t81_558_class_11_03_hf_datasets

June 23, 2025

1 T81-558: Applications of Deep Neural Networks

Module 11: Natural Language Processing with Hugging Face * Instructor: Jeff Heaton, McKelvey School of Engineering, Washington University in St. Louis * For more information visit the class website.

2 Module 11 Material

- Part 11.1: Introduction to Hugging Face [Video] [Notebook]
- Part 11.2: Hugging Face Tokenizers [Video] [Notebook]
- **Part 11.3: Hugging Face Datasets** [Video] [Notebook]
- Part 11.4: Training Hugging Face Models [Video] [Notebook]
- Part 11.5: What are Embedding Layers in Keras [Video] [Notebook]

3 Google CoLab Instructions

The following code ensures that Google CoLab is running the correct version of TensorFlow.

[ ]:
```
try:
    %tensorflow_version 2.x
    COLAB = True
    print("Note: using Google CoLab")
except:
    print("Note: not using Google CoLab")
    COLAB = False
```

```
Note: using Google CoLab
```

4 Part 11.3: Hugging Face Datasets

The Hugging Face hub includes data sets useful for natural language processing (NLP). The Hugging Face library provides functions that allow you to navigate and obtain these data sets. When we access Hugging Face data sets, the data is in a format specific to Hugging Face. In this part, we will explore this format and see how to convert it to Pandas or TensorFlow data.

We begin by installing Hugging Face if needed. It is also essential to install Hugging Face datasets.

[ ]:
```
# HIDE OUTPUT
!pip install transformers
!pip install transformers[sentencepiece]
!pip install datasets
```

```
Collecting transformers
  Downloading transformers-4.17.0-py3-none-any.whl (3.8 MB)
     |                  | 3.8 MB 5.1 MB/s
Requirement already satisfied: filelock in /usr/local/lib/python3.7/dist-
packages (from transformers) (3.6.0)
Requirement already satisfied: numpy>=1.17 in /usr/local/lib/python3.7/dist-
packages (from transformers) (1.21.5)
Requirement already satisfied: regex!=2019.12.17 in
/usr/local/lib/python3.7/dist-packages (from transformers) (2019.12.20)
Collecting tokenizers!=0.11.3,>=0.11.1
  Downloading
tokenizers-0.11.6-cp37-cp37m-manylinux_2_12_x86_64.manylinux2010_x86_64.whl (6.5
MB)
     |                  | 6.5 MB 55.4 MB/s
Collecting huggingface-hub<1.0,>=0.1.0
  Downloading huggingface_hub-0.4.0-py3-none-any.whl (67 kB)
     |                  | 67 kB 7.3 MB/s
Collecting sacremoses
  Downloading sacremoses-0.0.49-py3-none-any.whl (895 kB)
     |                  | 895 kB 55.9 MB/s
Requirement already satisfied: importlib-metadata in
/usr/local/lib/python3.7/dist-packages (from transformers) (4.11.3)
Collecting pyyaml>=5.1
  Downloading PyYAML-6.0-cp37-cp37m-
manylinux_2_5_x86_64.manylinux1_x86_64.manylinux_2_12_x86_64.manylinux2010_x86_6
4.whl (596 kB)
     |                  | 596 kB 61.0 MB/s
Requirement already satisfied: requests in /usr/local/lib/python3.7/dist-
packages (from transformers) (2.23.0)
Requirement already satisfied: tqdm>=4.27 in /usr/local/lib/python3.7/dist-
packages (from transformers) (4.63.0)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.7/dist-
packages (from transformers) (21.3)
Requirement already satisfied: typing-extensions>=3.7.4.3 in
/usr/local/lib/python3.7/dist-packages (from huggingface-
hub<1.0,>=0.1.0->transformers) (3.10.0.2)
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in
/usr/local/lib/python3.7/dist-packages (from packaging>=20.0->transformers)
(3.0.7)
Requirement already satisfied: zipp>=0.5 in /usr/local/lib/python3.7/dist-
packages (from importlib-metadata->transformers) (3.7.0)
Requirement already satisfied: chardet<4,>=3.0.2 in
/usr/local/lib/python3.7/dist-packages (from requests->transformers) (3.0.4)
```

```
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.7/dist-
packages (from requests->transformers) (2.10)
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in
/usr/local/lib/python3.7/dist-packages (from requests->transformers) (1.24.3)
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.7/dist-packages (from requests->transformers) (2021.10.8)
Requirement already satisfied: joblib in /usr/local/lib/python3.7/dist-packages
(from sacremoses->transformers) (1.1.0)
Requirement already satisfied: click in /usr/local/lib/python3.7/dist-packages
(from sacremoses->transformers) (7.1.2)
Requirement already satisfied: six in /usr/local/lib/python3.7/dist-packages
(from sacremoses->transformers) (1.15.0)
Installing collected packages: pyyaml, tokenizers, sacremoses, huggingface-hub,
transformers
  Attempting uninstall: pyyaml
    Found existing installation: PyYAML 3.13
    Uninstalling PyYAML-3.13:
      Successfully uninstalled PyYAML-3.13
Successfully installed huggingface-hub-0.4.0 pyyaml-6.0 sacremoses-0.0.49
tokenizers-0.11.6 transformers-4.17.0
Requirement already satisfied: transformers[sentencepiece] in
/usr/local/lib/python3.7/dist-packages (4.17.0)
Requirement already satisfied: requests in /usr/local/lib/python3.7/dist-
packages (from transformers[sentencepiece]) (2.23.0)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.7/dist-
packages (from transformers[sentencepiece]) (21.3)
Requirement already satisfied: sacremoses in /usr/local/lib/python3.7/dist-
packages (from transformers[sentencepiece]) (0.0.49)
Requirement already satisfied: huggingface-hub<1.0,>=0.1.0 in
/usr/local/lib/python3.7/dist-packages (from transformers[sentencepiece])
(0.4.0)
Requirement already satisfied: tokenizers!=0.11.3,>=0.11.1 in
/usr/local/lib/python3.7/dist-packages (from transformers[sentencepiece])
(0.11.6)
Requirement already satisfied: tqdm>=4.27 in /usr/local/lib/python3.7/dist-
packages (from transformers[sentencepiece]) (4.63.0)
Requirement already satisfied: importlib-metadata in
/usr/local/lib/python3.7/dist-packages (from transformers[sentencepiece])
(4.11.3)
Requirement already satisfied: regex!=2019.12.17 in
/usr/local/lib/python3.7/dist-packages (from transformers[sentencepiece])
(2019.12.20)
Requirement already satisfied: pyyaml>=5.1 in /usr/local/lib/python3.7/dist-
packages (from transformers[sentencepiece]) (6.0)
Requirement already satisfied: filelock in /usr/local/lib/python3.7/dist-
packages (from transformers[sentencepiece]) (3.6.0)
Requirement already satisfied: numpy>=1.17 in /usr/local/lib/python3.7/dist-
packages (from transformers[sentencepiece]) (1.21.5)
```

```
Collecting sentencepiece!=0.1.92,>=0.1.91
  Downloading
sentencepiece-0.1.96-cp37-cp37m-manylinux_2_17_x86_64.manylinux2014_x86_64.whl
(1.2 MB)
     |                  | 1.2 MB 5.1 MB/s
Requirement already satisfied: protobuf in /usr/local/lib/python3.7/dist-
packages (from transformers[sentencepiece]) (3.17.3)
Requirement already satisfied: typing-extensions>=3.7.4.3 in
/usr/local/lib/python3.7/dist-packages (from huggingface-
hub<1.0,>=0.1.0->transformers[sentencepiece]) (3.10.0.2)
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in
/usr/local/lib/python3.7/dist-packages (from
packaging>=20.0->transformers[sentencepiece]) (3.0.7)
Requirement already satisfied: zipp>=0.5 in /usr/local/lib/python3.7/dist-
packages (from importlib-metadata->transformers[sentencepiece]) (3.7.0)
Requirement already satisfied: six>=1.9 in /usr/local/lib/python3.7/dist-
packages (from protobuf->transformers[sentencepiece]) (1.15.0)
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.7/dist-
packages (from requests->transformers[sentencepiece]) (2.10)
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.7/dist-packages (from
requests->transformers[sentencepiece]) (2021.10.8)
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in
/usr/local/lib/python3.7/dist-packages (from
requests->transformers[sentencepiece]) (1.24.3)
Requirement already satisfied: chardet<4,>=3.0.2 in
/usr/local/lib/python3.7/dist-packages (from
requests->transformers[sentencepiece]) (3.0.4)
Requirement already satisfied: joblib in /usr/local/lib/python3.7/dist-packages
(from sacremoses->transformers[sentencepiece]) (1.1.0)
Requirement already satisfied: click in /usr/local/lib/python3.7/dist-packages
(from sacremoses->transformers[sentencepiece]) (7.1.2)
Installing collected packages: sentencepiece
Successfully installed sentencepiece-0.1.96
Collecting datasets
  Downloading datasets-2.0.0-py3-none-any.whl (325 kB)
     |                  | 325 kB 5.0 MB/s
Collecting xxhash
  Downloading
xxhash-3.0.0-cp37-cp37m-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (212 kB)
     |                  | 212 kB 86.4 MB/s
Requirement already satisfied: dill in /usr/local/lib/python3.7/dist-
packages (from datasets) (0.3.4)
Requirement already satisfied: huggingface-hub<1.0.0,>=0.1.0 in
/usr/local/lib/python3.7/dist-packages (from datasets) (0.4.0)
Requirement already satisfied: pyarrow>=5.0.0 in /usr/local/lib/python3.7/dist-
packages (from datasets) (6.0.1)
Requirement already satisfied: tqdm>=4.62.1 in /usr/local/lib/python3.7/dist-
```

```
packages (from datasets) (4.63.0)
Collecting responses<0.19
  Downloading responses-0.18.0-py3-none-any.whl (38 kB)
Requirement already satisfied: packaging in /usr/local/lib/python3.7/dist-
packages (from datasets) (21.3)
Requirement already satisfied: importlib-metadata in
/usr/local/lib/python3.7/dist-packages (from datasets) (4.11.3)
Requirement already satisfied: numpy>=1.17 in /usr/local/lib/python3.7/dist-
packages (from datasets) (1.21.5)
Requirement already satisfied: multiprocess in /usr/local/lib/python3.7/dist-
packages (from datasets) (0.70.12.2)
Requirement already satisfied: requests>=2.19.0 in
/usr/local/lib/python3.7/dist-packages (from datasets) (2.23.0)
Collecting aiohttp
  Downloading aiohttp-3.8.1-cp37-cp37m-
manylinux_2_5_x86_64.manylinux1_x86_64.manylinux_2_12_x86_64.manylinux2010_x86_6
4.whl (1.1 MB)
     |                  | 1.1 MB 70.0 MB/s
Requirement already satisfied: pandas in /usr/local/lib/python3.7/dist-
packages (from datasets) (1.3.5)
Collecting fsspec[http]>=2021.05.0
  Downloading fsspec-2022.2.0-py3-none-any.whl (134 kB)
     |                  | 134 kB 87.8 MB/s
Requirement already satisfied: filelock in /usr/local/lib/python3.7/dist-
packages (from huggingface-hub<1.0.0,>=0.1.0->datasets) (3.6.0)
Requirement already satisfied: typing-extensions>=3.7.4.3 in
/usr/local/lib/python3.7/dist-packages (from huggingface-
hub<1.0.0,>=0.1.0->datasets) (3.10.0.2)
Requirement already satisfied: pyyaml in /usr/local/lib/python3.7/dist-packages
(from huggingface-hub<1.0.0,>=0.1.0->datasets) (6.0)
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in
/usr/local/lib/python3.7/dist-packages (from packaging->datasets) (3.0.7)
Requirement already satisfied: chardet<4,>=3.0.2 in
/usr/local/lib/python3.7/dist-packages (from requests>=2.19.0->datasets) (3.0.4)
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.7/dist-
packages (from requests>=2.19.0->datasets) (2.10)
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in
/usr/local/lib/python3.7/dist-packages (from requests>=2.19.0->datasets)
(1.24.3)
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.7/dist-packages (from requests>=2.19.0->datasets)
(2021.10.8)
Collecting urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1
  Downloading urllib3-1.25.11-py2.py3-none-any.whl (127 kB)
     |                  | 127 kB 89.0 MB/s
Collecting multidict<7.0,>=4.5
  Downloading
multidict-6.0.2-cp37-cp37m-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (94
```

```
kB)
     |                  | 94 kB 4.7 MB/s
Collecting async-timeout<5.0,>=4.0.0a3
  Downloading async_timeout-4.0.2-py3-none-any.whl (5.8 kB)
Collecting asynctest==0.13.0
  Downloading asynctest-0.13.0-py3-none-any.whl (26 kB)
Collecting frozenlist>=1.1.1
  Downloading frozenlist-1.3.0-cp37-cp37m-
manylinux_2_5_x86_64.manylinux1_x86_64.manylinux_2_17_x86_64.manylinux2014_x86_6
4.whl (144 kB)
     |                  | 144 kB 88.6 MB/s
Collecting aiosignal>=1.1.2
  Downloading aiosignal-1.2.0-py3-none-any.whl (8.2 kB)
Collecting yarl<2.0,>=1.0
  Downloading yarl-1.7.2-cp37-cp37m-
manylinux_2_5_x86_64.manylinux1_x86_64.manylinux_2_12_x86_64.manylinux2010_x86_6
4.whl (271 kB)
     |                  | 271 kB 87.1 MB/s
Requirement already satisfied: attrs>=17.3.0 in
/usr/local/lib/python3.7/dist-packages (from aiohttp->datasets) (21.4.0)
Requirement already satisfied: charset-normalizer<3.0,>=2.0 in
/usr/local/lib/python3.7/dist-packages (from aiohttp->datasets) (2.0.12)
Requirement already satisfied: zipp>=0.5 in /usr/local/lib/python3.7/dist-
packages (from importlib-metadata->datasets) (3.7.0)
Requirement already satisfied: pytz>=2017.3 in /usr/local/lib/python3.7/dist-
packages (from pandas->datasets) (2018.9)
Requirement already satisfied: python-dateutil>=2.7.3 in
/usr/local/lib/python3.7/dist-packages (from pandas->datasets) (2.8.2)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/dist-
packages (from python-dateutil>=2.7.3->pandas->datasets) (1.15.0)
Installing collected packages: multidict, frozenlist, yarl, urllib3, asynctest,
async-timeout, aiosignal, fsspec, aiohttp, xxhash, responses, datasets
  Attempting uninstall: urllib3
    Found existing installation: urllib3 1.24.3
    Uninstalling urllib3-1.24.3:
      Successfully uninstalled urllib3-1.24.3
ERROR: pip's dependency resolver does not currently take into account all
the packages that are installed. This behaviour is the source of the following
dependency conflicts.
datascience 0.10.6 requires folium==0.2.1, but you have folium 0.8.3 which is
incompatible.
Successfully installed aiohttp-3.8.1 aiosignal-1.2.0 async-timeout-4.0.2
asynctest-0.13.0 datasets-2.0.0 frozenlist-1.3.0 fsspec-2022.2.0 multidict-6.0.2
responses-0.18.0 urllib3-1.25.11 xxhash-3.0.0 yarl-1.7.2
```

We begin by querying Hugging Face to obtain the total count and names of the data sets. This

code obtains the total count and the names of the first five datasets.

[ ]:
```
from datasets import list_datasets

all_datasets = list_datasets()

print(f"Hugging Face hub currently contains {len(all_datasets)}")
print(f"datasets. The first 5 are:")
print("\n".join(all_datasets[:10]))
```

```
Hugging Face hub currently contains 3832
datasets. The first 5 are:
acronym_identification
ade_corpus_v2
adversarial_qa
aeslc
afrikaans_ner_corpus
ag_news
ai2_arc
air_dialogue
ajgt_twitter_ar
allegro_reviews
```

We begin by loading the emotion data set from the Hugging Face hub. Emotion is a dataset of English Twitter messages with six basic emotions: anger, fear, joy, love, sadness, and surprise. [Cite:saravia2018carer] The following code loads the emotion data set from the Hugging Face hub.

[ ]:
```
from datasets import load_dataset

emotions = load_dataset("emotion")
```

```
Downloading builder script:   0%|          | 0.00/1.66k [00:00<?, ?B/s]

Downloading metadata:   0%|          | 0.00/1.61k [00:00<?, ?B/s]

Using custom data configuration default

Downloading and preparing dataset emotion/default (download: 1.97 MiB,
generated: 2.07 MiB, post-processed: Unknown size, total: 4.05 MiB) to /root/.ca
che/huggingface/datasets/emotion/default/0.0.0/348f63ca8e27b3713b6c04d723efe6d82
4a56fb3d1449794716c0f0296072705…

Downloading data:   0%|          | 0.00/1.66M [00:00<?, ?B/s]

Downloading data:   0%|          | 0.00/204k [00:00<?, ?B/s]

Downloading data:   0%|          | 0.00/207k [00:00<?, ?B/s]

Generating train split:   0%|          | 0/16000 [00:00<?, ? examples/s]

Generating validation split:   0%|          | 0/2000 [00:00<?, ? examples/s]

Generating test split:   0%|          | 0/2000 [00:00<?, ? examples/s]
```

```
Dataset emotion downloaded and prepared to /root/.cache/huggingface/datasets/emo
tion/default/0.0.0/348f63ca8e27b3713b6c04d723efe6d824a56fb3d1449794716c0f0296072
705. Subsequent calls will reuse this data.

  0%|          | 0/3 [00:00<?, ?it/s]
```

A quick scan of the downloaded data set reveals its structure. In this case, Hugging Face already separated the data into training, validation, and test data sets. The training set consists of 16,000 observations, while the test and validation sets contain 2,000 observations. The dataset is a Python dictionary that includes a Dataset object for each of these three divisions. The datasets only contain two columns, the text and the emotion label for each text sample.

[ ]:
```
emotions
```

[ ]:
```
DatasetDict({
    train: Dataset({
        features: ['text', 'label'],
        num_rows: 16000
    })
    validation: Dataset({
        features: ['text', 'label'],
        num_rows: 2000
    })
    test: Dataset({
        features: ['text', 'label'],
        num_rows: 2000
    })
})
```

You can see a single observation from the training data set here. This observation includes both the text sample and the assigned emotion label. The label is a numeric index representing the assigned emotion.

[ ]:
```
emotions['train'][2]
```

[ ]:
```
{'label': 3, 'text': 'im grabbing a minute to post i feel greedy wrong'}
```

We can display the labels in order of their index labels.

[ ]:
```
emotions['train'].features
```

[ ]:
```
{'label': ClassLabel(num_classes=6, names=['sadness', 'joy', 'love', 'anger',
'fear', 'surprise'], id=None),
 'text': Value(dtype='string', id=None)}
```

Hugging face can provide these data sets in a variety of formats. The following code receives the emotion data set as a Pandas data frame.

[ ]:
```
import pandas as pd
```

```
emotions.set_format(type='pandas')
df = emotions["train"][:]
df[:5]
```

[ ]:

	text	label
0	i didnt feel humiliated	0
1	i can go from feeling so hopeless to so damned…	0
2	im grabbing a minute to post i feel greedy wrong	3
3	i am ever feeling nostalgic about the fireplac…	2
4	i am feeling grouchy	3

We can use the Pandas "apply" function to add the textual label for each observation.

[ ]:
```
def label_it(row):
  return emotions["train"].features["label"].int2str(row)


df['label_name'] = df["label"].apply(label_it)
df[:5]
```

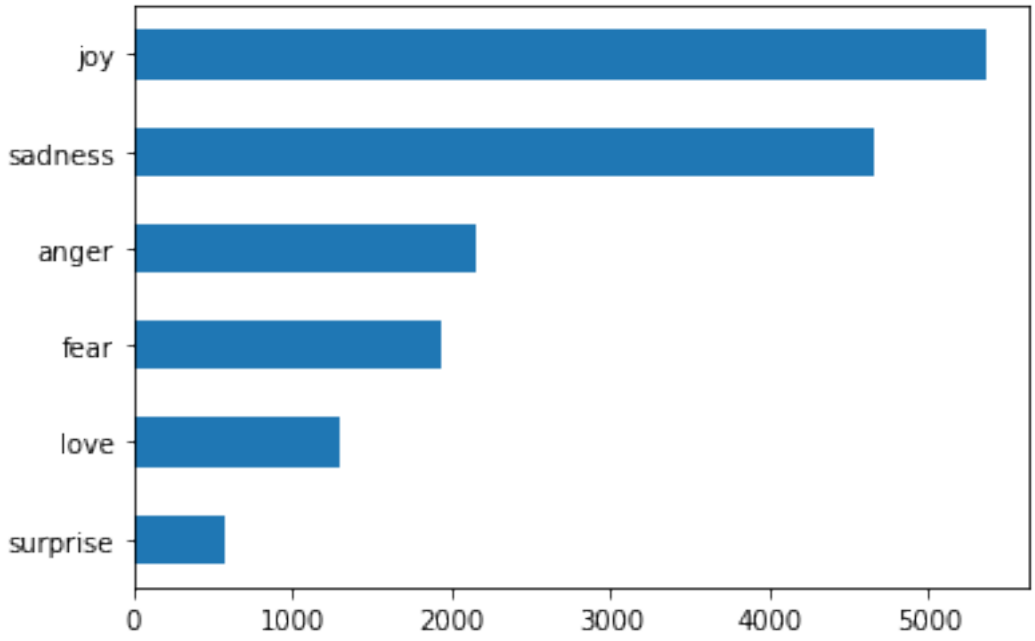
[ ]:

	text	label	label_name
0	i didnt feel humiliated	0	sadness
1	i can go from feeling so hopeless to so damned…	0	sadness
2	im grabbing a minute to post i feel greedy wrong	3	anger
3	i am ever feeling nostalgic about the fireplac…	2	love
4	i am feeling grouchy	3	anger

With the data in Pandas format and textually labeled, we can display a bar chart of the frequency of each of the emotions.

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

df["label_name"].value_counts(ascending=True).plot.barh()
plt.show()
```



Finally, we utilize Hugging Face tokenizers and data sets together. The following code tokenizes the entire emotion data set. You can see below that the code has transformed the training set into subword tokens that are now ready to be used in conjunction with a transformer for either inference or training.

[ ]:
```
from transformers import AutoTokenizer


def tokenize(rows):
    return tokenizer(rows['text'], padding=True, truncation=True)


model_ckpt = "distilbert-base-uncased"
tokenizer = AutoTokenizer.from_pretrained(model_ckpt)

emotions.set_format(type=None)

encoded = tokenize(emotions["train"][:2])

print("**Input IDs**")
for a in encoded.input_ids:
    print(a)
```

```
Downloading:   0%|          | 0.00/28.0 [00:00<?, ?B/s]

Downloading:   0%|          | 0.00/483 [00:00<?, ?B/s]

Downloading:   0%|          | 0.00/226k [00:00<?, ?B/s]
```

```
Downloading:   0%|          | 0.00/455k [00:00<?, ?B/s]
```

```
**Input IDs**
[101, 1045, 2134, 2102, 2514, 26608, 102, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0]
[101, 1045, 2064, 2175, 2013, 3110, 2061, 20625, 2000, 2061, 9636, 17772, 2074,
2013, 2108, 2105, 2619, 2040, 14977, 1998, 2003, 8300, 102]
```