilenet v3 model to classify flowers, celebrities and other real world objects. mobilenet v3 model was trained on ImageNet dataset, which also used real life images. So, it is interesting to see how well it performs on fictional characters like Pokemon.

We can use the dataset from [huggingface](#) for this task.

Taking a closer look at dataset, we see that it has about 110 classes and 4892 training images.

The dataset is not large enough to train a model from scratch as it has only 4892 images. In the cases, where we don't have large enough data, using transfer learning can be a great option. Let's see how well mobilenet v3 model performs on this dataset.

To simplify, we only classify the first 6 classes ('Golbat', 'Machoke', 'Omastar', 'Diglett', 'Lapras', 'Kabuto'), which have 274 images in total.

Out of the 274 images, we use 200 images for training and 74 images for testing.

```
In [ ]: import torch
import torch.nn as nn
from datasets import load_dataset
from torchvision.models import mobilenet_v3_large, MobileNet_V3_Large_Weight

device = "cpu"

if torch.cuda.is_available(): #
    device = "cuda"

if torch.backends.mps.is_available(): # GPU for MacOS
    device = "mps"

print("Using device:", device)
device = torch.device(device)
```

Using device: mps

Load Pokemon Dataset from HuggingFace

<https://huggingface.co/datasets/fcakyon/pokemon-classification>

```
In [ ]: ds = load_dataset("fcakyon/pokemon-classification", name="full").shuffle()

# print dataset layout
print(ds)

pokemon_names = ['Golbat', 'Machoke', 'Omastar', 'Diglett', 'Lapras', 'Kabuto']

DatasetDict({
  train: Dataset({
    features: ['image_file_path', 'image', 'labels'],
    num_rows: 4869
  })
  validation: Dataset({
    features: ['image_file_path', 'image', 'labels'],
    num_rows: 1390
  })
  test: Dataset({
    features: ['image_file_path', 'image', 'labels'],
    num_rows: 732
  })
})
```

```
In [ ]: import matplotlib.pyplot as plt

sample_images = ds["train"]["image"][:5]
sample_labels = ds["train"]["labels"][:5]

fig, axes = plt.subplots(1, 5, figsize=(20, 20))
for i, (image, label) in enumerate(zip(sample_images, sample_labels)):
    axes[i].imshow(image)
    axes[i].set_title(pokemon_names[label])
    axes[i].axis("off")

plt.show()
```



Train and Test Methods

```
In [ ]: from torch.utils.data import DataLoader
```

```
from torchvision import transforms

#Create pytorch dataset
class PokemonDataset(torch.utils.data.Dataset):
    def __init__(self, dataset, transform=None):
        self.dataset = dataset
        self.transform = transform

    def __getitem__(self, index):
        image = self.dataset[index]["image"]
        label = self.dataset[index]["labels"]

        if self.transform is not None:
            image = self.transform(image)

        return image, label

    def __len__(self):
        return len(self.dataset)

def pil_to_tensor(image):
    transform = transforms.ToTensor()
    return transform(image)
```

```
In [ ]: def train(model, loader, optimizer, criterion, num_epochs=10):
        loss_history = []
        for epoch in range(num_epochs):
            model.train()
            total_loss = 0
            for i, (images, labels) in enumerate(loader):
                images = images.to(device)
                labels = labels.to(device)
                optimizer.zero_grad()
                outputs = model(images)
                loss = criterion(outputs, labels)
                loss.backward()
                optimizer.step()
                total_loss += loss.item()
                print(f"Epoch: {epoch} | Batch: {i} | Loss: {loss.item()}")
            loss_history.append(total_loss / len(loader))

        return loss_history

def test(model, loader, criterion):
    model.eval()
    with torch.no_grad():
        correct = 0
        total = 0
```

```

total_loss = 0
for images, labels in loader:
    images = images.to(device)
    labels = labels.to(device)
    outputs = model(images)
    _, predicted = torch.max(outputs.data, 1)
    total += labels.size(0)
    loss = criterion(outputs, labels)
    correct += (predicted == labels).sum().item()

print(f"Test accuracy: {correct / total}")
return total_loss / len(loader), correct / total

```

Train and Test the model

```

In [ ]: from datasets import Dataset
        # Select only the first 12 labels
        selected_labels = list(range(6))

        # Filter the dataset to include only the selected labels
        new_ds = ds['train'].filter(lambda example: example['labels'] in selected_labels)

        train_ds = Dataset.from_dict({
            'image_file_path': new_ds['image_file_path'][:200],
            'image': new_ds['image'][:200],
            'labels': new_ds['labels'][:200]
        })

        test_ds = Dataset.from_dict({
            'image_file_path': new_ds['image_file_path'][200:],
            'image': new_ds['image'][200:],
            'labels': new_ds['labels'][200:]
        })

        # # Create datasets
        train_dataset = PokemonDataset(train_ds, transform=pil_to_tensor)

        test_dataset = PokemonDataset(test_ds, transform=pil_to_tensor)

        # Create dataloaders
        train_loader = DataLoader(train_dataset, batch_size=4, shuffle=True)
        test_loader = DataLoader(test_dataset, batch_size=4, shuffle=False)

        large_model = mobilenet_v3_large(weights=MobileNet_V3_Large_Weights.DEFAULT)
        num_features = large_model.classifier[-1].in_features
        large_model.classifier[-1] = nn.Linear(num_features, len(selected_labels))

```

```
large_model = large_model.to(device)
```

Filter: 0% | 0/4869 [00:00<?, ? examples/s]

```
In [ ]: criterion = nn.CrossEntropyLoss()
optimizer = torch.optim.Adam(large_model.parameters(), lr=0.001)
loss_history = train(large_model, train_loader, optimizer, criterion, num_ep
```

```
Epoch: 0 | Batch: 0 | Loss: 1.7300410270690918
Epoch: 0 | Batch: 1 | Loss: 2.1007516384124756
Epoch: 0 | Batch: 2 | Loss: 1.6431167125701904
Epoch: 0 | Batch: 3 | Loss: 2.6426329612731934
Epoch: 0 | Batch: 4 | Loss: 2.4147181510925293
Epoch: 0 | Batch: 5 | Loss: 2.023914337158203
Epoch: 0 | Batch: 6 | Loss: 1.509876012802124
Epoch: 0 | Batch: 7 | Loss: 1.2980494499206543
Epoch: 0 | Batch: 8 | Loss: 1.738901972770691
Epoch: 0 | Batch: 9 | Loss: 1.9879652261734009
Epoch: 0 | Batch: 10 | Loss: 1.5952770709991455
Epoch: 0 | Batch: 11 | Loss: 2.1753768920898438
Epoch: 0 | Batch: 12 | Loss: 1.3784875869750977
Epoch: 0 | Batch: 13 | Loss: 0.9578273892402649
Epoch: 0 | Batch: 14 | Loss: 0.9168980717658997
Epoch: 0 | Batch: 15 | Loss: 1.819047212600708
Epoch: 0 | Batch: 16 | Loss: 1.0400279760360718
Epoch: 0 | Batch: 17 | Loss: 0.7506875991821289
Epoch: 0 | Batch: 18 | Loss: 1.125089406967163
Epoch: 0 | Batch: 19 | Loss: 1.040075659751892
Epoch: 0 | Batch: 20 | Loss: 1.0333597660064697
Epoch: 0 | Batch: 21 | Loss: 1.0568053722381592
Epoch: 0 | Batch: 22 | Loss: 1.0303821563720703
Epoch: 0 | Batch: 23 | Loss: 0.5982067584991455
Epoch: 0 | Batch: 24 | Loss: 0.9883239269256592
Epoch: 0 | Batch: 25 | Loss: 0.6000623106956482
Epoch: 0 | Batch: 26 | Loss: 0.4848746061325073
Epoch: 0 | Batch: 27 | Loss: 1.4534374475479126
Epoch: 0 | Batch: 28 | Loss: 1.3407987356185913
Epoch: 0 | Batch: 29 | Loss: 1.054560899734497
Epoch: 0 | Batch: 30 | Loss: 1.0287446975708008
Epoch: 0 | Batch: 31 | Loss: 0.41576600074768066
Epoch: 0 | Batch: 32 | Loss: 0.21432574093341827
Epoch: 0 | Batch: 33 | Loss: 0.7232288122177124
Epoch: 0 | Batch: 34 | Loss: 0.7097659111022949
Epoch: 0 | Batch: 35 | Loss: 0.1938248723745346
Epoch: 0 | Batch: 36 | Loss: 0.2970845699310303
Epoch: 0 | Batch: 37 | Loss: 0.325447142124176
Epoch: 0 | Batch: 38 | Loss: 0.865879237651825
Epoch: 0 | Batch: 39 | Loss: 0.15939593315124512
Epoch: 0 | Batch: 40 | Loss: 0.5557529926300049
Epoch: 0 | Batch: 41 | Loss: 0.9263700842857361
Epoch: 0 | Batch: 42 | Loss: 2.3228049278259277
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Epoch: 0 | Batch: 43 | Loss: 1.599755048751831
Epoch: 0 | Batch: 44 | Loss: 0.2653549909591675
Epoch: 0 | Batch: 45 | Loss: 0.048266083002090454
Epoch: 0 | Batch: 46 | Loss: 0.4431353211402893
Epoch: 0 | Batch: 47 | Loss: 0.6319307088851929
Epoch: 0 | Batch: 48 | Loss: 0.017704930156469345
Epoch: 0 | Batch: 49 | Loss: 0.5518016815185547
Epoch: 1 | Batch: 0 | Loss: 0.5456952452659607
Epoch: 1 | Batch: 1 | Loss: 0.22535032033920288
Epoch: 1 | Batch: 2 | Loss: 1.1488988399505615
Epoch: 1 | Batch: 3 | Loss: 0.2378859668970108
Epoch: 1 | Batch: 4 | Loss: 0.32427677512168884
Epoch: 1 | Batch: 5 | Loss: 0.6181137561798096
Epoch: 1 | Batch: 6 | Loss: 0.37256819009780884
Epoch: 1 | Batch: 7 | Loss: 0.3225770890712738
Epoch: 1 | Batch: 8 | Loss: 1.2710790634155273
Epoch: 1 | Batch: 9 | Loss: 0.399877667427063
Epoch: 1 | Batch: 10 | Loss: 1.7506835460662842
Epoch: 1 | Batch: 11 | Loss: 0.5389829874038696
Epoch: 1 | Batch: 12 | Loss: 0.523149847984314
Epoch: 1 | Batch: 13 | Loss: 0.9136214256286621
Epoch: 1 | Batch: 14 | Loss: 0.27155208587646484
Epoch: 1 | Batch: 15 | Loss: 1.2677446603775024
Epoch: 1 | Batch: 16 | Loss: 0.7672273516654968
Epoch: 1 | Batch: 17 | Loss: 0.593294620513916
Epoch: 1 | Batch: 18 | Loss: 0.37678396701812744
Epoch: 1 | Batch: 19 | Loss: 0.2719576060771942
Epoch: 1 | Batch: 20 | Loss: 0.049014851450920105
Epoch: 1 | Batch: 21 | Loss: 1.9027588367462158
Epoch: 1 | Batch: 22 | Loss: 0.11226595938205719
Epoch: 1 | Batch: 23 | Loss: 0.052815474569797516
Epoch: 1 | Batch: 24 | Loss: 0.3344844579696655
Epoch: 1 | Batch: 25 | Loss: 0.11781202256679535
Epoch: 1 | Batch: 26 | Loss: 0.149855375289917
Epoch: 1 | Batch: 27 | Loss: 0.4534529149532318
Epoch: 1 | Batch: 28 | Loss: 1.031923532485962
Epoch: 1 | Batch: 29 | Loss: 0.4691019356250763
Epoch: 1 | Batch: 30 | Loss: 0.12726764380931854
Epoch: 1 | Batch: 31 | Loss: 0.08942633122205734
Epoch: 1 | Batch: 32 | Loss: 0.692829966545105
Epoch: 1 | Batch: 33 | Loss: 0.009032883681356907
Epoch: 1 | Batch: 34 | Loss: 0.47855135798454285
Epoch: 1 | Batch: 35 | Loss: 0.6330157518386841
Epoch: 1 | Batch: 36 | Loss: 0.14973531663417816
Epoch: 1 | Batch: 37 | Loss: 0.04628764092922211
Epoch: 1 | Batch: 38 | Loss: 0.10104592144489288
Epoch: 1 | Batch: 39 | Loss: 0.003309590043500066
Epoch: 1 | Batch: 40 | Loss: 0.03064475581049919
Epoch: 1 | Batch: 41 | Loss: 0.8459746837615967
Epoch: 1 | Batch: 42 | Loss: 0.025431346148252487
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Epoch: 1	Batch: 43	Loss: 0.2876198887825012
Epoch: 1	Batch: 44	Loss: 0.3522840738296509
Epoch: 1	Batch: 45	Loss: 0.049630843102931976
Epoch: 1	Batch: 46	Loss: 2.059096336364746
Epoch: 1	Batch: 47	Loss: 2.1545042991638184
Epoch: 1	Batch: 48	Loss: 0.02591908536851406
Epoch: 1	Batch: 49	Loss: 0.4160301983356476
Epoch: 2	Batch: 0	Loss: 0.03405517712235451
Epoch: 2	Batch: 1	Loss: 0.37927013635635376
Epoch: 2	Batch: 2	Loss: 0.45877933502197266
Epoch: 2	Batch: 3	Loss: 0.6842266321182251
Epoch: 2	Batch: 4	Loss: 0.5476323962211609
Epoch: 2	Batch: 5	Loss: 0.2301114797592163
Epoch: 2	Batch: 6	Loss: 0.2508322596549988
Epoch: 2	Batch: 7	Loss: 0.206368550658226
Epoch: 2	Batch: 8	Loss: 0.28361237049102783
Epoch: 2	Batch: 9	Loss: 2.653529644012451
Epoch: 2	Batch: 10	Loss: 0.06302997469902039
Epoch: 2	Batch: 11	Loss: 0.086391381919384
Epoch: 2	Batch: 12	Loss: 0.5920036435127258
Epoch: 2	Batch: 13	Loss: 0.22397558391094208
Epoch: 2	Batch: 14	Loss: 0.26423007249832153
Epoch: 2	Batch: 15	Loss: 0.1245182454586029
Epoch: 2	Batch: 16	Loss: 0.028534337878227234
Epoch: 2	Batch: 17	Loss: 0.009295159950852394
Epoch: 2	Batch: 18	Loss: 0.00487868208438158
Epoch: 2	Batch: 19	Loss: 0.02742060273885727
Epoch: 2	Batch: 20	Loss: 1.7378472089767456
Epoch: 2	Batch: 21	Loss: 1.136115550994873
Epoch: 2	Batch: 22	Loss: 0.08231611549854279
Epoch: 2	Batch: 23	Loss: 0.09533403068780899
Epoch: 2	Batch: 24	Loss: 0.8168634176254272
Epoch: 2	Batch: 25	Loss: 1.6489639282226562
Epoch: 2	Batch: 26	Loss: 0.4887279272079468
Epoch: 2	Batch: 27	Loss: 0.06023543328046799
Epoch: 2	Batch: 28	Loss: 0.24178354442119598
Epoch: 2	Batch: 29	Loss: 0.27194637060165405
Epoch: 2	Batch: 30	Loss: 0.07184939831495285
Epoch: 2	Batch: 31	Loss: 0.04821273311972618
Epoch: 2	Batch: 32	Loss: 0.02347249537706375
Epoch: 2	Batch: 33	Loss: 0.09911558032035828
Epoch: 2	Batch: 34	Loss: 0.18849973380565643
Epoch: 2	Batch: 35	Loss: 0.014317573979496956
Epoch: 2	Batch: 36	Loss: 0.07843764871358871
Epoch: 2	Batch: 37	Loss: 0.058896876871585846
Epoch: 2	Batch: 38	Loss: 0.2986711263656616
Epoch: 2	Batch: 39	Loss: 0.13127732276916504
Epoch: 2	Batch: 40	Loss: 0.0008129218476824462
Epoch: 2	Batch: 41	Loss: 0.054334722459316254
Epoch: 2	Batch: 42	Loss: 0.006887524854391813

Epoch: 2	Batch: 43	Loss: 0.02636571414768696
Epoch: 2	Batch: 44	Loss: 0.3508443534374237
Epoch: 2	Batch: 45	Loss: 0.1686926931142807
Epoch: 2	Batch: 46	Loss: 0.13933515548706055
Epoch: 2	Batch: 47	Loss: 0.021822089329361916
Epoch: 2	Batch: 48	Loss: 0.016279712319374084
Epoch: 2	Batch: 49	Loss: 0.01298262644559145
Epoch: 3	Batch: 0	Loss: 1.1273473501205444
Epoch: 3	Batch: 1	Loss: 0.10850249230861664
Epoch: 3	Batch: 2	Loss: 0.10939168184995651
Epoch: 3	Batch: 3	Loss: 0.030836008489131927
Epoch: 3	Batch: 4	Loss: 0.07129812985658646
Epoch: 3	Batch: 5	Loss: 0.020220641046762466
Epoch: 3	Batch: 6	Loss: 0.2020014375448227
Epoch: 3	Batch: 7	Loss: 0.011463811621069908
Epoch: 3	Batch: 8	Loss: 0.00149898964446038
Epoch: 3	Batch: 9	Loss: 4.078142166137695
Epoch: 3	Batch: 10	Loss: 0.2893625795841217
Epoch: 3	Batch: 11	Loss: 0.0071603660471737385
Epoch: 3	Batch: 12	Loss: 0.12340493500232697
Epoch: 3	Batch: 13	Loss: 0.01900620386004448
Epoch: 3	Batch: 14	Loss: 0.0020140036940574646
Epoch: 3	Batch: 15	Loss: 0.015117782168090343
Epoch: 3	Batch: 16	Loss: 0.4825393259525299
Epoch: 3	Batch: 17	Loss: 0.029464922845363617
Epoch: 3	Batch: 18	Loss: 0.6019668579101562
Epoch: 3	Batch: 19	Loss: 0.07465342432260513
Epoch: 3	Batch: 20	Loss: 0.1575479805469513
Epoch: 3	Batch: 21	Loss: 0.14335758984088898
Epoch: 3	Batch: 22	Loss: 0.1348022073507309
Epoch: 3	Batch: 23	Loss: 0.011090046726167202
Epoch: 3	Batch: 24	Loss: 0.0992601215839386
Epoch: 3	Batch: 25	Loss: 0.030584469437599182
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Epoch: 3	Batch: 28	Loss: 0.6151566505432129
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Epoch: 3	Batch: 31	Loss: 0.11062584817409515
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Epoch: 3	Batch: 35	Loss: 0.7569804787635803
Epoch: 3	Batch: 36	Loss: 1.163190484046936
Epoch: 3	Batch: 37	Loss: 0.0026385511737316847
Epoch: 3	Batch: 38	Loss: 0.11706386506557465
Epoch: 3	Batch: 39	Loss: 0.12477842718362808
Epoch: 3	Batch: 40	Loss: 0.004272543825209141
Epoch: 3	Batch: 41	Loss: 0.5401341915130615
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Epoch: 3 | Batch: 43 | Loss: 0.4855097532272339
Epoch: 3 | Batch: 44 | Loss: 0.002220266265794635
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Epoch: 3 | Batch: 47 | Loss: 0.09308657795190811
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Epoch: 3 | Batch: 49 | Loss: 0.3481975495815277
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Epoch: 4 | Batch: 26 | Loss: 0.7348440885543823
Epoch: 4 | Batch: 27 | Loss: 0.9850842952728271
Epoch: 4 | Batch: 28 | Loss: 0.20848585665225983
Epoch: 4 | Batch: 29 | Loss: 0.40446507930755615
Epoch: 4 | Batch: 30 | Loss: 0.022745667025446892
Epoch: 4 | Batch: 31 | Loss: 0.055704016238451004
Epoch: 4 | Batch: 32 | Loss: 0.0005645999335683882
Epoch: 4 | Batch: 33 | Loss: 0.0017280513420701027
Epoch: 4 | Batch: 34 | Loss: 0.15719491243362427
Epoch: 4 | Batch: 35 | Loss: 0.2624884843826294
Epoch: 4 | Batch: 36 | Loss: 0.12265210598707199
Epoch: 4 | Batch: 37 | Loss: 0.0032056253403425217
Epoch: 4 | Batch: 38 | Loss: 0.7155651450157166
Epoch: 4 | Batch: 39 | Loss: 2.65981388092041
Epoch: 4 | Batch: 40 | Loss: 0.0029087287839502096
Epoch: 4 | Batch: 41 | Loss: 0.07524541020393372
Epoch: 4 | Batch: 42 | Loss: 0.4984770715236664
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Epoch: 4 | Batch: 43 | Loss: 0.008044460788369179
Epoch: 4 | Batch: 44 | Loss: 0.0010168158914893866
Epoch: 4 | Batch: 45 | Loss: 0.44061943888664246
Epoch: 4 | Batch: 46 | Loss: 0.17329058051109314
Epoch: 4 | Batch: 47 | Loss: 0.02806153893470764
Epoch: 4 | Batch: 48 | Loss: 0.21980753540992737
Epoch: 4 | Batch: 49 | Loss: 0.045411307364702225
Epoch: 5 | Batch: 0 | Loss: 0.013591037131845951
Epoch: 5 | Batch: 1 | Loss: 0.33474209904670715
Epoch: 5 | Batch: 2 | Loss: 0.17571280896663666
Epoch: 5 | Batch: 3 | Loss: 0.02573985978960991
Epoch: 5 | Batch: 4 | Loss: 0.03208430856466293
Epoch: 5 | Batch: 5 | Loss: 0.024187933653593063
Epoch: 5 | Batch: 6 | Loss: 0.2808779776096344
Epoch: 5 | Batch: 7 | Loss: 0.0005548720364458859
Epoch: 5 | Batch: 8 | Loss: 0.0544690378010273
Epoch: 5 | Batch: 9 | Loss: 0.2669380307197571
Epoch: 5 | Batch: 10 | Loss: 0.012419669888913631
Epoch: 5 | Batch: 11 | Loss: 0.0033938924316316843
Epoch: 5 | Batch: 12 | Loss: 0.2598583400249481
Epoch: 5 | Batch: 13 | Loss: 0.6333903670310974
Epoch: 5 | Batch: 14 | Loss: 0.06451436877250671
Epoch: 5 | Batch: 15 | Loss: 0.024807965382933617
Epoch: 5 | Batch: 16 | Loss: 0.020441528409719467
Epoch: 5 | Batch: 17 | Loss: 0.050086766481399536
Epoch: 5 | Batch: 18 | Loss: 0.0004910498973913491
Epoch: 5 | Batch: 19 | Loss: 1.253739356994629
Epoch: 5 | Batch: 20 | Loss: 0.008410146459937096
Epoch: 5 | Batch: 21 | Loss: 0.00850391574203968
Epoch: 5 | Batch: 22 | Loss: 0.00902988389134407
Epoch: 5 | Batch: 23 | Loss: 1.6962344646453857
Epoch: 5 | Batch: 24 | Loss: 0.005045513156801462
Epoch: 5 | Batch: 25 | Loss: 0.004050883464515209
Epoch: 5 | Batch: 26 | Loss: 0.05727914348244667
Epoch: 5 | Batch: 27 | Loss: 0.007298941258341074
Epoch: 5 | Batch: 28 | Loss: 0.04118979722261429
Epoch: 5 | Batch: 29 | Loss: 0.026160599663853645
Epoch: 5 | Batch: 30 | Loss: 0.010686364024877548
Epoch: 5 | Batch: 31 | Loss: 0.011873234063386917
Epoch: 5 | Batch: 32 | Loss: 0.15974834561347961
Epoch: 5 | Batch: 33 | Loss: 0.02533872053027153
Epoch: 5 | Batch: 34 | Loss: 0.36549630761146545
Epoch: 5 | Batch: 35 | Loss: 0.007181537337601185
Epoch: 5 | Batch: 36 | Loss: 0.0002708146639633924
Epoch: 5 | Batch: 37 | Loss: 0.02631531096994877
Epoch: 5 | Batch: 38 | Loss: 0.003653106512501836
Epoch: 5 | Batch: 39 | Loss: 0.04121840000152588
Epoch: 5 | Batch: 40 | Loss: 0.0021893931552767754
Epoch: 5 | Batch: 41 | Loss: 0.012695680372416973
Epoch: 5 | Batch: 42 | Loss: 0.10253110527992249

Epoch: 5	Batch: 43	Loss: 0.007810313254594803
Epoch: 5	Batch: 44	Loss: 0.013557536527514458
Epoch: 5	Batch: 45	Loss: 0.07635155320167542
Epoch: 5	Batch: 46	Loss: 0.13881179690361023
Epoch: 5	Batch: 47	Loss: 0.2877511978149414
Epoch: 5	Batch: 48	Loss: 0.002135863061994314
Epoch: 5	Batch: 49	Loss: 0.19300197064876556
Epoch: 6	Batch: 0	Loss: 1.018462896347046
Epoch: 6	Batch: 1	Loss: 0.02452331967651844
Epoch: 6	Batch: 2	Loss: 0.005150779150426388
Epoch: 6	Batch: 3	Loss: 0.0009583610808476806
Epoch: 6	Batch: 4	Loss: 0.00039112006197683513
Epoch: 6	Batch: 5	Loss: 0.01700226217508316
Epoch: 6	Batch: 6	Loss: 0.004823953378945589
Epoch: 6	Batch: 7	Loss: 0.005093544255942106
Epoch: 6	Batch: 8	Loss: 0.0005407426506280899
Epoch: 6	Batch: 9	Loss: 0.3879043757915497
Epoch: 6	Batch: 10	Loss: 0.0005086041637696326
Epoch: 6	Batch: 11	Loss: 0.007142865099012852
Epoch: 6	Batch: 12	Loss: 0.03252016007900238
Epoch: 6	Batch: 13	Loss: 0.0026270821690559387
Epoch: 6	Batch: 14	Loss: 0.003755797166377306
Epoch: 6	Batch: 15	Loss: 0.01587330736219883
Epoch: 6	Batch: 16	Loss: 0.0203802939504385
Epoch: 6	Batch: 17	Loss: 0.44707125425338745
Epoch: 6	Batch: 18	Loss: 0.002026940695941448
Epoch: 6	Batch: 19	Loss: 0.0006921239546500146
Epoch: 6	Batch: 20	Loss: 0.0016225266736000776
Epoch: 6	Batch: 21	Loss: 0.8126207590103149
Epoch: 6	Batch: 22	Loss: 0.07591097056865692
Epoch: 6	Batch: 23	Loss: 0.015784984454512596
Epoch: 6	Batch: 24	Loss: 1.5836793184280396
Epoch: 6	Batch: 25	Loss: 0.0008679276797920465
Epoch: 6	Batch: 26	Loss: 0.0003970194957219064
Epoch: 6	Batch: 27	Loss: 0.005140230059623718
Epoch: 6	Batch: 28	Loss: 0.6080795526504517
Epoch: 6	Batch: 29	Loss: 0.0007357364520430565
Epoch: 6	Batch: 30	Loss: 0.006736878305673599
Epoch: 6	Batch: 31	Loss: 0.06272327899932861
Epoch: 6	Batch: 32	Loss: 0.07604996114969254
Epoch: 6	Batch: 33	Loss: 0.0662393867969513
Epoch: 6	Batch: 34	Loss: 0.0050136614590883255
Epoch: 6	Batch: 35	Loss: 0.07063309848308563
Epoch: 6	Batch: 36	Loss: 0.07099021226167679
Epoch: 6	Batch: 37	Loss: 0.012250414118170738
Epoch: 6	Batch: 38	Loss: 0.001082279602997005
Epoch: 6	Batch: 39	Loss: 0.0007377984002232552
Epoch: 6	Batch: 40	Loss: 0.00034800084540620446
Epoch: 6	Batch: 41	Loss: 0.03524994105100632
Epoch: 6	Batch: 42	Loss: 0.008846554905176163

Epoch: 6 | Batch: 43 | Loss: 0.007007535081356764
Epoch: 6 | Batch: 44 | Loss: 0.004328748676925898
Epoch: 6 | Batch: 45 | Loss: 0.22833755612373352
Epoch: 6 | Batch: 46 | Loss: 0.13574552536010742
Epoch: 6 | Batch: 47 | Loss: 0.0035985177382826805
Epoch: 6 | Batch: 48 | Loss: 3.1321513233706355e-05
Epoch: 6 | Batch: 49 | Loss: 1.1817837953567505
Epoch: 7 | Batch: 0 | Loss: 0.00013071371358819306
Epoch: 7 | Batch: 1 | Loss: 7.396332512144e-05
Epoch: 7 | Batch: 2 | Loss: 0.00016910281556192786
Epoch: 7 | Batch: 3 | Loss: 0.00021659322374034673
Epoch: 7 | Batch: 4 | Loss: 0.13118211925029755
Epoch: 7 | Batch: 5 | Loss: 0.08095647394657135
Epoch: 7 | Batch: 6 | Loss: 0.03472645580768585
Epoch: 7 | Batch: 7 | Loss: 0.2651110887527466
Epoch: 7 | Batch: 8 | Loss: 0.02176562137901783
Epoch: 7 | Batch: 9 | Loss: 0.045543372631073
Epoch: 7 | Batch: 10 | Loss: 0.003593319794163108
Epoch: 7 | Batch: 11 | Loss: 0.002271894598379731
Epoch: 7 | Batch: 12 | Loss: 0.00014256716531235725
Epoch: 7 | Batch: 13 | Loss: 0.2881318926811218
Epoch: 7 | Batch: 14 | Loss: 0.0033469749614596367
Epoch: 7 | Batch: 15 | Loss: 0.12362230569124222
Epoch: 7 | Batch: 16 | Loss: 0.0003362084971740842
Epoch: 7 | Batch: 17 | Loss: 6.034753459971398e-05
Epoch: 7 | Batch: 18 | Loss: 0.0029587028548121452
Epoch: 7 | Batch: 19 | Loss: 0.018210630863904953
Epoch: 7 | Batch: 20 | Loss: 0.0036228224635124207
Epoch: 7 | Batch: 21 | Loss: 0.2438795417547226
Epoch: 7 | Batch: 22 | Loss: 0.06399539858102798
Epoch: 7 | Batch: 23 | Loss: 0.0018657692708075047
Epoch: 7 | Batch: 24 | Loss: 0.0007575033232569695
Epoch: 7 | Batch: 25 | Loss: 0.031046312302350998
Epoch: 7 | Batch: 26 | Loss: 0.008223636075854301
Epoch: 7 | Batch: 27 | Loss: 0.020827023312449455
Epoch: 7 | Batch: 28 | Loss: 0.0002971439389511943
Epoch: 7 | Batch: 29 | Loss: 0.005152589175850153
Epoch: 7 | Batch: 30 | Loss: 6.794885848648846e-06
Epoch: 7 | Batch: 31 | Loss: 0.0012327685253694654
Epoch: 7 | Batch: 32 | Loss: 1.6968655586242676
Epoch: 7 | Batch: 33 | Loss: 0.02467271499335766
Epoch: 7 | Batch: 34 | Loss: 0.25045451521873474
Epoch: 7 | Batch: 35 | Loss: 0.12335456162691116
Epoch: 7 | Batch: 36 | Loss: 0.011114606633782387
Epoch: 7 | Batch: 37 | Loss: 0.0020296096336096525
Epoch: 7 | Batch: 38 | Loss: 0.0033354111947119236
Epoch: 7 | Batch: 39 | Loss: 0.00018339032249059528
Epoch: 7 | Batch: 40 | Loss: 0.005268642213195562
Epoch: 7 | Batch: 41 | Loss: 0.0003748078888747841
Epoch: 7 | Batch: 42 | Loss: 0.00217835302464664

Epoch: 7 | Batch: 43 | Loss: 0.009403727017343044
Epoch: 7 | Batch: 44 | Loss: 0.0007568566943518817
Epoch: 7 | Batch: 45 | Loss: 0.0007773847901262343
Epoch: 7 | Batch: 46 | Loss: 0.05030947923660278
Epoch: 7 | Batch: 47 | Loss: 0.34597015380859375
Epoch: 7 | Batch: 48 | Loss: 0.00046526387450285256
Epoch: 7 | Batch: 49 | Loss: 0.011724398471415043
Epoch: 8 | Batch: 0 | Loss: 0.00016328001220244914
Epoch: 8 | Batch: 1 | Loss: 0.005487372167408466
Epoch: 8 | Batch: 2 | Loss: 0.019083866849541664
Epoch: 8 | Batch: 3 | Loss: 0.00537300668656826
Epoch: 8 | Batch: 4 | Loss: 0.19742317497730255
Epoch: 8 | Batch: 5 | Loss: 0.0006915207486599684
Epoch: 8 | Batch: 6 | Loss: 0.0016205195570364594
Epoch: 8 | Batch: 7 | Loss: 0.0016208933666348457
Epoch: 8 | Batch: 8 | Loss: 0.00021429944899864495
Epoch: 8 | Batch: 9 | Loss: 0.06664170324802399
Epoch: 8 | Batch: 10 | Loss: 0.0006880027940496802
Epoch: 8 | Batch: 11 | Loss: 0.0015528289368376136
Epoch: 8 | Batch: 12 | Loss: 0.36142221093177795
Epoch: 8 | Batch: 13 | Loss: 0.20771700143814087
Epoch: 8 | Batch: 14 | Loss: 0.05143529176712036
Epoch: 8 | Batch: 15 | Loss: 0.007774626836180687
Epoch: 8 | Batch: 16 | Loss: 0.013216273859143257
Epoch: 8 | Batch: 17 | Loss: 9.207459515891969e-05
Epoch: 8 | Batch: 18 | Loss: 0.006581519264727831
Epoch: 8 | Batch: 19 | Loss: 0.2862379550933838
Epoch: 8 | Batch: 20 | Loss: 0.0005380333750508726
Epoch: 8 | Batch: 21 | Loss: 0.002440985292196274
Epoch: 8 | Batch: 22 | Loss: 0.00040399073623120785
Epoch: 8 | Batch: 23 | Loss: 0.06815307587385178
Epoch: 8 | Batch: 24 | Loss: 7.50645631342195e-05
Epoch: 8 | Batch: 25 | Loss: 0.02912912890315056
Epoch: 8 | Batch: 26 | Loss: 0.013527282513678074
Epoch: 8 | Batch: 27 | Loss: 1.3530072465073317e-05
Epoch: 8 | Batch: 28 | Loss: 0.19677706062793732
Epoch: 8 | Batch: 29 | Loss: 0.026800915598869324
Epoch: 8 | Batch: 30 | Loss: 0.0019289200427010655
Epoch: 8 | Batch: 31 | Loss: 3.9635862776776776e-05
Epoch: 8 | Batch: 32 | Loss: 3.0195417404174805
Epoch: 8 | Batch: 33 | Loss: 0.00017438891518395394
Epoch: 8 | Batch: 34 | Loss: 6.722948455717415e-05
Epoch: 8 | Batch: 35 | Loss: 0.10734887421131134
Epoch: 8 | Batch: 36 | Loss: 0.03582218289375305
Epoch: 8 | Batch: 37 | Loss: 0.006699816323816776
Epoch: 8 | Batch: 38 | Loss: 0.021737581118941307
Epoch: 8 | Batch: 39 | Loss: 0.049932144582271576
Epoch: 8 | Batch: 40 | Loss: 0.00015249518037308007
Epoch: 8 | Batch: 41 | Loss: 0.0004391573602333665
Epoch: 8 | Batch: 42 | Loss: 0.0039716605097055435

Epoch: 8	Batch: 43	Loss: 9.693581523606554e-05
Epoch: 8	Batch: 44	Loss: 0.012165104039013386
Epoch: 8	Batch: 45	Loss: 1.2393295764923096
Epoch: 8	Batch: 46	Loss: 0.020487962290644646
Epoch: 8	Batch: 47	Loss: 0.12442319095134735
Epoch: 8	Batch: 48	Loss: 0.004707482643425465
Epoch: 8	Batch: 49	Loss: 4.246569733368233e-05
Epoch: 9	Batch: 0	Loss: 0.06730356067419052
Epoch: 9	Batch: 1	Loss: 0.009941807016730309
Epoch: 9	Batch: 2	Loss: 0.02348209358751774
Epoch: 9	Batch: 3	Loss: 0.004963108338415623
Epoch: 9	Batch: 4	Loss: 0.03511326387524605
Epoch: 9	Batch: 5	Loss: 0.31584328413009644
Epoch: 9	Batch: 6	Loss: 0.00019120860088150948
Epoch: 9	Batch: 7	Loss: 0.006904233247041702
Epoch: 9	Batch: 8	Loss: 0.00683322229033709
Epoch: 9	Batch: 9	Loss: 0.22781212627887726
Epoch: 9	Batch: 10	Loss: 0.0005249708192422986
Epoch: 9	Batch: 11	Loss: 0.004737017210572958
Epoch: 9	Batch: 12	Loss: 0.013022156432271004
Epoch: 9	Batch: 13	Loss: 7.581221871078014e-05
Epoch: 9	Batch: 14	Loss: 0.11927010864019394
Epoch: 9	Batch: 15	Loss: 1.5884405001997948e-05
Epoch: 9	Batch: 16	Loss: 0.008076690137386322
Epoch: 9	Batch: 17	Loss: 0.018787626177072525
Epoch: 9	Batch: 18	Loss: 0.08185791224241257
Epoch: 9	Batch: 19	Loss: 1.0693516731262207
Epoch: 9	Batch: 20	Loss: 0.002661222591996193
Epoch: 9	Batch: 21	Loss: 0.0021802359260618687
Epoch: 9	Batch: 22	Loss: 0.0011720821494236588
Epoch: 9	Batch: 23	Loss: 0.11011888831853867
Epoch: 9	Batch: 24	Loss: 0.0007081250660121441
Epoch: 9	Batch: 25	Loss: 0.07298067957162857
Epoch: 9	Batch: 26	Loss: 0.0008396765333600342
Epoch: 9	Batch: 27	Loss: 0.003171160351485014
Epoch: 9	Batch: 28	Loss: 0.056618742644786835
Epoch: 9	Batch: 29	Loss: 0.0005884882411919534
Epoch: 9	Batch: 30	Loss: 1.249178409576416
Epoch: 9	Batch: 31	Loss: 3.5702105378732085e-05
Epoch: 9	Batch: 32	Loss: 0.0162955354899168
Epoch: 9	Batch: 33	Loss: 0.002082719001919031
Epoch: 9	Batch: 34	Loss: 8.472138870274648e-05
Epoch: 9	Batch: 35	Loss: 0.002898251637816429
Epoch: 9	Batch: 36	Loss: 0.0005912688211537898
Epoch: 9	Batch: 37	Loss: 0.006682191975414753
Epoch: 9	Batch: 38	Loss: 0.03318125009536743
Epoch: 9	Batch: 39	Loss: 0.0486176423728466
Epoch: 9	Batch: 40	Loss: 0.005521699320524931
Epoch: 9	Batch: 41	Loss: 0.012424544431269169
Epoch: 9	Batch: 42	Loss: 0.0031037211883813143

```
Epoch: 9 | Batch: 43 | Loss: 0.031156960874795914
Epoch: 9 | Batch: 44 | Loss: 0.18394134938716888
Epoch: 9 | Batch: 45 | Loss: 0.4787321984767914
Epoch: 9 | Batch: 46 | Loss: 0.0003494480042718351
Epoch: 9 | Batch: 47 | Loss: 0.027304813265800476
Epoch: 9 | Batch: 48 | Loss: 0.0008737572934478521
Epoch: 9 | Batch: 49 | Loss: 0.00022059159527998418
```

```
In [ ]: test_loss, test_acc = test(large_model, test_loader, criterion)
        torch.save(large_model.state_dict(), "pokemon_model.pth")
        print(test_loss, test_acc)
```

```
Test accuracy: 0.972972972972973
0.0 0.972972972972973
```

After training the model with only 200 images (6 classes) for 10 epochs, we get the test accuracy of about 97%.

The training time for 10 epochs was about 1 minute with pytorch mps backend (Apple M2 Pro).

Conclusion

We can see that the model performs well on the test set with 97% accuracy. This is a good result considering that we only used 200 images for training and the model was never trained on fictional characters like Pokemon.

Transferring learning on fictional characters classification like Pokemon works surprisingly well with really small amount of data and training time.