```
C:\Users\Andrew\anaconda3\envs\CEML-Notebook\lib\site-
packages\torchvision\transforms\transforms.py:333: UserWarning: Argument
interpolation should be of type InterpolationMode instead of int. Please, use
InterpolationMode enum.
  "Argument interpolation should be of type InterpolationMode instead of int. "

Split Datasets…
train_ds:  8886
+---------+-------------+--------+-----------+---------------+-------+----------
----+--------+-------------+-------+
| Dataset | bright_dune | crater | dark_dune | impact_ejecta | other |
slope_streak | spider | swiss_cheese | Total |
+---------+-------------+--------+-----------+---------------+-------+----------
----+--------+-------------+-------+
|  Train  |     310     |  739   |    457    |      17       | 6993  |     215
|   47    |     108     | 8886  |
|  Test   |     44      |  131   |    75     |       3       | 1252  |      45
|    5    |      14     | 1569  |
+---------+-------------+--------+-----------+---------------+-------+----------
----+--------+-------------+-------+
```

[3]:
```
huggingface_model = 'google/vit-base-patch16-224'
```

```
ERROR! Session/line number was not unique in database. History logging moved to
new session 229
```

[4]:
```
from hugsvision.nnet.VisionClassifierTrainer import VisionClassifierTrainer
from transformers import ViTFeatureExtractor, ViTForImageClassification

model_name = "HIRISE_20EPOCH"

trainer = VisionClassifierTrainer(
    model_name   = model_name,
    train        = train,
    test         = test,
    output_dir   = "hirise-map-proj-v3/out/",
    max_epochs   = 5,
    batch_size   = 12, # On RTX 2080 Ti
    lr           = 2e-5,
    model = ViTForImageClassification.from_pretrained(
        huggingface_model,
        num_labels = len(label2id),
        label2id   = label2id,
        id2label   = id2label,
        ignore_mismatched_sizes = True
    ),
    feature_extractor = ViTFeatureExtractor.from_pretrained(
        huggingface_model,
```

```
        ignore_mismatched_sizes = True,
    ),
)
```

```
loading configuration file https://huggingface.co/google/vit-base-
patch16-224-in21k/resolve/main/config.json from cache at C:\Users\Andrew/.cache\
huggingface\transformers\7bba26dd36a6ff9f6a9b19436dec361727bea03ec70fbfa82b70628
109163eaa.92995a56e2eabab0c686015c4ad8275b4f9cbd858ed228f6a08936f2c31667e7
```

```
ERROR! Session/line number was not unique in database. History logging moved to
new session 231
```


```
Model config ViTConfig {
  "_name_or_path": "google/vit-base-patch16-224-in21k",
  "architectures": [
    "ViTModel"
  ],
  "attention_probs_dropout_prob": 0.0,
  "encoder_stride": 16,
  "hidden_act": "gelu",
  "hidden_dropout_prob": 0.0,
  "hidden_size": 768,
  "id2label": {
    "0": "bright_dune",
    "1": "crater",
    "2": "dark_dune",
    "3": "impact_ejecta",
    "4": "other",
    "5": "slope_streak",
    "6": "spider",
    "7": "swiss_cheese"
  },
  "image_size": 224,
  "initializer_range": 0.02,
  "intermediate_size": 3072,
  "label2id": {
    "bright_dune": "0",
    "crater": "1",
    "dark_dune": "2",
    "impact_ejecta": "3",
    "other": "4",
    "slope_streak": "5",
    "spider": "6",
    "swiss_cheese": "7"
  },
  "layer_norm_eps": 1e-12,
  "model_type": "vit",
  "num_attention_heads": 12,
```

```
  "num_channels": 3,
  "num_hidden_layers": 12,
  "patch_size": 16,
  "qkv_bias": true,
  "transformers_version": "4.18.0"
}

loading weights file https://huggingface.co/google/vit-base-
patch16-224-in21k/resolve/main/pytorch_model.bin from cache at C:\Users\Andrew/.
cache\huggingface\transformers\d01bfc4a52063e6f2cc1bc7063192e012043a7c6d8e75981b
b6afbb9dc911001.e4710baf72bd00d091aab2ae692d487c057734cf044ba421696823447b95521e
Some weights of the model checkpoint at google/vit-base-patch16-224-in21k were
not used when initializing ViTForImageClassification: ['pooler.dense.bias',
'pooler.dense.weight']
- This IS expected if you are initializing ViTForImageClassification from the
checkpoint of a model trained on another task or with another architecture (e.g.
initializing a BertForSequenceClassification model from a BertForPreTraining
model).
- This IS NOT expected if you are initializing ViTForImageClassification from
the checkpoint of a model that you expect to be exactly identical (initializing
a BertForSequenceClassification model from a BertForSequenceClassification
model).
Some weights of ViTForImageClassification were not initialized from the model
checkpoint at google/vit-base-patch16-224-in21k and are newly initialized:
['classifier.bias', 'classifier.weight']
You should probably TRAIN this model on a down-stream task to be able to use it
for predictions and inference.
loading feature extractor configuration file https://huggingface.co/google/vit-
base-patch16-224-in21k/resolve/main/preprocessor_config.json from cache at C:\Us
ers\Andrew/.cache\huggingface\transformers\7c7f3e780b30eeeacd3962294e5154788caa6
d9aa555ed6d5c2f0d2c485eba18.c322cbf30b69973d5aae6c0866f5cba198b5fe51a2fe259d2a50
6827ec6274bc
Feature extractor ViTFeatureExtractor {
  "do_normalize": true,
  "do_resize": true,
  "feature_extractor_type": "ViTFeatureExtractor",
  "image_mean": [
    0.5,
    0.5,
    0.5
  ],
  "image_std": [
    0.5,
    0.5,
    0.5
  ],
  "resample": 2,
  "size": 224
```

```
}

PyTorch: setting up devices
The default value for the training argument `--report_to` will change in v5
(from all installed integrations to none). In v5, you will need to use
`--report_to all` to get the same behavior as now. You should start updating
your code and make this info disappear :-).
***** Running training *****
  Num examples = 8886
  Num Epochs = 5
  Instantaneous batch size per device = 12
  Total train batch size (w. parallel, distributed & accumulation) = 12
  Gradient Accumulation steps = 1
  Total optimization steps = 3705
{'0': 'bright_dune', '1': 'crater', '2': 'dark_dune', '3': 'impact_ejecta', '4':
'other', '5': 'slope_streak', '6': 'spider', '7': 'swiss_cheese'}
{'bright_dune': '0', 'crater': '1', 'dark_dune': '2', 'impact_ejecta': '3',
'other': '4', 'slope_streak': '5', 'spider': '6', 'swiss_cheese': '7'}
Trainer builded!
Start Training!
<IPython.core.display.HTML object>
***** Running Evaluation *****
  Num examples = 1569
  Batch size = 12
***** Running Evaluation *****
  Num examples = 1569
  Batch size = 12
***** Running Evaluation *****
  Num examples = 1569
  Batch size = 12
***** Running Evaluation *****
  Num examples = 1569
  Batch size = 12
***** Running Evaluation *****
  Num examples = 1569
  Batch size = 12


Training completed. Do not forget to share your model on huggingface.co/models
=)


Saving model checkpoint to hirise-map-
proj-v3/out/HIRISE_20EPOCH/5_2022-05-08-09-45-30/trainer/
Configuration saved in hirise-map-
proj-v3/out/HIRISE_20EPOCH/5_2022-05-08-09-45-30/trainer/config.json
```

```
Model weights saved in hirise-map-
proj-v3/out/HIRISE_20EPOCH/5_2022-05-08-09-45-30/trainer/pytorch_model.bin
Configuration saved in hirise-map-
proj-v3/out/HIRISE_20EPOCH/5_2022-05-08-09-45-30/model/config.json
Model weights saved in hirise-map-
proj-v3/out/HIRISE_20EPOCH/5_2022-05-08-09-45-30/model/pytorch_model.bin
Feature extractor saved in hirise-map-proj-v3/out/HIRISE_20EPOCH/5_2022-05-08-09
-45-30/feature_extractor/preprocessor_config.json

Model saved at: hirise-map-

proj-v3/out/HIRISE_20EPOCH/5_2022-05-08-09-45-30
```

[6]:
```
model_name2 = "HIRISE_5EPOCH_BATCH16"

trainer2 = VisionClassifierTrainer(
    model_name   = model_name2,
    train        = train,
    test         = test,
    output_dir   = "hirise-map-proj-v3/out/",
    max_epochs   = 5,
    batch_size   = 16, # On RTX 2080 Ti
    lr           = 2e-5,
    model = ViTForImageClassification.from_pretrained(
        huggingface_model,
        num_labels = len(label2id),
        label2id   = label2id,
        id2label   = id2label,
        ignore_mismatched_sizes = True
    ),
    feature_extractor = ViTFeatureExtractor.from_pretrained(
        huggingface_model,
        ignore_mismatched_sizes = True,
    ),
)
```

```
loading configuration file https://huggingface.co/google/vit-base-
patch16-224-in21k/resolve/main/config.json from cache at C:\Users\Andrew/.cache\
huggingface\transformers\7bba26dd36a6ff9f6a9b19436dec361727bea03ec70fbfa82b70628
109163eaa.92995a56e2eabab0c686015c4ad8275b4f9cbd858ed228f6a08936f2c31667e7
Model config ViTConfig {
  "_name_or_path": "google/vit-base-patch16-224-in21k",
  "architectures": [
    "ViTModel"
  ],
  "attention_probs_dropout_prob": 0.0,
  "encoder_stride": 16,
  "hidden_act": "gelu",
  "hidden_dropout_prob": 0.0,
```

```
  "hidden_size": 768,
  "id2label": {
    "0": "bright_dune",
    "1": "crater",
    "2": "dark_dune",
    "3": "impact_ejecta",
    "4": "other",
    "5": "slope_streak",
    "6": "spider",
    "7": "swiss_cheese"
  },
  "image_size": 224,
  "initializer_range": 0.02,
  "intermediate_size": 3072,
  "label2id": {
    "bright_dune": "0",
    "crater": "1",
    "dark_dune": "2",
    "impact_ejecta": "3",
    "other": "4",
    "slope_streak": "5",
    "spider": "6",
    "swiss_cheese": "7"
  },
  "layer_norm_eps": 1e-12,
  "model_type": "vit",
  "num_attention_heads": 12,
  "num_channels": 3,
  "num_hidden_layers": 12,
  "patch_size": 16,
  "qkv_bias": true,
  "transformers_version": "4.18.0"
}

loading weights file https://huggingface.co/google/vit-base-
patch16-224-in21k/resolve/main/pytorch_model.bin from cache at C:\Users\Andrew/.
cache\huggingface\transformers\d01bfc4a52063e6f2cc1bc7063192e012043a7c6d8e75981b
b6afbb9dc911001.e4710baf72bd00d091aab2ae692d487c057734cf044ba421696823447b95521e
Some weights of the model checkpoint at google/vit-base-patch16-224-in21k were
not used when initializing ViTForImageClassification: ['pooler.dense.bias',
'pooler.dense.weight']
- This IS expected if you are initializing ViTForImageClassification from the
checkpoint of a model trained on another task or with another architecture (e.g.
initializing a BertForSequenceClassification model from a BertForPreTraining
model).
- This IS NOT expected if you are initializing ViTForImageClassification from
the checkpoint of a model that you expect to be exactly identical (initializing
a BertForSequenceClassification model from a BertForSequenceClassification
```

```
model).
Some weights of ViTForImageClassification were not initialized from the model
checkpoint at google/vit-base-patch16-224-in21k and are newly initialized:
['classifier.bias', 'classifier.weight']
You should probably TRAIN this model on a down-stream task to be able to use it
for predictions and inference.
loading feature extractor configuration file https://huggingface.co/google/vit-
base-patch16-224-in21k/resolve/main/preprocessor_config.json from cache at C:\Us
ers\Andrew/.cache\huggingface\transformers\7c7f3e780b30eeeacd3962294e5154788caa6
d9aa555ed6d5c2f0d2c485eba18.c322cbf30b69973d5aae6c0866f5cba198b5fe51a2fe259d2a50
6827ec6274bc
Feature extractor ViTFeatureExtractor {
  "do_normalize": true,
  "do_resize": true,
  "feature_extractor_type": "ViTFeatureExtractor",
  "image_mean": [
    0.5,
    0.5,
    0.5
  ],
  "image_std": [
    0.5,
    0.5,
    0.5
  ],
  "resample": 2,
  "size": 224
}

PyTorch: setting up devices
The default value for the training argument `--report_to` will change in v5
(from all installed integrations to none). In v5, you will need to use
`--report_to all` to get the same behavior as now. You should start updating
your code and make this info disappear :-).
C:\Users\Andrew\anaconda3\envs\CEML-Notebook\lib\site-
packages\transformers\optimization.py:309: FutureWarning: This implementation of
AdamW is deprecated and will be removed in a future version. Use the PyTorch
implementation torch.optim.AdamW instead, or set `no_deprecation_warning=True`
to disable this warning
  FutureWarning,
***** Running training *****
  Num examples = 8886
  Num Epochs = 5
  Instantaneous batch size per device = 16
  Total train batch size (w. parallel, distributed & accumulation) = 16
  Gradient Accumulation steps = 1
  Total optimization steps = 2780
```

```
{'0': 'bright_dune', '1': 'crater', '2': 'dark_dune', '3': 'impact_ejecta', '4':
'other', '5': 'slope_streak', '6': 'spider', '7': 'swiss_cheese'}
{'bright_dune': '0', 'crater': '1', 'dark_dune': '2', 'impact_ejecta': '3',
'other': '4', 'slope_streak': '5', 'spider': '6', 'swiss_cheese': '7'}
Trainer builded!
Start Training!
```

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

```
***** Running Evaluation *****
  Num examples = 1569
  Batch size = 16
***** Running Evaluation *****
  Num examples = 1569
  Batch size = 16
***** Running Evaluation *****
  Num examples = 1569
  Batch size = 16
***** Running Evaluation *****
  Num examples = 1569
  Batch size = 16
***** Running Evaluation *****
  Num examples = 1569
  Batch size = 16
```

```
Training completed. Do not forget to share your model on huggingface.co/models
=)
```

```
Saving model checkpoint to hirise-map-
proj-v3/out/HIRISE_5EPOCH_BATCH16/5_2022-05-09-00-55-06/trainer/
Configuration saved in hirise-map-
proj-v3/out/HIRISE_5EPOCH_BATCH16/5_2022-05-09-00-55-06/trainer/config.json
Model weights saved in hirise-map-proj-v3/out/HIRISE_5EPOCH_BATCH16/5_2022-05-09
-00-55-06/trainer/pytorch_model.bin
Configuration saved in hirise-map-
proj-v3/out/HIRISE_5EPOCH_BATCH16/5_2022-05-09-00-55-06/model/config.json
Model weights saved in hirise-map-
proj-v3/out/HIRISE_5EPOCH_BATCH16/5_2022-05-09-00-55-06/model/pytorch_model.bin
Feature extractor saved in hirise-map-proj-v3/out/HIRISE_5EPOCH_BATCH16/5_2022-0
5-09-00-55-06/feature_extractor/preprocessor_config.json
```

```
Model saved at: hirise-map-
```

```
proj-v3/out/HIRISE_5EPOCH_BATCH16/5_2022-05-09-00-55-06
```

1.5 4. Evaluate CNN vs ViT

[ ]:
```
# Evaluating the CNN - BEST IS 81% AFTER 5 EPOCHS
test_loss, test_accuracy = model.evaluate(test_images, test_labels)
print("Final loss was {}.\nAccuracy of model was {}".format(test_loss,␣
 ↪test_accuracy))
```

[5]:
```
# Evaluate the ViT
ref, hyp = trainer.evaluate_f1_score()
```

```
  0%|          | 0/1569 [00:00<?, ?it/s]
```

```
ERROR! Session/line number was not unique in database. History logging moved to
new session 232
```

```
100%|      | 1569/1569 [11:00<00:00,  2.38it/s]
```

	precision	recall	f1-score	support
bright_dune	0.9773	0.9773	0.9773	44
crater	0.8702	0.8702	0.8702	131
dark_dune	0.9863	0.9600	0.9730	75
impact_ejecta	1.0000	0.3333	0.5000	3
other	0.9770	0.9832	0.9801	1252
slope_streak	0.9500	0.8444	0.8941	45
spider	0.8333	1.0000	0.9091	5
swiss_cheese	1.0000	1.0000	1.0000	14
accuracy			0.9675	1569
macro avg	0.9493	0.8711	0.8880	1569
weighted avg	0.9675	0.9675	0.9671	1569

```
Logs saved at: hirise-map-
proj-v3/out/HIRISE_20EPOCH/5_2022-05-08-09-45-30
```

[7]:
```
# Evaluate the ViT
ref, hyp = trainer2.evaluate_f1_score()
```

```
100%|      | 1569/1569 [12:29<00:00,  2.09it/s]
```

	precision	recall	f1-score	support
bright_dune	0.9556	0.9773	0.9663	44
crater	0.8800	0.8397	0.8594	131
dark_dune	1.0000	0.9600	0.9796	75
impact_ejecta	1.0000	0.3333	0.5000	3
other	0.9724	0.9840	0.9782	1252
slope_streak	0.9474	0.8000	0.8675	45

```
       spider     0.8333    1.0000    0.9091         5
 swiss_cheese     0.9333    1.0000    0.9655        14

     accuracy                         0.9643      1569
    macro avg     0.9402    0.8618    0.8782      1569
 weighted avg     0.9641    0.9643    0.9636      1569
```

```
Logs saved at: hirise-map-
proj-v3/out/HIRISE_5EPOCH_BATCH16/5_2022-05-09-00-55-06
```

Short response to our findings: Was the output expected? what did we do for optimizations? is it overfit/underfit?

1.6 5. Train 3 more ViTs

[ ]:
```
# Retrain 3 times each
```

1.7 Helper Code - Should not be run

[8]:
```
import pandas as pd
import seaborn as sn
import matplotlib.pyplot as plt
from sklearn.metrics import confusion_matrix

cm = confusion_matrix(ref, hyp)
labels = list(label2id.keys())
df_cm = pd.DataFrame(cm, index = labels, columns = labels)

plt.figure(figsize = (10,7))
sn.heatmap(df_cm, annot=True, annot_kws={"size": 8}, fmt="")
plt.savefig("./hirise-map-proj-v3/out/"+model_name+"/conf_matrix_1.jpg")

print("Confusion Matrix saved to ./hirise-map-proj-v3/out/"+model_name+"/
 ↪conf_matrix_1.jpg")
```

```
Confusion Matrix saved to ./hirise-map-
proj-v3/out/HIRISE_20EPOCH/conf_matrix_1.jpg
```

[ ]:
```
# Converting Data from map-proj-v3 : We need 7 folders named
# for each class label with all of the images that apply to that class

# import os
# import os.path
# from shutil import copy2
```