In [ ]:
```
import numpy as np
import tensorflow as tf
import pandas as pd
```

In [ ]:
```
import tensorflow_datasets as tfds
```

In [ ]:
```
(fashion_train, fashion_test), info = tfds.load('fashion_mnist', split=['train
```

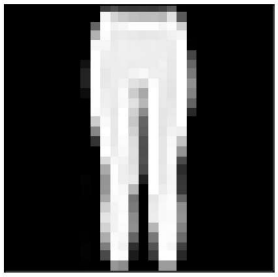
```
Downloading and preparing dataset Unknown size (download: Unknown size, gener
ated: Unknown size, total: Unknown size) to /root/tensorflow_datasets/fashion
_mnist/3.0.1...

Dl Completed...: 0 url [00:00, ? url/s]

Dl Size...: 0 MiB [00:00, ? MiB/s]

Extraction completed...: 0 file [00:00, ? file/s]

Generating splits...:   0%|          | 0/2 [00:00<?, ? splits/s]

Generating train examples...: 0 examples [00:00, ? examples/s]

Shuffling /root/tensorflow_datasets/fashion_mnist/3.0.1.incomplete8QOTTJ/fash
ion_mnist-train.tfrecord*...:   0…

Generating test examples...: 0 examples [00:00, ? examples/s]

Shuffling /root/tensorflow_datasets/fashion_mnist/3.0.1.incomplete8QOTTJ/fash
ion_mnist-test.tfrecord*...:   0%…

Dataset fashion_mnist downloaded and prepared to /root/tensorflow_datasets/fa
shion_mnist/3.0.1. Subsequent calls will reuse this data.
```

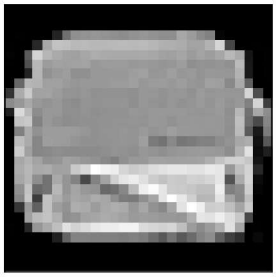
In [ ]:
```
fashion_train
```

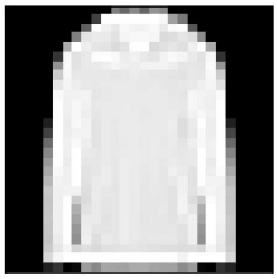
Out[4]:
```
<PrefetchDataset element_spec={'image': TensorSpec(shape=(28, 28, 1), dtype=t
f.uint8, name=None), 'label': TensorSpec(shape=(), dtype=tf.int64, name=Non
e)}>
```

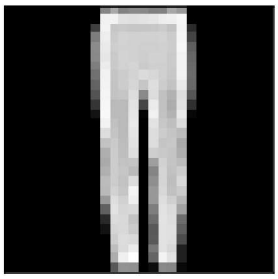
In [ ]:
```
tfds.show_examples(fashion_train, info)
```

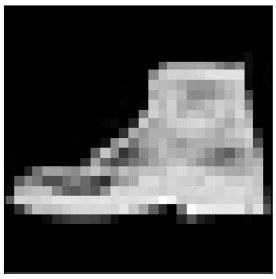

Pullover (2)


Trouser (1)

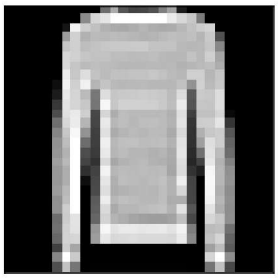

Bag (8)

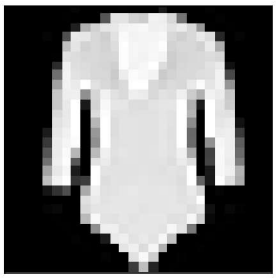

Coat (4)


Trouser (1)

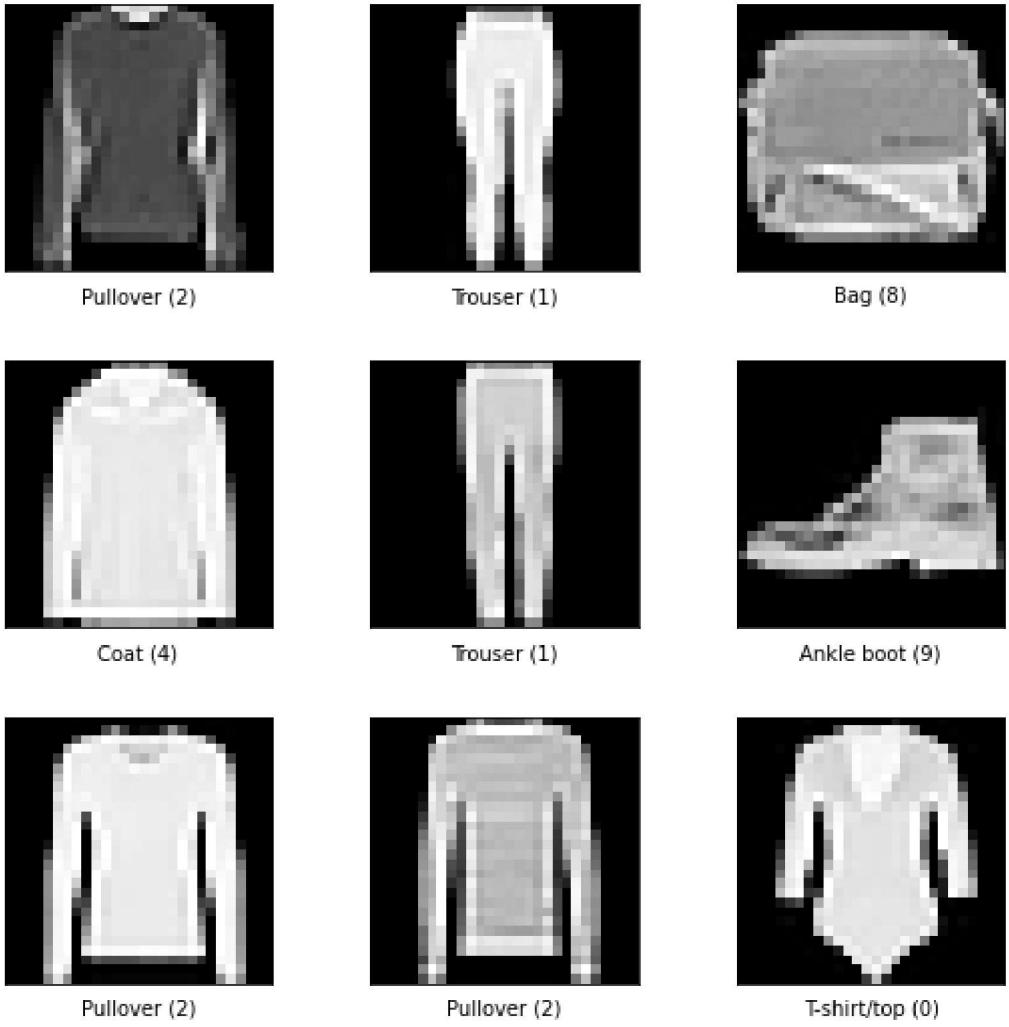

Ankle boot (9)


Pullover (2)


Pullover (2)


T-shirt/top (0)

Out[5]:



In [ ]:
```
X_train = []
Y_train = []

for instance in fashion_train:
  X_train.append(instance['image'])
  Y_train.append(instance['label'])
```

In [ ]:
```
X_train = np.array(X_train)
X_train.shape
```

Out[9]:
```
(60, 28, 28, 1)
```

In [ ]:
```
Y_train = np.array(Y_train)
Y_train.shape
```

Out[10]:
```
(60,)
```

In [ ]:
```
Y_train
```

Out[11]:
```
array([2, 1, 8, 4, 1, 9, 2, 2, 0, 2, 6, 9, 0, 7, 5, 4, 0, 1, 8, 0, 4, 2,
       6, 7, 0, 6, 4, 0, 3, 1, 2, 7, 1, 2, 5, 5, 8, 6, 6, 4, 5, 1, 2, 9,
       4, 9, 3, 1, 2, 9, 0, 8, 9, 1, 3, 3, 1, 3, 6, 7])
```

In [ ]:
```
# One Hot Encoding, 10 possibel values or classes
Y_train = tf.one_hot(Y_train, 10)
```

In [ ]:
```
Y_train
```

Out[17]:
```
<tf.Tensor: shape=(60, 10), dtype=float32, numpy=
array([[0., 0., 1., 0., 0., 0., 0., 0., 0., 0.],
       [0., 1., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 1., 0.],
       [0., 0., 0., 0., 1., 0., 0., 0., 0., 0.],
       [0., 1., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 1.],
       [0., 0., 1., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 1., 0., 0., 0., 0., 0., 0., 0.],
       [1., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 1., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 1., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 1.],
       [1., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 1., 0., 0.],
       [0., 0., 0., 0., 0., 1., 0., 0., 0., 0.],
       [0., 0., 0., 0., 1., 0., 0., 0., 0., 0.],
       [1., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 1., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 1., 0.],
       [1., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 1., 0., 0., 0., 0., 0.],
       [0., 0., 1., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 1., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 1., 0., 0.],
       [1., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 1., 0., 0., 0.],
       [0., 0., 0., 0., 1., 0., 0., 0., 0., 0.],
       [1., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 1., 0., 0., 0., 0., 0., 0.],
       [0., 1., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 1., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 1., 0., 0., 0.],
       [0., 1., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 1., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 1., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 1., 0.],
       [0., 0., 0., 0., 0., 0., 1., 0., 0., 0.],
       [0., 0., 0., 0., 0., 1., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 1.],
       [0., 0., 0., 0., 1., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 1.],
       [0., 0., 0., 1., 0., 0., 0., 0., 0., 0.],
       [0., 1., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 1., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 1.],
       [1., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 1., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 1.],
       [0., 1., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 1., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 1., 0., 0., 0., 0., 0., 0.],
```

```
       [0., 1., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 1., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 1., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 1., 0., 0.]], dtype=float32)>
```

In [ ]:
```
# Building the Neural Network, Convolution Neural Network!

# Importing libraries
from tensorflow import keras
from keras import layers
from keras.layers import Conv2D, MaxPooling2D, Dense, Flatten
```

In [ ]:
```
cnn_model = keras.Sequential()
```

In [ ]:
```
cnn_model.add(Conv2D(20, kernel_size=(2,2), strides=(1,1), activation='relu',
cnn_model.add(MaxPooling2D(pool_size=(2,2), strides=(1,1)))
cnn_model.add(Conv2D(15, kernel_size=(2,2), strides=(1,1), activation='relu',
cnn_model.add(MaxPooling2D(pool_size=(2,2), strides=(1,1)))
cnn_model.add(Conv2D(10, kernel_size=(2,2), strides=(1,1), activation='relu',
cnn_model.add(MaxPooling2D(pool_size=(2,2), strides=(1,1)))
cnn_model.add(Flatten())
cnn_model.add(Dense(10, activation='softmax'))
```

In [ ]:
```
cnn_model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 27, 27, 20)        100

 max_pooling2d (MaxPooling2D  (None, 26, 26, 20)       0
 )

 conv2d_1 (Conv2D)           (None, 25, 25, 15)        1215

 max_pooling2d_1 (MaxPooling  (None, 24, 24, 15)       0
 2D)

 conv2d_2 (Conv2D)           (None, 23, 23, 10)        610

 max_pooling2d_2 (MaxPooling  (None, 22, 22, 10)       0
 2D)

 flatten (Flatten)           (None, 4840)              0

 dense (Dense)               (None, 10)                48410

=================================================================
Total params: 50,335
Trainable params: 50,335
Non-trainable params: 0
_________________________________________________________________
```

In [ ]:
```
X_train = X_train/255
```

In [ ]:
```
SGD = tf.keras.optimizers.SGD(learning_rate=0.1, momentum=0.4)
```

In [ ]:
```
cnn_model.compile(optimizer=SGD, loss='categorial_crossentropy', metrics=['acc
```

In [ ]:
```
cnn_model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=[
```

In [ ]:
```
cnn_model.fit(X_train, Y_train, epochs=35, batch_size=150, shuffle=True)
```

```
Epoch 1/35
1/1 [==============================] - 2s 2s/step - loss: 2.3035 - accuracy:
0.1167
Epoch 2/35
1/1 [==============================] - 0s 191ms/step - loss: 2.2184 - accurac
y: 0.3167
Epoch 3/35
1/1 [==============================] - 0s 182ms/step - loss: 2.1328 - accurac
y: 0.3167
Epoch 4/35
1/1 [==============================] - 0s 160ms/step - loss: 2.0434 - accurac
y: 0.3000
Epoch 5/35
1/1 [==============================] - 0s 167ms/step - loss: 1.9493 - accurac
y: 0.3167
Epoch 6/35
1/1 [==============================] - 0s 96ms/step - loss: 1.8492 - accurac
y: 0.3167
Epoch 7/35
1/1 [==============================] - 0s 92ms/step - loss: 1.7410 - accurac
y: 0.3667
Epoch 8/35
1/1 [==============================] - 0s 94ms/step - loss: 1.6234 - accurac
y: 0.5333
Epoch 9/35
1/1 [==============================] - 0s 94ms/step - loss: 1.4977 - accurac
y: 0.5833
Epoch 10/35
1/1 [==============================] - 0s 100ms/step - loss: 1.3672 - accurac
y: 0.6167
Epoch 11/35
1/1 [==============================] - 0s 93ms/step - loss: 1.2371 - accurac
y: 0.6333
Epoch 12/35
1/1 [==============================] - 0s 101ms/step - loss: 1.1124 - accurac
y: 0.8000
Epoch 13/35
1/1 [==============================] - 0s 91ms/step - loss: 0.9953 - accurac
y: 0.8833
Epoch 14/35
1/1 [==============================] - 0s 99ms/step - loss: 0.8849 - accurac
y: 0.9167
Epoch 15/35
1/1 [==============================] - 0s 97ms/step - loss: 0.7801 - accurac
y: 0.8833
Epoch 16/35
1/1 [==============================] - 0s 96ms/step - loss: 0.6843 - accurac
y: 0.8833
Epoch 17/35
1/1 [==============================] - 0s 98ms/step - loss: 0.6025 - accurac
y: 0.9000
Epoch 18/35
1/1 [==============================] - 0s 100ms/step - loss: 0.5341 - accurac
y: 0.9000
Epoch 19/35
1/1 [==============================] - 0s 98ms/step - loss: 0.4743 - accurac
y: 0.9000
```

```
Epoch 20/35
1/1 [==============================] - 0s 97ms/step - loss: 0.4216 - accurac
y: 0.9500
Epoch 21/35
1/1 [==============================] - 0s 97ms/step - loss: 0.3720 - accurac
y: 0.9333
Epoch 22/35
1/1 [==============================] - 0s 102ms/step - loss: 0.3302 - accurac
y: 0.9500
Epoch 23/35
1/1 [==============================] - 0s 97ms/step - loss: 0.2955 - accurac
y: 0.9667
Epoch 24/35
1/1 [==============================] - 0s 99ms/step - loss: 0.2644 - accurac
y: 0.9500
Epoch 25/35
1/1 [==============================] - 0s 91ms/step - loss: 0.2362 - accurac
y: 0.9500
Epoch 26/35
1/1 [==============================] - 0s 92ms/step - loss: 0.2088 - accurac
y: 0.9833
Epoch 27/35
1/1 [==============================] - 0s 93ms/step - loss: 0.1872 - accurac
y: 0.9833
Epoch 28/35
1/1 [==============================] - 0s 104ms/step - loss: 0.1675 - accurac
y: 0.9833
Epoch 29/35
1/1 [==============================] - 0s 98ms/step - loss: 0.1499 - accurac
y: 0.9833
Epoch 30/35
1/1 [==============================] - 0s 91ms/step - loss: 0.1325 - accurac
y: 0.9833
Epoch 31/35
1/1 [==============================] - 0s 91ms/step - loss: 0.1179 - accurac
y: 0.9833
Epoch 32/35
1/1 [==============================] - 0s 108ms/step - loss: 0.1053 - accurac
y: 1.0000
Epoch 33/35
1/1 [==============================] - 0s 92ms/step - loss: 0.0938 - accurac
y: 1.0000
Epoch 34/35
1/1 [==============================] - 0s 90ms/step - loss: 0.0834 - accurac
y: 1.0000
Epoch 35/35
1/1 [==============================] - 0s 93ms/step - loss: 0.0736 - accurac
y: 1.0000
```

Out[29]: <keras.callbacks.History at 0x7fa3497ed5b0>

In [ ]:
```
cnn_model.evaluate(X_train, Y_train)
```

```
2/2 [==============================] - 0s 21ms/step - loss: 0.0658 - accurac
y: 1.0000
```

Out[43]:
```
[0.06579912453889847, 1.0]
```

In [ ]:
```
predictions = cnn_model.predict(X_train)
predicted_classes = np.argmax(predictions, axis=1)
```

```
2/2 [==============================] - 0s 18ms/step
```

In [ ]:
```
predictions
```

Out[47]:
```
array([[1.42760517e-03, 3.81910992e-09, 7.86436677e-01, 1.40670512e-04,
        6.46193884e-03, 1.41876126e-05, 2.05075517e-01, 1.70843464e-06,
        4.07553802e-04, 3.41386949e-05],
       [2.06437835e-06, 9.99750733e-01, 5.84289117e-10, 2.46565323e-04,
        1.01774404e-07, 9.02744102e-10, 1.95544874e-13, 3.78346438e-10,
        6.08842640e-07, 1.12563727e-08],
       [1.20474651e-04, 3.95834387e-09, 2.03076899e-02, 7.52018650e-06,
        1.57811795e-03, 3.52655803e-07, 9.67818648e-02, 8.51141913e-09,
        8.80837560e-01, 3.66408000e-04],
       [5.61110901e-05, 3.40041970e-12, 4.51142527e-02, 8.70700603e-07,
        9.39068556e-01, 3.82725839e-12, 1.54239824e-02, 2.76612101e-11,
        3.36041849e-04, 8.73967068e-08],
       [8.16105785e-06, 9.99485314e-01, 2.00117123e-09, 5.02846960e-04,
        1.38197478e-07, 9.22988335e-08, 3.13147468e-12, 4.36744330e-09,
        3.06956917e-06, 2.75852102e-07],
       [8.15724945e-08, 6.09963191e-09, 1.52533937e-06, 2.52788254e-06,
        3.25430527e-08, 1.27206102e-03, 6.30434170e-06, 1.96805422e-06,
        7.69840670e-04, 9.97945726e-01],
       [7.14714755e-04, 1.66266549e-11, 9.86168206e-01, 1.15530156e-06,
```

In [2]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

In [10]:
```
!pip install nbconvert
!jupyter nbconvert --to pdf Sample1.ipynb
```

```
Looking in indexes: https://pypi.org/simple, (https://pypi.org/simple,) ht
tps://us-python.pkg.dev/colab-wheels/public/simple/ (https://us-python.pk
g.dev/colab-wheels/public/simple/)
Requirement already satisfied: nbconvert in /usr/local/lib/python3.9/dist-
packages (6.5.4)
Requirement already satisfied: nbclient>=0.5.0 in /usr/local/lib/python3.
9/dist-packages (from nbconvert) (0.7.2)
Requirement already satisfied: nbformat>=5.1 in /usr/local/lib/python3.9/d
ist-packages (from nbconvert) (5.7.3)
Requirement already satisfied: jupyterlab-pygments in /usr/local/lib/pytho
n3.9/dist-packages (from nbconvert) (0.2.2)
Requirement already satisfied: packaging in /usr/local/lib/python3.9/dist-
packages (from nbconvert) (23.0)
Requirement already satisfied: pandocfilters>=1.4.1 in /usr/local/lib/pyth
on3.9/dist-packages (from nbconvert) (1.5.0)
Requirement already satisfied: defusedxml in /usr/local/lib/python3.9/dist
-packages (from nbconvert) (0.7.1)
Requirement already satisfied: bleach in /usr/local/lib/python3.9/dist-pac
kages (from nbconvert) (6.0.0)
```

In [11]:
```
!pip install nbconvert
```

```
Looking in indexes: https://pypi.org/simple, (https://pypi.org/simple,) http
s://us-python.pkg.dev/colab-wheels/public/simple/ (https://us-python.pkg.dev/
colab-wheels/public/simple/)
Requirement already satisfied: nbconvert in /usr/local/lib/python3.9/dist-pac
kages (6.5.4)
Requirement already satisfied: nbclient>=0.5.0 in /usr/local/lib/python3.9/di
st-packages (from nbconvert) (0.7.2)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.9/di
st-packages (from nbconvert) (2.1.2)
Requirement already satisfied: mistune<2,>=0.8.1 in /usr/local/lib/python3.9/
dist-packages (from nbconvert) (0.8.4)
Requirement already satisfied: tinycss2 in /usr/local/lib/python3.9/dist-pack
ages (from nbconvert) (1.2.1)
Requirement already satisfied: jupyter-core>=4.7 in /usr/local/lib/python3.9/
dist-packages (from nbconvert) (5.2.0)
Requirement already satisfied: entrypoints>=0.2.2 in /usr/local/lib/python3.
9/dist-packages (from nbconvert) (0.4)
Requirement already satisfied: nbformat>=5.1 in /usr/local/lib/python3.9/dist
-packages (from nbconvert) (5.7.3)
Requirement already satisfied: pandocfilters>=1.4.1 in /usr/local/lib/python
3.9/dist-packages (from nbconvert) (1.5.0)
Requirement already satisfied: traitlets>=5.0 in /usr/local/lib/python3.9/dis
t-packages (from nbconvert) (5.7.1)
Requirement already satisfied: lxml in /usr/local/lib/python3.9/dist-packages
(from nbconvert) (4.9.2)
Requirement already satisfied: jinja2>=3.0 in /usr/local/lib/python3.9/dist-p
ackages (from nbconvert) (3.1.2)
Requirement already satisfied: beautifulsoup4 in /usr/local/lib/python3.9/dis
t-packages (from nbconvert) (4.6.3)
Requirement already satisfied: defusedxml in /usr/local/lib/python3.9/dist-pa
ckages (from nbconvert) (0.7.1)
Requirement already satisfied: jupyterlab-pygments in /usr/local/lib/python3.
9/dist-packages (from nbconvert) (0.2.2)
Requirement already satisfied: packaging in /usr/local/lib/python3.9/dist-pac
kages (from nbconvert) (23.0)
Requirement already satisfied: bleach in /usr/local/lib/python3.9/dist-packag
es (from nbconvert) (6.0.0)
Requirement already satisfied: pygments>=2.4.1 in /usr/local/lib/python3.9/di
st-packages (from nbconvert) (2.6.1)
Requirement already satisfied: platformdirs>=2.5 in /usr/local/lib/python3.9/
dist-packages (from jupyter-core>=4.7->nbconvert) (3.1.0)
Requirement already satisfied: jupyter-client>=6.1.12 in /usr/local/lib/pytho
n3.9/dist-packages (from nbclient>=0.5.0->nbconvert) (6.1.12)
Requirement already satisfied: jsonschema>=2.6 in /usr/local/lib/python3.9/di
st-packages (from nbformat>=5.1->nbconvert) (4.3.3)
Requirement already satisfied: fastjsonschema in /usr/local/lib/python3.9/dis
t-packages (from nbformat>=5.1->nbconvert) (2.16.3)
Requirement already satisfied: webencodings in /usr/local/lib/python3.9/dist-
packages (from bleach->nbconvert) (0.5.1)
Requirement already satisfied: six>=1.9.0 in /usr/local/lib/python3.9/dist-pa
ckages (from bleach->nbconvert) (1.15.0)
Requirement already satisfied: pyrsistent!=0.17.0,!=0.17.1,!=0.17.2,>=0.14.0
in /usr/local/lib/python3.9/dist-packages (from jsonschema>=2.6->nbformat>=5.
1->nbconvert) (0.19.3)
Requirement already satisfied: attrs>=17.4.0 in /usr/local/lib/python3.9/dist
-packages (from jsonschema>=2.6->nbformat>=5.1->nbconvert) (22.2.0)
Requirement already satisfied: tornado>=4.1 in /usr/local/lib/python3.9/dist-
```

```
packages (from jupyter-client>=6.1.12->nbclient>=0.5.0->nbconvert) (6.2)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python
3.9/dist-packages (from jupyter-client>=6.1.12->nbclient>=0.5.0->nbconvert)
(2.8.2)
Requirement already satisfied: pyzmq>=13 in /usr/local/lib/python3.9/dist-pac
kages (from jupyter-client>=6.1.12->nbclient>=0.5.0->nbconvert) (23.2.1)
```