21BDS0340

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Deep Learning Lab

Assignment – III

Procedure:

1. Load the MNIST dataset
2. Flatten the data to feed to a neural network
3. Make the labels into categorical data from sparse categorical data
4. Create helper methods for the history and test accuracy measures
5. Create the base model 1
6. View the history and accuracies
7. Add a kernel initialization to the model 2
8. View the history and accuracies
9. Change the activation from sigmoid to relu for the model 3
10. View the history and accuracies
11. Change the optimizer to adam for the model 4
12. View the history and accuracies
13. Add batch normalization between the hidden dense layers for the model 5
14. View the history and accuracies
15. Change the batch normalization to dropout layers for the model 6
16. View the history and accuracies

Interactive Python Notebook on the following pages:

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Deep Learning Lab

In [ ]:
```
import pandas as pd
import tensorflow as tf
from tensorflow.keras.utils import to_categorical
import numpy as np
import random
import matplotlib.pyplot as plt
import numpy as np
```

In [ ]:
```
(X_train, y_train), (X_test, y_test) = tf.keras.datasets.mnist.load_data(
X_train.shape, y_train.shape
```

Out[ ]:
```
((60000, 28, 28), (60000,))
```

In [ ]:
```
X_train_flattened = np.reshape(X_train, (len(X_train), -1))
X_test_flattened = np.reshape(X_test, (len(X_test), -1))
X_train_flattened.shape
```

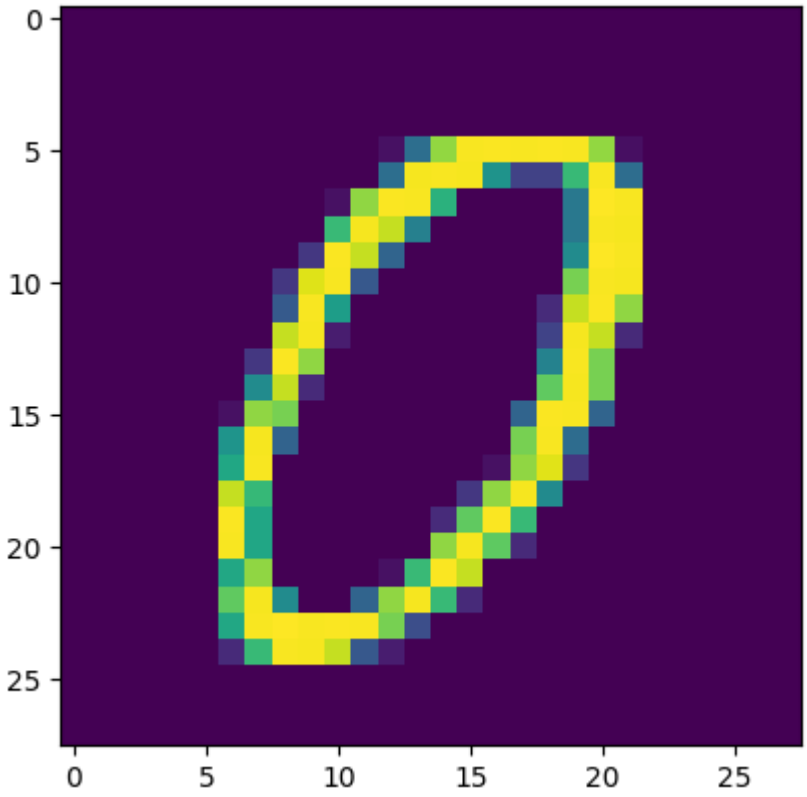
Out[ ]:
```
(60000, 784)
```

In [ ]:
```
y_train_categorical = to_categorical(y_train)
y_test_categorical = to_categorical(y_test)
y_train_categorical.shape
```

Out[ ]:
```
(60000, 10)
```

In [ ]:
```
def plot_random(data):
    i = int(random.random() * len(data))
    plt.imshow(data[i])
```

In [ ]:
```
plot_random(X_train)
```



In [ ]:
```
def plot_history(history):
    plt.plot(history.history["accuracy"])
    plt.plot(history.history["val_accuracy"])
    plt.legend(["Training", "Validation"], loc="upper left")
    plt.show()
```

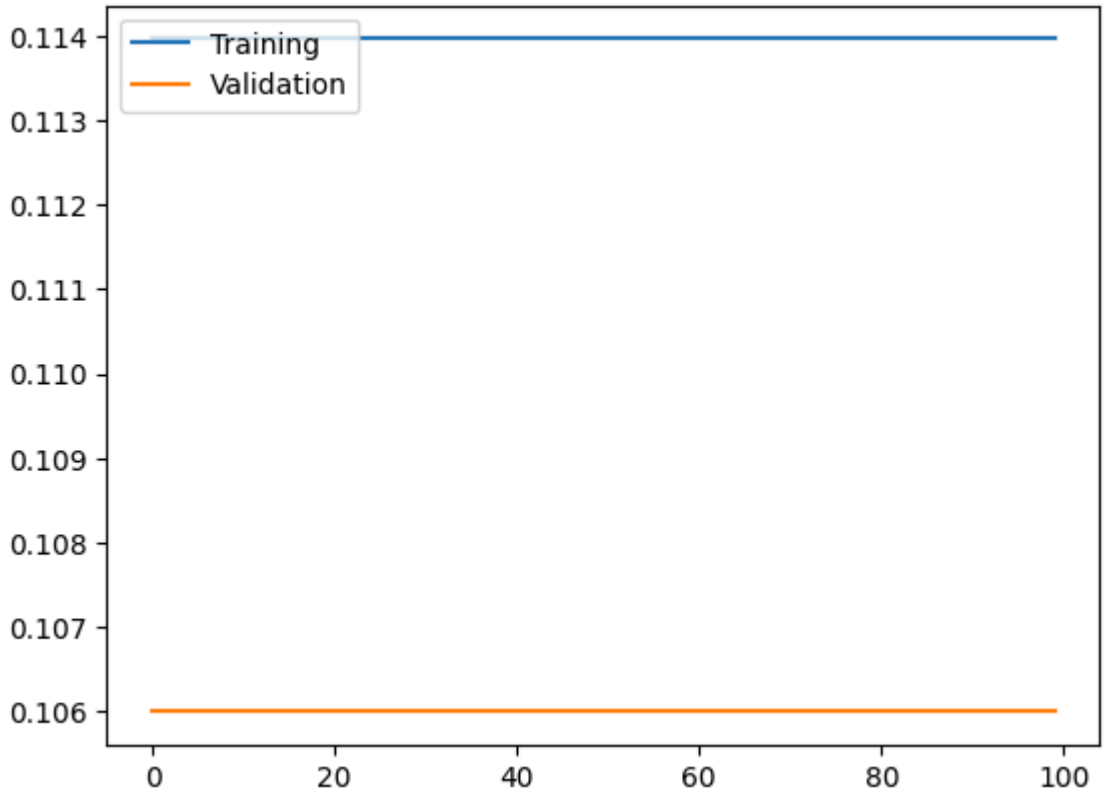
In [ ]:
```
def test_accuracy(model, features, labels):
    results = model.evaluate(features, labels)
    return results[1]
```

In [ ]:
```
model1 = tf.keras.Sequential([
    tf.keras.layers.Input((X_train_flattened.shape[1],)),
    tf.keras.layers.Dense(50, activation="sigmoid"),
    tf.keras.layers.Dense(50, activation="sigmoid"),
    tf.keras.layers.Dense(50, activation="sigmoid"),
    tf.keras.layers.Dense(50, activation="sigmoid"),
    tf.keras.layers.Dense(10, activation="softmax"),
])

sgd = tf.keras.optimizers.SGD(learning_rate=0.001)
model1.compile(
    optimizer=sgd,
    loss="categorical_crossentropy",
    metrics=["accuracy"]
)

history1 = model1.fit(X_train_flattened, y_train_categorical,
                      batch_size=256, validation_split=0.2, epochs=100, v
```

In [ ]:
```
plot_history(history1)
```



In [ ]:
```
test_accuracy(model1, X_test_flattened, y_test_categorical)
```

```
313/313 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.1160 - loss: 2.2908
```

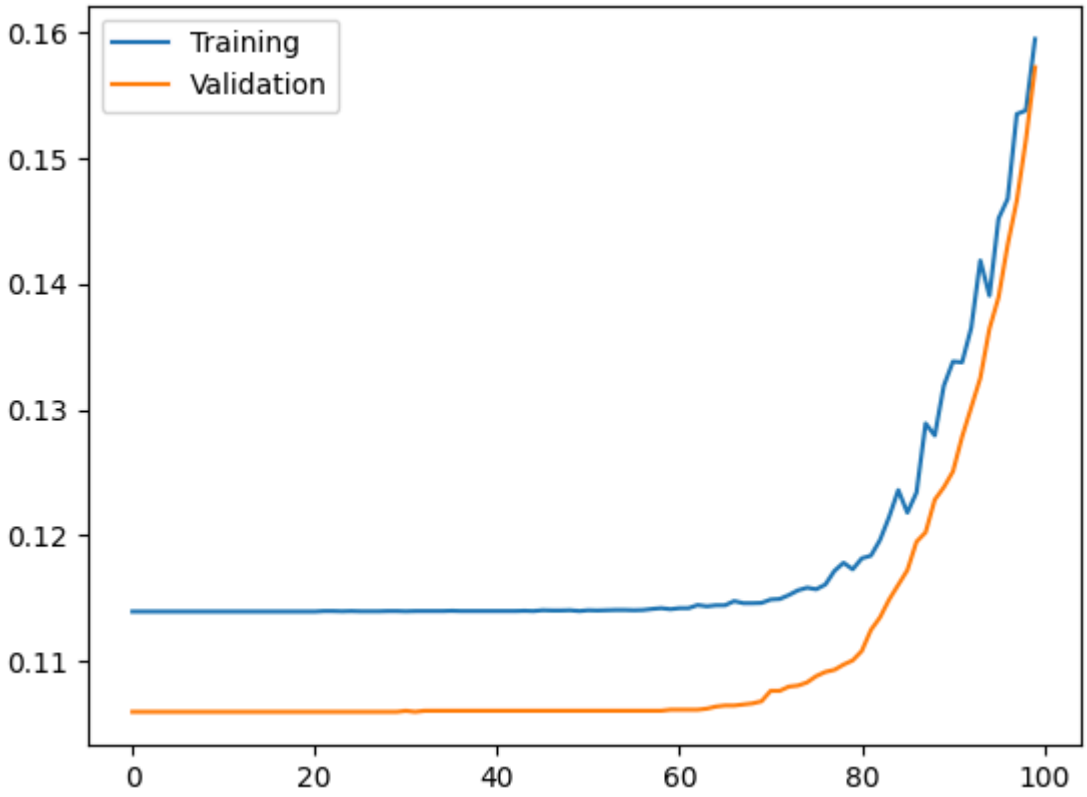
Out[ ]:
```
0.11349999904632568
```

In [ ]:
```
model2 = tf.keras.Sequential([
    tf.keras.layers.Input((X_train_flattened.shape[1],)),
    tf.keras.layers.Dense(50, activation="sigmoid", kernel_initializer="h
    tf.keras.layers.Dense(50, activation="sigmoid", kernel_initializer="h
    tf.keras.layers.Dense(50, activation="sigmoid", kernel_initializer="h
    tf.keras.layers.Dense(50, activation="sigmoid", kernel_initializer="h
    tf.keras.layers.Dense(10, activation="softmax", kernel_initializer="h
])

sgd = tf.keras.optimizers.SGD(learning_rate=0.001)
model2.compile(
    optimizer=sgd,
    loss="categorical_crossentropy",
    metrics=["accuracy"]
)

history2 = model2.fit(X_train_flattened, y_train_categorical,
                      batch_size=256, validation_split=0.2, epochs=100, v
```

In [ ]:
```
plot_history(history2)
```



In [ ]:
```
test_accuracy(model2, X_test_flattened, y_test_categorical)
```

```
313/313 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.1700 - loss: 2.2545
```

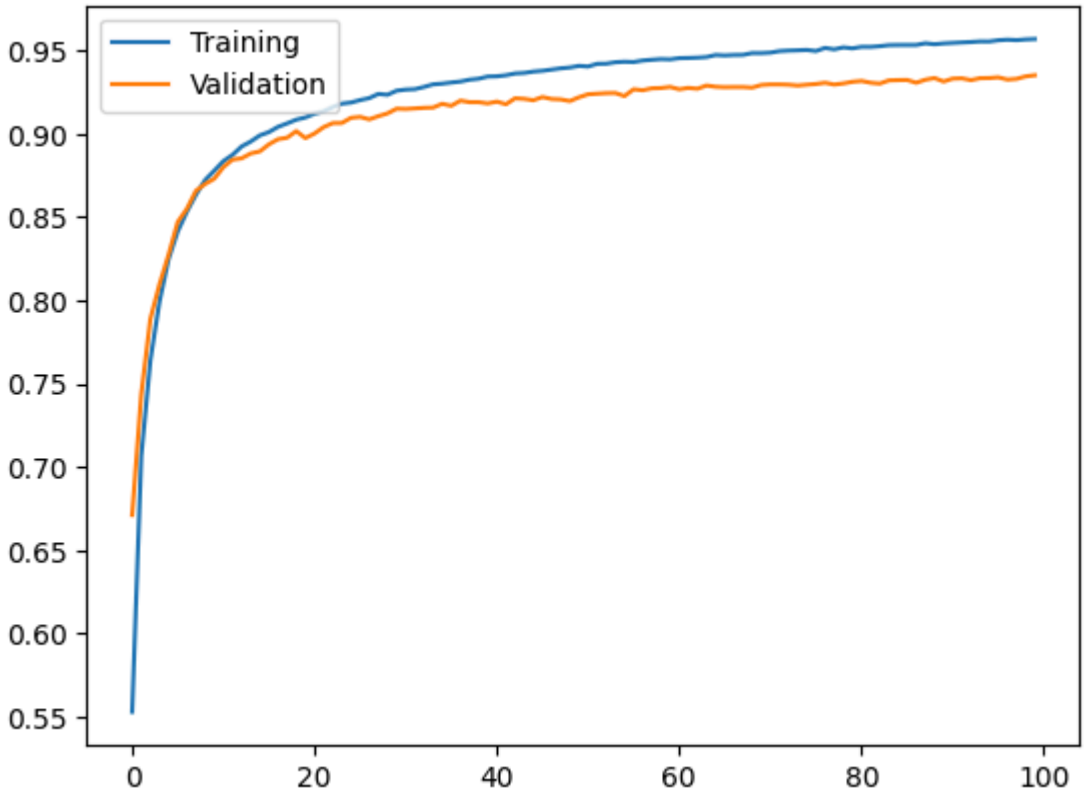
Out[ ]:
```
0.16990000009536743
```

In [ ]:
```
model3 = tf.keras.Sequential([
    tf.keras.layers.Input((X_train_flattened.shape[1],)),
    tf.keras.layers.Dense(50, activation="relu", kernel_initializer="he_n
    tf.keras.layers.Dense(50, activation="relu", kernel_initializer="he_n
    tf.keras.layers.Dense(50, activation="relu", kernel_initializer="he_n
    tf.keras.layers.Dense(50, activation="relu", kernel_initializer="he_n
    tf.keras.layers.Dense(10, activation="softmax", kernel_initializer="h
])

sgd = tf.keras.optimizers.SGD(learning_rate=0.001)
model3.compile(
    optimizer=sgd,
    loss="categorical_crossentropy",
    metrics=["accuracy"]
)

history3 = model3.fit(X_train_flattened, y_train_categorical,
                      batch_size=256, validation_split=0.2, epochs=100, v
```

In [ ]:
```
plot_history(history3)
```



In [ ]:
```
test_accuracy(model3, X_test_flattened, y_test_categorical)
```

```
313/313 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.9193 - loss: 0.2994
```

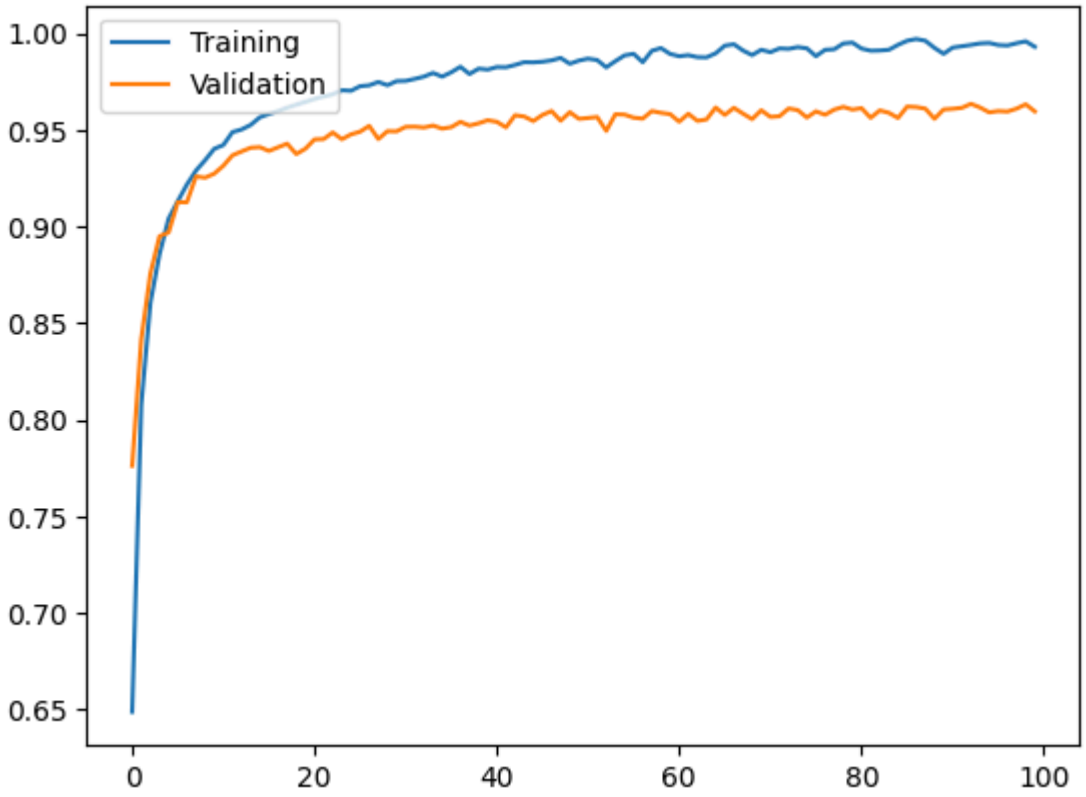
Out[ ]:
```
0.9289000034332275
```

In [ ]:
```
model4 = tf.keras.Sequential([
    tf.keras.layers.Input((X_train_flattened.shape[1],)),
    tf.keras.layers.Dense(50, activation="relu", kernel_initializer="he_n
    tf.keras.layers.Dense(50, activation="relu", kernel_initializer="he_n
    tf.keras.layers.Dense(50, activation="relu", kernel_initializer="he_n
    tf.keras.layers.Dense(50, activation="relu", kernel_initializer="he_n
    tf.keras.layers.Dense(10, activation="softmax", kernel_initializer="h
])

adam = tf.keras.optimizers.Adam(learning_rate=0.001)
model4.compile(
    optimizer=adam,
    loss="categorical_crossentropy",
    metrics=["accuracy"]
)

history4 = model4.fit(X_train_flattened, y_train_categorical,
                      batch_size=256, validation_split=0.2, epochs=100, v
```

In [ ]:
```
plot_history(history4)
```



In [ ]:
```
test_accuracy(model4, X_test_flattened, y_test_categorical)
```

```
313/313 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.9539 - loss: 0.4193
```

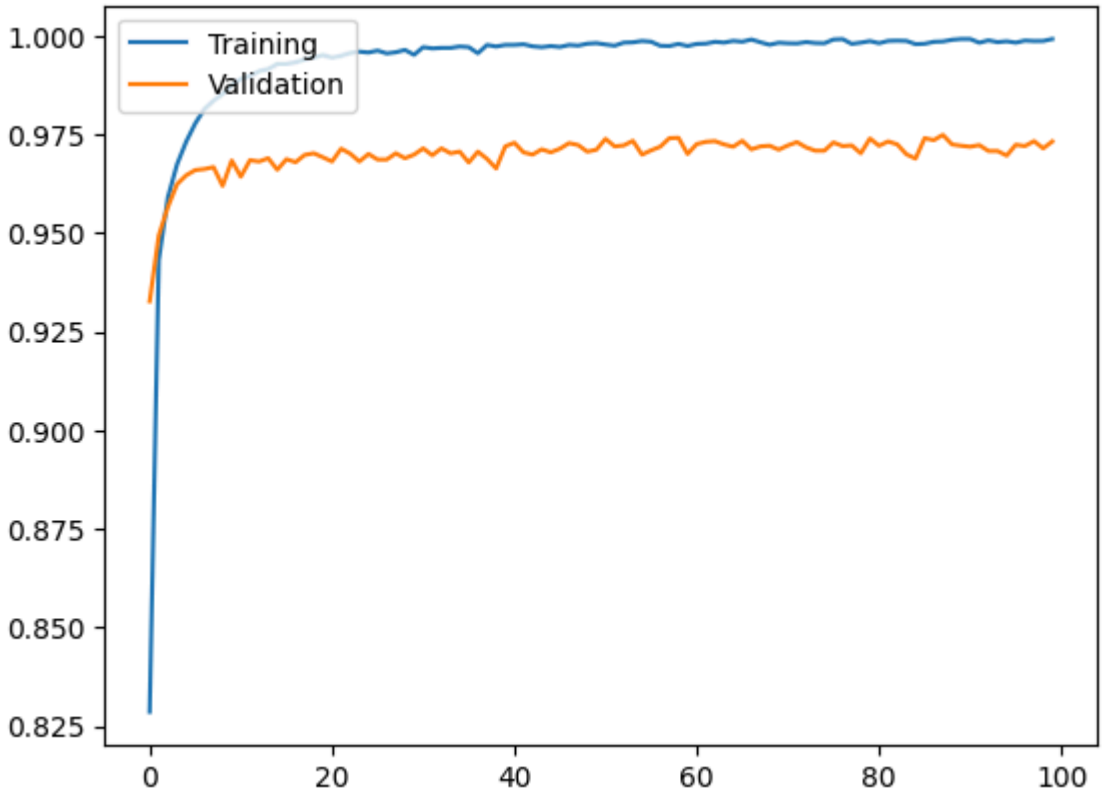
Out[ ]:
```
0.9606000185012817
```

In [ ]:
```
model5 = tf.keras.Sequential([
    tf.keras.layers.Input((X_train_flattened.shape[1],)),
    tf.keras.layers.Dense(50, activation="relu", kernel_initializer="he_n
    tf.keras.layers.BatchNormalization(),
    tf.keras.layers.Dense(50, activation="relu", kernel_initializer="he_n
    tf.keras.layers.BatchNormalization(),
    tf.keras.layers.Dense(50, activation="relu", kernel_initializer="he_n
    tf.keras.layers.BatchNormalization(),
    tf.keras.layers.Dense(50, activation="relu", kernel_initializer="he_n
    tf.keras.layers.BatchNormalization(),
    tf.keras.layers.Dense(10, activation="softmax", kernel_initializer="h
])

adam = tf.keras.optimizers.Adam(learning_rate=0.001)
model5.compile(
    optimizer=adam,
    loss="categorical_crossentropy",
    metrics=["accuracy"]
)

history5 = model5.fit(X_train_flattened, y_train_categorical,
                      batch_size=256, validation_split=0.2, epochs=100, v
```

In [ ]:
```
plot_history(history5)
```



In [ ]:
```
test_accuracy(model5, X_test_flattened, y_test_categorical)
```

```
313/313 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.9705 - loss: 0.1893
```

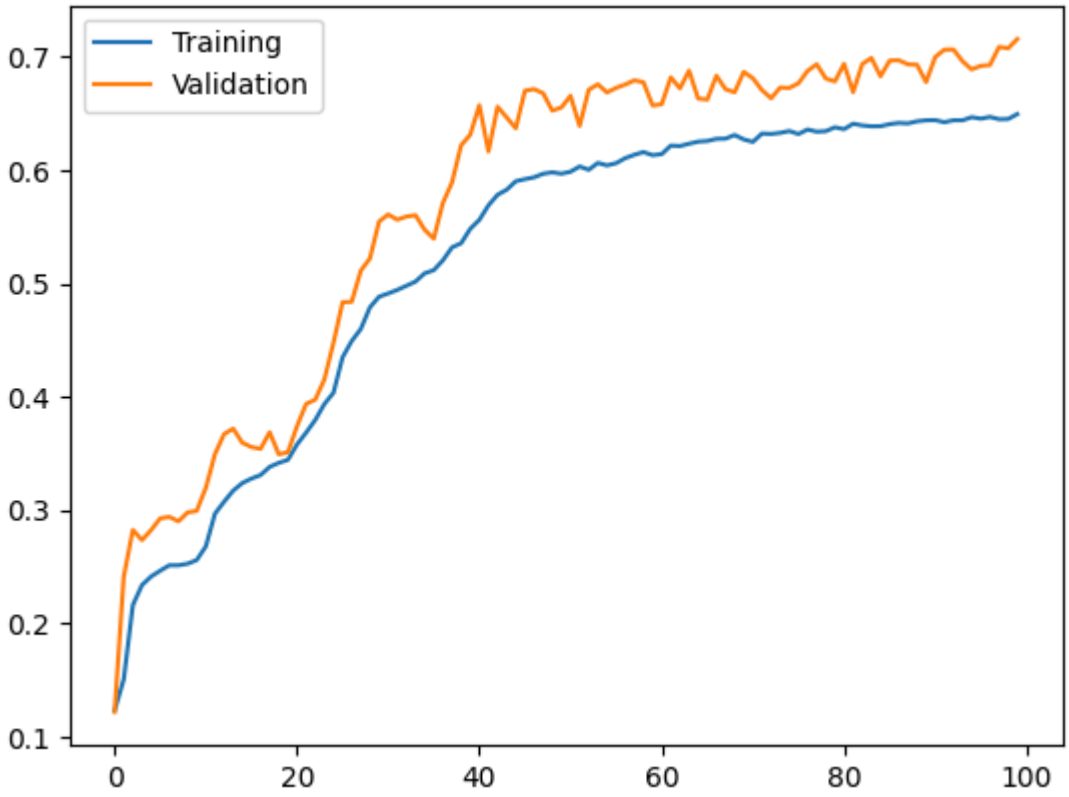
Out[ ]:
```
0.9754999876022339
```

In [ ]:
```
model6 = tf.keras.Sequential([
    tf.keras.layers.Input((X_train_flattened.shape[1],)),
    tf.keras.layers.Dense(50, activation="relu", kernel_initializer="he_n
    tf.keras.layers.Dropout(0.2),
    tf.keras.layers.Dense(50, activation="relu", kernel_initializer="he_n
    tf.keras.layers.Dropout(0.2),
    tf.keras.layers.Dense(50, activation="relu", kernel_initializer="he_n
    tf.keras.layers.Dropout(0.2),
    tf.keras.layers.Dense(50, activation="relu", kernel_initializer="he_n
    tf.keras.layers.Dropout(0.2),
    tf.keras.layers.Dense(10, activation="softmax", kernel_initializer="h
])

adam = tf.keras.optimizers.Adam(learning_rate=0.001)
model6.compile(
    optimizer=adam,
    loss="categorical_crossentropy",
    metrics=["accuracy"]
)

history6 = model6.fit(X_train_flattened, y_train_categorical,
                      batch_size=256, validation_split=0.2, epochs=100, v
```

In [ ]:
```
plot_history(history6)
```



In [ ]:
```
test_accuracy(model6, X_test_flattened, y_test_categorical)
```

```
313/313 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7080 - loss: 0.7772
```

Out[ ]:
```
0.7185999751091003
```