In [ ]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Dense, Flatten, Dropout
```

In [ ]:
```
# Load the data
train_df = pd.read_csv('fashion-mnist_train.csv')
test_df = pd.read_csv('fashion-mnist_test.csv')
```

In [ ]:
```
train_df.head(20)
```

Out[ ]:

	label	pixel1	pixel2	pixel3	pixel4	pixel5	pixel6	pixel7	pixel8	pixel9	...	pixel775	pixel776
0	2	0	0	0	0	0	0	0	0	0	...	0	0
1	9	0	0	0	0	0	0	0	0	0	...	0	0
2	6	0	0	0	0	0	0	0	5	0	...	0	0
3	0	0	0	0	1	2	0	0	0	0	...	3	0
4	3	0	0	0	0	0	0	0	0	0	...	0	0
5	4	0	0	0	5	4	5	5	3	5	...	7	8
6	4	0	0	0	0	0	0	0	0	0	...	14	0
7	5	0	0	0	0	0	0	0	0	0	...	0	0
8	4	0	0	0	0	0	0	3	2	0	...	1	0
9	8	0	0	0	0	0	0	0	0	0	...	203	214
10	0	0	0	0	0	1	0	0	0	0	...	164	177
11	8	0	0	0	0	0	0	0	0	0	...	9	10
12	9	0	0	0	0	0	0	0	0	0	...	0	0
13	0	0	0	0	0	0	0	0	0	0	...	0	0
14	2	0	0	0	0	1	1	0	0	0	...	0	0
15	2	0	0	0	0	0	0	0	0	16	...	0	0
16	9	0	0	0	0	0	0	0	0	0	...	0	0
17	3	0	0	0	0	0	0	0	0	0	...	101	20
18	3	0	0	0	0	0	0	0	0	0	...	0	11
19	3	0	0	0	0	0	0	0	0	0	...	0	0

20 rows × 785 columns

In [ ]:
```
train_df.tail(20)
```

Out[ ]:

	label	pixel1	pixel2	pixel3	pixel4	pixel5	pixel6	pixel7	pixel8	pixel9	...	pixel775	pixel7
59980	0	0	0	0	2	0	0	0	0	0	...	37	
59981	5	0	0	0	0	0	0	0	0	0	...	0	
59982	5	0	0	0	0	0	0	0	0	0	...	61	
59983	5	0	0	0	0	0	0	0	0	0	...	0	
59984	7	0	0	0	0	0	0	0	0	0	...	0	
59985	6	0	0	0	0	0	0	0	0	0	...	0	
59986	6	0	0	0	0	0	0	0	0	0	...	0	
59987	5	0	0	0	0	0	0	0	0	0	...	0	
59988	5	0	0	0	0	0	0	0	0	0	...	0	
59989	4	0	0	0	0	0	0	0	0	0	...	122	
59990	0	0	0	0	0	0	0	0	0	0	...	154	
59991	5	0	0	0	0	0	0	0	0	0	...	0	
59992	5	0	0	0	0	0	0	0	0	0	...	0	
59993	2	0	0	0	0	0	0	1	0	0	...	0	
59994	9	0	0	0	0	0	0	0	0	0	...	0	
59995	9	0	0	0	0	0	0	0	0	0	...	0	
59996	1	0	0	0	0	0	0	0	0	0	...	73	
59997	8	0	0	0	0	0	0	0	0	0	...	160	
59998	8	0	0	0	0	0	0	0	0	0	...	0	
59999	7	0	0	0	0	0	0	0	0	0	...	0	

20 rows × 785 columns

In [ ]:
```
train_df.label.unique
```

Out[ ]:
```
<bound method Series.unique of 0        2
1        9
2        6
3        0
4        3
        ..
59995    9
59996    1
59997    8
59998    8
59999    7
Name: label, Length: 60000, dtype: int64>
```

In [ ]:
```
train_df.shape
```

Out[ ]:
```
(60000, 785)
```

In [ ]:
```
test_df.shape
```

Out[ ]:
```
(10000, 785)
```

In [ ]:
```
# Prepare the data
X_train = train_df.iloc[:, 1:].values.astype('float32') / 255.0
y_train = train_df.iloc[:, 0].values.astype('int32')
X_test = test_df.iloc[:, 1:].values.astype('float32') / 255.0
y_test = test_df.iloc[:, 0].values.astype('int32')
```

In [ ]:
```
X_train = X_train.reshape((-1, 28, 28, 1))
X_test = X_test.reshape((-1, 28, 28, 1))
```

In [ ]:
```
y_train = to_categorical(y_train)
y_test = to_categorical(y_test)
```

In [ ]:
```
X_train
```

Out[ ]:
```
array([[[[0.        ],
         [0.        ],
         [0.        ],
         ...,
         [0.        ],
         [0.        ],
         [0.        ]],

        [[0.        ],
         [0.        ],
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       [[0.        ],
        [0.        ],
        [0.62352943],
        ...,
        [0.01960784],
        [0.        ],
        [0.        ]],
```

```
       [[0.        ],
        [0.        ],
        [0.        ],
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        [0.        ],
        [0.        ],
        [0.00392157]],

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        [0.        ]],
```

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

In [ ]:
```
# Define the model
model = Sequential([
    Conv2D(32, (3,3), activation='relu', padding='same', input_shape=(28,28,1)),
    MaxPooling2D((2,2)),
    Conv2D(64, (3,3), activation='relu', padding='same'),
    MaxPooling2D((2,2)),
    Conv2D(128, (3,3), activation='relu', padding='same'),
    MaxPooling2D((2,2)),
    Flatten(),
    Dense(128, activation='relu'),
    Dropout(0.5),
    Dense(10, activation='softmax')
])
```

In [ ]:
```
# Compile the model
model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])
```

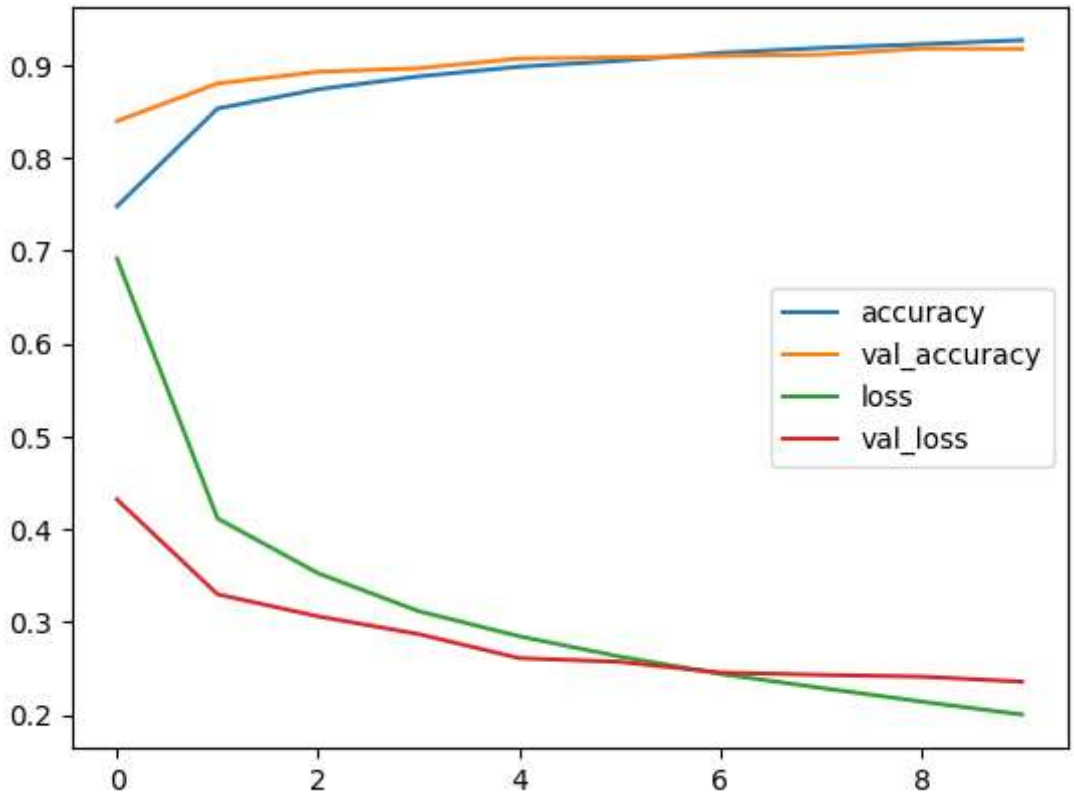
In [ ]:
```
# Train the model
history = model.fit(X_train, y_train, epochs=10, batch_size=128, validation_split=0.2)
```

```
Epoch 1/10
375/375 [==============================] - 6s 5ms/step - loss: 0.6916 - accuracy: 0.7
479 - val_loss: 0.4321 - val_accuracy: 0.8397
Epoch 2/10
375/375 [==============================] - 2s 5ms/step - loss: 0.4115 - accuracy: 0.8
533 - val_loss: 0.3299 - val_accuracy: 0.8802
Epoch 3/10
375/375 [==============================] - 2s 5ms/step - loss: 0.3526 - accuracy: 0.8
739 - val_loss: 0.3061 - val_accuracy: 0.8928
Epoch 4/10
375/375 [==============================] - 2s 4ms/step - loss: 0.3116 - accuracy: 0.8
878 - val_loss: 0.2869 - val_accuracy: 0.8966
Epoch 5/10
375/375 [==============================] - 2s 4ms/step - loss: 0.2846 - accuracy: 0.8
982 - val_loss: 0.2611 - val_accuracy: 0.9070
Epoch 6/10
375/375 [==============================] - 2s 4ms/step - loss: 0.2627 - accuracy: 0.9
046 - val_loss: 0.2571 - val_accuracy: 0.9082
Epoch 7/10
375/375 [==============================] - 2s 5ms/step - loss: 0.2441 - accuracy: 0.9
131 - val_loss: 0.2455 - val_accuracy: 0.9099
Epoch 8/10
375/375 [==============================] - 2s 5ms/step - loss: 0.2290 - accuracy: 0.9
184 - val_loss: 0.2430 - val_accuracy: 0.9112
Epoch 9/10
375/375 [==============================] - 2s 5ms/step - loss: 0.2142 - accuracy: 0.9
224 - val_loss: 0.2411 - val_accuracy: 0.9178
Epoch 10/10
375/375 [==============================] - 2s 5ms/step - loss: 0.2002 - accuracy: 0.9
269 - val_loss: 0.2357 - val_accuracy: 0.9175
```

In [ ]:
```
# Evaluate the model
test_loss, test_acc = model.evaluate(X_test, y_test)
print('Test accuracy:', test_acc)
```

```
313/313 [==============================] - 1s 2ms/step - loss: 0.2142 - accuracy: 0.9
225
Test accuracy: 0.9225000143051147
```

In [ ]:
```
# Plot the accuracy and loss for training and validation data
plt.plot(history.history['accuracy'], label='accuracy')
plt.plot(history.history['val_accuracy'], label='val_accuracy')
plt.plot(history.history['loss'], label='loss')
plt.plot(history.history['val_loss'], label='val_loss')
plt.legend()
plt.show()
```



In [ ]:
```
model.save('fashion_mnist_cnn.h5')
```

In [ ]:
```
# Load the saved model
model = load_model('fashion_mnist_cnn.h5')

# Load the test dataset
test_data = pd.read_csv('fashion-mnist_test.csv')

# Extract the image data and labels
test_images = np.array(test_data.iloc[:, 1:])
test_labels = np.array(test_data.iloc[:, 0])

# Define the labels dictionary
labels = {
    0: 'T-shirt/top',
    1: 'Trouser',
    2: 'Pullover',
```

```
    3: 'Dress',
    4: 'Coat',
    5: 'Sandal',
    6: 'Shirt',
    7: 'Sneaker',
    8: 'Bag',
    9: 'Ankle boot'
}

# Choose 10 random images from the test set
indices = np.random.choice(test_images.shape[0], size=10, replace=False)
images = test_images[indices]
true_labels = test_labels[indices]

# Reshape the images to a 4D array
images = images.reshape(-1, 28, 28, 1)

# Make predictions on the images
predictions = model.predict(images)

# Plot the images with their true labels and predicted labels
fig, axes = plt.subplots(nrows=2, ncols=5, figsize=(12, 6))
axes = axes.flatten()
for i, ax in enumerate(axes):
    # Plot the image
    ax.imshow(images[i].reshape(28, 28), cmap='gray')
    ax.set_title('True label: {}\nPredicted label: {}'.format(labels[true_labels[i]],
    ax.axis('off')
plt.tight_layout()
plt.show()
```