

```

1 import pandas as pd
2 import tensorflow as tf
3 import numpy as np
4 from tensorflow.keras.preprocessing.image import ImageDataGenerator, array_to_img, load_img
5 import matplotlib.pyplot as plt
6 import string

```

```

1 # Load the dataset from the specified path in Google Drive
2 file_path = 'sign_mnist_train.csv'
3 train_df = pd.read_csv(file_path)
4 test_df = pd.read_csv(file_path)
5 train_df = train_df[:math.floor(0.7*len(train_df))]
6 test_df = test_df[math.ceil(0.7*len(train_df)):]
7 # Display the first few rows of the training dataset
8 train_df.head()

```

↗

	label	pixel1	pixel2	pixel3	pixel4	pixel5	pixel6	pixel7	pixel8	pixel9	...	pixel775	pixel776	pixel777	pixel778	pixel779
0	3	107	118	127	134	139	143	146	150	153	...	207	207	207	207	207
1	6	155	157	156	156	156	157	156	158	158	...	69	149	128	87	158
2	2	187	188	188	187	187	186	187	188	187	...	202	201	200	199	199
3	2	211	211	212	212	211	210	211	210	210	...	235	234	233	231	231
4	13	164	167	170	172	176	179	180	184	185	...	92	105	105	108	108

5 rows × 785 columns

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1 X_train, y_train = np.array(train_df.iloc[:, 1:]).reshape(-1, 28, 28).astype('float64'), np.array(train_df.label).astype('float64')
2 X_test, y_test = np.array(test_df.iloc[:, 1:]).reshape(-1, 28, 28).astype('float64'), np.array(test_df.label).astype('float64')
3
4 print(X_train.shape, y_train.shape)
5 print(X_test.shape, y_test.shape)

```

↗

```

(19218, 28, 28) (19218,)
(14002, 28, 28) (14002,)

```

```

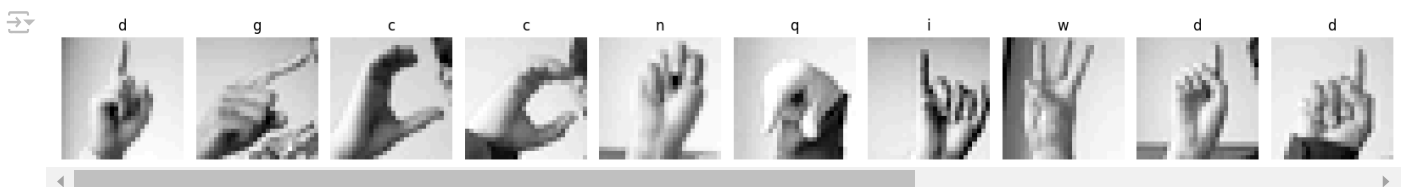
1 train_datagen = ImageDataGenerator(rescale=1.0/255.0,
2                                   zoom_range=0.2,
3                                   width_shift_range=0.2,
4                                   height_shift_range=0.2)
5
6 train_generator = train_datagen.flow(x=np.expand_dims(X_train, axis=-1), y=y_train,
7                                     batch_size=32)
8
9 test_datagen = ImageDataGenerator(rescale=1.0/255.0)
10
11 test_generator = test_datagen.flow(x=np.expand_dims(X_test, axis=-1), y=y_test,
12                                   batch_size=32)

```

```

1 # Plot a sample of 10 images from the training set
2 def plot_categories(training_images, training_labels):
3     fig, axes = plt.subplots(1, 10, figsize=(16, 15))
4     axes = axes.flatten()
5     letters = list(string.ascii_lowercase)
6
7     for k in range(10):
8         img = training_images[k]
9         img = np.expand_dims(img, axis=-1)
10        img = array_to_img(img)
11        ax = axes[k]
12        ax.imshow(img, cmap="Greys_r")
13        ax.set_title(f"{letters[int(training_labels[k])]}")
14        ax.set_axis_off()
15
16 plt.tight_layout()
17 plt.show()
18
19 plot_categories(X_train, y_train)


```



```

1 from tensorflow.keras import Sequential
2 from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense, Dropout
3
4 tf.random.set_seed(1234)
5
6 model = tf.keras.Sequential([
7     Conv2D(16, (3, 3), activation='relu', input_shape=(28, 28, 1)),
8     MaxPooling2D(2, 2),
9     Conv2D(32, (3, 3), activation='relu'),
10    MaxPooling2D(2, 2),
11    Flatten(),
12    Dense(256, activation='relu'),
13    Dropout(0.2),
14    Dense(26, activation='softmax')
15 ])
16
17 model.compile(
18     optimizer='adam',
19     loss='sparse_categorical_crossentropy',
20     metrics=['accuracy']
21 )
22
23 model.summary()

```

 /usr/local/lib/python3.10/dist-packages/keras/src/layers/convolutional/base_conv.py:107: UserWarning: Do not pass an `input_shape` argument to the constructor of Conv2D. Use the `input_shape` argument of the `compile` method instead.
 super().__init__(activity_regularizer=activity_regularizer, **kwargs)
 Model: "sequential_2"

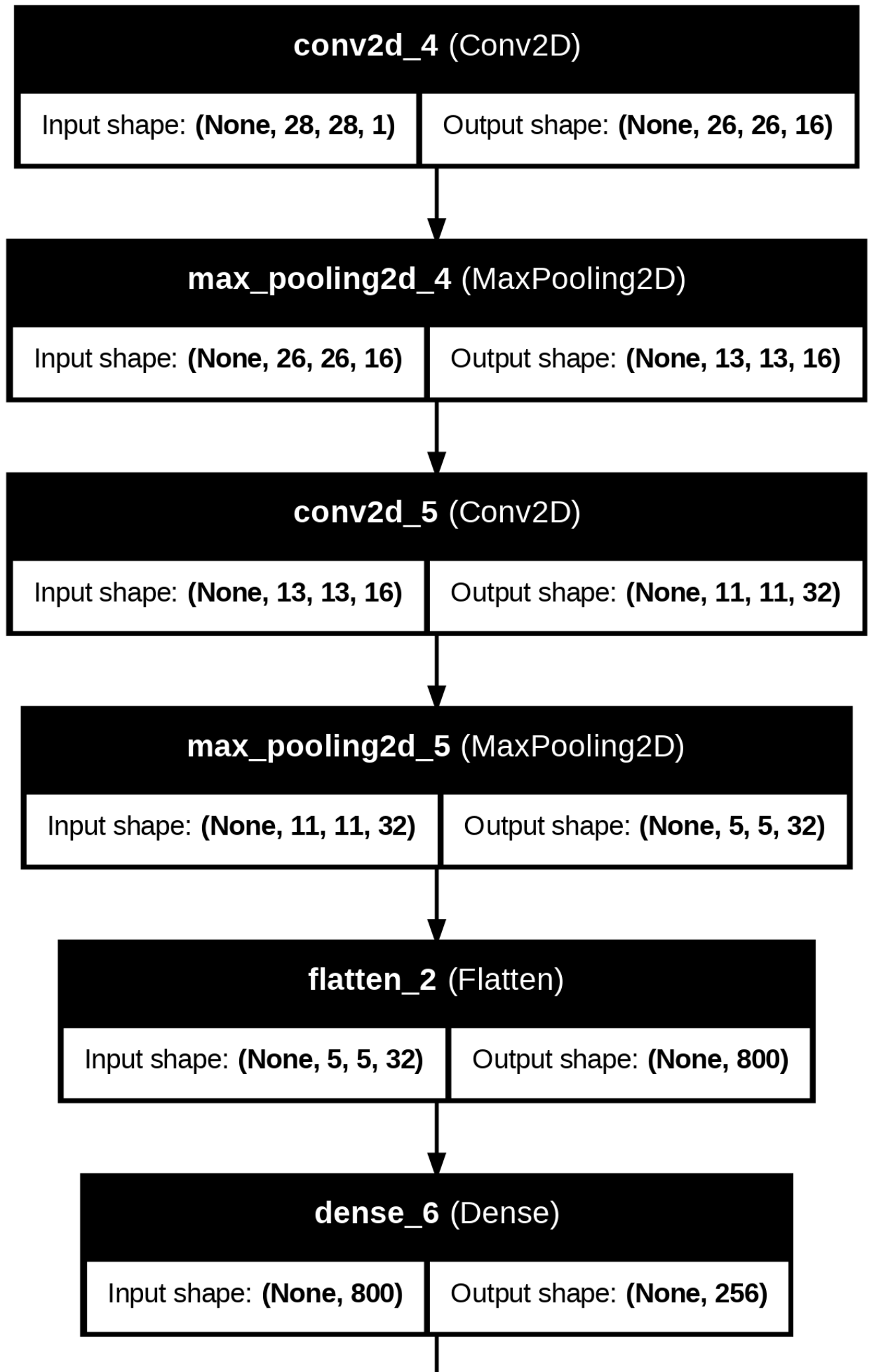
Layer (type)	Output Shape	Param #
conv2d_4 (Conv2D)	(None, 26, 26, 16)	160
max_pooling2d_4 (MaxPooling2D)	(None, 13, 13, 16)	0
conv2d_5 (Conv2D)	(None, 11, 11, 32)	4,640
max_pooling2d_5 (MaxPooling2D)	(None, 5, 5, 32)	0
flatten_2 (Flatten)	(None, 800)	0
dense_6 (Dense)	(None, 256)	205,056
dropout_2 (Dropout)	(None, 256)	0
dense_7 (Dense)	(None, 26)	6,682

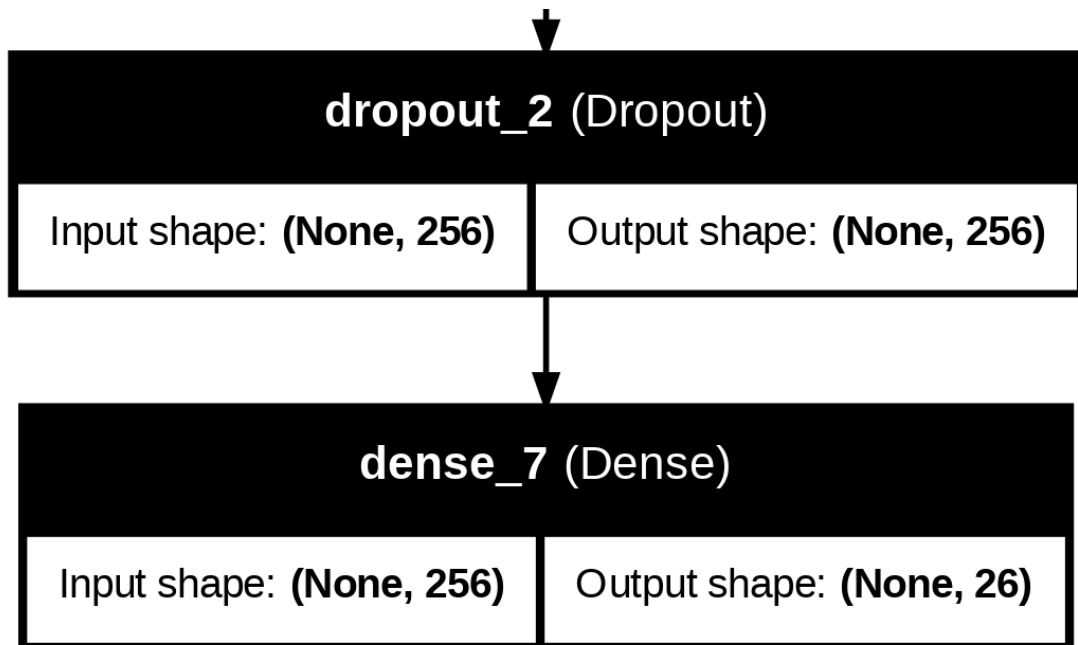
Total params: 216,538 (845.85 KB)
 Trainable params: 216,538 (845.85 KB)

```

1 from tensorflow.keras.utils import plot_model
2
3 # Assuming 'model' is your defined CNN model
4 plot_model(model, to_file='model_plot.png', show_shapes=True, show_layer_names=True)
5

```

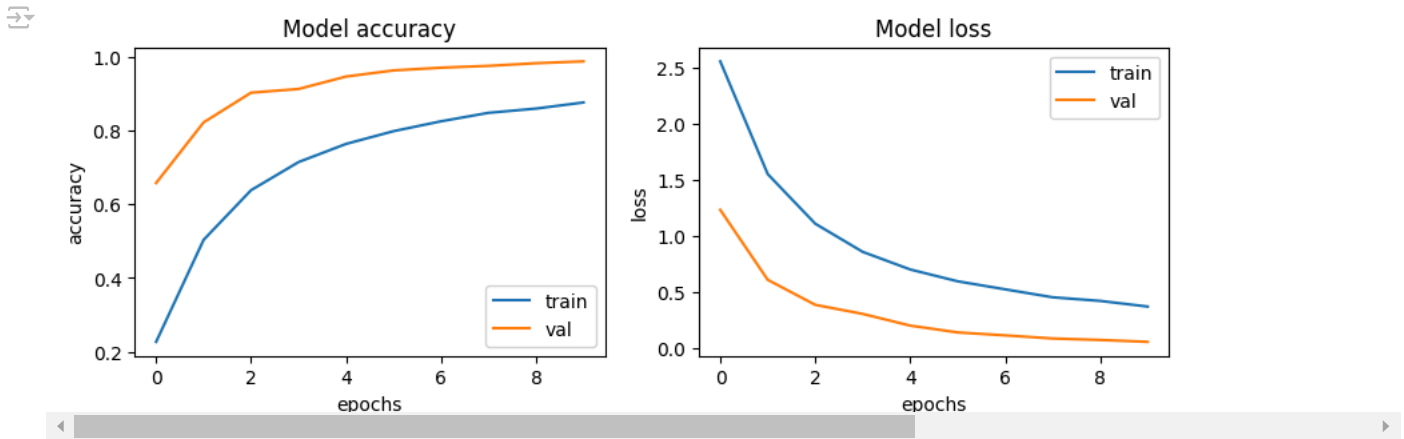




```
1 history = model.fit(train_generator, validation_data=test_generator, epochs=10)
```

```
Epoch 1/10
3/601 _____ 17s 29ms/step - accuracy: 0.0625 - loss: 3.2779/usr/local/lib/python3.10/dist-packages/keras/src/train
self._warn_if_super_not_called()
601/601 _____ 24s 37ms/step - accuracy: 0.1277 - loss: 2.9223 - val_accuracy: 0.6578 - val_loss: 1.2369
Epoch 2/10
601/601 _____ 43s 40ms/step - accuracy: 0.4504 - loss: 1.7381 - val_accuracy: 0.8224 - val_loss: 0.6129
Epoch 3/10
601/601 _____ 23s 37ms/step - accuracy: 0.6138 - loss: 1.1976 - val_accuracy: 0.9032 - val_loss: 0.3897
Epoch 4/10
601/601 _____ 25s 42ms/step - accuracy: 0.7040 - loss: 0.9054 - val_accuracy: 0.9131 - val_loss: 0.3088
Epoch 5/10
601/601 _____ 41s 42ms/step - accuracy: 0.7548 - loss: 0.7298 - val_accuracy: 0.9469 - val_loss: 0.2043
Epoch 6/10
601/601 _____ 42s 43ms/step - accuracy: 0.7832 - loss: 0.6304 - val_accuracy: 0.9635 - val_loss: 0.1436
Epoch 7/10
601/601 _____ 24s 40ms/step - accuracy: 0.8202 - loss: 0.5432 - val_accuracy: 0.9709 - val_loss: 0.1173
Epoch 8/10
601/601 _____ 41s 39ms/step - accuracy: 0.8512 - loss: 0.4591 - val_accuracy: 0.9759 - val_loss: 0.0895
Epoch 9/10
601/601 _____ 41s 39ms/step - accuracy: 0.8555 - loss: 0.4475 - val_accuracy: 0.9831 - val_loss: 0.0763
Epoch 10/10
601/601 _____ 41s 40ms/step - accuracy: 0.8749 - loss: 0.3773 - val_accuracy: 0.9880 - val_loss: 0.0598
```

```
1 fig, ax = plt.subplots(1, 2, figsize=(10, 3))
2 ax = ax.ravel()
3
4 for i, met in enumerate(['accuracy', 'loss']):
5     ax[i].plot(history.history[met])
6     ax[i].plot(history.history['val_' + met])
7     ax[i].set_title('Model {}'.format(met))
8     ax[i].set_xlabel('epochs')
9     ax[i].set_ylabel(met)
10    ax[i].legend(['train', 'val'])
```



```

1 import pandas as pd
2 import numpy as np
3 import tensorflow as tf
4 import math
5 from tensorflow.keras.preprocessing.image import ImageDataGenerator
6
7 # Load dataset
8 train_df = pd.read_csv('sign_mnist_train.csv')
9 test_df = pd.read_csv('sign_mnist_train.csv')
10
11 train_df = train_df[:math.floor(0.7*len(train_df))]
12 test_df = test_df[math.ceil(0.7*len(train_df)):]
13
14 # Extract features and labels
15 X_train = np.array(train_df.iloc[:, 1:]).reshape(-1, 28, 28, 1).astype('float32') / 255.0
16 y_train = np.array(train_df['label']).astype('float32')
17 X_test = np.array(test_df.iloc[:, 1:]).reshape(-1, 28, 28, 1).astype('float32') / 255.0
18 y_test = np.array(test_df['label']).astype('float32')
19
20 # Resize images to (128, 128, 3)
21 X_train_resized = tf.image.resize(X_train.repeat(3, axis=-1), [128, 128])
22 X_test_resized = tf.image.resize(X_test.repeat(3, axis=-1), [128, 128])
23
24 # Data generators
25 train_datagen = ImageDataGenerator(
26     zoom_range=0.2, width_shift_range=0.2, height_shift_range=0.2, horizontal_flip=True
27 )
28 test_datagen = ImageDataGenerator()
29
30 train_generator = train_datagen.flow(X_train_resized, y_train, batch_size=32)
31 test_generator = test_datagen.flow(X_test_resized, y_test, batch_size=32)
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