Information

TUGAS 1 - ADVANCE DEEP LEARNING

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Link Collab : https://colab.research.google.com/drive/1K6xZbYdRAE7_QhEOlhq4zNqBAiZXI_XJ?usp=sharing

Laporan : https://docs.google.com/document/d/1xYNUiVXY-jPQIBeP3bgkzJPTSXdF_Kyns9kOgp88i4o/edit?usp=sharing

Dataset Cumida

Double-click (or enter) to edit

```
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Dropout
from tensorflow.keras.activations import relu
import tensorflow as tf
from sklearn.preprocessing import LabelEncoder, StandardScaler

import warnings;
warnings.filterwarnings('ignore');
```

TYPE	GSE	GPL PLATFORM	SAMPLES	GENES	CLASSES	
Prostate	6919_U95B	92	124	12621	2	Download

ZEROR	SVM	MLP	DT	NB	RF	HC	KNN	K-MEANS
0.52	0.68	0.62	0.6	0.71	0.67	0.51	0.56	0.54

https://sbcb.inf.ufrgs.br/cumida

https://sbcb.inf.ufrgs.br/data/cumida/Genes/Prostate/GSE6919_U95B/Prostate_GSE6919_U95B.csv

```
# Step 1: Load Data from CSV
df = pd.read_csv('https://raw.githubusercontent.com/k4ilham/dataset/main/Prostate_GSE6919_U95B.csv')
```

```
df.head(10)
```

	samples	type	41880_at	41881_at	41882_at	41883_at	4188
0	GSM152992.CEL	primary_prostate_tumor	2.414076	4.113824	2.035911	3.102248	2.11
1	GSM152993.CEL	primary_prostate_tumor	2.385157	4.078664	2.123064	3.087631	2.25
2	GSM152994.CEL	primary_prostate_tumor	2.295522	4.085505	2.144344	3.071539	2.22
3	GSM152995.CEL	primary_prostate_tumor	2.260478	4.466391	2.206410	3.505265	2.60
4	GSM152996.CEL	primary_prostate_tumor	2.229731	4.291435	2.506255	3.220628	2.40
5	GSM152997.CEL	primary_prostate_tumor	2.323719	4.042794	2.219460	3.030761	2.53
6	GSM152998.CEL	primary_prostate_tumor	2.557032	4.196903	2.122405	3.495034	2.35
7	GSM152999.CEL	primary_prostate_tumor	2.441765	4.148545	1.968985	3.230116	2.24
8	GSM153000.CEL	primary_prostate_tumor	2.604707	4.234341	2.167552	3.394769	2.29
9	GSM153001.CEL	primary_prostate_tumor	2.364670	4.183144	1.866217	3.169024	2.37

10 rows × 12622 columns

```
X = df.drop(df.columns[[0, 1]], axis=1)
y = df['type']
```

```
df.isnull().sum().sum()
```

```
0
```

```
# Encoding label menjadi angka menggunakan LabelEncoder
label_encoder = LabelEncoder()
y = label_encoder.fit_transform(y)
```

```
# Bagi data menjadi data pelatihan, validasi, dan pengujian
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
X_train, X_val, y_train, y_val = train_test_split(X_train, y_train, test_size=0.2, random_state=42)

print(X_train.shape)
```

```
(79, 12620)
```

```
# Normalisasi data
#scaler = StandardScaler()
#X_train_scaled = scaler.fit_transform(X_train)
#X_val_scaled = scaler.transform(X_val)

# Normalisasi data
scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train)
X_val_scaled = scaler.transform(X_val)
X_test = scaler.transform(X_test)
```

```
# Membuat DataFrame kosong untuk menyimpan hasil evaluasi
results_df = pd.DataFrame(columns=['Optimizer', 'Hidden Layers', 'Validation Accuracy', 'Test Accuracy'])

# Fungsi untuk menambahkan atau memperbarui nilai dalam DataFrame
def update_results(optimizer, hidden_layers, val_acc, test_acc):
    global results_df
    # Mencari baris yang sesuai dengan kombinasi optimizer dan hidden layers
    mask = (results_df['Optimizer'] == optimizer) & (results_df['Hidden Layers'] == hidden_layers)
    # Jika kombinasi sudah ada, update nilai
    if mask.any():
        results_df.loc[mask, ['Validation Accuracy', 'Test Accuracy']] = val_acc, test_acc
    # Jika kombinasi belum ada, tambahkan baris baru
    else:
        results_df = pd.concat([results_df, pd.DataFrame({'Optimizer': [optimizer],
                                                     'Hidden Layers': [hidden_layers],
                                                     'Validation Accuracy': [val_acc],
                                                     'Test Accuracy': [test_acc]})],
                                ignore_index=True)
```

1. Membangun 4 DNN

1.A. Hidden layer 1: 1000 neurons, ReLU activation

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```
# Function to build the DNN model with one hidden layer
def build_model_one_hidden():
    model = tf.keras.models.Sequential([
        tf.keras.layers.Dense(1000, activation='relu', input_shape=(X_train_scaled.shape[1],)),  # Hidden layer with 1000 neurons and R
        tf.keras.layers.Dense(len(label_encoder.classes_), activation='sigmoid')          # Output layer with sigmoid activation
    ])
    return model
```

1.B. Hidden layer 2: 500 neurons, ReLU activation

```
# Function to build the DNN model with two hidden layer
def build_model_two_hidden():
    model = tf.keras.models.Sequential([
        tf.keras.layers.Dense(500, activation='relu', input_shape=(X_train_scaled.shape[1],)),  # 1st hidden layer with 500 neurons and
        tf.keras.layers.Dense(500, activation='relu'),                                   # 2nd hidden layer with 500 neurons and ReLU a
        tf.keras.layers.Dense(len(label_encoder.classes_), activation='sigmoid')         # Output layer with sigmoid activation
    ])
    return model
```

1.C. Hidden layer 3: 250 neurons, ReLU activation

```
# Function to build the DNN model with three hidden layer
def build_model_three_hidden():
    model = tf.keras.models.Sequential([
        tf.keras.layers.Dense(250, activation='relu', input_shape=(X_train_scaled.shape[1],)),  # First hidden layer with 250 neurons a
        tf.keras.layers.Dense(250, activation='relu'),                                   # Second hidden layer with 250 neurons and ReL
        tf.keras.layers.Dense(250, activation='relu'),                                   # Third hidden layer with 250 neurons and ReLU
        tf.keras.layers.Dense(len(label_encoder.classes_), activation='sigmoid')         # Output layer with sigmoid activation
    ])
    return model
```

1.D. Hidden layer 4: 100 neurons, ReLU activation

```
# Function to build the DNN model with four hidden layer
def build_model_four_hidden():
    model = tf.keras.models.Sequential([
        tf.keras.layers.Dense(100, activation='relu', input_shape=(X_train_scaled.shape[1],)),  # First hidden layer with 100 neurons a
        tf.keras.layers.Dense(100, activation='relu'),                                   # Second hidden layer with 100 neurons and ReL
        tf.keras.layers.Dense(100, activation='relu'),                                   # Third hidden layer with 100 neurons and ReLU
        tf.keras.layers.Dense(100, activation='relu'),                                   # Fourth hidden layer with 100 neurons and ReL
        tf.keras.layers.Dense(len(label_encoder.classes_), activation='sigmoid')         # Output layer with sigmoid activation
    ])
    return model
```

```
# Build the DNN model
model_one_hidden_layer = build_model_one_hidden()
model_two_hidden_layer = build_model_two_hidden()
model_three_hidden_layer = build_model_three_hidden()
model_four_hidden_layer = build_model_four_hidden()
```

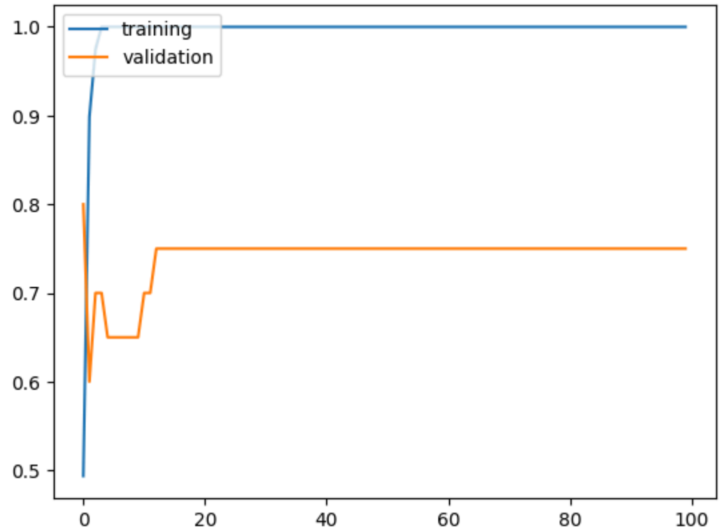
1.E. Optimizer: SGD

Train and evaluate the model with 1 hidden Layer

```
# Melatih model dengan data pelatihan
# optimizer_sgd = tf.keras.optimizers.SGD(learning_rate=0.01)  # Define the optimizer with learning rate
%%time
model_one_hidden_layer.compile(optimizer='sgd', loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_one_hidden_layer.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_val))
```

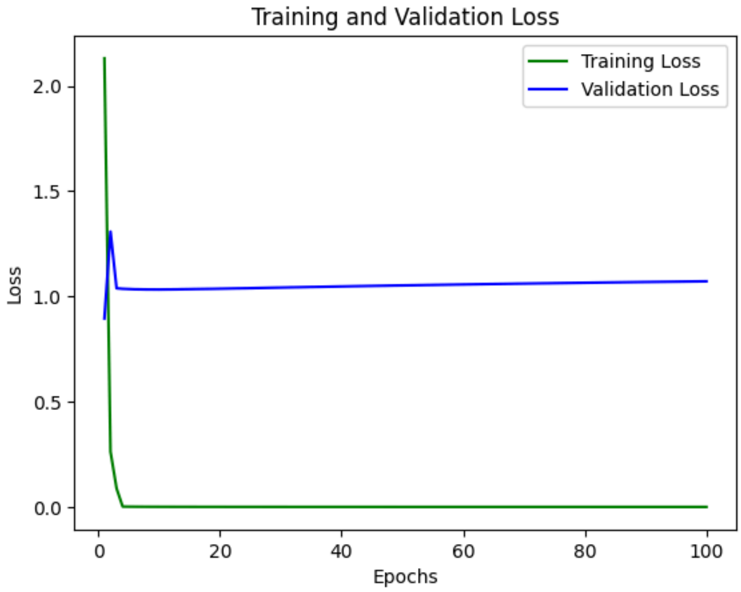
```
Epoch 76/100
8/8 [==============================] - 1s 74ms/step - loss: 2.0608e-04 - accuracy: 1.0000 - val_loss: 1.0637 - val_accuracy: 0.75
Epoch 77/100
8/8 [==============================] - 1s 79ms/step - loss: 2.0409e-04 - accuracy: 1.0000 - val_loss: 1.0641 - val_accuracy: 0.75
Epoch 78/100
8/8 [==============================] - 1s 78ms/step - loss: 2.0199e-04 - accuracy: 1.0000 - val_loss: 1.0644 - val_accuracy: 0.75
Epoch 79/100
8/8 [==============================] - 1s 74ms/step - loss: 2.0005e-04 - accuracy: 1.0000 - val_loss: 1.0648 - val_accuracy: 0.75
Epoch 80/100
8/8 [==============================] - 1s 80ms/step - loss: 1.9822e-04 - accuracy: 1.0000 - val_loss: 1.0652 - val_accuracy: 0.75
Epoch 81/100
8/8 [==============================] - 1s 75ms/step - loss: 1.9623e-04 - accuracy: 1.0000 - val_loss: 1.0656 - val_accuracy: 0.75
Epoch 82/100
8/8 [==============================] - 1s 76ms/step - loss: 1.9440e-04 - accuracy: 1.0000 - val_loss: 1.0659 - val_accuracy: 0.75
Epoch 83/100
8/8 [==============================] - 1s 75ms/step - loss: 1.9257e-04 - accuracy: 1.0000 - val_loss: 1.0663 - val_accuracy: 0.75
Epoch 84/100
8/8 [==============================] - 1s 75ms/step - loss: 1.9071e-04 - accuracy: 1.0000 - val_loss: 1.0667 - val_accuracy: 0.75
Epoch 85/100
8/8 [==============================] - 1s 81ms/step - loss: 1.8904e-04 - accuracy: 1.0000 - val_loss: 1.0671 - val_accuracy: 0.75
Epoch 86/100
8/8 [==============================] - 1s 79ms/step - loss: 1.8735e-04 - accuracy: 1.0000 - val_loss: 1.0674 - val_accuracy: 0.75
Epoch 87/100
8/8 [==============================] - 1s 77ms/step - loss: 1.8574e-04 - accuracy: 1.0000 - val_loss: 1.0678 - val_accuracy: 0.75
Epoch 88/100
8/8 [==============================] - 1s 79ms/step - loss: 1.8411e-04 - accuracy: 1.0000 - val_loss: 1.0682 - val_accuracy: 0.75
Epoch 89/100
8/8 [==============================] - 1s 79ms/step - loss: 1.8241e-04 - accuracy: 1.0000 - val_loss: 1.0685 - val_accuracy: 0.75
Epoch 90/100
8/8 [==============================] - 1s 82ms/step - loss: 1.8088e-04 - accuracy: 1.0000 - val_loss: 1.0689 - val_accuracy: 0.75
Epoch 91/100
8/8 [==============================] - 1s 79ms/step - loss: 1.7934e-04 - accuracy: 1.0000 - val_loss: 1.0692 - val_accuracy: 0.75
Epoch 92/100
8/8 [==============================] - 1s 119ms/step - loss: 1.7781e-04 - accuracy: 1.0000 - val_loss: 1.0695 - val_accuracy: 0.7
Epoch 93/100
8/8 [==============================] - 1s 122ms/step - loss: 1.7639e-04 - accuracy: 1.0000 - val_loss: 1.0699 - val_accuracy: 0.7
Epoch 94/100
8/8 [==============================] - 1s 111ms/step - loss: 1.7486e-04 - accuracy: 1.0000 - val_loss: 1.0702 - val_accuracy: 0.7
Epoch 95/100
8/8 [==============================] - 1s 75ms/step - loss: 1.7349e-04 - accuracy: 1.0000 - val_loss: 1.0705 - val_accuracy: 0.75
Epoch 96/100
8/8 [==============================] - 1s 75ms/step - loss: 1.7207e-04 - accuracy: 1.0000 - val_loss: 1.0708 - val_accuracy: 0.75
Epoch 97/100
8/8 [==============================] - 1s 82ms/step - loss: 1.7063e-04 - accuracy: 1.0000 - val_loss: 1.0712 - val_accuracy: 0.75
Epoch 98/100
8/8 [==============================] - 1s 74ms/step - loss: 1.6931e-04 - accuracy: 1.0000 - val_loss: 1.0715 - val_accuracy: 0.75
Epoch 99/100
8/8 [==============================] - 1s 77ms/step - loss: 1.6796e-04 - accuracy: 1.0000 - val_loss: 1.0718 - val_accuracy: 0.75
Epoch 100/100
8/8 [==============================] - 1s 74ms/step - loss: 1.6666e-04 - accuracy: 1.0000 - val_loss: 1.0721 - val_accuracy: 0.75
CPU times: user 1min 9s, sys: 32.1 s, total: 1min 41s
Wall time: 1min 17s
```

```
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.legend(['training', 'validation'], loc = 'upper left')
plt.show()
```



```
# Ambil loss dari history
train_loss = history.history['loss']
val_loss = history.history['val_loss']
epochs = range(1, len(train_loss) + 1)
```

```
# Plot kurva loss
plt.plot(epochs, train_loss, 'g', label='Training Loss')
plt.plot(epochs, val_loss, 'b', label='Validation Loss')
plt.title('Training and Validation Loss')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()
plt.show()
```




```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_one_hidden_layer.evaluate(X_val_scaled, y_val)
print("Model Validation Accuracy:", val_acc)

# Pilih model terbaik berdasarkan kinerja validasi
best_model = model_one_hidden_layer  # Misalnya, model pertama dianggap sebagai model terbaik
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 155ms/step - loss: 1.0721 - accuracy: 0.7500
Model Validation Accuracy: 0.75
1/1 [==============================] - 0s 49ms/step - loss: 1.6707 - accuracy: 0.6400
Best Model Test Accuracy: 0.6399999856948853
```

```
results = model_one_hidden_layer.evaluate(X_test, y_test)
```

```
1/1 [==============================] - 0s 43ms/step - loss: 1.6707 - accuracy: 0.6400
```

```
update_results('SGD', 1, val_acc, test_acc)
print(results_df)
```

```
  Optimizer Hidden Layers  Validation Accuracy  Test Accuracy
0       SGD             1                 0.75           0.64
```

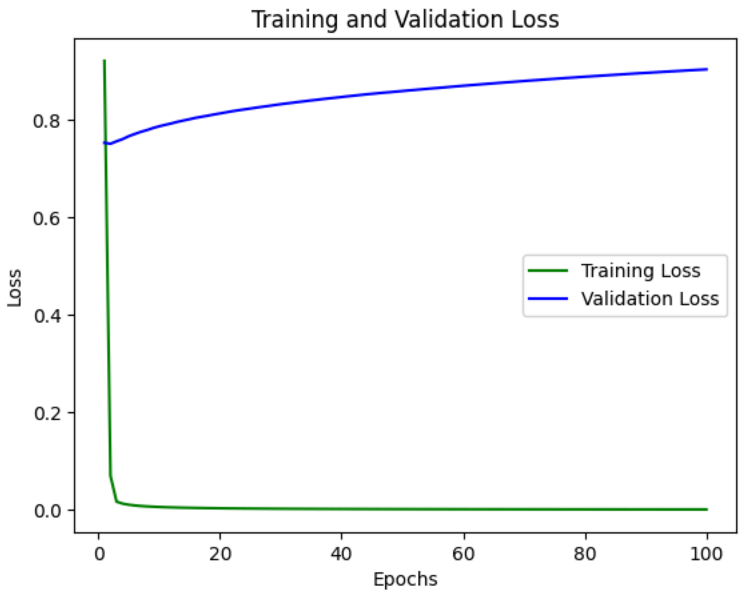
Train and evaluate the model with 2 hidden Layer

```
# Melatih model dengan data pelatihan
model_two_hidden_layer.compile(optimizer='sgd', loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_two_hidden_layer.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_val))
```

```
Epoch 76/100
8/8 [==============================] - 0s 37ms/step - loss: 8.4737e-04 - accuracy: 1.0000 - val_loss: 0.8841 - val_accuracy: 0.75
Epoch 77/100
8/8 [==============================] - 0s 39ms/step - loss: 8.3655e-04 - accuracy: 1.0000 - val_loss: 0.8850 - val_accuracy: 0.75
Epoch 78/100
8/8 [==============================] - 0s 34ms/step - loss: 8.2549e-04 - accuracy: 1.0000 - val_loss: 0.8858 - val_accuracy: 0.75
Epoch 79/100
8/8 [==============================] - 0s 36ms/step - loss: 8.1503e-04 - accuracy: 1.0000 - val_loss: 0.8867 - val_accuracy: 0.75
Epoch 80/100
8/8 [==============================] - 0s 35ms/step - loss: 8.0493e-04 - accuracy: 1.0000 - val_loss: 0.8875 - val_accuracy: 0.75
Epoch 81/100
8/8 [==============================] - 0s 33ms/step - loss: 7.9500e-04 - accuracy: 1.0000 - val_loss: 0.8883 - val_accuracy: 0.75
Epoch 82/100
8/8 [==============================] - 0s 35ms/step - loss: 7.8523e-04 - accuracy: 1.0000 - val_loss: 0.8891 - val_accuracy: 0.75
Epoch 83/100
8/8 [==============================] - 0s 35ms/step - loss: 7.7525e-04 - accuracy: 1.0000 - val_loss: 0.8899 - val_accuracy: 0.75
Epoch 84/100
8/8 [==============================] - 0s 36ms/step - loss: 7.6604e-04 - accuracy: 1.0000 - val_loss: 0.8907 - val_accuracy: 0.75
Epoch 85/100
8/8 [==============================] - 0s 32ms/step - loss: 7.5700e-04 - accuracy: 1.0000 - val_loss: 0.8915 - val_accuracy: 0.75
Epoch 86/100
8/8 [==============================] - 0s 33ms/step - loss: 7.4797e-04 - accuracy: 1.0000 - val_loss: 0.8923 - val_accuracy: 0.75
Epoch 87/100
8/8 [==============================] - 0s 34ms/step - loss: 7.3928e-04 - accuracy: 1.0000 - val_loss: 0.8931 - val_accuracy: 0.75
Epoch 88/100
8/8 [==============================] - 0s 33ms/step - loss: 7.3083e-04 - accuracy: 1.0000 - val_loss: 0.8939 - val_accuracy: 0.75
Epoch 89/100
8/8 [==============================] - 0s 30ms/step - loss: 7.2243e-04 - accuracy: 1.0000 - val_loss: 0.8947 - val_accuracy: 0.75
Epoch 90/100
8/8 [==============================] - 0s 33ms/step - loss: 7.1416e-04 - accuracy: 1.0000 - val_loss: 0.8953 - val_accuracy: 0.75
Epoch 91/100
8/8 [==============================] - 0s 43ms/step - loss: 7.0606e-04 - accuracy: 1.0000 - val_loss: 0.8961 - val_accuracy: 0.75
Epoch 92/100
8/8 [==============================] - 0s 33ms/step - loss: 6.9807e-04 - accuracy: 1.0000 - val_loss: 0.8969 - val_accuracy: 0.75
Epoch 93/100
8/8 [==============================] - 0s 38ms/step - loss: 6.9046e-04 - accuracy: 1.0000 - val_loss: 0.8976 - val_accuracy: 0.75
Epoch 94/100
8/8 [==============================] - 0s 40ms/step - loss: 6.8313e-04 - accuracy: 1.0000 - val_loss: 0.8984 - val_accuracy: 0.75
Epoch 95/100
8/8 [==============================] - 0s 35ms/step - loss: 6.7569e-04 - accuracy: 1.0000 - val_loss: 0.8990 - val_accuracy: 0.75
Epoch 96/100
8/8 [==============================] - 0s 36ms/step - loss: 6.6830e-04 - accuracy: 1.0000 - val_loss: 0.8998 - val_accuracy: 0.75
Epoch 97/100
8/8 [==============================] - 0s 33ms/step - loss: 6.6115e-04 - accuracy: 1.0000 - val_loss: 0.9006 - val_accuracy: 0.75
Epoch 98/100
8/8 [==============================] - 0s 49ms/step - loss: 6.5425e-04 - accuracy: 1.0000 - val_loss: 0.9012 - val_accuracy: 0.75
Epoch 99/100
8/8 [==============================] - 0s 48ms/step - loss: 6.4751e-04 - accuracy: 1.0000 - val_loss: 0.9019 - val_accuracy: 0.75
Epoch 100/100
8/8 [==============================] - 0s 51ms/step - loss: 6.4077e-04 - accuracy: 1.0000 - val_loss: 0.9026 - val_accuracy: 0.75
```

```
# Ambil loss dari history
train_loss = history.history['loss']
val_loss = history.history['val_loss']
epochs = range(1, len(train_loss) + 1)
```

```
# Plot kurva loss
plt.plot(epochs, train_loss, 'g', label='Training Loss')
plt.plot(epochs, val_loss, 'b', label='Validation Loss')
plt.title('Training and Validation Loss')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()
plt.show()
```




```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_two_hidden_layer.evaluate(X_val_scaled, y_val)
print("Model 2 Hidden Layer SGD Optimizer Validation Accuracy:", val_acc)

# 5. Pilih model terbaik berdasarkan kinerja validasi
best_model = model_two_hidden_layer  # Misalnya, model pertama dianggap sebagai model terbaik

# 6. Evaluasi akhir menggunakan data pengujian
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 142ms/step - loss: 0.9026 - accuracy: 0.7500
Model 2 Hidden Layer SGD Optimizer Validation Accuracy: 0.75
1/1 [==============================] - 0s 62ms/step - loss: 0.6905 - accuracy: 0.6400
Best Model Test Accuracy: 0.6399999856948853
```

```
update_results('SGD', 2, val_acc, test_acc)
print(results_df)
```

```
  Optimizer Hidden Layers  Validation Accuracy  Test Accuracy
0       SGD             1                 0.75           0.64
1       SGD             2                 0.75           0.64
```

Train and evaluate the model with 3 hidden Layer

```
# Melatih model dengan data pelatihan
model_three_hidden_layer.compile(optimizer='sgd', loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_three_hidden_layer.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_val))
```

```
8/8 [==============================] - 0s 19ms/step - loss: 0.0011 - accuracy: 1.0000 - val_loss: 0.7643 - val_accuracy: 0.7000
Epoch 87/100
8/8 [==============================] - 0s 22ms/step - loss: 0.0011 - accuracy: 1.0000 - val_loss: 0.7655 - val_accuracy: 0.7000
Epoch 88/100
8/8 [==============================] - 0s 18ms/step - loss: 0.0011 - accuracy: 1.0000 - val_loss: 0.7667 - val_accuracy: 0.7000
Epoch 89/100
8/8 [==============================] - 0s 18ms/step - loss: 0.0011 - accuracy: 1.0000 - val_loss: 0.7679 - val_accuracy: 0.7000
Epoch 90/100
8/8 [==============================] - 0s 19ms/step - loss: 0.0011 - accuracy: 1.0000 - val_loss: 0.7690 - val_accuracy: 0.7000
Epoch 91/100
8/8 [==============================] - 0s 19ms/step - loss: 0.0011 - accuracy: 1.0000 - val_loss: 0.7703 - val_accuracy: 0.7000
Epoch 92/100
8/8 [==============================] - 0s 23ms/step - loss: 0.0010 - accuracy: 1.0000 - val_loss: 0.7714 - val_accuracy: 0.7000
Epoch 93/100
8/8 [==============================] - 0s 19ms/step - loss: 0.0010 - accuracy: 1.0000 - val_loss: 0.7726 - val_accuracy: 0.7000
Epoch 94/100
8/8 [==============================] - 0s 20ms/step - loss: 0.0010 - accuracy: 1.0000 - val_loss: 0.7737 - val_accuracy: 0.7000
Epoch 95/100
8/8 [==============================] - 0s 19ms/step - loss: 9.9855e-04 - accuracy: 1.0000 - val_loss: 0.7748 - val_accuracy: 0.70
Epoch 96/100
8/8 [==============================] - 0s 18ms/step - loss: 9.8534e-04 - accuracy: 1.0000 - val_loss: 0.7758 - val_accuracy: 0.70
Epoch 97/100
8/8 [==============================] - 0s 18ms/step - loss: 9.7267e-04 - accuracy: 1.0000 - val_loss: 0.7769 - val_accuracy: 0.70
Epoch 98/100
8/8 [==============================] - 0s 18ms/step - loss: 9.6005e-04 - accuracy: 1.0000 - val_loss: 0.7780 - val_accuracy: 0.70
Epoch 99/100
8/8 [==============================] - 0s 17ms/step - loss: 9.4755e-04 - accuracy: 1.0000 - val_loss: 0.7791 - val_accuracy: 0.70
Epoch 100/100
8/8 [==============================] - 0s 22ms/step - loss: 9.3555e-04 - accuracy: 1.0000 - val_loss: 0.7800 - val_accuracy: 0.70
```

```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_three_hidden_layer.evaluate(X_val_scaled, y_val)
print("Model 3 Hidden Layer SGD Optimizer Validation Accuracy:", val_acc)

# Pilih model terbaik berdasarkan kinerja validasi
best_model = model_three_hidden_layer  # Misalnya, model pertama dianggap sebagai model terbaik

# Evaluasi akhir menggunakan data pengujian
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 170ms/step - loss: 0.7800 - accuracy: 0.7000
Model 3 Hidden Layer SGD Optimizer Validation Accuracy: 0.699999988079071
1/1 [==============================] - 0s 31ms/step - loss: 0.7084 - accuracy: 0.6800
Best Model Test Accuracy: 0.6800000071525574
```

```
update_results('SGD', 3, val_acc, test_acc)
print(results_df)
```

```
  Optimizer Hidden Layers  Validation Accuracy  Test Accuracy
0       SGD             1                 0.75           0.64
1       SGD             2                 0.75           0.64
2       SGD             3                 0.70           0.68
```

Train and evaluate the model with 4 hidden Layer

```
# Melatih model dengan data pelatihan
model_four_hidden_layer.compile(optimizer='sgd', loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_four_hidden_layer.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_val))
```

```
8/8 [==============================] - 0s 11ms/step - loss: 9.0420e-04 - accuracy: 1.0000 - val_loss: 1.1804 - val_accuracy: 0.70
Epoch 85/100
8/8 [==============================] - 0s 12ms/step - loss: 8.8982e-04 - accuracy: 1.0000 - val_loss: 1.1825 - val_accuracy: 0.70
Epoch 86/100
8/8 [==============================] - 0s 11ms/step - loss: 8.7556e-04 - accuracy: 1.0000 - val_loss: 1.1848 - val_accuracy: 0.70
Epoch 87/100
8/8 [==============================] - 0s 13ms/step - loss: 8.6183e-04 - accuracy: 1.0000 - val_loss: 1.1865 - val_accuracy: 0.70
Epoch 88/100
8/8 [==============================] - 0s 16ms/step - loss: 8.4806e-04 - accuracy: 1.0000 - val_loss: 1.1888 - val_accuracy: 0.70
Epoch 89/100
8/8 [==============================] - 0s 11ms/step - loss: 8.3518e-04 - accuracy: 1.0000 - val_loss: 1.1907 - val_accuracy: 0.70
Epoch 90/100
8/8 [==============================] - 0s 14ms/step - loss: 8.2222e-04 - accuracy: 1.0000 - val_loss: 1.1929 - val_accuracy: 0.70
Epoch 91/100
8/8 [==============================] - 0s 11ms/step - loss: 8.0997e-04 - accuracy: 1.0000 - val_loss: 1.1949 - val_accuracy: 0.70
Epoch 92/100
8/8 [==============================] - 0s 11ms/step - loss: 7.9800e-04 - accuracy: 1.0000 - val_loss: 1.1969 - val_accuracy: 0.70
Epoch 93/100
8/8 [==============================] - 0s 11ms/step - loss: 7.8619e-04 - accuracy: 1.0000 - val_loss: 1.1986 - val_accuracy: 0.70
Epoch 94/100
8/8 [==============================] - 0s 11ms/step - loss: 7.7479e-04 - accuracy: 1.0000 - val_loss: 1.2005 - val_accuracy: 0.70
Epoch 95/100
8/8 [==============================] - 0s 12ms/step - loss: 7.6337e-04 - accuracy: 1.0000 - val_loss: 1.2025 - val_accuracy: 0.70
Epoch 96/100
8/8 [==============================] - 0s 11ms/step - loss: 7.5243e-04 - accuracy: 1.0000 - val_loss: 1.2045 - val_accuracy: 0.70
Epoch 97/100
8/8 [==============================] - 0s 13ms/step - loss: 7.4200e-04 - accuracy: 1.0000 - val_loss: 1.2063 - val_accuracy: 0.70
Epoch 98/100
8/8 [==============================] - 0s 11ms/step - loss: 7.3169e-04 - accuracy: 1.0000 - val_loss: 1.2081 - val_accuracy: 0.70
Epoch 99/100
8/8 [==============================] - 0s 15ms/step - loss: 7.2161e-04 - accuracy: 1.0000 - val_loss: 1.2100 - val_accuracy: 0.70
Epoch 100/100
8/8 [==============================] - 0s 13ms/step - loss: 7.1172e-04 - accuracy: 1.0000 - val_loss: 1.2117 - val_accuracy: 0.70
```

```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_four_hidden_layer.evaluate(X_val_scaled, y_val)
print("Model 3 Hidden Layer SGD Optimizer Validation Accuracy:", val_acc)

# Pilih model terbaik berdasarkan kinerja validasi
best_model = model_four_hidden_layer  # Misalnya, model pertama dianggap sebagai model terbaik

# Evaluasi akhir menggunakan data pengujian
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 150ms/step - loss: 1.2117 - accuracy: 0.7000
Model 3 Hidden Layer SGD Optimizer Validation Accuracy: 0.699999988079071
1/1 [==============================] - 0s 29ms/step - loss: 1.1738 - accuracy: 0.6400
Best Model Test Accuracy: 0.6399999856948853
```

```
update_results('SGD', 4, val_acc, test_acc)
print(results_df)
```

```
  Optimizer Hidden Layers  Validation Accuracy  Test Accuracy
0       SGD             1                 0.75           0.64
1       SGD             2                 0.75           0.64
2       SGD             3                 0.70           0.68
3       SGD             4                 0.70           0.64
```

2. Mengganti Optimizer

2.A Adam

Train and evaluate the model with 1 hidden Layer with Adam Optimizer

```
# Melatih model dengan data pelatihan
# optimizer_adam = tf.keras.optimizers.Adam(learning_rate=0.001)  # Define the optimizer with learning rate
model_one_hidden_layer.compile(optimizer='adam', loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_one_hidden_layer.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_val))
```

```
8/8 [==============================] - 2s 285ms/step - loss: 9.5065e-08 - accuracy: 1.0000 - val_loss: 19.6395 - val_accuracy: 0.
Epoch 78/100
8/8 [==============================] - 2s 272ms/step - loss: 9.3556e-08 - accuracy: 1.0000 - val_loss: 19.6393 - val_accuracy: 0.
Epoch 79/100
8/8 [==============================] - 2s 213ms/step - loss: 9.3556e-08 - accuracy: 1.0000 - val_loss: 19.6392 - val_accuracy: 0.
Epoch 80/100
8/8 [==============================] - 2s 213ms/step - loss: 9.3556e-08 - accuracy: 1.0000 - val_loss: 19.6390 - val_accuracy: 0.
Epoch 81/100
8/8 [==============================] - 2s 220ms/step - loss: 9.3556e-08 - accuracy: 1.0000 - val_loss: 19.6388 - val_accuracy: 0.
Epoch 82/100
8/8 [==============================] - 2s 215ms/step - loss: 9.2047e-08 - accuracy: 1.0000 - val_loss: 19.6386 - val_accuracy: 0.
Epoch 83/100
8/8 [==============================] - 2s 220ms/step - loss: 9.2047e-08 - accuracy: 1.0000 - val_loss: 19.6384 - val_accuracy: 0.
Epoch 84/100
8/8 [==============================] - 3s 332ms/step - loss: 9.2047e-08 - accuracy: 1.0000 - val_loss: 19.6383 - val_accuracy: 0.
Epoch 85/100
8/8 [==============================] - 2s 223ms/step - loss: 9.0539e-08 - accuracy: 1.0000 - val_loss: 19.6380 - val_accuracy: 0.
Epoch 86/100
8/8 [==============================] - 2s 222ms/step - loss: 9.0539e-08 - accuracy: 1.0000 - val_loss: 19.6379 - val_accuracy: 0.
Epoch 87/100
8/8 [==============================] - 2s 215ms/step - loss: 9.0539e-08 - accuracy: 1.0000 - val_loss: 19.6377 - val_accuracy: 0.
Epoch 88/100
8/8 [==============================] - 2s 214ms/step - loss: 8.9030e-08 - accuracy: 1.0000 - val_loss: 19.6375 - val_accuracy: 0.
Epoch 89/100
8/8 [==============================] - 2s 218ms/step - loss: 8.9030e-08 - accuracy: 1.0000 - val_loss: 19.6373 - val_accuracy: 0.
Epoch 90/100
8/8 [==============================] - 2s 223ms/step - loss: 8.9030e-08 - accuracy: 1.0000 - val_loss: 19.6372 - val_accuracy: 0.
Epoch 91/100
8/8 [==============================] - 3s 331ms/step - loss: 8.9030e-08 - accuracy: 1.0000 - val_loss: 19.6369 - val_accuracy: 0.
Epoch 92/100
8/8 [==============================] - 2s 213ms/step - loss: 8.7521e-08 - accuracy: 1.0000 - val_loss: 19.6367 - val_accuracy: 0.
Epoch 93/100
8/8 [==============================] - 2s 218ms/step - loss: 8.7521e-08 - accuracy: 1.0000 - val_loss: 19.6366 - val_accuracy: 0.
Epoch 94/100
8/8 [==============================] - 2s 213ms/step - loss: 8.7521e-08 - accuracy: 1.0000 - val_loss: 19.6364 - val_accuracy: 0.
Epoch 95/100
8/8 [==============================] - 2s 217ms/step - loss: 8.6012e-08 - accuracy: 1.0000 - val_loss: 19.6362 - val_accuracy: 0.
Epoch 96/100
8/8 [==============================] - 2s 214ms/step - loss: 8.6012e-08 - accuracy: 1.0000 - val_loss: 19.6360 - val_accuracy: 0.
Epoch 97/100
8/8 [==============================] - 2s 245ms/step - loss: 8.4503e-08 - accuracy: 1.0000 - val_loss: 19.6358 - val_accuracy: 0.
Epoch 98/100
8/8 [==============================] - 3s 309ms/step - loss: 8.4503e-08 - accuracy: 1.0000 - val_loss: 19.6356 - val_accuracy: 0.
Epoch 99/100
8/8 [==============================] - 2s 220ms/step - loss: 8.2994e-08 - accuracy: 1.0000 - val_loss: 19.6354 - val_accuracy: 0.
Epoch 100/100
8/8 [==============================] - 2s 219ms/step - loss: 8.2994e-08 - accuracy: 1.0000 - val_loss: 19.6353 - val_accuracy: 0.
```

```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_one_hidden_layer.evaluate(X_val_scaled, y_val)
print("Model 1 Hidden Layer Adam Optimizer Validation Accuracy:", val_acc)

# Pilih model terbaik berdasarkan kinerja validasi
best_model = model_one_hidden_layer  # Misalnya, model pertama dianggap sebagai model terbaik

# Evaluasi akhir menggunakan data pengujian
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 144ms/step - loss: 19.6353 - accuracy: 0.7000
Model 1 Hidden Layer Adam Optimizer Validation Accuracy: 0.699999988079071
1/1 [==============================] - 0s 49ms/step - loss: 19.2272 - accuracy: 0.6000
Best Model Test Accuracy: 0.6000000238418579
```

```
update_results('ADAM', 1, val_acc, test_acc)
print(results_df)
```

	Optimizer	Hidden Layers	Validation Accuracy	Test Accuracy
0	SGD	1	0.75	0.64
1	SGD	2	0.75	0.64
2	SGD	3	0.70	0.68
3	SGD	4	0.70	0.64
4	ADAM	1	0.70	0.60

Train and evaluate the model with 2 hidden Layer with Adam Optimizer

```
# Melatih model dengan data pelatihan
model_two_hidden_layer.compile(optimizer='adam', loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_two_hidden_layer.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_val))
```

```
8/8 [==============================] - 1s 72ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 75/100
8/8 [==============================] - 1s 78ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 76/100
8/8 [==============================] - 1s 77ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 77/100
8/8 [==============================] - 1s 81ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 78/100
8/8 [==============================] - 1s 79ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 79/100
8/8 [==============================] - 1s 87ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 80/100
8/8 [==============================] - 1s 98ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 81/100
8/8 [==============================] - 1s 123ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.
Epoch 82/100
8/8 [==============================] - 1s 116ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.
Epoch 83/100
8/8 [==============================] - 1s 98ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 84/100
8/8 [==============================] - 1s 71ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 85/100
8/8 [==============================] - 1s 77ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 86/100
8/8 [==============================] - 1s 81ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 87/100
8/8 [==============================] - 1s 73ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 88/100
8/8 [==============================] - 1s 83ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 89/100
8/8 [==============================] - 1s 76ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 90/100
8/8 [==============================] - 1s 84ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 91/100
8/8 [==============================] - 1s 80ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 92/100
8/8 [==============================] - 1s 86ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 93/100
8/8 [==============================] - 1s 82ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 94/100
8/8 [==============================] - 1s 84ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 95/100
8/8 [==============================] - 1s 79ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3902 - val_accuracy: 0.7
Epoch 96/100
8/8 [==============================] - 1s 83ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3903 - val_accuracy: 0.7
Epoch 97/100
8/8 [==============================] - 1s 82ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3903 - val_accuracy: 0.7
Epoch 98/100
8/8 [==============================] - 1s 79ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3903 - val_accuracy: 0.7
Epoch 99/100
8/8 [==============================] - 1s 131ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3903 - val_accuracy: 0.
Epoch 100/100
8/8 [==============================] - 1s 113ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3903 - val_accuracy: 0.
```

```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_two_hidden_layer.evaluate(X_val_scaled, y_val)
print("Model 2 Hidden Layer Adam Optimizer Validation Accuracy:", val_acc)

# Pilih model terbaik berdasarkan kinerja validasi
best_model = model_two_hidden_layer  # Misalnya, model pertama dianggap sebagai model terbaik

# Evaluasi akhir menggunakan data pengujian
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 145ms/step - loss: 11.3903 - accuracy: 0.7500
Model 2 Hidden Layer Adam Optimizer Validation Accuracy: 0.75
1/1 [==============================] - 0s 37ms/step - loss: 19.7588 - accuracy: 0.6400
Best Model Test Accuracy: 0.6399999856948853
```

```
update_results('ADAM', 2, val_acc, test_acc)
print(results_df)
```

```
  Optimizer Hidden Layers  Validation Accuracy  Test Accuracy
0       SGD             1                 0.75           0.64
1       SGD             2                 0.75           0.64
2       SGD             3                 0.70           0.68
3       SGD             4                 0.70           0.64
4      ADAM             1                 0.70           0.60
5      ADAM             2                 0.75           0.64
```

Train and evaluate the model with 3 hidden Layer with Adam Optimizer

```
# Melatih model dengan data pelatihan
model_three_hidden_layer.compile(optimizer='adam', loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_three_hidden_layer.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_val))
```

```
8/8 [==============================] - 0s 38ms/step - loss: 1.9586e-06 - accuracy: 1.0000 - val_loss: 5.0317 - val_accuracy: 0.65
Epoch 73/100
8/8 [==============================] - 0s 40ms/step - loss: 1.9194e-06 - accuracy: 1.0000 - val_loss: 5.0313 - val_accuracy: 0.65
Epoch 74/100
8/8 [==============================] - 0s 39ms/step - loss: 1.8787e-06 - accuracy: 1.0000 - val_loss: 5.0308 - val_accuracy: 0.65
Epoch 75/100
8/8 [==============================] - 0s 38ms/step - loss: 1.8349e-06 - accuracy: 1.0000 - val_loss: 5.0305 - val_accuracy: 0.65
Epoch 76/100
8/8 [==============================] - 0s 39ms/step - loss: 1.8032e-06 - accuracy: 1.0000 - val_loss: 5.0301 - val_accuracy: 0.65
Epoch 77/100
8/8 [==============================] - 0s 38ms/step - loss: 1.7685e-06 - accuracy: 1.0000 - val_loss: 5.0295 - val_accuracy: 0.65
Epoch 78/100
8/8 [==============================] - 0s 40ms/step - loss: 1.7308e-06 - accuracy: 1.0000 - val_loss: 5.0288 - val_accuracy: 0.65
Epoch 79/100
8/8 [==============================] - 0s 40ms/step - loss: 1.6900e-06 - accuracy: 1.0000 - val_loss: 5.0283 - val_accuracy: 0.65
Epoch 80/100
8/8 [==============================] - 0s 39ms/step - loss: 1.6583e-06 - accuracy: 1.0000 - val_loss: 5.0276 - val_accuracy: 0.65
Epoch 81/100
8/8 [==============================] - 0s 43ms/step - loss: 1.6297e-06 - accuracy: 1.0000 - val_loss: 5.0271 - val_accuracy: 0.65
Epoch 82/100
8/8 [==============================] - 0s 41ms/step - loss: 1.5965e-06 - accuracy: 1.0000 - val_loss: 5.0265 - val_accuracy: 0.65
Epoch 83/100
8/8 [==============================] - 0s 40ms/step - loss: 1.5708e-06 - accuracy: 1.0000 - val_loss: 5.0259 - val_accuracy: 0.65
Epoch 84/100
8/8 [==============================] - 0s 39ms/step - loss: 1.5437e-06 - accuracy: 1.0000 - val_loss: 5.0256 - val_accuracy: 0.65
Epoch 85/100
8/8 [==============================] - 0s 40ms/step - loss: 1.5105e-06 - accuracy: 1.0000 - val_loss: 5.0253 - val_accuracy: 0.65
Epoch 86/100
8/8 [==============================] - 0s 38ms/step - loss: 1.4878e-06 - accuracy: 1.0000 - val_loss: 5.0249 - val_accuracy: 0.65
Epoch 87/100
8/8 [==============================] - 0s 40ms/step - loss: 1.4622e-06 - accuracy: 1.0000 - val_loss: 5.0247 - val_accuracy: 0.65
Epoch 88/100
8/8 [==============================] - 0s 40ms/step - loss: 1.4350e-06 - accuracy: 1.0000 - val_loss: 5.0247 - val_accuracy: 0.65
Epoch 89/100
8/8 [==============================] - 0s 40ms/step - loss: 1.4139e-06 - accuracy: 1.0000 - val_loss: 5.0246 - val_accuracy: 0.65
Epoch 90/100
8/8 [==============================] - 0s 40ms/step - loss: 1.3837e-06 - accuracy: 1.0000 - val_loss: 5.0245 - val_accuracy: 0.65
Epoch 91/100
8/8 [==============================] - 0s 40ms/step - loss: 1.3656e-06 - accuracy: 1.0000 - val_loss: 5.0244 - val_accuracy: 0.65
Epoch 92/100
8/8 [==============================] - 0s 38ms/step - loss: 1.3505e-06 - accuracy: 1.0000 - val_loss: 5.0241 - val_accuracy: 0.65
Epoch 93/100
8/8 [==============================] - 0s 39ms/step - loss: 1.3234e-06 - accuracy: 1.0000 - val_loss: 5.0239 - val_accuracy: 0.65
Epoch 94/100
8/8 [==============================] - 0s 43ms/step - loss: 1.3037e-06 - accuracy: 1.0000 - val_loss: 5.0235 - val_accuracy: 0.65
Epoch 95/100
8/8 [==============================] - 0s 39ms/step - loss: 1.2811e-06 - accuracy: 1.0000 - val_loss: 5.0232 - val_accuracy: 0.65
Epoch 96/100
8/8 [==============================] - 0s 47ms/step - loss: 1.2675e-06 - accuracy: 1.0000 - val_loss: 5.0227 - val_accuracy: 0.65
Epoch 97/100
8/8 [==============================] - 0s 58ms/step - loss: 1.2404e-06 - accuracy: 1.0000 - val_loss: 5.0225 - val_accuracy: 0.65
Epoch 98/100
8/8 [==============================] - 0s 52ms/step - loss: 1.2238e-06 - accuracy: 1.0000 - val_loss: 5.0222 - val_accuracy: 0.65
Epoch 99/100
8/8 [==============================] - 0s 56ms/step - loss: 1.2072e-06 - accuracy: 1.0000 - val_loss: 5.0221 - val_accuracy: 0.65
Epoch 100/100
8/8 [==============================] - 0s 55ms/step - loss: 1.1921e-06 - accuracy: 1.0000 - val_loss: 5.0217 - val_accuracy: 0.65
```

```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_three_hidden_layer.evaluate(X_val_scaled, y_val)
print("Model 3 Hidden Layer Adam Optimizer Validation Accuracy:", val_acc)

# Pilih model terbaik berdasarkan kinerja validasi
best_model = model_three_hidden_layer  # Misalnya, model pertama dianggap sebagai model terbaik

# Evaluasi akhir menggunakan data pengujian
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 148ms/step - loss: 5.0217 - accuracy: 0.6500
Model 3 Hidden Layer Adam Optimizer Validation Accuracy: 0.6499999761581421
1/1 [==============================] - 0s 35ms/step - loss: 6.8095 - accuracy: 0.5600
Best Model Test Accuracy: 0.5600000023841858
```

```
update_results('ADAM', 3, val_acc, test_acc)
print(results_df)
```

```
  Optimizer Hidden Layers  Validation Accuracy  Test Accuracy
0       SGD             1                 0.75           0.64
1       SGD             2                 0.75           0.64
2       SGD             3                 0.70           0.68
3       SGD             4                 0.70           0.64
```

```
4      ADAM           1                 0.70          0.60
5      ADAM           2                 0.75          0.64
6      ADAM           3                 0.65          0.56
```

Train and evaluate the model with 4 hidden Layer with Adam Optimizer

```
# Melatih model dengan data pelatihan
model_four_hidden_layer.compile(optimizer='adam', loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_four_hidden_layer.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_val))
```

```
8/8 [==============================] - 0s 20ms/step - loss: 5.6826e-06 - accuracy: 1.0000 - val_loss: 4.4464 - val_accuracy: 0.75
Epoch 73/100
8/8 [==============================] - 0s 21ms/step - loss: 5.4593e-06 - accuracy: 1.0000 - val_loss: 4.4503 - val_accuracy: 0.75
Epoch 74/100
8/8 [==============================] - 0s 19ms/step - loss: 5.2420e-06 - accuracy: 1.0000 - val_loss: 4.4546 - val_accuracy: 0.75
Epoch 75/100
8/8 [==============================] - 0s 21ms/step - loss: 4.9116e-06 - accuracy: 1.0000 - val_loss: 4.4576 - val_accuracy: 0.75
Epoch 76/100
8/8 [==============================] - 0s 19ms/step - loss: 4.7531e-06 - accuracy: 1.0000 - val_loss: 4.4615 - val_accuracy: 0.75
Epoch 77/100
8/8 [==============================] - 0s 20ms/step - loss: 4.5690e-06 - accuracy: 1.0000 - val_loss: 4.4674 - val_accuracy: 0.75
Epoch 78/100
8/8 [==============================] - 0s 21ms/step - loss: 4.4197e-06 - accuracy: 1.0000 - val_loss: 4.4738 - val_accuracy: 0.75
Epoch 79/100
8/8 [==============================] - 0s 22ms/step - loss: 4.2869e-06 - accuracy: 1.0000 - val_loss: 4.4807 - val_accuracy: 0.75
Epoch 80/100
8/8 [==============================] - 0s 19ms/step - loss: 4.1586e-06 - accuracy: 1.0000 - val_loss: 4.4879 - val_accuracy: 0.75
Epoch 81/100
8/8 [==============================] - 0s 19ms/step - loss: 4.0681e-06 - accuracy: 1.0000 - val_loss: 4.4914 - val_accuracy: 0.75
Epoch 82/100
8/8 [==============================] - 0s 20ms/step - loss: 3.9413e-06 - accuracy: 1.0000 - val_loss: 4.4927 - val_accuracy: 0.75
Epoch 83/100
8/8 [==============================] - 0s 24ms/step - loss: 3.8478e-06 - accuracy: 1.0000 - val_loss: 4.4957 - val_accuracy: 0.75
Epoch 84/100
8/8 [==============================] - 0s 29ms/step - loss: 3.7452e-06 - accuracy: 1.0000 - val_loss: 4.4988 - val_accuracy: 0.75
Epoch 85/100
8/8 [==============================] - 0s 29ms/step - loss: 3.6592e-06 - accuracy: 1.0000 - val_loss: 4.5044 - val_accuracy: 0.75
Epoch 86/100
8/8 [==============================] - 0s 28ms/step - loss: 3.5445e-06 - accuracy: 1.0000 - val_loss: 4.5134 - val_accuracy: 0.75
Epoch 87/100
8/8 [==============================] - 0s 26ms/step - loss: 3.3996e-06 - accuracy: 1.0000 - val_loss: 4.5194 - val_accuracy: 0.75
Epoch 88/100
8/8 [==============================] - 0s 26ms/step - loss: 3.2472e-06 - accuracy: 1.0000 - val_loss: 4.5274 - val_accuracy: 0.75
Epoch 89/100
8/8 [==============================] - 0s 25ms/step - loss: 3.1461e-06 - accuracy: 1.0000 - val_loss: 4.5369 - val_accuracy: 0.75
Epoch 90/100
8/8 [==============================] - 0s 27ms/step - loss: 3.0858e-06 - accuracy: 1.0000 - val_loss: 4.5436 - val_accuracy: 0.75
Epoch 91/100
8/8 [==============================] - 0s 30ms/step - loss: 2.9530e-06 - accuracy: 1.0000 - val_loss: 4.5456 - val_accuracy: 0.75
Epoch 92/100
8/8 [==============================] - 0s 29ms/step - loss: 2.8941e-06 - accuracy: 1.0000 - val_loss: 4.5493 - val_accuracy: 0.75
Epoch 93/100
8/8 [==============================] - 0s 28ms/step - loss: 2.8353e-06 - accuracy: 1.0000 - val_loss: 4.5546 - val_accuracy: 0.75
Epoch 94/100
8/8 [==============================] - 0s 30ms/step - loss: 2.7689e-06 - accuracy: 1.0000 - val_loss: 4.5606 - val_accuracy: 0.75
Epoch 95/100
8/8 [==============================] - 0s 29ms/step - loss: 2.6935e-06 - accuracy: 1.0000 - val_loss: 4.5664 - val_accuracy: 0.75
Epoch 96/100
8/8 [==============================] - 0s 19ms/step - loss: 2.6346e-06 - accuracy: 1.0000 - val_loss: 4.5718 - val_accuracy: 0.75
Epoch 97/100
8/8 [==============================] - 0s 19ms/step - loss: 2.5743e-06 - accuracy: 1.0000 - val_loss: 4.5772 - val_accuracy: 0.75
Epoch 98/100
8/8 [==============================] - 0s 19ms/step - loss: 2.5260e-06 - accuracy: 1.0000 - val_loss: 4.5819 - val_accuracy: 0.75
Epoch 99/100
8/8 [==============================] - 0s 19ms/step - loss: 2.4596e-06 - accuracy: 1.0000 - val_loss: 4.5874 - val_accuracy: 0.75
Epoch 100/100
8/8 [==============================] - 0s 21ms/step - loss: 2.4203e-06 - accuracy: 1.0000 - val_loss: 4.5917 - val_accuracy: 0.75
```

```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_four_hidden_layer.evaluate(X_val_scaled, y_val)
print("Model 4 Hidden Layer Adam Optimizer Validation Accuracy:", val_acc)

# Pilih model terbaik berdasarkan kinerja validasi
best_model = model_four_hidden_layer  # Misalnya, model pertama dianggap sebagai model terbaik

# Evaluasi akhir menggunakan data pengujian
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 159ms/step - loss: 4.5917 - accuracy: 0.7500
Model 4 Hidden Layer Adam Optimizer Validation Accuracy: 0.75
1/1 [==============================] - 0s 31ms/step - loss: 5.2001 - accuracy: 0.4800
Best Model Test Accuracy: 0.47999998927116394
```

```
update_results('ADAM', 4, val_acc, test_acc)
print(results_df)
```

```
  Optimizer Hidden Layers  Validation Accuracy  Test Accuracy
0       SGD             1                 0.75           0.64
1       SGD             2                 0.75           0.64
2       SGD             3                 0.70           0.68
3       SGD             4                 0.70           0.64
4      ADAM             1                 0.70           0.60
5      ADAM             2                 0.75           0.64
6      ADAM             3                 0.65           0.56
7      ADAM             4                 0.75           0.48
```

2.B AdaGrad

Train and evaluate the model with 1 hidden Layer with AdaGrad Optimizer

```
# Melatih model dengan data pelatihan
optimizer_adagrad = tf.keras.optimizers.Adagrad()
model_one_hidden_layer.compile(optimizer=optimizer_adagrad, loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_one_hidden_layer.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_val))
```

```
8/8 [==============================] - 2s 188ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6346 - val_accuracy: 0.
Epoch 73/100
8/8 [==============================] - 1s 177ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6346 - val_accuracy: 0.
Epoch 74/100
8/8 [==============================] - 1s 174ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6346 - val_accuracy: 0.
Epoch 75/100
8/8 [==============================] - 1s 171ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6346 - val_accuracy: 0.
Epoch 76/100
8/8 [==============================] - 1s 177ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6346 - val_accuracy: 0.
Epoch 77/100
8/8 [==============================] - 1s 174ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6346 - val_accuracy: 0.
Epoch 78/100
8/8 [==============================] - 1s 177ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6346 - val_accuracy: 0.
Epoch 79/100
8/8 [==============================] - 2s 239ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6346 - val_accuracy: 0.
Epoch 80/100
8/8 [==============================] - 2s 230ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6346 - val_accuracy: 0.
Epoch 81/100
8/8 [==============================] - 1s 173ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6345 - val_accuracy: 0.
Epoch 82/100
8/8 [==============================] - 1s 173ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6345 - val_accuracy: 0.
Epoch 83/100
8/8 [==============================] - 1s 179ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6345 - val_accuracy: 0.
Epoch 84/100
8/8 [==============================] - 1s 174ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6345 - val_accuracy: 0.
Epoch 85/100
8/8 [==============================] - 1s 173ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6345 - val_accuracy: 0.
Epoch 86/100
8/8 [==============================] - 1s 188ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6345 - val_accuracy: 0.
Epoch 87/100
8/8 [==============================] - 2s 226ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6345 - val_accuracy: 0.
Epoch 88/100
8/8 [==============================] - 2s 272ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6345 - val_accuracy: 0.
Epoch 89/100
8/8 [==============================] - 1s 181ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6345 - val_accuracy: 0.
Epoch 90/100
8/8 [==============================] - 1s 184ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6345 - val_accuracy: 0.
Epoch 91/100
8/8 [==============================] - 2s 196ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6345 - val_accuracy: 0.
Epoch 92/100
8/8 [==============================] - 1s 185ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6345 - val_accuracy: 0.
Epoch 93/100
8/8 [==============================] - 1s 179ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6344 - val_accuracy: 0.
Epoch 94/100
8/8 [==============================] - 2s 189ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6344 - val_accuracy: 0.
Epoch 95/100
8/8 [==============================] - 2s 236ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6344 - val_accuracy: 0.
Epoch 96/100
8/8 [==============================] - 2s 271ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6344 - val_accuracy: 0.
Epoch 97/100
8/8 [==============================] - 1s 186ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6344 - val_accuracy: 0.
Epoch 98/100
8/8 [==============================] - 1s 185ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6344 - val_accuracy: 0.
Epoch 99/100
8/8 [==============================] - 1s 186ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6344 - val_accuracy: 0.
Epoch 100/100
8/8 [==============================] - 1s 183ms/step - loss: 8.1485e-08 - accuracy: 1.0000 - val_loss: 19.6344 - val_accuracy: 0.
```

```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_one_hidden_layer.evaluate(X_val_scaled, y_val)
print("Model 1 Hidden Layer AdaGrad Optimizer Validation Accuracy:", val_acc)

# Pilih model terbaik berdasarkan kinerja validasi
best_model = model_one_hidden_layer  # Misalnya, model pertama dianggap sebagai model terbaik

# Evaluasi akhir menggunakan data pengujian
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 174ms/step - loss: 19.6344 - accuracy: 0.7000
Model 1 Hidden Layer AdaGrad Optimizer Validation Accuracy: 0.699999988079071
1/1 [==============================] - 0s 48ms/step - loss: 19.2263 - accuracy: 0.6000
Best Model Test Accuracy: 0.6000000238418579
```

```
update_results('AdaGrad', 1, val_acc, test_acc)
print(results_df)
```

```
  Optimizer Hidden Layers  Validation Accuracy  Test Accuracy
0       SGD             1                 0.75           0.64
1       SGD             2                 0.75           0.64
2       SGD             3                 0.70           0.68
3       SGD             4                 0.70           0.64
4      ADAM             1                 0.70           0.60
5      ADAM             2                 0.75           0.64
6      ADAM             3                 0.65           0.56
7      ADAM             4                 0.75           0.48
8   AdaGrad             1                 0.70           0.60
```

Train and evaluate the model with 2 hidden Layer with AdaGrad Optimizer

```
# Melatih model dengan data pelatihan
optimizer_adagrad = tf.keras.optimizers.Adagrad()
model_two_hidden_layer.compile(optimizer=optimizer_adagrad, loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_two_hidden_layer.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_val))
```

```
8/8 [==============================] - 0s 56ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3903 - val_accuracy: 0.7
Epoch 97/100
8/8 [==============================] - 0s 51ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3903 - val_accuracy: 0.7
Epoch 98/100
8/8 [==============================] - 1s 80ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3903 - val_accuracy: 0.7
Epoch 99/100
8/8 [==============================] - 1s 77ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3903 - val_accuracy: 0.7
Epoch 100/100
8/8 [==============================] - 1s 84ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 11.3903 - val_accuracy: 0.7
```

```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_two_hidden_layer.evaluate(X_val_scaled, y_val)
print("Model 2 Hidden Layer AdaGrad Optimizer Validation Accuracy:", val_acc)

# Pilih model terbaik berdasarkan kinerja validasi
best_model = model_two_hidden_layer  # Misalnya, model pertama dianggap sebagai model terbaik

# Evaluasi akhir menggunakan data pengujian
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 157ms/step - loss: 11.3903 - accuracy: 0.7500
Model 2 Hidden Layer AdaGrad Optimizer Validation Accuracy: 0.75
1/1 [==============================] - 0s 37ms/step - loss: 19.7588 - accuracy: 0.6400
Best Model Test Accuracy: 0.6399999856948853
```

```
update_results('AdaGrad', 2, val_acc, test_acc)
print(results_df)
```

```
  Optimizer Hidden Layers  Validation Accuracy  Test Accuracy
0       SGD             1                 0.75           0.64
1       SGD             2                 0.75           0.64
2       SGD             3                 0.70           0.68
3       SGD             4                 0.70           0.64
4      ADAM             1                 0.70           0.60
5      ADAM             2                 0.75           0.64
6      ADAM             3                 0.65           0.56
7      ADAM             4                 0.75           0.48
8   AdaGrad             1                 0.70           0.60
9   AdaGrad             2                 0.75           0.64
```

Train and evaluate the model with 3 hidden Layer with AdaGrad Optimizer

```
# Melatih model dengan data pelatihan
optimizer_adagrad = tf.keras.optimizers.Adagrad()
model_three_hidden_layer.compile(optimizer=optimizer_adagrad, loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_three_hidden_layer.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_val))
```

```
8/8 [==============================] - 0s 30ms/step - loss: 1.1679e-06 - accuracy: 1.0000 - val_loss: 5.0218 - val_accuracy: 0.65
Epoch 91/100
8/8 [==============================] - 0s 28ms/step - loss: 1.1664e-06 - accuracy: 1.0000 - val_loss: 5.0218 - val_accuracy: 0.65
Epoch 92/100
8/8 [==============================] - 0s 30ms/step - loss: 1.1664e-06 - accuracy: 1.0000 - val_loss: 5.0218 - val_accuracy: 0.65
Epoch 93/100
8/8 [==============================] - 0s 29ms/step - loss: 1.1664e-06 - accuracy: 1.0000 - val_loss: 5.0218 - val_accuracy: 0.65
Epoch 94/100
8/8 [==============================] - 0s 31ms/step - loss: 1.1664e-06 - accuracy: 1.0000 - val_loss: 5.0218 - val_accuracy: 0.65
Epoch 95/100
8/8 [==============================] - 0s 29ms/step - loss: 1.1664e-06 - accuracy: 1.0000 - val_loss: 5.0218 - val_accuracy: 0.65
Epoch 96/100
8/8 [==============================] - 0s 28ms/step - loss: 1.1649e-06 - accuracy: 1.0000 - val_loss: 5.0218 - val_accuracy: 0.65
Epoch 97/100
8/8 [==============================] - 0s 29ms/step - loss: 1.1649e-06 - accuracy: 1.0000 - val_loss: 5.0218 - val_accuracy: 0.65
Epoch 98/100
8/8 [==============================] - 0s 31ms/step - loss: 1.1649e-06 - accuracy: 1.0000 - val_loss: 5.0218 - val_accuracy: 0.65
Epoch 99/100
8/8 [==============================] - 0s 29ms/step - loss: 1.1649e-06 - accuracy: 1.0000 - val_loss: 5.0218 - val_accuracy: 0.65
Epoch 100/100
8/8 [==============================] - 0s 28ms/step - loss: 1.1649e-06 - accuracy: 1.0000 - val_loss: 5.0218 - val_accuracy: 0.65
```

```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_three_hidden_layer.evaluate(X_val_scaled, y_val)
print("Model 3 Hidden Layer AdaGrad Optimizer Validation Accuracy:", val_acc)

# Pilih model terbaik berdasarkan kinerja validasi
best_model = model_three_hidden_layer  # Misalnya, model pertama dianggap sebagai model terbaik

# Evaluasi akhir menggunakan data pengujian
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 153ms/step - loss: 5.0218 - accuracy: 0.6500
Model 3 Hidden Layer AdaGrad Optimizer Validation Accuracy: 0.6499999761581421
1/1 [==============================] - 0s 37ms/step - loss: 6.8103 - accuracy: 0.5600
Best Model Test Accuracy: 0.5600000023841858
```

```
update_results('AdaGrad', 3, val_acc, test_acc)
print(results_df)
```

```
   Optimizer Hidden Layers  Validation Accuracy  Test Accuracy
0        SGD             1                 0.75           0.64
1        SGD             2                 0.75           0.64
2        SGD             3                 0.70           0.68
3        SGD             4                 0.70           0.64
4       ADAM             1                 0.70           0.60
5       ADAM             2                 0.75           0.64
6       ADAM             3                 0.65           0.56
7       ADAM             4                 0.75           0.48
8    AdaGrad             1                 0.70           0.60
9    AdaGrad             2                 0.75           0.64
10   AdaGrad             3                 0.65           0.56
```

Train and evaluate the model with 4 hidden Layer with AdaGrad Optimizer

```
# Melatih model dengan data pelatihan
optimizer_adagrad = tf.keras.optimizers.Adagrad()
model_four_hidden_layer.compile(optimizer=optimizer_adagrad, loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_four_hidden_layer.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_val))
```

```
Epoch 84/100
8/8 [==============================] - 0s 20ms/step - loss: 2.3208e-06 - accuracy: 1.0000 - val_loss: 4.5927 - val_accuracy: 0.75
Epoch 85/100
8/8 [==============================] - 0s 16ms/step - loss: 2.3208e-06 - accuracy: 1.0000 - val_loss: 4.5928 - val_accuracy: 0.75
Epoch 86/100
8/8 [==============================] - 0s 18ms/step - loss: 2.3192e-06 - accuracy: 1.0000 - val_loss: 4.5928 - val_accuracy: 0.75
Epoch 87/100
8/8 [==============================] - 0s 17ms/step - loss: 2.3177e-06 - accuracy: 1.0000 - val_loss: 4.5928 - val_accuracy: 0.75
Epoch 88/100
8/8 [==============================] - 0s 18ms/step - loss: 2.3177e-06 - accuracy: 1.0000 - val_loss: 4.5928 - val_accuracy: 0.75
Epoch 89/100
8/8 [==============================] - 0s 16ms/step - loss: 2.3177e-06 - accuracy: 1.0000 - val_loss: 4.5928 - val_accuracy: 0.75
Epoch 90/100
8/8 [==============================] - 0s 15ms/step - loss: 2.3162e-06 - accuracy: 1.0000 - val_loss: 4.5928 - val_accuracy: 0.75
Epoch 91/100
8/8 [==============================] - 0s 18ms/step - loss: 2.3162e-06 - accuracy: 1.0000 - val_loss: 4.5928 - val_accuracy: 0.75
Epoch 92/100
8/8 [==============================] - 0s 16ms/step - loss: 2.3147e-06 - accuracy: 1.0000 - val_loss: 4.5928 - val_accuracy: 0.75
Epoch 93/100
8/8 [==============================] - 0s 15ms/step - loss: 2.3132e-06 - accuracy: 1.0000 - val_loss: 4.5929 - val_accuracy: 0.75
Epoch 94/100
8/8 [==============================] - 0s 16ms/step - loss: 2.3132e-06 - accuracy: 1.0000 - val_loss: 4.5929 - val_accuracy: 0.75
Epoch 95/100
8/8 [==============================] - 0s 16ms/step - loss: 2.3132e-06 - accuracy: 1.0000 - val_loss: 4.5929 - val_accuracy: 0.75
Epoch 96/100
8/8 [==============================] - 0s 22ms/step - loss: 2.3132e-06 - accuracy: 1.0000 - val_loss: 4.5929 - val_accuracy: 0.75
Epoch 97/100
8/8 [==============================] - 0s 24ms/step - loss: 2.3117e-06 - accuracy: 1.0000 - val_loss: 4.5929 - val_accuracy: 0.75
Epoch 98/100
8/8 [==============================] - 0s 24ms/step - loss: 2.3102e-06 - accuracy: 1.0000 - val_loss: 4.5929 - val_accuracy: 0.75
Epoch 99/100
8/8 [==============================] - 0s 25ms/step - loss: 2.3102e-06 - accuracy: 1.0000 - val_loss: 4.5929 - val_accuracy: 0.75
Epoch 100/100
8/8 [==============================] - 0s 22ms/step - loss: 2.3087e-06 - accuracy: 1.0000 - val_loss: 4.5930 - val_accuracy: 0.75
```

```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_four_hidden_layer.evaluate(X_val_scaled, y_val)
print("Model 4 Hidden Layer AdaGrad Optimizer Validation Accuracy:", val_acc)
# Pilih model terbaik berdasarkan kinerja validasi
best_model = model_four_hidden_layer  # Misalnya, model pertama dianggap sebagai model terbaik
# Evaluasi akhir menggunakan data pengujian
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 226ms/step - loss: 4.5930 - accuracy: 0.7500
Model 4 Hidden Layer AdaGrad Optimizer Validation Accuracy: 0.75
1/1 [==============================] - 0s 39ms/step - loss: 5.2078 - accuracy: 0.4800
Best Model Test Accuracy: 0.47999998927116394
```

```
update_results('AdaGrad', 4, val_acc, test_acc)
print(results_df)
```

```
   Optimizer Hidden Layers  Validation Accuracy  Test Accuracy
0        SGD             1                 0.75           0.64
1        SGD             2                 0.75           0.64
2        SGD             3                 0.70           0.68
3        SGD             4                 0.70           0.64
4       ADAM             1                 0.70           0.60
5       ADAM             2                 0.75           0.64
6       ADAM             3                 0.65           0.56
7       ADAM             4                 0.75           0.48
8    AdaGrad             1                 0.70           0.60
9    AdaGrad             2                 0.75           0.64
10   AdaGrad             3                 0.65           0.56
11   AdaGrad             4                 0.75           0.48
```

2.C RMSProp

Train and evaluate the model with 1 hidden Layer with RMSProp Optimizer

```
# Melatih model dengan data pelatihan
optimizer_rmsprop = tf.keras.optimizers.RMSprop()
model_one_hidden_layer.compile(optimizer=optimizer_rmsprop, loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_one_hidden_layer.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_val))
```

```
Epoch 76/100
8/8 [==============================] - 2s 191ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 19.5032 - val_accuracy: 0.
Epoch 77/100
8/8 [==============================] - 1s 186ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 19.5025 - val_accuracy: 0.
Epoch 78/100
8/8 [==============================] - 1s 187ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 19.5019 - val_accuracy: 0.
Epoch 79/100
8/8 [==============================] - 2s 221ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 19.5012 - val_accuracy: 0.
Epoch 80/100
8/8 [==============================] - 2s 262ms/step - loss: 9.0539e-09 - accuracy: 1.0000 - val_loss: 19.5006 - val_accuracy: 0.
Epoch 81/100
8/8 [==============================] - 2s 194ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.5001 - val_accuracy: 0.
Epoch 82/100
8/8 [==============================] - 2s 210ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4996 - val_accuracy: 0.
Epoch 83/100
8/8 [==============================] - 1s 184ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4991 - val_accuracy: 0.
Epoch 84/100
8/8 [==============================] - 1s 182ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4986 - val_accuracy: 0.
Epoch 85/100
8/8 [==============================] - 1s 186ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4981 - val_accuracy: 0.
Epoch 86/100
8/8 [==============================] - 1s 185ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4976 - val_accuracy: 0.
Epoch 87/100
8/8 [==============================] - 2s 259ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4971 - val_accuracy: 0.
Epoch 88/100
8/8 [==============================] - 2s 229ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4966 - val_accuracy: 0.
Epoch 89/100
8/8 [==============================] - 1s 181ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4961 - val_accuracy: 0.
Epoch 90/100
8/8 [==============================] - 1s 183ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4956 - val_accuracy: 0.
Epoch 91/100
8/8 [==============================] - 2s 283ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4952 - val_accuracy: 0.
Epoch 92/100
8/8 [==============================] - 2s 236ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4947 - val_accuracy: 0.
Epoch 93/100
8/8 [==============================] - 2s 190ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4942 - val_accuracy: 0.
Epoch 94/100
8/8 [==============================] - 2s 230ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4937 - val_accuracy: 0.
Epoch 95/100
8/8 [==============================] - 2s 252ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4932 - val_accuracy: 0.
Epoch 96/100
8/8 [==============================] - 1s 188ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4928 - val_accuracy: 0.
Epoch 97/100
8/8 [==============================] - 1s 185ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4923 - val_accuracy: 0.
Epoch 98/100
8/8 [==============================] - 2s 191ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4919 - val_accuracy: 0.
Epoch 99/100
8/8 [==============================] - 1s 181ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4914 - val_accuracy: 0.
Epoch 100/100
8/8 [==============================] - 1s 183ms/step - loss: 6.0359e-09 - accuracy: 1.0000 - val_loss: 19.4910 - val_accuracy: 0.
```

```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_one_hidden_layer.evaluate(X_val_scaled, y_val)
print("Model 1 Hidden Layer RMSprop Optimizer Validation Accuracy:", val_acc)
# Pilih model terbaik berdasarkan kinerja validasi
best_model = model_one_hidden_layer  # Misalnya, model pertama dianggap sebagai model terbaik
# Evaluasi akhir menggunakan data pengujian
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 143ms/step - loss: 19.4910 - accuracy: 0.7000
Model 1 Hidden Layer RMSprop Optimizer Validation Accuracy: 0.699999988079071
1/1 [==============================] - 0s 44ms/step - loss: 19.0706 - accuracy: 0.6000
Best Model Test Accuracy: 0.6000000238418579
```

```
update_results('RMSprop', 1, val_acc, test_acc)
print(results_df)
```

```
   Optimizer Hidden Layers  Validation Accuracy  Test Accuracy
0        SGD             1                 0.75           0.64
1        SGD             2                 0.75           0.64
2        SGD             3                 0.70           0.68
3        SGD             4                 0.70           0.64
4       ADAM             1                 0.70           0.60
5       ADAM             2                 0.75           0.64
6       ADAM             3                 0.65           0.56
7       ADAM             4                 0.75           0.48
8    AdaGrad             1                 0.70           0.60
9    AdaGrad             2                 0.75           0.64
10   AdaGrad             3                 0.65           0.56
11   AdaGrad             4                 0.75           0.48
12   RMSprop             1                 0.70           0.60
```

Train and evaluate the model with 2 hidden Layer with RMSProp Optimizer

```
# Melatih model dengan data pelatihan
optimizer_rmsprop = tf.keras.optimizers.RMSprop()
model_two_hidden_layer.compile(optimizer=optimizer_rmsprop, loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_two_hidden_layer.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_val))
```

```
8/8 [==============================] - 1s 97ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3910 - val_accuracy: 0.7
Epoch 73/100
8/8 [==============================] - 1s 87ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3910 - val_accuracy: 0.7
Epoch 74/100
8/8 [==============================] - 1s 96ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3910 - val_accuracy: 0.7
Epoch 75/100
8/8 [==============================] - 1s 67ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3910 - val_accuracy: 0.7
Epoch 76/100
8/8 [==============================] - 1s 65ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3910 - val_accuracy: 0.7
Epoch 77/100
8/8 [==============================] - 1s 66ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3910 - val_accuracy: 0.7
Epoch 78/100
8/8 [==============================] - 0s 62ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3910 - val_accuracy: 0.7
Epoch 79/100
8/8 [==============================] - 1s 68ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3911 - val_accuracy: 0.7
Epoch 80/100
8/8 [==============================] - 1s 64ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3911 - val_accuracy: 0.7
Epoch 81/100
8/8 [==============================] - 1s 69ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3911 - val_accuracy: 0.7
Epoch 82/100
8/8 [==============================] - 0s 63ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3911 - val_accuracy: 0.7
Epoch 83/100
8/8 [==============================] - 0s 64ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3911 - val_accuracy: 0.7
Epoch 84/100
8/8 [==============================] - 0s 63ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3911 - val_accuracy: 0.7
Epoch 85/100
8/8 [==============================] - 0s 63ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3911 - val_accuracy: 0.7
Epoch 86/100
8/8 [==============================] - 0s 63ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3912 - val_accuracy: 0.7
Epoch 87/100
8/8 [==============================] - 1s 67ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3912 - val_accuracy: 0.7
Epoch 88/100
8/8 [==============================] - 0s 62ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3912 - val_accuracy: 0.7
Epoch 89/100
8/8 [==============================] - 0s 63ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3912 - val_accuracy: 0.7
Epoch 90/100
8/8 [==============================] - 0s 62ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3912 - val_accuracy: 0.7
Epoch 91/100
8/8 [==============================] - 0s 62ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3912 - val_accuracy: 0.7
Epoch 92/100
8/8 [==============================] - 1s 64ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3913 - val_accuracy: 0.7
Epoch 93/100
8/8 [==============================] - 1s 65ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3913 - val_accuracy: 0.7
Epoch 94/100
8/8 [==============================] - 1s 77ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3913 - val_accuracy: 0.7
Epoch 95/100
8/8 [==============================] - 1s 96ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3913 - val_accuracy: 0.7
Epoch 96/100
8/8 [==============================] - 1s 90ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3913 - val_accuracy: 0.7
Epoch 97/100
8/8 [==============================] - 1s 87ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3913 - val_accuracy: 0.7
Epoch 98/100
8/8 [==============================] - 1s 66ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3913 - val_accuracy: 0.7
Epoch 99/100
8/8 [==============================] - 1s 66ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3913 - val_accuracy: 0.7
Epoch 100/100
8/8 [==============================] - 1s 65ms/step - loss: 7.5449e-09 - accuracy: 1.0000 - val_loss: 11.3914 - val_accuracy: 0.7
```

```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_two_hidden_layer.evaluate(X_val_scaled, y_val)
print("Model 2 Hidden Layer RMSprop Optimizer Validation Accuracy:", val_acc)
# Pilih model terbaik berdasarkan kinerja validasi
best_model = model_two_hidden_layer  # Misalnya, model pertama dianggap sebagai model terbaik
# Evaluasi akhir menggunakan data pengujian
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 147ms/step - loss: 11.3914 - accuracy: 0.7500
Model 2 Hidden Layer RMSprop Optimizer Validation Accuracy: 0.75
1/1 [==============================] - 0s 38ms/step - loss: 19.7389 - accuracy: 0.6400
Best Model Test Accuracy: 0.6399999856948853
```

```
update_results('RMSprop', 2, val_acc, test_acc)
print(results_df)
```

```
  Optimizer Hidden Layers  Validation Accuracy  Test Accuracy
0       SGD             1                 0.75           0.64
1       SGD             2                 0.75           0.64
2       SGD             3                 0.70           0.68
3       SGD             4                 0.70           0.64
4      ADAM             1                 0.70           0.60
```

```
5       ADAM             2                  0.75          0.64
6       ADAM             3                  0.65          0.56
7       ADAM             4                  0.75          0.48
8    AdaGrad             1                  0.70          0.60
9    AdaGrad             2                  0.75          0.64
10   AdaGrad             3                  0.65          0.56
11   AdaGrad             4                  0.75          0.48
12   RMSprop             1                  0.70          0.60
13   RMSprop             2                  0.75          0.64
```

Train and evaluate the model with 3 hidden Layer with RMSProp Optimizer

```
# Melatih model dengan data pelatihan
optimizer_rmsprop = tf.keras.optimizers.RMSprop()
model_three_hidden_layer.compile(optimizer=optimizer_rmsprop, loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_three_hidden_layer.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_val))
```

```
8/8 [==============================] - 0s 32ms/step - loss: 1.6599e-07 - accuracy: 1.0000 - val_loss: 5.0186 - val_accuracy: 0.65
Epoch 73/100
8/8 [==============================] - 0s 32ms/step - loss: 1.6448e-07 - accuracy: 1.0000 - val_loss: 5.0187 - val_accuracy: 0.65
Epoch 74/100
8/8 [==============================] - 0s 32ms/step - loss: 1.6297e-07 - accuracy: 1.0000 - val_loss: 5.0188 - val_accuracy: 0.65
Epoch 75/100
8/8 [==============================] - 0s 35ms/step - loss: 1.6146e-07 - accuracy: 1.0000 - val_loss: 5.0188 - val_accuracy: 0.65
Epoch 76/100
8/8 [==============================] - 0s 32ms/step - loss: 1.5844e-07 - accuracy: 1.0000 - val_loss: 5.0188 - val_accuracy: 0.65
Epoch 77/100
8/8 [==============================] - 0s 32ms/step - loss: 1.5844e-07 - accuracy: 1.0000 - val_loss: 5.0188 - val_accuracy: 0.65
Epoch 78/100
8/8 [==============================] - 0s 32ms/step - loss: 1.5693e-07 - accuracy: 1.0000 - val_loss: 5.0187 - val_accuracy: 0.65
Epoch 79/100
8/8 [==============================] - 0s 33ms/step - loss: 1.5542e-07 - accuracy: 1.0000 - val_loss: 5.0188 - val_accuracy: 0.65
Epoch 80/100
8/8 [==============================] - 0s 32ms/step - loss: 1.5542e-07 - accuracy: 1.0000 - val_loss: 5.0188 - val_accuracy: 0.65
Epoch 81/100
8/8 [==============================] - 0s 32ms/step - loss: 1.5392e-07 - accuracy: 1.0000 - val_loss: 5.0189 - val_accuracy: 0.65
Epoch 82/100
8/8 [==============================] - 0s 33ms/step - loss: 1.5090e-07 - accuracy: 1.0000 - val_loss: 5.0190 - val_accuracy: 0.65
Epoch 83/100
8/8 [==============================] - 0s 34ms/step - loss: 1.5090e-07 - accuracy: 1.0000 - val_loss: 5.0192 - val_accuracy: 0.65
Epoch 84/100
8/8 [==============================] - 0s 34ms/step - loss: 1.4788e-07 - accuracy: 1.0000 - val_loss: 5.0192 - val_accuracy: 0.65
Epoch 85/100
8/8 [==============================] - 0s 34ms/step - loss: 1.4486e-07 - accuracy: 1.0000 - val_loss: 5.0192 - val_accuracy: 0.65
Epoch 86/100
8/8 [==============================] - 0s 33ms/step - loss: 1.4184e-07 - accuracy: 1.0000 - val_loss: 5.0193 - val_accuracy: 0.65
Epoch 87/100
8/8 [==============================] - 0s 31ms/step - loss: 1.4184e-07 - accuracy: 1.0000 - val_loss: 5.0193 - val_accuracy: 0.65
Epoch 88/100
8/8 [==============================] - 0s 35ms/step - loss: 1.4033e-07 - accuracy: 1.0000 - val_loss: 5.0193 - val_accuracy: 0.65
Epoch 89/100
8/8 [==============================] - 0s 35ms/step - loss: 1.4033e-07 - accuracy: 1.0000 - val_loss: 5.0193 - val_accuracy: 0.65
Epoch 90/100
8/8 [==============================] - 0s 34ms/step - loss: 1.3883e-07 - accuracy: 1.0000 - val_loss: 5.0193 - val_accuracy: 0.65
Epoch 91/100
8/8 [==============================] - 0s 33ms/step - loss: 1.3732e-07 - accuracy: 1.0000 - val_loss: 5.0194 - val_accuracy: 0.65
Epoch 92/100
8/8 [==============================] - 0s 33ms/step - loss: 1.3732e-07 - accuracy: 1.0000 - val_loss: 5.0194 - val_accuracy: 0.65
Epoch 93/100
8/8 [==============================] - 0s 31ms/step - loss: 1.3732e-07 - accuracy: 1.0000 - val_loss: 5.0194 - val_accuracy: 0.65
Epoch 94/100
8/8 [==============================] - 0s 36ms/step - loss: 1.3430e-07 - accuracy: 1.0000 - val_loss: 5.0196 - val_accuracy: 0.65
Epoch 95/100
8/8 [==============================] - 0s 30ms/step - loss: 1.3430e-07 - accuracy: 1.0000 - val_loss: 5.0197 - val_accuracy: 0.65
Epoch 96/100
8/8 [==============================] - 0s 32ms/step - loss: 1.3279e-07 - accuracy: 1.0000 - val_loss: 5.0197 - val_accuracy: 0.65
Epoch 97/100
8/8 [==============================] - 0s 31ms/step - loss: 1.3279e-07 - accuracy: 1.0000 - val_loss: 5.0197 - val_accuracy: 0.65
Epoch 98/100
8/8 [==============================] - 0s 33ms/step - loss: 1.2977e-07 - accuracy: 1.0000 - val_loss: 5.0197 - val_accuracy: 0.65
Epoch 99/100
8/8 [==============================] - 0s 31ms/step - loss: 1.2977e-07 - accuracy: 1.0000 - val_loss: 5.0198 - val_accuracy: 0.65
Epoch 100/100
8/8 [==============================] - 0s 34ms/step - loss: 1.2977e-07 - accuracy: 1.0000 - val_loss: 5.0198 - val_accuracy: 0.65
```

```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_three_hidden_layer.evaluate(X_val_scaled, y_val)
print("Model 3 Hidden Layer RMSprop Optimizer Validation Accuracy:", val_acc)
# Pilih model terbaik berdasarkan kinerja validasi
best_model = model_three_hidden_layer  # Misalnya, model pertama dianggap sebagai model terbaik
# Evaluasi akhir menggunakan data pengujian
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 210ms/step - loss: 5.0198 - accuracy: 0.6500
Model 3 Hidden Layer RMSprop Optimizer Validation Accuracy: 0.6499999761581421
1/1 [==============================] - 0s 57ms/step - loss: 7.0093 - accuracy: 0.5600
Best Model Test Accuracy: 0.5600000023841858
```

```
update_results('RMSprop', 3, val_acc, test_acc)
print(results_df)
```

```
   Optimizer Hidden Layers  Validation Accuracy  Test Accuracy
0        SGD             1                 0.75           0.64
1        SGD             2                 0.75           0.64
2        SGD             3                 0.70           0.68
3        SGD             4                 0.70           0.64
4       ADAM             1                 0.70           0.60
5       ADAM             2                 0.75           0.64
6       ADAM             3                 0.65           0.56
7       ADAM             4                 0.75           0.48
8    AdaGrad             1                 0.70           0.60
9    AdaGrad             2                 0.75           0.64
10   AdaGrad             3                 0.65           0.56
11   AdaGrad             4                 0.75           0.48
12   RMSprop             1                 0.70           0.60
13   RMSprop             2                 0.75           0.64
14   RMSprop             3                 0.65           0.56
```

Train and evaluate the model with 4 hidden Layer with RMSProp Optimizer

```
# Melatih model dengan data pelatihan
optimizer_rmsprop = tf.keras.optimizers.RMSprop()
model_four_hidden_layer.compile(optimizer=optimizer_rmsprop, loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_four_hidden_layer.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_val))
```

```
8/8 [==============================] - 0s 20ms/step - loss: 2.0522e-07 - accuracy: 1.0000 - val_loss: 4.8447 - val_accuracy: 0.75
Epoch 100/100
8/8 [==============================] - 0s 17ms/step - loss: 2.0371e-07 - accuracy: 1.0000 - val_loss: 4.8459 - val_accuracy: 0.75
```

```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_four_hidden_layer.evaluate(X_val_scaled, y_val)
print("Model 4 Hidden Layer RMSprop Optimizer Validation Accuracy:", val_acc)
# Pilih model terbaik berdasarkan kinerja validasi
best_model = model_four_hidden_layer  # Misalnya, model pertama dianggap sebagai model terbaik
# Evaluasi akhir menggunakan data pengujian
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

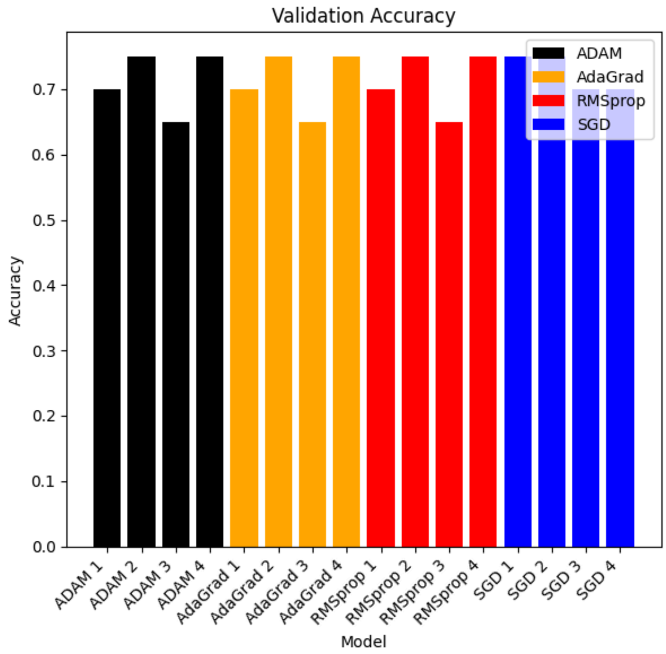
```
1/1 [==============================] - 0s 150ms/step - loss: 4.8459 - accuracy: 0.7500
Model 4 Hidden Layer RMSprop Optimizer Validation Accuracy: 0.75
1/1 [==============================] - 0s 36ms/step - loss: 5.7399 - accuracy: 0.4800
Best Model Test Accuracy: 0.47999998927116394
```

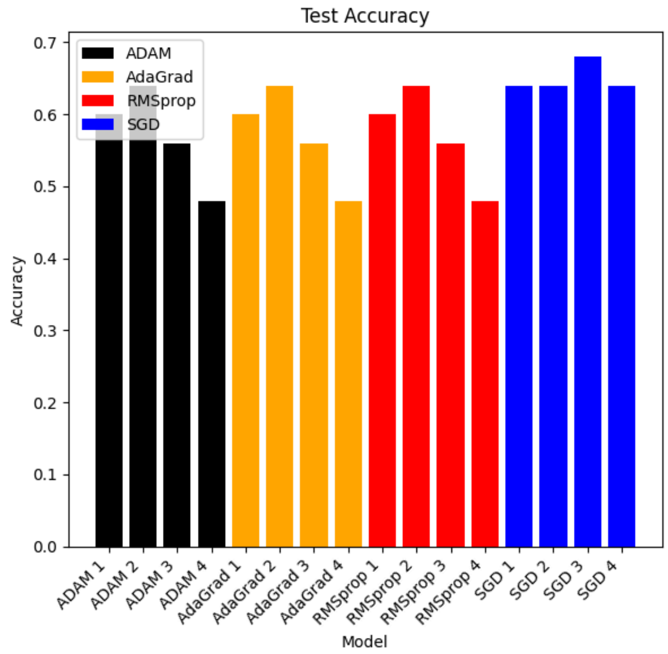
```
update_results('RMSprop', 4, val_acc, test_acc)
print(results_df)
```

```
   Optimizer Hidden Layers  Validation Accuracy  Test Accuracy
0        SGD             1                 0.75           0.64
1        SGD             2                 0.75           0.64
2        SGD             3                 0.70           0.68
3        SGD             4                 0.70           0.64
4       ADAM             1                 0.70           0.60
5       ADAM             2                 0.75           0.64
6       ADAM             3                 0.65           0.56
7       ADAM             4                 0.75           0.48
8    AdaGrad             1                 0.70           0.60
9    AdaGrad             2                 0.75           0.64
10   AdaGrad             3                 0.65           0.56
11   AdaGrad             4                 0.75           0.48
12   RMSprop             1                 0.70           0.60
13   RMSprop             2                 0.75           0.64
14   RMSprop             3                 0.65           0.56
15   RMSprop             4                 0.75           0.48
```

2.D Hasil Perbandingan Optimizer SGD, ADAM, AdaGrad, RMSprop

```
import matplotlib.pyplot as plt

# Membuat palet warna yang berbeda untuk setiap optimizer
colors = {'SGD': 'blue', 'Adam': 'green', 'AdaGrad': 'orange', 'RMSprop': 'red'}

# Membuat subplots
fig, axs = plt.subplots(nrows=1, ncols=2, figsize=(12, 6))

# Grafik akurasi validasi
for optimizer, group in results_df.groupby('Optimizer'):
    axs[0].bar(group['Optimizer'] + ' ' + group['Hidden Layers'].astype(str), group['Validation Accuracy'], color=colors.get(optimizer,
axs[0].set_title('Validation Accuracy')
axs[0].set_xlabel('Model', fontsize=10)  # Penyesuaian ukuran font
axs[0].set_ylabel('Accuracy')
axs[0].set_xticklabels(axs[0].get_xticklabels(), rotation=45, ha='right')  # Rotasi label sumbu x
axs[0].legend()

# Grafik akurasi pengujian
for optimizer, group in results_df.groupby('Optimizer'):
    axs[1].bar(group['Optimizer'] + ' ' + group['Hidden Layers'].astype(str), group['Test Accuracy'], color=colors.get(optimizer, 'blac
axs[1].set_title('Test Accuracy')
axs[1].set_xlabel('Model', fontsize=10)  # Penyesuaian ukuran font
axs[1].set_ylabel('Accuracy')
axs[1].set_xticklabels(axs[1].get_xticklabels(), rotation=45, ha='right')  # Rotasi label sumbu x
axs[1].legend()

# Menampilkan grafik
plt.tight_layout()
plt.show()
```






```
from IPython.display import display

# Menampilkan DataFrame
display(results_df)
```

	Optimizer	Hidden Layers	Validation Accuracy	Test Accuracy
0	SGD	1	0.75	0.64
1	SGD	2	0.75	0.64
2	SGD	3	0.70	0.68
3	SGD	4	0.70	0.64
4	ADAM	1	0.70	0.60
5	ADAM	2	0.75	0.64
6	ADAM	3	0.65	0.56
7	ADAM	4	0.75	0.48
8	AdaGrad	1	0.70	0.60
9	AdaGrad	2	0.75	0.64
10	AdaGrad	3	0.65	0.56
11	AdaGrad	4	0.75	0.48
12	RMSprop	1	0.70	0.60
13	RMSprop	2	0.75	0.64
14	RMSprop	3	0.65	0.56
15	RMSprop	4	0.75	0.48

Next steps: View recommended plots

```
# Temukan indeks baris dengan akurasi pengujian tertinggi dan terendah
best_model_idx = results_df['Test Accuracy'].idxmax()
worst_model_idx = results_df['Test Accuracy'].idxmin()

# Dapatkan informasi tentang model dengan akurasi pengujian tertinggi dan terendah
best_model_info = results_df.loc[best_model_idx]
worst_model_info = results_df.loc[worst_model_idx]

print("Model dengan akurasi pengujian tertinggi:")
print(best_model_info)
print("\nModel dengan akurasi pengujian terendah:")
print(worst_model_info)
```

```
Model dengan akurasi pengujian tertinggi:
Optimizer               SGD
Hidden Layers             3
Validation Accuracy     0.7
Test Accuracy          0.68
Name: 2, dtype: object

Model dengan akurasi pengujian terendah:
Optimizer              ADAM
Hidden Layers             4
Validation Accuracy    0.75
Test Accuracy          0.48
Name: 7, dtype: object
```

3. Menambahkan Dropout 50%

3.A Menambahkan Dropout di salah satu layer

```
# Function to build the DNN model with one hidden layer
def build_model_one_hidden_with_dropout():
    model = tf.keras.models.Sequential([
        tf.keras.layers.Dense(1000, activation='relu', input_shape=(X_train_scaled.shape[1],)),  # Hidden layer with 1000 neurons and R
        tf.keras.layers.Dropout(0.5),  # Dropout layer with dropout rate of 50%
        tf.keras.layers.Dense(len(label_encoder.classes_), activation='sigmoid')          # Output layer with sigmoid activation
    ])
    return model

# Function to build the DNN model with two hidden layer
def build_model_two_hidden_with_dropout():
    model = tf.keras.models.Sequential([
        tf.keras.layers.Dense(500, activation='relu', input_shape=(X_train_scaled.shape[1],)),  # 1st hidden layer with 500 neurons and
        tf.keras.layers.Dense(500, activation='relu'),                                  # 2nd hidden layer with 500 neurons and ReLU a
        tf.keras.layers.Dropout(0.5),  # Dropout layer with dropout rate of 50%
        tf.keras.layers.Dense(len(label_encoder.classes_), activation='sigmoid')         # Output layer with sigmoid activation
    ])
    return model

# Function to build the DNN model with three hidden layer
def build_model_three_hidden_with_dropout():
    model = tf.keras.models.Sequential([
        tf.keras.layers.Dense(250, activation='relu', input_shape=(X_train_scaled.shape[1],)),  # First hidden layer with 250 neurons a
        tf.keras.layers.Dense(250, activation='relu'),                                  # Second hidden layer with 250 neurons and ReL
        tf.keras.layers.Dense(250, activation='relu'),                                  # Third hidden layer with 250 neurons and ReLU
        tf.keras.layers.Dropout(0.5),  # Dropout layer with dropout rate of 50%
        tf.keras.layers.Dense(len(label_encoder.classes_), activation='sigmoid')         # Output layer with sigmoid activation
    ])
    return model

# Function to build the DNN model with four hidden layer
def build_model_four_hidden_with_dropout():
    model = tf.keras.models.Sequential([
        tf.keras.layers.Dense(100, activation='relu', input_shape=(X_train_scaled.shape[1],)),  # First hidden layer with 100 neurons a
        tf.keras.layers.Dense(100, activation='relu'),                                  # Second hidden layer with 100 neurons and ReL
        tf.keras.layers.Dense(100, activation='relu'),                                  # Third hidden layer with 100 neurons and ReLU
        tf.keras.layers.Dense(100, activation='relu'),                                  # Fourth hidden layer with 100 neurons and ReL
        tf.keras.layers.Dropout(0.5),  # Dropout layer with dropout rate of 50%
        tf.keras.layers.Dense(len(label_encoder.classes_), activation='sigmoid')         # Output layer with sigmoid activation
    ])
    return model
```

```
# Build the DNN model
model_one_hidden_layer_with_dropout = build_model_one_hidden_with_dropout()
model_two_hidden_layer_with_dropout = build_model_two_hidden_with_dropout()
model_three_hidden_layer_with_dropout = build_model_three_hidden_with_dropout()
model_four_hidden_layer_with_dropout = build_model_four_hidden_with_dropout()
```

SGD - Train and evaluate the model with 1 hidden Layer

```
# Melatih model dengan data pelatihan
# optimizer_sgd = tf.keras.optimizers.SGD(learning_rate=0.01)  # Define the optimizer with learning rate
model_one_hidden_layer_with_dropout.compile(optimizer='sgd', loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_one_hidden_layer_with_dropout.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_
```

```
8/8 [==============================] - 1s 79ms/step - loss: 5.8558e-04 - accuracy: 1.0000 - val_loss: 1.1739 - val_accuracy: 0.70
Epoch 73/100
8/8 [==============================] - 1s 79ms/step - loss: 4.9079e-04 - accuracy: 1.0000 - val_loss: 1.1782 - val_accuracy: 0.70
Epoch 74/100
8/8 [==============================] - 1s 81ms/step - loss: 2.2518e-04 - accuracy: 1.0000 - val_loss: 1.1786 - val_accuracy: 0.70
Epoch 75/100
8/8 [==============================] - 1s 79ms/step - loss: 3.3354e-04 - accuracy: 1.0000 - val_loss: 1.1845 - val_accuracy: 0.70
Epoch 76/100
8/8 [==============================] - 1s 115ms/step - loss: 5.0152e-04 - accuracy: 1.0000 - val_loss: 1.1772 - val_accuracy: 0.7
Epoch 77/100
8/8 [==============================] - 1s 122ms/step - loss: 7.3789e-04 - accuracy: 1.0000 - val_loss: 1.1779 - val_accuracy: 0.7
Epoch 78/100
8/8 [==============================] - 1s 113ms/step - loss: 5.8728e-04 - accuracy: 1.0000 - val_loss: 1.1733 - val_accuracy: 0.7
Epoch 79/100
8/8 [==============================] - 1s 82ms/step - loss: 3.0727e-04 - accuracy: 1.0000 - val_loss: 1.1747 - val_accuracy: 0.70
Epoch 80/100
8/8 [==============================] - 1s 84ms/step - loss: 4.9781e-04 - accuracy: 1.0000 - val_loss: 1.1800 - val_accuracy: 0.70
Epoch 81/100
8/8 [==============================] - 1s 80ms/step - loss: 5.1610e-04 - accuracy: 1.0000 - val_loss: 1.1792 - val_accuracy: 0.70
Epoch 82/100
8/8 [==============================] - 1s 80ms/step - loss: 5.5726e-04 - accuracy: 1.0000 - val_loss: 1.1780 - val_accuracy: 0.70
Epoch 83/100
8/8 [==============================] - 1s 80ms/step - loss: 6.1182e-04 - accuracy: 1.0000 - val_loss: 1.1858 - val_accuracy: 0.70
Epoch 84/100
8/8 [==============================] - 1s 76ms/step - loss: 2.7168e-04 - accuracy: 1.0000 - val_loss: 1.1866 - val_accuracy: 0.70
Epoch 85/100
8/8 [==============================] - 1s 78ms/step - loss: 4.7250e-04 - accuracy: 1.0000 - val_loss: 1.1848 - val_accuracy: 0.70
Epoch 86/100
8/8 [==============================] - 1s 74ms/step - loss: 6.0051e-04 - accuracy: 1.0000 - val_loss: 1.1894 - val_accuracy: 0.70
Epoch 87/100
8/8 [==============================] - 1s 78ms/step - loss: 1.0878e-04 - accuracy: 1.0000 - val_loss: 1.1900 - val_accuracy: 0.70
Epoch 88/100
8/8 [==============================] - 1s 77ms/step - loss: 1.4265e-04 - accuracy: 1.0000 - val_loss: 1.1905 - val_accuracy: 0.70
Epoch 89/100
8/8 [==============================] - 1s 81ms/step - loss: 1.9531e-04 - accuracy: 1.0000 - val_loss: 1.1915 - val_accuracy: 0.70
Epoch 90/100
8/8 [==============================] - 1s 82ms/step - loss: 5.5735e-04 - accuracy: 1.0000 - val_loss: 1.1944 - val_accuracy: 0.70
Epoch 91/100
8/8 [==============================] - 1s 76ms/step - loss: 3.8377e-04 - accuracy: 1.0000 - val_loss: 1.1936 - val_accuracy: 0.70
Epoch 92/100
8/8 [==============================] - 1s 81ms/step - loss: 2.2634e-04 - accuracy: 1.0000 - val_loss: 1.1932 - val_accuracy: 0.70
Epoch 93/100
8/8 [==============================] - 1s 75ms/step - loss: 6.8256e-04 - accuracy: 1.0000 - val_loss: 1.1876 - val_accuracy: 0.70
Epoch 94/100
8/8 [==============================] - 1s 84ms/step - loss: 2.3576e-04 - accuracy: 1.0000 - val_loss: 1.1886 - val_accuracy: 0.70
Epoch 95/100
8/8 [==============================] - 1s 121ms/step - loss: 4.7486e-04 - accuracy: 1.0000 - val_loss: 1.1939 - val_accuracy: 0.7
Epoch 96/100
8/8 [==============================] - 1s 134ms/step - loss: 3.8855e-04 - accuracy: 1.0000 - val_loss: 1.1892 - val_accuracy: 0.7
Epoch 97/100
8/8 [==============================] - 2s 306ms/step - loss: 5.5889e-04 - accuracy: 1.0000 - val_loss: 1.1921 - val_accuracy: 0.7
Epoch 98/100
8/8 [==============================] - 2s 245ms/step - loss: 1.2166e-04 - accuracy: 1.0000 - val_loss: 1.1930 - val_accuracy: 0.7
Epoch 99/100
8/8 [==============================] - 2s 237ms/step - loss: 3.7764e-04 - accuracy: 1.0000 - val_loss: 1.1937 - val_accuracy: 0.7
Epoch 100/100
8/8 [==============================] - 2s 281ms/step - loss: 3.9685e-04 - accuracy: 1.0000 - val_loss: 1.1931 - val_accuracy: 0.7
```

```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_one_hidden_layer_with_dropout.evaluate(X_val_scaled, y_val)
print("Model Validation Accuracy:", val_acc)

# Pilih model terbaik berdasarkan kinerja validasi
best_model = model_one_hidden_layer_with_dropout  # Misalnya, model pertama dianggap sebagai model terbaik
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 155ms/step - loss: 1.1931 - accuracy: 0.7000
Model Validation Accuracy: 0.699999988079071
1/1 [==============================] - 0s 46ms/step - loss: 1.4047 - accuracy: 0.6000
Best Model Test Accuracy: 0.6000000238418579
```

```
update_results('SGD+D', 1, val_acc, test_acc)
print(results_df)
```

```
   Optimizer Hidden Layers  Validation Accuracy  Test Accuracy
0        SGD             1                 0.75           0.64
1        SGD             2                 0.75           0.64
2        SGD             3                 0.70           0.68
3        SGD             4                 0.70           0.64
4       ADAM             1                 0.70           0.60
5       ADAM             2                 0.75           0.64
6       ADAM             3                 0.65           0.56
7       ADAM             4                 0.75           0.48
8    AdaGrad             1                 0.70           0.60
9    AdaGrad             2                 0.75           0.64
10   AdaGrad             3                 0.65           0.56
11   AdaGrad             4                 0.75           0.48
12   RMSprop             1                 0.70           0.60
13   RMSprop             2                 0.75           0.64
14   RMSprop             3                 0.65           0.56
15   RMSprop             4                 0.75           0.48
16     SGD+D             1                 0.70           0.60
```

3.B Menambahkan Dropout di semua layer

SGD - Train and evaluate the model with 2 hidden Layer

```
# Melatih model dengan data pelatihan
model_two_hidden_layer_with_dropout.compile(optimizer='sgd', loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_two_hidden_layer_with_dropout.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_
```

```
8/8 [==============================] - 0s 35ms/step - loss: 9.5807e-04 - accuracy: 1.0000 - val_loss: 0.8846 - val_accuracy: 0.75
Epoch 72/100
8/8 [==============================] - 0s 36ms/step - loss: 0.0012 - accuracy: 1.0000 - val_loss: 0.8832 - val_accuracy: 0.7500
```

SGD - Train and evaluate the model with 3 hidden Layer

```
# Melatih model dengan data pelatihan
model_three_hidden_layer_with_dropout.compile(optimizer='sgd', loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_three_hidden_layer_with_dropout.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y_
```

```
8/8 [==============================] - 0s 30ms/step - loss: 0.0013 - accuracy: 1.0000 - val_loss: 0.5991 - val_accuracy: 0.7500
Epoch 68/100
8/8 [==============================] - 0s 28ms/step - loss: 0.0018 - accuracy: 1.0000 - val_loss: 0.6068 - val_accuracy: 0.7500
Epoch 69/100
8/8 [==============================] - 0s 30ms/step - loss: 0.0011 - accuracy: 1.0000 - val_loss: 0.6076 - val_accuracy: 0.7500
Epoch 70/100
8/8 [==============================] - 0s 28ms/step - loss: 0.0016 - accuracy: 1.0000 - val_loss: 0.6072 - val_accuracy: 0.7500
Epoch 71/100
8/8 [==============================] - 0s 28ms/step - loss: 0.0019 - accuracy: 1.0000 - val_loss: 0.6099 - val_accuracy: 0.7500
Epoch 72/100
8/8 [==============================] - 0s 30ms/step - loss: 0.0015 - accuracy: 1.0000 - val_loss: 0.6122 - val_accuracy: 0.7500
Epoch 73/100
8/8 [==============================] - 0s 30ms/step - loss: 9.9485e-04 - accuracy: 1.0000 - val_loss: 0.6128 - val_accuracy: 0.75
Epoch 74/100
8/8 [==============================] - 0s 31ms/step - loss: 0.0015 - accuracy: 1.0000 - val_loss: 0.6145 - val_accuracy: 0.7500
Epoch 75/100
8/8 [==============================] - 0s 35ms/step - loss: 0.0013 - accuracy: 1.0000 - val_loss: 0.6148 - val_accuracy: 0.7500
Epoch 76/100
8/8 [==============================] - 0s 27ms/step - loss: 0.0011 - accuracy: 1.0000 - val_loss: 0.6167 - val_accuracy: 0.7500
Epoch 77/100
8/8 [==============================] - 0s 20ms/step - loss: 0.0021 - accuracy: 1.0000 - val_loss: 0.6203 - val_accuracy: 0.7500
Epoch 78/100
8/8 [==============================] - 0s 21ms/step - loss: 0.0025 - accuracy: 1.0000 - val_loss: 0.6229 - val_accuracy: 0.7500
Epoch 79/100
8/8 [==============================] - 0s 20ms/step - loss: 0.0013 - accuracy: 1.0000 - val_loss: 0.6250 - val_accuracy: 0.7500
Epoch 80/100
8/8 [==============================] - 0s 18ms/step - loss: 0.0015 - accuracy: 1.0000 - val_loss: 0.6224 - val_accuracy: 0.7500
Epoch 81/100
8/8 [==============================] - 0s 19ms/step - loss: 0.0019 - accuracy: 1.0000 - val_loss: 0.6244 - val_accuracy: 0.7500
Epoch 82/100
8/8 [==============================] - 0s 19ms/step - loss: 0.0018 - accuracy: 1.0000 - val_loss: 0.6281 - val_accuracy: 0.7500
Epoch 83/100
8/8 [==============================] - 0s 18ms/step - loss: 8.9276e-04 - accuracy: 1.0000 - val_loss: 0.6284 - val_accuracy: 0.75
Epoch 84/100
8/8 [==============================] - 0s 18ms/step - loss: 0.0013 - accuracy: 1.0000 - val_loss: 0.6276 - val_accuracy: 0.7500
Epoch 85/100
8/8 [==============================] - 0s 21ms/step - loss: 0.0014 - accuracy: 1.0000 - val_loss: 0.6264 - val_accuracy: 0.7500
Epoch 86/100
8/8 [==============================] - 0s 19ms/step - loss: 0.0018 - accuracy: 1.0000 - val_loss: 0.6280 - val_accuracy: 0.7500
Epoch 87/100
8/8 [==============================] - 0s 19ms/step - loss: 0.0012 - accuracy: 1.0000 - val_loss: 0.6297 - val_accuracy: 0.7500
Epoch 88/100
8/8 [==============================] - 0s 20ms/step - loss: 0.0019 - accuracy: 1.0000 - val_loss: 0.6326 - val_accuracy: 0.7500
Epoch 89/100
8/8 [==============================] - 0s 18ms/step - loss: 0.0015 - accuracy: 1.0000 - val_loss: 0.6343 - val_accuracy: 0.7500
Epoch 90/100
8/8 [==============================] - 0s 18ms/step - loss: 0.0013 - accuracy: 1.0000 - val_loss: 0.6375 - val_accuracy: 0.7500
Epoch 91/100
8/8 [==============================] - 0s 25ms/step - loss: 0.0020 - accuracy: 1.0000 - val_loss: 0.6343 - val_accuracy: 0.7500
Epoch 92/100
8/8 [==============================] - 0s 19ms/step - loss: 0.0014 - accuracy: 1.0000 - val_loss: 0.6361 - val_accuracy: 0.7500
Epoch 93/100
8/8 [==============================] - 0s 19ms/step - loss: 0.0011 - accuracy: 1.0000 - val_loss: 0.6367 - val_accuracy: 0.7500
Epoch 94/100
8/8 [==============================] - 0s 21ms/step - loss: 6.3100e-04 - accuracy: 1.0000 - val_loss: 0.6379 - val_accuracy: 0.75
Epoch 95/100
8/8 [==============================] - 0s 18ms/step - loss: 8.1607e-04 - accuracy: 1.0000 - val_loss: 0.6384 - val_accuracy: 0.75
Epoch 96/100
```

```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_two_hidden_layer_with_dropout.evaluate(X_val_scaled, y_val)
print("Model 2 Hidden Layer SGD Optimizer Validation Accuracy:", val_acc)

# 5. Pilih model terbaik berdasarkan kinerja validasi
best_model = model_two_hidden_layer_with_dropout  # Misalnya, model pertama dianggap sebagai model terbaik

# 6. Evaluasi akhir menggunakan data pengujian
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 153ms/step - loss: 0.9057 - accuracy: 0.7500
Model 2 Hidden Layer SGD Optimizer Validation Accuracy: 0.75
1/1 [==============================] - 0s 38ms/step - loss: 0.9844 - accuracy: 0.6000
Best Model Test Accuracy: 0.6000000238418579
```

```
update_results('SGD+D', 2, val_acc, test_acc)
print(results_df)
```

```
   Optimizer Hidden Layers  Validation Accuracy  Test Accuracy
0        SGD             1                 0.75           0.64
1        SGD             2                 0.75           0.64
2        SGD             3                 0.70           0.68
3        SGD             4                 0.70           0.64
4       ADAM             1                 0.70           0.60
5       ADAM             2                 0.75           0.64
6       ADAM             3                 0.65           0.56
7       ADAM             4                 0.75           0.48
8    AdaGrad             1                 0.70           0.60
9    AdaGrad             2                 0.75           0.64
10   AdaGrad             3                 0.65           0.56
11   AdaGrad             4                 0.75           0.48
12   RMSprop             1                 0.70           0.60
13   RMSprop             2                 0.75           0.64
14   RMSprop             3                 0.65           0.56
15   RMSprop             4                 0.75           0.48
16     SGD+D             1                 0.70           0.60
17     SGD+D             2                 0.75           0.60
```

```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_three_hidden_layer_with_dropout.evaluate(X_val_scaled, y_val)
print("Model 3 Hidden Layer SGD Optimizer Validation Accuracy:", val_acc)

# Pilih model terbaik berdasarkan kinerja validasi
best_model = model_three_hidden_layer_with_dropout  # Misalnya, model pertama dianggap sebagai model terbaik

# Evaluasi akhir menggunakan data pengujian
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 152ms/step - loss: 0.6483 - accuracy: 0.7500
Model 3 Hidden Layer SGD Optimizer Validation Accuracy: 0.75
1/1 [==============================] - 0s 31ms/step - loss: 1.0951 - accuracy: 0.5600
Best Model Test Accuracy: 0.5600000023841858
```

```
update_results('SGD+D', 3, val_acc, test_acc)
print(results_df)
```

```
   Optimizer Hidden Layers  Validation Accuracy  Test Accuracy
0        SGD             1                 0.75           0.64
1        SGD             2                 0.75           0.64
2        SGD             3                 0.70           0.68
3        SGD             4                 0.70           0.64
4       ADAM             1                 0.70           0.60
5       ADAM             2                 0.75           0.64
6       ADAM             3                 0.65           0.56
7       ADAM             4                 0.75           0.48
8    AdaGrad             1                 0.70           0.60
9    AdaGrad             2                 0.75           0.64
10   AdaGrad             3                 0.65           0.56
11   AdaGrad             4                 0.75           0.48
12   RMSprop             1                 0.70           0.60
13   RMSprop             2                 0.75           0.64
14   RMSprop             3                 0.65           0.56
15   RMSprop             4                 0.75           0.48
16     SGD+D             1                 0.70           0.60
17     SGD+D             2                 0.75           0.60
18     SGD+D             3                 0.75           0.56
```

SGD - Train and evaluate the model with 4 hidden Layer

```
# Melatih model dengan data pelatihan
model_four_hidden_layer_with_dropout.compile(optimizer='sgd', loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model_four_hidden_layer_with_dropout.fit(X_train_scaled, y_train, epochs=100, batch_size=10, validation_data=(X_val_scaled, y
```

```
Epoch 80/100
8/8 [==============================] - 0s 11ms/step - loss: 0.0011 - accuracy: 1.0000 - val_loss: 1.0470 - val_accuracy: 0.7500
Epoch 81/100
8/8 [==============================] - 0s 11ms/step - loss: 0.0044 - accuracy: 1.0000 - val_loss: 1.0506 - val_accuracy: 0.7500
Epoch 82/100
8/8 [==============================] - 0s 11ms/step - loss: 0.0070 - accuracy: 1.0000 - val_loss: 1.0515 - val_accuracy: 0.8000
Epoch 83/100
8/8 [==============================] - 0s 11ms/step - loss: 0.0029 - accuracy: 1.0000 - val_loss: 1.0564 - val_accuracy: 0.8000
Epoch 84/100
8/8 [==============================] - 0s 13ms/step - loss: 0.0011 - accuracy: 1.0000 - val_loss: 1.0600 - val_accuracy: 0.8000
Epoch 85/100
8/8 [==============================] - 0s 14ms/step - loss: 7.7562e-04 - accuracy: 1.0000 - val_loss: 1.0611 - val_accuracy: 0.80
Epoch 86/100
8/8 [==============================] - 0s 13ms/step - loss: 0.0079 - accuracy: 1.0000 - val_loss: 1.0606 - val_accuracy: 0.8000
Epoch 87/100
8/8 [==============================] - 0s 14ms/step - loss: 0.0011 - accuracy: 1.0000 - val_loss: 1.0627 - val_accuracy: 0.8000
Epoch 88/100
8/8 [==============================] - 0s 11ms/step - loss: 0.0022 - accuracy: 1.0000 - val_loss: 1.0628 - val_accuracy: 0.8000
Epoch 89/100
8/8 [==============================] - 0s 11ms/step - loss: 0.0010 - accuracy: 1.0000 - val_loss: 1.0659 - val_accuracy: 0.8000
Epoch 90/100
8/8 [==============================] - 0s 11ms/step - loss: 0.0021 - accuracy: 1.0000 - val_loss: 1.0690 - val_accuracy: 0.8000
Epoch 91/100
8/8 [==============================] - 0s 13ms/step - loss: 0.0014 - accuracy: 1.0000 - val_loss: 1.0719 - val_accuracy: 0.8000
Epoch 92/100
8/8 [==============================] - 0s 11ms/step - loss: 0.0026 - accuracy: 1.0000 - val_loss: 1.0769 - val_accuracy: 0.8000
Epoch 93/100
8/8 [==============================] - 0s 13ms/step - loss: 0.0012 - accuracy: 1.0000 - val_loss: 1.0800 - val_accuracy: 0.8000
Epoch 94/100
8/8 [==============================] - 0s 11ms/step - loss: 0.0019 - accuracy: 1.0000 - val_loss: 1.0837 - val_accuracy: 0.8000
Epoch 95/100
8/8 [==============================] - 0s 11ms/step - loss: 0.0014 - accuracy: 1.0000 - val_loss: 1.0843 - val_accuracy: 0.8000
Epoch 96/100
8/8 [==============================] - 0s 12ms/step - loss: 0.0013 - accuracy: 1.0000 - val_loss: 1.0889 - val_accuracy: 0.8000
Epoch 97/100
8/8 [==============================] - 0s 12ms/step - loss: 0.0028 - accuracy: 1.0000 - val_loss: 1.0913 - val_accuracy: 0.8000
Epoch 98/100
8/8 [==============================] - 0s 14ms/step - loss: 0.0022 - accuracy: 1.0000 - val_loss: 1.0982 - val_accuracy: 0.8000
Epoch 99/100
8/8 [==============================] - 0s 11ms/step - loss: 0.0016 - accuracy: 1.0000 - val_loss: 1.1022 - val_accuracy: 0.8000
Epoch 100/100
8/8 [==============================] - 0s 11ms/step - loss: 0.0013 - accuracy: 1.0000 - val_loss: 1.1056 - val_accuracy: 0.8000
```

```
# Mengevaluasi kinerja model menggunakan data validasi
val_loss, val_acc = model_four_hidden_layer_with_dropout.evaluate(X_val_scaled, y_val)
print("Model 3 Hidden Layer SGD Optimizer Validation Accuracy:", val_acc)

# Pilih model terbaik berdasarkan kinerja validasi
best_model = model_four_hidden_layer_with_dropout  # Misalnya, model pertama dianggap sebagai model terbaik

# Evaluasi akhir menggunakan data pengujian
test_loss, test_acc = best_model.evaluate(X_test, y_test)
print("Best Model Test Accuracy:", test_acc)
```

```
1/1 [==============================] - 0s 154ms/step - loss: 1.1056 - accuracy: 0.8000
Model 3 Hidden Layer SGD Optimizer Validation Accuracy: 0.800000011920929
1/1 [==============================] - 0s 29ms/step - loss: 1.4271 - accuracy: 0.5200
Best Model Test Accuracy: 0.5199999809265137
```

```
update_results('SGD+D', 4, val_acc, test_acc)
print(results_df)
```

	Optimizer	Hidden Layers	Validation Accuracy	Test Accuracy
0	SGD	1	0.75	0.64
1	SGD	2	0.75	0.64
2	SGD	3	0.70	0.68
3	SGD	4	0.70	0.64
4	ADAM	1	0.70	0.60
5	ADAM	2	0.75	0.64
6	ADAM	3	0.65	0.56
7	ADAM	4	0.75	0.48
8	AdaGrad	1	0.70	0.60
9	AdaGrad	2	0.75	0.64
10	AdaGrad	3	0.65	0.56
11	AdaGrad	4	0.75	0.48
12	RMSprop	1	0.70	0.60
13	RMSprop	2	0.75	0.64
14	RMSprop	3	0.65	0.56
15	RMSprop	4	0.75	0.48
16	SGD+D	1	0.70	0.60
17	SGD+D	2	0.75	0.60
18	SGD+D	3	0.75	0.56
19	SGD+D	4	0.80	0.52

3.C Hasil Penambahan Dropout 50%

```
from IPython.display import display

# Menampilkan DataFrame
display(results_df)
```

	Optimizer	Hidden Layers	Validation Accuracy	Test Accuracy
0	SGD	1	0.75	0.64